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Full Length Research Paper

Evaluation of allelopathic potential of some selected medicinal species

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Laboratory trials were made to evaluate the allelopathic potential of selected medicinal species. The aqueous extracts bioassay on two test plants (wheat and pea) was carried out through filter paper method. Toxicity and non toxicity was assessed by recording their effects on germination and percentage growth of radicle and plumule of test plants. The trials were replicated three times in Randomized Complete Split Block Design. The data was analyzed by using software SPSS v II. The results suggested that *Sonchus asper* and *Melilotus officinalis* stimulate the growth of wheat (*Triticum aestivum*) up to 150% of plumule and 40% of radicle. These species had significantly enhanced effect on the percentage growth of test plant. The inhibitory effect was more on the wheat, by aqueous extractions of *Sisymbrium irio, Cannabis sativus* and *Oxalis corniculata.* The growth of wheat was more enhanced in the aqueous extractions of *Gallium aperine* and *Ageratum conizoides*, almost 150% of radicle. But the most inhibitory and retarded effect was observed in case of *S. irio, O. corniculata, Rumex dentatus* and *Parthenium hysterophorus.*

Key words: Allelopathy, medicinal species, filter paper.

INTRODUCTION

Hundreds of medicinal plant species are being used in modern medicines. They have been used as remedy for different diseases e.g. fever, malaria, cough, flu, asthma, colds, chest diseases, skin itch, acne, headache, jaundice, nausea, ulcer, tumors, typhus, stomach pain, heart attack, chills, inflammation, herpes, hepatitis, swelling, etc (Ishaque and Shahni, 1998). Most of them have been collected from wild sources. There is an increasing demand for medicinal plants-based drugs and pharmaceuticals in the world market. However, pharmaceutically active compounds can also behave as allelochemicals. These allelopathic compounds can also be used as natural herbicides and other pesticides (Einhelling, 1995).

The term "allelopathy" was proposed for expressing the harmful, stimulatory, enhanced and beneficial effects that one plant species has on another through the formation of chemical retardants escaping into the environment (Molisch, 1937). Allelochemicals (inhibitors) are present in plants as end products, by-products, and metabolites. These chemicals are present in different parts of plants like stem, leaves, roots, flowers, inflorescence, fruits and seeds. Out of these plant parts, leaves seem to be the most consistent producers of these allelochemicals. These allelochemicals are oftentimes released from the plants by volatilization, leaching, exudation and decomposition from plant residues (Molisch, 1937). The concept of allelopathy was further supported and developed by Bonner (1950), Grummer and Beyer (1960), Evenari (1961), Whittaker (1970), Pitman and Duke (1978) and Fischer et al. (1978). According to Lavabre (1991), allelopathic effects are controversial and still poorly understood.

In allelopathy, a major tool for research is bioassay,

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Table 1. List of the selected medicinal species used for the allelopathy screening.

S/N	Species name	Family name	Location
1	*A. conyzoides* Hk. F., FBI	Astereaceae	Self sown, Poonch, Chitral, Swat, Muree, Kashmir
2	*Cannabis sativa* L.	Cannabiniaceae	Lahore, Chitral
3	*Coronopus didymus.,* (L.) Sm., FL. Brit	Cruciferae	Sindh, Baluch, Chitral, Swat, Gilgit, Poonch, Kuram, Wazir
4	*Galium aparine*	Rubiaceae	Plains of West Pakistan
5	*Melilotus officinalis* (L.) Desr. In Lam Encycl Meth	Papilionodiaceae	Balti, Nubra, Ladak, Chitral, Gilgit
6	*Oxalis corniculata* L. Sp Pl..	Oxalidaceae	India, Lahore, Cult. In Hunza
7	*Parthenium hysterophorus* L.	Astereaceae	Lahore (Sabzazar). Rawalpindi, Jhelum, Attock, Mianwali.
8	*Rumex dentatus* L.	Polygonaceae	Lahore, Chitral
9	*Sisymbrium irio* L.	Cruciferae	Lahore, Rawalpindi
10	*Sonchus asper* L. (Hill)	Astereaceae	Sindh, Baluch, Chitral, Swat, Gilgit, Muree, Kashmir

which controls laboratory condition, high sensitivity gives reproducible result, and take relative short time to perform. There are many ways to evaluate the herbal aqueous extracts of allelopathic activities. These are hydroponic culture methods, Ratoon screening method, Plant box method (Lee et al., 2003), a plastic tray with 6 holes (Fujii et al., 2004), Dish pack method - a new bioassay for volatile allelopathy (Fujii et al., 2005), Sandwich method (Fujii et al., 2003) and Filter paper (Barbosal et al., 2008). The filter paper is a more suitable method because it can tolerate the moderate temperature during incubation (25 c) in the laboratory. The aqueous extracts remain fresh for longer period of time. Millipore filter paper is used to make the method sterile. The reason for the use of filter paper in techniques is that, it is easily available and free from contamination. It is easily handled and a good media for germination, it has high flow rate for movement of extracts and porosity (Gill et al., 2009).

Allelopathic effect of medicinal species against temperate crop is well studied (Wahab et al., 1967; Rice, 1971; Han et al., 2008 and Li et al., 2009). Allelopathic potential of some selected species had been studied by Xuan et al. (2004), Maharjan et al. (2007), Kumar et al. (2007), Aziz et al. (2008), Compton et al. (2009), Timothy et al. (2009), and Hussain et al. (1997). However, information on the allelopathic effects of medicinal herbs on many vegetables and cereals is limited, hence the main purpose of the present study is to evaluate the allelopathic activity of some selected medicinal species of Pakistan on Wheat and Pea.

MATERIALS AND METHODS

Plant materials collection

To study the allelopathic activities, ten different medicinal species (Table 1) were collected from different localities of Pakistan. These were used to analyze the effects of transformable compounds. These compounds are considered to be stable to drought and high temperature (Shiraishi et al., 2002). The field area was thoroughly visited to select commonly present species. These commonly present species were washed to remove the dust particles and kept on the filter paper for absorbance of water. The medicinal plants with fully expanded parts were selected as donor of allelochemicals.

Dryness of medicinal species

After washing all the species and placing them on filter paper to absorb excessive amount of water, species were then sun dried for three to four days. They were sorted out into three different parts (root, stem and leaves) to make aqueous extraction of all the three parts separately.

Preparation of aqueous extracts

The sun dried medicinal plants were crushed and separated into three parts of 1, 3 and 5 g for all the vegetative parts of species (root, stems and leaves). All parts were soaked separately in 100 ml distilled water for 24 h in the beakers. These beakers were covered with Aluminum foil and stored at room temperature (25°C). Then filtrate was extracted.

Test plants

Pea and wheat seeds were used as receptor plants for initial screening of species to check allelopathic activity. Wheat development was promoted by exposure of seedlings to temperature in 38 to 46°C ranges (Machado and Paulsen, 2001). The other test plant was pea, grown in April to July. The optimum mean daily temperature is 17- minimum 10°C and maximum 23°C. Its germination takes 6 days under the temperature of 20 - 30°C. The value of pH range 5.5 - 6.5 (Sivaprasad et al., 1987). Seeds were obtained from the Seed Bank of IABGR (Institute of Agro-biotechnology and genetic resources), NARC (National Agriculture Research Center), Islamabad. The seeds of these two species germinate easily, easy to handle, with high fecundity rate, showed pronounced effects after the application of aqueous extracts.

