Advances in Environmental Biology, 6(3): 940-950, 2012
ISSN 1995-0756

This is a refereed journal and all articles are professionally screened and reviewed **ORIGINAL ARTICLE**

Evaluation the allelopathic effect of bindweed (*Convolvulus arvensis* L.) on germination and seedling growth of millet and basil

Esfandiar Fateh, Seyedeh Samaneh Sohrabi and Farzad Gerami

Department of Agronomy and Plant Breeding, Agriculture Faculty, ShahidChamran University, Ahvaz, Iran.

Esfandiar Fateh, Seyedeh Samaneh Sohrabi and Farzad Gerami, Evaluation the allelopathic effect of bindweed (*Convolvulus arvensis* L.) on germination and seedling growth of millet and basil

ABSTRACT

In order to study the allelopathic effect of different vegetative parts of bindweed on millet and basil seed germination and growth characteristics, two separate laboratory experiments were conducted on Agricultural Faculty of Shahid Chamran University of Ahvaz in 2010. The experimental design was completely randomized, with three replications. The treatments were arranged in a 4 × 3 factorial design including different extract of bindweed vegetative parts (i.e. stem (P_{stem}), leaf (P_{leaf}) and whole vegetative parts ($P_{stem} + P_{leaf} = P_{total}$)) and extract concentration in four levels including distilled water (control), 33% w/v ($AE_{33\%}$), 66% w/v ($AE_{66\%}$) and 100% w/v ($AE_{100\%}$). In this study germination percent, seed germination rate, radicle and plumule length, seed vigor index, radicle to plumule ratio and radicle and plumule dry weight of millet and basil were measured. Among different extracted parts, P_{total} of bindweed had the highest inhibitory effect on millet and basil germination and growth characters. $AE_{100\%}$ had the highest inhibitory effects on millet and basil germination and seedling growth as compared with control. In contrast, $AE_{33\%}$ had the lowest inhibitory effect on both plants. Therefore, inhibitory effects of bindweed increased by increasing extract concentration. Radicle length and dry weight was more sensitive to bindweed allelochemical materials than plumule length and dry weight. Also, germination percent of basil was lower than millet as influenced by allelopathic effects. Radicle and plumule dry weight less affected than other studied characters to different extracts.

Key words: allelopathy, millet, basil, germination, radicle, Plumule.

Introduction

Allelopathic compounds from plants residues that called allelochemicals may inhibit germination, emergence and growth of subsequent plants. Any direct or indirect and harmful or beneficial effect by one plant (including micro-organisms) on another through production of chemical compounds that escape into the environment is called allelopathy [17]. Allelopathy involving secondary metabolites is produced by plants, micro-organisms, viruses, and fungi that influence growth and development of biological systems [15]. The concept of allelopathy was first introduced by Molisch [12] to describe both the beneficial and the detrimental chemical interactions of plants and microorganisms. Allelochemicals, of many plant have been reported to effect the growth of the other plants, a wide range of injurious effect on crop growth has been reported as being due to phytotoxic decomposing products, release from leaves, stem, roots, fruit and seeds.

Allelochemicals may be formed during the growth of the residue crop, or they may be a product of its decomposition. A variety of secondary plant products have been implicated as possible allelopathic compounds. Of these, those most commonly identified as allelopathic agents are phenolic compounds, which include simple phenols, phenolic acids, cinnamic acid derivatives, coumarins, flavinoids, quinones, and tannins [11]. Also, many researchers have found that inhibitory substances involved in allelopathy are terpenoids and phenolic substances [9]. For example, both root fresh weight and root length of pea (*Pisum sativa* L.) were decreased by vanillic, p-coumaric, and p-hydroxybenzoic acids at both the 0.5 mM and 1.0 mM levels. Shoot growth was less affected than root growth by the phenolic acids. Caffeic, syringic, and ferulic acids also produced significant effects on pea root morphology [24].

All parts of the weed plants including leaf, stem, root and fruit had allelpoathic potential [22]. Weeds also exert allelopathic effects on crop seed germination and growth by releasing water-soluble compounds in to the soil [4].

Experiments were conducted to investigate allelopathic effect of 1 to 10 percent aqueous leaf extract of *Parthenium* on germination and seedling

Corresponding Author
Esfandiar Fateh, Department of Agronomy and Plant Breeding, Agriculture Faculty, ShahidChamran University, Ahvaz, Iran.
E-mail: e.fateh@scu.ac.ir

growth in sunflower and sorghum. Results indicated that the germination of sunflower and sorghum decreased with increase in *Parthenium* extract concentration 35 and 20 percent, respectively. Shoot and root length and dry weight were also decreased by increasing concentration [14]. Piskorz [16] showed that the effect of aqueous extracts of *Echinocloa crusgalli* prepared from above ground parts and roots immediately after harvest and from whole weed eight months after harvest on seed germination of cucumber, tomato and radish. The aqueous extracts did not significantly affect germination of cucumber but at higher concentration inhibited germination in radish and tomato. Also, experiments were conducted to assess the allelopathic effects of leachates from leaf, stem flower and roots of *Parthenium hysterophorus* containing phenolic compounds (caffeic, p-coumaric acid, p-hydroxy benzoic acid and vanillic acid) that were tested on cowpea, black gram, greengram, horse gram and pigeon pea. The mixture of these phenolic acids as well as individual compounds inhibited the germination and vigor index of all test crops [18]. Wheat seed germination and yield significantly decreased 14 and 80%, respectively as influenced by bindweed (*Convolvulus arvensis* L.) residues extract. Therefore, the objective of present study was evaluation the allelopathic effects of bindweed different parts on germination and growth characters of millet and basil.

