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ALLELOCHEMICALS FROM SOME MEDICINAL AND AROMATIC PLANTS AND THEIR POTENTIAL USE AS BIOHERBICIDES

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وَالْبَلَدُ الطَّيِّبُ يَخْرُجُ نَبَاتُهُ بِإِذْنِ رَبِّهِ
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نُصَرِّفُ الآيَاتِ لِقَوْمٍ يَشْكُرُونَ

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DECLARATION

This thesis has not been previously submitted for a degree at this or any other university, and is the original work of the writer

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ABSTRACT

The aim of the present study was to investigate the potential allelopathic effects of *Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata* (donor species) aqueous extract and crude powder on germination efficiency and some growth parameters of two weeds (*Bromus tectorum* and *Melilotus indica*) and one crop species (*Triticum aestivum*) under laboratory conditions to have the greatest inhibitory allelopathic effect on all the recipient species in mixed culture compared to that pure culture. The germination percentage, plumule and radicle length of *Bromus tectorum* in mixed culture was completely inhibited at the highest concentration of aqueous extracts of the donor species level (10%). the two recipient species exerted weak measures as affected by the highest concentration level of all donors in pure culture. This inhibition was markedly in obvious *Bromus tectorum* than in *Melilotus indica* indicating that *Bromus tectorum* is more sensitive to all of tested donors, while the *Melilotus indica* is more adapted to the aqueous extract than the *Bromus tectorum*. The growth parameters of two recipient species were significantly decreased with the increase of each of the eight donor species crude powder concentration levels. Concerning the type of sol the t- test indicated that the difference was insignificant between clay and sandy soils.

The domineering effect of crude powder of all donors on the two weeds species was in the following order *Bromus tectorum*> Melilotus *indica* .However, the effect was more prominent on weeds than crop species (*Triticum aestivum*)**.**

The inhibitory allelopathic effect of aqueous extract and crude powder of the donor species were differently affected. Evidently, the variant response to the allelopathic substance could be related to the species specific ,growth regulatory effect of allelochemicals and concentration dependent.

In conclusion, the species with the strongest allelopathic potential such as *Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata* must be examined for their allelopathic activity. The isolation and characterization of growth inhibitors, which might be responsible for the strong allelopathic potential of these species is needed. There is possibility of using these allelochemicals directly or as structural leads for the discovery and development of environment friendly herbicides to control weeds. We hope that the study will provide information on the possibilities of using one or more of the donor species as bioherbicides.

الملخص

تهدف هذه الدراسة إلى التعرف علي التأثيرات الكيميائية التضادية (الأليلوباثية) للمستخلصات المائية و المسحوق الجاف للمجموع الخضرى لنبات *Retama retam, Euphorbia guyoniana, Zygophyllum album* , *Oudneya , Artemisia herba-alba, Haloxylon scoparium,Pituranthos chloranthus africana* و*Ephedra alata* (الانواع المانحة) على نسبة الإنبات ونمو البادرات لاثنين من الحشائش الضارة وهما (*Bromus tectorum* و*Melilotus indica*) ونوع واحد من المحاصيل الحقلية و هو القمح اللين *Triticum aestivum*) (الانواع المستقبلة) وذلك تحت الظروف المعملية لمعرفة التأثير الأليلوباثي للأنواع المستقبلة .

اوضحت التجارب بان نسبة الانبات وسرعته ونسبة التثبيط الانبات للنباتين المستقبلين (الاعشاب الضارة) قد تناقصت بزيادة تراكيز المستخلصات للنباتات المانحة حيث ان *Bromus tectorum* كان اكثر تأثر من *Melilotus indica* .نسبة الانبات وطول الريشة وجذيرعند *Bromus tectorum* في الزراعة المختلطة تم تثبطهم كليا عند التركيز العالي للمستخلص المائي للنباتات المانحة (10%) , من ناحية اخرى تبين بان الجذير اكثر تأثر من الريشة.بالنسبة للزراعة النقية فان النباتين المستقبلين قد تاثرا بالتراكيز العالية لكل النباتات المانحة ,هذا التاثير كان واضح عند *Bromus tectorum* اكثر من *Melilotus indica* حيث توضح بان *Bromus tectorum* حساس جدا لكل النباتات المانحة المدروسة في حين ان *Melilotus indica* اكثر تاقلم للمستخلصات النباتية المستعملة .

كما اتضح بان معايير النمو لكل من النباتين المستقبلين كان تناقصها معنوى مع تزايد تركيز المسحوق الجاف للنباتات المانحة حيث ان الفعل التثبيطي للانواع المانحة على *Bromus tectorum* اكثر تاثر من *Melilotus indica* لكن هذا التاثير كان اكثر وضوح عند الاعشاب الضارة اكتر من المحصول (القمح) .اما بالنسبة لتاثير نوع التربة فان اختبار tبين بانه لا يوجد فرق معنوي بين التربة الطينية والرملية.

التأثير الاليلوباثي التثبيطي للمستخلصات المائية والمسحوق الجاف للنباتات المانحة كان تاثيره مختلف, عموما هذا الاختلاف في الاستجابة الى المواد الليولوباثية يعود اما الى الاختلاف في تاثير المواد الكيميائية التضادية و تركيزها وكذلك الى النوع النباتي المستقبل .

واخيرا نوصي بضرورة اجراء دراسات أوسع وأكثر تفصيلا للانواع النباتية المانحة ذات التأثير الأليلوباثي واختبار تأثيرها على أنواع نباتية أخرى تشمل المحاصيل والحشائش تحت ظروف الحقل، والحاجة الى فصل والتعرف على مثبطات النمو التى قد تكون مسئولة عن التأثير الأليلوباثي لهذه الانواع، ودراسة امكانية استخدام هذه المركبات الأليلوباثية اما بطريقة مباشرة أو بمعرفة تراكيبها الكيميائية و محاولة اكتشاف وتطوير مبيدات للحشائش أمنة بيئيا.

RESUME

La présente étude visait à étudier les effets potentiels allélopathiques du *Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* et *Ephedra alata* extrait aqueux et poudre sec sur l'efficacité de germination et de certains paramètres de croissance de deux mauvaises herbes (*Bromus tectorum* et *Melilotus indica*) et une espèce de culture (*Triticum aestivum*) sous conditions de laboratoire pour avoir l`effet allelopathique inhibiteur sur les espèces récepteurs en culture mixte et a celui de culture pure . Le pourcentage de germination, longueur plumule et la radicule du *Bromus tectorum* en culture mixte a été complètement inhibée au niveau de la maximale concentration d'extraits aqueux les espèces donneurs (10%). en culture pure les deux espèces bénéficiaires ont été affectée par le niveau le plus élevé de concentration de tous les donateurs. Cette inhibition a été marquée en *Bromus tectorum* évident que dans *Melilotus indica* indiquant que *Bromus tectorum* est plus sensible à l'ensemble des donneurs testés, tandis que le *Melilotus indica* est plus adapté à l'extrait aqueux que le *Bromus tectorum*. Les paramètres de croissance de deux espèces de bénéficiaires ont été significativement diminués avec l'augmentation de chaque niveau de concentration de poudre des espèces donneuses. Concernant les types de sol le test -t indique que la différence était non significatifs entre le sol argileux et sableux. L'effet suppressif de l'ensemble des espèces donateurs sur les deux espèces de mauvaises herbes ont été dans l'ordre suivant *Bromus tectorum> Melilotus indica*. Mais l`effet a été plus important sur les mauvaises herbe que la plante cultivée (*Triticum aestivum*)**.**

L'effet d'allélopathie inhibiteur des extraits aqueux et les poudres sec des espèces donneuses ont été affectés différemment. Evidemment, la variation des réponses des substances allélopathique pourrait être liée à l'effet allélochimiques, leur concentration et a les espèces réceptrices.

En conclusion, l'espèce avec une fort potentiel allélopathique doit être examinée pour leur activité allélopathique. L'isolement et la caractérisation d'inhibiteurs de croissance, qui pourrait être responsable de le fort potentiel allélopathique de ces espèces est nécessaire. Il ya possibilité d'utiliser ces effets allélochimiques directement ou conduit comme structurelle pour la découverte et le développement des herbicides respectueux de l'environnement pour contrôler les mauvaises herbes. Nous espérons que cette étude fournira des informations sur les possibilités d'utiliser une ou plusieurs espèces donateurs comme bioherbicides.

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INTRODUCTION

INTRODUCTION

The term Allelopathy was coined by Prof. Hans Molisch in 1937, combining two Greek words “allelo” and “pathos” literally meaning “mutual suffering”. Based on that concept **Rice (1984)** defined allelopathy as the direct or indirect harmful or beneficial effects of one plant or another through the production of chemical compounds that escape into the environment. Hence, International Allelopathy Society in 1996, broadened the definition so that the term allelopathy refers to any process involving secondary metabolites (allelochemicals) produced by plants, microorganisms, viruses and fungi that influence the growth and development of agricultural and biological systems including positive and negative effects. Allelochemicals from plants are released into the environment by exudation from roots, leaching from stems and leaves or decomposition of plant material **(Rice, 1984; Lovett and Ryuntyu, 1992; Rizvi and Rizvi, 1992)**.

Plants or organisms that release these compounds are called “donor species”, while those that are influenced in their growth and development are called “target or recipient species”. Allelopathy includes plant-plant, plant-microorganisms, plant-virus, plant-insects, and plant-soil-plant chemical interactions. Allelopathic effects can be stimulatory or inhibitory, depending on the identity of the active compound on the static and dynamic availability, persistence and fate of organics in the environment and on the particular target species (**Torres *et al*., 1996; Inderjit and Keating, 1999)**.

Allelopathy offers the potential for biorational weed control through the production and release of allelochemicals from leaves, flowers, seeds, stems and roots of living or decomposing plant materials (**Weston, 1996**). Also, allelopathy is generally accepted as a significant ecological factor in determining the structure and composition of plant communities (**Scrivanti *et al*., 2003**).

Plants compete with each other for light, water and nutrients. Production of secondary metabolites, accumulation and release of these compounds is one of several complex defense strategies that have evolved by plants (**Rice, 1984; Swain, 1977**)**.** There are hundreds of secondary metabolites in the plant kingdom and many are known to be phytotoxic (**Einhellig, 2002**).

A variety of allelochemicals are plant secondary metabolites for medicinal and aromatic plants (**Delabys *et al*., 1998**) ; have been identified, including the phenolic acids, coumarins, terpenoids, flavoniods, alkaloids, glycosides and glucosinolates. These chemical substance (phytotoxic) are known to be exuded by plants to suppress emergence or growth of the other

plants; that are submitted to biological and toxicological screens to identify their potential as natural herbicide (**Carlos *et al*., 2006**).

Allelochemicals leached from the aerial parts of donor plants finally enter into the soil. In many situations, the chemicals may reach other plants (recipients) through transport from the donor plants in the soil and may induce the inhibitory or stimulatory activity on the recipient plants. In addition to the physicochemical property of the allelochemical, phytotoxic activity may be affected by many factors. These include soil and plant factors of both the donor and recipient plants, all of which are influenced by meteorological factors. Thus, it is indicated that allelopathy is a complicated phenomenon, and it is difficult to separate the allelopathic effects from other competition and/or interaction events among plants (**Qasem and Hill 1989; Wardle *et al*. 1992; Duke *et al*. 2000a; Inderjit *et al*. 2001**).

In general, allelochemicals from plants are considered to be safe and beneficial to the environment and mankind, unlike synthetic chemical herbicides widely used which may pollute water and soil in crop ecosystems, causing harm to mankind health. It was reported that buckwheat (*Fagopyrum esculentum* Moench.) (**Yoshino *et al*., 2000**), alfalfa (*Medicago sativa* L.) (**Chung and Miller, 1995b; Tsuzuki *et al*., 1999a, Zein El-Dien, 2010**), sunflower (*Helianthus annuus* L.) (**Leather, 1983**), residue of hairy vetch (*Vicia villosa* Roth.) (**Teasdale, 1988**) and kava (*Piper methysticum* L.) (**Ogushi *et al*., 2000**) possessed inhibitory effects on selected weeds.

The interaction of plants through chemical signals has many possible agricultural applications including crop-weed interactions, cropping sequences, compatibility of legume-grass mixtures and expanded potential for genetic improvements of crop plants. Utilization of allelopathy in cropping systems, however, will depend on better understanding of the chemical or chemicals involved and their behavior in natural and agricultural ecosystems (**Mallik and Williams, 2009**).

The weed have allelopathic superiority over crops besides their competition superiority (**Zzet and Yusuf, 2004)**. In allelopathy, relations between weeds and crops, between weeds and weeds and between crops and crops (**Rice, 1984; Narwal, 1994)**. because the modern agriculture relays on synthetic chemicals to get rid of these unwanted plants. Contemporary research in allelopathy focuses on isolating, identifying and quantifying specific active allelochemicals. Once these substances are identified and characterized they can be used either as natural herbicides (**Tehmina *et al*., 2005**).

A number of plant species have been reported to possess allelopathic activity on the growth of other plant species (**Narwal, 1999; Duke *et al*., 2000b**). Allelopathic effects of these compounds are often observed to occur early in the life cycle, causing inhibition of seed germination and seedling growth. These compounds exhibit a wide range of mechanisms of action and interpretations of mechanisms of action are complicated by the fact that individual compounds can have multiple phytotoxic effects (**Einhellig, 2002**).

At present, there is a trend towards searching for novel natural plant products to develop bio-herbicides. Numerous plants are reported to possess allelopathic potential and efforts have been made to apply them for weed control. Although most common allelopathic plants have potential for weed suppression, their effects are usually short-lived and weeds re-emerge (**Xuan *et al*., 2004**). Furthermore, to successfully suppress the initial growth of weeds, a large amount of plant material (at least 1–2 t ha^{-1}) needs to be added to the soil. This would require a large labour force. The isolation and identification of allelochemicals in higher plants has been attempted, but the identified allelochemicals were mostly in low concentrations and interactive. Currently, only a few natural products such as cineole (cinmethylene, Shell, USA), leptospermones (triketones, Zeneca) and benzoxazinones and quinolinic acid (BASF, Germany) have been marketed (**Kohli *et al*., 1998; Dayan *et al*., 1999**). These products are used in agricultural practices and show promising results. It is estimated that there are about 1,400,000 compounds in plants with allelopathic activities, of which only 3% have been examined (**Einhellig and Leather, 1988**).

Medicinal plant, had inhibitory effects (**Lin *et al*., 2003, 2004**) on selected weeds and its allelochemicals inhibiting weed growth was identified (**Lin et al., 2004**). In addition, the previous results (**Fujii *et al*., 1991, 2003**).confirmed that it was easier to screen allelopathic plants from medicinal plants than other plants possibly because there existed certain metabolic compounds curing many diseases of mankind in medicinal plants.

The present study was designed to achieve the following objectives:

- To determine the allelopathic effects of eight donor species (*Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata*) on two weedy species; *Bromus tectorum* and *Melilotus indica* and one crop species; wheat (*Triticum aestivum)*.
- To look into possibility to exploited for the development of bio-herbicides for minimizing the use of synthetic herbicides.

LITERATURE REVIEW

LITERATURE REVIEW

1. Background of Allelopathy

Knowledge about interactions between plants has been gathered for over two thousand years. As Rice indicates, there are many examples described by botanists, farmers and gardeners that strongly suggest allelopathic interactions among plants (**Rice, 1984**). Theophrastus (300 B.C.) observed the destruction of weeds by chickpea (*Cicer arietinum*) plants. The Roman Pliny (Plinius Secundus) in 1A.D. reported that chickpea, barley (*Hordeum vulgare*), fenugreek (*Trigonella foenumgraecum*), and bitter vetch (*Vicia ervilia*) destroy or burn up farmland (**Rice, 1984**). He also described the shade of black walnut (*Juglan, spp*) as heavy and believed that walnut and its residues could cause potential injury to man and anything planted in the vicinity. In the 1600's several naturalists noted in the English literature that certain plants do not grow well in the presence of each other. The Japanese literature also shows examples of plants causing injury to others due to the production of toxic compounds with rainfall, specifically Japanese red pine (*Pine densiflora*) (**Rice, 1984**).

In the 1800's, agronomists started to note problems with repeated cropping of some perennials. For example, Young in 1804, discovered that clover was apt to fail in some regions of England where it was cultivated constantly due to soil sickness, which accrues over time. De Candolle as first performed experiments and suggested that soil sickness, that is the impossibility for a crop to succeed to itself may be due to the toxicity associated with root exudates (**DeCandolle, 1832**). In 1881, Stickney and Hoy observed that vegetation under black walnut was very sparse in pasture settings, and pointed out that this might be due to high mineral requirement of the tree, or to the poisonous character of the moisture dripping off the tree itself (**Stickney and Hoy, 1881**). It is interesting to note that many of the species demonstrated to have powerful medicinal effects on humans also have been subsequently demonstrated to have powerful allelopathic effects as well (**Rice, 1984**; **Chevallier, 1996; Wink, 1999**).

Interest in the field of allelopathy revived again in the 20th century, with the development of effective techniques of extraction, bioassay, and chemical isolation and identification (**Willis, 1997**).

Mc Calla and co-workers published a series of papers from 1948 until 1965 that described allelochemicals produced from plant residues and the importance of the interaction of microbes upon the decomposition of these residues (**Putnam and Weston, 1986**).

Two outstanding contributors to the field of allelopathy during this period also included. Muller and hisassociates at Santa Barbara, California who published many articles on volatile inhibitors produced by plants growing in the chaparral and desert. Later, Elroy Rice at the University of Oklahoma contributed with many papers documenting allelopathy in prairie type ecosystems of the central U.S.A. and described impacts of allelochemicals on nitrifying and nitrogen fixing bacteria in the soil rhizosphere (**Rice, 1984; Putnam and Weston, 1986**). Rick Willis completed an exhaustive review that thoroughly documented the history and the science of allelopathy as a field of research. Some of his work has been published in the Allelopathy Journal (**Willis, 1997; Willis 2000**). In the twenty one century, the number of publications in the field of allelopathy has increased exponentially as physiologists, soil scientists, weed scientists and natural products chemists continue to study this challenging area (**Macias, 2002**). In 1994 the International Allelopathy Society was formed. The association is organized for scientific purposes, specifically to promote the cooperation and collaboration between scientists in the field of allelopathy. Allelopathy research can pull different disciplines together to make sustainable agriculture a success, and many international conferences have been organized to forge ahead with renewed enthusiasm in allelopathy research.

Allelopathic effects extend beyond mere plant suppression to include: vegetation patterns, seed preservation and germination of fungal spores, the nitrogen cycle, mutualistic associations, crop productivity and plant defense (**Einhellig, 1995a**). Recently, researches demonstrated critical cases of seed and growth inhibition by allelochemicals that influenced vegetation patterns, rate and sequences in plant succession, weed abundance, crop productivity, and problems in replanting fruit and other crops (**El-Darier, 2002; El-Darier and Youssef, 2007; El-Darier and Tammam, 2009; Hatata and El-Darier, 2009**).

Plants or organisms that release these compounds are called “donor species”, while those that are influenced in their growth and development are called “target species”. Allelopathy includes plant-plant, plant-microorganisms, plant-virus, plant-insects, and plant-soil-plant chemical interactions. Allelopathic effects can be stimulatory or inhibitory, depending on the identity of the active compound on the static and dynamic availability,

persistence and fate of organics in the environment and on the particular target species (**Inderjit and Keating, 1999**).

Chemicals released from plants and imposing allelopathic influences are known as allelochemicals. Most allelochemicals are classified as secondary metabolites from acetate or the shikimic acid pathway ranged in structure from simple hydrocarbons to complex polycyclic aromatics such as phenolic compounds, tannins, flavonoids, terpenoids, alkaloids, steroids, quinons and glycosides (**Corcuera, 1993; Niemeyer, 1998; Inderjit and Malik, 2002**). Almost every class of secondary plant products has been implicated to take part in allelopathic interference (**Weston and Duke, 2003**). The term "allelochemical" relates to the role the compound plays, but not to the actual chemical identity, since depending on an organism or specific environmental parameters, the same compound may some times acts as an allelochemical and at other times or places can share other roles (**Inderjit and Duke, 2003**). There are hundreds of secondary metabolites in the plant kingdom and many are known to be phytotoxic (**Einhellig, 2002**). For allelopathy to occur, chemicals must be transferred from one organism to another (**Einhellig, 1995a**). Several phytotoxic substances (allelochemicals) suspected of causing germination and growth inhibition has been identified from plant tissues and soils. The phytotoxic activity of allelochemicals, once outside the plant, is modified by biological abiotic factors occur in the soil (**Kobayashi, 2004**). Some allelochemicals are water soluble leached from foliage parts by rain, mist, dew, or fog drip (**Qasem, 1994**).

These compounds can be produced by several parts of plants including roots, rhizomes, stems, leaves, flowers, Inflorescences, fruits, and seeds (**Rice, 1974**). The allelochemicals are produced in above or below ground plant parts or in both to cause allelopathic effects in a wide range of plant communities. The donor plants which release these chemicals generally store them in the plant cell in an inactive form, such as water soluble glycosides, polymers including tannins, lignins and salts. These toxic chemicals are released through cleavage by plants enzyme or some environmental stress (**Putnam and Duke, 1978; Einhellig, 1985a; Weston, 1996**). The allelochemicals in higher plants, are released through volatilization (it is only significant under arid or semi-arid conditions), leaf or stem leachates (release of chemicals by rainfall, dew or irrigation from the aerial parts of plants), root exudation (release of chemicals through roots by various mechanisms including diffusion, vesicle transport, ion channels) and decomposition by microorganism or other mechanisms, and carried away by

wind and water (**Lovett and Ryuntyu, 1992; Rizvi and Rizvi, 1992; Inderjit and Keating, 1999**).

Allelochemicals concentrations in the producer plant may also vary over time and in the plant tissue produced. Foliar and leaf litter leachates of *Eucalyptus* species, for example, are more toxic than bark leachates to some food crops (**Rizvi *et al*., 1999**). Allelochemicals are generally secondary plant products or breakdown products from decomposing plant tissues. These chemicals are commonly stored in the vacuoles and prevent harmful effects on the producing plant, but are often exuded or leached out of the tissue (**Rice, 1984; Hall and Henderlong, 1989**). However, the inhibitory materials may be autoinhibitory or heteroinhibitory (**Kumari and Kohli, 1987**), some can be highly selective (**Sahid and Sugau, 1993**), and their effect is concentration dependent (**Qasem, 1993**). It has been demonstrated that phytotoxic effects are density-dependent. Phytotoxicity is greatest at low plant densities, while growth reductions due to resource competition are greatest at high plant densities (**Weidenhamer *et al*., 1989**).

2. Factors Influencing Production of Allelochemicals

The amount of chemicals produced in the donor plant is a result of the interaction of the plant's genetic factors and those of the environment (**Wink, 1999**). Climatic factors have a great influence on allelochemicals production. Some allelochemicals are influenced by the amount, intensity and duration of light. The greatest quantities are produced during exposure to ultraviolet and long-day photoperiods (**Aldrich, 1984**). Rice (**1984**) reported increased amounts of allelochemicals from plants that were exposed to high ambient temperatures. Water plays a very important role in allelopathy it serves as a solvent and carrier of allelochemicals and leachates from an aerial plant parts and in the soil. The activity of soil microorganisms is sensitive to soil moisture level (**Rizvi and Rizvi, 1992; Reinhardt *et al*., 1996**). Tang *et al*. (**1995**) showed that drought stress increased the inhibitory activity of tissue extracts and root exudates of purple nutsedge (*Cyperus rotundus*) which could explain their field observation that purple nutsedge interfere with sweet corn yields was most severe under limited soil-moisture conditions. In addition, allelopathy in sorghum spp. also involves multiple compounds that affect several aspects of plant metabolism, including water relations (**Einhellig, 1995b**).

Composition and concentration of allelochemicals differ with age, plant organs and amongst plant species (**Qasem and Foy, 2001**). Habitat may have a significant influence on the expression of allelopathy. In nature the allelopathic potential of a plant is likely to vary with site due to its climatic and edaphic conditions.

Allelopathy is modified by seasonal conditions such as air and soil temperature and soil moisture. Dolling *et al*. (**1994**) found that allelopathic inhibition of germination and growth of aspen (*Populus tremula*) was most significant in May, June, and September.

The isolation and identification of chemicals from donor plants with biological activity do not demonstrate that these compounds interfere in nature through allelopathy (**Inderjit and Weston, 2000**). Retention, transformation and transport of allelopathic chemicals in soil and physicochemical and biological components of soil influence the fate of allelopathic chemicals, and thus allelopathy, in soil (**Inderjit, 2001 and 2005**). Physicochemical factors affect the quantity and quality of allelopathic compounds; in particular, soil texture significantly influences the expression of allelopathy in natural systems. Compared to fine-textured soils, sandy loam soils sorb lesser amounts of phenolic compounds. Soil biological and chemical characteristics such as texture, nutrients, microorganisms, organic matter, moisture and PH influence allelopathic expression. They affect adsorption and transport in soil and the metabolism of allelochemical (**Qasem and Hill, 1989; Duke *et al*., 2000b; Inderjit *et al*., 2001; Kobayashi, 2004**). Soil pH plays an important role in the uptake and immobilization of inorganic ions and on the resultant accumulation of nutrients, and higher pH can stimulate microbial activity (**Inderjit and Dakshini, 1994**).

The chemical characteristics of soil often change after addition of plant debris, roots, leaves, or leachate of donor plants, and such changes have been shown to modify the action of allelopathic chemicals (**Blum *et al*., 1992**). Allelopathic interactions in soil environments depend greatly on the turnover rate of allelochemicals in the soil rhizosphere and their interaction with clay, organic matter and other factors which change the physico-chemical and biotic characteristics of the soil (**Blum and Shafer, 1988; Blum, 1995; Blum *et al*., 1999**). Recent research by Blum and his laboratory have shown that soil texture, soil pH, organic C, available N are also very important in influencing uptake and of allelochemicals and their ability to persist in the presence of soil microorganisms (**Blum, 1995; Blum, 1998**).Soil moisture dynamics can also influence the phytotoxicity of allelochemicals. In recent studies by Blum, data suggested that enhanced evapotranspiration and lower soil moisture will also result in decreased plant phytotoxicity of allelochemicals in the soil solution (**Blum, 2002**).

Soil microorganisms also play an important role in allelopathy because they have the potential to modify the effects, degrading toxic compounds or producing toxic ones (**Inderjit, 2001**). They can influence the availability of soil nutrients, the release of chemical compounds bound to soil particles. Allelopathic compounds may be present in free, reversibly bound, or irreversibly bound forms. Generally, the first two forms are considered important from the standpoint of allelopathy. Bound forms, however, can also be important (**Inderjit, 2005**). Allelopathic plant species increase production of phytotoxic secondary metabolites when subjected to environmental stresses such as mineral deficiency, extreme temperatures, moisture stress, extreme light levels, herbicides, fungicides, insecticides and plant growth regulators (**Rice, 1984; Einhellig, 1989**).

Allelochemicals must be taken up by the target plant in order to have a direct effect (**Willis, 1985**). These are mainly absorbed by the receptor plant through the roots, via active or passive transport and the allelochemicals move through the xylem by mass flow (**Inderjit, 2005**). After an allelochemical is taken up, it interferes with various physiological processes of the target plant. However, studies have reported that the response to allelochemicals may be concerning on the concentration dependent. Allelochemicals that inhibit the growth of some species at certain concentration might stimulate the growth of the same or different species at different concentrations (**Narwal, 1994**). It is essential to identify concentration at which each specific response occurs if allelopathic interaction is to be used in weed management programme. In addition, various plant parts may vary in their allelopathic potential (**Chon and Kim, 2002**). Duke (**1986**) and Weston *et al*. **(1989)** reported that the metabolites leached from plants consisted of a variety of substances, such as mineral nutrients, carbohydrates, amino acids, and other organic compounds, these substances may inhibit or sometimes stimulate plant growth, depending on the concentration, the leachability, the season, and the age of the plants. More recently Morris *et al*. (**2009**) suggested that complex biochemicals may not be the only substances plants use to interfere with one another, and it has also been suggested that inorganic elements may be used in allelopathic manner. They reported that elements like heavy metals and salts in soils can occur by hyperaccumulation and litter decomposition and by altering rhizosphere chemistry.

Under field conditions, the allelopathic plant residues may remain on the soil surface and the succeeding crop can either be translated or seeded into the residues using no-tillage tools. Also, the residues can be incorporated into the soil in the planting area through strip tillage so that customary equipment can be used (**Weston, 1996**).

The phytotoxic activity of chemicals released from incorporated residues can be influenced by abiotic and biotic factors such as physicochemical and microbiological soil properties (**Kobayashi, 2004**; **Popa *et al*., 2008**). Thus, a phytotoxic compound may be inactivated, become more activated and/or converted to new toxins by soil microorganisms (**Kobayashi, 2004**). Composition profile and quantity of allelochemicals depend on the time after incorporation into the soil (**An *et al*., 2000**). It was demonstrated that the phytotoxic potential of decaying plant residues was maximum at an early stage of decomposition in most cases (**Xuan *et al*., 2005b; Sampietro *et al*., 2007**). As decomposition proceeds, phytotoxicity drastically decreases or even disappears (**Sampietro *et al*., 2007**). This could be partly explained by the fact that quantity and activity of phytotoxins could be affected by biotic and abiotic processes in the soil (**Batish *et al*., 2005**).

3. Mechanisms of Action of Allelochemicals

The mode of action of a chemical can broadly be divided into a direct and an indirect action (**Rizvi and Rizvi, 1992**). Effects through the alternation of soil properties, nutritional status and an altered population or activity of micro-organisms and nematodes represent the indirect action. The direct action involves the biochemical/physiological effects of allelochemicals on various important processes of plant growth and metabolism.

The mechanism and modes of allelochemicals action were firstly described by Rice (**1974**) and have been subsequently reviewed (**Lovett, 1982; Einhellig, 1985; Mandava, 1985; Patterson, 1986**). Several modes of action for allelochemicals are involved in the inhibition and modification of plant growth and development (**Einhellig, 1986**). The following sites or processes are known targets for allelochemicals : cell division , production of plant hormones and their balance , membrane stability and permeability , germination of pollen , mineral uptake , movement of stomata , pigment synthesis , photosynthesis , respiration , amino acid synthesis , nitrogen fixation , specific enzyme activities , inhibition of nitrifying bacteria, N_2 fixing bacteria, plant –water relations, modification of DNA and RNA and complexities of nutrients and conduction tissue (**Rizvi *et al*., 1992; Wink and Twardowski, 1992; Wink *et al*., 1998**) .

Allelochemicals may be selective in their actions or plants may be selective in their response. These considerations are complicated further by the presence of more than an active compound from a single plant. For example, sorghum spp. contains cyanogenic glycosides,

tannins, flavonoids, quinones, and phenolic acids; all of these have inhibitory functions, and most of them produce different biological lesions (**Einhellig, 1995a**).

The inhibitory effects of the foliar extracts of most *Artemisia* spp. clearly appear to be due to the presence of a mixture of compounds, some which are terpenoids, and also include coumarins and polyacetylenes that have been identified as well (**Weston and Duke, 2003**). Plant sesquiterpenes represent a large class of natural products that has been a source of many biologically active compounds, including some with interesting herbicidal activity (**Tellez *et al*., 2000**). Other observations have shown that glandular hair-like trichomes on the leaf surface produce large quantities of camphor, camphene, cineole and significant quantities of artemisinin and arteether among others, with camphor being most active in seed inhibition (**Duke and Abbas, 1995; Barney and Weston, 2002**). Duke *et al*. (**1987**) first reported the phytotoxic activity of artemisinin a sesquiterpene endoperoxide lactone isolated from *Artemisia* spp. The effect of artemisinin is most evident on root growth and chlorophyll content. Inhibition of mitosis dose-dependent and is accompanied with abnormal mitotic configurations (**Duke *et al*., 2000a**). Studies by Romagni *et al*. (**2000a**) showed that the monoterpenes such as 1, 8 -cineole inhibite mitochondrial respiration and strongly inhibits all stages of cell mitosis, in the meristem of wheat root tips. Camphor has effects on mitosis and respiration that are similar to those of 1, 8 -cineole (**Romagni *et al*., 2000b**).

The initial biochemical effect of allelochemicals seems to be on the synthesis of protein mediated by RNA/DNA (**Grodzinsky, 1989**). A variety of allelochemics have been shown to inhibit mitosis in plant roots. For example, coumarin can completely block mitosis in onion (*Allium cepa* L.) roots within a few hours after treatment. Volatile terpenes from *Salvia leucophylla* are potent inhibitors of mitosis in cucumber seedlings. These compounds are also inhibitory to division of a large number of bacterial species isolated from soil (**Einhellig, 1995b**). Toxins from perennial sowthistle (*Sonchus arvensis* L.), common lambsquartes, and Canada thistle can reduce miotic activity in roots of several crops.

Germination of cereals depends on α-amylase activity that regulates starch break down, necessary for supplying substrates to respiratory metabolism. Eucalyptus *(Eucaliptus globosus)* leaf leachates decreased α-amylase activity in seeds of finger-milet (*Eleusine coracanta),* resulting in inhibition of germination (**Padhy *et al*., 2000**).

Similar data were obtained in the case of cress (*Lepidium sativum*) seeds in the presence of 6-methoxy-2-benz-oxazolinone (MBOA), commonly occurring in cereals (**Kato-Naguchi and Macias, 2004**).

During germination of fat-storing seeds, the glyoxylate cycle plays a key role in the mobilisation of triacylglycerides. During early stages of germination enzymes of glyoxylate cycle such as isocitratelyase (ICL), increase their activity due to maximum lipid metabolism in the storage tissue of germinating seeds (**McLaughlin and Smith, 1994**). Inhibition lipid mobilisation in the presence of ferulic and *p*-coumaric acids was detected during (*Brassica napus)* seed germination (**Baleroni *et al*., 2000**), as well as in (*Heliantus annus*) seeds germinating in the presence of alkaloids from (*Datura stramonium)* (**Levitt *et al*., 1984**). Data obtained by Maffei *et al.* (**1999**) suggest the influence of allelopathic compounds not only on activity of isocitratelyase (ICL), but also on ICL gene expression. Thus, ICL seems to be one of the most sensitive enzymes in reaction to allelopathy stress and its decreased activity may result in inhibition or delay of seed germination. Additionally, it was suggested that the observed decrease in enzymatic activity is a secondary effect of allelochemicals, related to protein damage. Therefore, effects of allelochemicals on seed germination appear to be mediated through a disruption of normal cellular metabolism rather than through damage of organelles. Reserve mobilisation, a process which usually takes place rapidly during early stages of seed germination seems to be delayed or decreased under allelopathy stress conditions (**Muscolo *et al*., 2001**).

MBOA has recently shown to inhibit germination of lettuce seeds and induction of α-amylase in the seeds at concentration greater than 0.03 mM, and the germination rate was positively correlated with the activity of α-amylase in the seeds. Thus, MBOA may inhibit α-amylase induction in antagonism with gibberellin-induced events in α-amylase translation process. (**Kato-Noguchi and Macías, 2005**).

Disturbances of photosynthesis are one of the most frequently observed physiological effects of many allelochemicals. Due to this action of allelopathic compounds they possess perspectives to be commonly used inorganic agriculture e.g. in sustainable weed management as natural herbicide (**Gniazdowska and Bogatek, 2005**). Decreased chlorophyll content, accompanied by reduction of carotenoid concentration was detected in lettuce (*Lactuca sativa*) seedlings treated by artemisinin and some of its sesquiterpene analogs (**Dayan *et al*., 1999**). On the other hand reduced photosynthesis rate in leaves of *Sinapis alba* plants exposed to *Heliantus annuus* allelochemicals corresponded with reduction in transpiration rate suggesting limited CO_2 diffusion into chloroplast due to stomata closing (**Bernat *et al*., 2004a**).

One of the suggested explanations for disruption of seedling growth and development during allelopathy stress is modification in mitochondrial respiration leading to decreased supply of ATP for all energy demanding processes.Coumarins decreased mitochondrial respiration rate in *Allium cepa* root cells (**Kupidłowska *et al*., 1994**). Monoterpenes are allelochemicals which diminished the mitochondrial respiration by increasing the rates of electron transport through an alternative path way α-Pinene and cinnamic acid also decreased the oxygen consumption in *Glycine max* cotyledons and increased relative partitioning of electrons to the alternative path way (**Penuelas *et al*., 1996**). Abrahim *et al*. (**2000**) demonstrated that reduced respiratory activity of *Zea mays* primary root mitochondria by monoterpenes led to a complete repression of respiratory control. It was suggested that those compounds may act as uncouplers of oxidative phosphorylation. Most of effects of allelochemicals on respiration are examined on isolated mitochondria, since measurement of allelopathy influence on respiration of intact plant may be disturbed by photorespiration. Inhibitory effect on O_2 up take of such allelochemicals as monoterpenes, hydroxamic acids or coumarins may depend on their ability to penetrate plant tissue. On the other hand allelopathic extract from *Heliantus annuus* leaves, which inhibited *Sinapis alba* seed germination (**Bernat *et al*., 2004b, Ciarka *et al*., 2004, Bogatek *et al*., 2006**), lowered seed respiration rate during 3 first days of germination. This suggests correlation between inhibition of dark respiration and delay of germination in the presence of allelopathic compounds (**Gniazdowska and Bogatek, 2005**).

Inhibition of seedling growth in allelopathy stress conditions may be there fore a result of decreased ion up take. A root is the first organ to come into contact with allelochemicals in the rhizosphere, thus the effect of allelochemicals on ion up take is particularly important. Root exudates of *Cucumis sativus* inhibited ion (NO_3^-, K^+, Ca^{2+}, Mg^{2+}, Fe^{2+}, BO_3^{3-}) up take by cucumber seedlings (**Yu and Matsui, 1997**). An inhibitory effect of *p*-hydroxycinnamic, vanillic and ferulic acids on the up takes of $H_2PO_4^-$ by cucumber roots was also detected (**Lyu *et al*., 1990**). Salicylic acid, a phenolic compound, has been shown to inhibit the uptake of potassium by plants. Both salicylic acid and ferulic acid were both inhibitory to K+ uptake by oat roots, particularly at lower pH. Other recent work indicated that salicylic acid uptake by plants is also greater at low pH (**Einhellig, 1995b**). Numerous other studies with whole plants and cell cultures have indicated a reduction in uptake of both macro and micronutrients in the presence of phenolic acids (**Einhellig, 1987**).

The phenolic acids suppress absorption of phosphate, potassium, nitrate, and magnesium ions, and overall changes in tissue content of mineral ions are one of the effects on plants growth (**Einhellig**, **2001)**. Stowe and Osborn **(1980)** recorded greater toxicity from vanillic and *p*-coumaric acids when barley seedling were deficient in P or N. They concluded that toxicity of these phenolic compounds depends on nutrient concentrations. There fore, influence of allelochemicals on ion uptake may be a result of the decreased respiration rate and insufficient amount of ATP synthesized in root cells (**Gniazdowska and Bogatek, 2005**).

It's known that most volatile compounds (terpenoids) are released from plants in drought areas. In contrast, water- born phytotoxins such as flavonoids, alkaloids, and phenolics are released from plants in humid zone areas. Allelopathic chemicals can also persist in the soil, affecting both neighboring plants as well as plants in successions. The allelopathic effects of these compounds are often observed in the early life cycle, causing Inhibition of seed germination and/or seedling growth. The compounds exhibit a wide range of mechanisms of actions; Alkaloids affects on DNA, Quinons photosynthetic and mitochondrial functions, while phenolics affects phytohormonal activity, ion uptake, and water balance (**Chou, 1999**).

There are many secondary metabolites that act as plant allelochemicals including phenolic, terpenoid, flavonoid, and alkaloids. Among these, phenolic compounds such as p-hydroxybenzoic, vanillic, p-coumaric, syringic and ferulic acids are a main category of allelochemicals. These phenolic acids have been identified as allelopathic agents in natural and agroecosystems (**Blum *et al*., 1991; Ben-Hammouda *et al*., 1995**). They are known to affect seed germination, seedling growth, chlorophyll content, respiratory activity, enzymes activities and cell division (**Rice, 1995; Inderjit, 2001**). Although there is little information on the interaction of phenols or other compounds as to how they affect germination and seedling growth, there is evidence that a mixture of phenols enhances their inhibitory action. It can be used as both pre- and post-emergent herbicide and is phytotoxic towards a number of weedy species (**Li *et al*., 1993**).

The most common phenolic compounds in allelopathy are the derivatives of cinnamic and benzoic acids, coumarins, tannins and other polyphenolic complexes, and certain flavonoids. While the level of production and release of these compounds varies significantly among plants (**Macias *et al*., 2004**).

The different phenolic acids, coumarins, and tannins appear to have quite similar mechanisms of action, inhibiting plant growth through multiple physiological effects that confer a generalized cytotoxicity (**Einhellig, 1996**).

Mechanisms of flavonoid action are less understood than the phenolic acids. Some of the allelopathic flavonoids are potent inhibitors of energy metabolism, blocking mitochondrial and chloroplast functions (**Macias *et al*., 2004**). The concentration of a phenolic acids required to inhibit seed germination is generally higher than it is to inhibit growth in whole seedlings (**Einhellig, 2001**).

Greater amounts of phenolics were leached from sunflowers grown with limited phosphorous than from control plants (**Koeppe *et al*., 1976**). Furthermore, Hall *et al*. (**1982**) found that the total phenolic content of sunflower residues correlated with the extent of nutrient deficiency. When residues from nutrient-limited plants were added to the soil, this residue depressed redroot pigweed germination significantly more than residue from unstressed plants. Stress-induced changes in organic constituents and their concentration in root exudates have often been reported, but only recently has a definitive connection been made to allelopathy.

Among so many symptoms, a decrease in photosynthesis efficiency is a common effect of allelopathic phenolics. Sorgoleone, a *p*-benzoquinone in sorghum root exudates was found to inhibit the oxygen evolution of soybean leaf disk and isolated pea chloroplasts, which in turn caused growth reduction (**Einhellig *et al*., 1993**) and photosystem II electron transfere reaction (**Gonzalez *et al*., 1997**). Additionally, sorghum roots exuded POH (p-hydroxybenzoic), VAN (vanillic acid), and SYR (syringic acid) that may enhance the overall allelopathic potential of sorghum during growth and after harvest when residues remain on the soil surface or are incorporated prior to planting a subsequent crop (**Ben-Hammoda *et al*., 1995**).

Laboratory bioassay is the first step used to investigate the possible involvement of allelopathy (**Foy, 1999**). Bioassays are useful and necessary tools for studying the allelopathic potential of plant or soil extracts and for evaluating the activity of the extracts during purification and identification of allelopathic compounds.

Nearly all reports on allelopathy describe some type of bioassay method used to demonstrate allelopathic activity (**Hoagland and Brandsaeter, 1996; Macias *et al*., 2000**).

Generally there are two types of measurements for testing biological activity of allelopathic compounds: the measurement of specific biological activity (e.g., inhibition of photosynthesis) or measurements of some aspects of growth (e.g., germination, root dry weight). Putnam and Duke (**1978**) and Leather and Einhellig (**1985**) reviewed various bioassays for the study of allelopathy.

The most widely used bioassay to test allelopathic activity in an extract is the technique of seed germination in Petri dishes on filter paper, sand, soil or agar. Percent germination has commonly been used to measure the effects of allelopathic compounds. This is a rapid method for a large number of samples. Recording germination is a commonly used measurement, but several investigations have revealed that this is not the most sensitive parameter (**Leather and Einhellig, 1988**). Root length has often shown to be a more sensitive, than the germination bioassay, possibly because radicle elongation occurs by cell extension only. Germination involves both cell extension and cell division (**Leather and Einhellig, 1986**). But roots are not as easy to measure as germination, and the design of the bioassay method may influence the growth of the roots (**Wardle *et al*., 1993**).

Bioassays for such studies typically include seed germination, seedling growth, coleoptiles and radicle length, seedling fresh weight, photosynthetic activity test and may detect potential allelopathic effects under controlled laboratory conditions (**Inderjit and Dakshini, 1995; Chiapusio *et al*., 1997; Hoagland and Williams, 2004; Aliotta *et al*., 2006; Gawronska *et al*., 2006**). Although bioassays using water extracts from plants are useful to prove the existence of allelopathic substances in them, these effects often disappear under field conditions due to adsorption to soil particles, decomposition and leaching (**DeAlmeida, 1985**). As a result to the criticisms directed to the aqueous extract bioassays, screening bioassays using intact plant seedlings have been developed. Plants at the seedling stage have been used in allelopathy studies (**Wu *et al*., 2000**).

Many species are used in bioassays to indicate allelopathic activity. Some standard indicator species, such as lettuce (*Lactuca sativa*), radish (*Raphanus sativa*) and duckweed (*Lemna minor*) have been recommended for the preliminary testing of allelopathic activity because of their availability and high sensitivity to allelopathic actions (**Putnam *et al*., 1983; Leather and Einhellig, 1986; Fujii, 1992**).

4. Utilization of Allelopathy for Weed Management in Agro-ecosystems

Interference of weeds with agricultural crops causes enormous financial losses in agro-ecosystems (**Batish *et al*., 2007a**).Worldwide, it is estimated that weeds are responsible for a loss of around 13.2% in the eight most important food and cash crops, even when they are intensively controlled (**Oerke *et al*., 1995**).

Mechanical methods such as hand weeding require huge labour and time input. Simultaneously, the overuse of herbicides can also cause environmental pollution, unsafe agricultural products and human health concerns (**Batish *et al*., 2007b; Kordali *et al*., 2009**). The appearance of herbicide resistant weed biotypes has created further problems in the use of herbicides.

Allelopathy plays an important role in agro-ecosystems leading to a wide array of interactions between crop–crop, crop–weed and tree– crops (**Singh *et al*., 2001**). Some weed species inhibit other weed species. They represent an excellent strategic source of natural chemicals that may be involved in developing natural herbicides (**Qasem and Foy, 2001**). Utilization of allelopathy in cropping systems, however, will depend on better understanding of the chemical or chemicals involved and their behaviour in natural and agricultural ecosystems (**Mallik and Williams, 2009**). The allelopathic characteristic of plants may be effectively exploited for biological weed management in crop production (**Rice, 1984; Kohli *et al*., 1998**). The use of crops having allelopathic properties can reduce the dependency on herbicides and increase crop yields (**Khanh *et al*., 2005**). The allelochemicals in these plants may be same or different, which might show synergistic or additive effects in combination (**Duke and Laydon, 1993**). Allelopathic crops may be used in different ways to influence weeds such as, surface mulch (**Cheema *et al*., 2000**), incorporation into the soil (**Sati *et al*., 2004**), spraying of water extracts (**Cheema *et al*., 2002**), rotation (**Narwal, 2000**), smothering (**Singh *et al*., 2003b**) or mixed cropping and intercropping (**Hatcher and Melander, 2003**).

Several studies on the screening for the allelopathic potential of plants in ecosystems have been reported. Fujii *et al*. (**2003**) evaluated the allelopathic potentials of 53 cover crop plants (26 leguminous, 19 graminaceous and eight others) and 239 medicinal species. Rizvi *et al*. (**1999**) have listed over 80 trees grown under agroforestry programme that exhibit allelopathy. Some such tree species are *Acacia* spp., *Albizzia lebbeck*, *Eucalyptus* spp., *Grewia optiva*, *Glircidia sepium*, *Leucaena leucocephala*, *Moringa oleifera*, and *Populus deltoides* that affect the crop performance through the phenomenon of allelopathy (**Kohli *et al*., 1998; Rizvi *et al*., 1999; Singh *et al*., 2001**). A number of weeds especially found in the agroecosystems are also known to possess allelopathic properties that further make them competitively stronger and thus adversely affecting crops (**Putnam and Weston, 1986; Kohli *et al*., 1998; Weston and Duke, 2003**).

Qasem and Foy (**2001**) reported nearly 240 weeds to be allelopathic.Most studies related to cover crop effects on weed suppression and crop development have focused on winter cereals or legumes (**Dhima *et al*., 2006**). Although numerous plants are allelopathic, only a few among them have strong allelopathic properties (**Fujii 2001, Xuan *et al*., 2001**). Chung and Miller (**1995**) evaluated the possibility of using alfalfa as a natural herbicide and reported inhibition by aqueous extracts of dry alfalfa on germination of weeds including lambsquarters (*Chenopodium album*), pigweed (*Amaranthus retroflexus*), velvetleaf (*Abutilon theophrasti*), giant foxtail (*Setaria faberi*), cheatgrass (*Bromus secalinus*), and crabgrass (*Digitaria sanguinalis*). Tsuzuki *et al*. (**1999**) suggested that the powder obtained by drying the aerial parts (stem and leaf) of alfalfa significantly inhibited germination of some lowland weeds. El-Darier and Youssef (**2000**) also reported the inhibitory effect of aqueous extract of alfalfa on germination and seedling growth of *Lepidium sativum*. Observations showed that alfalfa pellets significantly inhibited growth of paddy weeds and suggested that alfalfa pellets may be used as a natural herbicide in paddy fields (**Xuan and Tsuzuki, 2001; Xuan *et al*., 2001**).

Cheema *et al*. (**1997**) found that aqueous extract of sorghum and sunflower has the potential to suppress the weed infestation in wheat crop. Similarly, Mahmood and Cheema (2004) found that sorghum mulch significantly reduced the density and dry biomass of one of the world's worst weed *Cyperus rotundus.* Akhtar *et al*. (**2001**) reported that aqueous extracts of *Cirsium arvense* and *Ageratum conyzoides* could suppress the germination and early seedling growth of some weeds of wheat.

Moradshahi *et al*. (**2003**) found that aqueous extracts of *Eucalyptus camaldulensis*, has the potential to suppress growth of *Echinochloa crus-galli, Avena fatua,* and *Rumex acetosella*. Similarly Dahiya and Narwal (**2003**) found that root exudates of *Helianthus annuus*, are allelopathic towards *Agropyron repens, Ambrosia artemsiifolia, Avena fatua, Celosia crustata, Chenopodium album* and *Cynodon dectylon*. Singh *et al*. (**2005**) studied the herbicidal effect of volatile oils from leaves of *Eucalyptus citriodora* against the noxious weed *P. hysterophorus* and found that *Eucalyptus* oil completely inhibited the germination.