Filter paper was used as growth medium for germination (Randhawa et al., 1998). For sterilization of the medium from dust particles or fungal attack on petri plates of 9 cm, cleaned ethanol dipped cotton was used, then filter paper was placed. The percentage of 1, 3 and 5 g aqueous extracts of all selected medicinal species were applied on the test/receptor plant (pea and wheat).

Tools for data analysis

For each plant species, mean, SD variance (Fujii et al., 2003) and standard error were calculated to determine the growth pattern of 1, 3 and 5 g of leaves, stem and root of herbal species.

Statistical analysis

The data was analyzed by using Software of SPSS v 11 (Statistical analysis of Social Procedure) and Microsoft Excel. And the experimental design was Randomized Complete Split Block Design. Therefore, Single factor ANOVA was calculated to investigate the significance of activity. The level of significance was 0.05. Percentage growth of radicle and plumule of test plants under the influence of aqueous extract of various herbs is represented by line graphs.

RESULTS AND DISCUSSION

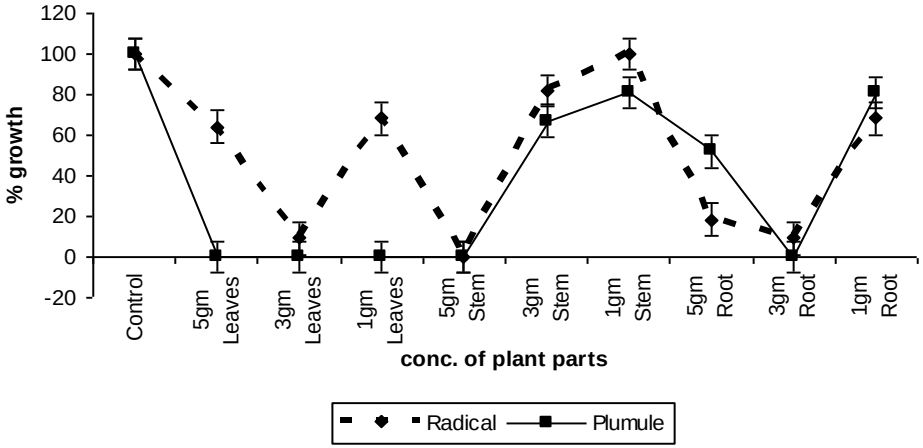
Ten selected species were collected from the tropical areas and were screened for their allelopathic activity. *Sonchus asper*, *parthenium hysterophorus* and *A. conyzoides* were found among the most active allelopathic species. These species belong to the family Astereaceae. For screening purpose three different concentrations of all vegetative parts (leaf, stem and root) were used. At highest concentration (5 g of leaves, stem and root) showed inhibitory action on the growth of radicle and plumule pea and wheat (test plants). The concentration of 5 g leaf of *S. asper* inhibited the 30% radicle and 100% plumule growth of pea (Figure 1). In the case of *P. hysterophorus* this reduction was up to 85% for the radicle and more than 95% for plumule on the same test plant (Figure 5). Similarly, *A. conyzoides* showed 50% reduction in growth of radicle and plumule (Figure 3). However, when radicle and plumule were observed for 5 g of leaves aqueous extract of *P. hysterophorus* and *S. asper,* they were found to completely inhibit growth of wheat (Figures 6 and 2). Same observation was made by Maharjan et al. (2007). They evaluated that crucifer species is completely inhibited at >2% leaf extract of *P. hysterophorus.* Whereas in same concentration of *A. conyzoides*, the growth was up to 50% of radicle and 78% for plumule in case of wheat (Figure 4). But for pea, 60% enhanced growth of radicle and inhibited growth of plumule up to 20% was observed.

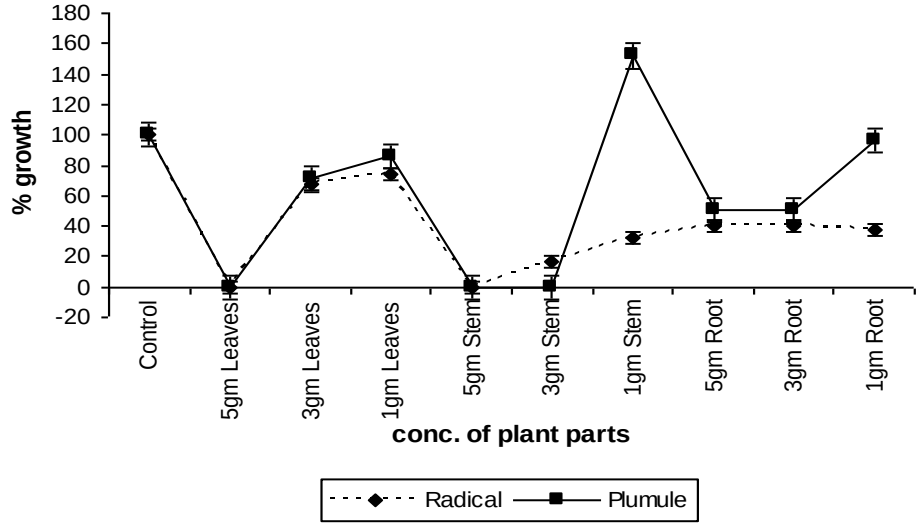
Stem concentration of 5 g and 3 g of *S. asper* inhibited the growth of plumule and radicle of both wheat and pea (Figures 1 and 2). Similarly, 1 g stem concentration showed the inhibitory effect on plumule of wheat up to 10% and radicle percentage growth up to 80% (Figure 2). Same inhibitory effect on the percentage growth of plumule was found on pea (Figure 1). However, 1 g stem enhanced 50% growth of wheat (Figure 2). The aqueous extract concentration of 3 g root inhibited the growth of plumule and almost negligible effect was observed on radicle growth of pea (Figure 1). But the same concentration inhibited the growth of radicle and plumule (30%) of wheat. The three concentrations (1, 3 and 5 g) of *P. hysterophorus* and *A. conyziodes* stem inhibited the growth of both radicle and plumule of pea (Figures 5 and 3). It also showed reduction in growth of wheat radicle and plumule.

A. conyzoides concentration completely retarded the growth of both test plants (Figures 3 and 4), but only 3 g root exhibited percentage growth of radicle and plumule (Figures 3 and 4). The influence of *Ageratum* aqueous extracts on wheat (Figure 4) was also pronounce. In this case, 3 g stem showed no effect on plumule, whereas inhibited the growth of radicle up to 50% of wheat as compared to control. The higher concentration of 5 g stem, 1 g stem and 3 g root of *Ageratum* exhibited nearly same result. The growth of 5 g stem showed radicle growth up to 50% and plumule almost 70%. The concentration of 1 g stem aqueous extract exhibited up to 50% growth of plumule and radicle of wheat. Similar observations were made for 3 g root aqueous extracts of *Ageratum.* Kumar et al. (2007) evaluated the allelopathic effects of *A. conyzoides.* The germination and radicle extension of *Brassica campestris* was completely inhibited by *A. conyzoides* the germination stimulated (14.94%) under *A. conyzoides* compared with control. To evaluate the allelopathic effect, the experiment was performed by Xuan et al. (2004). The leaves of *A. conyzoides* L. exhibited a great suppression of *B. campestis* than the stem and root.