Materials and Methods

Two separate experiments were carried out at the Seed Science Laboratory, Agronomy Department of Agriculture Faculty of Shahid Chamran University, Ahvaz, Iran, to study the allelopathic effect of bindweed (*Convolvulus arvensis* L.) extract on millet (*Pennisetum sp*.) and basil (*Ocimum basilicum* L.) seed germination and seedling growth during 2010. The experimental design was completely randomized, with three replications. The treatments were arranged in a 4 × 3 factorial design including extract concentration in four levels: distilled water (control), 33% w/v ($AE_{33\%}$), 66% w/v ($AE_{66\%}$) and 100% w/v ($AE_{100\%}$) and different vegetative parts of bindweed including stem (P_{stem}), leaf (P_{leaf}) and whole vegetative parts ($P_{total} = P_{stem} + P_{leaf}$).

For this purpose bindweed plants collected from experimental field of Agriculture Faculty of Shahid Chamran University of Ahvaz. Vegetative parts of bindweed including stems and leaves were separated and then washed with distilled water, dried in shade and grinded. For preparation of aqueous extracts, 100 grams of grinded materials were soaked with 1000 ml (1:10) of distilled water and continuously shaked for 48 hr by shaker set.

The petri dishes maintained in a dry oven at 120°C for 24 hr for sterilization. Seeds sterilized with ethanol 5% for 30 second and sodium hypochloride 1% for 10 min. Then seeds washed with distilled water and dried between two paper towel. 20 seeds were placed in each petri dish and 6ml aqueous extract added to each petri dish. Germination test of *Pennisetum sp*. and *Ocimum basilicum* L. were performed in petri dishes in laboratory germinator for 25 days at constant 26°C. Data on germinated seed were calculated daily measured. Seeds were considered germinated when radicle extended through the seed coat. Radicle and plumule length (mm) and radicle to plumule ratio were recorded in the end of experiment by taking five samples at random. Then germination percent, germination rate and seed vigor were measured. Dry weight of five seedlings was recorded after drying in hot air oven maintained at 65°C temperature for 24 hr. The dried seedlings were weighted, averaged and expressed in milligrams (mg).

Germination rate [3] and seed vigor [1] were calculated by the formula:

Germination rate = Number of germinated seeds / Days of first count + … + Number of germinated seeds / Days of final count

Seed Vigor Index = (Shoot length + Root length) × Germination percent

The data were processed by analysis of the variance (ANOVA) and analyzed with SAS program. The means were compared using the DUNCAN test at 5% probability level.

Results and Discussion

Germination percent:

Statistical analysis of variance results (Tables 1 and 2) showed that millet and basil seeds germination percent was significantly affected by all treatments (AE and P) and interaction of them (AE × P) ($P < 0.01$). Minimum germination percent obtained with $AE_{66\%}$ and $AE_{100\%}$ of whole bindweed vegetative parts (P_{total}) for millet (Fig 1) as well as $AE_{66\%}$ of P_{total} and $AE_{100\%}$ of P_{leaf} and P_{total} for basil (Fig 2). Our results demonstrated that no significant differences found between millet seed germination percent in control plots and $AE_{33\%}$ of P_{stem} and P_{leaf} as well as $AE_{66\%}$ of P_{stem} (Fig 1). Also, basil germination percent not affected by $AE_{33\%}$ of all bindweed parts (P_{stem}, P_{leaf} and P_{total}) as well as $AE_{66\%}$ of P_{stem} and P_{leaf} (Fig 2). Inhibition effect of all bindweed extract concentrations on millet germination percent was more than basil (comparison fig 1 and 2). Stem of bindweed only in maximum extract concentration (100% w/v) had the highest inhibitory effect on seed germination percent while in lower concentration had no significant effect on this trait (Fig 1 and 2). Ismail and Chong [8] believe that allelopathic materials in low concentration may be have positive or negative effect on plant growth while, in higher extract concentrations have only inhibitory (negative) effects. This trend (positive effect) observed for basil seeds germination percent as affected by lower extract concentration of various bindweed parts. While, same extracts concentrations had negative effect on millet seeds germination and inhibitory effect of bindweed extract with increasing of extract concentrations. In similar, Yarnya *et al*., [25] found that, bindweed had negative allelopathic effects on seed germination, growth and yield of wheat. In vivo studies were conducted to assess the allelopathic effects of eucalyptus leaf, bark and root extracts at different concentrations (1.0 to 10.0 percent) on germination and seedling growth of cucumber. Germination and seedling growth were severely hampered by leaf extract than bark and root. Whereas increase in concentration from 1 to 10 per cent there was decrease in germination percent and seedling growth [2]. Siddiqui *et al*., [19] demonstrated that Inhibitory effect of *Prosopsis Juliflora* on seed germination and radicle length of wheat may be related to the presence of allelochemicals including tannins, wax, flavonoides and phenolic acids.

Table 1: analysis of variance results of millet germination and seedling growth as affected by bindweed extract concentration.