Uremis *et al*. **(2005)** have reported significant suppression of *Physalis angulata*, a problem weed in maize, cotton and soybean fields in Turkey, by aqueous extracts of *Brassica* spp. Recently Iqbal and Cheema (**2007**) reported an effective control of purple nutsedge by utilizing natural plant extracts from various allelopathic crops (sorghum, sunflower and brassica) in the field However, very little is known about the allelopathic behaviour of

the medicinal and aromatic plants on germination and seedling growth of weeds and crops (**Qasem, 2002**). Recently, use of allelopathic medicinal and aromatic plants has been suggested as a viable option for alternative weed management under sustainable agriculture (**Fujii, 2001; Hong *et al*., 2003; Singh, *et al*., 2003a; Mekky, 2008**). Natural products released from allelopathic and medicinal plant residues may help to reduce the use of synthetic herbicides for weed management and therefore cause less pollution and safer agricultural products (**Singh *et al*., 2003a; Khanh *et al*., 2007**). However, studies on the effects of aromatic plants, used as cover crops incorporated into the soil as green manure or left on top of the soil as mulches, on crops and weeds, as well as studies on the inhibitory effects of aromatic plant extracts on weed germination are limited in literature.

In particular, Dudai *et al*. (**1999**) found that palmer amaranth (*Amaranthus palmeri*) germination was inhibited by essential oils of lemon basil (*Ocimum citriodorum*), oregano and sweet marjoram (*Origanum majorana*). In addition, Tworkoski (**2002**) found that essential oils from red thyme (*Thymus vulgaris*), clove (*Syzgium aromaticum*) and cinnamon (*Cinnamomum zeylanicum*) caused electrolyte leakage resulting in death of dandelion (*Taraxacum officinale*) cells. Also, Vasilakoglou *et al*. **(2007)** found that essential oils extracted from four sweet basil cultivars and six oregano or marjoram populations reduced germination and root growth of barnyardgrass and common lambsquarters. These results constitute evidence that aromatic plants incorporated as green manure into the soil or left on top of the soil as mulches, with the capacity to produce phytotoxic essential oils, could play an important role for weed suppression in sustainable agriculture systems (**Dhima *et al*., 2009**).

Phytotoxicity of some terpenes or essential oils which contain terpenes on weeds has been widely documented. Kohli *et al*. (**1998**) showed that volatile oils extracted from leaves of *Eucalyptus globulus* and *Eucalyptus citriodora* inhibited the germination of the weed *Parthenium hysterophorus*, reduced the chlorophyll content and cellular respiration of the mature plants and was accompanied by increased water loss, resulting in the complete wilting of the plants. Muller *et al*. (**1964**) and Muller (**1965**) reported that in the vicinity of aromatic shrubs, such as *Artemisia californica* or *Salvia leucophylla*, there were no annual plants within a diameter of 90 cm and presence of annuals was very limited within 2–6 m. Muller *et al*. (**1964**) and Friedman *et al*. (**1977**) found that volatile foliage compounds were the active ingredients causing the repression of growth in the vicinity of the *Artemisia* and *Salvia* species.

This ecological phenomenon provides a competitive advantage to aromatic plants in their natural environments. These reports suggest that allelochemicals could be used for weed control in agriculture.

Numerous members of *Artemisia* genus have been reported to suppress weed growth through their allelopathic activity in diverse field settings. The foliage and aqueous extracts of *A. vulgaris,* A. *annua, A. campestris* and *A. herba-alba* have all been reported to cause potent growth inhibition of seedlings (**Barney and Weston, 2002**) besides possessing medicinal properties. Soil collected from underneath these plants or from infested sites was also inhibitory to the germination and growth of a variety of test species (**Yun and Maun, 1997**). The allelopathic properties of *Artemisia* spp. have been attributed to the release of volatile essential oils rich in mono- and sesquiterpenes besides phenolics and a few flavonoids identified in aqueous extracts (**Kong *et al*., 1999, 2002; Singh *et al*., 2003a**).

Kil and Yun (**1992**) reported that germination percentage, seedling elongation and dry weight of some weeds (*Lactuca sativa* , *Achyranthse japonica, Oenothera odorata*., *Plantago asiatica,* and *Echinochloa crus-galli*) was slightly increased at lower concentrations of *Artemisia princeps* var. *orientalis* extracts, whereas it was proportionally inhibited at higher concentration at the two type of soil. Additionally, Lydon *et al*. (**1997**) showed that dried leaves of *Artemisia annua* incorporated in soil provided good weed control, but the level of herbicidal activity was independent on the concentration of artemisinin in soil.Escudero *et al*. (**2000**) observed the inhibitory effect of aqueous extract of *Artemisia herba alba* on the final germination percentage of scarified seeds of *Helianthemum squamatum*.

Assaeed (**2003**) observed that aqueous extracts prepared from leaves and inflorescence of *Artemisia monosperma* decreased seed germination of some species of sandy habitat (*Lasiurus scindicus, Pennisetum divisum, Scrophularia hypericifolia,* and *Plantago boissieri*) in the bioassay experiment, Additionally of *A. monosperma* litter to soil surface in pots experiment decreased seedling relative growth rate (RGR) and survival in proportion to the amount of litter added.

Modallal and Al-Charchafchi (**2006**) also reported that the phenolic compounds inside fruits of the common medicinal plant *Artemisia herba alba* exhibit some potential inhibitory activity of germination and seedling growth of some plant species. Recently Deef and AbdEL-Fattah (**2008**) observed that aqueous extract of *Artemisia princeps* var. *orientalis* shoot system was phytotoxic to germination and growth of *Triticum aestivum* in sandy and silty soil.

The allelopathy of *Artemisia* species varied with the concentration of the extracts. The chlorophyll content and biomass production gradually decreased with the increasing in extract concentration at the soils.

Mekky (**2008**) reported that the inhibitory effect of methanol extracts of *Artemisia annua* , *Eucalyptus globules* , *Ocimum basilicum* on seed germination and seedling growth of some weed species (*Avena fatua* , *Phalaris minor* , *Rumex dentated* , *Amaranthus retroflexu*). It is well known that some annual and perennial species such as *Artemisia* spp., *Tribulus terrestris*, *Pluchea lanceolata*, *Lantana camara*, *Buchloe dactyloides*, *Achillea santolina* and *Eucalyptus* spp. excrete growth inhibiting substances from the tissues of their living or dead shoots roots (**Inderjit and Dakshini, 1994; El-Darier and Youssef, 2000; El-Darier, 2002**). These inhibitors greatly retard and reduce the growth, productivity and physiology of associated crop plants (**El-Darier and Youssef, 2007**).

Kato-Noguchi (**2001**) found that an aqueous acetone extract of lemon balm, *Melissa officinalis* (widely medicinal herb*)* shoots inhibited the seed germination and seedling growth of *Amaranthus caudatus*, *Lepidium sativum*, *Digitaria sanguinalis*, *Phleum pratense*, *Lactuca sative* and *Lolium multiflorum*. He also reported that the effectiveness of extract on the roots was greater than that of the shoots of the test plants, and the inhibitory effect was related to the extract concentration. Xuan *et al*. (**2004a**) reported that neem (*Azadirachta indica*) strongly inhibits germination and growth of several specific crops: alfalfa (*Medicago sativa*), bean (*Vigna angularis*), carrot (*Daucus carota*), radish (*Raphanus sativus*), rice (*Oryza sativa*), and sesame (*Sesamum indicum*) and weeds: *Echinochloa crus-galli*, *Monochoria vaginalis*, and *Aeschynomene indica* in a bioassay and in soil. The sensitivity of weeds varied between bioassay and soil.

In the greenhouse and paddy fields, they caused a more than 70% reduction in paddy weed biomass and suppression of weed emergence greater than70%. All of the six plant species studied are very promising for weed control; these plants might be useful as natural herbicides and might also contain numerous growth inhibitors that could be used for the development of bioherbicides (**Khanh *et al*., 2005**). In a bioassay, aqueous extracts of *Passiflora edulis* strongly suppressed germination and seedling growth of lettuce, radish and two major paddy weeds *Echinochloa crusgalli* and *Monochoria vaginalis.* In green house and field experiments, *P. edulis* also strongly inhibited the growth of paddy weeds (**Khanh *et al*., 2006**).

Ahmed *et al*. (**2007**) stated that the growth inhibitory effects of aqueous extracts derived from *Lantana camara* on six popular agricultural crops (*Brassica juncea , Cucumis sativus , Phaseolus mungo, Raphanus sativus ,Vigna unguiculata* and *Cicer arietinum*) the concentrations of aqueous leaf extracts caused significant inhibitory effect on germination, root and shoot elongation and development of lateral roots of receptor crops . This was proportional to the concentrations of the extracts and higher concentration had the stronger inhibitory effect whereas the lower concentration showed stimulatory effect in some cases. The inhibitory effect was much pronounced in root and lateral root development rather than shoot and germination.

Allan and Adkins (**2007**) investigated the potential of bioactive chemicals in medicinal plants to inhibit plant growth using a Lemna (*Lemna aequinoctialis*) bioassay. Aqueous extracts from plant parts of eight test species, *Ageratum conyzoides, Acacia farnesiana, Acacia melanoxylon, Alphitonia excelsa, Castanospermum australe, Chamaesyce hyssopifolia, Melaleuca quinquenervia* and *Phyllanthus virgatus*. Extracts from all eight species inhibited the growth of *L. aequinoctialis* with the strongest growth inhibition coming from leaf, stem and bark extract.

Batish *et al*.(**2007a**) observed that *Tagetes minuta* (medicinal plant) leaf powder applied to rice field soil significantly reduced emergence and growth of two paddy weeds *Echinochloa crusgalli* and *Cyperus rotundus* in pots under green house and in rice field . In the search of methods of weed management, Batish *et al*. (**2007b**) assessed a medicinal plant, *Anisomeles indica* for potential inhibitory activity against *Phalaris minor* and other weeds of the wheat crop. *A. indica* leaf and root powder applied as mulch significantly reduced the emergence and growth of *P. minor* and other weeds of wheat crop similar to herbicides, without any negative effect on the wheat growth and yield.They concludes that mulch of *A. indica* a medicinal plant, hold good promise for use as natural herbicides for managing weeds in wheat fields.

Pawar and Chavan (**2007**) found that leaf leachates of *Eucalyptus globules, Moringa oleifera, Parthenium hysterophorus* decreased activity of α-amylase, invertase and reduced the level of reducing and non-reducing sugars. The leaf leachates caused maximum disturbances in the carbohydrate metabolism. Kato-Noguchi and Macías (**2008**) reported that 6-Methoxy-2-benzoxazolinone (MBOA) inhibited germination of rice (*Oryza sativa*), wheat (*Triticum aethiopicum*), rye (*Secale cereale*), onion (*Allium cepa*), wild oat (*Avena fatua*), barnyard grass (*Echinochloa crus-galli*), ryegrass (*Lolium rigidum*), cress (*Lepidium*

sativum), lettuce (*Lactuca sativa*), tomato (*Lycopersicum esculentum*), carrot (*Daucus carota*) and amaranth (*Amaranthus retroflexus*) and the inhibition increased with increasing MBOA concentrations. MBOA also inhibited the induction of α-amylase in these plant seeds and the inhibition increased with increasing MBOA concentrations. There were variations in sensitivity of these plant species to MBOA. They suggested that MBOA may inhibit the germination of these seeds by inhibiting the induction of α-amylase activity.

The n-hexane soluble, acetone-soluble and water-soluble fractions obtained from the acetone extract of *Azadirachta indica* shoots inhibited the germination and the growth of roots and shoots of six test plant species (*Amaranthus rotundus, Cirsium arvense, Digitaria sanguinalis, Sinapis arvensis, Lactuca sativa and Lolium ultiforum*).The inhibitory activity of the water-soluble fraction was greatest, followed by that of the n-hexane-soluble and acetone-soluble fractions in all bioassays. Significant reductions in the germination and growth of the roots and hypocotyls were observed as the extract concentration increased. The concentration-dependent responses of the test plants to the fractions suggested that all three fractions might contain allelochemicals, but that the greatest potential was in the water-soluble fraction. These results indicate that *A. indica* residues or aqueous extracts may be useful for weed management **(Ashrafi *et al*., 2009).**

Singh *et al*. (**2009**) was examined the effects of aqueous leachate of *Nicotiana plumbaginifoli* on germination, seedling growth, amylase activity, sugar and starch contents of germinated seeds of maize (*Zea mays*). Effects of leachate on photosynthetic pigments, protein content, activities of nitrate reductase and some antioxidants were also studied. They showed that higher concentration of aqueous leachate reduced the germination rate. However, final germination percentage remained almost unaffected. Lower concentration of leachate stimulated the amylase activity and resulted in higher sugar content and germination rate. On the other hand the increasing concentrations of leachate inhibited the conversion of starch into sugars. Allelochemicals decreased the amount of chlorophyll a, chlorophyll b, carotenoids, protein and nitrate reductase activity. The leachate of lower concentrations stimulated the activity of peroxidase but slight decrease was recorded in higher concentration. Superoxide dismutase and catalase exhibited concentration dependent increase except in seedlings treated with 100% concentration of leachate. Impairment of various metabolic activities due to leachate resulted in decreased root and shoot length.

Abu-Romman *et al.* (**2010**) reported that higher concentration of aqueous leachate of *Euphorbia hierosolymitana* caused significant reduction and decreased root and shoot length, fresh, dry weights of wheat (*Triticum durum* local var. Hourani 27) seedlings and decreased the amount of total chlorophyll and protein contents. Additionally, Sodaeizadeh *et al*. (**2010**) evaluated the herbicidal potential of *Peganum harmala* L. (Zygophyllaceae) residues on seedling growth of *Avena fatua* L. (Poaceae) and *Convolvulus arvensis* L. (Convolvulaceae), and decomposition dynamics of its phytotoxins in the soil and found that among the different *Peganum harmala* plant parts used, leaves were the most toxic and caused the greatest negative effect on seedling length, seedling dry weight, leaf area and chlorophyll content of *Avena fatua* and *Convolvulus arvensis*. Both weed species differed in their sensitivity to *Peganum harmala* residues. Higher reduction in plant growth parameters occurred in *Convolvulus arvensis*. Total phenolic acid content was higher in soil amended with leaf residues than that of soils with stem or root residues. They suggested that *Peganum harmala* residues had potent herbicidal activity and could be used as a natural herbicide for weed control.

STUDY SPECIES

STUDY SPECIES

1. Donor Species

1.1.*Zygophyllum album* L.

Zygophyllum album (locally named Agga) belongs to Zygophyllaceae family, genus *Zygophyllum* (**Tackholm,1974**).This plant used in traditional medicine as a remedy for rheumatism, gout, Hypoglycemic ,antiseptic, antispasmodic, anti-eczema, stomachand liver pain. **(Bellakhdar, 1997; Bellakhdar, *et al*., 1991; Hmamouchi, 1999)** asthma and as diuretic. Some Bedouins used it as hay or added it to the dry ration. However, it was found to be toxic to the sheep and caused high mortality (**Attia and Samar, 2004**). Previous investigation of *Zygophyllum album* revealed that the plant contains Zygophyllin,β-sitosterol-β-D-glucopyranoside,carbohydrates,tannins,lactones,proteins/amino acids, saponins,triterpene and flavonoid glycosids (**Attia and samar,2004;Hani, 1995; El-Monayeri, *et al*.,1981**). **(Figure a)**

1.2. *Euphorbia guyoniana* Boiss. & Reut.

Euphorbia guyoniana (locally named Lebina) is an endemic Saharan plant growing in sandy and desert habitat (**Quezel and Santa, 1963**), and belongs to the large family of Euphorbiaceae. With more of 1600 species, *Euphorbia* genus is the most representative of the family (**Ozenda, 1991**). Plant Perennial up to one meter high. leaving the base. Leaves narrow, especially on the flowering branches. Flowers yellowish. Like the previous species, stems and leaves ooze latex when they break. In dry seasons, it is drying up completely. Habitat feet and isolated in small groups in areas ensablees.il is common across the northern Sahara desert and the regions first. For the period of vegetation in bloom from January to February (**Chehma, 2006**).Plants of this genus are known for their rich content in secondary metabolites. Indeed, numerous studies undertaken on this genus have revealed presence of triterpenes (**Lima *et al*., 2003**), diterpenes (**Shi *et al*., 2005**), macrocyclic diterpenes (**Redei *et al*., 2003**), steroids (**Tanaka *et al*., 1999**) and aromatic compounds (**Oksuz *et al*., 2002**) Chemically, E. guyoniana has received little attention apart from the work done recently on the aerial parts from which two new diterpene polyesters with jatrophane skeleton have been isolated (**Ahmed *et al*., 2006**). This species contains an irritant white latex for the eyes and skin, alike the other species of the genus Euphorbia. It is used against snake bites. (**Bellakhdar, 1997**). (**Figure b**)

1.3.*Retama raetam (*Forssk.) Webb & Berthel.

Retama raetam (locally named Rtem**).** Sapling has long branches that can exceed three meters in height, silky, thoroughly jounatre. The Rami is strongly throughout. Lower leaves trifoliolate, the skins simple, all very outdated. White flowers in small clusters along the branches laterals. Pods oviodes acute, completed in bec.elle is living in isolated or foot colonize very large surface depressions, river beds and sandy areas. It is common throughout the Sahara septentrional. It is flowering in January-February. Its snake bites. The plant aerial part is used in tea, powder or compress to treat rheumatism, wounds and bites of a scorpion. (**Chahma, 2006; Ozenda, 1991; Quezel and Santa, 1963**) And used for making eye wash for eye troubles. Root is used against diarrhoea. Branches are used as febrifuge, for treatment of wounds; powdered branches mixed with honey are emetic, given as a purgative and vermifuge, abortive in large doses. (**Figure c**)

1.4. *Pituranthos chloranthus* (Coss. & Dur) Benth & Hook

Pituranthos chloranthus (locally named Guezah).Perennial a yellowish green stem, shaped rods, branched from the base, 0.5 to 1 meter high. Leaves small (reduced to scales) quickly obsolete. Inflorescence in umbels arranged at the tops of stems. Flowers green has broad petals wearing their hair on Rib dorsale.Fruit achene ovoid, 1 to 2 mm in diameter, hairy. It is inhabited Hamad and wadi beds and a bedrock depression. It is common throughout the Sahara. They present themselves in very large colonies. It is April mia.les flora flowers and leaves, *Pituranthos* species are used in traditional medicine for the treatment of asthma, rheumatism, postpartum care, spasms, pains, fevers, diabetes, lice (head and pubis), hepatitis, digestive difficulties, urinary infections and scorpions stings **(Vérité *et al.*, 2004)** and used to treat sore abdomen and poultice on the head in the care of headache**. (Chahma, 2006; Quezel and Santa, 1963)** (**Figure d**)

1.5. *Haloxylon scoparium* (Pomel).

Haloxylon scoparium (locally named Remth). (Family chenopodiaceae) Low bushes not exceeding 50 cm tall, has thick and strain trueuse. Rameauxarticules, slender, very numerous, blackening in drying; Epis floral short. Fruit has wings strongly colored, yellowish white Pink or red. She met with it in large colonies; and very common throughout the northern Sahara. It is well known for its medicinal virtues, its branches, leaves and flowers (decoction, maceration in, as a poultice), are for salaries Utilizes indigestions, of scorpion

bites and dermatitis.(**Chahma, 2006;Ozanda, 1991**).*H.scoparium* from Algeria has been reported to contain the alkaloids carnegine and Nmethylisosalsoline as major tetrahydroisoquinoline alkaloids in addition to isosalsoline, salsolidine, dehydrosalsolidine, isosalsolidine, N-methylcorydaldine, tryptamine and N-methyltryptamine as minor alkaloids (**Benkrief *et al.*, 1990**). **(Figure e)**

1.6.*Artemisia herba-alba* L.

The genus *Artemisia* L. (locally named shih,) (family Asteraceae, tribe Anthemideae), comprises a variable number of species (from 200 to over 400, depending on the authors) found throughout the northern half of the world. The genus may be divided into sections *Artemisia* and *Dracunculus* **(Mohsen and Ali, 2008).** *Artemisia herba-alba* Asso, known also as desert wormwood *A. herba-alba* is a greenish-silver perennial herb grows 20-40 cm in height; it is a chamaeophyte (i.e. the buds giving rise to new growth each year are borne close to the ground). The stems are rigid and erect. The grey leaves of sterile shoots are petiolate, ovate to orbicular in outline whereas leaves of flowering stems are much smaller. The flowering heads are sessile, oblong and tapering at base. The plants flower from September to December. Plants are oblong and tapering at base. Plants are found on the steppes of the Middle East and North Africa where they are common and sometimes stand-forming (**Ozanda, 1991)**.*A. herba-alba* ,has been used in folk medicine by many cultures since ancient times, used in Moroccan folk medicine to treat arterial hypertension and/or diabetes (**Ziyyat *et al.*,1997; Zeggwagh, *et al*., 2008**). Herbal tea from this species has been used as analgesic, antibacterial, antispasmodic, and hemostatic agents **(Laid *et al*., 2008**). During an ethnopharmacological survey carried out among the Bedouins of the Negev desert, it was found that *Artemisia herba-alba* relieved stomach disorders (**Friedman *et al.*, 1986**) This plant is also suggested to be important as a fodder for sheep and for livestock in the plateau regions of Algeria where it grows abundantly (**Fenardji, 1974; Benmansour and Taleb Bendiab, 1998)**. Ascaridae from hogs and ground worms were killed by the oil of the Libyan *A. herba-alba* in a short time (**Callegari and Rossi, 1940)**. (**Figure f**)

1.7. *Oudneya africana* R.Br .

Oudneya africana (locally named Henat l`ibel**)** commonly used as medicinal plant. The genus *Oudneya* belongs to the Brassicaceae family and the brassiciodeae subfamily; it comprises about four thousand species (**Quezel and Santa, 1963**). They occur mainly in

temperate and cold regions of the Northern Hemisphere (**Brooks, 1987**). Is an endemic plant of sahara and is used in folk medicine by local people of Ouargla (Algeria) to treat wound cicatrisation and against the scorpion's bites. Therefore, the lack of the phytochemical information in the literature prompted this investigation in order to evaluate the chemical composition of the *Oudneya Africana* extracts its anti-microbial activity The phytochemical tests of the aerial parts of *Oudneya africana* showed the presence of saponosids, flavonoids, sterols, steroids and tannins in different quantities (**Bouhadjera *et al* 2005**).(**Figure g**)

1.8. *Ephedra alata* Decne.

Ephedra alata (locally named Alanda) Shrub 1to 3 meters high Rod was very branched twigs articles. Leaves opposite, alternant one node to the other, reduced, welded in sheath at their base. Flowers whitish in small cones, males and females generally differ on foot. She lives on the sandy terrian at the reg and river beds. It is common throughout northern and western Sahara. Fruits and young shoots are used in local medicine it is used in tea, against influenza, whooping cough and general weakness. It is also used as nasal drop cons rums.as an astringent. It is used also in the treatment of asthma, and as a cardiac stimulant. Relatives of this species contain ephedrine. (**Chahma, 2006; Ozenda, 1991; Quezel-Santa, 1962**) (**Figure h**)

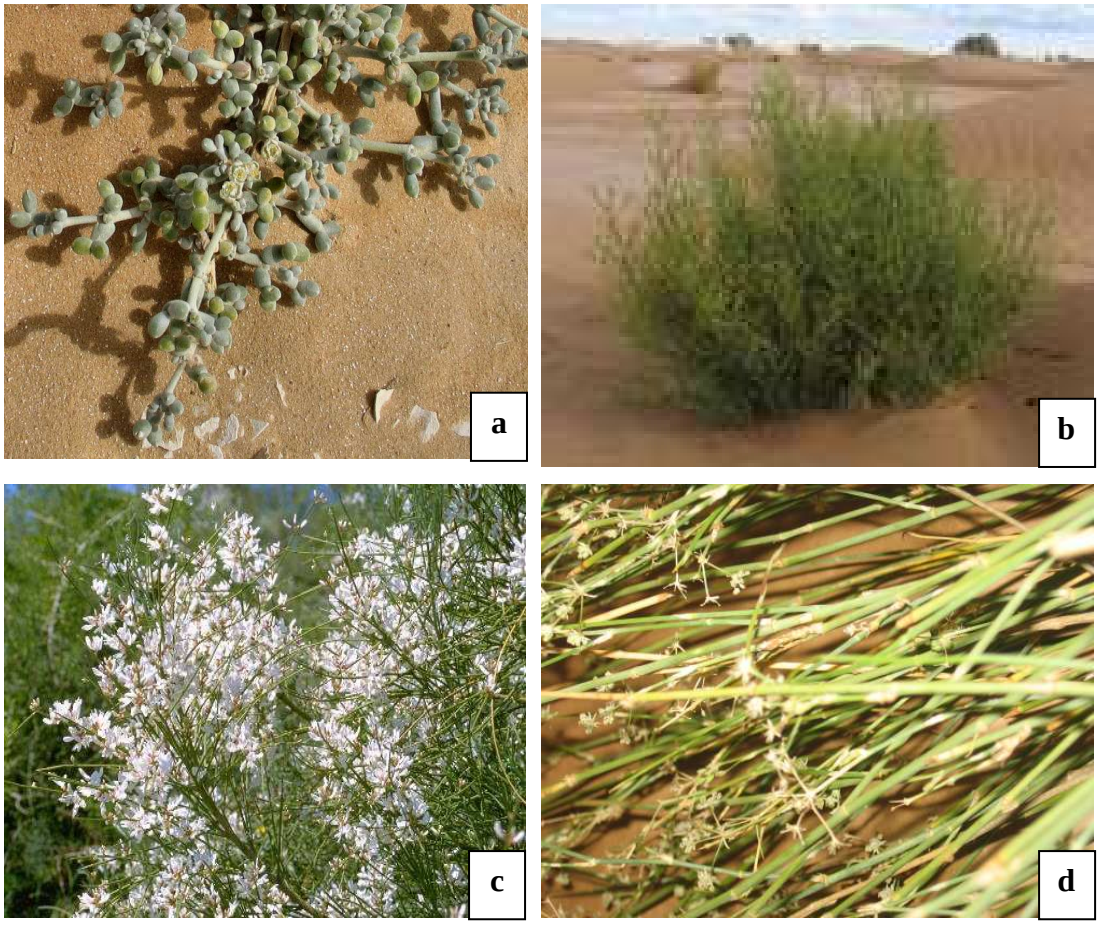

Plate 1a. The morphology of the selected donor species.
a. ***Zygophyllum album*** **. b.** ***Euphorbia guyoniana***
c. ***Retama raetam*** **d.** ***Pituranthos chloranthus***

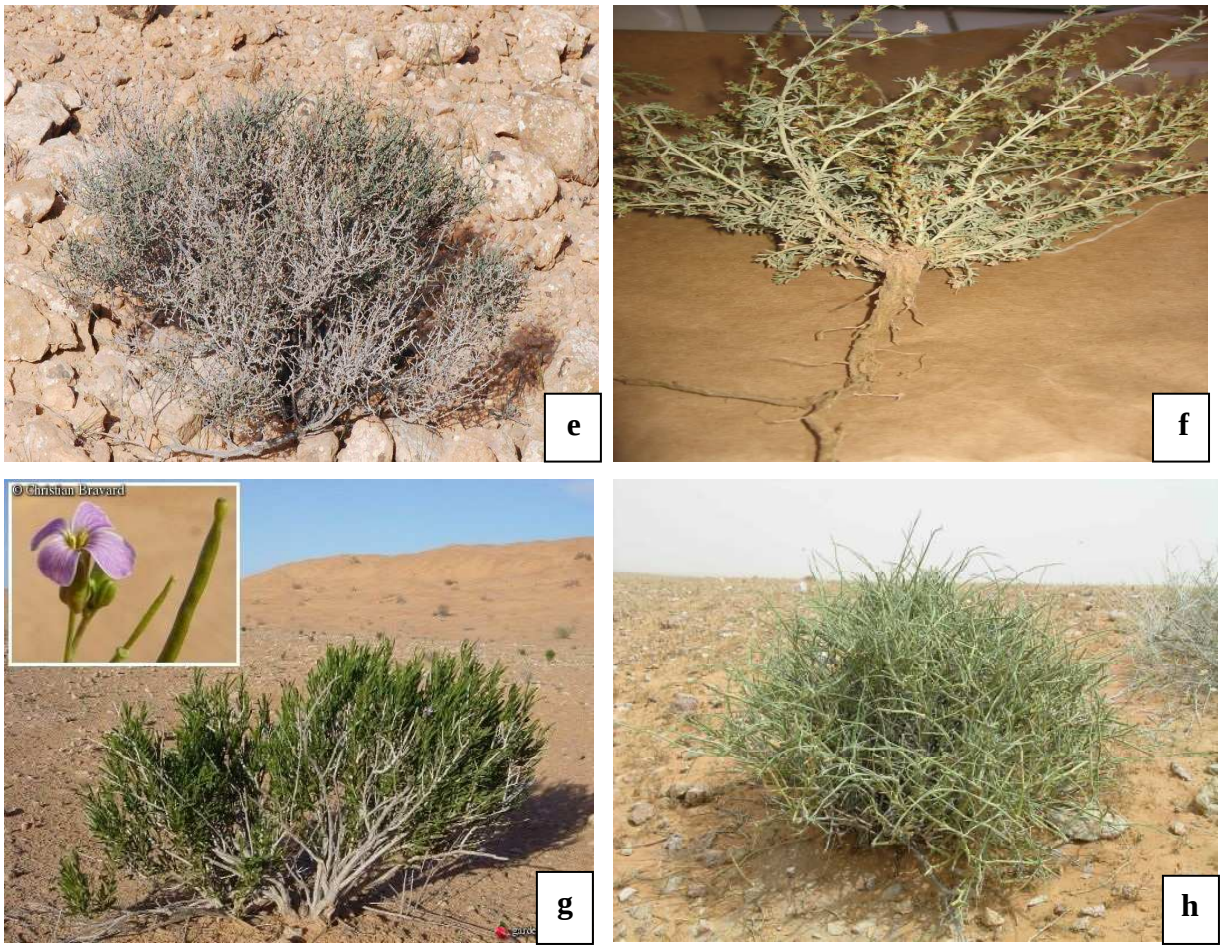

Plate 1b. The morphology of the selected donor species.

e. Haloxylon scoparium **f**. ***Artemisia herba-alba***
g. Oudneya Africana **h.** ***Ephedra alata***

2. Recipient Species (Weedy Species)

2.1 *Bromus tectorum* L.

Bromus tectorum.is a large genus of the true grass family (Poaceae). Estimates in the scientific literature of the number of species have ranged from 100 to 400, but plant taxonomists currently recognize around 160–170 species. Cheat grass is an annual or winter annual, softly downy to short-hairy throughout, and generally 10- 60cm (4- 24 in) tall. Stems are solitary or in a few-stemmed tuft. Ligules are short (usually 1- 2 mm long), membranous, and fringed at the top; auricles are lacking. Leaf blades are up to 20 cm (8 in) long, flat, relatively narrow, usually 2- 5 mm wide (1/8- 3/16 in), and generally long-ciliate near the base. The roots are fibrous and usually quite shallow; the plants do not root at the nodes. The inflorescence is a soft and drooping, much-branched, open panicle, usually becoming a dull red- purple color as it matures to a tan- buff color when fully cured. Spikelet's are about 1.5- 2.0 cm (0.6- 0.8 in) long with 3- 6 florets. Florets are 12- 19 mm (1/2- 3/4 in) long, tapering to sharp points. The glumes are shorter than the florets, the first 1-veined and the second 3-veined. Lemmas are sharply tipped, glabrous to densely hairy, more-or-less rounded on the back, and with a nearly straight awn that is 7- 18 mm (3/8- 5/8 in) long. Flowering occurs from April to mid June depending on climate and location. Reproduction is by seed. Germination occurs in fall through winter to early spring, depending on the climate and rainfall (**Hickman, 1993; Gleason and Cronquist, 1991; Cronquist *et al*., 1977; Uva *et al*., 1997**).

2.2 *Melilotus indica* L.

Melilotus indica (known in Arabic as Handakok) It is an annual or biennial herb from 10 to 50 centimetres in height (rarely to one metre), with yellow flowers. Leaves alternate, trifoliate. Leaflets obovate or oblong dentate, serrate in the upper half. Flowers in axillary racemes (20 -30), papilionate, Legume small, globose .Seeds yellow, small (**El-Hassanein *et al*., 2000**).It has a wide native distribution, ranging from Macaronesia and northern Africa, through Europe, and into temperate and tropical Asia. It is naturalised throughout most of the rest of the world, including the United Kingdom, the United States, South America, Australia and Zealand. It is used as a source of nectar for bees, as forage, and as a soil improver. It is also used in folk medicine. It is poisonous to some mammals, and is a potential seed crop contaminant.

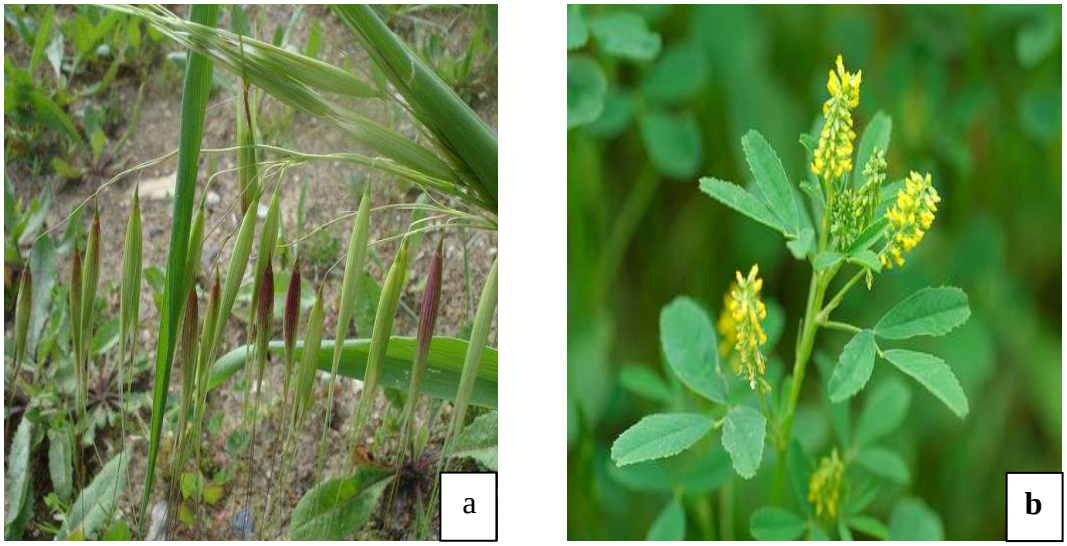

Plate 2. The morphology of the selected recipient species.

a. *Bromus tectorum* L.
b. *Melilotus indica* L.

MATERIALS AND METHODS

MATERIALS AND METHODS

The field work was set up during year 2007 and extended to the next season during 2008. Eight medicinal and aromatic plant species (donors) were used in this investigation to study their biological effect on the germination and growth criteria of two weeds and one crop species. Donor plants have been collected from three different areas of the basin of Ouargla **(Figure 3. 1).**

The seeds of the two weeds were collected from the farm of Technical Institute of Development and Agriculture Saharan in Hassi ben Abdullah while the seeds of the crop species were obtained from the Breeding Program of the Agricultural Research Center, Giza, Egypt. Donors, weeds and crop species are shown in Table.3.1

Table 3.1 Scientific names and families of donor and weed species.

Scientific Name	Family
Donor species	
Zygophyllum album L.	Zygophyllaceae
Euphorbia guyoniana Boiss. & Reut	Euphorbiaceae
Retama retam (Forssk.) Webb & Berthel	Fabaceae
Pituranthos chloranthus (Coss.&Dur) Benth & Hook	Apiaceae
Haloxylon scoparium (Pomel)	Chenopodiaceae
Artemisia herba-alba L.	Asteraceae
Oudneya africana R.Br.	Brassicaceae
Ephedra alata Decne .	Ephedraceae
Weed species	
Bromus tectorum L.	Poaceae
Melilotus indica L.	Fabaceae
Crop species	
Triticum aestivum L., var sahel 1	Poaceae

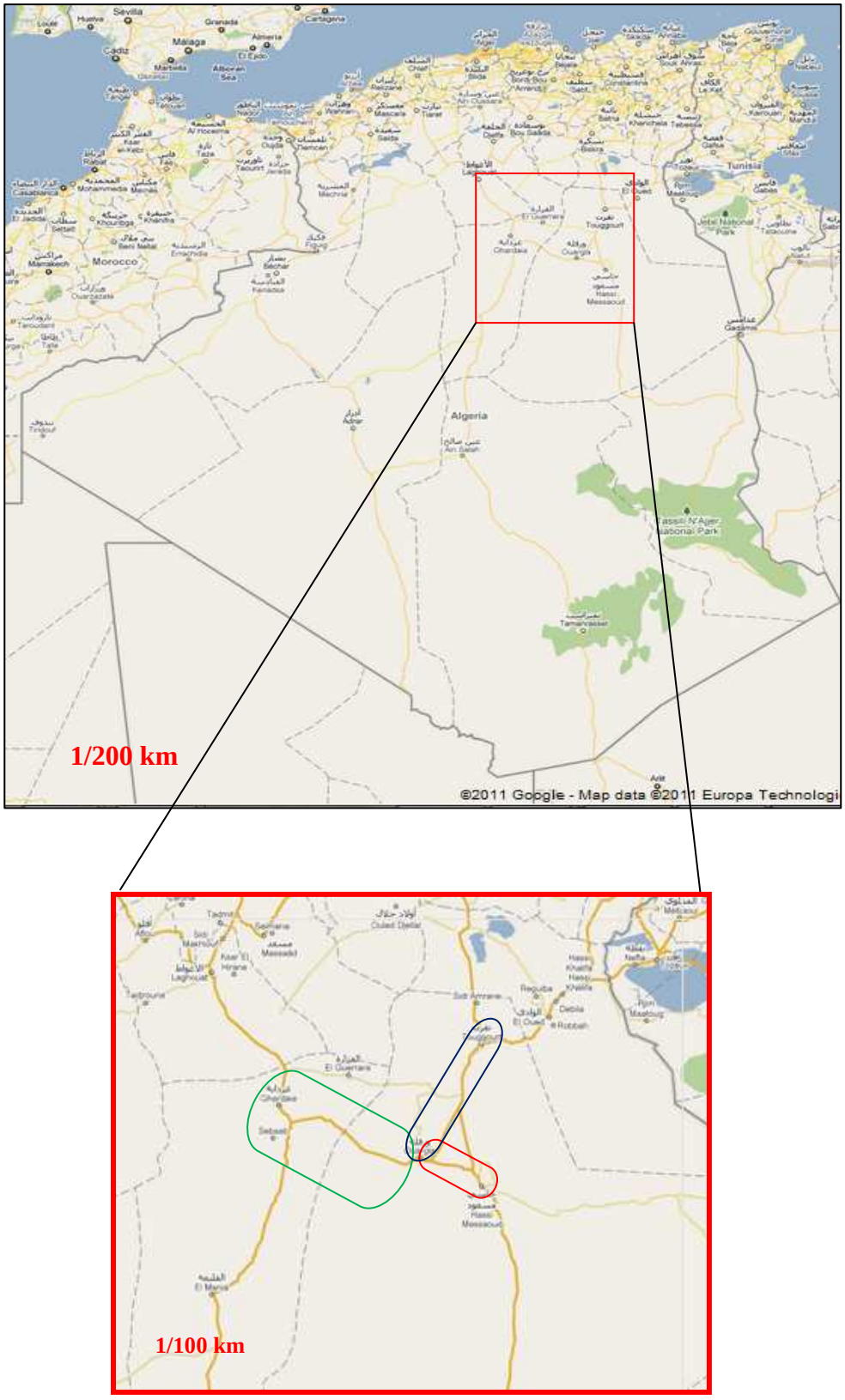

Figure 3.1 Situation of the study area (2011 Google- Map data)

1. Sampling and Preparation of Donor Species Aqueous Extract

A number of fresh samples from the aerial shoots of the donor species were collected from the natural habitats in the study area during the vegetative stage. The samples were air- dried thenafter ground in a Wiley Mill to fine uniform texture and stored in glass jars until use. Stock aqueous extract was obtained by soaking 50 g air-dried plant material in 500 ml of cold distilled water (10% w/v) at room temperature (20 $\pm 2^{o}$C) for 24 hours with occasional shaking. The mixture were filtered through two layers of cheesecloth and centrifuged for 20 min. at 10.000 r.p.m to remove particulate material and the purified extract was adjusted to pH 6.8 with 1M HCl. Different concentrations (2.5, 5, 7.5 and 10%) were prepared from the stock solution in addition to the control (distilled water).

2. Petri- dish Experiment

Petri-dish experiment was applied to investigate the possible allelopathic effects of each of the donor species aqueous extract on germination percentage (GP), seed germination index (SGI), inhibition percentage (IP), and plumule (PL) and radicle length (RL) of the two weeds (*Bromus tectorum* and *Melilotus indica*.) as well as the crop speceies (*Triticum aestivum* L., var sahel 1).

To achieve this experiment, ten seeds of each of the weed and crop species were arranged in 9-cm diameter Petri-dishes lined with two discs of Whatman No.1 filter paper under normal laboratory conditions with day temperature ranging from 19-22^{o}C and night temperature from 12-14^{o}C. Two ml of each level of the donor species extract (2.5, 5, 7.5 and 10%) were added daily to three replicates. Before sowing, the seeds were surface sterilized with 2% sodium hypochlorite for 2 minutes then rinsed four times with distilled water. The sterilized seeds were soaked in aerated distilled water for 24 hours. The experiment includes three seed sowing treatments 1- weed only (weed pure culture), 2- wheat only (crop pure culture) and 3-wheat and weed (mixed culture). GP, PL and RL were recorded after one weak at the end of the experiment. SGI was calculated according to the following equation (**Scott *et al.*, 1984; Khanh *et al.*, 2005**).

$$SGI = \sum Ti\ Ni / S$$

Where,
Ti = is the number of days after sowing
Ni = is the number of seeds germinated on day i
S = is the total number of seeds planted

Likewise, IP was calculated according to the general equations:

Relative reduction = [1- (allelopathic/control) × 100]

3. Pot Experiment

Pot experiment was performed to test the effect of different levels of the donor species crude powder mixed (w/w) with clay and sandy soils (collected from control locations) on some growth parameters and phytomass of two weedy species; *Bromus tectorum* and *Melilotus indica* and one crop species; wheat (*Triticum aestivum***)**. To achieve this, soil samples (clay and sandy) were collected from the adjacent crop fields, air-dried under shade, sieved to get rid of pebbles and plant debris and stored in paper bags ready for the analysis of some physico-chemical properties.

The samples finally sterilized at (90ºC for 48 h) to remove any microorganisms and weed seeds. Ten seeds of each of the recipient species were sown in plastic pots (16 cm in diameter) with about 1500 g of each clay and sandy soils thoroughly mixed (w/w) with 1, 3 and 6% of electrically crushed crude powder of the eight donor species (*Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata*).

The experiment was performed under normal laboratory conditions (23±2°C temperature, 75±2% relative humidity, and 14/10 h light/dark photoperiod). One treatment was run as control with zero percent of crude powder. Treatments were arranged in a completely randomized block design with three replications. The plants were watered every two days on the average with normal tap water. The amount of water corresponding to average soil–plant evapotranspiration calculated from weight loss over a 24 –hour interval

After 30 days the homogenous seedling were taken carefully from each treatment, washed with tap water to remove the adhering soil particles, and then by distilled water, gently blotted with filter paper. The data of the growth parameters are shoot length (SL) (cm), root length (RL) (cm), fresh and dry weight of shoot and root (gm) (SFw, RFw, SDw and RDw respectively) and the leaf number (LN). The samples were dried at 105^{o}C till constant weight to determine the dry weight.

4. Soil analysis

The soil samples were air-dried and passed through 2mm sieve to eliminate the gravels and debris, and finally analyzed for some of their chemical and physical properties. The electrical conductivity (EC) of soil- water extract (1:1 w/v) was measured using conductivity meter. Soil pH was determined in 1:1 (w/v) soil: water suspension using glass electrode. Soluble calcium and magnesium were determined volumetrically in soil – water extract 1:1 by the varsinate method (EDTA) using ammonium purpurate as an indicator for calcium and Eriochrome black T for calcium plus magnesium. Soluble chlorides were determined by titration with 0.01 N silver nitrate solution and potassium chromate as indicator. Soluble carbonate was determined volumetrically, in the soil water extract (1:1) by titration against 0.05 N hydrochloric acid solution using methyl orange as an indicator. Soluble sulphate was determined turbidimetrically with barium chloride. The organic carbon content was measured by the wet combustion method. Free carbon was estimated using a modified Walkely and Black method. Particle size distribution (sand, silt, and clay percentages and soil texture class) was determined according to the Bouyoucos hydrometer method. Available N in soil was determined by Micro-Kjeldahl method. Available P was extracted by sodium bicarbonate at pH 8.5, using the ascorbic sulfomolybdic blue color method. Available K was estimated by 1N ammonium acetate solution of pH 7. All these procedures were according to **Allen *et al*. (1974).**

5. Statistical analysis

All the data of the present study were subjected where appropriate; to standard two-way analysis of variance (ANOVA) and student's t-test (p-value < 0.05 was considered as significant) using the COSTAT 2.00 statistical analysis software manufactured by CoHort Software Company (**Zar, 1984**). Where a significant difference was detected by ANOVA test, pair-wise comparisons of means were performed using Least Significant Differences (LSD) at 0.05 probability level.

RESULTS

RESULTS

Two experiments were performed to verify the effect of different concentration levels of each of eight donor species (*Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata*) on two weedy species; *Bromus tectorum* and *Melilotus indica* and one crop species; wheat (*Triticum aestivum*). Petri-dish experiment was performed using aqueous extract to asses the effect on germination efficiency while pot experiment was applied to test the effect crude powder mixed (w/w) with clay and sandy soils (collected from control locations) on some growth parameters and phytomass. All the three mentioned species (one crop and two weeds) were considered as target or recipient species. The routine analyses for the two types of soils applied in the current study are presented in flowing Tables.

I. Allelopathic Potential of *Zygophyllum album* on *Bromus tectorum* , *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species)

1. Effect of *Zygophyllum album* aqueous extract (ZAAE) on germination efficiency (Petri-Dish Experiment)

Data of germination percentage (GP), seed germination index (SGI), germination inhibition percentage (GIP) and plumule (PL) and radicle (RL) length of the two weed species and wheat beside their statistical representation are illustrated in Table 4.1, 4.2..& 4.3

1.1 Germination Percentage (GP)

Commonly, GP of *Bromus tectorum* in pure and mixed cultures was significantly ($P \leq 0.05$) affected upon applying different concentrations of *Zygophyllum album* aqueous extract (ZAAE) (Table4.1 & Figure 4.1). It was obvious that in *Bromus tectorum* pure culture, the value was about 100% at control level. Continuously, it was decreased to about 83.3% at 2.5 and 5 % ZAAE concentrations. A great noteworthy reduction in GP values was attained along the higher ZAAE concentrations. Correspondingly, values were decreased to about 26.6 and 20% at 7.5 and 10% ZAAE concentrations, respectively. Lower values were detected in mixed culture compared to that estimated in pure culture. At control level, the value was initiated at about 96.6% and reduced to 75% at 2.5% concentration. Continuously, at 5% ZAAE concentrations, a great inhibition of about 20% respectively has occurred. Finally, germination was completely inhibited at 7.5 and 10% ZAAE concentration.

Table 4.1. Variation in the germination percentage (GP), Seed germination index (SGI), germination inhibition percentage (GIP) and plumule (PL) and radicle length (RL) of *Bromus tectorum* (pure culture) and *Bromus tectorum* x Wheat (mixed culture) as affected by different concentrations of *Zygophyllum album* aqueous extract (ZAAE)in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100.0^{a}	96.6^{a}	32.33^{a}	29.70^{a}	0.00	0.00	19.66^{a}	25.00^{a}	34.00^{a}	39.33^{a}
02.5	83.3^{b}	75.0^{b}	23.49^{b}	13.05^{b}	16.70^{c}	22.36^{c}	11.66^{b}	16.00^{b}	14.33^{b}	16.00^{b}
05.0	83.3^{b}	20.0^{c}	19.6^{c}	5.00^{c}	16.70^{c}	79.29^{b}	1.66^{c}	0.00^{c}	9.33^{c}	5.00^{c}
07.5	26.6^{c}	0.0^{d}	4.67^{d}	0·00^{d}	73.40^{b}	100^{a}	0.00^{d}	0.00^{c}	2.83^{d}	0.00^{d}
10.0	20.0^{d}	0.0^{d}	3.42^{e}	0·00^{d}	80·00^{a}	100^{a}	0.00^{d}	0.00^{c}	2.33^{d}	0.00^{d}
P-value	0.041*		0.018*		0.049*		0.15		0.39	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		*		NS	
AB interaction	**		**		**		*		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA:NS: not significant *: Significant at 0.05 **: Significant at 0.01

Similarly, GP of *Melilotus indica* seeds in pure and mixed cultures was significantly (P≤ 0.01) affected upon applying different concentrations of *Zygophyllum album* aqueous extract (ZAAE). (Table 4.2 & Figure 4.1). At control and 2.5% ZAAE, value attained was about 60% in pure culture. The percentage was reduced to about 45% at 5% ZAAE concentration level and to 30% at 7.5 and 10%. However, the values were decreased with the increase in ZAAE concentration in mixed cultures. The initial value (50%) at control was continuously reduced to 40 and 30% at 2.5 and 5% ZAAE concentrations, respectively, thereafter; the value attained a percentage of about 25% at 7.5 and 10 % ZAAE concentrations

Table 4.3& Figure 4.1 illustrate that the GP of wheat seeds in pure and two types of mixed cultures (Wheat x *Bromus tectorum* ; M1 and Wheat x *Melilotus indica*; M2) was significantly (P≤ 0.01) affected upon applying different concentrations of *Zygophyllum album* aqueous extract (ZAAE) and their interaction while the type of seed cultures not significant. Generally, GP of wheat decreased with the increase in ZAAE concentration in pure and mixed cultures (type M1 and M2). It was obvious that in pure culture, the value was about 100% at control and 2.5% ZAAE concentration. Continuously, it was 95% at 5 and7.5 % ZAAE concentrations. A great noteworthy reduction in the value was attained along the higher ZAAE concentrations. Correspondingly, values were decreased in pure culture to about 90% at 10% ZAAE concentrations. Lower values were detected in mixed culture (type M1). At control level, GP was initiated at about 96.66 % and increased to 100% at 2.5% concentration. Continuously, at 5 and 7% ZAAE concentration, a reduction to about 95% has occurred. Finally, GP value reached to its minimum (90%) at 10% ZAAE concentration. On the other hand, the GP in mixed culture type M2 was 100% at control, 2.5, 5 and 7.5% ZAAE while a value of 95% was obtained at 10% ZAAE concentration.