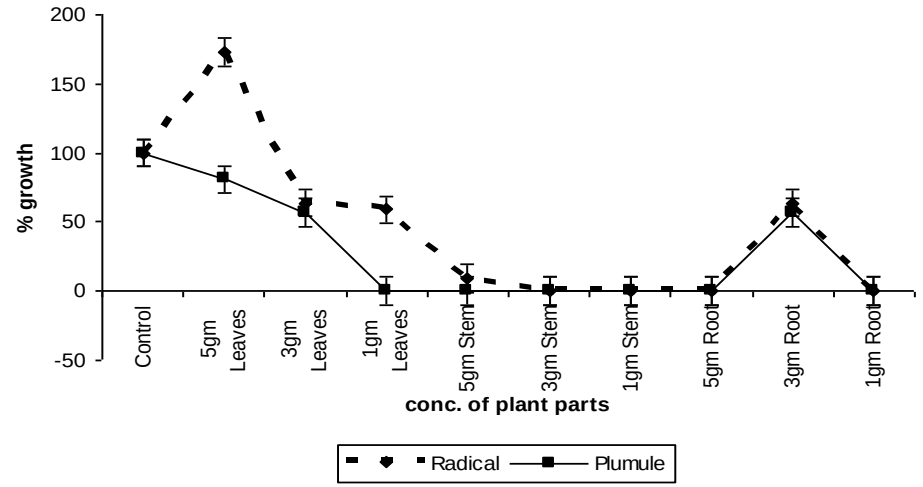
The concentration of 5 g root of *P. hysterophorus* showed almost 40% growth of radicle but inhibits 95% growth of plumule of pea (Figure 5). The same concentration showed inhibitory effect on the percentage growth of plumule and radicle of wheat (Figure 6). Whereas 1 g root aqueous extract concentration produced complete inhibition for wheat plumule. These observations revealed that these species were highly significant on both monocotyledons and dicotyledons. These findings are in accordance with Maharjan et al. (2007). Their results showed that *P. hysterphorous* extract had strong inhibitory effect to root elongation of seedling in cereals and to shoot elongation in crucifers and wild Asteraceae. So these were significantly active allelopathyic weed species (Tables 2 and 3).

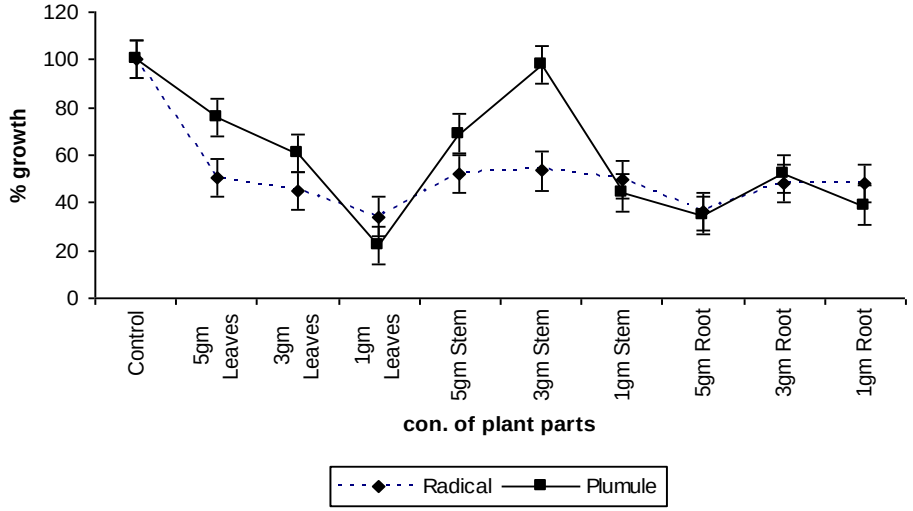
Coronopis didymus and *Sisysmbrium irio* were the commom weed of family Cruciferae. The members of this family were also allelopathically active. These selected medicinal species have allelopathic influence on the other plants of interest, but badly effected by the allelo-chemicals released by *A. conyzoides* (Kumar et al., 2007). Leaf aqueous extracts of *C. didymus* and *S. irio* of 5 g leaf and root suppress the growth of plumule and radicle of pea (Figures 7 and 9). But 5 g stem, 5 and 1 g root of *C. didymus* retarded the growth of wheat (Figure 8) plumule and radicle. Whereas only 5 g root prevent the growth of pea plumule and radicle. The root aqueous



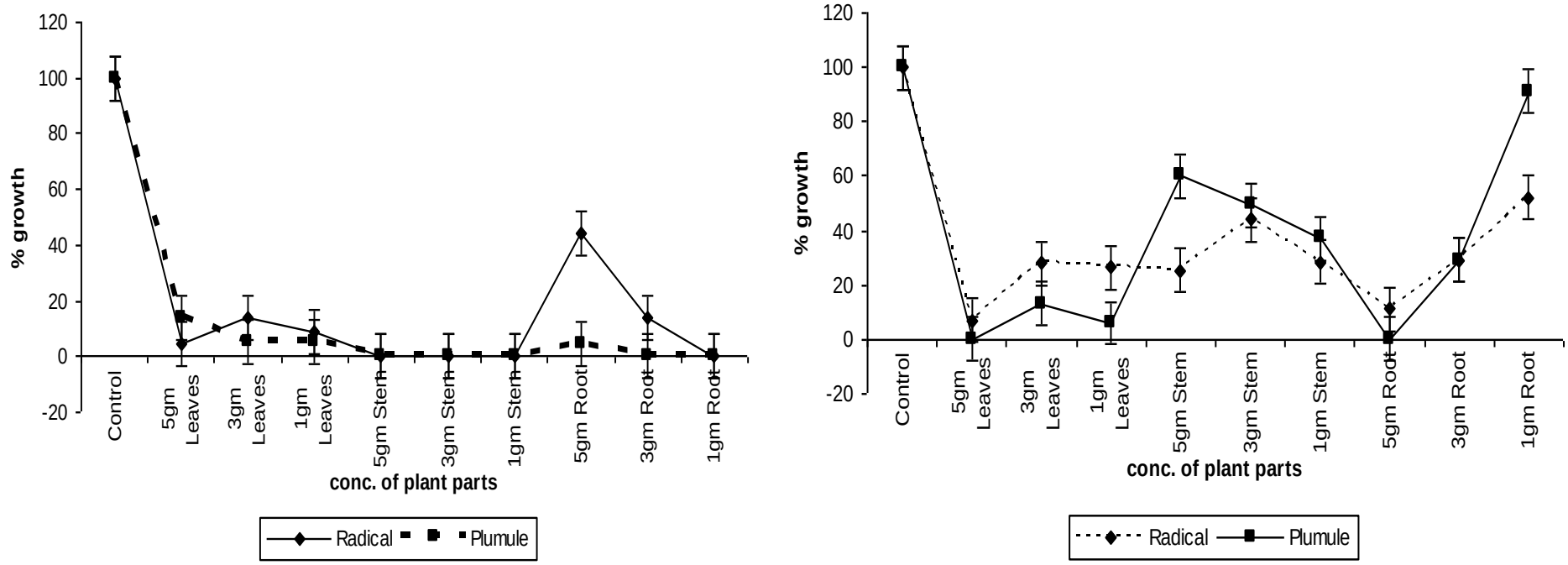


Figures 1 - 2. Effect of aqueous extracts of *S. asper* on the percentage growth of pea (left) and wheat (right).