Source of variation	d.f.	Mean of square							
		Germination percent	Germination rate	Plumule length	Radicle length	Radicle/ plumule	Seed vigor	Plumule weight	Radicle weight
AE	3	4171**	34**	793**	2679**	2.63**	4117**	2.26**	3.26**
P	2	10023**	107**	750**	5327**	5.98**	1063**	4.52**	3.24**
AE × P	6	1428**	12**	197**	683**	0.557**	1374**	5.6**	6.51**
Error	24	66.66	0.49	23.72	47.69	0.083	92.37	0.00009	5.8

** Significant at P = 0.01 d.f. degree of freedom. AE: extract concentration. P: bindweed extracted parts.

Table 2: analysis of variance results of basil germination and seedling growth as affected by bindweed extract concentration.

Source of variation	d.f.	Mean of square							
		Germination percent	Germination rate	Plumule length	Radicle length	Radicle/ plumule	Seed vigor	Plumule weight	Radicle weight
AE	3	2504**	14.14**	632**	233**	0.91**	720**	8.7**	2.04**
P	2	13409**	129**	735**	2035**	3.3**	4576**	7.3**	7.5**
AE × P	6	1589**	12.09**	265**	154**	0.2**	444**	2.9**	6.4**
Error	24	47.22	0.32	4.85	2.005	0.01	7.2	3.1	2.03

** Significant at P = 0.01 d.f. degree of freedom. AE: extract concentration. P: bindweed extracted parts.

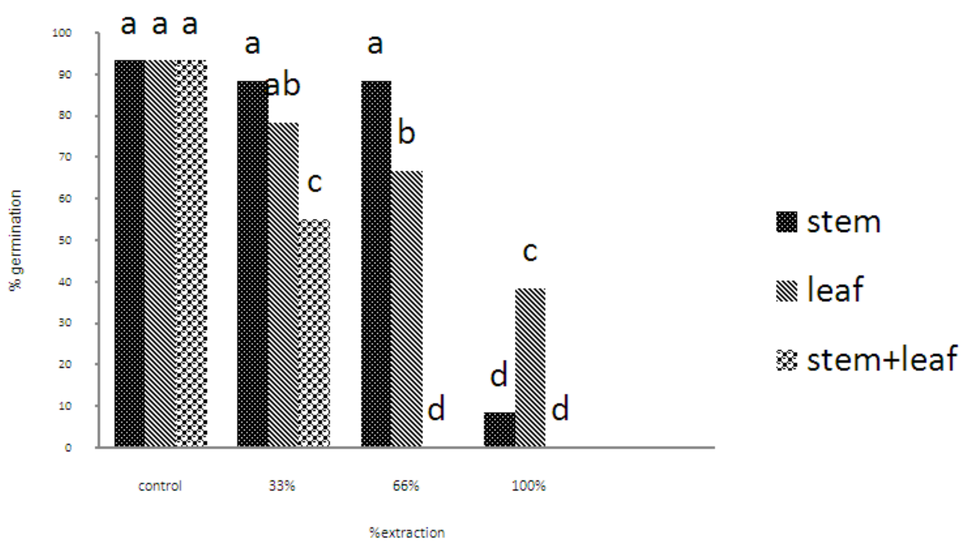

Fig. 1: Mean comparison of millet seeds germination percent as affected by different extract concentrations of bindweed vegetative parts.

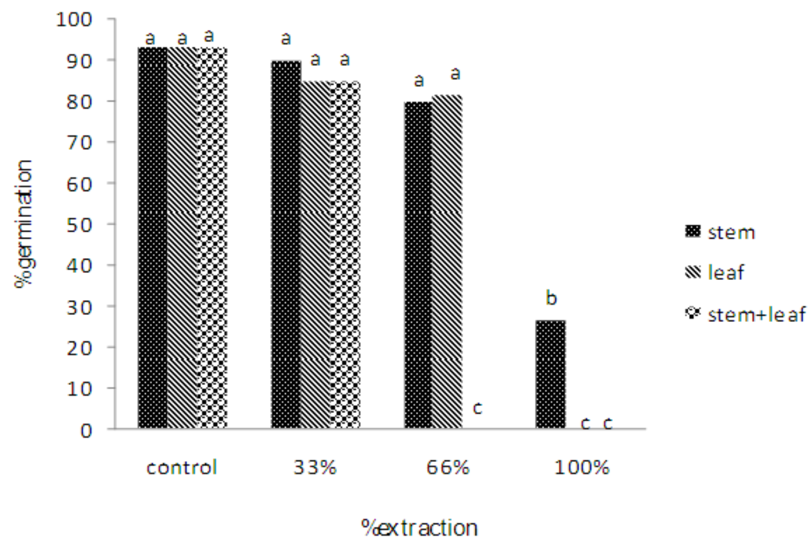

Fig. 2: Mean comparison of basil seeds germination percent as affected by different extract concentrations of bindweed vegetative parts.

Rate of germination:

Analysis of variance results in Tables 1 and 2 indicated that basil and millet germination rate was significantly affected by AE, P and interaction of treatments (AE × P) at 0.01 probability levels and this trait in both plants (millet and basil) significantly decreased with increasing of extract concentration of bindweed different vegetation parts (Fig 2 and 3). Millet seed germination rate in $AE_{33\%}$ and $AE_{66\%}$ of stem (P_{stem}) had no significant differences with control (Fig 2). Also in basil, this trait in $AE_{33\%}$ of P_{stem} and P_{total} had no significant differences with control (Fig 3) while other treatments significantly decreased germination rate in both plants (millet and basil) (Fig 2 and 3). Makkizadeh *et al.*, [10] showed that, purslane seed germination significantly decreased as affected by medicinal common rue (*Ruta graveolens*). Tanveer *et al.*, [20] reported that, germination rate in maize, barley, rice, wheat and sunflower was reduced by leaf leaches of *X. strumarium* L.