1.2 Seed germination index (SGI)

With respect to SGI of *Bromus tectorum* the value decreased distinctly as ZAAE concentration increased in pure and mixed culture. This reduction was statistically (P≤ 0.01) highly significant. Starting with pure culture, SGI began with a value of about 32.33 at both controls. On the other hand, lower SGI value (29.7) was detected in mixed culture at control. Continuously, in pure culture, the values 23.49 and 19.6 were obtained at 2.5 and 5% ZAAE concentrations, while in mixed culture the two values were reduced to 13.05 and 5, respectively. Finally, SGI declined till reached to the minimum values (4.67 and 3.42) in pure culture at 7.5 and 10% ZAAE concentration, respectively, and on the other hand the zero values at 7.5 and 10% ZAAE concentrations.(Table 4.1)

Table 4.2 Variation in germination percentage (GP), Seed germination index (SGI) ,germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of *Melilotus indica* (pure culture) and *Melilotus indica* x Wheat (mixed culture) as affected by different concentration of *Zygophyllum album* aqueous extract(ZAAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60[a]	50[a]	24.42[a]	21.93[a]	0.00	0.00	20.00[a]	23.00[a]	28.00[a]	18.66[a]
02.5	60[a]	40[b]	24.10[b]	17.05[b]	0.00[c]	20.00[c]	20.00[a]	22.5[b]	16.50[b]	8.50[b]
05.0	45[b]	30[c]	10.51[c]	10.83[c]	25.00[b]	40.00[b]	14.50[b]	15.00[c]	12.00[c]	6.00[c]
07.5	30[c]	25[d]	9.93[d]	8.75[d]	50.00[a]	50.00[a]	7.00[c]	14.40[d]	10.00[d]	6.00[c]
10.0	30[c]	25[d]	5.71[e]	5.43[e]	50.00[a]	50.00[a]	2.00[d]	4.50[e]	4.5.00[e]	5.00[c]
P-value	0.009**		0.090		0.094		0.032*		0.017*	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		**		**	
AB interaction	**		**		**		*		*	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test

TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

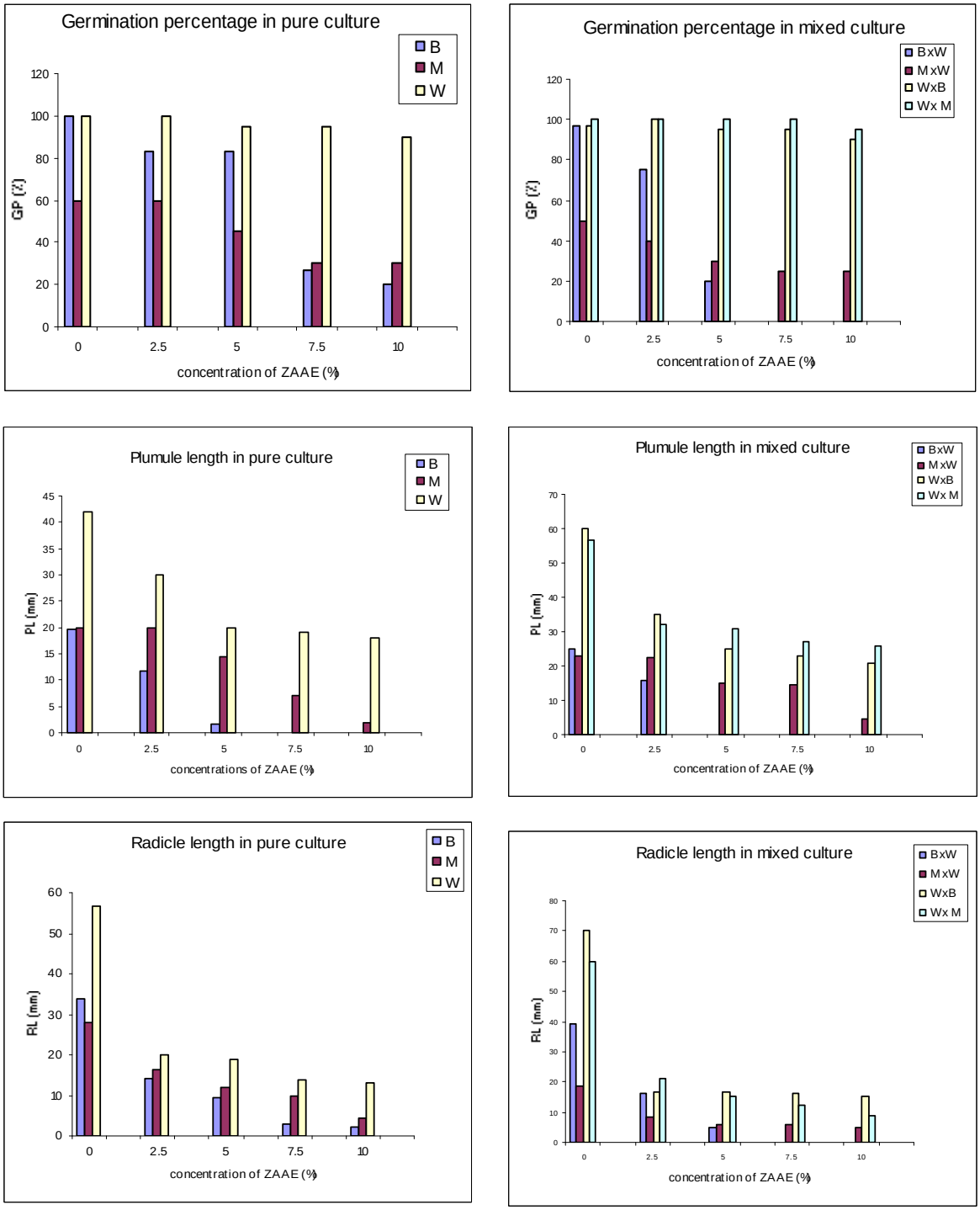

Figure 4.1. Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Zygophyllum album* aqueous extract (ZAAE) in Petri-dish experiment.

To go through with this, SGI of *Melilotus indica* in pure culture achieved higher values relative to that estimated in mixed one. Values of about 24.42 and 21.93 were attained in pure and mixed culture, respectively. Strikingly, in pure culture the values recorded at 2.5, 5, 7.5 and 10% ZAAE concentrations were about 24.1, 10.51, 9.93 and 5.71, respectively, while the comparable values in mixed culture were 17.5, 10.83, 8.75 and 5.43 respectively.(Table 4.2)

Concerning to SGI of wheat, the value decreased distinctly as ZAAE concentration increased in pure and mixed culture. This reduction was statistically ($P \leq 0.01$) highly significant. Starting with pure culture (Table 4.3), SGI began with a value of about 33.3 at control. On the other hand, the lower SGI values (32.2 and 47.5) were detected in mixed culture (M1 and M2), respectively, at control. Continuously, in pure culture, the values 31 and 30.71 were obtained at 2.5 and 5% ZAAE concentrations, respectively. However, SGI declined to the minimum values (4.67 and 3.42) in pure culture at 7.5 and 10% ZAAE concentration, respectively. In the mixed culture (type M1) the values were increased to 33.3 at 2.5% ZAAE but at 5 and 7.5% ZAAE level the equivalent value was 31.66 and 30 at 10% ZAAE concentration. Finally, the values 46.62, 46.6 and 44.3 at 5, 7.5 and 10% ZAAE concentrations were obtained in mixed culture (type M2).

1.3 Germination inhibition percentage (GIP)

In completion, data of the present study also demonstrated that GIP of *Bromus tectorum* was significantly affected ($P \leq 0.01$) due to the apparent allelopathic action of ZAAE concentrations in both pure and mixed culture (Table 4.1). No any GIP was attained at controls. Alternatively, at 2.5% concentration level, GIP in pure culture was (16.7%) compared to that attained in mixed culture (22.36%). To go through with this, GIP attained values of about 16.7, 73.4 and 80% at 5, 7.5 and 10% ZAAE concentration, respectively, in pure culture compared with 79.29, 100 and 100% in mixed one.

Accordingly, calculations of GIP demonstrated a steady elevation in both types of seed culture as extra ZAAE concentrations were applied. The values zero % at 2.5 %, 25% at 5 and 50% at 7.5 and 10% ZAAE were recorded in pure culture. Additionally, the values 20 and 40% at 2.5 and 5% ZAAE concentrations and 50% at 7.5 and 10% ZAAE concentrations, respectively, were attained in mixed culture. (Table 4.2)

Table 4.3. Variation in germination percentage (GP), seed germination index (SGI), germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of wheat (W) (pure culture), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentrations of *Zygophyllum album* aqueous extract (ZAAE) in Petri-dish experiment.

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.00^{a}	96.60b^{c}	100.00^{a}	33.30^{a}	32.20^{b}	47.50^{a}	0.00	0.00	0.00	42.00^{a}	60.00^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.00^{a}	100.00^{a}	100.00^{a}	31.00^{b}	33.30^{a}	47.50^{a}	0.00^{c}	0.00	0.00^{a}	30.00^{b}	35.00^{b}	32^{b}	20.00^{b}	16.50^{b}	21.00^{b}
5.0	95.00^{b}	95.00^{c}	100.00^{a}	30.71^{b}	31.66^{b}	46.62^{b}	5.00^{b}	1.65	0.00^{a}	20.00^{c}	25.00^{c}	31^{b}	19.00^{b}	16.50^{b}	15.00^{c}
7.5	95.00^{b}	95.00^{c}	100.00^{a}	30.38^{b}	31.66^{b}	46.60^{b}	5.00^{b}	1.65	0.00^{a}	19.00^{c}	23.00^{d}	27.00^{c}	14.00^{c}	16.00^{b}	12.50^{d}
10.0	90.00^{c}	90.00^{d}	95.00^{b}	28.75^{c}	30.00^{c}	44.30^{c}	10.00^{a}	6.83	5.00^{a}	18.00^{c}	21^{c}	26.00^{c}	13^{c}	15.00^{b}	9.00^{e}
TWO-WAY ANOVA															
A-Treatment		**			**			**			**			**	
B-Seed Culture		NS			**			NS			**			**	
AB interaction		**			**			**			**			**	

Different letters within each column indicate significance at P<0.05

Two-way ANOVA: NS: not significant **: Significant at 0.01

Data of GIP was significantly affected (P≤ 0.01) due to the apparent allelopathic action of ZAAE concentrations and their interaction in both pure and mixer culture (M1 and M2) while the type of seed culture was not significant. No any value of GIP was attained at control level. Alternatively, at the same concentration, the GIP in pure and mixed culture; type M2 was zero % at 2.5 % ZAAE concentration compared to in mixed culture; type M1 (Table 4.3) To go through with this, GIP attained values of about 5% at 5 and 7.5% ZAAE concentration level. At 10% ZAAE the value was 10% in pure culture but in mixed culture; type M1 the value was 1.65 at 5 and 7.5% ZAAE concentration and at 10% was 6.83%. In mixed culture; type M2 the same value (zero %) was attained at 2.5, 5 and 7.5% ZAAE while at 10% ZAAE a value of 5% was obtained.

1.4 Plumule length (PL)

In *Bromus tectorum* pure culture, the plumule elongation was not completely inhibited by the extract, but it was less at higher concentration levels (Table 4.1& Figure 4.1). Obviously, all allelopathic concentrations have reduced PL. Statistically, the applied concentrations of ZAAE, type of seed culture and their interaction were significantly (P≤ 0.05) affecting PL. As well, the immense negative response of the plumule growth was marked at 7.5 and 10% concentration in both pure and mixed cultures. Actually, at control level, PL of *Bromus* was about 19.66 and 25 mm in pure and mixed culture respectively. On the other hand, 2.5 and 5 % concentrations were considered as an inhibited concentration (the values in pure culture was about 11.66 and 1.66 respectively). On the other hand, in mixed culture, PL at 5, 7.5 and 10% concentration levels was completely inhibited.

The demonstrated data in Table 4.2 & Figure 4.1 pointed up that PL monitored in *Melilotus indica* was significantly affected (P ≤ 0.01). In pure culture, there was a noticed reduction in values of PL. at control and 2.5% ZAAE concentrations values were about 20 mm decreased to 14.5,7 and 2 mm at 5, 7.5 and 10% ZAAE concentrations, respectively. During growth, PL of *Melilotus indica* exerted an obvious PL elongation corresponding to that estimated in mixed culture. At control level, a value of about 23mm was noticed. This value was reduced to 22.5, 15, and 14.4 and 4.5 mm at 2.5, 5, 7.5 and 10% ZAAE concentrations, respectively.

Table 4.3& Figure 4.1 showed that in pure culture, the plumule elongation of wheat was not completely inhibited by the extract, but it was less at higher concentration levels. Obviously, all allelopathic concentrations have reduced PL. Statistically, the applied

concentrations of ZAAE, type of seed culture and their interaction were significantly (P≤ 0.01) affecting PL. Besides, the immense negative response of the plumule growth was marked at 7.5 and 10% concentration in pure and mixed culture. Actually, at control level, PL of wheat was about 42, 60 and 56.66 mm in pure and mixed culture type M1 and M2, respectively. On the other hand, 2.5, 5, 7.5 and 10% concentrations were considered as inhibitory concentrations (the value in pure culture was about 30, 20, 19 and 18mm respectively). On the other hand, in mixed culture type M1, PL at 5, 7.5 and 10% concentration levels was (35 ,25,23 and 21 mm) compared in the same level the values were 32, 31, 27and 26mm was obtained in mixed culture type M2.

1.5 Radicle length (RL)

Compared to control, a gradual decrease in RL of *Bromus tectorum* was observed along the gradual increase in ZAAE concentrations in pure and mixed cultures (Table 4.1 & figure 4.1). RL implication was significantly affected by the treatment at P≤ 0.01, their interaction are significantly affected at (P≤ 0.05) while the type of seed culture consequence was not significant. At control, the values of RL were 34 and 39.33 mm in pure and mixed culture, respectively. Higher concentrations of ZAAE were notably active disturbing radicle emergence. In pure culture, and at 2.5, and 5% concentrations, RL decreased to 14.33 and 9.33mm. Constantly, it continued reduction till it attained a value of about 2.83 and 2.33 mm at 7.5 and 10% concentration level. Almost the same reduction has occurred in mixed culture; the lowest value (zero mm) of RL was noticed at 7.5 and 10% ZAAE concentration. At 2.5 and 5% ZAAE concentration, RL decreased to 16 and 5 mm respectively in mixed culture.

Evaluation of RL correlated with higher ZAAE concentrations has demonstrated their depressing influence on *Melilotus indica*. Growth process (Table 4.2& Figure4.1). Furthermore, ZAAE concentration and interaction were significantly (P ≤ 0.01) affecting RL. In pure culture, the control value was about 28mm. At 2.5, 5, 7.5 and 10% ZAAE concentrations there has been a marked reduction in RL (16.5, 12, 10 and 4.5 mm respectively). The control value of RL in mixed culture was 18.66 mm. There was an explicit inhibitory effect of ZAAE concentrations to radicle elongation among the applied concentrations. At 2.5% ZAAE concentration, value of about 8.5 mm and 6mm at 5 and 7.5% ZAAE concentrations, finely 5 mm at 10%. ZAAE concentrations was recorded.The RL of wheat implication was significantly affected by the treatment, type of seed culture and their interaction at P≤ 0.01 (Table 4.3& Figure 4.1). At control, the values were 56.66,70 and 60 mm in pure and mixed culture type M1 and M2 respectively.

Higher concentrations of ZAAE were notably active disturbing radicle emergence. In pure culture, and at 2.5, and 5% concentrations, RL decreased to 20 and 19mm. constantly, it continues reduction till it attained a value of about 14 and 13 mm at 7.5 and 10% concentration level. Almost the same reduction has occurred in mixed culture; the lowest value (15 and 9 mm) of RL was noticed at 10% ZAAE concentration in M1 and M2 respectively. At 2.5 and 5%ZAAE concentration, RL decreased to16 mm in mixed culture type M1 and 15 mm at 7.5 ZAAE concentrations, while in M2 the values were 21, 15 and 12.5 mm at 2.5,5 and 7.5% ZAAE concentration, respectively.

2. Effect of *Zygophyllum album* Crude Powder (ZACP) on some growth parameters and phytomass (Pot Experiment)

2.1 Shoot length (SL)

The allelopathic effects of the Crude powder of *Zygophyllum album* on shoot length (SL) of the three recipient (target) species; Wheat and *Bromus tectorum* are represented in Table 4.4.a&b Data demonstrated that SL of all the two recipient species was significantly affected upon applying the different concentrations of ZACP. Generally, SL decreased with the increase in treatment concentrations under the clay and sandy soil. At control level and under clay soil the values were about 18.87 and 13.06 cm in Wheat and *Bromus tectorum* , respectively. Afterward, it reduced to 16.75 and 11.9 cm at 1%, 16.42 and 11.9 cm at 3% and 15.25 and 11.8cm at 6% ZACP concentrations for the two recipient species, respectively. Likewise, in sandy soil, values of SL were about 17.23 and 13.03 cm, respectively at control level. These values were reduced to 16.37 and 12.6cm at 1% and to 16.12 and 11cm at 3% while at 6% ZACP concentration the values 15.75 and zero cm were recovered for the two recipient species, respectively. The allelopathic effects of the Crude powder of *Zygophyllum album* on shoot length (SL) of the three recipient (target) species; Wheat and *Melilotus indica* are represented in Table 4.5.a&b. Data of the present study demonstrated that shoot length (SL) was significantly affected due to the apparent allelopathic action of ZACP concentrations under the clay and sandy soils. In clay soil, there was a slight reduction in values of SL. At control level, values of about 17.83 and14.46 cm of SL were noticed respectively. These values were reduced to 16.25 and 13, 25 at1% and to 15.35 and 13.40cm at 3% and at 6% ZACP concentration the values 14.37and13.25were obtained. Correspondingly, in sandy soil values of SL were about 18 and 13.40 cm at control level. These values were increased to 18.56 and17.80 cm at 1% but reduced to 16.53 and 16cm at 6% ZACP concentration for the two recipient species respectively.

Table 4.4.a. Allelopathic effect of different percentage of *Zygophyllum album* crude powder (ZACP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables / Treatment (%)	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.93^{a}	0.32^{a}	0.185^{a}	0.468^{a}	0.105^{a}	0.046^{a}	0.026^{a}	0.086^{a}
1	16.75^{b}	16.37^{b}	9.62^{b}	12.05^{b}	4.25^{b}	3.00^{a}	0.44^{b}	0.295^{a}	0.035^{b}	0.147^{a}	0.073^{b}	0.03^{a}	0.013^{B}	0.026^{b}
3	16.42^{b}	16.12^{b}	7.52^{c}	11.70^{c}	4.00^{b}	3.00^{a}	0.27^{c}	0.23^{b}	0.025^{b}	0.126^{c}	0.03^{c}	0.03^{a}	0.003^{c}	0.02^{bc}
6	15.25^{c}	15.75^{c}	6.67^{d}	9.20^{d}	4.00^{b}	3.00^{a}	0.26^{c}	0.17^{c}	0.01^{c}	0.046^{b}	0.022^{c}	0.03^{a}	0.003^{c}	0.0133^{c}
P-value	0.196		0.388		0.001**		0.095		0.046*		0.122		0.086	
TWO-WAY ANOVA														
A - Treatment	**		**		NS		**		**		**		**	
B- **Soil Type**	**		**		NS		**		**		**		**	
A x B	**		**		NS		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant **: Significant at 0.01

Table 4.4.b. Allelopathic effect of different percentage of *Zygophyllum album* crude powder (ZACP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06[a]	13.03[a]	7.10[a]	6.23[a]	3.00[a]	2.33[a]
1	11.90[b]	12.60[a]	3.43[b]	5.70[b]	2.66[b]	1.00[b]
3	11.90[b]	11.00[b]	3.43[b]	2.70[c]	2.33[b]	1.00[b]
6	11.80[b]	0.00[c]	3.13[b]	0.00[d]	2.00[b]	0.00[c]
P-value	0.214		0.317		0.007*	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-Soil Type	*		**		*	
A x B	**		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.2 Root length (RL)

Compared to control, RL of wheat and *Bromus tectorum* exhibited a significant reduction along gradual ZACP concentrations (Table 4.4.a&b). In clay soil, the control values were about 22.12 and 7.1cm for two recipient species respectively. At 1, 3 and 6% ZACP concentrations there has been a marked reduction in RL (9.62 and 3.43 cm and 7.52 and 3.43cm and 6.67 and3.13 cm respectively). Additionally, the control value of RL in sandy soil was about 16.6 and 6.23cm, respectively, at 1% concentration; the values of about 12.05 and 5.7cm and at 3%level the values 11.7 and 2.5cm were achieved. It was reduced to 9.2 and zero cm at 6% ZACP concentration for the two recipient species respectively.

Compared to control, RL of wheat and *Melilotus indicus* demonstrated significantly reduction along gradual ZACP concentrations (Table 4.5.a&b). In clay soil, the control values were about 25.10and 6.10cm for the tow recipient species respectively. These values were reduced to 10.82 and15.28 cm at 1% and to 8 and 5.05cm at3% level and at 6% ZACP concentration the values 7.95 and 4.12 cm were observed respectively. Likewise, the control values of RL in sandy soil were about 11.37and 6.56 cm for two recipients respectively. At 1% concentration the values of about 25.16and 9.50 cm were achieved, it reduced to 15.16 and 6.00cm at 6% ZACP concentration for the two recipient species respectively.

2.3 Leaf number (LN)

Generally, the effect on leaf number (LN) is not significant with the increase in treatment concentrations under the clay and sandy soil. At control level and under clay soil the values were about 5.25 and 3 in Wheat and *Bromus tectorum* respectively. Afterward, it reduced to 4.25 and 2.66 at 1%, 4 and 2.33 at 3% and 4 and 2 at 6% ZACP concentrations for the two recipient species respectively. Likewise, in sandy soil values of LN were about 3.66 and 2.33 respectively at control level. These the same value was about 3 at 1, 3% and 6% ZACP concentration for Wheat while, the value 1 at 1 and 3% level and zero at 6% ZACP concentration were recovered for of Bromus tectorum (Table4.4.a&b)

Leaf number (LN) was significantly affected by ZACP concentrations for Wheat while for *Melilotus indica*. Was not significant (Table 4.5 a&b).Values of about 4.33 and3.33 were attained at control level in clay soil for two recipients respectively but in sandy soil the values 4.66 and 2 for two recipients respectively . On Wheat were obtained the same value at 1 and 3 % concentration 3.25 and to 3 at 6% ZACP in clay and in sandy soil the value 4 at 1 and3% ZACP and at 6% ZACP concentration the value 3.66 was obtained. While the values of NL

on *Melilotus indica* were obtained 3 at1% ZACP and 2.5 at3 and 6% ZACP concentration was obtained in clay soil, compared in clay soil the value of 4 at 1 % concentration ZACP and at 3 and6% ZACP the value3 was obtained.

2.4 Shoot fresh weight (SFw)

Shoot fresh weight (SFw) of Wheat was significantly affected by ZACP concentrations (Table 4.4.a). The value 0.39 g plant^{-1} was attained at control level in clay soil. The values of SFw decreased to 0.44, 0.27 and 0.26 at 1,3and 6% ZACP concentration respectively. Similarly, in sandy soil, the control value of SFw 0.32 g plant^{-1} was obtained. As a response to ZACP allelopathic stress, SFw gradually decreased to 0.295, 0.225 and 0,175 g plant^{-1} at 1, 3 and 6% ZACP concentration, respectively

Shoot fresh weight (SFw) of Wheat was significantly affected by ZACP concentrations (Table 4.5.a). The Values 0.82 and 0.48 g.plant^{-1} was attained at control level in clay and sandy soil. The values of SFw decreased to 0.215, 0.120 and0.105 g.plant^{-1} at 1,3and 6% ZACP concentration respectively in clay soil. Similarly, in sandy soil, as a response to ZACP allelopathic stress, SFw gradually decreased to 0.50, 0.40 and 0.36 g.plant-^{1} at 1, 3 and6% ZACP concentration, respectively.

2.5 Root fresh weight (RFw)

In clay and sandy soil, the values of root fresh weight (RFw) of Wheat were about 0.185 and 0.468 g plant^{-1} at control level respectively. Through applying subsequent higher ZACP concentrations there was a continual reduction in RDw. Eventually, the values reduced to 0.035, 0.025 and 0.01 g plant^{-1} at 1, 3 and6% ZACP concentrations respectively in clay soil. On the other hand, the values of RFw in sandy soil were about 0.147, 0.1260.046 g.plant^{-1} at 1, 3 and 6% concentrations, respectively (Table4.4..a).

Root fresh weight (RFw) of whaet was significantly decreased in clay and sandy soils (Table 4.5.a). In clay and sandy soil, the values of RFw were about 0.146and 0.31g.plant-^{1} at control level. During applying higher ZACP concentrations there was a continual reduction in RFw. Eventually, at1.3 and 6% concentration, the values of RFw have reduced to 0.053, 0.025 and 0.02g.plant^{-1} for Wheat in clay soil. Likewise in sandy soil, At 1, 3 and 6% EGCP concentration, RFw reduced to 0.53, 0.246 and 0.04g.plant^{-1} were obtained, respectively.

Table 4.5.a .Allelopathic effect of different percentage of *Zygophyllum album* crude powder (ZACP) on some growth parameters of wheat (mixed culture with *Melilotus indica*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	17.83^{a}	18.00^{a}	25.10^{a}	11.37^{d}	4.33^{a}	4.66^{a}	0.82^{a}	0.48^{a}	0.146^{a}	0.310^{b}	0.100^{a}	0.060^{b}	0.026^{a}	0.073^{a}
1	16.25^{b}	18.56^{a}	10.82^{b}	25.16^{a}	3.25^{b}	3.66^{c}	0.10^{c}	0.36^{b}	0.053^{b}	0.530^{a}	0.040^{ab}	0.093^{d}	0.020^{b}	0.080^{a}
3	15.35^{c}	18.26^{a}	8.00^{c}	21.83^{b}	3.25^{b}	4.00^{b}	0.21^{b}	0.40^{b}	0.025^{b}	0.246^{c}	0.025^{b}	0.066^{b}	0.020^{b}	0.073^{a}
6	14.37^{d}	16.53^{b}	7.95^{c}	15.16^{c}	3.00^{b}	4.00^{b}	0.12^{c}	0.50^{a}	0.020^{b}	0.090^{d}	0.020^{b}	0.046^{c}	0.013^{c}	0.020^{b}
P-value	0.049*		0.235		0.013*		0.253		0.051*		0.207		0.019*	
TWO-WAY ANOVA														
A - Treatment	*		**		*		**		**		**		**	
B- Soil Type	**		**		*		*		**		**		**	
A x B	*		**		NS		**		**		**		**	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test

TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.5.b.Allelopathic effect of different percentage of *Zygophyllum album* crude (ZACP) on some growth parameters of *Melilotus indica* , (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables treatment	Shoot length (cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46^{a}	3.40^{c}	6.10^{a}	6.56^{c}	3.33^{a}	2.00^{b}
1	14.25^{a}	17.80^{a}	5.28^{b}	9.50^{a}	2.50^{a}	4.00^{a}
3	13.40^{b}	16.50^{b}	5.05^{b}	8.30^{b}	2.50^{a}	3.00^{ab}
6	13.25^{b}	16.00^{b}	4.12^{b}	6.00^{c}	3.00^{a}	3.00^{ab}
P-value	0.193		0.028*		0.397	
TWO-WAY ANOVA						
A – Treatment	*		*		NS	
B-Soil Type	**		**		NS	
A x B	*		*		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.6 Shoot dry weight (SDw)

Shoot dry weight (SDw) of wheat was significantly affected by ZACP concentrations (Table 4.4.a). Values of about 0.105 and 0.046 g.plant^{-1} were attained at control level in clay and sandy soil respectively. The values of SDw decreased to 0.073, 0.03 and 0.022 g.plant^{-1} at 1, 3 and 6% ZACP concentrations, respectively, in clay soil. Similarly, in sandy soil, the same value of SDw 0.03 g.plant^{-1} was obtained at 1, 3 and 6% ZACP concentrations.

Statistically, there was not significant reduction of Shoot dry weight (SDw) of wheat as a consequence of raising ZACP concentrations (Table 4.5.a). In clay soil, the control value of SDw was about 0.10 g.plant^{-1}, at1, 3 and 6% ZACP concentration the values of about 0.04, 0.025 and 0.02 g.plant^{-1} were achieved for Wheat. Similarly, in sandy soil the control value of SDw was about 0.046 g.plant^{-1}. At 1, 3 and6% ZACP concentrations the Value of about0.093, 0.066 and0.046 g.plant^{-1} were achieved.

2.7 Root dry weight (RDw)

In clay soil, the value of root dry weight (RDw) of wheat was 0.026 g.plant^{-1} at control level. Through applying subsequent higher ZACP concentrations there was a continual reduction in RDw. Eventually, the value reduced to 0.013 g.plant^{-1} at 1% ZACP concentrations while at 3 and6%ZACP the value 0.003 g.plant^{-1} was recovered. On the other hand, the control value of RDw in sandy soil was 0.086 g.plant^{-1} and at 1, 3 and 6%ZACP concentrations the RDw was reduced to 0.026, 0.02 and 0.013 g.plant-1 for Wheat (Table 4.4.a).

Discernibly, significant reduction of root dry weight (RDw) of Wheat upon applying the different concentrations of ZACP was attained. In clay soil, there was a slight reduction in values of RDw; at control level the values of RDw were about 0.026 g.plant^{-1} and 0.02 g.plant^{-1} at 1and 3 % ZACP concentration and at 6% ZACP the value 0.013g.plant^{-1} was obtained. Correspondingly, in sandy soil the control and 3% the same value of RDw was about 0.073g.plant^{-1}. At 1and 6% ZACP concentrations, RDw values about 0.08 and 0.02 g.plant^{-1} was obtained. (Table 4.5.a).

II. Allelopathic Potential of *Euphorbia guyoniana* on *Bromus tectorum* , *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species).

1. Effect of *Euphorbia guyoniana* Aqueous Extract (EGAE) on germination efficiency (Petri-Dish Experiment)

Table 4.6, 4.7 & 4.8 Demonstrates a great variation in the calculated values of GP, SGI and GIP of *Bromus tectorum* , *Melilotus indica* and wheat seeds in pure and mixed cultures.

1.1 Germination Percentage (GP)

The GP of *Bromus tectorum* was significantly ($P \leq 0.01$) affected by the increase in EGAE concentration. (Table 4.6 &Figure 4.2). At control and 2.5% EGAE, GP value was about 100% in pure culture. The percentage was reduced to 36.6% at 5 and 7.5% EGAE concentration level and to 10% at 10% EGAE concentrations. However the GP values were decreased with the increase in EGAE concentration in mixed cultures the value was about 96.6% at control. Continuously, it was 65% at 2.5%, finally; germination was completely inhibited at 5, 7.5 and 10% EGAE concentrations.

Generally, GP of *Melilotus indica* seeds were apparently varied with of EGAE concentrations (Table 4.7&Figure 4.2) which is supported statistically ($P \leq 0.01$). In pure culture, the attained GP values at control conditions (60%) were increased upon applying 2.5 and 5% EGAE concentrations (55 and 50% respectively). However, this current motivation goes to a marked reduction at 7.5 and 10% concentrations (40 and 35% respectively). On contrast, *Melilotus indica* germination process was better in mixed culture relative to pure culture. GP value at control level (50%) undergoes minor diminishing (60%) at 2.5% concentration level. Continually, GP decreased to about 45, 40 and 30 % at 5, 7.5 and 10% EGAE concentrations, respectively.

Table 4.8 & Figure4.2 demonstrates a great variation in the calculated values of GP of wheat seeds in both pure and mixed cultures (type M1 and M2). The GP was significantly ($P \leq 0.01$) affected by the increase in EGAE concentrations. In mixed culture ; type M1 the value was obtained about 96.6% at control and at control, 2.5 and 5% EGAE, GP values were about 100% in pure culture and mixed culture; type M2. The percentage was reduced to 95 % at7.5 and 10% EGAE concentration level in pure and mixed culture type M1 and M2, respectively.

Table 4.6 Variation in germination percentage(GP),Seed germination index (SGI) ,germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of *Bromus tectorum* (pure culture) and *Bromus tectorum* x wheat (mixed culture) as affected by different concentration *Euphorbia guyoniana* aqueous extract (EGAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100.0^{a}	96.6^{a}	32.33^{a}	29.7^{a}	00.0	00.0	19.66^{a}	25^{a}	34^{a}	39.33^{a}
02.5	100.0^{a}	65.0^{b}	26.59^{b}	17.5^{b}	00.0^{c}	32.71^{b}	10.66^{b}	0.00^{b}	5.66^{b}	5.00^{b}
05.0	36.6^{b}	0.0^{c}	6.94^{c}	0.0^{c}	63.4^{b}	100.0^{a}	0.00^{c}	0 .00^{b}	2.66^{c}	0.00^{c}
07.5	36.6^{b}	0.0^{c}	5.30^{d}	0.0^{c}	63.4^{b}	100.0^{a}	0.00^{c}	0.00^{b}	1.83^{c}	0.00^{c}
10.0	10.0^{c}	0.0^{c}	2.26^{e}	0.0^{c}	90.0^{a}	100.0^{a}	00.0^{c}	0.00^{b}	1.33^{c}	0.00^{c}
P-value	0.014*		0.007**		0.01**		0.35		0.43	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		*		NS	
AB interaction	**		*		**		**		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

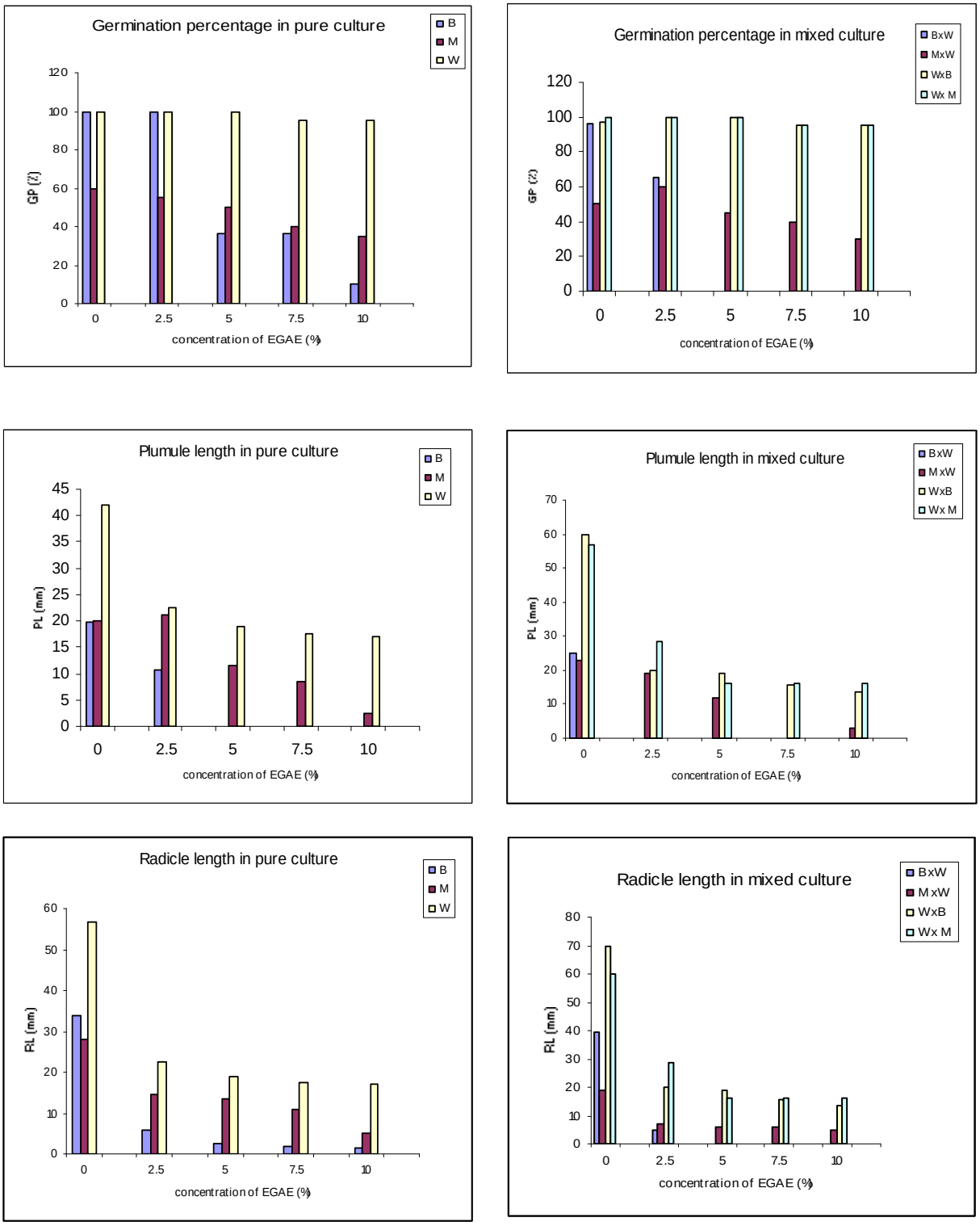

Figure 4.2. Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Euphorbia guyoniana* aqueous extract (EGAE) in Petri-dish experiment.

1.2 Seed germination index (SGI)

As a response to higher EGAE concentrations, fewer *Bromus tectorum* seeds succeeded in germination (significantly affected at P≤ 0.01) (Table 4.6). Generally, SGI in pure culture was higher relative to that estimated in mixed culture. The control values 32.33 and 29.7 were attained in pure and mixed culture respectively. Values of SGI recorded at 2.5, 5, 7.5 and 10% EGAE concentrations were about 26.59, 6.94, 5.3 and 2.26 respectively in pure culture, while the parallel values in mixed culture one were 17.5 and zero, respectively.

The SGI of *Melilotus indica* a values at control were about 24.42 and 21.93 in pure and mixed culture, respectively. The statistical implications elucidate the effect of EGAE concentration-type of seed culture interaction, EGAE concentration, and type of seed culture was highly significant (P≤ 0.01) (Table 4.7). Perceptibly, the values of about 17.41,11.43,10.62and 9.37 were obtained in pure culture at 2.5, 5,7.5 and 10% concentrations, respectively, while parallel values of about 22.5,15.3,13.3and 12.85 were attained in mixed culture .

The control values of SGI for wheat (33.3, 32.2 and46.62) were attained in pure and mixed culture type; M1 and M2, respectively. Values of SGI recorded at 2.5, 5, 7.5 and 10% EGAE concentrations were about 31.6, 30.8, 30.55 and 29.3, respectively in pure culture, while the parallel values in mixed culture; type M2 were 50, 38.75, 32.85 and 31.7, respectively, but in mixed culture; type M1 the was obtained the same value (31, 25) at 7.5 and 10% EGAE concentrations while at 2.5and 5 % EGAE the values were 32.5 and 32 was obtained. (Table 4.8)

1.3 Germination inhibition percentage (GIP)

Consequently, calculations of GIP of *Bromus tectorum* demonstrated a steady elevation in both seed culture as more EGAE concentrations were applied (Table 4.6). The values zero % at 2.5 % and 63.4% at 5 and 7.5% EGAE concentrations and 90% at 10% EGAE was recorded in pure culture whereas the values 32.71% at 2.5% and 100% was attained in mixed culture at 5, 7.5and 10% EGAE concentrations, respectively. Thus, it is patent that *Bromus tectorum* seeds experienced more inhibition when germinated in mixed culture.

Table 4.7 Variation in germination percentage (GP), Seed germination index (SGI) ,germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of *Melilotus indica* (pure culture) and *Melilotus indica* x Wheat (mixed culture) as affected by different concentration *Euphorbia guyoniana* aqueous extract (EGAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60^{a}	50^{b}	24.42^{a}	21.93^{b}	0.00	0.00	20.00^{a}	23.00^{a}	28.00^{a}	18.66^{a}
02.5	55^{ab}	60^{a}	17.41^{b}	22.50^{a}	8.33^{c}	-20.00d	18.00^{b}	19.00^{b}	14.50^{b}	7.00^{b}
05.0	50^{b}	45^{bc}	11.43^{c}	15.30^{c}	16.66^{c}	10.00^{c}	11.50^{b}	12.00^{c}	13.50^{b}	6.00^{bc}
07.5	40^{c}	40^{c}	10.62^{d}	13.30^{d}	33.33^{b}	20.00^{b}	8.50^{c}	11.50^{c}	11.00^{c}	6.00^{bc}
10.0	35^{d}	30^{d}	9.37^{e}	12.85^{d}	41.66^{a}	40.00^{a}	2.50^{d}	3.00^{d}	5.00^{d}	5.00^{c}
P-value	0.009**		0.090		0.094		0.032*		0.017*	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		NS		*		**	
AB interaction	**		**		NS		*		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant

The influence of EGAE concentrations on GIP of *Melilotus indica* was highly significant (P≤ 0.01) However, GIP response to type of seed culture and their EGAE concentration-type of seed culture interaction were not significant (Table 4.7). GIP started with a value of about 8.33% at 2% EGAE concentration level. Evidently, the pure culture caused a regular inhibition to *Melilotus indica* seeds at all EGAE concentrations. Thus, GIP was higher compared to that of pure culture. At 10% EGAE concentration, the value of GIP was 41.66% in pure culture while in mixed culture the highest values of about 40% were achieved.

The GIP of wheat demonstrated a steady elevation in both seed culture as more EGAE concentrations were applied. The values zero% at 2.5 and 5% EGAE were recorded in pure and mixed culture; type M1 and M2, respectively, whereas the values 5% was attained in pure and mixed culture; type M2 at 7.5 and 10% EGAE concentrations, respectively, and 1.65 at 7.5and10% EGAE concentration was recorded in mixed culture; type M1.(Table 4.8)

1.4 Plumule length (PL)

Findings of PL of *Bromus tectorum* imply the downbeat effect of the allelopathic substances on seedling stage (Table 4.6& Figure 4.2). Evidently, PL was significantly reduced (P≤ 0.01) either due to each main effect as an individual or due to their interactions. Additionally, in pure culture, values of PL were 19.66 mm at control level. Afterward, it reduced to 10.66 mm at 2.5% EGAE concentration. Expectedly, the maximum allelopathic action of 5, 7.5 and 10% EGAE concentration has completely inhibited PL. The influence of the type of seed culture was observed on PL measurements in mixed culture. This type of culture has evidently promoted the plumule growth. At control level, values of PL were 25mm in mixed culture. Except control, PL has attained zero value at all EGAE concentration.

The allelopathic effect of EGAE concentration on PL of *Melilotus indica* is illustrated in Table 4.7& Figure 4.2 In pure and mixed culture, the plumule elongation was not completely inhibited by the extract, but it was less at higher concentration levels. Obviously, all allelopathic concentrations have reduced PL. Statistically, the applied concentrations of EGAE was highly significant (P≤ 0.01) but, the type of seed culture and their interaction was significantly (P≤ 0.05) affecting PL. Actually, at control level, PL of *Melilotus indica* .was about 20 and 23 mm in pure and mixed culture respectively. On the other hand, 2.5, 5, 7.5 and 10 % concentrations were considered as inhibitory concentrations (the value in pure culture about 18, 11.5, 8.5and 2.5mm respectively). On the other hand, in mixed culture, PL at 2.5,5, 7.5 and 10% concentration levels were 19, 12, 11.5 and 3mm were attained.

Table 4.8 Variation in germination percentage (GP), Seed germination index (SGI) , germination inhibition percentage (GIP) ,plumule (PL) and radicle length (RL) of wheat (W) (pure culture) , wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentration of *Euphorbia guyoniana* aqueous extract (EGAE) in Petri-dish experiment.

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.0^{a}	96.6^{b}	100.0^{a}	33.30^{a}	32.20^{a}	46.62^{b}	0.00	0.00	0.00	42.00^{a}	60.0^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.0^{a}	100.0^{b}	100.0^{a}	31.60^{a}	32.50^{a}	50.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}	37.50^{b}	47.50 ^{b}	52.50^{b}	22.50^{b}	20.00^{b}	28. 50^{b}
5.0	100.0^{a}	100.0^{b}	100.0^{a}	30.80^{c}	32.00^{a}	38.75^{c}	0.00^{b}	0.00^{b}	0.00$^{.b}$	26.50^{c}	15.00^{cd}	40.00^{c}	19.00^{c}	19.00^{b}	16.00c
7.5	95.0^{b}	95.0^{c}	95.0^{b}	30.55^{d}	31.25^{a}	32.85^{d}	5.00^{a}	1.65	5.00^{a}	19.00^{d}	13.50^{d}	25.00^{d}	17.50^{d}	15.50^{c}	16.00^{c}
10.0	95.0^{b}	95.0^{c}	95.0^{b}	29.30^{e}	31.25^{a}	31.70^{e}	5.00^{a}	1.65	5.00^{b}	18.00^{d}	13.50^{d}	21.00^{e}	17.00^{d}	13.50^{d}	16.00^{c}
TWO-WAY ANOVA															
A-Treatment		**			**			**			**			**	
B-Seed Culture		**			**			**			**			**	
AB interaction		**			**			**			**			**	

Different letters within each column indicate significance at P<0.05

Two-way ANOVA:
NS: not significant *: Significant at 0.05 **: Significant at 0.01

The PL of wheat was significantly (P≤ 0.01) either due to each main effect as an individual or due to their interactions (Table 4.8& Figure 4.2). Additionally, in pure culture, value of about 42 mm at control level. Afterward, it reduced to 37.3 mm at 2.5% EGAE concentration. Expectedly, the maximum allelopathic action of 5, 7.5 and 10% EGAE concentration was 26.5, 19 and18mm were recorded. The influence of the type of seed culture was observed on PL measurements in mixed culture. This type of culture has evidently promoted the plumule growth. At control level, values were 60 and 56.66 mm in mixed culture; type M1 and M2 respectively. the PL has attained 47 and 15 mm at 2.5 and 5% EGAE concentration and at 7.5 and10% was obtained the same value (13.5mm) were attained in mixed culture; type M1 while in mixed culture; type M2 the values were 52.5,40,25 and 21mm was obtained.

1.5 Radicle length (RL)

A slight difference was observed among *Bromus tectorum* RL assessment in seeds culture (Table 4.6 & Figure 4.2). In pure culture, the control value was 34 mm. Elevated EGAE concentrations have possessed a significant inhibitory effect on radical growth (P≤ 0.01). At 2.5% EGAE concentration, it was 5.66 mm in pure culture. Upon applying the highest EGAE concentration (10%), it has reduced to 1.33mm. Evidently, RL measurements have illustrated lower assessments in mixed culture. At control, 39.33 mm was achieved. A gradual reduction has then occurred as a result of applying ascending EGAE concentrations. A value was 5mm at 2.5% but at 5, 7.5 and 10% EGAE concentrations the germination was completely inhibited.

Compared to control, a gradual decrease in RL of *Melilotus indica* was observed along gradual increase in EGAE concentrations in pure and mixed cultures. RL implication was significantly affected by the treatment at P≤ 0.01 while the type of seed culture consequence and their interaction are significantly affected at (P≤ 0.05) (Table 4.7& Figure 4.2). At control, the values of RL were 28 and 18.66 mm in pure and mixed culture respectively. Higher concentrations of EGAE were notably active disturbing radicle emergence. In pure culture, at 2.5, and 5% concentrations, RL decreased to 14.5 and 13.5mm. Constantly, it continues reduction till it attained a value of about 11 and 5 mm at 7.5 and 10% concentration level. Almost the same reduction has occurred in mixed culture; the lowest value (6 mm) of RL was noticed at 5 and 7.5% EGAE concentration. At 2.5 and 10% EGAE concentration, RL decreased to 7 and 5 mm respectively were attained in mixed culture.

In pure and mixed culture; type M1 and M2, the control values of RL of wheat were 56.66,70 and 60 mm respectively. Elevated EGAE concentrations have possessed a significant inhibitory effect on radical growth ($P \leq 0.01$) (Table 4.8 &Figure 4.2). At 2.5% EGAE concentration it was 22.5, 20 and 28 mm in pure and mixed culture; type M1 and M2. Upon applying the highest EGAE concentration (10%), it has reduced to 17mm in pure culture and at 5 and 7.5% EGAE the values were 19 and 17.5 mm. On the other hand in mixed culture; type M1. At 5, 7.5 and 10% EGAE the values were 19, 15.5 and 13.5 mm respectively. While in mixed culture; type M2 the same value (16mm) was obtained at 5, 7.5 and 10% EGAE concentrations.

2. Effect of *Euphorbia guyoniana* Crude Powder (EGCP) on some growth parameters and phytomass (Pot Experiment)

2.1 Shoot length (SL)

The demonstrated data of *Bromus tectorum* in Table 4.9a&b. pointed up that shoot length (SL) was significantly affected upon applying the different concentrations of EGCP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 18.87and13.06 cm of SL were noticed respectively. These values were reduced to 15.97 and 12.43cm at 1% and to 15.9 and 11.9cm at 3% and at 6% EGCP concentration the values 15.75 and 11.83cm were obtained for the two recipient species, respectively. Likewise, in sandy soil values of SL were about 17.23 and 13.03cm at control level, respectively. These values were reduced to 16.05 and 11.66cm at 1% and to 16.02 and 11.6cm at 3% while at 6%EGCP concentration the values 15.65 and 11.25 cm were recovered for the two recipient species, in that order.

Data of Wheat and *Melilotus indica* the present study demonstrated that SL was not significant affected due to the apparent allelopathic action of EGCP concentrations under the clay and sandy soils for Wheat while for *Melilotus indica* was significantly affected , (Table 4.10.a.b). In clay soil, there was a slight reduction in values of SL. At control level, values of about 17.83 and14.46 cm of SL were noticed respectively. These values were reduced to 16.37 and 16.25cm at1% and to 15.87 and 15.05cm at 3% and at 6% EGCP concentration the values 15.80 and14.50 cm were obtained. Correspondingly, in sandy soil values of SL were about 18.00 and 13.40 cm at control level. These values were increased to 18.10 and17.20 cm at 1% and at3 and 6% EGCP concentration these values were reduced to 17.50 and zero cm were obtained for the two recipient species, respectively.