Figures 3 -4. Effect of aqueous extracts of *A. conyzoides* on the percentage growth of pea (left) and wheat (right).



Figures 5-6. Effect of aqueous extracts of *P. hysterophorus* on the percentage growth of pea (right) and wheat (left).

extracts (3 g) of *C. didymus* showed percentage growth up to 60% of pea plumule and radicsle, whereas only 20% of plumule and radicle of wheat was inhibited by it. The concentration of (3 g) leaves, 1 and 5 g stem showed growth of plumule in between 50 - 60% of pea. The same results were studied under the influence of 1 and 3 g stem concentrations.

The concentration of 3 g stem and 1 g root of *S. irio* showed no effect on growth as compared to other parts of species in case of pea (Figure 9). But other concentrations showed growth in between 0 - 15% of both plumule and radicle. The only 1 g stem showed slight growth of wheat up to 20% of radicle but retarded the plumule, whereas the other concentrations completely suppressed the growth of plumule and radicle of wheat (Figure 10). These are allelopathic species and showed significant effects for all concentration of root, stem and leaves for *Pisum sativum* and *Triticum aestivum* (Tables 2 and 3). So during observations, it was proved that these species have significant effect on whole range of both monocotyledons and dicotyledons (Tables 2 and 3).

Galium aparine is one of the most important member of the family Rubiaceae which enhanced growth of radicle of *P. sativum* (Figure 11). The effect was more pronounced when aqueous extraction of 3 g leaves and root were used. But 3 g of leaves, stem, root and 1 g root concentration exhibited no effect on plumule, so the percentage growth was 100%. However, 1 g leaves and 5 g root completely retarded the growth of radicle and plumule (Figure 11). Same observations were made by Aziz et al. (2008). The aqueous extracts reduced the root and shoot length and biomass of wheat seedlings by 34.0 to 67.9%, 10.4 to 61.6% and 16.5 to 38.0%, respectively. The considerable concentration of 5 and 1 g stem, and 1 g root completely inhibited the growth up to 100% of radicle in case of pea (Figure 11). According to Aziz

Table 2. Analysis of variance for allelopathic activity of selected medicinal species of tropical areas (Test plant: pea).

Species name	Plant parts	Control		Length of radicle and plumule on different concentrations						F-value	P*-value
				1		3		5 g			
		R	P	R	P	R	P	R	P (cm)		
Sonchus asper	Leaf	2.3	2.2	1.5	0	.2	0	1.4	0	0.36	0.7
	Stem			2.2	1.7	1.9	1.4	0	0	26.46	0.1
	Root			1.07	2.3	1.2	1.1	0.4	1.1	1.31	.38
Galium aparine	Leaf	2.3	2.2	0.12	0	5.1	2	2	1.2	3.57	0.16
	Stem			2.5	3	0.3	1.5	0	0	4.47	0.12
	Root			0	0	0	0	0	0	0.1	0.1
Cannabis sativa	Leaf	2.3	2.2	1.2	0.8	1.2	0.7	0	0	9.52	.05
	Stem			1.2	1.1	0	0	0	0	4.24	0. 1
	Root			0	0	0	0	0	0	0.1	0.1
Coronopis didymus	Leaf	2.3	2.2	0.6	1.2	1.3	1.1	0.4	0	5.6	0. 9
	Stem			0.2	0.5	0.1	0	0	1.1	24.6	0. 1
	Root			0.1	1	0.2	0.3	0	0	24.6	0. 1
Sisymbrium irio	Leaf	2.3	2.2	0.1	0.3	0.7	0.1	0	0	2.6	0.22
	Stem			3.2	0.3	0.1	0.2	0.2	0	1.69	0.3
	Root			0.1	0.3	0.4	0.4	0	0	1.1	0.43
Melilotus officinalis	Leaf	2.3	2.2	0	0	1.7	1.2	1.2	0	27.1	0. 1
	Stem			0	0	0	0	0	0	0.1	0.1
	Root			0	0	0	0	0	4.4	0.1	0.1
Parthenium hysterophorus	Leaf	2.3	2.2	0.2	0.1	0.3	0.1	0.1	0	0.11	0.9
	Stem			0.2	0.1	0.3	0.1	0.1	5.2	0.1	0.8
	Root			0	0	0	0	0.2	0	9	0.05
Oxalis corniculta	Leaf	2.3	2.2	0.2	0.3	0.2	0.0	0	0	3.8	0.15
	Stem			1.1	0.2	0	0	0	0	2.08	0.27
	Root			1.1	0.2	0	0	0	2.5	2.08	0.27
Rumex dentatus	Leaf	2.3	2.2	1.2	0.7	0	0	0	2.2	14.4	0. 2
	Stem			0	0	2.2	0	1.5	0	0.54	0.54
	Root			0	0	1	1.2	0	0	121	0.1
A. conyzoides	Leaf	2.3	2.2	1.3	0	1.4	1.2	3.8	6.6	2.25	0.25
	Stem			0	0.2	0	0.1	2	0	0.84	0.51
	Root			0	0	0	0	0	3	0.1	0.1

R = Radicle; P = plumule; F = frequency; P* = probability.

et al. (2008), root extract increased the shoot dry weight (32.4%) and seedling biomass (11.4%).

Higher concentration (5 g) of *G. aparine* leaf/root and one of lower concentration (1 g) fully retarded the growth of plumule of wheat (Figure 12). However, 1 g leaf and 5 g root showed 15 and 20% growth, respectively. Whereas 1 g root concentration exhibited no effect on the plumule of wheat, but inhibited 40% growth of radicle, similar results were found with 5 g aqueous extract of stem. So this study showed that it was highly significant on both *T. aestivum* and *P. sativum* (Tables 2 and 3).

Cannabiniaceae family has its most important member that is, *Cannabis sativus,* which has uses and abuses (Compton et al., 2009). The present study examined the allelopathic activity of *Cannabis sativus* (Compton et al., 2009). It showed considerable reduction in growth of both test plants (Figures 13 and 14). The highest concentration of 5 g leaves completely retarded the growth of plumule and radicle of *P. sativum* (Figure 13), and *T. aestivum* (Figure 14). Whereas aqueous extraction of 3 g leaf, root, stem and 1 g leaf showed up to 60% growth of pea radicle (Figure 13). But the plumule percentage growth ranged between 38 - 70% above all concentrations. However, the response of 5 g root and stem extractions were retarded for pea (Figure 13). The results of same concentration were different in case of *T. aestivum* (Figure 14), in which 5 g stem and 3 g root extractions inhibited the growth of both plumule and radicle up to

Table 3. Analysis of variance for allelopathic activity of selected medicinal species of tropical areas (Test plant: wheat).