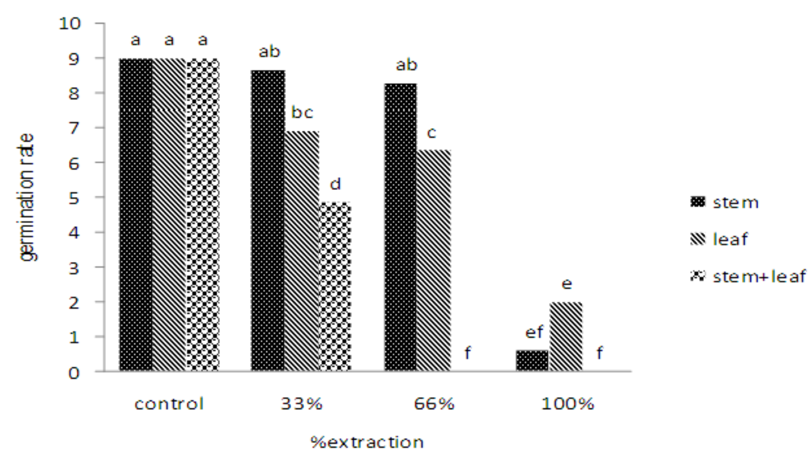

Fig. 3: Mean comparison of millet seeds germination rate as affected by different extract concentrations of bindweed vegetative parts.

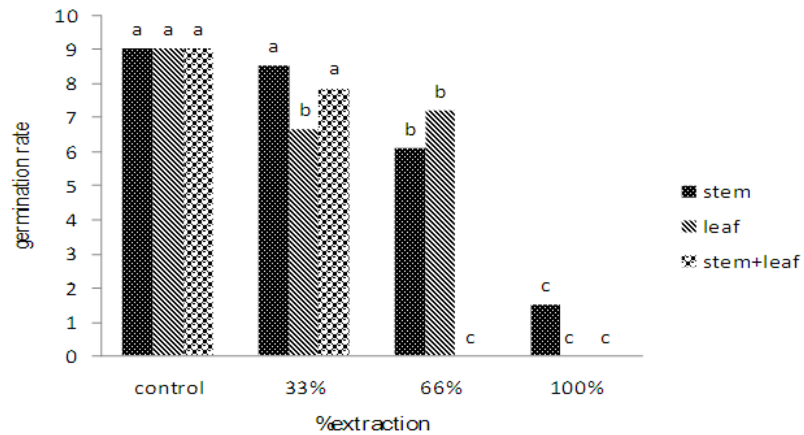

Fig. 4: Mean comparison of basil seeds germination rate as affected by different extract concentrations of bindweed vegetative parts.

Radicle and plumule length:

Based on statistical analysis results, plumule and radicle lengths significantly ($P < 0.01$) influenced by various aqueous extract concentrations (AE) of stems, leaves and whole parts (P) and interaction of treatments (tables 1 and 2). Plumule length of millet significantly decreased as affected by $AE_{100\%}$ of all vegetative parts (P_{stem}, P_{leaf} and P_{total}) as well as $AE_{33\%}$ and $AE_{66\%}$ of P_{total}. In contrast, millet plumule length increased as influenced by $AE_{33\%}$ and $AE_{66\%}$ of P_{stem} and P_{leaf} but this increase had no significant differences with control (Fig 5). $AE_{33\%}$ and $AE_{66\%}$ of P_{leaf} had positive effect on basil plumule length and this trait increased significantly as compared with control and other treatments (Fig 6). In contrast, $AE_{66\%}$ of P_{total} and $AE_{100\%}$ of P_{leaf} and P_{total} had a highest inhibitory effect on basil plumule length and completely inhibit plumule growth (Fig 6). Also, maximum radicle length of millet observed in $AE_{33\%}$ of P_{stem}. Radicle length of millet significantly decreased as influenced by $AE_{33\%}$ and $AE_{66\%}$ of P_{leaf} and P_{total} as well as $AE_{100\%}$ all vegetative parts (P_{stem}, P_{leaf} and P_{total}) (Fig 7). Also, basil radicle length significantly decreased as influenced by all treatments (Fig. 8). Among all treatments $AE_{33\%}$ of P_{stem} had the lowest inhibitory effect on radicle length and $AE_{100\%}$ of all parts (P_{stem}, P_{leaf} and P_{total}) had the highest inhibitory effects on this trait (Fig 7 and 8). Inhibition effect of different aqueous concentration of bindweed vegetative parts on basil plumule and radicle length was more than millet (comparison of fig 7 and 8). Bhowmik and Doll (1982) reported that aqueous extract of dried residue Lambs quarter, pigweed, greenbristle, and several foxtail species had inhibitory effect on corn roots elongation. The decrease in plumule length induced by allelochemicals might be due to either the prevention of cell division and enlargement or by reduction of the stimulatory growth controlling effects of IAA and GA_3 [23]. Moosavi *et al.* [13] found that, shoot and root length of *Vigna radiate* L. significantly decreased as