Table 4.9.a .Allelopathic effect of different percentage of *Euphorbia guyoniana* crude powder (EGCP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.93^{a}	0.32^{a}	0.185^{a}	0.468^{a}	0.105^{a}	0.046^{a}	0.026^{a}	0.086^{a}
1	15.97^{b}	16.05^{b}	9.32^{b}	12.25^{b}	4.25^{a}	3^{a}	0.27^{b}	0.29^{a}	0.040^{b}	0.070^{b}	0.027^{b}	0.040^{a}	0.013^{b}	0.026^{b}
3	15.9^{bc}	16.02^{b}	8.7^{b}	11.75^{c}	4^{a}	3^{a}	0.25^{b}	0.24^{b}	0.040^{b}	0.045^{c}	0.027^{b}	0.030^{a}	0.013^{b}	0.013^{c}
6	15.75^{c}	15.65^{c}	7.5^{b}	11.22^{d}	4^{a}	3^{a}	0.25^{b}	0.18^{c}	0.025^{b}	0.040^{c}	0.022^{b}	0.025^{a}	0.006^{c}	0.013^{c}
P-value	0.219		0.359		0.001*		0.172		0.152		0.294		0.118	
TWO-WAY ANOVA														
A - Treatment	**		**		NS		**		**		**		**	
B- Soil Type	**		*		NS		**		**		*		**	
A x B	**		**		NS		**		**		**		**	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test

TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.9.b.Allelopathic effect of different percentage of *Euphorbia guyoniana* crude powder (EGCP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06[a]	13.03[a]	7.10[a]	6.23[a]	3.00[a]	2.33[a]
1	12.43[b]	11.66[b]	4.60[b]	5.83[a]	3.00[a]	1.00[a]
3	11.90[c]	11.60[b]	4.43[b]	4.10[b]	2.66[a]	1.00[a]
6	11.83[c]	11.25[b]	2.70[c]	3.50[b]	2.66[a]	1.00[a]
P-value	0.1009		0.4220		0.0068*	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-Soil Type	**		NS		*	
A x B	*		**		NS	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test

TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.2 Root length (RL)

The allelopathic effect of EGCP concentration on RL of Wheat and *Bromus tectorum* are illustrated in Table 4.9 a&b. apparently all allelopathic concentrations have significantly reduced RL. In clay soil, the control values were about 22.12 and 7.1cm for the two recipient species respectively. At 1 % EGCP concentration, RL reduced to 9.32 and 4.6cm and to 8.7 and 4.43cm at 3%. Constantly, it continues reduction till it attained values of about 7.5 and 2.7 cm at 6% EGCP concentration for the two recipient species respectively. Similarly, the control values of RL in sandy soil were about 16.16and 6.23cm respectively. At 1% concentration, the values of about 12.25 and 5.83cm were obtained and at 3% concentration the values 1.75 and 4.1cm were recorded. It reduced to 11.22 and 3.5cm at 6% EGCP concentration for the two recipient species, respectively.

Compared to control, RL of wheat and *Melilotus indica* demonstrated significantly reduction along gradual EGCP concentrations (Table 4.10 a&b). In clay soil, the control values were about 25.10and 6.10cm for the tow recipient species respectively. These values were reduced to 9.20 and 5.60 cm at 1% and to 7.50 and 4.23 cm at3% level and at 6% EGCP concentration the values 6.00 and 3.46cm were observed respectively. Likewise, the control values of RL in sandy soil were about 16.16and 6.23 cm for two recipients respectively. At 1% concentration the values of about 13.42 and 5.13cm were achieved, it reduced to 12.17 and 3.5cm at 6% EGCP concentration for the two recipient species, respectively.

2.3 Leaf number (LN)

The values of leaf number (LN) of wheat were about 5.25 and 3.66 at control level in clay and sandy soil respectively. In clay soil; this value decreased to 4 at 1% EGCP concentration while was obtained the same value (4) at 3 and 6%EGCP concentration. Correspondingly, in sandy soil, the same value of LN was about 3 at all concentration level. On the other hand the values of LN on *Broums tectorum*. In clay soil, was obtained same value (3) at control and 1% concentration and at 3 and 6%EGCP the value (2.66) was recovered. While in sandy soil at control the value was about 2.33 and at 1, 3 and6%concentration this value was reduced to 1 (Table 4.9 a&b).

Table 4.10.a.Allelopathic effect of different percentage of *Euphorbia guyoniana* crude powder (EACP) on some growth parameters of wheat (mixed culture with *Melilotus indica)*, 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	17.83^{a}	18.00^{a}	25.10^{a}	11.37^{c}	4.33^{ab}	4.66^{a}	0.820^{a}	0.480^{a}	0.146^{a}	0.310^{a}	0.100^{a}	0.060^{a}	0.026^{a}	0.073^{a}
1	16.37^{b}	18.10^{a}	9.20^{b}	24.66^{a}	3.75^{a}	4.66^{a}	0.215^{b}	0.460^{a}	0.040^{b}	0.260^{b}	0.035^{ab}	0.066^{a}	0.026^{a}	0.066^{a}
3	15.87^{c}	17.50^{a}	7.50^{c}	24.50^{a}	2.50^{b}	4.66^{a}	0.210^{b}	0.400^{ab}	0.025^{b}	0.200^{c}	0.030^{b}	0.040^{b}	0.013^{b}	0.030^{b}
6	15.80^{c}	17.50^{a}	6.00^{d}	18.50^{b}	2.50^{b}	3.66^{a}	0.155^{c}	0.280^{b}	0.020^{b}	0.130^{d}	0.025^{b}	0.026^{b}	0.006^{c}	0.030^{b}
P-value	0.020*		0.179		0.029*		0.477		0.004*		0.487		0.032*	
TWO-WAY ANOVA														
A - Treatment	NS		**		*		**		*		**		*	
B- Soil Type	**		**		**		NS		**		NS		**	
A x B	NS		**		*		**		NS		*		*	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.10.b.Allelopathic effect of different percentage of *Euphorbia guyoniana* crude powder (EACP) on some growth parameters of *Melilotus indica,* (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables treatment	Shoot length(cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46^{b}	13.40^{b}	6.10^{a}	6.56^{a}	3.33^{a}	2.00^{a}
1	16.25^{a}	17.20^{a}	5.60^{b}	4.50^{b}	3.00^{a}	4.00^{a}
3	15.05^{b}	0.00^{c}	4.23^{c}	0.00^{c}	3.00^{a}	0.00^{b}
6	14.50^{b}	0.00^{c}	3.46^{d}	0.00^{c}	3.00^{a}	0.00^{b}
P-value	0.142		0.074		0.096	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-Soil Type	**		**		*	
A x B	**		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Leaf number (LN) was significantly affected by EGCP concentrations for Wheat while for *Melilotus indica* was not significant (Table 4.10 a&b). The Values of about 4.33 and 3.33 were attained at control level in clay soil for two recipients, respectively. On Wheat the value 3.75 at1% EGCP and 2.5 was obtained at 3 and 6% EGCP concentrations in clay soil; however in sandy soil the value 4.66 at control, 1 and3%EGCP concentrations, as well at 6% the value 3.66 was obtained .whereas on *Melilotus indica* the values were about 3.33 and 2 in clay and sandy soil, respectively. In clay soil the value of 3 at 3 and 6 % concentration EGCP compared in sandy soil the development was completely inhibited.

2.4 Shoot fresh weight (SFw)

The represented data in table 4.9.a showed the values of shoot fresh weight (SFw) of Wheat were about 0.93 and 0.32g.plant^{-1} at control level in clay and sandy soil, respectively. These values decreased to 0.27g.plant^{-1} at 1% and at 3 and 6% EGCP concentration the value 0.25g.plant-1was obtained in clay soil. Correspondingly, in sandy soil, the values of SFw were about 0.29, 0.24 and 0.18g.plant^{-1} at 1, 3 and 6% EGCP concentration respectively.

Shoot fresh weight (SFw) of Wheat was significantly affected by EGCP concentrations (Table 4.10.a). The Values 0.82 and 0.48 g.plant-^{1} was attained at control level in clay and sandy soil. The values of SFw decreased to 0.215, 0.210 and 0.155g.plant-^{1} at 1,3and 6% EGCP concentrations, respectively in clay soil. Similarly, in sandy soil, as a response to EGCP allelopathic stress, SFw gradually decreased to 0.46, 0.40 and 0.28 g.plant^{-1} at 1, 3 and6% EGCP concentrations, respectively.

2.5 Root fresh weight (RFw)

Root fresh weight (RFw) of wheat significantly decreased in clay and sandy soils (Table 4.9.a). In clay soil, the value of RFw was about 0.185g at control level. During applying higher EGCP concentrations there was a continual reduction in RFw. Eventually, at 6% concentration, the value of RFw have reduced to 0.025g.plant^{-1} for Wheat. Likewise in sandy soil, the control value of RFw was about 0.468g.plant^{-1}. At 1, 3 and 6% EGCP concentration, RFw reduced to 0.07, 0.045 and 004 g.plant^{-1} were obtained respectively.

Root fresh weight (RFw) significantly decreased in clay and sandy soils (Table 4.10.a). In clay and sandy soil, the values of RFw were about 0.146 and 0.31 g.plant^{-1} at control level. During applying higher EGCP concentrations there was a continual reduction in RFw. Eventually, at1.3 and 6% concentration, the values of RFw have reduced to 0.04, 0.025 and

0.02g.plant^{-1} for Wheat in clay soil. Likewise in sandy soil, At 1, 3 and 6% EGCP concentration, RFw reduced to 0.26, 0.20 and 0.13g.plant^{-1} were obtained respectively.

2.6 Shoot dry weight (SDw)

In clay and sandy soil, the values of shoot dry weight (SDw) for Wheat were about 0.105 and 0.046g.plant^{-1} at control level. This value decreased to 0.022g.plant^{-1} at 6% EGCP concentration. Correspondingly, in sandy soil, the control value of SDw was about 0.046 g.plant^{-1}. The values of SDw decreased to 0.04, 0.03 and 0.025g.plant^{-1} at 1, 3 and 6% EGCP concentration respectively (Table 4.9.a).

Statistically, there was not significant reduction of Shoot dry weight (SDw) of wheat as a consequence of raising EGCP concentrations (Table 4.10.a). In clay soil, the control value of SDw was about 0.10g.plant^{-1}, at1 and 3% EGCP concentration the values of about 0.035 and 0.03 g.plant^{-1} was achieved respectively and 0.02g.plant^{-1} was attained for Wheat at 6% EGCP concentration. Similarly, in sandy soil the control value of SDw was about0.06 g.plant^{-1}. Value of about0.035 g.plant^{-1} was achieved at 1% level and at 3 and6% EGCP concentration was obtained the value (0.04 and 0.026 g.plant^{-1}).

2.7 Root dry weight (RDw)

Due to the allelopathic influence of EGCP, root dry weight (RDw) of wheat significantly decreased in clay and sandy soils (Table 4.9..a). In clay soil, the value of RDw was about 0.026g.plant^{-1} at control level. During applying higher EGCP concentrations there was a continual reduction in RDw. Eventually, at 6% concentration, the value of RDw have reduced to 0.006g.plant^{-1}. Likewise in sandy soil, the control value of RDw was about 0.086g.plant^{-1}. At 3 and6% EGCP concentration, RDw reduced to 0.013g.plant^{-1}was recorded.

Discernibly, significant reduction of root dry weight (RDw) of Wheat upon applying the different concentrations of EGCP was attained. In clay soil, there was a slight reduction in values of RDw; the values of RDw were about 0.026 at control and 1%EGCP and 0.0.13 and 0.006 g.plant^{-1} at 3 and 6% EGCP concentration respectively. Correspondingly, in sandy soil the control value of RDw was about 0.073g.plant^{-1}. At 1 % level the value 0.066 g.plant^{-1} and at 3and 6% EGCP concentrations, RDw value was obtained about 0.03 g.plant^{-1}. (Table 4.10.a).

III.Allelopathic Potential of *Retama retam* on *Bromus tectorum* , *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species)

1. Effect of *Retama retam* Aqueous Extract (RRAE) on germination efficiency (Petri-Dish Experiment)

1.1Germination Percentage (GP)

In pure culture, the attained GP of *Bromus tectorum* values at control conditions (100%) was increased upon applying at 2.5 and 5% RRAE concentrations to 96.6 and 93.6%, respectively. However, this current motivation goes to a marked reduction at 7.5 and 10% concentrations (43.3 and 40% respectively). On contrast, *Bromus tectorum* germination process was better in mixed culture relative to pure culture. In mixed culture a value at control level (96.6%) undergoes minor diminishing (85%) at 2.5% concentration level. Continually, GP decreased to about 55.20 and zero % at 5, 7.5 and 10% RRAE concentrations, respectively.(Table 4.11& figure 4.3)

The results in Table 4.12 & Figure 4.3indicate GP of *Melilotus indica* seeds were apparently varied with of RRAE concentrations which is supported statistically ($P \leq 0.01$) while type of seed culture and their interaction were not significant. In pure and mixed culture the attained GP values at control conditions (60 and 50%), this value was increased to 70 and 65 % at 2.5% RRAE concentrations in pure and mixed culture, respectively. on the other hand were increased upon applying 5, 7.5 and 10% RRAE concentrations (55,35 and 25% in pure culture, respectively). On contrast, *Melilotus indica* germination process was same in pure and mixed culture. Continually, GP in mixed culture decreased to about 45, 40 and 20% at 5, 7.5 and 10% RRAE concentrations, respectively.

The germination percentage (GP) of wheat seeds were apparently varied with of RRAE concentrations (Table 4.13& Figure 4.3) which is supported statistically ($P \leq 0.01$). In pure culture, the attained GP values at control, 2.5,5 and 7.5% RRAE conditions (100%) were increased upon applying 10% RRAE concentration (95%). However, this current motivation goes to a marked reduction in mixed culture; type M1 the values were 96.6 and 85% at control and 10% RRAE, respectively but at 2.5, 5 and 7.5 it was obtained same value (95%). On contrast, GP value at control and 2.5 % level (100%) undergoes minor diminishing (95%) at 5, 7.5 and 10% RRAE concentrations, respectively was recorded in mixed culture; type M2.

Table 4.11 Variation in germination percentage (GP), Seed germination index (SGI) ,germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Bromus tectorum* (pure culture) and *Bromus tectorum* x Wheat (mixed culture) as affected by different concentration of *Retama retam* aqueous extract (RRAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100.0 [a]	96.6[a]	32.33[a]	29.70[a]	0.00	000	19.66[a]	25.00[a]	34.00[a]	39.33[a]
02.5	96.6[b]	85.0[b]	27.44[b]	24.05[b]	0.40[c]	12.00[d]	9.66[b]	0.00[b]	10.33_b	4.00[b]
05.0	93.3[c]	55.0[c]	21.86[c]	16.06[c]	0.70[c]	43.06[c]	4.66[c]	0.00[b]	6.66[c]	5.00[b]
07.5	43.3[d]	20.0[d]	10.97[d]	4.75[d]	56.70[b]	79.29[b]	0.66[d]	0.00[b]	2.50[d]	1.00[c]
10.0	40.0[e]	0.0[e]	9.32[e]	0.00[e]	60.00[a]	100.00[a]	0.00[d]	0.00[b]	1.16[e]	0.00[c]
P-value	0.015*		0.004**		0.014*		0.24		0.29	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		**		NS	
AB interaction	**		*		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

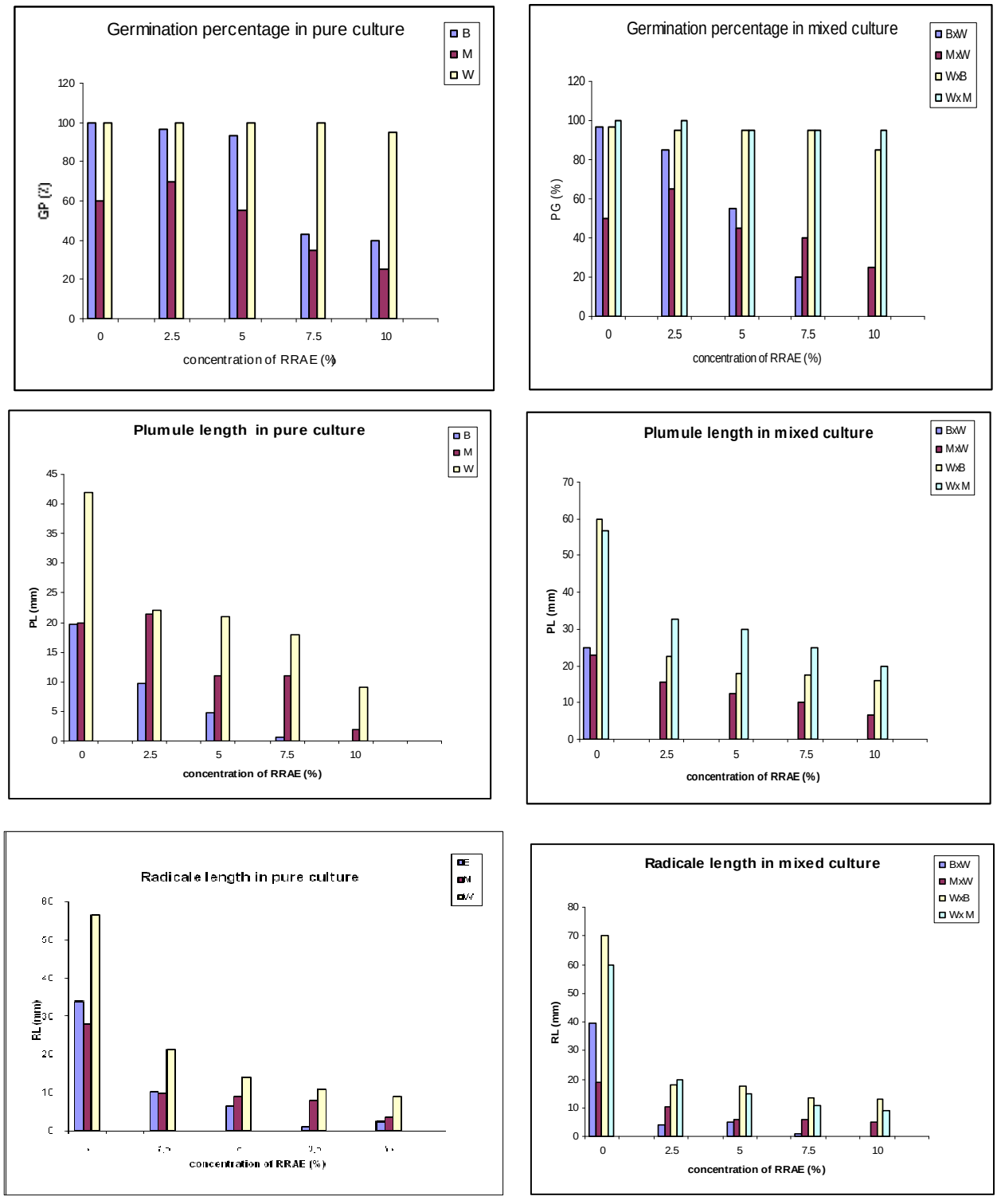

Figure 4.3 Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Retama retam* aqueous extract (RRAE) in Petri-dish experiment.

1.2 Seed germination index (SGI)

The SGI of *Bromus tectorum* values at control were about 32.33 and 29.7 in pure and mixed cultures, respectively. The statistical implications elucidate the effect of RRAE concentration- seed culture interaction which was significant at P≤ 0.05. Perceptibly (Table 4.11), RRAE concentration, and seed culture were highly significant (P≤ 0.01), the values of about 27.44, 21.86, 10.97 and 9.32 were obtained in pure culture at 2.5, 5, 7.5 and 10% concentrations, respectively. Compared in mixed culture were attained about 24.05,16,4,75 and zero.

The statistical implications of SGI for *Melilotus indica* elucidate the effect of RRAE concentration- seed culture interaction, RRAE concentration, and seed culture were highly significant (P≤ 0.01) (Table 4.12). The values of SGI at control were about 24.42 and 21.93 in pure and mixed cultures, respectively. observably, the values of about 32.05,21.6,12.51and 7.18 were obtained in pure culture at 2.5, 5,7.5 and 10% concentrations, respectively, however in similar level of about 24.33,18.87,14.56 and 7.89 were attained in mixed culture .

The statistical representation of SGI of wheat is illustrated in Table4.13 the effect of RRAE concentration- and seed culture were highly significant (P≤ 0.01). The SGI values at control were about 33.3, 32.2 and 46.62 in pure and mixed cultures; type M1 and M2 respectively the values of about 32.08,31.35,30.45 and 29.3 were obtained in pure culture at 2.5, 5,7.5 and 10% concentrations, respectively, while parallel values of about 31.66,31.25,30.08 and 27 were attained in mixed culture; type M1 ,on the other hand in mixed culture ; type M2 the values were 42.85,41.5,38.33 and 34.58 obtained at2.5,5,7.5 and 10% RRAE concentrations, respectively.

1.3 Germination inhibition percentage (GIP)

The influence of RRAE concentrations and type of seed culture on GIP of *Bromus tectorum* in pure culture was highly significant (P≤ 0.01) (Table4.11). GIP started with a value of about 0.4% at 2% RRAE concentration level. Evidently, the mixed culture caused a regular inhibition to *Bromus tectorum* seeds at all of RRAE concentrations. Thus, GIP was higher compared to that of pure culture. At 10% RRAE concentration, the value of GIP was 60% in pure culture while in mixed culture the highest values of about 100% were achieved.

Table 4.12. Variation in germination percentage (GP),Seed germination index (SGI) ,germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Melilotus indica* (pure culture) and *Melilotus indica* x Wheat (mixed culture) as affected by different concentration of *Retama retam* aqueous extract (RRAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60^{b}	50^{a}	24.42^{b}	21.93^{b}	0.00	0.00	20.00^{b}	23.00^{a}	28.00^{a}	18.66^{a}
02.5	70^{a}	65^{a}	32.05^{a}	24.33^{a}	- 16.66	-30.00	21.50^{a}	15.50^{b}	10.00^{b}	10.50^{b}
05.0	55^{bc}	45^{b}	21.60^{c}	18.87^{c}	8.33^{c}	10.00^{c}	11.00^{c}	12.50^{c}	9.00^{bc}	6.00^{c}
07.5	35^{c}	40^{b}	12.51^{d}	14.56^{d}	41.66^{b}	20.00^{b}	11.00^{c}	10.00^{d}	8.00^{c}	6.00^{c}
10.0	25^{d}	25^{c}	7.18^{e}	7.89^{e}	58.33^{a}	50.00^{a}	2.00^{d}	6.50^{e}	3.50^{d}	5.00^{c}
P-value	0.120		0.147		0.061		0.419		0.132	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	NS		**		**		NS		*	
AB interaction	NS		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

The Potential of RRAE concentrations, type of seed culture and RRAE concentration-seed culture interaction on GIP of *Melilotus indica* was highly significant (P≤ 0.01) (Table 4.12). GIP started with 2.5% RRAE concentration level was stimulated in pure and mixed cultures the values about -16.66 and -30%, respectively. Evidently, the pure and mixed culture caused a regular inhibition to *Melilotus indica* seeds at all of RRAE concentrations. Thus, GIP was higher compared to that of pure culture. At 10% RRAE concentrations, the value of GIP was 58.33% in pure culture while in mixed culture the highest values of about 50% were achieved.

The influence of RRAE concentrations and type of seed cultures on GIP of wheat was highly significant (P≤ 0.01) (Table 4.13).In pure culture the GIP was completely inhibited at 2.5, 5 and 7.5% RRAE concentrations. While, in the mixed culture caused a regular inhibition of wheat seeds at all of RRAE concentrations. At 10% RRAE concentrations, the value of GIP was 5% in pure culture and mixed culture; type M2 while in mixed culture; type M1 the highest values of about 12% were achieved

1.4 Plumule length (PL)

The demonstrated data in Table 4.11& Figure 4.3 pointed up that PL of *Bromus tectorum* was significantly affected (P ≤ 0.01) by each of the main effects individually and their interactions. In pure culture, there was a noticed reduction in values of PL, the control value was about 19.66 mm decreased to 9.66, 4.66, 0.66 and zero mm at 2.5, 5, 7.5 and 10% RRAE concentrations, respectively. During growth process of *Bromus tectorum* in pure culture, an obvious PL elongation was observed corresponding to that estimated in mixed culture. At control level, a value of about 25mm of PL was noticed. This value was completely inhibited at all concentrations of RRAE were applied.

The PL data of *Melilotus indica* showed in Table 4.12 & Figure 4.3 was significantly affected (P ≤ 0.01) in RRAE concentration and interaction were significantly however the type of seed cultures was not significant. In pure culture, there was a noticed reduction in values of PL. The control value was about 20 mm increased to 21.5mm at 2.5 % RRAE concentrations However at 5 and 7.5% RRAE was similar value obtained (11mm) this value decreased to 2 mm at 10% RRAE concentration . In mixed culture, at control level, a value of about 18.66mm of PL was noticed. This value was reduced to 15.5, 12.5,10 and 6.5 mm at 2.5, 5, 7.5and 10% RRAE concentrations, respectively.

Table 4.13. Variation in germination percentage (GP),Seed germination index (SGI) , germination inhibition percentage (GI P), plumule (PL) and radicle length (RL) of wheat (w) (pure culture) , wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentration of *Retama retam* aqueous extract (RRAE) in Petri-dish experiment.

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.0^{a}	96.6^{ab}	100.0^{a}	33.30^{a}	32.20^{a}	46.62^{a}	0.00	0.00	0.00	42.00^{a}	60.00^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.0^{a}	95.0^{b}	100.0^{a}	32.08^{b}	31.66^{a}	42.85^{b}	0.00^{b}	1.65^{b}	0.00^{b}	22.00^{b}	22.50^{b}	32.50^{b}	21.50^{b}	18.00^{b}	20.00^{b}
5.0	100.0^{a}	95.0^{b}	95.0^{b}	31.35^{c}	31.25^{a}	41.50^{c}	0.00^{b}	1.65^{b}	5.00^{a}	21.00^{c}	17.70^{c}	30.00^{c}	14.00^{c}	17.50^{b}	15.00^{c}
7.5	100.0^{a}	95.0^{b}	95.0^{b}	30.45^{d}	30.08^{b}	38.33^{d}	0.00^{b}	1.65^{b}	5.00^{a}	18.00^{d}	17.50^{c}	25.00^{d}	11.00^{d}	13.50^{c}	11.00^{d}
10.0	95.0^{b}	85.0^{c}	95.0^{b}	29.30^{e}	27.00^{c}	34.58^{e}	5.00^{a}	12.00^{a}	5.00^{a}	9.00^{d}	16.00^{d}	20.00^{e}	9.00^{e}	13.00^{c}	9.00^{e}
TWO-WAY ANOVA															
A-Treatment		**			**			**			**			**	
B-Seed Culture		**			**			**			**			**	
AB interaction		**			**			**			**			**	

Different letters within each column indicate significance at P<0.05

Two-way ANOVA:
NS: not significant *: Significant at 0.05 **: Significant at 0.01

The PL of wheat was significantly (P≤ 0.01) by each of the main effects individually and their interactions (Table 4.13& Figure 4.3). In pure culture, the control value was about 42 mm decreased to 22, 21, 18 and 9 mm at 2.5, 5, 7.5 and 10% RRAE concentrations, respectively. During growth process of wheat in pure culture, an obvious PL elongation was observed corresponding to that estimated in mixed culture; type M1. At control level, a value of about 60mm of PL was noticed. This value was reduced to 22.5, 17.7, 17.5 and 16mm when the all concentrations of RRAE were applied but in mixed culture; type M2 the values were 56.66,32.5,30,25 and 20mm at control, 2.5,5,7.5and 10% RRAE concentration.

1.5 Radicle length (RL)

Evaluation of RL correlated with higher RRAE concentrations has demonstrated their depressing influence on *Bromus tectorum* growth process (Table 4.11& Figure 4.3). Furthermore, RRAE concentration and interaction were significantly (P ≤ 0.01) affecting RL while the type of seed culture was not significant. In pure culture, the control value was about 34mm. At 2.5, 5, 7.5 and 10% RRAE concentrations there has been a marked reduction in RL (6.33, 10.33, 1.16 and 2.5 mm, respectively). The control value of RL in mixed culture was 39.33 mm. There was an explicit inhibitory effect of RRAE concentrations to radicle elongation among the applied concentrations. At 10% RRAE concentration, was completely inhibited.

The RRAE concentrations and interaction were highly significant (P ≤ 0.01) affecting RL of *Melilotus indica* while their type of seed cultures was significantly (P ≤ 0.05) (Table 4.12 &Figure 4.3). In pure culture, the control value was about 28mm. The values of about 10, 9, 8 and 3.5 mm At 2.5, 5, 7.5 and 10% RRAE concentrations, respectively. In mixed culture at control value of RL was 18.66 mm. There was an explicit inhibitory effect of RRAE concentrations to radicle elongation among the applied concentrations. At 2.5 and 10% RRAE concentration, values of about10.5 and 5 mm, respectively was recorded however at 5 and 7.5% RRAE concentration it was same value (6mm).

The influence of RRAE concentrations on wheat growth process Furthermore, RRAE concentration and interaction were significantly (P ≤ 0.01) affecting RL. In pure culture, the control value was about 56.66 mm, and At 2.5, 5, 7.5 and 10% RRAE concentrations were marked reduction in RL about 21.5, 14, 11 and 9mm respectively. In mixed culture M1 and M2 the control values of RL were 70 and 60mm. There was an explicit inhibitory effect of RRAE concentrations to radicle elongation among the applied concentrations. At 10% RRAE concentration, value of about 13 and 9 mm were recorded (Table 4.13 &Figure 4.3)

2. Effect of *Retama retam* Crude Powder (RRCP) on some growth parameters and phytomass (Pot Experiment)

2.1 Shoot length (SL)

Data of the present study demonstrated that shoot length (SL) of wheat and *Bromus tectorum* was significantly affected due to the apparent allelopathic action of RRCP concentrations under the clay and sandy soils (Table 4.14 a&b). In clay soil, there was a slight reduction in values of SL. At control level, values of about 18.87 and13.06 cm of SL were noticed respectively. These values were reduced to 16.25 and 11.76 at1% and to 16 and 11.93cm at 3% and at 6% RRCP concentration the values 15.82and11.90 were obtained. Correspondingly, in sandy soil values of SL were about 17.23 and 13.03cm at control level. These values were reduced to 15.62 and12.5 cm at 1% and to 5.12and11.65cm at 6% RRCP concentration for the two recipient species respectively.

The demonstrated data in Table 4.15 a&b. pointed up that shoot length (SL) of wheat *Melilotus indica* and was significantly affected upon applying the different concentrations of RRCP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 17.83and14.46cm of SL were noticed respectively. These values were reduced to 16.55 and 14.50cm at 1% and to 15.62 and 14.35cm at 3% and at 6% RRCP concentration the values 15.32 and 14.25cm were obtained for the two recipient species respectively. Likewise, in sandy soil values of SL were about 18.00 and 13.40cm at control level respectively. These values were about to 18.16 and 17.90 cm at 1% and to 17.73 and 15.95 cm at 3% and at 6%RRCP concentration the values 17.23 and zero cm were recovered for the two recipient species respectively.

2.2 Root length (RL)

Compared to control, root length (RL) of wheat and *Bromus tectorum* demonstrated significantly reduction along gradual RRCP concentrations (Table 4.14 a&b). In clay soil, the control values were about 22.12and 7.1cm for the tow recipient species respectively. These values were reduced to 10.47 and5.33 cm at 1% and to 9.5 and 3.63cm at3% level and at 6% RRCP concentration the values 8.87 and 3.6cm were observed respectively. Likewise, the control values of RL in sandy soil were about 16.16and 6.23 cm for two recipients respectively. At 1% concentration the values of about 13.42 and 5.13cm were achieved, it reduced to 12.17 and 3.5cm at 6% RRCP concentration for the two recipient species respectively.

Table 4.14.a.Allelopathic effect of different percentage of *Retama retam* crude powder (RRCP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) a

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
nd C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.93^{a}	0.32^{a}	0.185^{a}	0.468^{a}	0.105^{a}	0.046^{a}	0.026^{a}	0.086^{a}
s 1	16.25^{b}	15.62^{b}	10.47^{b}	13.42^{b}	4.00^{a}	3.00^{a}	0.23^{b}	0.23^{b}	0.037^{b}	0.070^{b}	0.030^{b}	0.035^{b}	0.020^{b}	0.020^{b}
oi 3	16.00^{b}	15.42^{c}	9.50^{c}	12.80^{c}	4.00^{a}	3.00^{a}	0.21^{bc}	0.21b^{c}	0.032^{b}	0.052^{c}	0.030^{b}	0.025^{c}	0.020^{b}	0.020^{b}
l 6	15.82^{b}	15.12^{d}	8.87^{c}	12.17^{d}	4.00^{a}	3.00^{a}	0.18^{c}	0.20^{c}	0.025^{c}	0.045^{c}	0.022^{b}	0.025^{c}	0.013^{c}	0.020^{b}
(														
P-value	0.0190*		0.3630		0.0022*		0.2120		0.1320		0.2110		0.1650	
TWO-WAY ANOVA														
A – Treatment	**		**		**		**		**		**		*	
B- Soil Type	**		**		**		**		**		*		*	
A x B	NS		**		*		**		**		*		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.14.b.Allelopathic effect of different percentage of *Retama retam* crude powder (RRCP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06^{a}	13.03^{a}	7.10^{a}	6.23^{a}	3.00^{a}	2.33^{a}
1	11.76^{c}	12.05^{a}	5.33^{b}	5.13^{b}	2.33^{ab}	2.00^{a}
3	11.90^{c}	11.76^{b}	3.63^{c}	4.55^{b}	2.00^{b}	1.50^{ab}
6	11.93^{c}	11.65^{b}	3.60^{c}	3.50^{c}	2.00^{b}	1.00^{b}
P-value	0.385		0.470		0.019*	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-Soil Type	NS		NS		NS	
A x B	NS		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

The allelopathic effect of RRCP concentration on root length (RL) of Wheat and *Melilotus indica* are illustrated in Table 4.15.a.b. apparently all allelopathic concentrations have significantly reduced RL. In clay soil, the control values were about 25.10 and 6.10cm for the two recipient species respectively. At 1 % RRCP concentration, RL reduced to 7.75 and 5.54 cm and to 7.62 and 5.32cm at 3%. Constantly, it continues reduction till it attained values of about 7.30 and 4.45 cm at 6% RRCP concentration for the two recipient species respectively. Similarly, the control values of RL in sandy soil were about 11.37and 6.56cm respectively. At 1% concentration, the values of about 46.33 and 6.40cm were obtained and at 3% concentration the values 22.66 and 4.95cm were recorded. It reduced to 14.00 and zero cm at 6% RRCP concentration for the two recipient species respectively.

2.3 Leaf number (LN)

Leaf number (LN) was significantly affected by RRCP concentrations for Wheat while for *Bromus tectorum* Was not significant (Table 4.14 a&b).Values of about 5.25 and 3 were attained at control level in clay soil for two recipients respectively but in sandy soil the values 3.66 and 2.33 for two recipients, respectively . On Wheat were obtained the same value at all concentration (4 and 3) in clay and sandy soil respectively while the values of NL on *Bromus tectorum* were obtained 2.33 and 2 in clay and sandy soil respectively . In clay soil the value of LN 2 at 3 and 6 % concentration RRCP compared in sandy soil the values 1.5 and one were obtained.

The values of shoot leaf number (LN) of Wheat were about 4.33 and 4.66 at control level in clay and sandy soil respectively. This value decreased to 3 at all RRCP concentration in clay soil. Correspondingly, in sandy soil, the same value of LN was about 3 at1 and3% RRCP and at6% the value 3.66 was obtained. On the other hand the values of LN for *Melilotus indica* in clay soil, the value 3.33 was obtained at control and 3 at1% and 3 % level and at 6%RRCP the value 2.5 was recovered. While in sandy soil at control the value was about 2 and4 was recovered at 1, 3%RRCP and at 6% RRCP concentration this value was reduced to zero (Table 4.15 a&b).

2.4 Shoot fresh weight (SFw)

Shoot fresh weight (SFw) of Wheat was significantly affected by RRCP concentrations (Table 4.14.a). The Values 0.93 and 0.32 g.plant^{-1} was attained at control level in clay and sandy soil. The values of SFw decreased to 0.23, 0.21 and 0.18 g.plant^{-1} at 1,3and 6% RRCP concentration, respectively in clay soil. Similarly, in sandy soil, as a response to RRCP allelopathic stress, SFw gradually decreased to 0.23, 0.21 and 0.2 g.plant^{-1} at 1, 3 and6% RRCP concentration respectively.

Table 4.15.a.Allelopathic effect of different percentage of *Retama retam* crude powder (RRCP) on some growth parameters of wheat (mixed culture with *Melilotus indica)*, 30 days after sowing in two different types of soils(clay soil (CS) and sandy soil (SS))

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	17.83^{a}	18^{a}	25.1^{a}	11.37^{d}	4.33^{a}	4.66^{a}	0.82^{a}	0.48^{a}	0.146^{a}	0.31^{a}	0.10^{a}	0.06^{a}	0.026^{a}	0.073^{a}
1	16.55^{b}	18.16^{a}	7.75^{b}	46.33^{a}	3^{a}	4^{a}	0.28^{b}	0.42^{b}	0.05^{b}	0.25^{ab}	0.035^{ab}	0.06^{a}	0.026^{a}	0.03^{b}
3	15.32^{d}	17.73^{a}	7.62^{b}	22.66^{b}	3^{a}	4^{a}	0.255^{c}	0.3^{c}	0.032^{c}	0.21^{b}	0.035^{ab}	0.033^{b}	0.026^{a}	0.03^{b}
6	15.62^{c}	17.23^{a}	7.3^{b}	14^{c}	3^{a}	3.66^{a}	0.21^{c}	0.32^{c}	0.035^{c}	^{c}0.173^{c}	0.025^{b}	0.02^{b}	0.013^{b}	0.02^{b}
P-value	0.032*		0.182		0.009*		0.463		0.0004*		0.354		0.135	
TWO-WAY ANOVA														
A - Treatment	*		**		NS		**		**		**		*	
B- Soil Type	**		**		NS		NS		**		NS		*	
A x B	*		**		NS		**		*		*		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.15.b.Allelopathic effect of different percentage of *Retama retam* crude powder (RRCP) on some growth parameters of *Melilotus indica*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables / treatment	Shoot length (cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46[a]	13.40[c]	6.10[a]	6.56[a]	3.33[a]	2.00[a]
1	14.50[a]	15.95[b]	5.54[b]	4.95[c]	3.00[a]	4.00[a]
3	14.35[a]	17.90[a]	5.32[c]	6.40[b]	3.00[a]	4.00[a]
6	14.25[a]	0.00[d]	4.45[d]	0.00[d]	2.50[a]	0.00[b]
P-value	0.483		0.265		0.318	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-**Soil Type**	NS		**		NS	
A x B	**		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

The represented data of wheat showed in table 4.15.a. the values of shoot fresh weight (SFw) of Wheat were about 0.82 and 0.48 g.plant^{-1} at control level in clay and sandy soil, respectively. These values decreased to 0.28, 0.0225 and 0.21 g.pllant^{-1} at 1, 3 and 6% RRCP concentration were obtained in clay soil. Correspondingly, in sandy soil, the values of SFw were about 0.42, 0.32 and 0.21 g.plant^{-1} at 1, 3 and 6% RRCP concentration, respectively.

2.5 Root fresh weight (RFw)

Root fresh weight (RFw) of wheat significantly decreased in clay and sandy soils (Table 4.14.a). In clay and sandy soil, the values of RFw were about 0.185 and 0.468g.plant^{-1} at control level. During applying higher RRCP concentrations there was a continual reduction in RFw. Eventually, at1.3 and 6% concentration, the values of RFw have reduced to0.037, 0.032 and 0.025g.plant^{-1} for Wheat in clay soil. Likewise in sandy soil, At 1, 3 and 6% EGCP concentration, RFw reduced to 0.07, 0.052 and 0.045g.plant^{-1} were obtained respectively.

Root fresh weight (RFw) of wheat was significantly decreased in clay and sandy soils (Table 4.15.a). In clay soil, the value of RFw was about 0.146g .plant^{-1}at control level. During applying higher RRCP concentrations there was a continual reduction in RFw. Eventually, at1,3 and 6% concentration, the values of RFw have reduced to 0.05,0.035 and 0.032g.plant^{-1} for Wheat. Likewise in sandy soil, the control value of RFw was about 0.31g.plant^{-1}. At 1, 3 and 6% RRCP concentration, RFw reduced to 0.25, 0.21 and 0.173 g.plant^{-1} were obtained respectively

2.6 Shoot dry weight (SDw)

Statistically, Shoot dry weight (SDw) of wheat there was not significant reduction of as a consequence of raising RRCP concentrations (Table 4.14.a). In clay soil, the control value of SDw was about 0.105g.plant^{-1}, at1 and 3% RRCP concentration the values of about 0.03 g.plant^{-1} was achieved and 0.022g.plant^{-1} was attained for Wheat at 6% RRCP concentration. Similarly, in sandy soil the control value of SDw was about0.046 g.plant^{-1}. Value of about0.035 g .plant^{-1} was achieved at 1% level and at 3 and6% RRCP concentration was obtained the same value (0.025 g.plant^{-1}).

In clay and sandy soil, the values of shoot dry weight (SDw) for Wheat were about 0.10 and 0.06g.plant^{-1} at control level. This value decreased to 0.035g.plant^{-1} at 1 and3% level and at 6% RRCP concentration the value 0.025 g,plant $^{-1}$ was obtained . Correspondingly, in

sandy soil, the values of SDw decreased to 0.055, 0.033 and 0.025g.plant^{-1} at 1, 3 and 6% RRCP concentration respectively (Table 4.15.a).

2.7 Root dry weight (RDw)

Discernibly, significant reduction of root dry weight (RDw) of Wheat upon applying the different concentrations of RRCP was attained. In clay soil, there was a slight reduction in values of RDw; the values of RDw were about 0.026, 0.02 and 0.013g.plant^{-1} at control, 1, 3 and 6% RRCP concentration respectively. Correspondingly, in sandy soil the control value of RDw was about 0.086g.plant^{-1}. At 1,3and 6% RRCP concentrations, RDw value about 0.02 g.plant^{-1} was obtained. (Table 4.14.a) .

Due to the allelopathic influence of RRCP, root dry weight (RDw) of wheat significantly decreased in clay and sandy soils (Table 4.15.a). In clay soil, the value of RDw was about 0.026g.plant^{-1} at control, 1 and3% RRCP concentration level. During applying higher RRCP concentrations there was a continual reduction in RDw. Eventually, at 6% concentration, the value of RDw have reduced to 0.013g.plant^{-1}. Likewise in sandy soil, the control value of RDw was about 0.073g.plant^{-1}. At 1 and3% RRCP concentration, RDw reduced to 0.03g.plant^{-1}was recorded and to0.02 g.plant $^{-1}$ at 6% RRCP concentration.

IV. Allelopathic Potential of *Pituranthos chloranthus* on *Bromus tectorum* , *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species).

1. Effect of *Pituranthos chloranthus* Aqueous Extract (PCAE) on germination efficiency (Petri-Dish Experiment)

1.1 Germination Percentage (GP)

Generally, GP of *Bromus tectorum* was significantly ($P \leq 0.01$) affected by the increase in PCAE concentration, seed culture and their interaction (Table 4.16 & Figure 4.4). Despite GP of *Bromus tectorum* was reduced due to PCAE allelochemicals, its values were higher in pure culture compared to those estimated in mixed culture. At control, GP values were about 100% in pure culture. These percentages were reduced to 93.3 and 86.6% at 2.5 and 5% PCAE concentration respectively and to 46.6 and16.6% at 7.5 and 10% PCAE concentration level respectively. In mixed culture GP values at control were about 96.6% which gradually reduced upon applying ascending PCAE concentrations. At 7.5 and 10% concentration the germination was completely inhibited.

Table 4.16 Variation in germination percentage (GP), Seed germination index (SGI), germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Bromus tectorum* (pure culture) and *Bromus tectorum* x Wheat (mixed culture) as affected by different concentration of *Pituranthos chloranthus* aqueous extract (PCAE) in Petri-dish experiment.

Variables	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
Treatment (%)	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100.0^{a}	96.6^{a}	32.33^{a}	29.70^{a}	0.00	0.00	19.66^{a}	25.00^{a}	34.00^{a}	39.33^{a}
02.5	93.3^{b}	45.0^{b}	21.14^{b}	12.60^{b}	0.70^{d}	53.41^{c}	14.00^{b}	6.50^{b}	5.00^{b}	8.00^{b}
05.0	86.6^{c}	5.0^{c}	19.14^{c}	1.25^{e}	13.40^{c}	94.82^{b}	9.00^{c}	0.00^{c}	4.33^{b}	1.50^{c}
07.5	46.6^{d}	0.0^{d}	8.83^{d}	0.00^{d}	53.40^{b}	100.00^{a}	1.33^{d}	0.00^{c}	1.66^{c}	0.00^{d}
10.0	16.6^{e}	0.0^{d}	2.94^{d}	0.00^{d}	83.40^{a}	100.00^{a}	0.00^{e}	0.00^{c}	3.83^{b}	0.00^{d}
P-value	0.026*		0.026*		0.021*		0.19		0.49	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		**		NS	
AB interaction	**		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

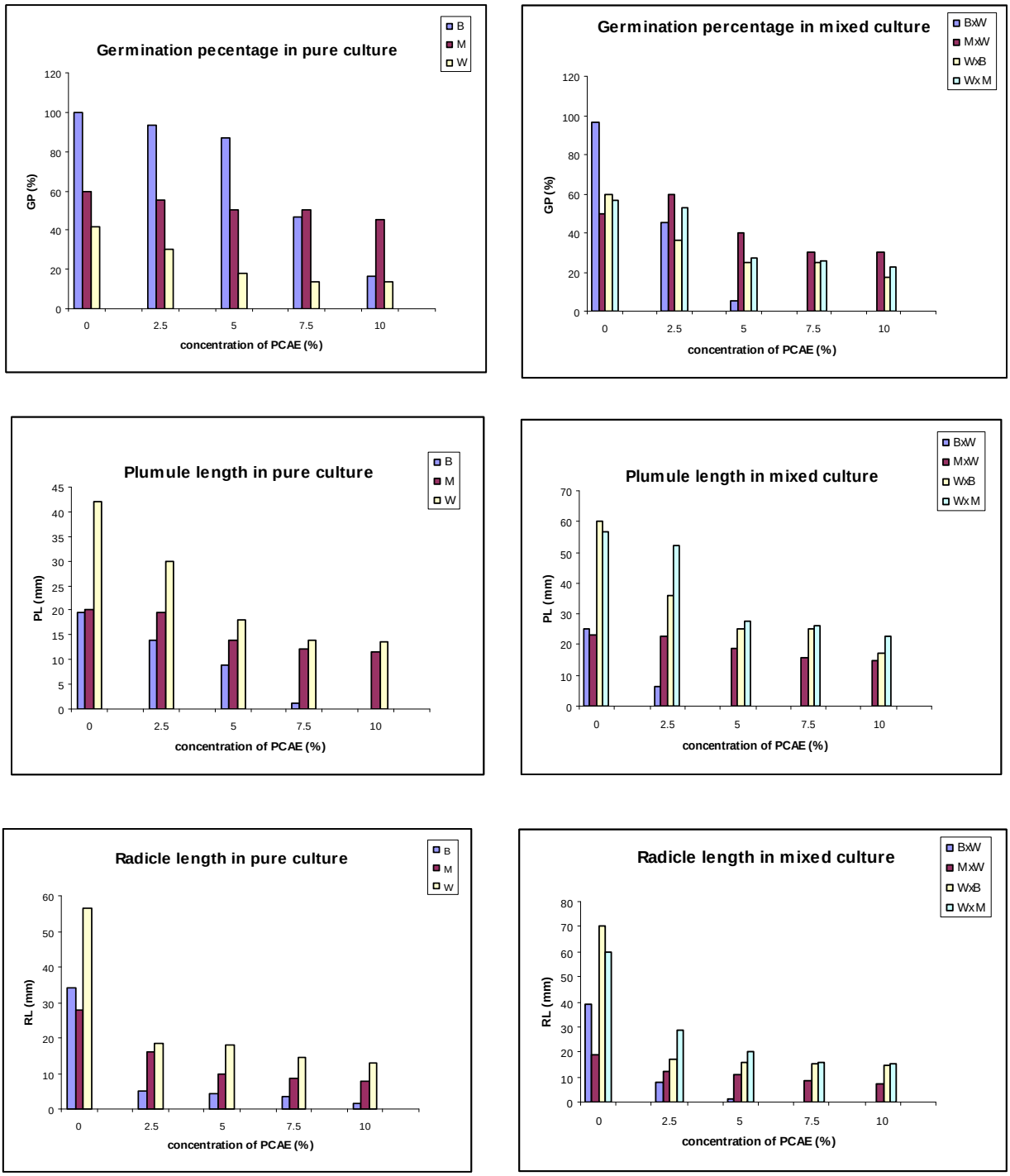

Figure 4.4 Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Pituranthos chloranthus* aqueous extract (PCAE) in Petri-dish experiment.

Table 4.17& Figure 4.4 demonstrates a great variation in the calculated GP was significantly (P≤0.01) affected by the increase in PCAE concentration, type of seed culture and their interaction. Despite GP of *Melilotus indica*, was reduced due to PCAE allelochemicals, its values were higher in pure culture compared to those estimated in mixed culture. At control, GP values were about 60 and 50% in pure and mixed culture respectively. These percentages were reduced to 55% at 2.5 % PCAE concentration and to 50% at 5 and 7.5% PCAE concentration level respectively and at 10% PCAE the value was 45% obtained in pure culture. But in mixed culture GP value at 2.5% PCAE concentration was increased to about 60% which gradually reduced upon applying ascending PCAE concentrations. More obvious reduction in GP occurred at 7.5and 10%PCAE concentration to reach 30% has occurred.

Table 4.18 &Figure 4.4 are illustrate the germination percentage GP of wheat was significantly (P≤0.01) affected by the increase in PCAE concentration, seed culture and their interaction. At control, 2.5 and 5% PCAE levels, the GP value was about 100% in pure culture. These percentages were reduced to 95% at 7.5 and 10% PCAE concentration respectively in mixed culture; type M1.a value at control was about 96.6 % and 100% at 2.5 and 5 % PCAE however at 7.5 and 10% PCAE the values were 95 and 85%, respectively was obtained. On the other hand in mixed culture; type M2 was obtained the same value (100%) at all levels accept at 10% PCAE the value85% was recorded.