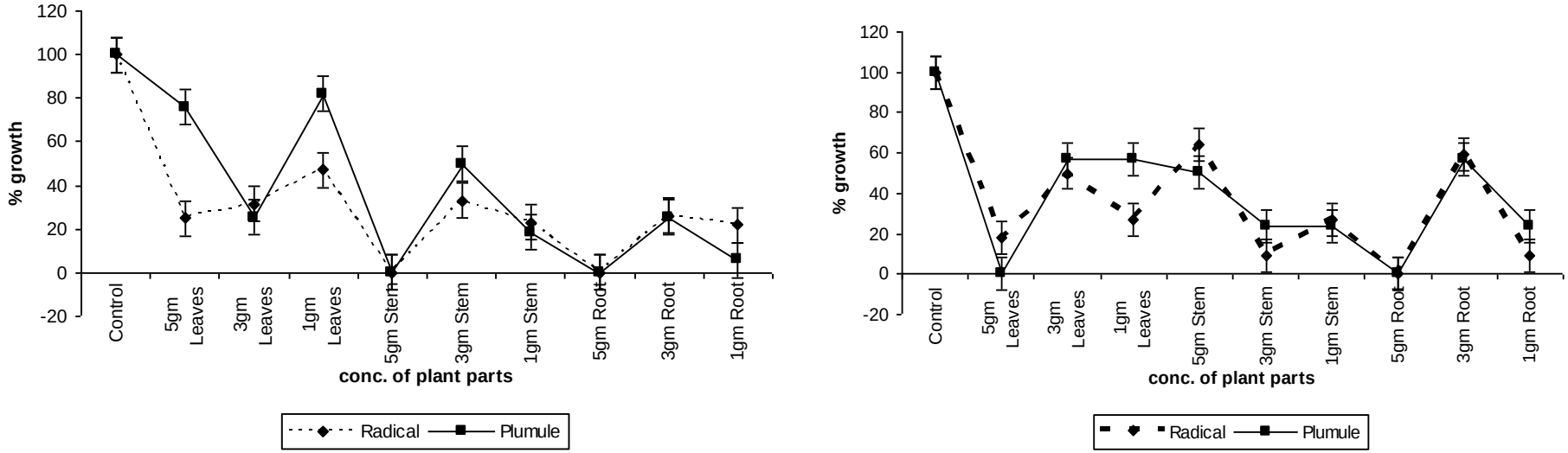
Species name	Plant parts	Control		Length of radicle and plumule on different concentration						F-value	P*-value
				1		3		5 g			
		R	P	R	P	R	P	R	P		
Sonchus asper	Leaf	13.5	8.7	7.3	5.1	7.3	5.5	5.2	2.2	1.59	0.33
	Stem			4.6	2.5	3.4	1.6	3.7	1.4	0.32	0.74
	Root			3	3.1	1.2	1.1	0.4	1.1	35.5	0. 8
Galium aparine	Leaf	13.5	8.7	10	9.1	7	7.4	3.9	1.2	18.4	0. 2
	Stem			6.7	8.1	5.5	6.4	2.9	1.1	15.5	0. 2
	Root			5.5	5.1	2.5	1.1	1.1	1.1	28.6	0.01
Cannabis sativus	Leaf	13.5	8.7	8.1	10.2	3.9	1.1	1.04	0.5	17.96	0. 2
	Stem			4.5	8.3	1.7	2	1.4	3.2	4.24	0. 2
	Root			5.7	7.7	3.5	5.6	0.3	1.6	10	0.05
Coronopis didymus	Leaf	13.5	8.7	11	10.1	9.4	10.4	1.7	0	77.4	0. 2
	Stem			5	6.5	0.7	0	0	0	45.5	0. 6
	Root			0.1	0.1	0	0	0	0	0.1	0.1
Sisymbrium irio	Leaf	13.5	8.7	0.1	0.3	0.7	0.1	0	0	4.3	0.13
	Stem			3.2	0.3	0.1	0.2	0.2	0	1.2	0.4
	Root			0.1	0.3	0.4	0.4	0	0	12	0.03
Melilotus officinalis	Leaf	13.5	8.7	10	7.5	8.7	6.2	0	0	20.05	0.02
	Stem			4.3	14	0	4.3	0	0	2.5	0.2
	Root			5.1	8.4	5.5	4.4	5.5	4.4	0.9	0.5
Parthinium hysterophorus	Leaf	13.5	8.7	3.6	9.5	3.8	1.1	2	0	2.2	0.3
	Stem			3.9	3.2	6	4.3	3.5	5.2	1.2	0.40
	Root			7.9	7.9	4	2.5	1.5	0	35.12	0. 8
Oxalis corniculata	Leaf	13.5	8.7	4	2	1.3	0	0	0	5.2	0.10
	Stem			5.2	2.3	4.9	4.7	0	0	9.0	0.05
	Root			3	0.5	0	0	1.5	2.5	1.9	0.2
Rumex dentatus	Leaf	13.5	8.7	6.4	7.1	4.3	2.2	3.4	2.2	8.8	0.05
	Stem			7.4	0.3	7.3	0.2	0.2	0	27.7	0.01
	Root			3	0.5	3.6	2.2	0	0	3.1	0.2
A. conyzoides	Leaf	13.5	8.7	4.7	7.1	6.2	5.3	6.9	6.6	4.32	0.13
	Stem			7.3	3.8	7.3	8.5	7.1	6	0.54	0.62
	Root			6.6	3.3	6.6	4.5	5	3	0.37	0.72

R = Radicle; P = plumule; F = frequency; P* = probability.