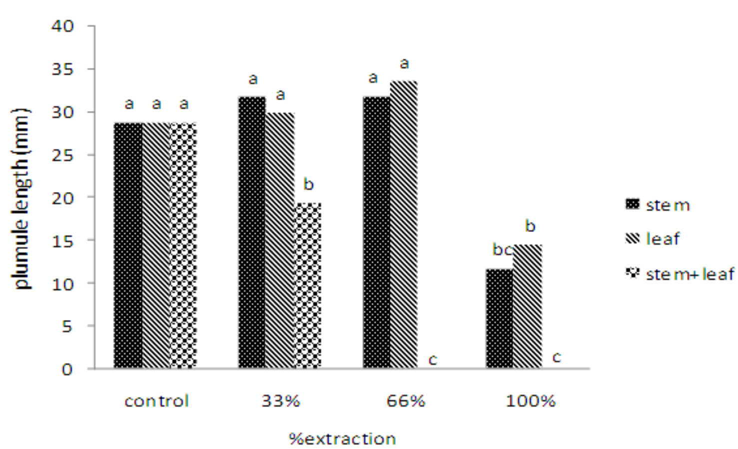

Fig. 5: Mean comparison of millet plumule length as affected by different extract concentrations of bindweed vegetative parts.

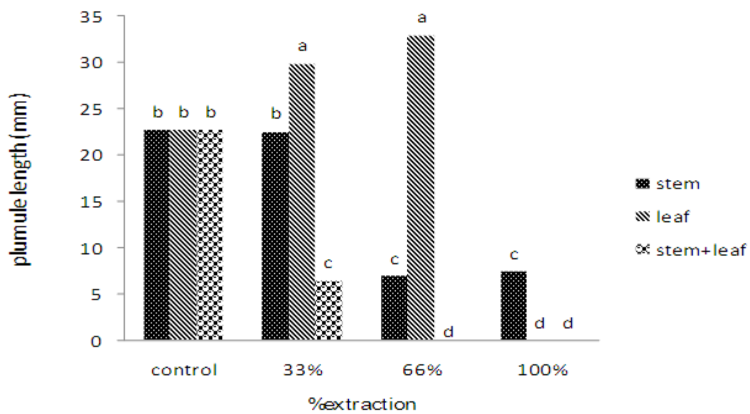

Fig. 6: Mean comparison of basil plumule length as affected by different extract concentrations of bindweed vegetative parts.

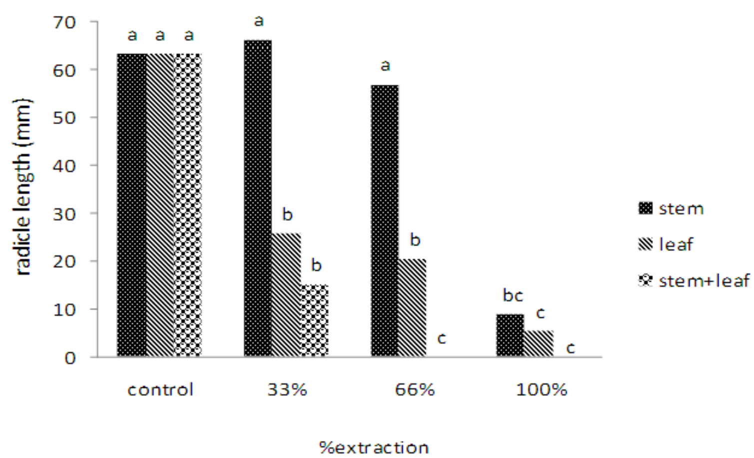

Fig. 7: Mean comparison of millet radicle length as affected by different extract concentrations of bindweed vegetative parts.

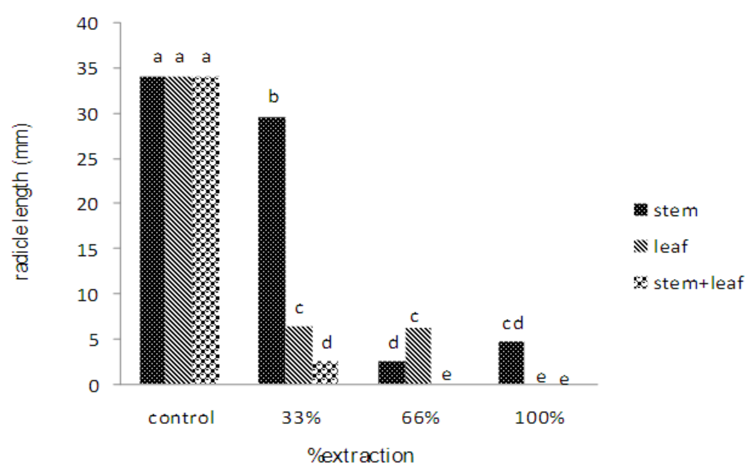

Fig. 8: Mean comparison of basil radicle length as affected by different extract concentrations of bindweed vegetative parts.