1.2 Seed germination index (SGI)

As a response to higher PCAE concentrations, fewer *Bromus tectorum* seeds succeeded in germination (significantly affected at P≤ 0.01) (Table 4.16). Generally, SGI in pure culture was higher relative to that estimated in mixed culture, in pure and mixed culture the control values about 32.33 and 29.7 were attained, respectively. Values of SGI recorded at 2.5, 5, 7.5 and 10% PCAE concentrations were about 21.14, 19.14, 8.83 and 2.94 respectively in pure culture, while the parallel values in mixed one were 12.6, 1.25 and zero, respectively

Generally, SGI of *Melilotus indica* in pure culture was higher relative to that estimated in mixed culture, the control values about 24.42 and 21.93 were attained in pure and mixed culture respectively. Values of SGI recorded at 2.5, 5, 7.5 and 10% PCAE concentrations were about 20.85,18.3,18and 17.05 respectively in pure culture, compared in mixed culture the values were obtained about 22.6,18.94,13.38 and 13.05, respectively.(Table 4.17)

Table 4.17. Variation in germination percentage (GP), Seed germination index (SGI), germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Melilotus indica* (pure culture) and *Melilotus indica* x Wheat (mixed culture) as affected by different concentration of *Pituranthos chloranthus* aqueous extract (PCAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60^{a}	50^{b}	24.42^{a}	21.93^{b}	0.00	0.00	20.00^{a}	23.00^{a}	28.00^{a}	18.66^{a}
02.5	55^{ab}	60^{a}	20.85^{b}	22.60^{a}	8.33^{c}	-20.00	19.50^{ab}	22.50^{a}	16.00^{b}	12.50^{b}
05.0	50^{b}	40^{c}	18.30^{c}	18.94^{c}	16.66^{b}	20.00^{b}	14.00^{b}	18.50^{b}	10.00^{c}	11.00^{c}
07.5	50^{b}	30^{d}	18.00^{c}	13.38^{d}	16.66^{b}	40.00^{a}	12.00^{c}	16.00^{c}	8.50^{d}	8.50^{d}
10.0	45^{c}	30^{d}	17.05^{d}	13.05^{d}	25.00^{a}	40.00^{a}	11.50^{cd}	15.00^{d}	8.00^{d}	7.50^{d}
P-value	0.037*		0.119		0.393		0.007**		0.129	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		**		**	
AB interaction	*		**		**		NS		**	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test

TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.0

The SGI of wheat were attained in pure and mixed culture; type M1 and M2 at control values about 33.3, 32.2 and 46.62, respectively These Values were recorded to 32.25, 31.8, 31.25 and 30 at 2.5, 5, 7.5 and 10% PCAE concentrations, respectively in pure culture, while in mixed culture; typeM1 the values were about 33.3, 31.66, 31.25 and 27.6, respectively; finally in mixed culture type M2 the values were 41.38, 43.3, 38.21 and 30.33 was obtained.(Table 4.18)

1.3 Germination inhibition percentage (GIP)

Data of the present study demonstrated that GIP of *Bromus tectorum* was significantly affected ($P \leq 0.01$) due to the apparent allelopathic action of PCAE concentrations in both pure and mixer culture (Table 4.16). The values 0.7, 13.4, 53.4and 83.4% were recorded in pure culture whereas the values 53.41, 94.82 and 100% were attained in mixed one at 2.5,5,7.5and 10% concentrations, respectively

Accordingly, calculations of GIP for *Melilotus indica* demonstrated a steady elevation in type of seed cultures as more PCAE concentrations were applied. The values 8.33, 16.66% and 25% were recorded in pure culture; Compared in mixed the values were attained about -20,20 and 40% at 2.5, 5, 7.5and 10% concentrations, respectively. Thus, it is patent that *Melilotus indica* seeds experienced more inhibition when germinated in mixed culture.(Table 4.17)

The GIP of wheat demonstrated a steady elevation in seed cultures as more PCAE concentrations was applied (Table 4.18). The values was completely inhibited at 2.5 and 5% PCAE in pure and mixed culture; type M1 and M2 and 5% at 7.5and 10% was recorded in pure culture whereas the values 1.65 and 12 %were attained in mixed culture; type M1at 7.5 and 10% concentrations, respectively. While in mixed culture; M2 at 2.5, 5and7.5% PCAE the value zero % was obtained and 15 % at 10% PCAE concentration.

1.4 Plumule length (PL)

Statistically, the applied concentrations of PCAE and type of seed culture and their interactions are significantly ($P \leq 0.01$) affecting PL of *Bromus tectorum* (Table 4.16 &Figure 4.4). Generally, in pure culture PL was relatively higher than that of mixed culture. At control, PL was 19.66 and 25 mm at pure and mixed culture, respectively. At 2.5, 5, 7.5 and 10% PCAE concentration, the PL was 14, 9, 1.33 and zero mm in pure culture, respectively. In mixed culture at 2.5 % PL was 6.5 mm in the higher concentration levels of PCAE the plumule elongation was completely inhibited.

Table 4.18. Variation in germination percentage (GP),Seed germination index (SGI) , germination inhibition percentage (GIP) plumule (PL) and radicle length (RL) of wheat (w) (pure culture) , wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentration of *Pituranthos chloranthus* aqueous extract (PCAE) in Petri-dish experiment.

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.0^{a}	96.60^{b}	100.0^{a}	33.30^{a}	32.20^{b}	46.62^{a}	0.00	0.00	0.00	42.00^{a}	60.00^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.0^{a}	100.0^{a}	100.0^{a}	32.25^{b}	33.30^{a}	41.38^{c}	0.00^{b}	0.00^{c}	0.00^{b}	30.00^{b}	36.00^{b}	52.50^{b}	18.50^{b}	17.00^{b}	29.00^{b}
5.0	100.0^{a}	100.0^{a}	100.0^{a}	31.80^{b}	31.66^{c}	43.30^{b}	0.00^{b}	0.00^{c}	0.00^{b}	18.00^{c}	25.00^{c}	27.50^{c}	18.00^{b}	16.00^{bc}	20.00^{c}
7.5	95.0^{b}	95.0^{c}	100.0^{a}	31.55^{b}	31.25^{c}	38.21^{d}	5.00^{a}	1.65^{b}	0.00^{b}	14.00^{d}	25.00^{c}	26.00^{d}	14.50^{c}	15.00^{bc}	16.00^{d}
10.0	95.0^{b}	85.0^{d}	85.0^{b}	30.00^{c}	27.60^{d}	30.33^{e}	5.00^{a}	12.00^{a}	15.00^{c}	13.50^{d}	17.50^{d}	22.50^{e}	13.00^{c}	14.50^{c}	15.00^{d}
TWO-WAY ANOVA															
A-Treatment		**			*			**			**			**	
B-Seed Culture		*			**			**			*			**	
AB interaction		**			*			**			**			**	

Different letters within each column indicate significance at P<0.05

Two-way ANOVA:
NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.17 & Figure 4.4 are illustrating the PL of *Melilotus indica* statistically; the applied concentrations of PCAE and type of seed cultures were significantly (P≤ 0.01). In mixed culture PL was relatively higher than that of pure culture. At control, PL was 20 and 23 mm at pure and mixed culture, respectively. Perceptibly, among higher PCAE concentrations, an observed gradual decrease in the PL was reported. At 2.5, 5, 7.5 and 10% PCAE concentration, the PL was 19.5,14,12 and 11.5 mm in pure culture respectively. But in mixed culture, at 2.5 % level PL was 22.5 mm, and 18.5, 16 and 15 values were obtained at 5, 7.5 and 10% PCAE concentrations. The allelopathic effect of PCAE concentration on plumule length (PL) of wheat is illustrated in Table 4.18 & Figure 4.4 Statistically, the applied concentrations of PCAE and type of seed culture and their interactions were significantly (P≤ 0.01). In mixed culture; type M1 and M2 the PL was relatively higher than that of pure culture. At control, PL was 42, 60 and 56.66 mm at pure and mixed culture; type M1 and M2 respectively. Perceptibly, among higher PCAE concentrations, an observed gradual decrease in the PL was reported. At 2.5, 5, 7.5 and 10% PCAE concentration, the PL was 30, 18, 14 and 13.5mm in pure culture, respectively. At the higher concentration levels of PCAE reduced the plumule elongation in mixed culture. At 2.5 % PL was 36 mm, and 25mm values were obtained at 5, 7.5 and at10% PCAE concentrations the value 17.5 was recorded in mixed culture; type M1. While, in mixed culture; type M2 the values were 52.5, 27.5, 26 and 22.5 at 2.5, 5, 7.5 and 10% PCAE concentration.

1.5 Radicle length (RL)

Compared to control, a gradual decrease in RL of *Bromus tectorum* was observed along gradual PCAE concentrations in pure culture. RL implication was significantly affected at P≤ 0.01, while the type of seed culture was not significant (Table 4.16 &Figure 4.4). At control, RL was 34 and 39.33 mm in pure and mixed culture, respectively. In pure culture higher concentrations of PCAE were notably active disturbing radicle emergence. At 2.5, 5 and 7.5% concentrations, RL decreased to 5, 4.33 and 1.66 mm. constantly, it continually reduced till it attained a value of about 3.83 mm at 10% concentration level. In mixed culture at 2.5 and 5 levels, the RL was about 8 and 1.5 mm, respectively however at 7.5 and10% PCAE concentration the radical length was completely inhibited.

The PCAE concentrations and interaction were highly significant (P ≤ 0.01) affecting RL of *Melilotus indica* (Table 4.17 &Figure 4.4) At control, RL was 28 and 18.66 mm in pure and mixed culture, respectively. In pure culture higher concentrations of PCAE were notably active disturbing radicle emergence. At 2.5, 5 and 7.5 and 10% concentrations, RL

decreased to 16, 10, 8.5and 8 mm. In mixed culture, At 2.5,5 and 7.5% level, RL was about 12.5, 11and 7.5 mm; respectively the lowest value (7.5 mm) of RL was noticed at 10% PCAE concentration.

The influence of PCAE concentrations on wheat growth process Furthermore, PCAE concentration and interaction were significantly ($P \leq 0.01$) affecting RL (Table 4.18 &Figure 4.4). At control, RL was 56.66,70 and 60 mm in pure and mixed culture; type M1 and M2, respectively. In pure culture, at 2.5, 5 and 7.5% concentrations, RL decreased to 18.5,18 and 14.5mm. Constantly, it reduced till it attained a value of about 13 mm at 10% concentration level. In mixed culture; type M1, the values of RL were noticed about 17, 16, 15 and 14.5mm at 2.5, 5, 7.5 and10% PCAE concentrations. Compared, in mixed culture, type M2 the values were about 29, 20, 16 and15mm, respectively.

2. Effect of *Pituranthos chloranthus* Crude Powder (PCCP) on some growth parameters and phytomass (Pot Experiment)

2.1 Shoot length (SL)

Data in Table 4.19 a&b pointed up that shoot length (SL) of wheat *and Bromus tectorum* was significantly affected upon applying the different concentrations of PCCP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 18.87 and 13.06cm of SL were observed, respectively. These values were reduced to 16.55and 13.06cm at 1% and to 16.5 and 12.73cm at 3% level and at6% PCCP concentration the values 16.35 and12.1cm were obtained for the two recipient species respectively. Similarly, in sandy soil values of SL were about 17.23 and 13.03cm at control level respectively. These values were reduced to 16.47, 15.67and15.20 cm at 1, 3 and6% PCCP concentration, respectively, for Wheat compared of *Bromus tectorum* The values about to 12.6, 1.4and 11.20 cm were observed. The data of wheat and *Melilotus indica* are illustrated in Table 4.20 a&b pointed up that shoot length (SL) was significantly affected upon applying the different concentrations of PCCP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 17.83 and 14.46cm of SL were observed respectively. These values were reduced to 15.92and 14.75cm at 1% and to 15.37 and 13.60cm at 3% level and at6% PCCP concentration the values 15.30 and13.50cm were obtained for the two recipient species respectively. Similarly, in sandy soil values of SL were about 18.00 and 13.40 cm at control level respectively. These values were reduced to 17.83, 17.16and16.83 cm at 1, 3 and6% PCCP concentration respectively for Wheat compared for *Melilotus indica* The values about to 18, 16.10 and 16cm were observed.

Table 4.19.a.Allelopathic effect of different percentage of *Pituranthos chloranthus* crude powder (PCCP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.93^{a}	0.32^{a}	0.185^{a}	0.468^{a}	0.105^{a}	0.046^{a}	0.026^{a}	0.086^{a}
1	16.55^{b}	16.47^{b}	14.00^{b}	14.00^{b}	4.25^{b}	3.00^{ab}	0.21^{b}	0.24^{b}	0.040^{b}	0.060^{a}	0.037^{b}	0.040^{ab}	0.020^{b}	0.040^{b}
3	16.50^{b}	15.67^{c}	9.70^{c}	12.42^{c}	4.00^{b}	3.00^{ab}	0.19^{c}	0.15^{c}	0.040^{b}	0.050^{a}	0.030^{bc}	0.035^{ab}	0.013^{c}	0.026^{bc}
6	16.35^{b}	15.20^{d}	9.20^{c}	12.37^{c}	3.75^{b}	2.25^{b}	0.10^{d}	0.11^{c}	0.030^{b}	0.045^{a}	0.022^{c}	0.025^{b}	0.006^{d}	0.020^{c}
P-value	0.046*		0.497		0.009*		0.203		0.154		0.241		0.0483*	
TWO-WAY ANOVA														
A – Treatment	**		**		NS		**		**		**		**	
B- **Soil Type**	**		NS		*		**		**		*		**	
A x B	*		**		NS		**		**		**		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.19.b.Allelopathic effect of different percentage of *Pituranthos chloranthus* crude powder (PCCP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06[a]	13.03[a]	7.10[a]	6.23[a]	3.00[a]	2.33[a]
1	13.06[a]	12.60[a]	4.13[b]	5.10[b]	2.66[a]	1.00[b]
3	12.73[b]	11.40[b]	4.00[b]	3.80[c]	2.00[a]	1.00[b]
6	12.10[b]	11.20[b]	3.97[b]	3.00[d]	2.00[a]	1.00[b]
P-value	0.046*		0.316		0.006*	
TWO-WAY ANOVA						
A – Treatment	**		*		*	
B-**Soil Type**	**		NS		*	
A x B	**		NS		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.2 Root length (RL)

The allelopathic effects of PCCP concentration on root length (RL) of Wheat and *Bromus tectorum* are illustrated in Table 4.19 a&b. Generally, all allelopathic concentrations have significant reduced RL. In clay soil, the control values were about 22.12and 7.10cm for the two recipient species respectively. At 1 % PCCP concentration, RL reduced to 14and 4.13cm and 9.7 and1.4 at3% level. Constantly, it continues reduction till it attained values of about 9.2and 3.97cm at 6% PCCP concentration for the two recipient species respectively. Correspondingly, the control values of RL in sandy soil were about 16.16and 6.23cm respectively. At 1% concentration, the values of about 14 and 5.10cm were obtained. It reduced to 12.37 and3cm at 6% PCCP concentration for the two recipient species respectively.

Generally, all allelopathic concentrations have significant reduced RL for Wheat and *Melilotus indica* was not significant affected (Table 4.20 a&b). In clay soil, the control values were about 25.10 and 6.10cm for the two recipient species respectively. At 1 % PCCP concentration, RL reduced to 9.30 and 6.20cm and 9.05 and 6.00at3% level. Constantly, it continues reduction till it attained values of about 8.30and 5.40 cm at 6% PCCP concentration for the two recipient species respectively. Correspondingly, the control values of RL in sandy soil were about 11.37and 6.56cm respectively. At 1% concentration, the values of about 47.33 and 5.40 cm were obtained. It reduced to 11.66and4.00cm at 6% PCCP concentration for the two recipient species respectively.

2.3 Leaf number (LN)

Commonly, leaf number (LN) was not significant affected by the increase in PCCP concentration. In clay soil, the control values of LN were about 5.25and 3 respectively. At 6% PCCP concentration the values of about 3.75 and 2 were attained for the two recipient species respectively. Similarly, in sandy soil, the control values of LN were about 3.66and 2.33 respectively. At 6% PCCP concentration, values of about 2.25and one were obtained for the two recipient species, respectively (Table 4.19.a.b).

The leaf number (LN) of wheat and *Melilotus indica* was not significant affected by the increase in PCCP concentration. In clay soil, the control values were about 4.33and 3.33, respectively. At 6% PCCP concentration the values of about 2.75 and 2 were attained for the two recipient species respectively. Also, in sandy soil, the control values were about 4.66and 2, respectively. At 6% PCCP concentration, the same values 3 were obtained for the two recipient species respectively (Table 4.20 a&b).

Table 4.20.a.Allelopathic effect of different percentage of *Pituranthos chloranthus* crude powder (PACP) on some growth parameters of wheat (mixed culture with *Melilotus indica)*, 30 days after sowing in two different types of soils (clay soil (

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
Control	17.83^{a}	18.00^{a}	25.10^{a}	11.37^{c}	4.33^{a}	4.66^{a}	0.820^{a}	0.480^{a}	0.146^{a}	0.310^{a}	0.100^{a}	0.060^{a}	0.026^{a}	0.073^{a}
1	15.92^{b}	17.83^{a}	9.30^{b}	27.33^{a}	3.50^{ab}	4.33^{a}	0.200^{b}	0.400^{b}	0.015^{b}	0.210^{b}	0.035^{ab}	0.066^{a}	0.013^{a}	0.066^{a}
3	15.37^{c}	17.16^{a}	9.05^{b}	17.33^{b}	3.25^{ab}	4.00^{a}	0.195^{b}	0.320^{c}	0.020^{b}	0.220^{b}	0.025^{b}	0.033^{b}	0.013^{a}	0.060^{a}
6	15.30^{c}	16.83^{a}	8.30^{c}	11.66^{c}	2.75^{b}	3.00^{a}	0.180^{ab}	0.160^{d}	0.020^{b}	0.060^{c}	0.020^{b}	0.013^{c}	0.020^{a}	0.020^{b}
P-value	0.037*		0.234		0.017*		0.473		0.014*		0.450		0.029*	
TWO-WAY ANOVA														
A – Treatment (S	*		**		NS		**		**		**		*	
B- Soil Type	**		**		NS		NS		**		NS		**	
A x B)	NS		**		NS		**		**		*		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.20.b.Allelopathic effect of different percentage of *Pituranthos chloranthus* crude powder (PACP) on some growth parameters of *Melilotus indica,* (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables / treatment	Shoot length (cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46[a]	13.4c	6.10[a]	6.56[a]	3.33[a]	2.00[a]
1	14.75[a]	18.00[a]	6.20[a]	5.40[ab]	2.00[b]	4.00[a]
3	13.60[b]	16.10[b]	6.00[a]	5.20[bc]	2.50[ab]	4.00[a]
6	13.50[b]	16.00[b]	5. 40 [a]	4.00[c]	2.50[ab]	3.00[a]
P-value	0.110		0.177		0.215	
TWO-WAY ANOVA						
A – Treatment	*		NS		NS	
B-**Soil Type**	*		NS		NS	
A x B	*		NS		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.4 Shoot fresh weight (SFw)

The represented data in table 4.19.a showed the values of shoot fresh weight (SFw) of Wheat were about 0.93 and 0.32g.plant-^{1} at control level in clay and sandy soil respectively. These values decreased to 0.21, 0.185 and 0.10g.plant^{-1} at 1, 3 and 6% PCCP concentration were obtained in clay soil. Also, in sandy soil the values of SFw were about 0.24, 0.15 and 0.11g.plant^{-1} at 1, 3 and 6% PCCP concentration, respectively.

The data of shoot fresh weight (SFw) of Wheat showed in table 4.20.a the values were about 0.82 and 0.48 g.plant^{-1} at control level in clay and sandy soil, respectively, These values decreased to 0.20, 0.195 and 0.18 g.plant^{-1} at 1, 3 and 6% PCCP concentration were obtained in clay soil. Correspondingly, in sandy soil, the values of SFw were about 0.40, 0.32 and 0.16 g.plant^{-1} at 1, 3 and 6% PCCP concentration, respectively.

2.5 Root fresh weight (RFw)

In clay and sandy soil, the values of root fresh weight (RFw) of Wheat were about 0.185 and 0.468 g.plant^{-1} at control level, respectively. Through applying subsequent higher PCCP concentrations there was a continual reduction in RDw. Eventually, the values reduced to 0.04 at 1 and 3% PCCP and at6% PCCP concentrations the values 0.03 g.plant^{-1} was obtained in clay soil. whereas in sandy soil the values of RFw were about 0.147, 0.1260.046 g.plant^{-1} at 1, 3 and 6% concentration respectively (Table 4.19.a).

The values of root fresh weight (RFw) of Wheat were about 0.146 and 0.31 g.plant^{-1} at control level In clay and sandy soil, respectively. Through applying subsequent higher PCCP concentrations there was a continual reduction in RDw. however, the values reduced to 0.02 at 1 and 3% PCCP and at6% PCCP concentrations the values 0.015 g.plant^{-1} was obtained in clay soil. On the other hand, the values of RFw in sandy soil were about 0.22, 0.21 and 0.06 g.plant^{-1} at 1, 3 and 6% concentration respectively (Table 4.20.a).

2.6 Shoot dry weight (SDw)

Shoot dry weight (SDw) was significantly affected by PCCP concentrations (Table 4.19.a). Values of about 0.105 and0.046 g.plant^{-1} were achieved at control level in clay and sandy soil respectively. These values decreased to 0.037, 0.03 and0.022at1.3and 6% PCCP concentration respectively in clay soil. Similarly, in sandy soil, the values of SDw were about 0.04, 0.035 and0.025 g.plant^{-1} at 1, 3 and 6% PCCP concentration respectively.

Shoot dry weight (SDw) was significantly affected by PCCP concentrations (Table 4.20.a). Values of about 0.10 and0.06 g.plant^{-1} were achieved at control level in clay and sandy soil respectively. These values decreased to 0.035, 0.025 and0.02 at1.3and 6% PCCP concentration respectively in clay soil. Compared, in sandy soil, the values of SDw were about 0.066, 0.033 and0.013 g.plant^{-1} at 1, 3 and 6% PCCP concentration respectively.

2.7 Root dry weight (RDw)

Data of the present study demonstrated that root dry weight (RDw) of wheat and *Bromus tectorum* was significantly affected due to the apparent allelopathic action of PCCP concentrations under the clay and sandy soils. In clay soil, there was a notably reduction in values of RDw; the values of RDw were about 0.026, 0.02, 0.013 and0.006g.plant^{-1} at control and all the concentration levels respectively. Likewise, in sandy soil the control value of RDw was about 0.086g.plant^{-1}. At 1, 3 and 6% PCCP concentration, RDw reduced to 0.04, 0.026 and 0.02g.plant^{-1} respectively (Table 4.19.a). Table 4.20.a is showed the data of root dry weight (RDw) was significantly affected due to the apparent allelopathic action of PCCP concentrations under the clay and sandy soils. In clay soil, there was a notably reduction in values of RDw; the values of RDw was about 0.026 g.plant^{-1} at control and to 0.02 g.plant^{-1} at1% level and 0.013g.plant^{-1} at 3 and6% PCCP concentration. Likewise, in sandy soil the control value of RDw was about 0.073g.plant^{-1} but at 1, 3 and 6% PCCP concentration, RDw reduced to 0.066, 0.06 and 0.02g.plant^{-1}, respectively.

V. Allelopathic Potential of *Haloxylon scoparium* on *Bromus tectorum* , *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species)

1. Effect of *Haloxylon scoparium* Aqueous Extract (HSAE) on germination efficiency (Petri-Dish Experiment)

1.1Germination Percentage (GP)

The germination percentage (GP) of *Bromus tectorum* seeds in pure and mixed culture was significantly ($P \leq 0.01$) affected upon applying different concentrations of HSAE (Table 4.21& Figure 4.5). Generally, GP decreased with the increase in HSAE concentration in pure and mixed culture. GP was about 100% at control and 90% at 2.5% HSAE concentration level. Continuously, it was 73.3% at 5% HSAE concentration. A great noteworthy reduction in GP was attained along the higher HSAE concentrations. Correspondingly, GP was decreased to about 53.3 and 6.6% at 7.5and 10% HSAE concentrations, respectively.

Lower GP was detected pure culture compared to that estimated in mixed culture. At control level, GP was initiated at about 96.6% and reduced to 65 and 10% at 2.5and 5% concentration respectively. Continuously, at7.5and10 % HSAE concentrations, a completely inhibition has occurred.

The GP of *Melilotus indica* seeds in pure and mixed culture were significantly ($P \leq 0.01$) affected upon applying different concentrations (HSAE), however the type of seed cultures and their interaction of HSAE concentrations-seed cultures was not significant. (Table 4.22 & Figure 4.5) Commonly, in pure culture, The GP was about 60% at control and 50 and45% and at 2.5 and 5% HSAE concentration level. Continuously, GP was decreased to about 35and 30% at 7.5and 10% HSAE concentrations, respectively. While in mixed culture, at control level, GP was initiated at about 50% and increased to 55% at 2.5 and at5, 7.5 and10% concentration the values were 45, 40 and 35% respectively.

The data are illustrated in Table 4.23& Figure 4.5. The GP of wheat seeds in pure and mixed culture; type M1 and M2 were significantly ($P \leq 0.01$) affected upon applying different concentrations of (HSAE), The GP was about 100% at control and 2.5% HSAE concentration level. Continuously, it was 95% at 5 and 7.5 % HSAE concentration. GP was decreased to about 90% at 10% HSAE concentrations, but in mixed culture; type M1 at control level, GP was initiated at about 96.6% and increased to 100% at 2.5and 5% concentration, respectively. Continuously, at7.5and10 % HSAE concentrations, an inhibition of about 95 and 85% has occurred. While in mixed culture; type M2, at control and 2.5 % was same value (100%) and 95% at 5% level finally at 7.5 and 10% HSAE the same value (90%) was recorded.

1.2 Seed germination index (SGI)

Regarding SGI of *Bromus tectorum*, the value decreased distinctly as HSAE concentration increased. This reduction was statistically ($P \leq 0.01$) highly significant (Table 4.21). In pure culture has demonstrated a better medium permit larger number of *Bromus tectorum* seeds to germinate compared to mixed one. Starting with pure culture, SGI began with value of about 32.33 at control and15.56 at 2.5% HSAE concentration. On the other hand, lower SGI values were detected in mixed culture at control (29.7) and 2.5% concentration (15.5). Continuously, in pure culture, the values 13.76 and 3.02 were obtained at 7.5 and 10% HSAE concentrations respectively. The initiated SGI in mixed culture, the values of about 9.2 at 5% concentration, the reduction was continued to reach zero at 7.5 and 10% concentration, respectively.

Table 4.21 Variation in germination percentage (GP),Seed germination index (SGI) ,germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of *Bromus tectorum* (pure culture) and *Bromus tectorum* x Wheat (mixed culture) as affected by different concentration of *Haloxylon scoparium* aqueous extract (HSAE) in Petri-dish experiment.

Variables	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
Treatment (%)	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100. 0^{a}	96.6^{a}	32.33^{a}	29.70^{a}	0.00	0.00	19.66^{a}	25.00^{b}	34.00^{a}	39.33^{a}
02.5	90.0^{b}	65.0^{b}	15.56^{c}	15.50^{b}	10.00^{d}	32.71^{c}	13.00^{b}	31.50^{a}	2.66^{b}	13.50^{b}
05.0	73.3^{c}	10.0^{c}	21.03^{b}	9.20^{c}	26.70^{c}	85.63^{b}	6.00^{c}	0.50^{c}	3.33^{b}	4.00^{c}
07.5	53.3^{d}	0.0^{d}	13.76^{d}	0.00^{d}	46.70^{b}	100.00^{a}	5.33^{c}	0.00^{c}	3.66^{b}	0.00^{d}
10.0	6.6^{e}	0.0^{d}	3.02^{e}	0.00^{d}	93.40^{a}	100.00^{a}	0.00^{d}	0.00^{c}	0.50^{c}	0.00^{d}
P-value	0.033*		0.041*		0.032*		0.29		0.18	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		**		*	
AB interaction	**		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

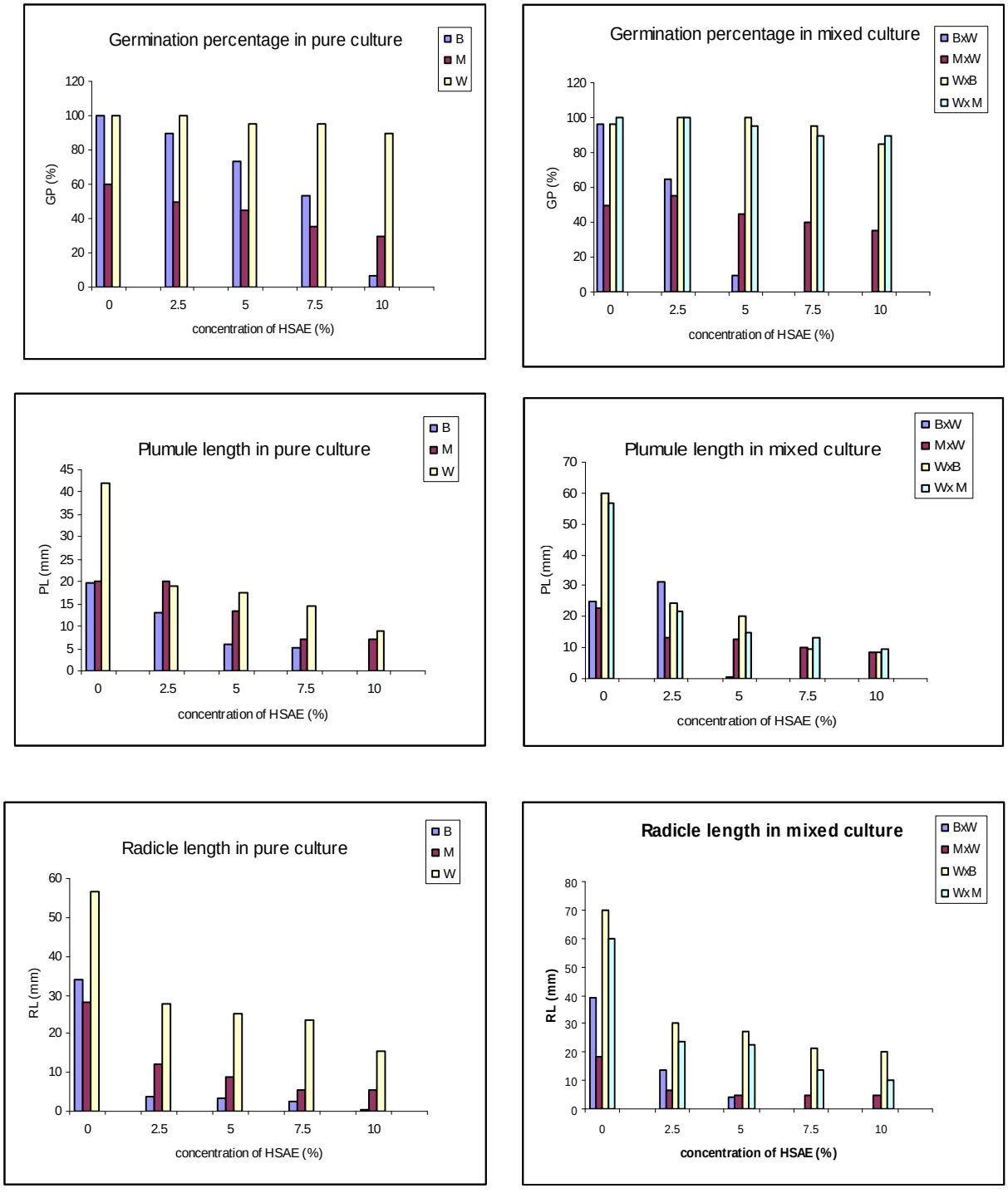

Figure 4.5 Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Haloxylon scoparium* aqueous extract (HSAE) in Petri-dish experiment

The SGI of *Melilotus indica*, values was decreased distinctly as HSAE concentration increased. This reduction was statistically highly significant (P≤ 0.01) (Table 4.22).in pure culture, SGI began with value of about 24.42 at control and 22.43at 2.5% HSAE concentration. Continuously, in pure culture, the values 18.3, 12.05 and 9.43 were obtained at5, 7.5 and 10% HSAE concentrations, respectively While, the SGI values were detected in mixed culture at control the value about 21.93 and at 2.5, 5, 7.5 and 10% concentration the values ware increased to 22.97, 20.33,18,21 and 10,25 At HSAE % concentrations, respectively,

The effect of HSAE concentration on the SGI of wheat statistically was not significant while the type of seed culture was significantly affected (P≤ 0.01) (Table 4.23).Generally, in pure culture, the SGI value was about 33.3 at control and 39.1at 2.5% HSAE concentration and at 7.5 and 10% HSAE concentrations the values were obtained 29.1 and 28.3, respectively .On the other hand, lower SGI values were detected in mixed culture; type M1 and M2 at control (32.2 and 46.62) and at2.5% concentration (33.3 and 43.56). Continuously, The SGI in mixed culture; type M1 and M2, the values about 31 and 37.85 at 5% concentration, the reduction was continued to reach 28.8 and 27at 7.5 and 10% concentration respectively in mixed culture; type M1 while in mixed culture; type M2 the values were 32.8 and 26.25 at 7.5 and 10% HSAE concentration.

1.3 Germination inhibition percentage (GIP)

Data of the present study demonstrated that GIP of *Bromus tectorum* was significantly affected (P≤ 0.01) due to the apparent allelopathic action of HSAE concentrations under both types of seed culture.(Table 4.21). GIP was attained at 2.5% HSAE concentrations in pure culture it was about 10%. Alternatively, at the same concentration, the GIP was higher in mixed culture (32.71%). In pure culture GIP attained values of about 26.7, 46.7 and 93.4% at 5, 7.5 and 10% HSAE concentrations, respectively compared in mixed culture with 85.63 and 100% were recorded.

The GIP of *Melilotus indica* was significantly affected (P≤ 0.01) due to the apparent allelopathic action of HSAE concentrations (Table 4.22). The GIP in pure and mixed culture it were about 16.66 and -10%, respectively at 2.5% HSAE concentrations. In pure culture GIP values were about 25, 41.66 and 50% at 5, 7.5 and 10% HSAE concentrations, respectively compared with 10, 20 and 30% in mixed culture.

Table 4.22 Variation in germination percentage (GP), Seed germination index (SGI), germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Melilotus indica* (pure culture) and *Melilotus indica* x wheat (mixed culture) as affected by different concentration of *Haloxylon scoparium* aqueous extract (HSAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60^{a}	50^{a}	24.42^{a}	21.93^{b}	0.00	0.00	20.00^{a}	23.00^{a}	28.00^{a}	18.66^{a}
02.5	50^{b}	55^{ab}	22.43^{b}	22.97^{a}	16.66^{d}	-10.00	20.00^{a}	13.00^{b}	12.00^{b}	6.50^{b}
05.0	45^{bc}	45^{b}	18.30^{c}	20.33^{b}	25.00^{c}	10.00^{c}	13.50^{b}	12.50^{b}	9.00^{c}	5.00^{c}
07.5	35^{cd}	40^{bc}	12.05^{d}	18.21^{c}	41.66^{b}	20.00^{b}	7.00^{c}	10.00^{c}	5.50^{d}	5.00^{c}
10.0	30^{c}	35^{c}	9.43^{e}	10.25^{d}	50.00^{a}	30.00^{a}	7.00^{c}	8.50^{d}	5.50^{d}	5.00^{c}
P-value	0.374		0.185		0.001**		0.479		0.037*	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	NS		**		**		NS		**	
AB interaction	NS		**		*		**		*	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test

TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.0

The Potential of HSAE concentrations, type of seed culture and RRAE concentration-seed culture interaction on GIP of Wheat was highly significant (P≤ 0.01).(Table 4.23). At 2.5% HSAE concentrations in pure and mixed culture; type M2 the GIP was inhibited and at the same concentration, in mixed culture; typeM1 the GIP was higher about 3.51%. GIP attained values of about 5% at 5 and7.5 % HSAE concentration and at 10 % level the value 10% was obtained in pure culture however in mixed culture; type M1 the values about 3.51,1.65and 12 % at 5,7.5 and 10% HSAE concentration . While in mixed culture; type M2 the value was 5% at 5% and at 7.5and10%HSAE concentration was the same value (10%) was obtained.

1.4 Plumule length (PL)

The PL of *Bromus tectorum* was significantly reduced (P≤ 0.01) either due to each main effect as an individual or due to their interactions. In pure culture, value of PL was 19.66 mm at control level. Afterward, it reduced to 13mm at 2.5% HSAE concentration. Expectedly, the maximum allelopathic action of 10% HSAE concentration the germination was completely inhibited. In mixed culture at control level, the value of PL was about 25 mm, and 31.5mm at 2.5% HSAE concentration. However, at 7.5 and 10% HSAE concentration, the germination was completely inhibited.(Table 4.21& Figure 4.5).Findings of PL for *Melilotus indica* imply the downbeat effect of the allelopathic substances on seedling stage (Table 4.22&Figure 4.5). Evidently, PL was significantly reduced (P≤ 0.01) either due to each main effect as a concentration or due to their interactions but the type of seed cultures was not significant . In pure culture, values of PL were similar 20 mm at control level and 2.5% HSAE. Afterward, it reduced to 13.5mm at 5% HSAE concentration. Expectedly, the maximum allelopathic action of 7.5 and 10% HSAE concentration has reduced PL to 7 mm. While , in mixed culture, l, the value was about 23 and 13mm at control and 2.5% HSAE concentration however At 5, 7.5 and 10% HSAE concentrations, the PL was reduced to 12.5, 10 and 8.5mm, respectively .Statistically, the applied concentrations of HSAE and type of seed culture and their interactions are significantly (P≤ 0.01) affecting PL of wheat (Table 4.23 & figure 4.5).in pure culture, the value of PL was 42mm at control level. Afterward, it reduced to 19, 17.5 14.5 and 9 mm at 2.5, 5 7.5 and10% HSAE concentrations, respectively. While in mixed culture; type M1 and M2At control level, the values of PL was about 60 and 56.66 mm, in mixed culture; type M1 the values about to 24.5, 20, 9.5 and 8.5 mm at 2.5 5 7.5and 10% concentrations respectively however in mixed culture; type M2 was marked 21,5,15 and 13.5 mm at 2.5,5 and 7.5 % concentration the lowest value (9,5mm) was obtained at 10% HSAE concentrations.

Table 4.23. Variation in germination percentage (GP),Seed germination index (SGI) , germination inhibition percentage (GIP) plumule (PL) and radicle length (RL) of wheat (W) (pure culture) , wheat x *Bromus tectorum* (WxB) and Wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentration of *Haloxylon scoparium* aqueous extract (HSAE) in Petri-dish experiment.

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.0^{a}	96.6^{b}	100.0^{a}	33.30^{b}	32.20^{a}	46.62^{a}	0.00	0.00	0.00	42.00^{a}	60.00^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.0^{a}	100.0^{a}	100.0^{a}	39.10^{a}	33.30^{a}	43.56^{b}	0.00^{c}	-3.51	0.00^{c}	19.00^{b}	24.50^{b}	21.50^{b}	27.50^{b}	30.50^{b}	23.50^{b}
5.0	95.0^{b}	100.0^{a}	95.0^{b}	29.55^{c}	31.00^{b}	37.85^{c}	5.00^{b}	-3.51	5.00^{b}	17.50^{b}	20.00^{c}	15.00^{c}	25.00^{c}	27.50^{c}	22.50^{b}
7.5	95.0^{b}	95.0^{b}	90.0^{c}	29.10^{d}	28.80^{c}	32.80^{d}	5.00^{b}	1.65^{b}	10.00^{a}	14.50^{c}	9.50^{d}	13.50^{b}	23.50^{d}	21.50^{d}	13.50^{c}
10.0	90.0^{c}	85.0^{d}	90.0^{c}	28.30^{e}	27.00^{d}	26.25^{e}	10.00^{a}	12.00^{a}	10.00^{a}	9.00^{d}	8.50^{d}	9.50^{e}	15.50^{e}	20.00^{e}	10.00^{d}
TWO-WAY ANOVA															
A-Treatment		**			NS			**			**			**	
B-Seed Culture		**			**			**			**			**	
AB interaction		**			NS			**			**			**	

Different letters within each column indicate significance at P<0.05
Two-way ANOVA: NS: not significant **: Significant at 0.01

1.5 Radicle length (RL)

A slight difference was observed among *Bromus tectorum* in respective to RL assessment in seed culture (Table 4.21& Figure 4.5). In pure culture, the control values were 34mm. Elevated HSAE concentrations have possessed a significant inhibitory effect on radicle growth (P≤ 0.01). At 2.5% HSAE concentration, it was 2.66mm. Upon applying the highest HSAE concentration (10%), it has reduced to 0.5mm. Evidently, RL measurements have illustrated lower assessments as a response in mixed culture. Beginning with a value of about 39.33mm at control level, and at 2.5 and 5% HSAE concentrations the RL values were 13.5 and 4 mm however at 7.5 and 10% HSAE the root emergence was completely inhibited.

The allelopathic effect of HSAE concentration on RL of *Melilotus indica* is illustrated in Table 4.22 &Figure 4.5 Statistically, the applied concentrations of HSAE and type of seed culture and their interactions are significantly (P≤ 0.01). In pure culture, the control value was about 28mm and at 2.5% HSAE concentration, it was 12mm. Upon applying the highest HSAE concentration (7.5 and10%), it has reduced to 5.5mm. Evidently, in mixed culture the value about 18.66mm at control level, a gradual reduction has then occurred as a result of applying ascending HSAE concentrations. RL values were 6.5mm at 2.5 and at 5% HSAE concentrations the values were 5 mm was obtained

Elevated HSAE concentrations have possessed a significant inhibitory effect on radicle growth of wheat (P≤ 0.01) (Table 4.23&Figure 4.5).In pure culture, the control value was 56.66 mm, and at 2.5, 5 and 7.5 % HSAE concentration, it was 27.5,25 and 23.5mm. Upon applying the highest HSAE concentration (10%), it has reduced to 15.5 mm. in mixed culture; type M1. at control level the value was about 70mm, while at 2.5,5, 7.5 and 10% HSAE concentrations the RL values were about 30.5,27,5,21,5 and 20 mm, respectively; Compared in mixed culture; type M2 the values were obtained 23, 5, 22, 5, 13.5 and 10 mm.

2. Effect of *Haloxylon scoparium* Crude Powder (HSCP) on some growth parameters and phytomass (Pot Experiment)

2.1Shoot length (SL)

Generally, SL of wheat and *Bromus tectorum* decreased with the increase in treatment concentrations under the clay and sandy soil. At control level and under clay soil the values were about 18.87 and 13.06 cm in Wheat and *Bromus tectorum* respectively.

Afterward, it reduced to 16.36 and 13.13 cm at 1%, 15.95 and 12.46 cm at 3% and 15.45 and 12.13 cm at 6% HSCP concentrations for the two recipient species respectively. Likewise, in sandy soil values of SL were about 17.23 and 13.03 cm respectively at control level. These values were reduced to 16 and 11.76cm at 1% and, to 15.45and 11.66cm at 3% while at 6% HSCP concentration the values 15.37 and 11.40 cm were recovered for the two recipient species respectively (Tabel4.24a&b).Generally, SL of wheat and *Melilotus indica* decreased with the increase in treatment concentrations under the clay and sandy soil. At control level and under clay soil the values were about 17.83 and 14.46 cm in Wheat and *Melilotus indica*, respectively. Afterward, it reduced to 15.70 and 15.25 cm at 1%, and 15.52 and 13.75 cm at 3% and 15.25 and 13.70 cm at 6% HSCP concentrations for the two recipient species respectively. Likewise, in sandy soil values of SL were about 18.00 and 13.40 cm respectively at control level. These values were reduced to 17.73 and 16.60cm at 1% and, to 17.50and 15.30 cm at 3% while at 6% HSCP concentration the values 16.90and zero cm were recovered for the two recipient species respectively (Tabel4.25a&b).

2.2 Root length (RL)

Compared to control, root length (RL) of wheat and *Bromus tectorum* exhibited a significant reduction along gradual HSCP concentrations (Table 4.24 a&b). In clay soil, the control values were about 22.12 and 7.1cm for two recipient species respectively. At 1, 3 and 6% HSCP concentrations there has been a marked reduction in RL were 9.5, 7.07 and 6.75cm, respectively for Wheat compared of *Bromus tectorum* The values were about 6.36, 5.2 and4.1 cm. additionally, the control values of RL in sandy soil were about 16.6 and 6.23cm, respectively, at 1% concentration; the values of about 13.37and 7.36cm and at 3% level the values 12.85and 5.9cm were achieved. It reduced to 10.25 and 3.46 cm at 6% HSCP concentration for the two recipient species respectively.

Compared to control, root length (RL) of wheat and *Melilotus indica* exhibited a significant reduction along gradual HSCP concentrations (Table 4.25 a&b). In clay soil, the control values were about 25.10 and 6.10cm for two recipient species respectively. At 1, 3 and 6% HSCP concentrations there has been a marked reduction in RL were 11.25, 10.30 and 9.25cm, respectively for Wheat, compared of *Melilotus indica*. The same value was about 3.00 cm. additionally, the control values of RL in sandy soil were about 11.37 and 6.56cm respectively, at 1% concentration; the values of about 26.33and 5.85cm and at 3%level the values 24.16and 2.60cm were achieved. It reduced to 16.50and zero cm at 6% HSCP concentration for the two recipient species respectively.

Table 4.24.a.Allelopathic effect of different percentage of *Haloxylon scoparium* crude powder (HSCP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.93^{a}	0.32^{a}	0.185^{a}	0.468^{a}	0.105^{a}	0.046^{a}	0.026^{a}	0.086^{a}
1	16.3b^{c}	16.00^{b}	9.50^{b}	13.37^{c}	3.75^{b}	3.00^{a}	0.22^{b}	0.26^{b}	0.040^{b}	0.050^{b}	0.03^{b}	0.035^{ab}	0.020^{a}	0.020^{b}
3	15.95^{b}	15.45^{b}	7.07^{c}	12.85^{b}	3.50^{b}	3.00^{a}	0.14^{c}	0.23^{b}	0.013^{c}	0.045^{b}	0.025^{b}	0.030^{b}	0.013^{a}	0.020^{b}
6	15.45^{d}	15.37^{b}	6.75^{c}	10.25^{b}	3.25^{b}	3.00^{a}	0.06^{d}	0.18^{c}	0.012^{c}	0.035^{b}	0.025^{b}	0.025^{b}	0.013^{a}	0.013^{b}
P-value	0.087		0.217		0.038*		0.324		0.139		0.245		0.165	
TWO-WAY ANOVA														
A – Treatment	**		**		*		**		**		**		**	
B- Soil Type	*		**		*		**		**		*		*	
A x B	NS		**		NS		**		**		*		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.24b. Allelopathic effect of different percentage of *Haloxylon scoparium* crude powder (HSCP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables / treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06^{b}	13.03^{a}	7.10^{a}	6.23^{b}	3.00^{a}	2.33^{a}
1	13.13^{c}	11.76^{b}	6.36^{a}	7.36^{a}	3.00^{a}	1.66^{a}
3	12.46^{b}	11.66^{b}	5.20^{c}	5.90^{c}	2.66^{a}	1.33^{ab}
6	12.13^{c}	11.40^{b}	4.10^{d}	3.46^{d}	2.00^{a}	1.00^{b}
P-value	0.037*		0.486		0.011*	
TWO-WAY ANOVA						
A – Treatment	**		**		**	
B-**Soil Type**	**		NS		**	
A x B	**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant **: Significant at 0.01

2.3 Leaf number (LN)

Generally, Leaf number (LN) of wheat and *Bromus tectorum* effect was significantly with the increase in treatment concentrations under the clay and sandy soil. At control level and under clay soil the values were about 5.25 and 3 in Wheat and *Bromus tectorum* respectively. Afterward, it reduced to 3.75 and 3 at 1%, 3.5 and 2.66 at 3% and 3.25 and 2 at 6% HSCP concentrations for the two recipient species respectively. Likewise, in sandy soil values of LN were about 3.66 and 2.33 respectively at \\\\\\control level. These the same value was about 3 at 1, 3% and6% HSCP concentration for Wheat while, for *Bromus tectorum* the values about 1.66 at 1% and at3% level the value was 1.33 and one at6% HSCP concentration was recovered.(Table 4.24a&b).

Generally, Leaf number (LN) of whaet and Melilotus *indica* effect was not significant with the increase in treatment concentrations under the clay and sandy soil. At control level and under clay soil the values were about 4.33 and 3.33 in Wheat and *Melilotus indica*, respectively. Afterward, it reduced to 3 at all concentration in Wheat But in *Melilotus indica* the values about 3, 2.5 and2 at1, 3 and 6% HSCP concentrations respectively. Likewise, in sandy soil values of LN were about 4.66 and 2 respectively at control level. These the same value was about 4.33 at 1and 3% and 3.66 at 6% HSCP concentration for Wheat while, for *Melilotus indica* the values about 4,3.5 and zero at 1,3 and 6% HSCP concentration was recovered.(Table 4.25a&b).

2.4 Shoot fresh weight (SFw)

Shoot fresh weight (SFw) of Wheat was significantly affected by HSCP concentrations (Table 24.a). The Value 0.93g.plant^{-1} was attained at control level in clay soil. The values of SFw decreased to 0.22, 0.14 and 0.06 at 1,3and 6% HSCP concentration respectively. Similarly, in sandy soil, the control value of SFw 0.32 g.plant^{-1} was obtained. As a response to HSCP allelopathic stress, SFw gradually decreased to 0.26, 0.23 and0, 18 g.plant^{-1} at 1, 3 and6% HSCP concentration respectively. Shoot fresh weight (SFw) of Wheat was significantly affected by HSCP concentrations (Table 25a). The Value 0.82g.plant^{-1} was attained at control level in clay soil. The values of SFw decreased to 0.305, 0.29 and 0.215 g.plant^{-1} at 1,3and 6% HSCP concentration respectively. Similarly, in sandy soil, the control value of SFw 0.48 g.plant^{-1} was obtained. As a response to HSCP allelopathic stress, SFw gradually decreased to 0.36, 0.35 and 0, 32 g.plant^{-1} at 1, 3 and 6% HSCP concentrations, respectively.