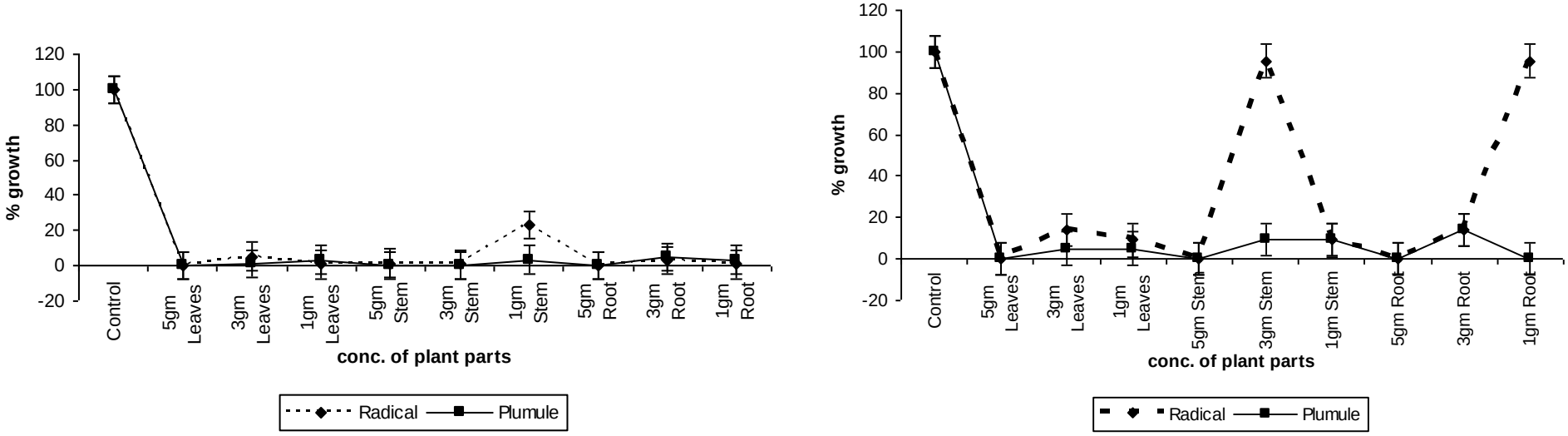
100%, whereas 3 g leaf showed 100% inhibition of plumule but slight effect on radicle. Of all the concentrations of plant parts, only 3 g stem extraction showed greater percentage growth of both radicle and plumule (39 and 58% respectively). So, it also has allelopathic effects on Angiospermic families (Tables 2 and 3).

Melilotus officinalis (yellow sweet clover) belongs to the family Papilionodiacea. It causes large changes in community composition in both the presence and absence of a cover crop (Dickson et al., 2009). Non-native species are hypothesized to decrease native species establishment, whereas cover crops are hypothesized to decrease non-native species abundance. In the present study, allelopathic behaviour of *M. officinalis* was evaluated. The concentration of 5 g leaves stimulate the growth up to 50% of radicle and plumule in case of *P. sativum* (Figure 15), but completely inhibited or retarded the growth of *T. aestivum* (Figure 16). However, 3 g root showed 40% radicle and 60% plumule growth of wheat (Figure 16). But the same concentration (3 g root) exhibited 80% growth of radicle of pea. These findings revealed that it has significant effect on monocotyledons and dicotyledons (Tables 2 and 3).

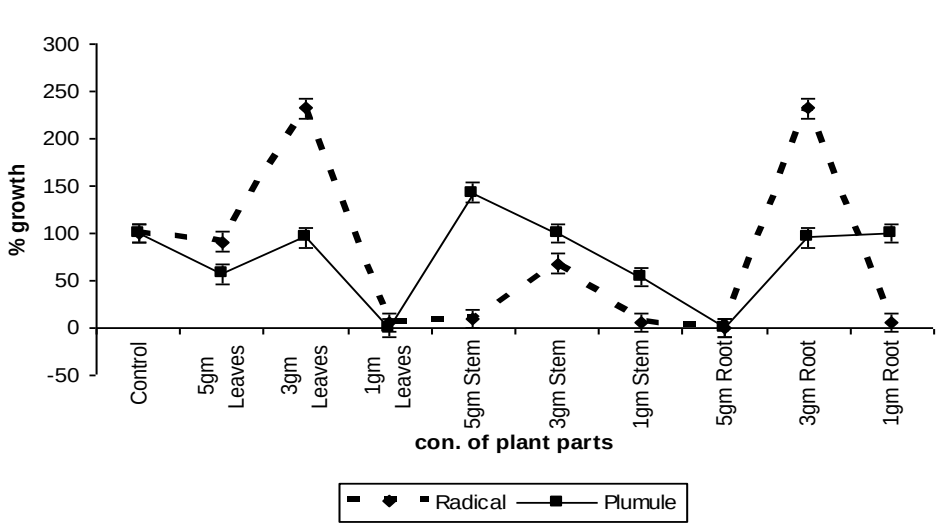
The same experiment was performed by Franciso et al.

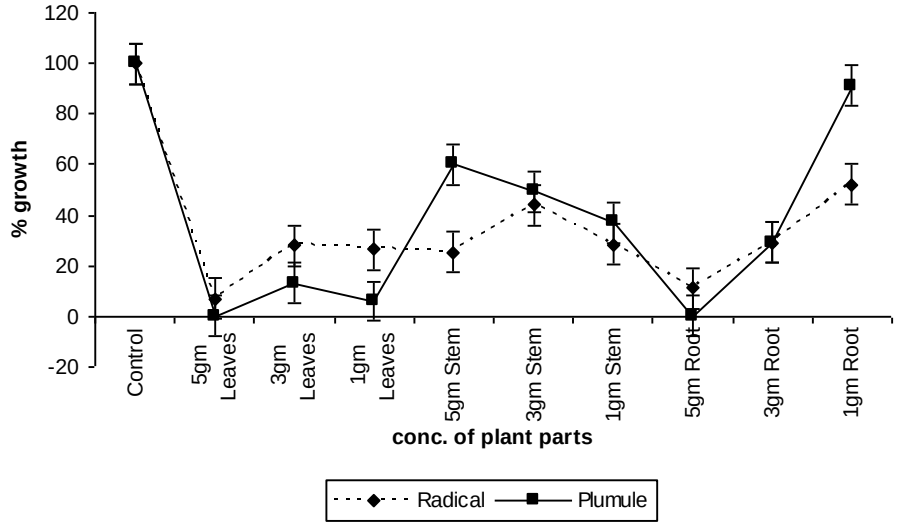


Figures 7-8. Effect of aqueous extracts of *C. didymus* on the percentage growth of pea (right) and wheat (lift).