Radicle to plumule ratio:

Analysis of variance (ANOVA) results demonstrated that radicle to plumule ratio significantly ($P < 0.01$) influenced by different extract concentrations (AE) of different bindweed vegetative part (P) and interaction of them (AE × P) (Tables 1 and 2). Millet radicle to plumule ratio significantly decreased as affected by all treatments in except of $AE_{33\%}$ and $AE_{66\%}$ of P_{stem} (Fig 9). Both plants (millet and basil) radicle and plumule ratio inhibition were increased with increasing aqueous extract (AE) concentrations, in except for basil that this trait was increased from 0.31 to 0.61 with increasing extract concentrations of bindweed stem (P_{stem}) from $AE_{33\%}$ to $AE_{66\%}$ (Fig 9 and 10). In basil this trait significantly decreased as influenced by all treatment in except to $AE_{33\%}$ of P_{stem}. These results can be expected, because the radicle is the first organ that absorbs allelopathic materials directly from the environment and may be more influenced by the materials. Tanveer *et al.*, [21] found that, *Euphorbia helioscopia* infested soil significantly inhibited the seedling emergence, seedling vigor index, root to shoot dry weight and total dry weight of chickpea, wheat and lentil.

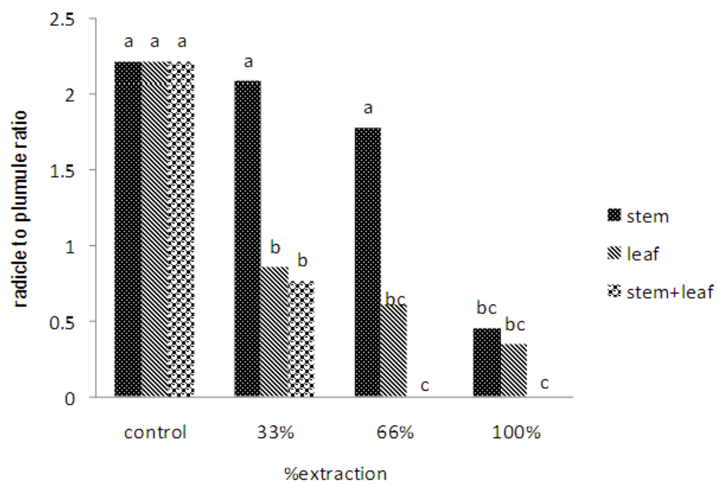

Fig. 9: Mean comparison of millet radicle to plumule ratio as affected by different extract concentrations of bindweed vegetative parts

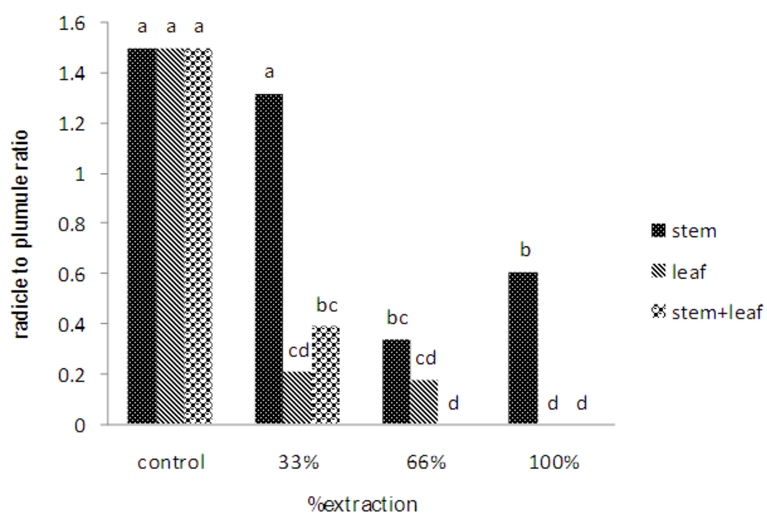

Fig. 10: Mean comparison of basil radicle to plumule ratio as affected by different extract concentrations of bindweed vegetative parts.

Seed vigor index:

The ANOVA for millet and basil seeds vigor data indicated that in similar to other studied characters, seed vigor significantly affected by all treatments (Table 1 and 2). Millet seed vigor decreased as influenced by all extract concentration ($AE_{33\%}$, $AE_{66\%}$ and $AE_{100\%}$) of bindweed leaves and whole vegetative parts (P_{leaf} and P_{total}) (Fig 11). In basil, this trait decreased as affected by all treatments except $AE_{33\%}$ of P_{stem} (Fig 12). In both plants minimum Seed vigor index observed in P_{total} and maximum of this trait observed in P_{stem} (Fig 11 and 12). Generally, in both millet and basil plants maximum inhibitory effect on seed vigor index observed in all extract concentrations of P_{total} that this results was expected according to the obtained result from germination characters and seedling growth.

Similarly, the interaction effects between treatments and weed species found significant. At 10 percent post flowering stage extract the weed species *Cynotis cuculata*, *Phylanthus niruri* and *Dinebra retroflexa* recorded lower seed vigor index (14.84, 103.99 and 112.66, respectively) [7].