Table 4.25.a.Allelopathic effect of different percentage *Haloxylon scoparium* crude powder (HACP) on some growth parameters of wheat (in mixed culture with *Melilotus indica)*, 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	17.83^{a}	18.00^{a}	25.10^{a}	11.37^{d}	4.33^{a}	4.66^{a}	0.820^{a}	0.480^{a}	0.146^{a}	0.310^{a}	0.100^{a}	0.06^{a}	0.026^{a}	0.073^{bc}
1	15.70^{b}	17.73^{a}	11.75^{b}	26.33^{a}	3.00^{b}	4.33^{a}	0.215^{c}	0.360^{b}	0.030^{b}	0.170^{c}	0.025^{b}	0.046^{ab}	0.020^{a}	0.093^{a}
3	15.52^{bc}	17.50^{a}	10.30^{c}	24.16^{b}	3.00^{b}	4.33^{a}	0.290^{b}	0.350^{bc}	0.030^{b}	0.260^{b}	0.025^{b}	0.046^{ab}	0.013^{a}	0.086^{ab}
6	15.25^{c}	16.90^{a}	9.25^{d}	16.50^{c}	3.00^{b}	3.66^{a}	0.305^{b}	0.320^{c}	0.040^{b}	0.260^{b}	0.030^{ab}	0.033^{b}	0.013^{a}	0.06^{c}
P-value	0.022*		0.236		0.017*		0.397		0.0016*		0.46		0.0020*	
TWO-WAY ANOVA														
A - Treatment	*		**		NS		**		**		NS		*	
B- Soil Type	**		**		NS		NS		**		NS		**	
A x B	*		**		NS		**		**		NS		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.25.b.Allelopathic effect of different percentage of *Haloxylon scoparium* crude powder (HACP) on some growth parameters of *Melilotus indica*,(mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables treatment	Shoot length (cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46^{ab}	13.40^{c}	6.10^{a}	6.56^{a}	3.33^{a}	2.00^{b}
1	15.25^{a}	16.60^{a}	6.00^{b}	5.85^{b}	3.00^{a}	4.00^{a}
3	13.75^{b}	15.30^{b}	6.00^{b}	4.60^{c}	2.50^{ab}	3.50^{ab}
6	13.70^{b}	0.00^{d}	6.00^{b}	0.00^{d}	2.00^{b}	0.00^{c}
P-value	0.363		0.493		0.374	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-**Soil Type**	*		NS		NS	
A x B	**		*		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.5 Root fresh weight (RFw)

In clay and sandy soil, the values of root fresh weight (RFw) of Wheat were about 0.185 and 0.468 g.plant^{-1} at control level respectively. Through applying subsequent higher HSCP concentrations there was a continual reduction in RDw. Eventually, the values reduced to 0.04, 0.013 and 0.012 g.plant^{-1} at 1, 3 and6% HSCP concentrations respectively in clay soil. On the other hand, the values of RFw in sandy soil were about 0.05, 0.45 and 0.035 g.plant^{-1} at 1, 3 and 6% concentration respectively (Table 24.a).

In clay and sandy soil, the values of root fresh weight (RFw) of Wheat were about 0.146 and 0.31 g.plant^{-1} at control level respectively. Through applying subsequent higher HSCP concentrations there was a continual reduction in RDw. Eventually, the values reduced to 0.04 g.plant^{-1} at 1% HSCP and to 0.03g.plant^{-1} at 3 and6% HSCP concentrations respectively in clay soil. On the other hand, the values of RFw in sandy soil were about 0.26 g.plant^{-1} at1 and3% HSCP and 0.17g.plant^{-1} at 6% concentration (Table 25.a).

2. 6 Shoot dry weight (SDw)

Shoot dry weight (SDw) of wheat was significantly affected by HSCP concentrations (Table 24.a). Values of about 0.105 and 0.046g.plant^{-1} were attained at control level in clay and sandy soil respectively. The values of SDw decreased to 0.03, 0.025and0.025 g.plant^{-1} at 1, 3 and 6% HSCP concentration respectively in clay soil. Similarly, in sandy soil, the values of SDw 0.035, 0.03 and 0.025 g.plant^{-1} were obtained at 1, 3 and 6% HSCP concentrations.

Shoot dry weight (SDw) of wheat was not significant affected by HSCP concentrations (Table 25.a). Values of about 0.10 and 0.06g.plant^{-1} were attained at control level in clay and sandy soil respectively. The values of SDw decreased to, 0.03 at 1 % HSCP and 0.025 g.plant^{-1} at 3 and 6% HSCP concentration were recovered in clay soil. Similarly, in sandy soil, the values of SDw 0.046 g.plant^{-1} at1 and3% HSCP and 0.033g.plant^{-1} were obtained at 6% HSCP concentrations.

2. 7 Root dry weight (RDw)

In clay soil, the value of root dry weight (RDw) of wheat was 0.026 g.plant^{-1} at control level. Through applying subsequent higher HSCP concentrations there was a continual reduction in RDw. Eventually, the value reduced to 0.02 g.plant^{-1} at 1% HSCP concentrations while at 3 and6%HSCP the value 0.013 g.plant^{-1} was recovered. On the other hand, the control value of RDw in sandy soil was 0.086 g.plant^{-1} and at 1 and3%HSCP concentrations

the same RDw was reduced to 0.02g.plant-1 and 0.013 g.plant^{-1} was obtained at 6% HSCP concentration.(Table 24.a).

In clay soil, the value of root dry weight (RDw) of wheat was 0.026 g.plant^{-1} at control level. Through applying subsequent higher HSCP concentrations there was a continual reduction in RDw. Eventually, the value reduced to 0.02 g.plant^{-1} at 1% HSCP concentrations while at 3 and6%HSCP the value 0.013 g.plant^{-1} was recovered. On the other hand, the control value of RDw in sandy soil was 0.073 g.plant^{-1}, the values of RDw about 0.093, 0.086 and 0.06 g.plant^{-1} was obtained at1, 3 and 6% HSCP concentration. (Table 25.a).

VI. Allelopathic Potential of *Artemisia herba-Alba* Aqueous on *Bromus tectorum*, *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species).

1. Effect of *Artemisia herba-Alba* Aqueous Extract (AHAE) on germination efficiency (Petri-Dish Experiment)

1.1 Germination Percentage (GP)

The germination percentage (GP) of *Bromus tectorum* was highly significant (P≤ 0.01) affected by the deferent concentration of AHAE (Table 4.26& Figure 4.6). In pure culture, the attained GP values at control conditions (100%) were increased upon applying 2.5% AHAE concentration (83.3%). However, this current motivation goes to a marked reduction at 5% concentrations (63.3%), and at 7.5 and 10% concentration (70%).but in mixed culture, GP control value (96.6%) undergoes minor diminishing at 2.5% concentration (15%). Continually, the germination was completely inhibited, at 5, 7.5 and 10% AHAE concentrations.

Table 4.27& Figure 4.6 showed that the GP of *Melilotus indica* were apparently varied with of AHAE concentrations which is supported statistically (P≤ 0.01) but the type of seed cultures and their interaction of AHAE concentration-type of seed cultures not significant. In pure culture, the GP values was about 60% at control level and 2.5 5 % AHAE concentrations the values were about 45 and 40% respectively . However at 7.5 and 10% concentration was obtained the same value (35%).while in mixed culture, the GP value was about 50% at control and at 2.5 5 7.5 and 10 % AHAE concentrations the values were about 45,40,35 and 20% ,respectively.

Generally, GP of wheat was apparently varied with of AHAE concentrations (Table 4.28&Figure 4.6) which is supported statistically (P≤ 0.01).while the type of seed culture was

not significant. In pure culture, the GP value at control conditions and 2.5 % AHAE concentrations was about 100% at 5 and 7.5 % AHAE concentration the value was about (90%). However, this current motivation goes to a marked reduction at 10% concentration (70%).but in mixed culture; type M1, the GP value about 96.6% at control level and at 2.5, 5 and 7.5% AHAE concentration the value was about 100%. Continually, the GP decreased to about 95% at 10% AHAE concentrations. While in mixed culture; type M2 the same value (100%) was about at control, 2.5 and 5% AHAE concentrations and at 7.5and 10% AHAE the values 95 and 80 mm were obtained.

1.2 Seed germination index (SG)

Regarding SGI of *Bromus tectorum,* the value decreased distinctly as AHAE concentration increased. This reduction was statistically highly significant ($P \leq 0.01$) (Table4.26). Generally, the SGI was higher in pure culture compared to mixed one, at control the values of about 32.33 and 29.7 were obtained in pure and mixed culture, respectively and at 2.5% was obtained the less value (9.18) but at 5, 7.5 and 10% concentrations the values of SGI were 13.48, 11.62 and11.37, respectively; while in mixed culture the SGI values of about 5.6 at 2.5% however at 5, 7.5 and 10% AHAE concentration the germination was completely inhibited.

The SGI of *Melilotus indica*, values was decreased distinctly as AHAE concentration increased. This reduction was statistically highly significant ($P \leq 0.01$) (Table 4.27), at control the SGI values of about 24.42and 21.93 were obtained in pure and mixed culture, respectively and at 2.5 5, 7.5 and 10%AHAE concentrations the values of SGI were 18.3, 16.6, 14.1 and 13.8, respectively; while in mixed culture the SGI values of about 18.75 at 2.5% and 15.38, 13.3 and 11.5 at 5, 7.5 and 10% AHAE concentration were attained.

Elevated AHAE concentrations have possessed a significant inhibitory effect on SIG of wheat ($P \leq 0.01$) (Table 4. 28), in pure and mixed culture; type M1 and M2 the values were about 33.3, 32.2 and 46.62, respectively was obtained at control and at 2.5% was obtained the values (30.1, 33.3 and46.6). however, in pure culture at 5, 7.5 and 10% concentrations the values of SGI were about 28.85, 28.25 and 18.67 respectively, while in mixed culture; type M1 the SGI values of about 32.91, 31.55 and 29.3 at 5, 7.5 and 10% AHAE concentration were attained but in mixed culture; type M2 the values were 45.35, 38.3 and 36.6 at 5, 7.5 and 10% AHAE concentration. Generally The SGI was higher in mixed culture; type M2 compared on mixed; type M1 and pure culture.

Table 4.26 Variation in germination percentage (GP),Seed germination index (SGI) ,germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of *Bromus tectorum* (pure culture) and *Bromus tectorum* x Wheat (mixed culture) as affected by different concentration of *Artemisia herba alba* aqueous extract (AHAE) in Petri-dish experiment.

Variables	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
Treatment (%)	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100.0^{a}	96.6^{a}	32.33^{a}	29.70^{a}	0.00	0.00	19.66^{a}	25^{a}	34.00^{a}	39.33^{a}
02.5	83.3^{b}	15.0^{b}	13.48^{b}	5.60^{b}	16.70^{c}	84.47	9.00^{b}	0.00^{b}	5.00^{b}	3.00^{b}
05.0	70.0^{c}	0.0^{c}	11.62^{c}	0.00^{c}	30.00^{b}	100.00^{a}	5.00^{c}	0.00^{b}	4.00^{b}	0.00^{c}
07.5	70.0^{c}	0.0^{c}	11.37^{c}	0.00^{c}	30.00^{b}	100.00^{a}	0.00^{d}	0.00^{b}	3. 00^{c}	0.00^{c}
10.0	63.3^{d}	0.0^{c}	9.18^{d}	0.00^{c}	36.70^{a}	100.00^{a}	0.00^{d}	0.00^{b}	2.83^{c}	0.00^{c}
P-value	0.006**		0.009**		1.39*		0.25		0.24	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		**		*	
AB interaction	**		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

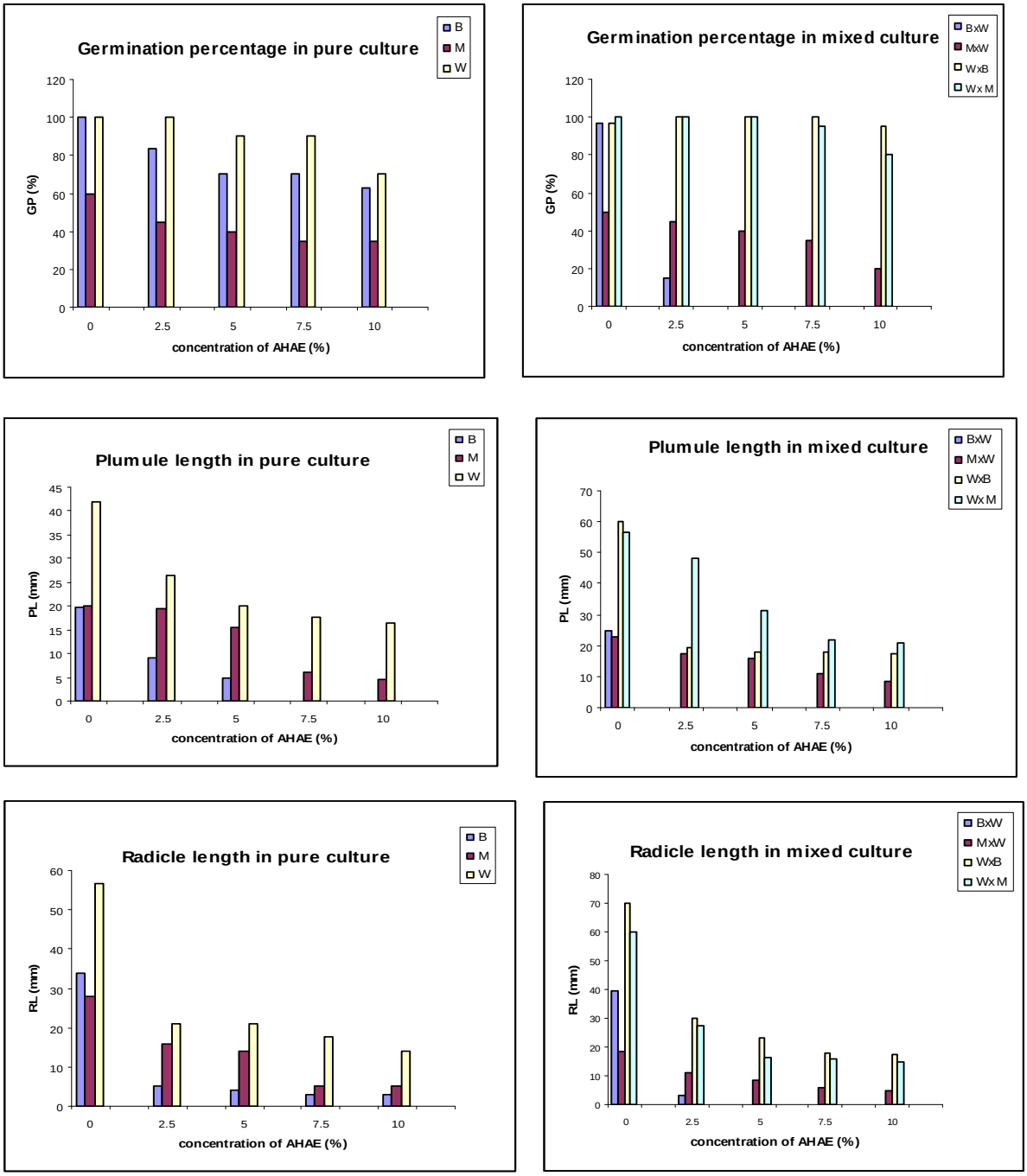

Figure 4.6 Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Artemisia herba-alba* aqueous extract (AHAE) in Petri-dish experiment.

1.3 Germination inhibition percentage (GIP)

Data of the present study demonstrated that GIP of *Bromus tectorum* was significantly affected (P≤ 0.01) due to the apparent allelopathic action of AHAE concentrations in both pure and mixer (Table 4.27). In pure culture GIP started with a value of about 16.7 at 2.5% AHAE concentration level. At 7.5 and 10% AHAE concentration, the value of GIP was 30% in pure culture while in mixed culture the highest values of about 100% obtained at 5, 7.5 and 10% AHAE concentrations.

The AHAE concentration influence and type of seed culture were highly significant (P≤ 0.01) effect on GIP of *Melilotus indica*. (Table 4.27) in pure culture GIP started with a value of about 25 at 2.5% AHAE concentration level. At 7.5 and 10% AHAE concentration, the same value of GIP was 41.66% in pure culture while in mixed culture the highest values of about 60% at 10% AHAE concentration on the other hand the values obtained 10, 20 and 30% at 2.5 5 and 7.5%AHAE concentration.

The influence of AHAE concentration and their interaction were highly significant (P≤ 0.01) of effect on GIP of wheat, while the type seed culture was not significant (Table 4.28). In pure culture at 2.5% AHAE concentration levels the GIP value about zero%. At 7.5 and 10% AHAE concentration, the value of GIP was 10% however in mixed culture; type M1 the values of about 1.65 at 10% AHAE concentration while in mixed culture; type M2 at 2.5 and 5 % AHAE the same value about zero % and at 7.5 and 10% the values 5 and 20% were obtained .

1.4 Plumule length (PL)

Statistically, the applied concentrations of AHAE and their interactions are significantly (P≤ 0.01) affecting PL of *Bromus tectorum,* except for type of seed culture was significant (P≤ 0.05) (table 4.26 & Figure 4.6). In mixed culture, the plumule elongation was completely inhibited by the extract, but in pure culture PL it was less at higher concentration levels. Obviously, all allelopathic concentrations have reduced PL. Besides, the immense negative response of the plumule growth was marked at 7.5 and 10% concentration (zero mm) in pure culture. Actually, at control level, PL of *Bromus tectorum* was about 19.66 and 25 mm in pure and mixed culture, respectively.

Table 4.27 Variation in germination percentage (GP), Seed germination index (SGI), germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Melilotus indica* (pure culture) and *Melilotus indica* x wheat (mixed culture) as affected by different concentration of *Artemisia herba alba* aqueous extract (AHAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60^{a}	50^{a}	24.42^{a}	21.93^{a}	0.00	0.00	20.00^{a}	23.00^{a}	28.00^{a}	18.66^{a}
02.5	45^{b}	45^{ab}	18.30^{b}	18.75^{b}	25.00^{c}	10.00^{d}	19.50^{ab}	17.50^{b}	16.00^{b}	11.00^{b}
05.0	40^{bc}	40^{b}	16.60^{c}	15.38^{c}	33.33^{b}	20.00^{c}	15.50^{b}	16.00^{c}	14.00^{c}	8.50^{c}
07.5	35^{c}	35^{bc}	14.10^{d}	13.30^{d}	41.66^{a}	30.00^{b}	6.00^{c}	11.00^{d}	5.00^{d}	6.00^{d}
10.0	35^{c}	20^{c}	13.80^{d}	11.50^{e}	41.66^{a}	60.00^{a}	4.50^{d}	8.50^{e}	5.00^{d}	5.00^{d}
P-value	0.090		0.038*		0.272		0.086		0.059	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	NS		**		**		NS		**	
AB interaction	NS		**		*		**		*	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.0

The table 4.27& Figure 4.6 is show the type of seed culture and their interactions was significant (P≤ 0.05), except for the applied concentrations of AHAE are significantly (P≤ 0.01) affecting PL of *Melilotus indica*. Actually, at control level, PL of *Melilotus indica* was about 20 and 23 mm in pure and mixed culture respectively besides, the immense negative response of the plumule growth was marked at 7.5 and 10% concentration (6 and4.5 mm, respectively) in pure culture. In the other hand in mixed culture the values were obtained 11, 8.5,6 and 5 mm at 2.5, 5, 7.5 and 10% AHAE concentration.

The allelopathic effect of AHAE concentration on plumule length (PL) of wheat is illustrated in Table 4.28& Figure 4.6 statistically, the applied concentrations of AHAE and their interactions are significantly (P≤ 0.01) affecting PL Actually, at control level, PL of Wheat. was about 42,60 and 56.66mm in pure and mixed culture; type M1 and M2 respectively, Besides, the immense negative response of the plumule growth was marked at2,5,5, 7.5 and 10% concentration (26.5,20,17.5 and 16.5 mm) in pure culture and in mixed culture; type M1 the values 19.5,18,18 and17.5mm at 2.5,5,7.5 and 10%AHAE compared in the mixed culture; type M2 the values 48,31.5,22 and 21 mm were obtained .

1.5 Radicle length (RL)

Compared to control, a gradual decrease in RL of *Bromus tectorum* was observed along gradual AHAE concentrations in pure culture. RL implication was significantly affected at P≤ 0.01, while the type of seed culture and interaction was significant at P≤ 0.05 (Table 4.26& Figure 4.6). At control, RL was 34 mm in pure culture. Higher concentrations of AHAE were notably active disturbing radicle emergence. And at 2.5, 5 and 7.5% concentrations, the RL decreased to 5.4 and 3mm. constantly, it continues reduction till it attained a value of about 2.83 mm at 10% concentration level. At control level, RL was about 39.33 mm in mixed culture. At 2.5% AHAE concentration, RL decreased to 3 mm. At 5, 7.5 and 10% concentration level, the germination was completely inhibited

The allelopathic effect of HSAE concentration on RL of *Melilotus indica* is illustrated in Table 4.27& Figure 4.6 Statistically; the applied concentrations of AHAE and type of seed culture are significantly (P≤ 0.01). While, the interaction was significant at P≤ 0.05. At control, RL was 28 mm in pure culture. Higher concentrations of AHAE were notably active disturbing radicle emergence. And at 2.5 and 5% concentrations, RL decreased to16 and14 mm. constantly; it continues reduction till it attained a value of about 5 mm at7.5 and 10% concentration level. At control level, RL was about 18.66 mm in mixed culture. At 2.5% AHAE concentration, RL decreased to 11 mm. At 5, 7.5 and 10% concentration level, a minor increase has been achieved to 8.5, 6 and 5 mm were obtained.

Table 4.28 Variation in germination percentage (GP),Seed germination index (SGI), germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of wheat (W) (pure culture) , wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentration of *Artemisia herba-alba* aqueous extract (AHAE) in Petri-dish experiment

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.0^{a}	96.6^{b}	100.0^{a}	33.30^{b}	32.20^{c}	46.62^{a}	0.00	0.00	0.00	42.00^{a}	60.00^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.0^{a}	100.0^{a}	100.0^{a}	30.10^{e}	33.30^{a}	46.60^{a}	0.00^{c}	-3.51	0.00^{c}	26.50^{b}	19.50^{b}	48.00^{b}	21.00^{b}	30.00^{b}	27.50^{b}
5.0	90.0^{b}	100.0^{a}	100.0^{a}	28.85^{c}	32.91^{b}	45.35^{b}	10.00^{b}	-3.51	0.00^{c}	20.00^{c}	18.00^{bc}	31.50^{c}	21.00^{b}	23.00^{c}	16.50^{c}
7.5	90.0^{b}	100.0^{a}	95.0^{b}	28.25^{a}	31.55^{d}	38.30^{c}	10.00^{b}	-3.51	5.00^{b}	17.50^{d}	18.00^{bc}	22.00^{d}	17.50^{c}	18.00^{d}	16.00^{c}
10.0	70.0^{c}	95.0^{c}	80.0^{c}	18.67^{d}	29.30^{e}	36.60^{d}	30.00^{a}	1.65^{a}	20.00^{a}	16.50^{d}	17.50^{c}	21.00^{d}	14.00^{d}	17.50^{d}	15.00^{c}
TWO-WAY ANOVA															
A-Treatment		**			**			**			**			**	
B-Seed Culture		NS			*			NS			**			NS	
AB interaction		*			*			**			**			**	

Different letters within each column indicate significance at P<0.05
Two-way ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Elevated AHAE concentrations have possessed a significant inhibitory effect on radicle growth of wheat (P≤ 0.01) while the type of seed culture was not significant(Table4.28 &Figure 4.6). At control, RL was 56.66 mm in pure culture. Higher concentrations of AHAE were notably active disturbing radicle emergence. And at 2.5, 5, 7.5 and 10% concentrations, RL decreased to 21, 15.5 and 14mm. constantly, at control level, RL was about 70 and 60 mm in mixed culture; type M1 and M2. RL decreased to 30, 23, 18 and 17.5 mm. At 2.5, 5, 7.5 and 10% concentration level in mixed culture; type M1 however in mixed culture; type M2 the values 27.5, 16, 16.6 and 15 mm were obtained at 2.5,5,7.5 and 10% AHAE concentration.

2. Effect of *Artemisia herba-alba* Crude Powder (AHCP) on some growth parameters and phytomass (Pot Experiment)

2.1 Shoot length (SL)

The demonstrated data in Table 4.29a&b. pointed up that shoot length (SL) of wheat and *Bromus tectorum* was significantly affected upon applying the different concentrations of AHCP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 18.87and13.06 cm of SL were noticed, respectively. These values were reduced to 16.125 and1 12.86cm at 1% and to 15.95 and 12.43cm at 3% and at 6% AHCP concentration the values 15.62 and 12.33cm were obtained for the two recipient species respectively. Likewise, in sandy soil values of SL were about 17.23 and 13.03cm at control level respectively. These values were reduced to 16.20 and 12.53cm at 1% and to 15.77 and 12.33cm at 3% while at 6%AHCP concentration the values 15.65 and zero cm were recovered for the two recipient species respectively.

The demonstrated data in Table 30.a&b. pointed up that shoot length (SL) of wheat and *Melilotus indica* was significantly affected upon applying the different concentrations of AHCP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 17.83and14.46 cm of SL were noticed respectively. These values were reduced to 15.97 and 14cm at 1% and to 15.72 and 13.75cm at 3% and at 6% AHCP concentration the values 15.06 and 13.50 cm were obtained for the two recipient species respectively. Likewise, in sandy soil values of SL were about 18.00 and 13.40 cm at control level respectively. These values increased to 18.73 and 16.50cm at 1% and to 18.50 and 15.75cm at 3% while at 6%AHCP concentration the values were reduced to 17.30 and zero cm were recovered for the two recipient species respectively.

Table 4.29.a.Allelopathic effect of different percentage of *Artemisia herba-alba* crude powder (AHCP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.930^{a}	0.320^{b}	0.185^{b}	0.468^{b}	0.105^{a}	0.046^{a}	0.026^{a}	0.086^{a}
1	16.13^{b}	16.20^{b}	9.27^{b}	14.55^{b}	4.00^{a}	3.00^{a}	0.260^{b}	0.590^{a}	0.237^{a}	0.063^{a}	0.035^{b}	0.035^{ab}	0.013^{b}	0.020^{b}
3	15.95^{c}	15.77^{c}	8.87^{c}	14.25^{a}	4.00^{a}	3.00^{a}	0.227^{c}	0.250^{b}	0.036^{c}	0.047^{b}	0.035^{b}	0.025^{b}	0.013^{b}	0.013^{b}
6	15.62^{d}	15.65^{c}	8.07^{d}	11.60^{c}	4.00^{a}	3.00^{a}	0.145^{d}	0.160^{b}	0.018^{d}	0.035^{c}	0.017^{c}	0.020^{b}	0.006^{c}	0.013^{b}
P-value	0.210		0.258		0.002*		0.392		0.374		0.168		0.138	
TWO-WAY ANOVA														
A – Treatment	**		**		**		**		**		**		**	
B- Soil Type	**		**		**		*		**		NS		**	
A x B	**		**		*		**		**		*		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.29.b.Allelopathic effect of different percentage of *Artemisia herba-alba* crude powder (AHCP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06[a]	13.03[a]	7.10[a]	6.23[a]	3.00[a]	2.33[a]
1	12.86[b]	12.53[a]	5.73[b]	5.20[b]	2.00[a]	2.00[a]
3	12.43[c]	12.33[a]	3.60[c]	5.16[b]	2.00[a]	2.00[a]
6	12.33[d]	0.00[c]	3.23[d]	0.00[c]	2.00[a]	0.00[b]
P-value	0.202		0.245		0.125	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-**Soil Type**	**		**		NS	
A x B	**		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant **: Significant at 0.01

2.2 Root length (RL)

The allelopathic effect of AHCP concentration on root length (RL) of Wheat and *Bromus tectorum* are illustrated in Table 4.29a&b. apparently all allelopathic concentrations have significantly reduced RL. In clay soil, the control values were about 22.12 and 7.1cm for the two recipient species respectively. At 1 % AHCP concentration, RL reduced to 9.27 and 5.73cm and to 8.87 and 4.60cm at 3%. Constantly, it continues reduction till it attained values of about 8.07 and 3.23 cm at 6% AHCP concentration for the two recipient species respectively. Similarly, the control values of RL in sandy soil were about 16.16and 6.23cm respectively. At 1% concentration, the values of about 14.55and 5.20cm were obtained and at 3% concentration the values 14.25 and 5.16cm were recorded. It reduced to 11.60 and zero cm at 6% AHCP concentration for the two recipient species respectively.

The allelopathic effect of AHCP concentration on root length (RL) of Wheat and *Melilotus indica* are illustrated in Table 4.30.a.b. apparently all allelopathic concentrations have significantly reduced RL. In clay soil, the control values were about 25.10 and 6.10cm for the two recipient species respectively. At 1 % AHCP concentration, RL reduced to 14.05 and 5.5cm and to 11.25 and 5.00cm at 3%. Constantly, it continues reduction till it attained values of about 8.06 and 4.75 cm at 6% AHCP concentration for the two recipient species respectively. Similarly, the control values of RL in sandy soil were about 11.37and 6.56cm, respectively. At 1% concentration, the values of about 26.33and 5.50 cm were obtained and at 3% concentration the values 24.66 and 4.75cm were recorded. It reduced to 23.00 and zero cm at 6% AHCP concentration for the two recipient species, respectively.

2.3 Leaf number (LN)

The values of leaf number (LN) of Wheat were about 5.25 and 3.66 leaves at control level in clay and sandy soil respectively. In clay soil while were obtained the same value (4) at1, 3 and 6%AHCP concentration. Correspondingly, in sandy soil, the same value of LN was about 3 at all concentration level. On the other hand the values of LN on *Broums tectorum*. In clay soil, was obtained same value (3) at control While in sandy soil at control the value was about 2.33 on other hand , at 1,3 and6% AHCP concentration was about the same value (2) was recovered in clay and sandy soil. (Table 4.29a&b). The values of leaf number (LN) were about 4.33 and 3.33 leaves at control level in clay soil for the two recipient species respectively. In clay soil were obtained the same value (3 and 2) at1, 3 and 6%AHCP concentration for the two recipient species respectively. Correspondingly, on the other hand

the values of LN. in sandy soil, the value of LN was about 4.66 and 2 at control level, at 1, 3 and6% AHCP concentration was about the values 4.33 leaves at 1%AHCP and at 3 and6% AHCP concentration the same value (4) was recovered for Wheat while for *Melilotus indica* the values about 5, 3 and zero were obtained at 1, 3 and6%AHCP concentration (Table 30a&b).

2.4 Shoot fresh weight (SFw)

The represented data in table 29.a showed the values of shoot fresh weight (SFw) of Wheat were about 0.93 and 0.32g.plant-^{1} at control level in clay and sandy soil respectively. These values decreased to 0.26g.pllant-^{1} at 1% and at 3 and 6% AHCP concentration the values 0.227 and 0.145g.plant-^{1}was obtained in clay soil. Correspondingly, in sandy soil, the values of SFw were about 0.59, 0.25 and 0.16g.plant-^{1} at 1, 3 and 6% AHCP concentration respectively.

The represented data in table 30.a showed the values of shoot fresh weight (SFw) of Wheat were about 0.82 and 0.48g.plant-^{1} at control level in clay and sandy soil respectively. These values decreased to 0.30g.plant-^{1} at 1% and at 3 and 6% AHCP concentration the values 0.265 and 0.16g.plant-^{1}was obtained in clay soil. Correspondingly, in sandy soil, the values of SFw were about 0.34 at 1 and3%AHCP concentration and 0.26g.plant-^{1} at 1 6% AHCP concentration.

2.5 Root fresh weight (RFw)

Root fresh weight (RFw) significantly decreased in clay and sandy soils (Table 29.a). In clay soil, the value of RFw was about 0.185g.plant^{-1} at control level. During applying higher AHCP concentrations there was a continual reduction in RFw. Eventually, at 1, 3 and6% concentration, the values of RFw have reduced to 0.237,0.036 and 0.018g.plant^{-1} for Wheat. Likewise in sandy soil, the control value of RFw was about 0.468g.plant^{-1}. At 1, 3 and 6% AHCP concentration, RFw reduced to 0.063, 0.047 and 0.035 g.plant^{-1} were obtained respectively. Root fresh weight (RFw) significantly decreased in clay and sandy soils (Table 30.a). In clay soil, the value of RFw was about 0.146g at control level. During applying higher AHCP concentrations there was a continual reduction in RFw. Eventually, at 1, 3 and6% concentrations, and the values of RFw have reduced to 0.043, 0.04 and 0.03g.plant^{-1} for Wheat. Likewise in sandy soil, the control value of RFw was about 0.31g.plant^{-1}. At 1, 3 and 6% AHCP concentration, RFw reduced to 0.16, 0.133 and 0.073 g.plant^{-1} were obtained respectively.

Table 4.30.a.Allelopathic effect of different percentage of *Artemisia herba-alba* crude powder (AACP) on some growth parameters of wheat (mixed culture with *Melilotus indica)*, 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	17.83^{a}	18.00^{a}	25.10^{a}	11.37^{c}	4.33^{a}	4.66^{a}	0.820^{a}	0.480^{a}	0.146^{a}	0.310^{a}	0.100^{a}	0.060^{a}	0.026^{a}	0.073^{a}
1	15.97^{b}	18.73^{a}	14.05^{b}	26.33^{a}	3.00^{b}	4.00^{a}	0.300^{b}	0.340^{b}	0.043^{b}	0.160^{b}	0.030^{b}	0.033^{b}	0.020^{a}	0.060^{a}
3	15.72^{c}	18.50^{a}	11.25^{c}	24.66^{ab}	3.00^{b}	4.00^{a}	0.265^{bc}	0.340^{b}	0.040^{b}	0.133^{c}	0.030^{b}	0.033^{b}	0.013^{a}	0.033^{b}
6	15.06^{d}	17.30^{a}	8.06^{d}	23.00^{b}	3.00^{b}	4.33^{a}	0.160^{c}	0.260^{c}	0.030^{b}	0.073^{d}	0.015^{b}	0.033^{b}	0.013^{a}	0.026^{b}
P-value	0.034*		0.204		0.011*		0.319		0.013*		0.385		0.016*	
TWO-WAY ANOVA														
A - Treatment	*		**		NS		**		**		**		*	
B- Soil Type	**		**		NS		NS		**		NS		**	
A x B	*		**		NS		**		**		NS		*	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.30.b.Allelopathic effect of different percentage of *Artemisia herba-alba* crude powder (AACP) on some growth parameters of *Melilotus indica,* (in mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables / treatment	Shoot length (cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46^{a}	13.40^{c}	6.10^{a}	6.56^{a}	3.33^{a}	2.00^{bc}
1	14.00^{a}	16.50^{a}	5.50^{a}	5.50^{b}	2.00^{b}	5.00^{a}
3	13.75^{a}	15.75^{b}	5.00^{a}	4.75^{c}	2.00^{b}	3.00^{ab}
6	13.50^{a}	0.00^{d}	4.75^{a}	0.00^{d}	2.00^{b}	0.00^{c}
P-value	0.496		0.248		0.446	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-**Soil Type**	NS		*		NS	
A x B	**		**		NS	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test

TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.6 Shoot dry weight (SDw)

In clay and sandy soil, the values of shoot dry weight (SDw) for Wheat were about 0.105 and 0.046g.plant-^{1} at control level. This value decreased to 0.035g.plant^{-1} at 1and3% level respectively and to 0.017g.plant^{-1} at 6% AHCP concentration. Correspondingly, in sandy soil, the control value of SDw was about 0.046g.plant^{-1}. The values of SDw decreased to 0.035, 0.025 and 0.02g.plant^{-1} at 1, 3 and 6% AHCP concentration respectively (Table 29.a).

In clay and sandy soil, the values of shoot dry weight (SDw) for Wheat were about 0.10 g.plant^{-1}at control level. This value decreased to 0.03g.plant^{-1} at 1and3% level respectively and to 0.015g.plant^{-1} at 6% AHCP concentration. Correspondingly, in sandy soil, the control value of SDw was about 0.06g.plant^{-1}. The values of SDw decreased to 0.033g.plant^{-1} at 1, 3 and 6% AHCP concentration, respectively (Table 30.a).

2.7 Root dry weight (RDw)

The allelopathic influence of AHCP, root dry weight (RDw) significantly decreased in clay and sandy soils (Table 29.a). In clay soil, the value of RDw was about to 0.026g.plant^{-1} at control level. During applying higher AHCP concentrations there was a continual reduction in RDw. Eventually, at 6% concentration, the value of RDw have reduced to 0.006g.plant^{-1}. Also in sandy soil, the control value of RDw was about 0.086g.plant^{-1}. At 3 and6% AHCP concentration, RDw reduced to 0.013g.plant^{-1}was recorded.

Due to the allelopathic effect of AHCP, root dry weight (RDw) significantly decreased in clay and sandy soils (Table 30.a). In clay soil, the value of RDw was about to 0.026g.plant^{-1} at control level. During applying higher AHCP concentrations there was a continual reduction in RDw. Eventually, at 1%AHCP the value0.02 g.plant^{-1} was obtained and at3 and 6% concentration, the value of RDw have reduced to 0.013g.plant^{-1}. Likewise in sandy soil, the control value of RDw was about 0.073g.plant^{-1}. At1, 3 and6% AHCP concentration, the values of RDw reduced to 0.06, 0.033 and0.026g.plant^{-1}was recorded.

VII. Allelopathic Potential of *Oudneya africana* on *Bromus tectorum* , *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species).

1. Effect of *Oudneya africana* Aqueous Extract (OAAE) on germination efficiency (Petri-Dish Experiment)

1.1 Germination percentage (GP)

The present data imply the significant promoting influence (P≤ 0.01) of OAAE on GP of *Bromus tectorum* (Table 4.31& Figure 4.7). At control, GP values were about 100 and 96.6% in pure and mixed culture, respectively. In pure culture the GP were about 73.3, 26.6, 13.3 and 6.6 % at 2.5, 5, 7.5 and10% OAAE concentrations. Commonly, GP decreased with the increase in OAAE concentration in pure culture. In mixed culture, at 2.5 and 5% GP of *Bromus tectorum* seeds were 55 and 10%, respectively. While at 7.5 and10% OAAE concentrations the germination percentage was completely inhabited.

Similarly, germination percentage (GP) of *Melilotus indica* seeds was significantly (P≤ 0.01) affected upon applying different concentrations of OAAE; while the type of seed cultures and their interaction were not significant on GP (Table 4.32& Figure 4.7). At control, the GP values were about 60 and 50% in pure and mixed culture, respectively. At 10% concentration, the values were about 25 and 15% in pure and mixed culture, respectively. Continuously, in pure culture the GP were about 55, 50, 40 % at 2.5 5, 7.5% OAAE concentrations. Finally, in mixed culture, at 2.5 % OAAE concentration the value was decreased to 60% and at 5 and7.5 %OAAE the GP values of *Melilotus indica* seeds were about 45 and 40 % respectively was attained.

Table 4.33 & Figure 4.7 is show the germination percentage (GP) of wheat seeds were apparently varied with of OAAE concentrations which is supported statistically (P≤ 0.01). In pure culture at control, 2.5, 5and 7.5 % OAAE concentrations, the GP values were about 100 % and. At 10% concentrations the value was about 90%. While In mixed culture; type M1 the GP value was about 96.6 % at control level. Continuously, it was 100% at 2.5% OAAE concentration. A great noteworthy reduction in GP was attained along the higher OAAE concentrations. Correspondingly, GP was decreased to about 95% at 5 and 7.5% OAAE concentrations. Finally in mixed culture; type M2 at control, 2.5 and 5 % OAAE concentration GP of wheat seeds were 100 %. However at 7.5 and10% OAAE concentrations the GP were about 95 and 80%.

Table 4.31 Variation in germination percentage (GP),Seed germination index (SGI) ,germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of *Bromus tectorum* (pure culture) and *Bromus tectorum* x Wheat (mixed culture) as affected by different concentration of *Oudneya africana* aqueous extract (OAAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100.0^{a}	96.6^{a}	32.33^{a}	29.70^{a}	0.00	0.00	19.66^{a}	25.00^{a}	34.00^{a}	39.33^{a}
02.5	73.3^{b}	55.0^{b}	15.22^{b}	13.16^{b}	26.70^{d}	43.06^{c}	6.33^{b}	0.00^{b}	3.00^{b}	2.00^{b}
05.0	26.6^{c}	10.0^{c}	5.48^{c}	2.50^{c}	73.40^{c}	89.64^{b}	0.66^{c}	0.00^{b}	1.66^{bc}	1.00^{bc}
07.5	13.3^{d}	0.0^{d}	2.27^{d}	0.00^{d}	86.70^{b}	100.00^{a}	0.00^{c}	0.00^{b}	0.83^{c}	0.00^{c}
10.0	6.6^{e}	0.0^{d}	1.60^{d}	0.00^{d}	93.40^{a}	100.00^{a}	0.00^{c}	0.00$^{.b}$	0.83^{c}	0.00^{c}
P-value	0.033*		0.033*		0.044*		0.430		0.320	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		*		**		NS		NS	
AB interaction	**		NS		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01.

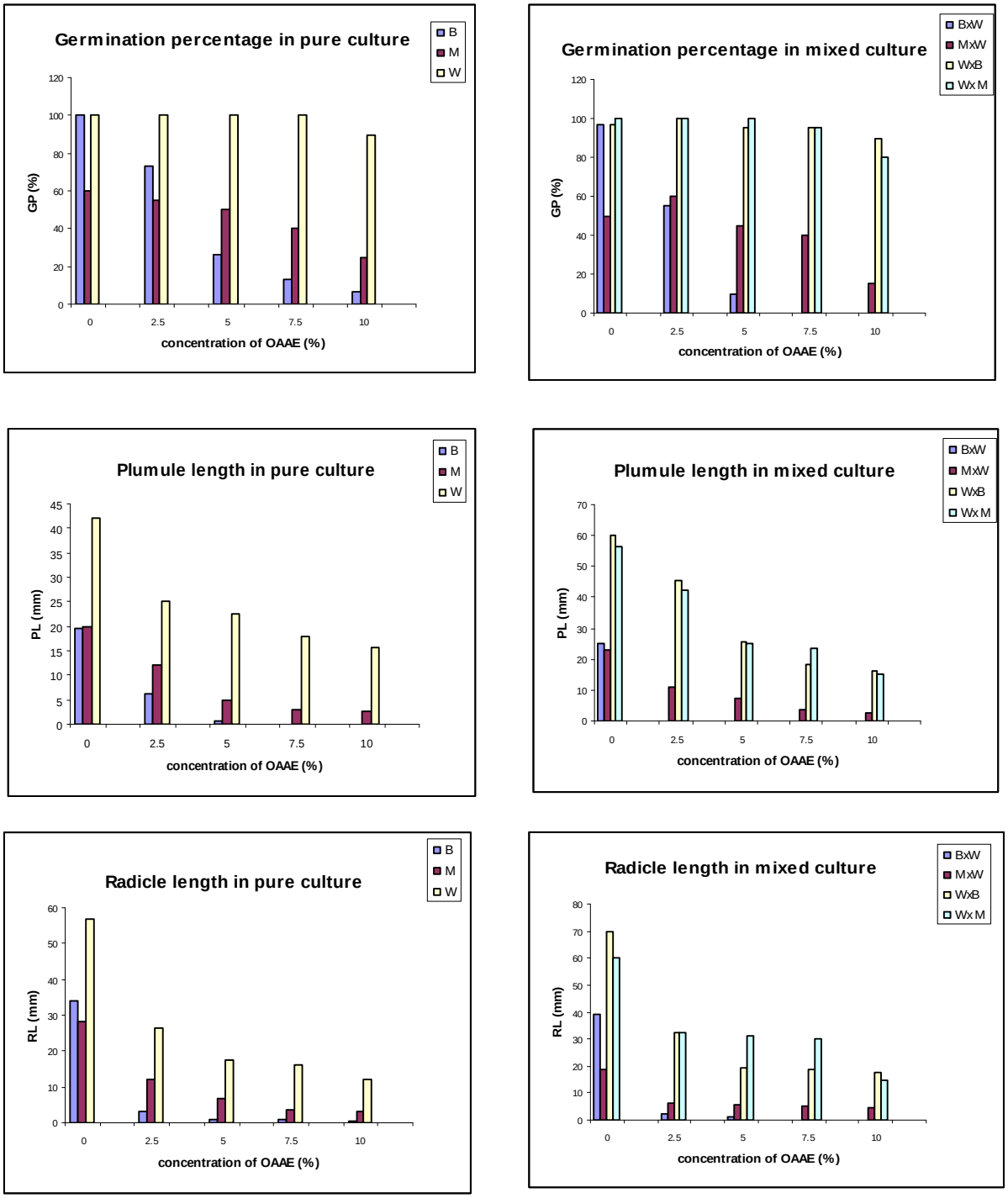

Figure 4.7 Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Oudneya africana* aqueous extract (OAAE) in Petri-dish experiment.

1.2 Seed germination index (SGI)

As a response to higher OAAE concentrations, fewer *Bromus tectorum* seeds succeeded in germination (significantly affected at P≤ 0.01) (Table 4.31). Generally, SGI in pure culture was higher relative to that estimated in mixed, the control values (32.3 and 29.7) were attained in pure and mixed culture, respectively. Values of SGI recorded at 2.5, 5, 7.5 and 10% OAAE concentrations were about 15.22,5.48,2.27and 1.6 respectively in pure culture, while in mixed culture the values were 13.16 and 2.5 r at 2.5 ,5.and 7.5 % OAAE concentrations, respectively but at 10% OAAE the germination was completely inhibited.

The SGI of *Melilotus indica*, values was decreased distinctly as OAAE concentration increased. This reduction was statistically highly significant (P≤ 0.01) (Table 4.32). At control the values (24.42 and 21.93) were recorded in pure and mixed culture, respectively. While at 2.5, 5, 7.5 and 10% OAAE concentrations were about 23.25, 18.66, 13.85 and 10.66 respectively in pure culture, Compared in mixed one the values were 27.8, 20.43, 14.06 and 7.96 respectively.

The statistical representation is illustrated in Table 4.33.the OAAE concentrations was not significant affected on SGI of wheat. At control the values were about 33.3, 32.2 and 46.62 were attained in pure and mixed culture; type M1 and M2, respectively. however at 2.5, 5, 7.5 and 10% OAAE concentrations were about 33.3, 30, 29.75 and 28.05 respectively in pure culture, while the parallel values in mixed culture; type M2 46, 45.83, 38.75 and 35.8 were respectively but in mixed culture, type M1 at 5 and 7.5 % OAAE was obtained same value (31.66) and at 2.5 and 10% OAAE concentration the values 32.08 and 30were recovered respectively. Commonly the SGI in mixed culture; type M2 was higher relative to that estimated in mixed culture; type M1 and pure culture

1.3 Germination inhibition percentage (GIP)

Data of the present study demonstrated that GIP of *Bromus tectorum* was significantly affected (P≤ 0.01) due to the apparent allelopathic action of OAAE concentrations (Table 4.31). In pure culture GIP attained values of about 26.7, 73.4, 86.7and 93.4 at 2.5, 5, 7.5and 10% OAAE concentration, respectively compared with 43.06, 89.64 and 100% in mixed culture.

Table 4. 32 Variation in germination percentage (GP), Seed germination index (SGI), germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Melilotus indica* (pure culture) and *Melilotus indica* x Wheat (mixed culture) as affected by different concentration of *Oudneya africana* aqueous extract (OAAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60^{a}	50^{b}	24.42^{a}	21.93^{b}	0.00	0.00	20.0^{a}	23.0^{a}	28.00^{a}	18.66^{a}
02.5	55^{a}	60^{a}	23.25^{b}	27.80^{a}	8.33^{d}	-20.00	12.0^{b}	11.0^{b}	12.00^{b}	6.00^{b}
05.0	50^{b}	45^{bc}	18.66^{c}	20.43^{c}	16.66^{c}	10.00^{c}	5.0^{c}	7.5^{c}	6.50^{c}	5.50^{b}
07.5	40^{b}	40^{b}	13.85^{d}	14.06^{c}	33.33^{b}	20.00^{b}	3.0^{c}	3.5^{d}	3.50^{cd}	5.00^{b}
10.0	25^{e}	15^{c}	10.66^{e}	7.96^{e}	58.33^{a}	70.00^{a}	2.5^{c}	2.5^{d}	3.00^{d}	4.50^{b}
P-value	0.120		0.426		0.174		0.128		0.141	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	NS		**		NS		NS		**	
AB interaction	NS		**		**		NS		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant **: Significant at 0.01

The GIP of *Melilotus indica* data was significantly affected (P≤ 0.01) due to the apparent allelopathic action of OAAE concentrations (Table 4.32). in pure culture GIP attained values of about 8.33, 16.66, 33.33and 58.33 at 2.5, 5, 7.5and 10% OAAE concentration respectively compared with -20, 10,20and 70% in mixed culture . Data of wheat present study demonstrated that GIP was significantly affected (P≤ 0.01) due to the apparent allelopathic action of OAAE concentrations (Table 4.33). GIP attained value of about zero% at 2.5,5 and 7.5% OAAE concentration and at 10% level the value 10% was obtained in pure culture while in mixed culture; type M1 the same value 1.65% was obtained at 5 and 7.5 % OAAE and 6.83 % at 10% OAAE concentration but at 2.5 and 5 % the germination percentage completely inhibited while at 7.5 and 10%OAAE concentration the values 5 and 20%, respectively were obtained in mixed culture; type M2.

1.4 Plumule length (PL)

Statistically, the applied concentrations of OAAE and their interactions are significantly (P≤ 0.01) affecting PL of *Bromus tectorum*, except for seed culture was not significant (Table 4.31& Figure 4.7). In pure culture, values of PL were 19.66mm at control level. Afterward, it reduced to 6.33mm at 2.5% OAAE. But 7.5 and10% OAAE concentrations the plumule length was completely inhibited. The influence of seed culture and treatment was observed on PL measurements. In mixed culture, at the control the value was 25mm the plumule elongation was completely inhibited by the different concentration of OAAE.

Findings of PL imply the downbeat effect of the allelopathic substances on seedling stage the applied concentrations of OAAE are significantly (P≤ 0.01) affecting PL of *Melilotus indica*, while the type of seed culture and their interactions was not significant. (Table 4.32& Figure 4.7). In pure culture, value of PL was 20 mm at control level. Afterward, it reduced to 12mm at 2.5% OAAE. Expectedly, the maximum allelopathic action of 7.5 and10% OAAE concentration has reduced PL to 3 and 2.5 mm.. In mixed culture, at control value was 23mm. Elevated OAAE concentrations have possessed a significant inhibitory effect on plumule growth .At 2.5, 5, 7.5and 10% OAAE concentration, the values were 11,7.5,3.5 and 2.5 mm it was obtained .