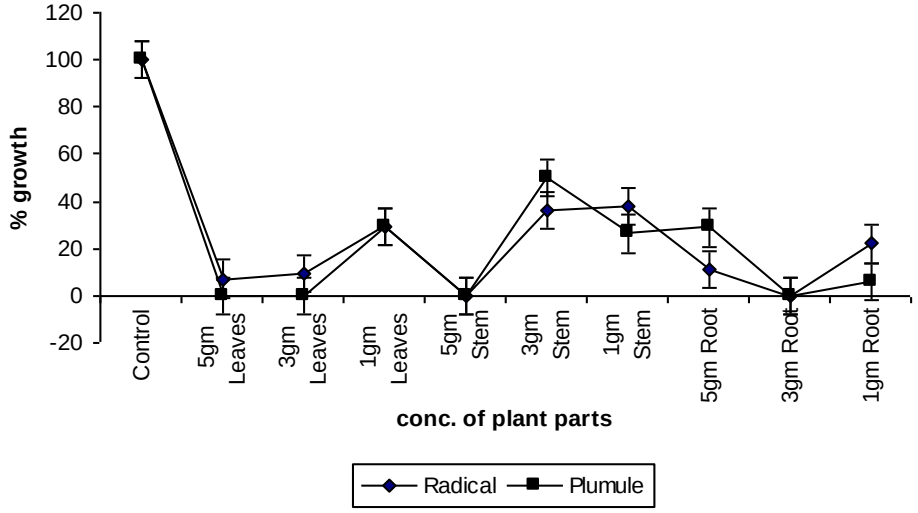


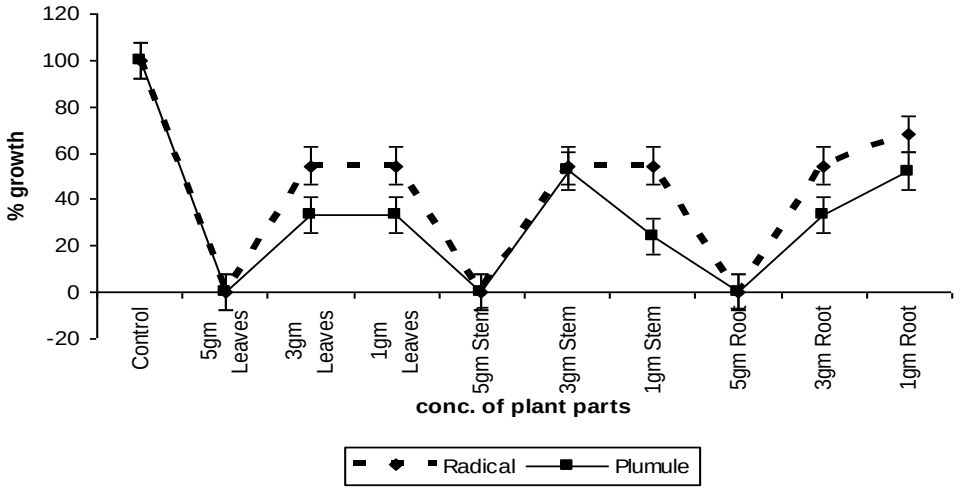
Figures 9-10. Effect of aqueous extracts of *S. irio* on the percentage growth of pea (right) and wheat (lift).



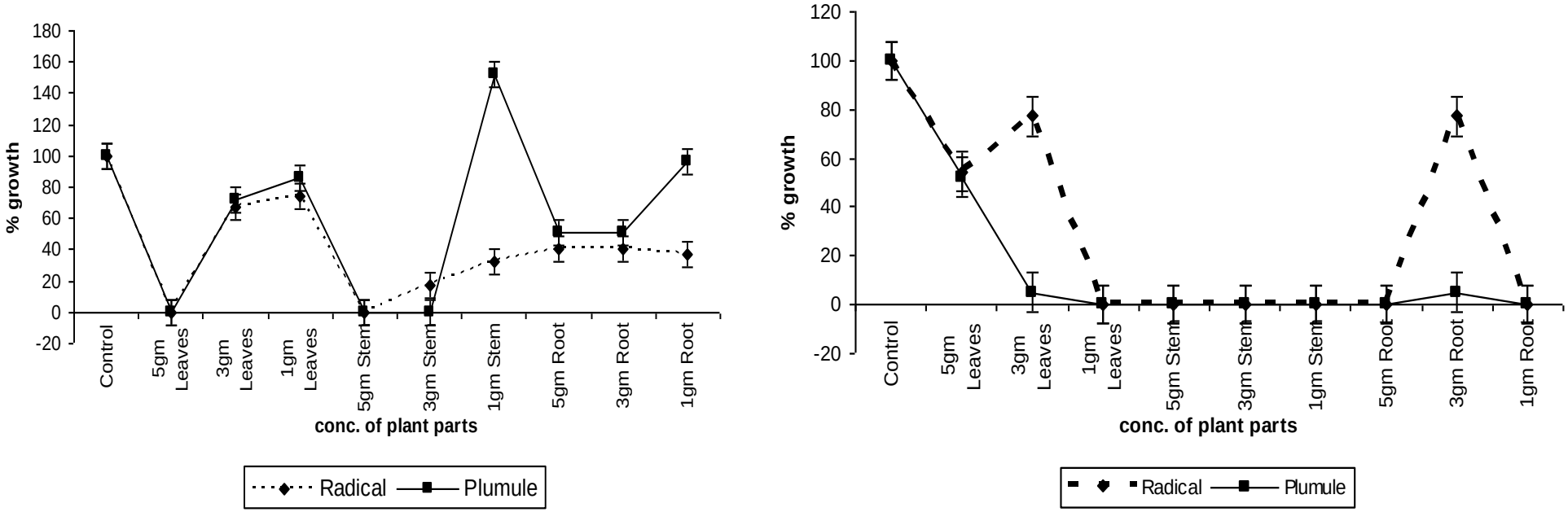


Figures 11-12. Effect of aqueous extracts of *G. aparine* on the percentage growth of pea (right) and wheat (lift).





Figures 13-14. Effect of aqueous extracts of *C. sativus* on the percentage growth of pea (right) and wheat (left).

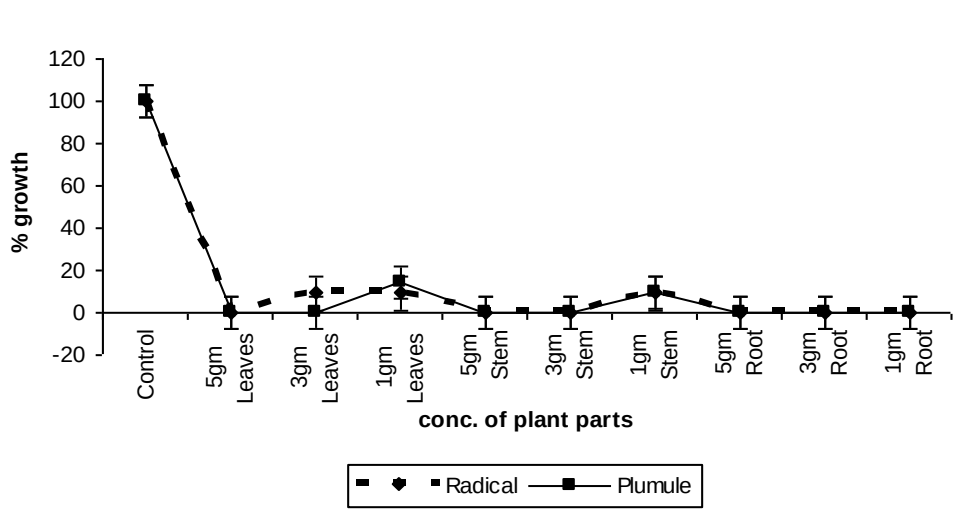


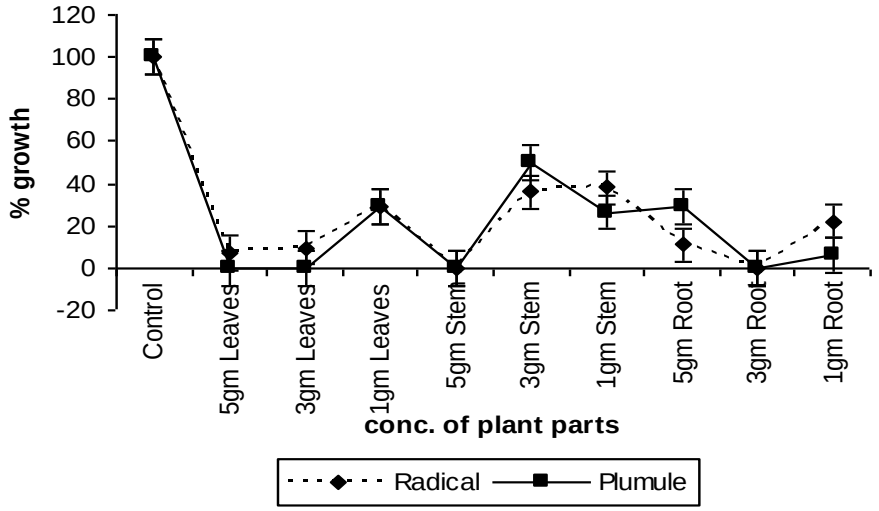
Figures 15-16. Effect of aqueous extracts of *M. officinalis* on the percentage growth of pea (right) and wheat (left).