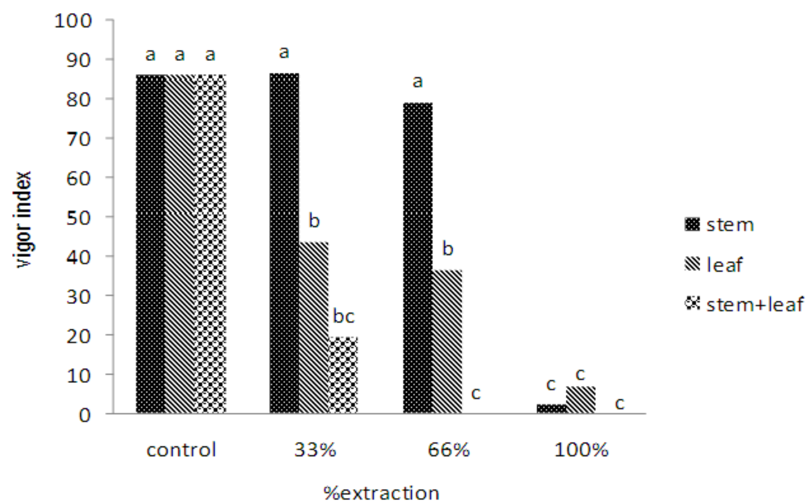

Fig. 11: Mean comparison of millet seed vigor index as affected by different extract concentrations of bindweed vegetative parts.

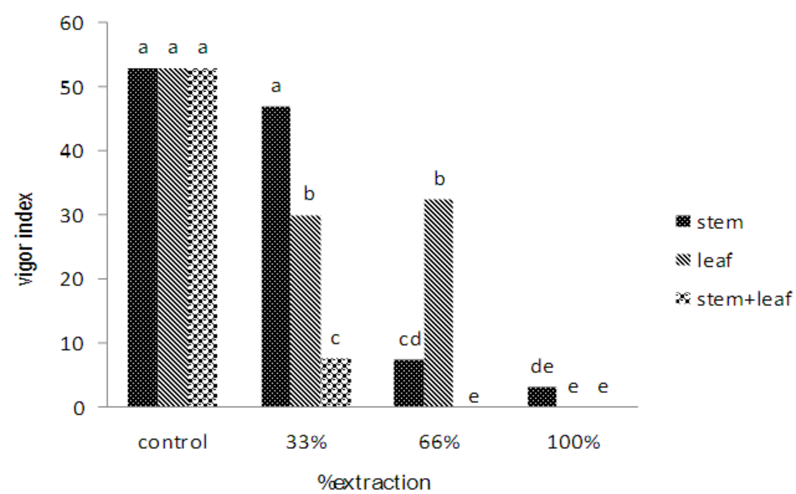

Fig. 12: Mean comparison of basil seed vigor index as affected by different extract concentrations of bindweed vegetative parts.

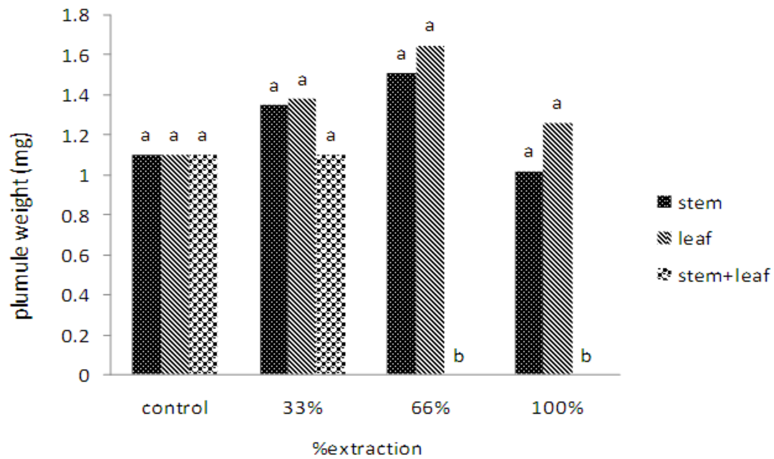

Fig. 13: Mean comparison of millet plumule weight as affected by different extract concentrations of bindweed vegetative parts.

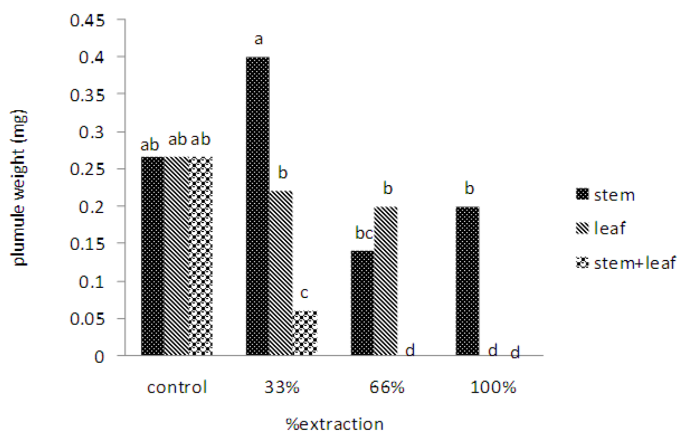

Fig. 14: Mean comparison of basil plumule weight as affected by different extract concentrations of bindweed vegetative parts.

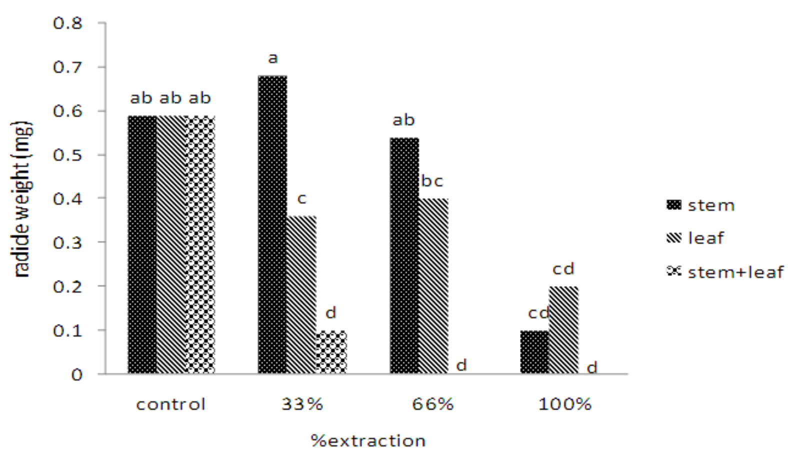

Fig. 15: Mean comparison of millet radicle weight as affected by different extract concentrations of bindweed vegetative parts.