Table 4.33. Variation in germination percentage (GP), Seed germination index (SGI) , germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of wheat (W) (pure culture), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentration of *Oudneya africana* aqueous extract (OAAE) in Petri-dish experiment.

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.0^{a}	96.6^{b}	100.0^{a}	33.30^{a}	32.20^{a}	46.62^{a}	0.00	0.00	0.00	42.00^{a}	60.00^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.0^{a}	100.0^{a}	100.0^{a}	33.30^{a}	32.08^{a}	46.00^{a}	0.00^{b}	-3.51	0.00^{c}	25.00^{b}	45.50^{b}	42.50^{b}	26.50^{b}	32.50^{b}	32.50^{b}
5.0	100.0^{b}	95.0^{a}	100.0^{a}	30.00^{b}	31.66^{a}	45.83^{a}	0.00^{b}	1.65^{b}	0.00^{c}	22.50^{c}	25.50^{c}	25.00^{c}	17.50^{c}	19.50^{c}	31.00^{bc}
7.5	100.0$^{.b}$	95.0^{a}	95.0^{b}	29.75^{b}	31.66^{a}	38.75^{b}	0.00^{b}	1.65^{b}	5.00^{b}	18.00^{d}	18.50^{d}	23.50^{d}	16.00^{c}	18.50^{cd}	30.00^{c}
10.0	90.0^{c}	90.0^{c}	80.0^{c}	28.05^{c}	30.00^{b}	35.80^{c}	10.00^{a}	6.83^{a}	20.00^{a}	15.50^{e}	16.00^{e}	15.00^{e}	12.00^{d}	17.50^{d}	15.00^{d}
TWO-WAY ANOVA															
A-Treatment		**			NS			**			**			**	
B-Seed Culture		**			*			**			**			**	
AB interaction		**			NS			**			**			**	

Different letters within each column indicate significance at P<0.05
Two-way ANOVA NS: not significant *: Significant at 0.05 **: Significant at 0.01

Data of PL imply (Table 4.33& Figure 4.7). The concentrations of OAAE and their interactions are significantly (P≤ 0.01) affecting PL of wheat, the values of PL were 42,60 and 56.66mm at control level in pure and mixed culture; type M1 and M2 . Afterward, it reduced to 25 and 22.5 mm at 2.5 and 5% OAAE. Expectedly, the maximum allelopathic action of 7.5 and10% OAAE concentration has reduced PL to 18 and 15.5 mm in pure culture. In mixed culture; type M1, the plumule elongation was inhibited by the extract. At 2.5, 5, 7.5and 10% OAAE concentration, it was 45,5,25.5,18.5 and 16 mm in all concentration compared 42,25,23.5 and 15 mm were obtained in mixed culture; type M2 .

1.5 Radicle length (RL)

Compared to control, a gradual decrease in RL of *Bromus tectorum* was observed along gradual OAAE concentrations RL implication was significantly affected at P≤ 0.01, while seed culture was not significant.(Table 4.31& figure 4.7) at control; RL was 34 mm in pure culture. Higher concentrations of OAAE were notably active disturbing radicle emergence. And at 2.5 and 5% concentrations, RL decreased to 3and 1.66 mm. constantly; it continues reduction till it attained a value of about 0.83 mm at 7.5 and 10% concentration level. While in mixed culture; at control level, RL was about 39.33. At 2.5 and 5% OAAE concentration, RL decreased to 2 and 1 mm respectively the RL was completely inhibited at 7.5 and 10% OAAE concentration.

The OAAE concentrations were highly significant (P ≤ 0.01) affecting RL of *Melilotus indica* (Table 4.32& Figure 4.7) in pure culture at control the RL value was 28mm. And at 2.5 5, 7.5 and 10% concentrations, the RL decreased to 12, 6.5, 3.5 and 3 mm. besides in mixed culture; at control level, RL was about 18.66. At 2.5,5 and 7.5% OAAE concentration, RL decreased to 6, 5.5 and5 mm, respectively. Finally the lowest value (4.5 mm) of RL was noticed at 10% OAAE concentration.

The data of RL of wheat showed the OAAE concentrations and type of seed culture was significantly affected at P≤ 0.01 (Table 4.33& Figure 4.7), at control; RL was 56.66 mm in pure culture. And at 2.5 and 5% concentrations, the RL decreased to26.5 and17.5 mm. constantly; at 7.5 and 10% concentration level the values were about 16 and 12mm. almost the reduction has occurred in mixed culture; type M1; at control level, RL was about70 mm. At 2.5 and 5% OAAE concentration, RL decreased to 32.5 and 19.5 mm, respectively, and at 7.5 and 10% OAAE concentration the values (18.5 and 17.5 mm) of RL were noticed., while in mixed culture; type M2, the RL at control level was about 60mm and at 2.5, 5, 7.5 and 10% OAAE concentration the values 32.5,31,30 and 15 mm, respectively, were noticed.

2. Effect of *Oudneya africana* Crude Powder (OACP) on some growth parameters and phytomass (Pot Experiment)

2. 1 Shoot length (SL)

Data in Table 34a&b pointed up that shoot length (SL) of wheat and *Bromus tectorum* was significantly affected upon applying the different concentrations of OACP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 18.87 and 13.06cm of SL were observed respectively. These values were reduced to 16.175and 12.53cm at 1% and to 16 and 12.43cm at 3% level and at6% OACP concentration the values 16.35 and12.1cm were obtained for the two recipient species respectively. Similarly, in sandy soil values of SL were about 17.23 and 13.03cm at control level respectively. At 1 % OACP was obtained 15.70cm these values were reduced to 15.37 cm at 3 and6% OACP concentrations respectively for Wheat compared of *Bromus tectorum* The values about to 11.90, 11.83and zero cm was observed. Data in Table 35a&b pointed up that shoot length (SL) of wheat and *Melilotus indica* was significantly affected upon applying the different concentrations of OACP. In clay soil, there was a noticed reduction in values of SL. At control level, values of about 17.83 and 14.46cm of SL were observed respectively. These values were reduced to 16.30,15.72 and 14.30 cm at 1,3 and6%OACP concentration respectively for Wheat and for *Melilotus indica* the value was 14.25cm at1 and3% OACP and a6% level the value about 13.75 cm. Similarly, in sandy soil values of SL were about 18 and 13.40 cm at control level respectively. At 1 and3 % OACP was obtained 18.60 and 18.30cm these values were reduced to 17.33 cm at 6% OACP concentrations for Wheat compared of *Melilotus indica* the value about to zero cm was observed.

2.2 Root length (RL)

The allelopathic effects of OACP concentration on root length (RL) of Wheat and *Bromus tectorum* are illustrated in Table 4.34.a.&b. Generally, all allelopathic concentrations have significantly reduced RL. In clay soil, the control values were about 22.12and 7.10cm for the two recipient species respectively. At 1 % OACP concentration, RL reduced to 10.42and 5.43cm and 9.12 and4.26 at3% level. Constantly, it continues reduction till it attained values of about 9.6and 3.8cm at 6% OACP concentration for the two recipient species respectively. Correspondingly, the control values of RL in sandy soil were about 16.16and 6.23cm respectively. At 1% concentration, the values of about 12.05 and 6.60cm were obtained. It reduced to 9.60 and zero at 6% OACP concentration for the two recipient species respectively.

Table 4.34a.Allelopathic effect of different percentage of *Oudneya africana* crude powder (OACP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.93^{a}	0.32^{a}	0.185^{a}	0.468^{a}	0.105^{a}	0.046^{a}	0.026^{a}	0.086^{a}
1	16.175^{b}	15.7^{b}	10.42^{b}	12.05^{b}	4.00^{ab}	3.00^{ab}	0.24^{b}	0.23^{b}	0.048^{b}	0.065^{b}	0.040^{b}	0.035^{ab}	0.013^{b}	0.040^{b}
3	16.00^{b}	15.37^{c}	9.12^{c}	11.12^{c}	3.50^{b}	3.00^{ab}	0.225^{b}	0.19^{c}	0.040^{b}	0.020^{c}	0.022^{c}	0.020^{b}	0.013^{b}	0.013^{c}
6	15.82^{b}	15.37^{c}	6.30^{d}	9.60^{d}	3.25^{b}	2.75^{b}	0.15^{c}	0.16^{c}	0.030^{b}	0.020^{c}	0.0175^{c}	0.020^{b}	0.003^{c}	0.013^{c}
P-value	0.038*		0.462		0.032*		0.180		0.212		0.176		0.009*	
TWO-WAY ANOVA														
A – Treatment	**		**		*		**		**		**		**	
B- Soil Type	*		**		*		**		**		*		**	
A x B	NS		**		NS		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.34.b.Allelopathic effect of different percentage of *Oudneya africana* crude powder (OACP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06[a]	13.03[a]	7.10[a]	6.23[b]	3.00[a]	2.33[a]
1	12.53[b]	11.90[b]	5.43[b]	6.60[a]	2.00[a]	1.66[a]
3	12.43[c]	11.83[b]	4.26[c]	6.06[c]	2.00[a]	1.33[a]
6	11.86[d]	0.00[c]	3.80[d]	0.00[d]	2.00[a]	0.00[b]
P-value	0.0680		0.3930		0.0439*	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-Soil Type	**		**		NS	
A x B	**		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant **: Significant at 0.01

The allelopathic effects of OACP concentration on root length (RL) of Wheat and *Melilotus indica* are illustrated in Table 4.35.a&b. Generally, all allelopathic concentrations have significantly reduced RL. In clay soil, the control values were about 25.10and 6.10cm for the two recipient species respectively. At 1 % OACP concentration, RL reduced to 15.42and 5.69cm and 9.00 and5.50at3% level. Constantly, it continues reduction till it attained values of about 8.32and 4.30cm at 6% OACP concentration for the two recipient species respectively. Correspondingly, the control values of RL in sandy soil were about 11.37and 6.56cm respectively, the values of about cm 25, 20 and 14.93cm were obtained for Wheat while for *Melilotus indica*, the value it reduced to zero at 1, 3 and6% OACP concentration.

2.3 Leaf number (LN)

Generally, leaf number (LN) of wheat and *Bromus tectorum* was not significant affected by the increase in OACP concentration. In clay soil, the control values of LN were about 5.25and 3, respectively. At 6% OACP concentration the values of about 3.25 and 2 were attained for the two recipient species respectively. Similarly, in sandy soil, the control values of LN were about 3.66 and 2.33 respectively. At 6% OACP concentration, values of about 2.75 and zero were obtained for the two recipient species respectively (Table 4.34 a&b).Commonly, leaf number (LN) of wheat and *Melilotus indica* was not significant affected by the increase in OACP concentration. In clay soil, the control values of LN were about 4.33and 3.33 leaves respectively. At 1% OACP concentration the values of about 3.25 and 2.5 leaves were attained for the two recipient species respectively but at3 and6% OACP concentration the same value 3 and 2 leaves was obtained for the two recipient species respectively . Similarly, in sandy soil, the control values of LN were about 4.66 and 2 leaves respectively. At1, 3 and 6% OACP concentration, values of about 5, 4.33 and 3.66 leaves were obtained for Wheat compared for *Melilotus indica* the values about to zero at all concentration (Table 4.35 a&b).

2.4 Shoot fresh weight (SFw)

The represented data in table 4.34.a showed the values of shoot fresh weight (SFw) of Wheat were about 0.93 and 0.32g.plant^{-1} at control level in clay and sandy soil respectively. These values decreased to 0.24, 0.225 and 0.15 g.plant^{-1} at 1, 3 and 6% OACP concentration were obtained in clay soil. Correspondingly, in sandy soil, the values of SFw were about 0.23, 0.19 and 0.16g.plant^{-1} at 1, 3 and 6% OACP concentration respectively.

Table 4.35.a.Allelopathic effect of different percentage of *Oudneya africana* crude powder (OACP) on some growth parameters of wheat (mixed culture with *Melilotus indica)*, 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	17.83^{a}	18.00^{a}	25.10^{a}	11.37^{d}	4.33^{a}	4.66^{a}	0.82^{a}	0.48^{a}	0.146^{a}	0.310^{a}	0.100^{a}	0.060^{a}	0.026^{b}	0.073^{a}
1	16.30^{b}	18.60^{a}	15.42^{b}	25.00^{a}	3.25^{b}	3.66^{a}	0.41^{b}	0.26^{d}	0.052^{b}	0.110^{b}	0.040^{ab}	0.040^{b}	0.033^{a}	0.033^{b}
3	15.72^{c}	18.30^{a}	9.00^{c}	20.00^{b}	3.00^{b}	4. 33 ^{a}	0.22^{c}	0.36^{c}	0.030^{c}	0.120^{b}	0.025^{b}	0.033^{b}	0.013^{c}	0.026^{c}
6	14.30^{d}	17.33^{a}	8.32^{c}	14.93^{c}	3.00^{b}	5.00^{a}	0.20^{c}	0.42^{b}	0.022^{d}	0.130^{b}	0.020^{b}	0.026^{b}	0.013^{c}	0.026^{c}
P-value	0.056		0.301		0.041*		0.408		0.008*		0.306		0.1	
TWO-WAY ANOVA														
A - Treatment	*		**		NS		**		**		**		**	
B- **Soil Type**	**		**		*		*		**		NS		**	
A x B	*		**		NS		**		*		*		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.35.b.Allelopathic effect of different percentage of *Oudneya africana* crude powder (OACP) on some growth parameters of *Melilotus indica,* (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables treatment	Shoot length (cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46[a]	13.40[a]	6.10[a]	6.56[a]	3.33[a]	2.00[a]
1	14.25[ab]	0.00[b]	5.69[a]	0.00[b]	2.50[ab]	0.00[b]
3	14.25[ab]	0.00[b]	5.50[a]	0.00[b]	2.00[b]	0.00[b]
6	13.75[b]	0.00[b]	4.30[b]	0.00[b]	2.00[b]	0.00[b]
P-value	0.011*		0.039*		0.001*	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-**Soil Type**	**		**		**	
A x B	**		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant **: Significant at 0.01

The represented data in table 4.35.a showed the values of shoot fresh weight (SFw) of Wheat were about 0.82 and 0.48g.plant^{-1} at control level in clay and sandy soil respectively. These values decreased to 0.41, 0.22 and 0.20 g.plant^{-1} at 1, 3 and 6% OACP concentration were obtained in clay soil. Correspondingly, in sandy soil, the values of SFw were about 0.42, 0.36 and 0.26g.plant^{-1} at 1, 3 and 6% OACP concentration, respectively.

2.5 Root Fresh weight (RFw)

In clay and sandy soil, the values of root fresh weight (RFw) of Wheat were about 0.185 and 0.468 g.plant^{-1} at control level respectively. Through applying subsequent higher OACP concentrations there was a continual reduction in RFw. Eventually, the values reduced to 0.048, 0.04 and0.03 g.plant^{-1} at 1, 3 and at6% OACP concentrations in clay soil. On the other hand, the value of RFw in sandy soil was about 0.065g.plant^{-1} at 1 and at 3, 6% concentration the same value 0.02 g.plant^{-1} was obtained (Table 4.34.a).

In clay and sandy soil, the values of root fresh weight (RFw) of Wheat were about 0.146 and 0.31 g.plant^{-1} at control level respectively. Through applying subsequent higher OACP concentrations there was a continual reduction in RDw. Eventually, the values reduced to 0.052, 0.03 and0.022 g.plant^{-1} at 1, 3 and at6% OACP concentrations in clay soil. On the other hand, the value of RFw in sandy soil at 1 and at 3, 6% concentration the value 0.11, 0.12 and 0.13g.plant^{-1} was obtained (Table 4.35.a).

2.6 Shoot dry weight (SDw)

Shoot dry weight (SDw) of wheat was significantly affected by OACP concentrations (Table 4.34.a). Values of about 0.105 and0.046 g.plant^{-1} were achieved at control level in clay and sandy soil respectively. These values decreased to 0.04, 0.022 and0.0175 g.plant^{-1} at1.3and 6% OACP concentration respectively in clay soil. Similarly, in sandy soil, the values of SDw were about 0.035 g.plant-1 at 1% OACP and 0.02 g.plant^{-1} were obtained at 3 and 6% OACP concentration.

Shoot dry weight (SDw) of wheat was significantly affected by OACP concentrations (Table 4.35.a). Values of about 0.10 and0.06 g.plant^{-1} were achieved at control level in clay and sandy soil respectively. These values decreased to 0.04, 0.025 and0.02 g.plant^{-1} at1.3 and 6% OACP concentration respectively in clay soil. Similarly, in sandy soil, the values of SDw were about 0.04, 0.033 and 0.026 g.plant^{-1} at 1, 3 and 6% OACP concentration.

2.7 Root dry weight (RDw)

In clay soil, the value of root dry weight (RDw) of wheat was 0.026 g.plant^{-1} at control level. Through applying subsequent higher OACP concentrations there was a continual reduction in RDw. Eventually, the value reduced to 0.013 g.plant^{-1} at 1 and 3% OACP concentrations while at 6%OACP the value 0.003 g.plant^{-1} was recovered. On the other hand, the control value of RDw in sandy soil was 0.086 g.plant^{-1} and 0.04 g.plant^{-1} at 1%OACP and at 3 and6%OACP concentrations the RDw was reduced to 0.026, 0.02 and 0.013 g.plant $^{-1}$for Wheat (Table 4.34.a).

In clay soil, the value of root dry weight (RDw) of wheat was 0.026 g.plant^{-1} at control level. Through applying subsequent higher OACP concentrations there was a continual reduction in RDw. Eventually, the value reduced to 0.013 g.plant^{-1} at 3 and 6% OACP concentrations. On the other hand, the control value of RDw in sandy soil was 0.073 g.plant^{-1} and 0.033 g.plant^{-1} at 1%OACP and at 3 and6%OACP concentrations the RDw was reduced to 0.026g.plant^{-1}for Wheat (Table 4.35.a)

VIII. Allelopathic Potential of *Ephedra alata* on *Bromus tectorum* , *Melilotus indica* (Weed Species) and *Triticum aestivum* (Crop Species)

1. Effect of *Ephedra alata* Aqueous Extract (EAAE) on germination efficiency (Petri-Dish Experiment)

1.1 Germination Percentage (GP)

Generally, GP of *Bromus tectorum* was significantly affected (P≤0.01) by the increase in EAAE concentration (Table 4.36& figure 4.8). At control, GP value was about 100% in pure culture. The value was reduced to 93.3% at 2.5% EAAE concentration and to 46.6% at 5% then to 30% at 7.5% last of all, at 10% EAAE concentration level, the lowest GP of *Bromus tectorum* was noticed (26.6%). In mixed culture, GP value was about 96.6%. The values gradually reduced upon applying ascending EAAE concentrations. More obvious reduction in GP occurred at 5% concentration to reach 5%. At 7.5 and 10% concentration the germination was completely inhibited. Table 4.37& Figure 4.8 showed the GP of *Melilotus indica* seeds in pure and mixed cultures was significantly (P≤ 0.01) affected upon applying different concentrations of EAAE. In pure culture at control the GP value was about 60% and at 2.5, 5, 7.5 and 10% the values were reduced to 55, 40, 35 and 10 %, respectively. While in mixed culture, at control the GP value was about 50% compared with 2.5% EAAE

concentration the value was increased (65%), but at 5 7.5 and 10% EAAE concentration 45, 40 and 35%, respectively.

The Table 4.38 & Figure 4.8. are showed that affected upon applying different concentrations of *Ephedra alata* aqueous extract (EAAE) on wheat , type of seed culture and their interaction was significantly (P≤ 0.01) .At control, 2.5,5 and 7.5, GP value was about 100% in pure culture. This percentage was reduced to 95% at 10% EAAE concentrations. In mixed culture; type M1, the GP value was about 96.6 % and 100% was observed at 2.5,5 and 7.5% EAAE concentration and at 10% level the value 95% was obtained while in mixed culture; type M2 was about a same value (100%) at control, 2.5 and 5 % EAAE concentration, this value was reduced to 95 and 90% at 7.5 and 10% EAAE concentrations, respectively.

1.2 Seed germination index (SGI)

Interpretations of SGI for *Bromus tectorum* clarify the effect of EAAE concentration in pure and mixed culture (Table 4.36), the control values (32.33) in pure culture. Conversely, the control values in mixed culture (29.7). The statistical implications elucidate the effect of EAAE concentration was significant at P≤ 0.01. Comparatively, SGI was higher in pure culture compared to mixed culture , the values of about 27.76,9.77,6.81 and 5.54 were obtained in pure culture at 2.5, 5,7.5 and 10% concentrations respectively. In mixed culture SGI was 12.25 and 2.5 at 2.5 and 5% EAAE concentrations were applied. At 7.5 and 10% EAAE concentration the germination was completely inhibited.

The statistical implications elucidate the effect of EAAE concentration on was significant at P≤ 0.01 on *Melilotus indica* (Table 4.37). At control the SGI values were about 24.42 and 21.93 in pure and mixed culture respectively. The values of about 18.5, 14.68, 12.85and 6.58 were obtained in pure culture at 2.5, 5, 7.5 and 10% concentrations, respectively. While in mixed culture the SGI values were 22.96, 20.25, 18.62 and 15.39 at 2.5, 5, 7.5 and 10% EAAE concentrations, respectively.

Table 4.38 are illustrated the effect of EAAE concentrations on SGI of wheat was significant at P≤ 0.01. At control the values were about 33, 3, 32.2 and 46.62 in pure and mixed culture; type M1 and M2. Then in pure culture at 2.5 and 5% concentrations the value was about 31.60 and at 7.5 and 10% EAAE the values 31.42 and 30.8 were obtained, respectively. While in mixed culture; type M1 the SGI values were applied 33.3, 32.66, 32.49 and 31.66 at 2.5, 5, 7.5 and 10% EAAE concentrations. Compared in mixed culture; type M2 the values 41.25, 39.81, 39.1 and 35 were recovered.

Table 4.36 Variation in germination percentage (GP), Seed germination index (SGI) ,germination inhibition percentage (GIP), plumule (PL) and radicle length (RL) of *Bromus tectorum* (pure culture) and *Bromus tectorum* x Wheat (mixed culture) as affected by different concentration of *Ephedra alata* aqueous extract (EAAE) in Petri-dish experiment.

Variables	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
Treatment (%)	B	BxW	B	BxW	B	BxW	B	BxW	B	BxW
C	100.0^{a}	96.6^{a}	32.33^{a}	29.70^{a}	0.00	0.00	19.66^{a}	25.00^{b}	34.00^{a}	39.33^{a}
02.5	93.3^{b}	40.0^{b}	27.76^{b}	12.25^{b}	6.70^{d}	58.59^{c}	9.66^{b}	32.50^{a}	3.33^{b}	15.00^{b}
05.0	46.6^{c}	5.0^{c}	9.77^{c}	2.30^{c}	53.40^{c}	94.82^{b}	5.66^{c}	0.00^{c}	0.83^{c}	1.00^{c}
07.5	30.0^{d}	0.0^{d}	6.81^{d}	0.00^{d}	70.00^{b}	100.0^{a}	0.00^{d}	0.00^{c}	0.50^{c}	0.00^{c}
10.0	26.6^{e}	0.0^{d}	5.54^{e}	0.00^{d}	73.40^{a}	10.00^{a}	0.00^{d}	0.00^{c}	0.50^{c}	0.00^{c}
P-value	0.010*		0.012*		0.003**		0.205		0.1321	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	**		**		**		**		**	
AB interaction	**		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
Two-way ANOVA: NS: not significant **: Significant at 0.01

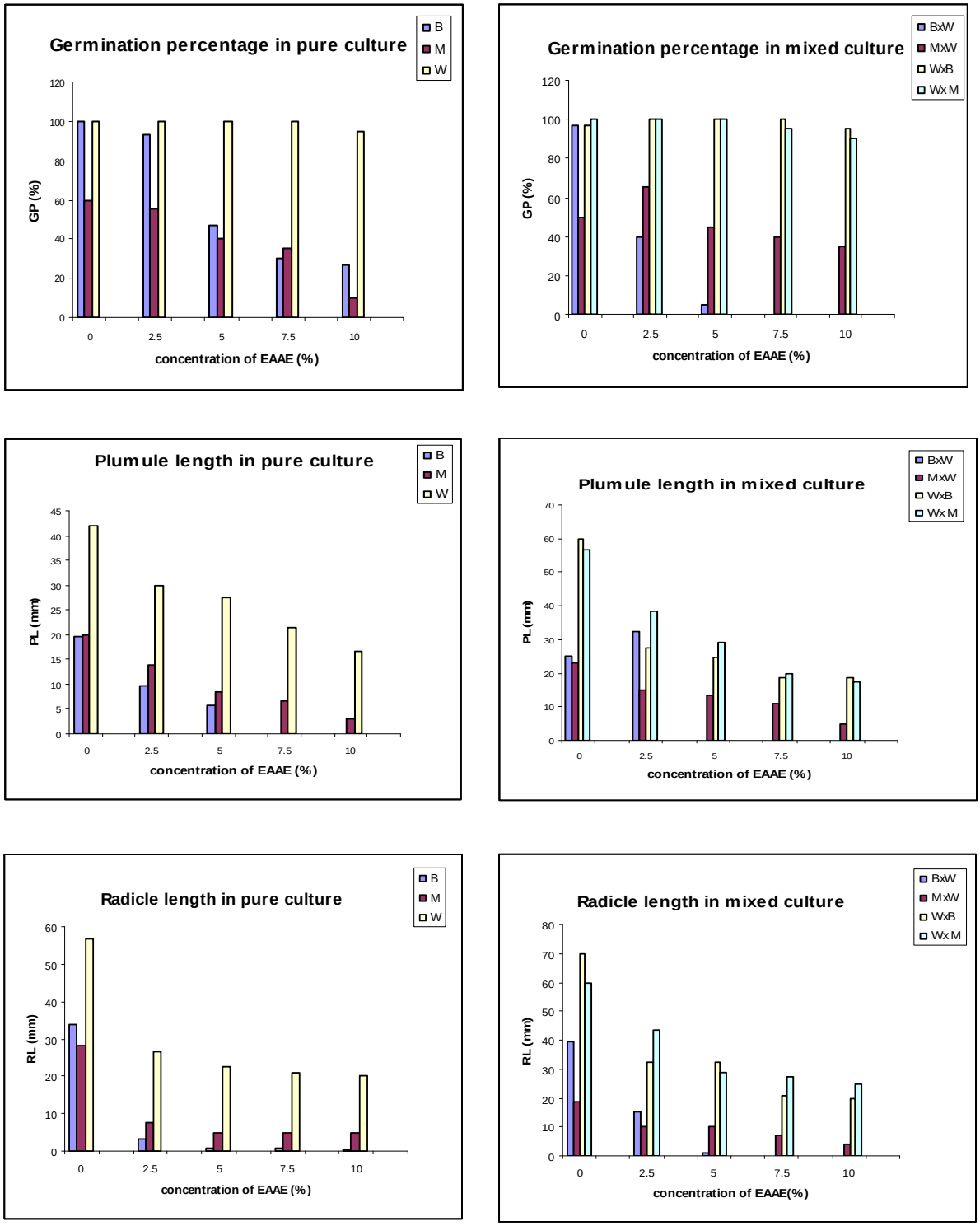

Figure 4.8 Variation in the germination percentage (GP) and plumule (PL) and radicle length (RL) in pure culture of *Bromus tectorum* (B), *Melilotus indica* (M), wheat (W) and mixed culture of *Bromus tectorum* x wheat (BxW), *Melilotus indica* x wheat (MxW), wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) as affected by different concentrations of *Ephedra alata* aqueous extract (EAAE) in Petri-dish experiment.

1.3 Germination inhibition percentage (GIP)

Data of the present study demonstrated that GIP of *Bromus tectorum* was significantly affected (P≤ 0.01) due to the apparent allelopathic action of EAAE concentrations under both seed culture(Table 4.36). GIP was attained at 2.5% EAAE concentration in pure and mixed culture it was about 6.7 and 58.59%. In pure the GIP values were attained about 53.4, 70 and 73.4 % at 5, 7.5 and 10% EAAE concentrations, respectively while in mixed culture at 5 % the value about 94.82 but at 7.5 and10% EAAE concentrations the germination was completely inhibited**.**

The Potential of EAAE concentrations, type of seed culture and EAAE concentration-seed culture interaction on GIP of *Melilotus indica* was highly significant (P≤ 0.01) (Table 4.37). The GIP value was attained at 2.5% EAAE concentration in pure culture it was about 8.33 % but in mixed culture at 2.5%EAAE concentration the germination value was stimulation compared with the (GIP = -30%) control, in pure culture the GIP attained values of about 33.33, 41.66 and 83.33% at 5, 7.5 and 10% EAAE concentration respectively compared with 10, 20 and30% in mixed culture were obtained.

The effect of HSAE concentration on the SGI of wheat statistically was not significant while the type of seed culture was significantly affected (P≤ 0.01). in pure culture at 2.5, 5 and 7.5 % EAAE concentrations the germination inhibition was null and at 10% the GIP value was about 5% while in mixed culture M1 the germination was stimulated (-3.51%) at 2.5,5 and 7.5 % EAAE concentrations and at 10% the GIP value was about 1.56 % besides in mixed culture M2 the GIP was null at 2.5 and 5% EAAE concentrations however at 7.5 and 10% EAAE the GIP values were about 5 and 10% respectively. (table 4.38)

1.4 Plumule length (PL)

The PL of *Bromus tectorum* was significantly affected (P≤ 0.01) either due to each main effect as an individual or due to their interactions (Table 4.36 & Figure 4.8). In pure culture, the value of PL was 19.66mm at control level. Afterward, it reduced to 9.66mm at 2.5% EAAE concentration. Expectedly, the maximum allelopathic action of EAAE concentrations at 7.5 and10% EAAE concentration germination was completely inhibited. While in mixed culture at control level, the value of PL was about 25 mm, the enhancing effect was elucidated (at 2.5% EAAE concentration PL value was 32.5mm) however at 5, 7.5 and 10% EAAE concentrations the germination was completely inhibited.

Table 4.37. Variation in germination percentage (GP), Seed germination index (SGI), germination inhibition percentage (GIP) plumule (PL) and radicle length (RL), of *Melilotus indica* (pure culture) and *Melilotus indica* x wheat (mixed culture) as affected by different concentration of *Ephedra alata* aqueous extract (EAAE) in Petri-dish experiment.

Variables / Treatment (%)	GP (%)		SGI		GIP (%)		PL (mm)		RL (mm)	
	M	MxW	M	MxW	M	MxW	M	MxW	M	MxW
C	60^{a}	50^{b}	24.42^{a}	21.93^{b}	0.00	0.00	20.0^{a}	23.0^{a}	28.00^{a}	18.66^{a}
02.5	55^{b}	65^{a}	18.05^{b}	22.96^{a}	8.33^{d}	-30.00	14.0^{b}	15.0^{b}	7.50^{b}	10.00^{b}
05.0	40^{c}	45^{bc}	14.68^{c}	20.25^{c}	33.33^{c}	10.00^{c}	8.5^{c}	13.5^{bc}	5.00^{bc}	10.00^{b}
07.5	35^{d}	40^{c}	12.85^{d}	18.62^{d}	41.66^{b}	20.00^{b}	6.5^{c}	11.0^{c}	5.00^{bc}	7.00^{bc}
10.0	10^{e}	35^{cd}	6.58^{e}	15.39^{e}	83.33^{a}	30.0^{a}	3.0^{d}	5.0^{d}	3.00^{d}	4.00^{d}
P-value	0.140		0.03*		0.009**		0.007**		0.465	
TWO-WAY ANOVA										
A-Treatment	**		**		**		**		**	
B-Seed Culture	*		**		**		**		NS	
AB interaction	**		**		**		NS		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Evidently, the PL of *Melilotus indica* was significantly reduced (P≤ 0.01). In pure culture, the value of PL was about 20 mm at control level. Then, it reduced to 14, 8.5, 6.5 and 3mm at 2.5 5.7.5 and10% EAAE concentrations respectively. In mixed culture at control level, a value of PL was about 23 mm. the PL has gradually decreased to 15, 13.5,11 and 5 mm at 2.5, 5, 7.5 and 10% EAAE concentrations, respectively. (Table 4.37 & Figure 4.8)

The PL of wheat was significantly (P≤ 0.01) by each of the main effects individually and their interactions. In pure culture, the value of PL was about 42mm at control level. Then the values of PL were reduced to 30, 27.5, 21.5 and 16.5mm at 2.5, 5, 7.5 and10 % EAAE concentrations. Afterward, in mixed culture; type M1 and M2 At control level, the values of PL were about 60 and 56.66 mm, respectively, in mixed culture; type M2 the enhancing effect was elucidated at 2.5 and 5% concentrations the PL values were 27.5 and 24.5 mm. the PL has gradually decreased at 7.5 and 10% EAAE concentrations, the value was 18.5mm while in mixed culture; type M2 the values 38.5,29,20 and 17.5 were obtained at 2.5, 5, 7.5 and 10% EAAE concentrations. (Table 4.38 &figure 4.8).

1.5 Radicle length (RL)

Elevated EAAE concentrations have possessed a significant inhibitory effect on radical growth (P≤ 0.01) a slight difference was observed among *Bromus tectorum* RL assessment in seed culture (Table 4.36& figure 4.8) in pure culture, the control value was 34 mm. At 2.5% EAAE concentration, it was 3.33mm. Upon applying the highest EAAE concentration (10%), it has reduced to 0.5mm. Evidently, RL measurements have illustrated lower assessments as a response in mixed culture. At control 39.33mm a gradual reduction has then occurred as a result of applying ascending EAAE concentrations. The RL values were 15and 1 mm at 2.5 and 5% EAAE concentrations however at 7.5 and 10% EAAE the germination was completely inhibited.

The allelopathic effect of EAAE concentration on RL of *Melilotus indica* is illustrated in Table 4.37& Figure 4.8 Statistically, the applied concentrations of EAAE, type of seed cultures and their interaction are significantly (P≤ 0.01). In pure culture, the control value was 28 mm and at 2.5% EAAE concentrations, the RL value was about 7.5mm. Upon applying the highest EAAE concentration (10%), it has reduced to 3mm. while in mixed culture. At control value was 18.66mm. A gradual reduction has then occurred as a result of applying ascending EAAE concentrations. RL value was 10 mm at 2.5 and 5% EAAE concentrations but in 7.5 and 10% EAAE the RL values were 7 and 4 mm was obtained.

Table 4.38.Variation in germination percentage (GP),Seed germination index (SGI),germination inhibition percentage (GIP) plumule (PL) and radicle length (RL) of wheat (W) (pure culture) , wheat x *Bromus tectorum* (WxB) and wheat x *Melilotus indica* (WxM) (mixed culture) as affected by different concentration of *Ephedra alata* aqueous extract (EAAE) in Petri-dish experiment.

Variables treatment	GP (%)			SGI			GIP (%)			PL (mm)			RL (mm)		
	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM	W	WxB	WxM
C	100.0^{a}	96.6^{b}	100.0^{a}	33.3^{a}	32.2^{bc}	46.62^{a}	0.00	0.00	0.00	42.00^{a}	60.00^{a}	56.66^{a}	56.66^{a}	70.00^{a}	60.00^{a}
2.5	100.0^{a}	100.0^{a}	100.0^{a}	31.6^{b}	33.3^{a}	41.25^{b}	0.00^{c}	-3.51	0.00^{c}	30.00^{b}	27.50^{b}	38.50^{b}	26.50^{b}	32.50^{b}	43.50^{b}
5.0	100.0^{b}	100.0^{a}	100.0^{a}	31.6^{b}	32.66^{ab}	39.81^{c}	0.00^{b}	-3.51	0.00^{c}	27.50^{c}	24.50^{c}	29.00^{c}	22.50^{c}	32.50^{b}	28.80^{c}
7.5	100.0$^{.b}$	100.0^{a}	95.0^{b}	31.42^{b}	32.49^{ab}	39.1^{c}	0.00^{b}	-3.51	5.00^{b}	21.50^{d}	18.50^{d}	20.00^{d}	21.00^{d}	21.00^{c}	27.50^{c}
10.0	95.0^{c}	95.0^{c}	90.0^{c}	30.8^{c}	31.66^{c}	35^{d}	5.00^{a}	1.65^{a}	10.00^{a}	16.50^{e}	18.50^{d}	17.50^{e}	20.00^{d}	20.00^{c}	25.00^{c}
TWO-WAY ANOVA															
A-Treatment	**			**			**			**			**		
B-Seed Culture	**			**			**			**			*		
AB interaction	**			**			**			**			**		

Different letters within each column indicate significance at P<0.05
Two-way ANOVA:NS: not significant **: Significant at 0.01

Elevated EAAE concentrations have possessed a significant inhibitory effect on radicle growth of Wheat ($P \leq 0.01$). In pure culture and mixed culture; type M1 and M2, the control values were 56.66,70 and 60mm. And at 2.5 and 5 % EAAE concentration, it was 26.5 and, 22.5 mm in pure culture. Upon applying the highest EAAE concentrations (7.5 and 10%), it has reduced to 20mm in pure and mixed culture; type M1. Compared to control in mixed culture; type M1. A gradual reduction has then occurred as a result of applying ascending EAAE concentrations. RL value was 32.5 mm at 2.5 and 5% EAAE concentrations however in mixed culture M2 the values 43.5, 28.8, 27.5 and 25 mm were observed at 2.5, 5, 7.5 and 10% EAAE concentration. (Table 4.38& Figure 4.8)

2. Effect of *Ephedra alata* Crude Powder (EACP) on some growth parameters and phytomass (Pot Experiment)

2.1Shoot length (SL)

Data of the present study demonstrated that shoot length (SL) of wheat and *Bromus tectorum* was significantly affected due to the apparent allelopathic action of EACP concentrations under the clay and sandy soils (Table 4.39 a&b). In clay soil, there was a slight reduction in values of SL. At control level, values of about 18.87 and13.06 cm of SL were noticed respectively. These values were reduced to 16.27 and 12.60 at1% and to 16 and 12.50 cm at 3% and at 6% EACP concentration the values 15.62and11.90 were obtained. Correspondingly, in sandy soil values of SL were about 17.23 and 13.03cm at control level. These values were reduced to 16.32 and 13.20 cm at 1% and to 15.17and11.86 cm at 6% EACP concentration for the two recipient species; respectively.

Data of the present study demonstrated that shoot length (SL) of wheat and *Melilotus indica* was significantly affected due to the apparent allelopathic action of EACP concentrations under the clay and sandy soils (Table 4.40.a.b). In clay soil, there was a slight reduction in values of SL. At control level, values of about 17.83 and14.46 cm of SL were noticed respectively. These values were reduced to 15.37 and 15.00 at1% and to 14.96 and 14.75 cm at 3% and at 6% EACP concentration the values 14.60and14.00 were obtained. Correspondingly, in sandy soil values of SL were about 18.00 and 13.40cm at control level. These values about to 18.16, 17.60 and 16.33 cm at 1,3 and6%EACP for Wheat compared for *Melilotus indica* the value of SL was completely inhibited at all concentration

Table 4.39a.Allelopathic effect of different percentage of *Ephedra alata* crude powder (EACP) on some growth parameters of wheat (mixed culture with *Bromus tectorum*), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	18.87^{a}	17.23^{a}	22.12^{a}	16.16^{a}	5.25^{a}	3.66^{a}	0.930^{a}	0.320^{a}	0.185^{a}	0.468^{a}	0.105^{a}	0.046^{a}	0.026^{ab}	0.086^{a}
1	16.27^{b}	16.32^{b}	12.37^{b}	11.57^{c}	4.00^{ab}	3.00^{a}	0.220^{b}	0.260^{b}	0.040^{b}	0.045^{b}	0.035^{b}	0.030^{b}	0.020^{a}	0.020^{b}
3	16.00^{b}	15.20^{c}	10.20^{c}	12.45^{b}	3.75^{b}	3.00^{a}	0.200^{b}	0.255^{b}	0.033^{b}	0.035^{b}	0.025^{b}	0.030^{b}	0.013^{bc}	0.013^{b}
6	15.62^{b}	15.17^{c}	7.82^{d}	12.75^{b}	3.25^{b}	3.00^{a}	0.155^{b}	0.185^{c}	0.030^{b}	0.030^{b}	0.020^{b}	0.030^{b}	0.003^{c}	0.013^{b}
P-value	0.094		0.482		0.078		0.255		0.188		0.261		0.164	
TWO-WAY ANOVA														
A – Treatment	**		**		NS		**		**		**		**	
B- Soil Type	*		NS		NS		*		**		NS		*	
A x B	NS		**		NS		**		**		*		**	

Different letters within each column indicate significance at P<0.05

*: significant at p< 0.05 as evaluated by t-test TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.39.b.Allelopathic effect of different percentage of *Ephedra alata* crude powder (EACP) on some growth parameters of *Bromus tectorum*, (mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS)).

Variables / treatment	Shoot length		Root length		Leaves number	
	CS	SS	CS	SS	CS	SS
C	13.06[a]	13.03[a]	7.10[a]	6.23[a]	3.00[a]	2.33[a]
1	12.6[a]	13.2[a]	3.93[b]	6.22[a]	2.00[a]	2.66[a]
3	12.5[ab]	12.03[b]	3.73[c]	5.16[b]	2.00[a]	1.00[b]
6	11.9[b]	11.86[b]	3.06[d]	4.50[b]	2.00[a]	1.00[b]
P-value	0.478		0.119		0.146	
TWO-WAY ANOVA						
A – Treatment	**		**		NS	
B-**Soil Type**	NS		**		NS	
A x B	*		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA: NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.2 Root length (RL)

Compared to control, root length (RL) of wheat and *Bromus tectorum* demonstrated significantly reduction along gradual EACP concentrations (Table 4.39a&b). In clay soil, the control values were about 22.12and 7.10 cm for the tow recipient species respectively. These values were reduced to 12.37 and 3.93cm at 1% and to 10.20 and 3.73 cm at3% level finely at 6% EACP concentration the values 7.82 and 3.06cm were observed respectively. Likewise, the control values of RL in sandy soil were about 16.16and 6.23 cm for two recipients respectively. At 1% concentration the values of about 12.75 and 6.22 cm were achieved, it reduced to 11.57 and 4.5cm at 6% EACP concentration for the two recipient species respectively.

Compared to control, root length (RL) of wheat and *Melilotus indica* demonstrated significantly reduction along gradual EACP concentrations (Table 4.40a&b). In clay soil, the control values were about 25.10 and 7.10 cm for the tow recipient species respectively. These values were reduced to 13.55 and 6.50cm at 1% and to 9.20 and 5.75 cm at3% level finely at 6% EACP concentration the values 7.97 and 4.4cm were observed respectively. Likewise, the control values of RL in sandy soil were about 11.37and 6.56 cm for two recipients respectively. At 1, 3 and6% EACP concentrations the values of about 42.66, 17.66 and17.33 cm were achieved for Wheat while for *Melilotus indica* the value of SL was completely inhibited at all concentration.

2.3 Leaf number (LN)

Leaf number (LN) was significantly affected by EACP concentrations for Wheat while for *Bromus tectorum* Was not significant (Table 4.39a&b).Values of about 5.25 and 3 were attained at control level in clay soil for two recipients respectively but in sandy soil the values 3.66 and 2.33 for two recipients respectively . On wheat were obtained the same value at all concentration (3) sandy soil and clay soil the values about to 4 leaves at 1%EACP and 3.37 at 3 and6% EACP concentration ,while the values of LN on *Bromus tectorum* were obtained 2.33 and 2 in clay and sandy soil respectively . In clay soil the value of LN 2 at 1, 3 and 6 % concentration EACP compared in sandy soil the values 2.66 and one were obtained. Leaf number (LN) was not significantly affected by EACP concentrations for Wheat and *Melilotus indica*. (Table 4. 40a&b).Values of about 4.33 and 3.33 were attained at control level in clay soil for two recipients respectively but in sandy soil the values 3.33 and 2 for two recipients respectively .

On Wheat were obtained the value3,2.75 and2.5 at 1,3 and6% EACP concentration in clay soil while in sandy soil the values about to 4.33,4 and3.66 at 1,3 and6% EACP concentration ,on the other hand the values of NL on *Melilotus indica* in clay soil about of LN 3,2.5 and2 were obtained at 1,3 and 6 % concentration EACP compared in sandy soil the value of LN was completely inhibited.

2.4 Shoot fresh weight (SFw)

Shoot fresh weight (SFw) of Wheat was significantly affected by EACP concentrations (Table 4.39.a). The Values 0.93 and 0.32 g.plant^{-1} was attained at control level in clay and sandy soil. The values of SFw decreased to 0.22, 0.20 and0.155 g.plant^{-1} at 1,3and 6% EACP concentration respectively in clay soil. Similarly, in sandy soil, as a response to EACP allelopathic stress, SFw gradually decreased to 0.26, 0.255 and 0.185 g.plant^{-1} at 1, 3 and6% EACP concentration respectively.

Shoot fresh weight (SFw) of Wheat was significantly affected by EACP concentrations (Table 4.40.a). The Values 0.82 and 0.48 g.plant^{-1} was attained at control level in clay and sandy soil. The values of SFw decreased to 0.27, 0.19 and0.175 g.plant^{-1} at 1,3and 6% EACP concentration respectively in clay soil. Similarly, in sandy soil, as a response to EACP allelopathic stress, SFw gradually decreased to 0.46, 0.33 and 0.32 g.plant^{-1} at 1, 3 and6% EACP concentration respectively.

2.5 Root fresh weight (RFw)

Root fresh weight (RFw) significantly decreased in clay and sandy soils (Table 4.39.a). In clay and sandy soil, the values of RFw were about 0.185 and 0.468g.plant^{-1} at control level. During applying higher EACP concentrations there was a continual reduction in RFw. Eventually, at1.3 and 6% concentration, the values of RFw have reduced to0.04, 0.033 and 0.03g.plant^{-1} for Wheat in clay soil. Likewise in sandy soil, At 1, 3 and 6% EGCP concentration, RFw reduced to 0.045, 0.035 and 0.03g.plant^{-1} were obtained respectively.

Root fresh weight (RFw) of wheat significantly decreased in clay and sandy soils (Table 4.40.a). In clay and sandy soil, the values of RFw were about 0.146 and 0.31g.plant^{-1} at control level. During applying higher EACP concentrations there was a continual reduction in RFw. Eventually, at1.3 and 6% concentration, the values of RFw have reduced to 0.035, 0.032 and 0.027g.plant^{-1} for wheat in clay soil. Likewise in sandy soil, At 1, 3 and 6% EGCP concentration, RFw reduced to 0.20, 0.14 and 0.06g.plant^{-1} were obtained respectively.

Table 4.40.a.Allelopathic effect of different percentage of *Ephedra alata* crude powder (EACP) on some growth parameters of wheat (in mixed culture with *Melilotus indica)*, 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables	Shoot length (cm)		Root length (cm)		Leaf number		Shoot fresh weight (g plant^{-1})		Root fresh Weight (g plant^{-1})		Shoot dry weight (g plant^{-1})		Root dry weight (g plant^{-1})	
Treatment (%)	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS	CS	SS
C	17.83^{a}	18.00^{a}	25.10^{a}	11.37^{c}	4.33^{a}	4.66^{a}	0.820^{a}	0.480^{a}	0.146^{a}	0.310^{a}	0.100^{a}	0.060^{a}	0.026^{a}	0.073^{a}
1	15.37^{b}	18.16^{a}	13.55^{c}	22.66^{a}	3.00^{b}	4.33^{a}	0.270^{b}	0.460^{a}	0.035^{b}	0.200^{b}	0.026^{b}	0.053^{a}	0.026^{a}	0.033^{b}
3	14.96^{c}	17.60^{ab}	9.20^{c}	17.66^{b}	2.75^{b}	4.00^{a}	0.190^{c}	0.330^{c}	0.032^{bc}	0.140^{c}	0.020^{b}	0.026^{b}	0.013^{b}	0.026^{c}
6	14.60^{b}	16.33^{b}	7.97^{d}	17.33^{b}	2.50^{b}	3.66^{a}	0.175^{c}	0.320^{b}	0.027^{c}	0.060^{d}	0.030^{b}	0.026^{b}	0.013^{b}	0.013^{d}
P-value	0.041*		0.233		0.016*		0.407		0.017*		0.432		0.133	
TWO-WAY ANOVA														
A - Treatment	*		**		*		**		**		**		**	
B- **Soil Type**	**		**		*		*		**		NS		**	
A x B	*		**		NS		**		**		**		**	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

Table 4.40.b.Allelopathic effect of different percentage of *Ephedra alata* crude powder (EACP) on some growth parameters of *Melilotus indica,* (in mixed culture with wheat), 30 days after sowing in two different types of soils (clay soil (CS) and sandy soil (SS))

Variables treatment	Shoot length (cm)		Root length (cm)		Leaves number	
	CS	SS	CS	SS	CS	SS
C	14.46[a]	13.4[a]	6.10[a]	6.56[a]	3.33[a]	2.00[a]
1	15.00[a]	0.00[b]	6.50[a]	0.00[b]	3.00[a]	0.00[b]
3	14.75[a]	0.00[b]	5.75[a]	0.00[b]	2.50[ab]	0.00[b]
6	14.00[a]	0.00[b]	4.40[b]	0.00[b]	2.00[b]	0.00[b]
P-value	0.013*		0.04*		0.004*	
TWO-WAY ANOVA						
A – Treatment	*		**		NS	
B-**Soil Type**	**		**		*	
A x B	*		**		NS	

Different letters within each column indicate significance at P<0.05
*: significant at p< 0.05 as evaluated by t-test
TWO-WAY ANOVA**:** NS: not significant *: Significant at 0.05 **: Significant at 0.01

2.6 Shoot dry weight (SDw)

Statistically, there was significantly reduction of Shoot dry weight (SDw) of wheat as a consequence of raising EACP concentrations (Table 4.39.a). In clay soil, the control value of SDw was about 0.105g.plant^{-1}, at1 and 3% EACP concentration the values of about 0.035 g.plant^{-1} was achieved and 0.02g.plant^{-1} was attained for Wheat at 6% EACP concentration. Similarly, in sandy soil the control value of SDw was about0.046 g.plant^{-1}. At 1, 3 and6% EACP concentrations were obtained the same value (0.03 g.plant-1).