(1999). They studied the stimulation and retardation of methanolic extract from sweet clover. *M. messanensis has* series of effects on aqueous solutions from 10^{-9} - 10^{-4} M of twelve phenolics on germination and growth of the dicotyledons *Lactuca sativa* cultivars (Franciso et al., 1999). The concentration of 3 g leaf and root showed growth of plumule up to 80% of pea (Figure 15). But 3 g leaf showed the same percentage growth of both radicle and plumule of wheat (Figure 16). Null effect was observed on wheat plumule. The pronounced stimulatory influence of 1 g stem, which enhanced the growth of wheat up to 30% (Figure 16).

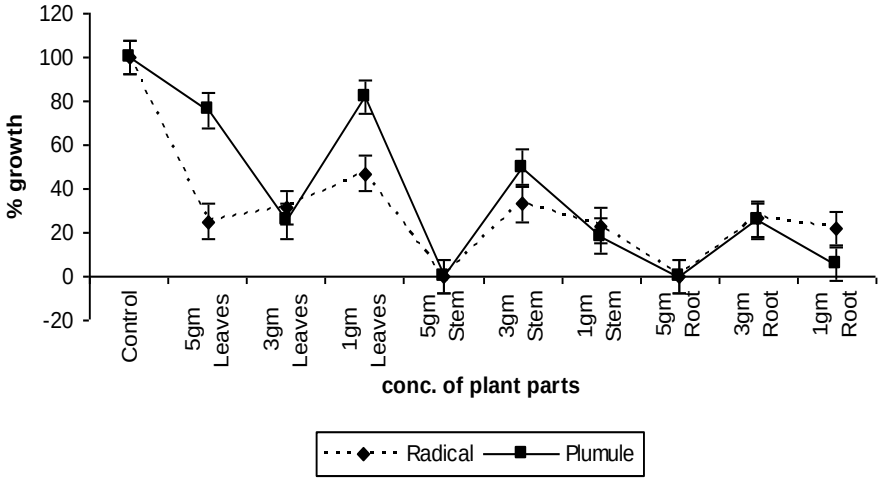
Oxalis corniculata belongs to the family Oxalidiaceae. It is a highly competitive species and can effectively compete native species for light. Once established, it forms dense stands and a thick mat of creeping roots and rhizomes. This dense growth prevents the establishment of other species (Pakeman et al., 1998). In the present study, it was observed that all concentrations of herbal parts showed slight growth up to 0 - 10% and inhibited the 90% growth of pea (Figure 17). But 3 g stem activated the growth of plumule up to 40% and radicle up to 60% in case of wheat (Figure 18). Whereas 3 and 5 g of leaves, 5 g stem and 3 g root concentration completely retarded the growth of wheat. Only the 3 g stem showed pronounced effect on growth of plumule and radicle (50 and 40%, respectively) of wheat. Then 1 g stem exhibited 40% radicle and 30% plumule growth. However, 1 g leaf showed 30% growth of both plumule and radicle of wheat. So these observations revealed that this weed has significant effects on both test plants (Tables 2 and 3).

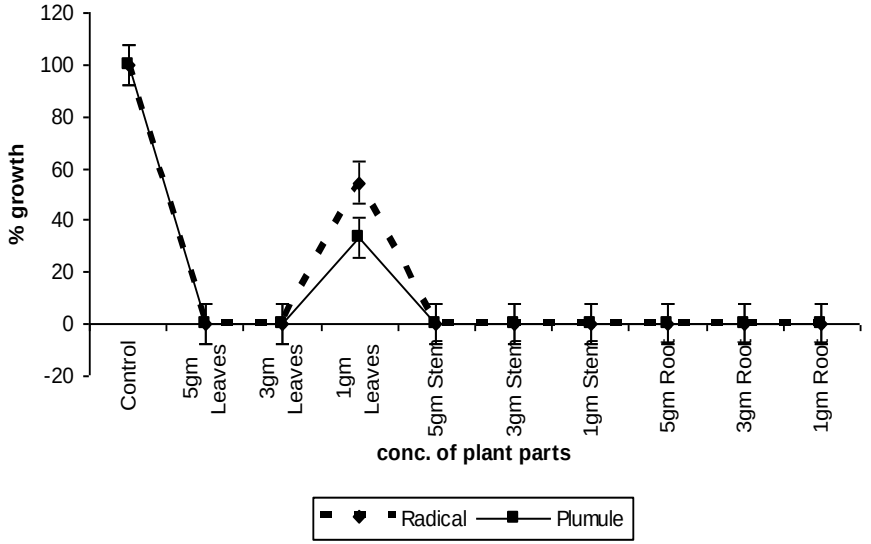
Rumex dentatus is a common weed. It belongs to the family Polygonacea. Hussain et al. (1997) observed that soil collected from beneath *R. dentatus* also proved harmful for the germination and seedling growth. At 1 g, leaves concentration stimulated 50% growth of radicle and 30% plumule of pea (Figure 19), whereas other concentrations completely retarded the growth of both radicle





Figures 17-18. Effect of aqueous extracts of *O. corniculata* on the percentage growth of pea(right) and wheat (left).





Figures 19-20. Effect of aqueous extracts of *R. dentatus* on the percentage growth of pea (right) and wheat (left).

and plumule. Elzaawely et al. (2005) explained that in the aerial parts and roots of *R. japonicas,* there are phenolic compounds etc. The extracts from aerial parts significantly decreased the seedling growth of lettuce and barnyard grass shoots as compared to other parts of plants, which inhibited the growth. But in case of wheat, 5 g leaves showed reduced growth up to 20% radicle and above 80% plumule (Figure 20). Similarly, 1 g leaf aqueous concentrations inhibited the growth up to 50% radicle and 10% plumule. The concentration of 3 g stem showed 50% plumule and 40% radicle growth of wheat. But 5 g root and 5 g stem prevented 100% growth of both radicle and plumule of wheat (Figure 20). The result of Elzaawely et al. (2005) showed that the inhibition caused by root concentration was greater as compared to other parts of plant. These results showed that it has significant effects on monocotyledons and dicotyledons (Tables 2 and 3).

The same allelopathic experiment was performed by Hussain et al. (1997). They evaluated that aqueous extracts of *R. dentatus* ssp. *klotzschianus* (Meissn) Rech, litter from dried and fresh shoot and roots invariably inhibited the germination and seedling growth of both wheat and mustard.

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