Statistically, there was significantly reduction of Shoot dry weight (SDw) of wheat as a consequence of raising EACP concentrations (Table 4. 40. a). In clay soil, the control value of SDw was about 0.10g.plant^{-1}, at1 3 and6% EACP concentration the values of about 0.03,0.026 and0.02 g.plant^{-1} was achieved for Wheat. Similarly, in sandy soil the control value of SDw was about0.06 g.plant^{-1} and the value 0.053 g.plant $^{-1}$ was recovered at 1%EACPconcentration while at 3 and6% EACP concentrations were obtained the same value (0.026 g.plant^{-1}).

2.7 Root dry weight (RDw)

Discernibly, significant reduction of root dry weight (RDw) of Wheat upon applying the different concentrations of EACP was attained. In clay soil, there was a slight reduction in values of RDw; the values of RDw were about 0.026, 0.02, 0.013 and 0.003g.plant^{-1} at control, 1, 3 and 6% EACP concentration respectively. Correspondingly, in sandy soil the control value of RDw was about 0.086g.plant^{-1}. At 1% level the value 0.02 g.plant^{-1} was recovered and at 3and 6% EACP concentrations, RDw value about 0.013 g.plant^{-1} was obtained. (Table 4.39.a).

Discernibly, significant reduction of root dry weight (RDw) of Wheat upon applying the different concentrations of EACP was attained. In clay soil, there was a slight reduction in values of RDw; the value of RDw was about 0.026g.plant^{-1} at control and 1% EACP and 0.013 g.plant^{-1} at 3 and 6% EACP concentration respectively. Correspondingly, in sandy soil the control value of RDw was about 0.073g.plant^{-1}. The value 0.033, 0.026 and0.013 g.plant^{-1} was recovered at1, 3and 6% EACP concentrations, (Table 4.40.a).

IX. Soil Characteristics

Data in **Table 4.41** illustrates the analysis of some physical and chemical properties of soil collected from the adjacent crop fields. Commonly, the soil was found to be clay and sandy in the texture and alkaline with pH ranging from to 7.52 and 9.37 in clay and sandy soils, respectively, and the values of EC of the two types of soils were about 1.07 and 0.65 ds/m in clay and sandy soils, respectively. The Organic material was in low levels in sandy soil compared to clay soil the values were about 2.79 and 0.36 %, respectively. The Nitrogen was about 0.03 and 0.01% in clay and sandy soils, respectively, while the total Phosphorous between 3.77 and 6.18 ppm in clay and sandy soils, respectively. On the other hand, the Available Potassium values were about 55 and 34 ppm in clay and sandy soils, respectively .The soil indicates poor nutrient status.

Table 4.41 Analysis of some physical and chemical properties of soil collected from the adjacent crop fields

Kind of analysis	Clay soil	Sandy soil
Ec ds/m	1.07	0.65
pH	7.52	9.37
Ca meq/kg	9.60	2.40
Mg meq/kg	2.40	1.20
Cl meq/kg	3.00	2.00
HCO_3 meq/kg	45.00	40.00
SO_4 p.pm	1.56	2.37
OM %	2.79	0.36
C Free %	1.62	0.21
N ppm available	0.03	0.01
P ppm available	3.77	6.18
K ppm available	55.00	34.00
Sand	27.75	76.25
Silt	5.50	2.65
Clay	66.75	21.10

DISCUSSION

DISCUSSION

In recent times, studies on unitization of allelelopathic chemicals (allelochemicals) as natural substances from plants for weed control in crop production have been widely recognized **(Einhellig, 1995a; Macias *et al*., 1998; Caldiz and Fernandez, 1999)**. The interaction of plants through chemical signals 'allelopathy' has many possible agricultural and ecological applications **(Rice, 1984; Nelson, 1996)**. Several medicinal plants may have inhibitory effects on some weeds and its allelochemicals may causes sever reduction in weed growth **(Lin *et al*., 2004)**. A number of plants have an inhibitory effect on the growth of neighboring or successional plants by releasing allelopathic chemicals into the soil, either as exudates from the living tissues or by decomposition of plant materials (**Putnam and Tang 1986; Einhellig, 1996; Inderjit, 1996**). A successful allelochemical for weed management should inhibit germination of several weed species and not inhibit the germination of the crop (**Sebile and Sengul, 2008)**.

1. Effect of aqueous extract of donor species on germination efficiency of recipient species (Petri-Dish Experiment).

The present study was performed using eight medicinal plants as donor species *(Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata*) to test their allelopathic potentials on the performance of two weeds (*Bromus tectorum* and *Melilotus indica*) and one crop species (*Triticum aestivum*). Generally, the results of the present study indicate that the aqueous extracts of the donor species were reported to inhibit the seed germination of both the weeds and crop species and the inhibition was more prominent in the first compared with the latter. Among the different donor plants, the effect was depending on type of donor species and on extract concentration.

The results from bioassay tests showed that aqueous extracts from terrestrial saururaceae contained water-soluble substances inhibiting seed germination and growth of lettuce (*Lactuca sativa* L.), *Echinochloa* and *Monocharia.* Also, the study suggested that the inhibitory natural substances present in saururaceae plants could be used as a potential natural herbicide (**Lin *et al*., 2006**). Additionally, **Kil *et al*. (2002)** reported that an inhibitory effect of *Tagetes minuta* extracts on germination and growth of *Lactuca sativa* was also recorded.

Lee *et al*. (**2002**) observed that *Tagetes minuta* aqueous extracts inhibited the callus induction in *Oryza sativa*, *Brassica campestris*, *Raphanus sativus* and *Sesamum indicum.* Plants are known to exhibit allelopathy by releasing water soluble phytoxins from leaves, stem, roots fruits and seeds and such metabolites play an inhibitory role in delay or complete inhibition of seed germination, stunted growth and injury to root systems of plants **Rice, (1984).**

Data of the current study indicated that the donor species containing essential oils such as *Artemisia herba-alba* exhibited potent allelopathic effects on seed germination and growth of the recipient weeds compared with the other donor species. The metabolism of essential oils has been investigated in various plant tissues which contain or produce these compounds (**Aviv *et al*., 1982; Gershenzon *et al*., 1989; Funk *et al*., 1992**). Germination inhibition by essential oils, when applied to dry seeds, has been reported (**Zhang *et al.*, 1995; Dudai *et al*., 1999**). The major components of essential oils are monoterpenes. It is well known that monoterpene vapors may cause anatomical and physiological changes in plant seedlings and exposure to volatile terpenes can lead to accumulation of lipid globules in the cytoplasm, and reduction in organelles including mitochondria and nuclei.

The present study showed that the degree of seed germination inhibition was enhanced by increasing the concentration. Germination reductions ranged between zero and 100% at the higher concentrations. The allelopathic effect of the donor species on *Bromus tectorum* in pure culture was ranked as follows: *Artemisia herba-alba > Haloxylon scoparium and Oudneya africana > Euphorbia guyoniana > Pituranthos chloranthus> Zygophyllum album> Ephedra alata > Retama retam* while in mixed culture the effect was classed as follows *Artemisia herba-alba > Ephedra alata> Euphorbia guyoniana> Haloxylon scoparium> Pituranthos chloranthus> Oudneya africana> Zygophyllum album> Retama retam*. On the other hand, The effect the donor species on *Melilotus indica in* pure culture was ranked as follows : *Artemisia herba-alba> Ephedra alata> Retama retam* and *Oudneya africana > Zygophyllum album* and *Haloxylon scoparium > Euphorbia guyoniana > Pituranthos chloranthus* while in mixed culture the effect of donor classed as *Zygophyllum album and Artemisia herba-alba > Euphorbia guyoniana ,Pituranthos chloranthus and Oudneya africana> Retama retam > Haloxylon scoparium* and *Ephedra alata* germination percentage (GP) of the tow investigated recipient species demonstrated a gradual decrease with applying higher concentrations of the donor species as follows: regardless season *Bromus tectorum >Melilotus indica*.

The physiological roles of allelochemicals have not been completely determined in plants. An allelochemical can be beneficial in one plant, or harmful in another plant. This depends on allelochemicals type, concentration, and on the time of treatment (**Whittaker and Feeny, 1971; Rice, 1979; Hale and Orcutt, 1987**). The lowest concentration of *Beta vulgaris* aqueous extract has stimulated germination of wheat (*Triticum vulgare*). On the other hand germination was retarded under the application of concentrations above 1% (**Hegab *et al*., 2008**)

Evenari (**1949**) stated that germination inhibition is nearly always accompanied by stimulation of germination. Sometimes inhibition and stimulation appear in different concentrations, sometimes one after the other in the same concentration. The considerable inhibition of seed germination may be due to the inhibitory effect of allelochemicals such as water soluble saponins, hormones or enzyme which could affect growth directly or by altering the mobilization of storage compounds during germination (**Chaves and Escudero, 1997; El-Khatib, 1997**). Allelopathic compounds including phenolic acids, alkaloids and flavonoids that can be used as natural herbicides are less disruptive of the global ecosystem than are synthetic agrochemicals (**Chou, 1999**). These interactions can significantly affect community and ecosystem properties, although studies of plant-plant chemical interactions have often been controversial because of difficulty in unambiguously demonstrating interference by chemical inhibition rather than through resource competition or other mechanisms (**Harper, 1977**). Al-Saadawi *et al.* (**1986)** reported that water extracts of different cultivars of sorghum significantly reduced the germination of redroot pigweed (*Amaranthus retroflexus*). Similarly, Einhellig and Souza (**1992**) found that root exudates of sorghum reduced. These phenolics inhibit the germination and seedling growth of same plant species or others by their effects on metabolic processes of germination and growth (**Castro *et al*., 1984**).

Results of seed germination index (SGI) indicated that a gradual reduction of SGI in the three investigated species (two weeds and one crop species) as a response to the regular applying of higher concentration levels of donor was attained, which support the previously documented GP implications. In pure culture and mixed culture, the existing reduction rate was in the following order: *Bromus tectorum* > *Melilotus indica* > *Triticum aestivum*. Furthermore, the results of the current investigation indicated the inhibitory effect of concentration of different donor, clearly related to concentration.

Germination inhibition percentage (GIP) or relative reduction increased gradually with the increase of the concentration of the donor; the maximum GIP of three estimated plant species was recorded at 10% concentration

Therefore, we can conclude from this study that the germination efficiency , plumule and radicle length of *Bromus tectorum* in mixed culture was completely inhibited at the highest concentration of aqueous extracts of the donor species level (10%) except for *Melilotus indica* which attained weak measures. On the other hand, the two recipient species exerted weak measures as affected by the highest concentration level of all donors in pure culture. This inhibition was markedly in obvious *Bromus tectorum* than in *Melilotus indica* indicating that *Bromus tectorum* is more sensitive to all of tested donors, while the *Melilotus indica* is more adapted to the aqueous extract than the *Bromus tectorum*. However, this variant response to the allelopathic substance could be explained through that allelopathic effect is species specific and concentration dependent. Different sensitivity of plant species to phytotoxins depends on the physiological and biochemical characteristics of each species as well as environmental conditions (**Kobayashi, 2004**). At certain concentrations, phytotoxins that exhibit negative effect on growth of a weed species might cause less or no inhibition on another weed (**Tawaha and Turk, 2003; Xuan *et al*., 2005a**).

Several allelopathic compounds are structurally similar to hormones (**Olofsdotter, 1998)**. These compounds probably affect inducible hormones of germination such as gibberellin (**Rice, 1984; Kruse *et al*., 2000**) or activity of specific enzymes such as amylases and proteinases, which are necessary for seed germination (**Rice, 1984**). Escudero *et al.* (**2000**) observed the inhibitory effect of aqueous extract of *Artemisia herba- alba* on the final germination percentage of scarified seeds of *Helianthemum squamatum*. Modallal and Al-Charchafchi (**2006**) also reported that the phenolic compounds inside fruits of the common medicinal plant *Artemisia herba-alba* exhibit some potential inhibitory activity of germination and seedling growth of some plant species. Sodaeizadeh *et al.* (**2010**) evaluated the herbicidal potential of *Peganum harmala* residues on seedling growth of *Avena fatua* and *Convolvulus arvensis*, and decomposition dynamics of its phytotoxins in the soil and found that among the different *P. harmala* plant parts used, leaves were the most toxic and caused the greatest negative effect on seedling length, seedling dry weight, leaf area and chlorophyll content of *A. fatua* and *C. arvensis*. Both weed species differed in their sensitivity to *P. harmala* residues. Higher reduction in plant growth parameters occurred in *C. arvensis*.

Qasem and Foy (**2001**) noted that although allelochemicals are synthesized in all plant parts, their concentration varies from one part to another. Among residues prepared from different plant parts of *P. harmala*, root residues were less effective in affecting seedling growth of *A. fatua and C. arvensis* .

Results of the current study suggested that aqueous extracts of all the donor species exhibited inhibitory effect on plumule (PL) and radicle (RL) length of the three recipient species under all concentration levels, which support the previously documented GP implications. However, RL appeared more sensitive to extracts than was PL. These results are in agreement with the declaration that water extracts of allelopathic plants generally have more pronounced effects on radicle, rather than plumule growth (**Turk and Tawaha 2002; Ashrafi *et al*., 2007; Mohammad *et al* 2011**). This may be attributable to the fact that radicle have direct contact with soil and can absorb many allelochemicals. As for as, plumule and radicle length was similar results concerned to germination efficiency in the studied species. In addition, the present experiment used the two parameters of the plumule and radicle growth to test the allelopathic potential of the two weeds (*Bromus tectorum* and *Melilotus indica*) and the crop (wheat) .The elongation of the hypocotyl or coleoptiles can be used in conjunction with germination percentage. Growth bioassays are often more sensitive than germination bioassays (**Bhowmik and Doll, 1984**). Fuentes *et al*. (**2004**) observed that seed germination has been regarded as a less sensitive method than plumule and radicle length when used as a bioassay for the evaluation of phytotoxicity**.**

El-Darier and Youssef (**2000**) stated that there was an increase in plumule growth rate of *Lepidium sativum* till 50% alfalfa extract after five days of experiment. Ilori *et al*. (**2007**) declared that leachates from plants have been shown to suppress early seedling growth. Inhibition of wheat (*Triticum aestivum*) radicle growth was positively associated (r=0.66) with concentrations of total phenolics contained in sorghum (*Sorghum bicolor*) plant parts (**Ben-Hammouda *et al.*, 1995)**. Aqueous extracts of four native shrubs of the Mexican desert (*Sicyos deppei, Accacia sedillense, Sebastiania adenophora and Lantana camara*) reduced root growth of *Zea mays*, *Phaseolus vulgaris*, *Cucurbita pepo* and *Lycopersicon esculentum* (**Romero-Romero *et al*., 2002**).

The suppressive influence of radicle growth may be explained by the existence of allelochemicals, which has been documented for their suppressive effect in *Eucalyptus* leaf aqueous extracts such as terpenes, phenyle propanoids, quinones, coumarin, flavonoids,

tannins, phenolic acids, glycosides and cynogenins (**Einhellig, 1986**) which reduced the percentage of germination and radicle growth of *Raphanus sativus* seedling (**Calegare *et al*., 1991**).Hill *et al*. (**2007**) explicated that corn and cucumber radicle elongation was stimulated at low concentrations of the methanol and ethyl acetate extracts of hairy vetch (*Vicia villosa*) and cowpea (*Vigna unguiculata*) residues extracts. The aqueous extract of leaves showed strong phytotoxicity in terms of radicle and hypocotyl growth inhibition. Both radicle and hypocotyl growth of the tested plants decreased proportionally with the increasing concentration of aqueous leaf extract the parameters assessed, root growth was generally slightly more sensitive than shoot growth to the presence of phytochemicals in aqueous extracts. (**Iqbal *et al*., 2006**).

Chon *et al.* (**2002**) mentioned that some plants root tip growth nearly inhibited to escape from allelochemicals absorption. Nevertheless Sing *et al*. (**2003**) found that aqueous leaf leachates of *E. citriodora* inhibited seed germination and seedling growth of vigna species and elongation of plumule more suppressed than radicals. These results are in contradiction with results observed in wheat radicle elongations. High concentrations of allelochemicals caused more reduction of root elongation than leaves. *Eucalyptus* leaf extracts stimulate the peroxidase activity in both roots a first leaves in all three wheat cultivars and root enzymes are more stimulated than leaves because of direct contact with Allelochemicals present in rooting medium. Allelochemicals absorbed by plant cells should be detoxified (**Rice, 1984**). The inhibitory effect was more on radicle than on plumule length. Radicle length reduced significantly in response to all the *Tagetes minuta* extracts, except 1% root and stem extracts (**Batish *et al,* 2007a)**

2. Effect of donor species crude powder on some growth parameters of the recipient species (Pot Experiment).

The crude powder of different donor plants mixed (w/w) with clay and sandy soils (collected from control locations) affect some growth parameters like shoot length, root length, number of leaves and shoot and root dry weight of *Bromus tectorum, Melilotus indica* and wheat. The effect was, in general, more severe on the tow weedy plant compared to the crop. Among the different donor plants, effect depending on the type of donor species and on the extract concentration.

Generally, under the present study, the growth parameters of all the three recipient species were significantly decreased with the increase of each of the eight donor species crude powder concentration levels regardless soil type. On the other hand, shoot (SL) and root length (RL) of the two recipients species were significantly decreased with the increase in treatment concentrations under clay and sandy soil.

Leaf and root lengthening inhibited effectively. Similar results obtained by Khan *et al*. (**1999**) on wheat and maize and also in many similar studies with eucalyptus. Shoot and root growth with more inhibitory effect on roots, this may be due to direct contact of roots with these extracts. Other workers reported similar finding through their work on weed and crop species (**Bhowmik and Doll, 1984; Issa, 1996**). Reduction in shoot and root growth may be due to the effect of certain allelochemicals on cell division and elongation ,resulted in a short root system and small shoot growth. Allelochemicals presented in aqueous extract of different plant species have been reported to affect different physiological processes through their effects on enzymes responsible for plant hormone synthesis and were found to associate with inhibition of nutrients and ion absorption by affecting plasma membrane permeability (**Qasem and Foy, 2001; Qasem and Hassan, 2003**). The inhibitory or stimulatory effects of leachates may be due to certain chemicals released from foliage parts including allelochemicals, amino acids, carbohydrates and phytohormones (**Tukey, 1969**). Incorporation of dried shoot residues of certain medicinal species in the soil showed varied effects on weed seed germination and seedlings growth, depending on source of residue used and weeds tested (**Qasem and Hassan, 2003**).

In general, plant growth inhibition have been attributed to inhibitory chemicals released from decomposing residues which was compatible with results reported by other researchers (**Putnam and Duke, 1978; Toai and Linscott, 1979**) or by leaching of toxic materials from the residue to the soil (**Mersie and singh, 1988**).The inhibitory effect on germination of weeds sown in soil containing plant residues might be due to leached chemicals from plant materials at the early stage of germination. (**Qasem and Hassan, 2003**). Lehman *et al*. (**1987**) observed that after introducing the same amount of particular allelochemical to different types of soil, the amount recovered were not the same. Kuiters and Denneman (**1987**) reported similar findings for phenolic compounds in sandy and clay soils. They discovered that higher amounts of allelochemicals were extractable from sandy soils than from clay soils. Oleszek and Jurzysta (**1987**) concluded that heavy soils adsorb more allelochemicals than sandy soils.

Experimental findings have reported that all donor species crude powder concentrations were suppressing to length (SL), root length (RL), fresh and dry weight of shoot and root (SFw, RFw, SDw and RDw, respectively and the leaf number (LN)) in both soil types and caused a gradual reduction particularly when they are high. However, the reduction degree was varied and species, concentration dependent. The suppressive effect of all the eight donors on the two weedy species was in the following order *Bromus tectorum> Melilotus indica.* In clay soil *Retama retam* crude powder had the greatest allelopathic potential at all concentrations while *Pituranthos chloranthus* had the lowest effect on *Bromus tectorum* while, in sandy soil *Zygophyllum album* crude powder had the greatest allelopathic compared to *Ephedra alata* extract on the other hand, on *Melilotus indica* in clay soil *Zygophyllum album* crude powder more allelopathic than *Euphorbia guyoniana* had the lowest effected besides in sandy soil the *Euphorbia guyoniana* had the best allelopathic than to *Ephedra alata* had the diffident effected. This reduction may be attributed to the presence of allelochemicals in the crude powder. In the present study, the inhibitory effects of the allelopathic treatments on fresh and dry weights of root and shoot as well as leaf number were almost alike in the two recipient species and may be related to the inhibition of cell division and/or cell expansion (**Javaid and Anjum, 2006**).

Del Moral and Muller (**1970**) found that extracts from *Eucalyptus camaldulensis* reduced radicle growth of *Bromus rigidis* more in loamy soil than in sandy one. They suggested that the loam has greater retention capacity than the sand for water-soluble phenolic compounds from litter of *E. camaldulensis*, allowing the allelochemicals to build physiologically active concentrations. Pine (*Pinus resinosa* and *P. strobus*) growth was inhibited more by adjacent walnut trees (*Juglans nigra*) in poorly drained soils in southwestern Ontario (**Fisher, 1987**). Jimsonweed (*Dataura stramonium*) exhibited more allelopathic activity on sunflower (*Helianthus annus* L.) in a soil having only 5% clay, than in a soil having 50% clay (**Levitt and Lovett, 1984**). Chou and Lin (**1976**) found the aqueous extracts of decomposing rice residues in soil contained five phenolics and several unknown compounds and that extracts inhibited the radicle growth of lettuce and rice seeds and the growth of rice seedlings.Burgos and Talbert (**2000**) they studied the differential activities of allelochemicals from rye (*Secale cereale*) in seedling bioassays. They stated that on average DIBOA [(2,4-dihydroxy-1,4-benzoxazine-3-one] was seven times more inhibitory to root growth and four times more inhibitory to shoot growth than BOA Same researchers reported that radicle length was more sensitive to aqueous extracts than seed germination or

hypocotyle length. An analogous work was conducted to determine the allelopathic effect of *Parthenium hysterophorus* extracts on seed germination and seedling growth of lettuce, it was reported that lettuce roots are more sensitive to the allelochemicals than shoot (**Wakjira *et al.*, 2005**).Sunflower was conducted in a greenhouse and laboratory experiment for its allelopathic effect on germination and growth of Wild Barely (*Hordeum spontaneum*); radicle length appeared more sensitive to allelochemicals than was hypocotyle length (**Ashrafi *et al.*, 2008**). The results are also in agreement with the finding that water extract of allelopathic plants generally have more pronounced effect on radicle rather than hypocotyl growth (**Chung and Miller, 1995; Turk and Tawaha, 2002**). Comparatively, PL of both broad bean and maize plant suffered more reduction relative to their radicle. Evidently, Siddiqui (**2007**) found that the allelopathic effect of black pepper was evident on shoot growth with increasing the concentrations than root growth of *Vigna mungo*.

In many studies, it was found that root growth was more inhibited than shoot growth (**Inderjit and Dakshini, 1995**). In a study of herbicidal effects of aqueous root and shoot extracts of three allelopathic crops, sunflower, sorghum and rice were evaluated against germination and growth of the noxious alien weed *Parthenium hysterophorus* L. It was indicated insignificant effects on shoot length and seedling biomass while germination and root length were significantly reduced by extracts of all the test crops (**Javaid *et al.*, 2006**). On the other hand, root growth is sensitive to autotoxic chemical at law concentrations, more so than hypocotyl growth and seed germination (**Chon *et al.*, 2000 & 2003**).

In the present investigated species, growth parameters was obviously higher illustrating better results in sandy soil than the clay soil, It was reported that extracts made from alfalfa top growth containing the autotoxic chemical passed more rapidly through leaching columns of sandy soil than through columns containing silty clay loam (**Jennings and Nelson, 1998**) Forest research provides suggestions for how allelopathy might work in urban soils. Juglone toxins from black walnut trees inter-planted with red and white pines caused a severe dieback or mortality of the pines on sites with poorly drained (**Fisher, 1987**) or clay soils (**Rietveld, 1982**).Rietveld *et al.* (**1983**) found that elongation and dry weight accumulation of root was less affected than the shoot by juglone in plant species. This discrepancy may be partly due to the differential response of various plant species to the juglone treatments.

In the present study, the inhibitory effects of the allelopathic treatments on elongation and dry weights of root and shoot were almost alike in the three investigated species. Baziramakenga *et al*. (**1994**) found that allelochemicals reduced the number of lateral roots, root and shoot dry biomass of soybean.

Terzi *et al*. (**2003**). The authors emphasized that the dry weights of root and stem of cucumber seedlings was influenced negatively by decomposed walnut leaves and juglone, depending on the concentration. There is similarity between root and stem elongations; in several pervious studies, it was determined that juglone and walnut leaf extracts decreased cucumber dry weights. Drost and Doll (**1980**) concluded that extracts and residues of *Cyperus esculentus* have an inhibitory effect on the growth of soybean and maize. At constant residue concentration, increasing the percentage of sand in the soil reduced the growth of corn and soybeans. Though all the bioassay species were suppressed some of them showed better performance (**Ahmed *et al.*, 2008**). It is interesting to note that *Avena fatua* is important weed of wheat, where its germination is reduced to 11% by senna mulching, while the same treatment is affecting germination of wheat by 20%, but at the same time contributing positively to crop plants shoot length, root length, root biomass and number of leaves. If wheat germination is compensated by using higher seed rate, it is possible to smother out the few poorly growing weed plants, enabling to develop an integrated weed management approach using allelopathic potential of senna. However, this study needs further evaluation at field level (**Hussain et al, 2007)**.Zimdahl and Stachon (**1980**) who found the ethanol extractsof *Cirsium arvense* (Canada thistle) more inhibitory to cucumber (*Cucumis sativis*) roots than to hypocotyls. The distinction between dicotyledonous and monocotyledonous species was less clear in shoot and root tests than in germination tests.Significant reductions in the germination and growth of the roots and shoots were observed as the extract concentration increased. The results are in agreement with previous investigations in that the activity of either water-extracts or weed residues was directly related to the concentration of the residue rates (**Chung and Miller, 1995a; Babu and Kandasanmy, 1997; Caussanel, 1979**). Recently, Javaid *et al.* (**2004**) showed a reduction in germination and growth of *P. hysterophorus* by aqueous extracts of allelopathic grass *Desmostachya bipinnata.* Similarly germination and growth suppression of *P. hysterophorus* due to aqueous extracts of three allelopathic grasses namely *Dicanthium annulatum, Cenchrus pennisiformis* and *Sorghum helepense* have been reported by Javaid and Anjum (**2005**).

Earlier works have also reported that foliar leachates of *Parthenium hysterophorus* reduced root and shoot elongation of *Oryza sativa* and wheat (**Singh and Sangeeta**, **1991**). Maize and soyabeans (**Bhatt *et al.* 1994**) as well as some common Australian pasture grasses (**Adkins and Sowerby 1996**). The extract had strong inhibitory effect to root elongation of seedling in cereals and to shoot elongation in crucifers and wild Asteraceae. Leaves of *Parthenium hysterophorus* may be a source of natural weedicide against *Ageratina adenophora* which will help to control invasive plants. Residues and extracts of cover crops were found to cause allelopathic suppression of certain weed species. These data suggest that a properly managed cover crop may be utilized as an additional component in weed management strategies for no-till cropping systems (**White et al., 1989**). water and methanolic extracts, had negative impact on weed germination through this mechanism. According to Williams *et al* (**1998**), cover crop residues affect weed suppression. In the presence of *Trifolium subterraneum* residues, weed biomass or density was reduced for *Amaranthus retroflexus*, *Lolium perenne* and *Sinapis arvensis*. Dyck and Liebman (**1994**) found that time to 50% emergence of *Amaranthus* was delayed 3.4 day in the presence of soil-incrporated Crimson clover residue. Crimson and subterraneum clovers have previously been shown to inhibit weed growth and germination and allelopathy was implicated as the cause (**Lehman and Blum, 1997**). The presence of allelochemicals like phenolic acids in the clover biomass may be the reason for poor germination of the weeds (**Challa and Ravindra, 1998**). Qasem (**1995**) confirmed the harmful effect that clover species imposed on weed species and the ecological significance of such effects. Allelopathy through the production and activity of allelochemicals play a major role in weed dynamics (**Challa and Ravindra, 1998**).Seed aqueous extract of *Nigella sativa* exerted inhibition effects on germination and seedling growth of *Vigna radiata*. Severe toxicity was observed at high concentration and moderate toxicity at low concentrations in comparison with water control. There by *Nigella sativa* seed may contain some toxic substance(s) that inhibits germination and seedling growth of *Vigna radaita*. Aqueous extract of some plant species may contain some toxic substances (**Habib and Abdul Rehman, 1988**). These substances probably inhibit the germination and seedling growth of other plants species (**Al-Charachafchi *et al.*, 1987**), which was due to their interference with indol acetic acid metabolism, or synthesis of protein and ions uptake by the plants (**Hussain and khan, 1988**). These phenolics inhibit the germination and seedling growth of same plant species or others by their effects on metabolic processes of germination and growth (**Castro *et al.*, 1984**).

Active allelochemicals present in leaf extract of eucalyptus are commonly phenolics (**Ballester *et al.*, 1989**) that show inhibitory effects on germination and growth of wheat cultivar seedlings. These results are in agreement with those obtained by El-Khawas and Shehata(**2005**) with very similar method of extraction on in seed germination and growth of bean and maize. Similar results have been obtained from different eucalyptus species on seed germination of plants effects of Eucalyptus globulous on germination and growth of maize, bean and potato (**Malik, 2004**).

3. Conclusion

Based on the results of this study:

1- The species with the strongest allelopathic potential such as *Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata* must be examined for their selective action on other specific plants including weeds and crops under field conditions, their allelopathic activity will be much more detailed.

2- Analysis of possible allelochemicals in these plants is also required. The isolation and characterization of growth inhibitors, which might be responsible for the strong allelopathic potential of these species is needed. There is possibility of using these allelochemicals directly or as structural leads for the discovery and development of environment friendly herbicides to control weeds.

SUMMARY

SUMMARY

The present study aimed to investigate the potential allelopathic effects of *Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* and *Ephedra alata* aqueous extract and crude powder on germination efficiency and some growth parameters of two weeds (*Bromus tectorum* and *Melilotus indica*) and one crop species (*Triticum aestivum*) under laboratory conditions.

The present work tries to explore the possibilities of using one or more of the donor species as bioherbicides. To accomplish this work, samples of fresh aerial shoots of the donor plants have been collected from three different areas of the basin of Ouargla. The seeds of two weedy species (*Bromus tectorum* and *Melilotus indica*) were collected locally from some wheat fields in the farm of Technical Institute of Development and Agriculture Saharan in Hassi ben Abdullah while The grains of the one crop species; wheat (*Triticum aestivum* L. var sahel 1) was obtained from the Agricultural Research Center, Giza, Egypt, Seven days- Petri-dish laboratory experiment was applied to investigate the allelopathic action of donor species aqueous extract (2.5, 5, 7.5 and 10%) on germination percentage (GP), seed germination index (SGI), germination inhibition percentage (GIP) and plumule (PL) and radicle (RL) length of the recipient species (*Bromus tectorum* and *Melilotus indica*) and one crop species *(Triticum aestivum*). A parallel pot bioassay was carried out to test the effect of different concentration levels of donor species crude powder 1, 3 and 6% (w/w) on some growth parameters (shoot length (SL), root length (RL), fresh and dry weight of shoot and root (SFw, RFw, SDw and RDw, respectively and the leaf number (LN)) of the two weedy species; *Bromus tectorum* and *Melilotus indica* and one crop species*; Triticum aestivum*. The influence of soil type (clay and sandy) was also estimated. Harvesting was approved one month (30 days) after initiation.

Results suggested that the aqueous extracts of the donor species were reported to inhibit the seed germination of both the weeds and crop species and the inhibition was more significant in the first compared with the latter. Among the different donor plants, the effect was depending on type of donor species and on extract concentration. The degree of seed germination inhibition was enhanced increasing the concentration. Germination reductions ranged between zero and 100% at the higher concentrations. The allelopathic effect of the donor species on *Bromus tectorum* in pure culture was ranked as follows: *Artemisia herba-*

alba > Haloxylon scoparium and Oudneya africana > Euphorbia guyoniana > Pituranthos chloranthus> Zygophyllum album> Ephedra alata > Retama retam while in mixed culture the effect was classed as follows *Artemisia herba-alba > Ephedra alata> Euphorbia guyoniana> Haloxylon scoparium> Pituranthos chloranthus> Oudneya africana> Zygophyllum album> Retama retam*. On the other hand, The effect the donor species on *Melilotus indica in* pure culture was ranked as follows: *Artemisia herba-alba> Ephedra alata> Retama retam* and *Oudneya africana > Zygophyllum album* and *Haloxylon scoparium > Euphorbia guyoniana > Pituranthos chloranthus* while in mixed culture the effect of donor classed as *Zygophyllum album and Artemisia herba-alba > Euphorbia guyoniana, Pituranthos chloranthus and Oudneya africana> Retama retam > Haloxylon scoparium* and *Ephedra alata*. Germination percentage (GP) seed germination index (SGI), germination inhibition percentage (GIP) of the tow investigated recipient species demonstrated a gradual decrease with applying higher concentrations of the donor species as follows: *Bromus tectorum >Melilotus indica*.

The germination percentage, plumule and radicle length of *Bromus tectorum* in mixed culture was completely inhibited at the highest concentration of aqueous extracts of the donor species level (10%). the two recipient species exerted weak measures as affected by the highest concentration level of all donors in pure culture. This inhibition was markedly in obvious *Bromus tectorum* than in *Melilotus indica* indicating that *Bromus tectorum* is more sensitive to all of tested donors, while the *Melilotus indica* is more adapted to the aqueous extract than the *Bromus tectorum*. The aqueous extracts of all the donor species exhibited inhibitory effect on plumule (PL) and radicle (RL) length of the two recipient species under all concentration levels, which support the previously documented GP implications. However, RL appeared more sensitive to extracts than was PL.

Experimental of pots findings have reported that all donor species crude powder concentrations were suppressing to Shoot length (SL), root length (RL), fresh and dry weight of shoot and root (SFw, RFw, SDw and RDw, respectively and the leaf number (LN)) in both soil types and caused a gradual reduction particularly when they are high. However, the reduction degree was varied and species, concentration dependent. The suppressive effect of all the eight donors on the two weedy species was in the following order *Bromus tectorum> Melilotus indica.* But, the effect was more prominent on weeds than crop species (*Triticum aestivum*)**.**

In clay soil *Retama retam* crude powder had the greatest allelopathic potential at all concentrations while *Pituranthos chloranthus* had the lowest effect on *Bromus tectorum* even as, in sandy soil *Zygophyllum album* crude powder had the greatest allelopathic compared to *Ephedra alata* crude powder on the other hand, on *Melilotus indica* in clay soil *Zygophyllum album* crude powder more allelopathic than *Euphorbia guyoniana* had the lowest effected, besides in sandy soil the *Euphorbia guyoniana* had the best allelopathic than to *Ephedra alata* had the diffident effected.

Generally, the growth parameters of two recipient species were significantly decreased with the increase of each of the eight donor species crude powder concentration levels. Concerning the type of sol the t- test indicated that the difference was insignificant between clay and sandy soils. Evidently, the variant response to the allelopathic substance could be related to the species specific growth regulatory effect of allelochemicals and concentration dependent.

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ARABIC & FRENCH SUMMARY

الخلاصة

تهدف هذه الدراسة إلى التعرف علي التأثيرات الكيميائية التضادية (الأليلوباثية) للمستخلصات المائية و المسحوق الجاف للمجموع الخضرى لنبات *Pituranthos chloranthus, Retama retam, Euphorbia guyoniana, Zygophyllum album* , *Oudneya africana, Artemisia herba-alba,Haloxylon scoparium* و*Ephedra alata* (الانواع المانحة) على نسبة الإنبات ونمو البادرات لاثنين من الحشائش الضارة وهما (*Bromus tectorum* و*Melilotus indica*) ونوع واحد من المحاصيل الحقلية و هو القمح اللين (*Triticum aestivum*) (الانواع المستقبلة) وذلك تحت الظروف المعملية فى محاولة لإمكانية إستخدام نبات واحد أو أكثرمن هذه الأنواع المانحة كمبيدات حيوية للأعشاب.

لإنجاز هذا العمل ، قد تم جمع عينات الجزء الخضري الغضة من النباتات المانحة من ثلاث مناطق مختلفة من حوض ورقلةاما بالنسبة لبذور الأعشاب الضارة (*Bromus tectorum* و*Melilotus indica*) فقد جمعت محليا من بعض حقول القمح في المعهد التقني للتنمية الفلاحة الصحروية بحاسي بن عبد الله. كما تم الحصول على بذور القمح اللين (*Triticum aestivum*) من مركز البحوث الزراعية بالجيزة , مصر .

أجريت التجربة المعملية الأولى بالاستعانة بأطباق" بترى" و امتدت لمدة سبعة ايام لمعرفة تأثير المستخلص المائى للانواع المانحة على اختلاف تركيزاتها (5,2.5 ,7.5و 10%) على النسبة المئوية للإنبات، نسبة التثبيط ، سرعة الانبات و طول الجذير والريشة للنوعين من الأعشاب الضارة (*Bromus tectorum* و*Melilotus indica*) و نوع واحد من المحصول (*Triticum aestivum*).

كما أجريت تجربة أخرى باستخدام الأصيصات لدراسة تأثير المسحوق الجاف للانواع المانحة بتركيزات1 ,3 ,6 % على بعض معايير النمو (طول الساق ، طول الجذر ،الوزن الرطب والجاف للساق والجذر وعدد الاوراق) للنوعين من الأعشاب الضارة (*Bromus tectorum* و) *Melilotus indica* و نوع واحد من المحصول (*Triticum aestivum*). والجدير بالذكر أن هناك أيضا اختبار لمعرفة مدى ارتباط هذه الظاهرة الأليلوباثية بنوع التربة، وقد عمد فى ذلك إلى استخدام نوعين من التربة وهي التربة الطينية والتربة الرملية.وقد تم الحصاد بعد مضى شهر(ثلاثين يوما) من بداية التجربة، وتم بعد ذلك تسجيل النتائج وتحليلها إحصائياً.

اظهرت النتائج ان المستخلصات المائية للنباتات المانحة كان لها تأثير مثبط على نسبة انبات كل من بذور الاعشاب الضارة اكثر من بذور المحصول (القمح) حيث ان التثبيط كان اكثر فعالية عند الاول عنه عند التالي .بإختلاف النباتات المانحة التأثير كان مختلف بحسب النوع النباتي وكذلك تركيز المستخلص المائي . اما نسبة ثبيط البذور المنبتة فقد ارتفعت بارتفاع التركيز حيث ان تراوحت نسبة التثبيط من 0الى 100 % عند التراكيز العالية , ان التأثير التضادي للنباتات المانحة على نبات *Bromus tectorum* في الزراعة النقية قد صنف حسب الترتيب التالي: *<Euphorbia guyoniana < Oudneya africana، Haloxylon scoparium<Artemisia herba-alba* *Ephedra alata< Zygophyllum album<Pituranthos chloranthus* واخيرا *Retama retam* بينما في الزراعة المختلطة الثأثير صنف كالاتي: *<Euphorbia guyoniana < Ephedra alata<Artemisia herba-alba* *Zygophyllum album< Oudneya africana< Pituranthos chloranthus<Haloxylon scoparium* وفي الاخير *Retama retam* .

من ناحية اخرى تأثير الانواع المانحة على *Melilotus indica* في الزراعة النقية ترتب كالتالي : *<Artemisia herba-alba* *Haloxylon* و *Zygophyllum album< Oudneya africana، Retama retam<Ephedra alata* *Euphorbia guyoniana<scoparium* في الاخير *Pituranthos chloranthus* بينما في الزراعة المختلطة تم ترتيب تأثير الأنواع المانحة كمايلى: *Euphorbia guyoniana < Artemisia herba- alba، Zygophyllum album,* *Pituranthos chloranthus* و *Retama retam < Oudneya africana* اخيرا *Haloxylon scoparium* و *Ephedra alata* .

اوضحت التجارب بان نسبة الانبات وسرعته ونسبة التثبيط الانبات للنباتين المستقبلين (الاعشاب الضارة) قد تناقصت بزيادة تراكيز المستخلصات للنباتات المانحة حيث ان *Bromus tectorum* كان اكثر تأثر من *Melilotus indica* .نسبة الانبات وطول الريشة وجذيرعند *Bromus tectorum* في الزراعة المختلطة تم تثبطهم كليا عند التركيز العالي للمستخلص المائي للنباتات المانحة (10%) ,

من ناحية اخرى تبين بان الجذير اكثر تأثر من الريشة.بالنسبة للزراعة النقية فان النباتين المستقبلين قد تاثرا بالتراكيز العالية لكل النباتات المانحة ,هذا التاثير كان واضح عند *Bromus tectorum* اكثر من *Melilotus indica* حيث توضح بان *Bromus tectorum* حساس جدا لكل النباتات المانحة المدروسة في حين ان *Melilotus indica* اكثر تاقلم للمستخلصات النباتية المستعملة .

اما بالنسبة لنتائج تجارب الاصص فقد افادت بان تراكيز المسحوق الجاف لجميع الانواع المانحة كان لها تأثير على طول الساق والجذور وكذلك على الوزن الرطب والجاف للساق والجذور بالاضافة الى عدد الاوراق في كل من التربة الطنية والرملية حيث ازداد التناقص بزيادة التراكيز, كمان ان نسبة التناقص اختلفت بإختلاف الأنواع النباتية المانحة وتراكيزها التأثير التثبيطي للانواع المانحة الثمانية على الاعشاب الضارة كان كالتالى : *Melilotus indica*<*Bromus tectorum* .

في التربة الطينية المسحوق الجاف *Retama retam* كان له فعل اليلوباثي في كل التراكيز المستعملة , بينما المسحوق الجاف *Pituranthos chloranthus* كان اقل تأثير على *Bromus tectorum* بينما في التربة الرملية المسحوق الجاف *Zygophyllum album* كان له فعل اليلوباثي مقارنة بالمسحوق الجاف *Ephedra alata* الذي كان اقل تأثير, من ناحية اخرى وفي التربة الطنية كان للمسحوق الجاف *Zygophyllum album* اكثر فعل اليلوباثي من المسحوق الجاف *Euphorbia guyoniana* الذي كان اقل تأثيرا على *Melilotus indica* في حين ان المسحوق الجاف *Euphorbia guyoniana* كان له فعل اليلوباثي اكثر من المسحوق الجاف *Ephedra alata* الذي كان اقل تأثير في التربة الرملية.

من الدراسة اتضح بان معايير النمو لكل من النباتين المستقبلين كان تناقصها معنوى مع تزايد تركيز المسحوق الجاف للنباتات المانحة اما بالنسبة لتاثير نوع التربة فان اختبار t بين بانه لا يوجد فرق معنوي بين التربة الطينية والرملية . واخيرا فان الاختلاف في الاستجابة الي المواد الليولوباثية يعود اما الى الاختلاف في تأثير المواد الكيميائية التضادية وكذلك تركيزها وكذلك الى النوع النباتي المستقبل .

واخيرا نوصي بضرورة اجراء دراسات أوسع وأكثر تفصيلا للانواع النباتية المانحة ذات التأثير الأليلوباثي واختبار تأثيرها على أنواع نباتية أخرى تشمل المحاصيل والحشائش تحت ظروف الحقل، والحاجة الى فصل والتعرف على مثبطات النمو التى قد تكون مسئولة عن التأثير الأليلوباثي لهذه الانواع، ودراسة امكانية استخدام هذه المركبات الأليلوباثية اما بطريقة مباشرة أو بمعرفة تراكيبها الكيميائية و محاولة اكتشاف وتطوير مبيدات للحشائش أمنة بيئيا.

SOMMAIRE

La présente étude visait à étudier les effets potentiels allélopathique du *Zygophyllum album, Euphorbia guyoniana, Retama retam, Pituranthos chloranthus, Haloxylon scoparium, Artemisia herba-alba, Oudneya africana* et *Ephedra alata* extrait aqueux et poudre sec sur l'efficacité de germination et de certains paramètres de croissance de deux mauvaises herbes (*Bromus tectorum* et *Melilotus indica*) et une espèce de culture (*Triticum aestivum*) sous les conditions de laboratoire

Le présent travail essayer d'explorer les possibilités d'utiliser une ou plusieurs des espèces donateurs comme bioherbicides. Pour accomplir ce travail, des échantillons partie aériennes fraîches des plantes donateurs ont été recueillies auprès de trois régions différentes du bassin de Ouargla. Les graines de deux espèces de mauvaises herbes (*Bromus tectorum* et *Melilotus indica*) ont été collectés localement à partir de certains champs de blé dans la ferme de l'Institut Technique du Développement et de l'Agriculture Saharienne à Hassi Ben Abdallah tandis que les grains de la seule espèce de culture; blé tendre (*Triticum aestivum* L. var Sahel 1) a été obtenu à partir de Center de Recherche Agricultural, à Gizeh, en Egypte, L`expérience de laboratoire- a été appliquée au boîte de Pétri pendent sept jours pour étudier l`effet allélopathique des différents concentrations de l`extrait aqueux (2,5, 5, 7,5 et 10%) des espèces donneuse sur le pourcentage de germination (GP), l'indice de germination des graines (SIG), pourcentage d'inhibition de germination (GIP) et la longueur plumule (PL) et radicule (RL) de mauvaises herbes (*Bromus tectorum* et *Melilotus indica*) et une espèce de culture (*Triticum aestivum*). Un bio-essai des pots a été menée en parallèle pour tester l'effet des différents niveaux de concentration de poudre sec 1, 3 et 6% (w / w) des espèces donateurs sur certains paramètres de croissance (longueur de partie aérienne (SL), racines (RL), poids frais et sec de partie aérienne et des racines (SFW, RFW, SDW et RDW, respectivement, et le nombre de feuilles (LN)) des deux espèces de mauvaises herbes; *Bromus tectorum* et *Melilotus indica* et une espèce de culture (*Triticum aestivum*). également été estimée l'influence du type de sol (argileux et sableux)sur l'effet allélopathique . La récolte a été approuvée un mois (30 jours) après l'initiation.

Les résultats suggèrent que les extraits aqueux des espèces donneuse ont été signalés à inhiber la germination des graines de mauvaises herbes et les espèces de cultures et de l'inhibition est plus importante dans le premier rapport à ce dernier. En estimée que la différence entre les effets des plantes donneurs a été meniez, selon le type d'espèces donneurs et la concentration d'extrait. Le degré d'inhibition de germination a été augmente en

augmentant la concentration. L` inhibition de germination varie entre 0 a 100% pour les concentrations plus élevées.

L'effet allélopathique des espèces donneurs sur *Bromus tectorum* en culture pure a été classée comme suit: *Artemisia herba-alba> Haloxylon scoparium* et *Oudneya africana> Euphorbia guyoniana> Pituranthos chloranthus> Zygophyllum album> Ephedra alata> Retama retam* et en culture mixte de l'effet a été classés comme suit *Artemisia herba-alba> Ephedra alata> Euphorbia guyoniana> Haloxylon scoparium> Pituranthos chloranthus> Oudneya africana> Zygophyllum album> Retama retam*. D'autre part, l'effet de l'espèce donneurs sur *Melilotus indica* en culture pure a été classée comme suit: *Artemisia herba-alba> Ephedra alata> Retama retam* et *Oudneya africana> Zygophyllum album* et *Haloxylon scoparium> Euphorbia guyoniana> Pituranthos chloranthus* puis en culture mixte l'effet des plantes donneuse sont classés comme suivent *Zygophyllum album* et *Artemisia herba-alba> Euphorbia guyoniana, Pituranthos chloranthus* et *Oudneya africana> Retama retam> Haloxylon scoparium* et *Ephedra alata*. Le Pourcentage de germination (GP) l'indice de germination des semences (SIG), pourcentage d'inhibition de germination (GIP) de l'espèce receveuse de étude a démontré une diminution progressive des concentrations plus élevées avec l'application de l'espèce donneuse comme suit: *Bromus tectorum> Melilotus indica*.

Le pourcentage de germination, longueur plumule et la radicule du *Bromus tectorum* en culture mixte a été complètement inhibée au niveau de maximale concentration des extraits aqueux de les espèces donneurs (10%). les deux espèces bénéficiaires ont été affectée par le niveau de concentration le plus élevé de tous les donateurs en culture pure. Cette inhibition a été marquée en *Bromus tectorum* évident que dans *Melilotus indica* indiquant que *Bromus tectorum* est plus sensible à l'ensemble des donneurs testés, tandis que les indicateurs *Melilotus indica* sont plus adapté à l'extrait aqueux que le *Bromus tectorum*. Les extraits aqueux de toutes les espèces exposées donateurs a un effet inhibiteur sur la longueur de plumule (PL) et radicule (RL) des deux bénéficiaire espèces en vertu tous les niveaux de concentration, qui soutiennent les implications de GP précédemment averti. Toutefois, RL semblé plus sensibles aux extraits que le PL.

Les résultats expérimentaux des pots ont signalé que toutes les concentrations de poudre des espèces donneurs ont été supprimant la longueur de partie aérienne (SL), et des racines (RL), et le poids frais et sec de partie aérienne et des racines (SFW, RFW, SDW et RDW, respectivement, et le nombre de feuilles (LN)) dans les deux types de sol et a entraîné

une réduction progressive surtout quand ils sont élevés. Cependant, Le degré de réduction des espèces a été varié, dépendant de la concentration.

L'effet suppressif de l'ensemble des plantes donateurs sur les deux espèces de mauvaises herbes a été dans l'ordre suivant *Bromus tectorum*> *Melilotus indica*. Dans sol argileux le poudre *Retama retam* eu le plus grand potentiel allélopathique à toutes les concentrations et chez *Pituranthos chloranthus* avait le plus faible effet sur *Bromus tectorum*, tandis que dans le sol sableux de poudre de *Zygophyllum album* a eu le plus effet allélopathique par rapport à *Ephédrine alata* sur un autre côté, le *Melilotus indica* dans le sol argileux le poudre de *Zygophyllum album* plus allélopathique que *Euphorbia guyoniana* avait effectué le plus bas, en plus dans le sol sableuse *guyoniana Euphorbia* a eu la meilleure effet allélopathique que *Ephedra alata*.

Généralement, les paramètres de croissance de deux espèces de bénéficiaires ont été significativement diminués avec l'augmentation de chaque niveau de concentration de poudre des espèces donneuses. Concernant les types de sol le test -t indique que la différence était non significatifs entre le sol argileux et sableux. Evidemment, la variation de réponse de la substance allélopathique pourrait être lié a l`effet allélochimique, leur concentration et a les espèces réceptrices.