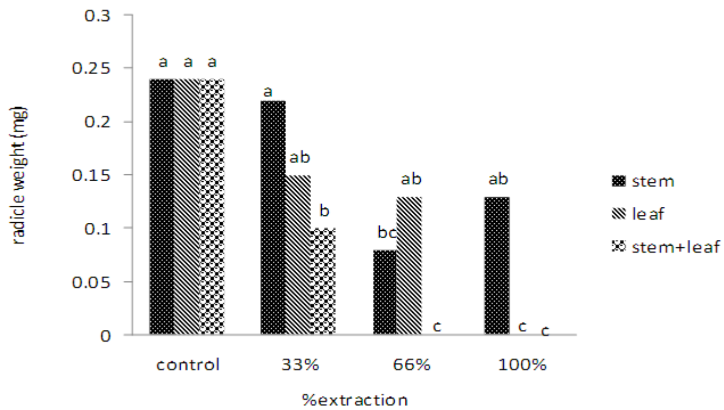

Fig. 16: Mean comparison of basil radicle weight as affected by different extract concentrations of bindweed vegetative parts.

Plumule and radicle dry weight:

ANOVA results of this study showed that, plumule and radicle weights significantly affected by all treatments and interaction of them (Table 1 and 2). Whole vegetative parts of bindweed had the highest inhibitory effect on millet radicle and plumule weights (Fig 13 and 15). Also, among different parts of bindweed whole vegetative parts (P_{total}) had the highest inhibitory effect on this trait in millet and basil. Millet plumule weight significantly affected by only $AE_{66\%}$ and $AE_{100\%}$ of P_{total} as compared with control (Fig 13). While this trait in basil significantly influenced by all extract concentrations of P_{total} as well as $AE_{100\%}$ of P_{leaf} (Fig 14).

Inhibitory effect of treatments on millet and basil radicle weight was more than Plumule weight (Fig 13 to 16), so that radicle weight of millet significantly decreased as influenced by all aqueous extract concentration of P_{total} and $AE_{100\%}$ of P_{stem}, and P_{leaf} as well as $AE_{33\%}$ of P_{stem}. Also, this trait in basil significantly decreased by all concentration of P_{total} as well as, $AE_{33\%}$ and $AE_{100\%}$ of P_{leaf}. Generally, some treatments such as $AE_{33\%}$ of P_{stem} and P_{leaf} and etc had positive effect on radicle and plumule weight of millet and basil (Fig 13 to 16). Dongre and Yadav [6] found inhibition in the length of plumule and radicle, a reduction in their dry weights and total seedling weights in wheat, pea and lentil with water extracts of various weeds.

Conclusion:

Results showed that, both millet and basil seed germination percent decreased with increasing of extract concentrations. The highest inhibition effect on germination and growth characters obtained by bindweed whole vegetative parts (P_{total}), while stem of bindweed (P_{stem}) had inhibitory effect on germination characters only in higher extract concentrations. Inhibitory effect of different bindweed extract on millet was more than basil. Therefore, our results indicated that vegetative parts of bindweed had various allelopathic effects on seed germination and seedling growth.

References

1. Abdul-Baki, A.A. and J.D. Anderson, 1973. Vigour determination in soybean by multiple criteria. Crop Science, 13: 630-637.
2. Alloli, T.B. and P. Narayan reddy, 2000. Allelopathic Effects of eucalyptus plant extracts on germination and seedling growth of cucumber. Karnataka Journal of Agriculture Science, 13(4): 947-951.
3. AOSA, 1983. Seed vigor hand testing book. Contribution No. 32 to the handbook on seed testing. Association of official seed analysis. Springfield, IL.
4. Batish, D., K. Lavanya, H. Singh and R. Kohli, 2007. Root mediated allelopathic interference of nettle leaved goosefoot (*Chenopodium Murale*) on wheat (*Triticum aestivum*). Journal of Agronomy and Crop Science, 193: 37-44.
5. Bhowmik, P.C. and J.D. Doll, 1982. Corn and soybean response to allelopatic effects of weed and crop residues. Agronomy journal, 74: 601-606.
6. Dongre P.N. and B. Yadav, 2005. Inhibitory allelopathic effect of weed leaf leachates on seed germination of pea (*Pisum sativum* L.). Crop Research Hisar, 29: 458-461.
7. Patil, C.K., 2007. Allelopathic effect of botanicals on major weeds of onion (*Alium Cepa* L.). M. S. thesis, University of Agricultural Sciences, Dharwad.
8. Ismail, B.S. and T.V. Chong, 2002. Effect of aqueous extract and decomposition of Mikania micrantha on selected agronomic crops. Weed Biology and Management, 2: 31- 38.
9. Khanh, D., T.D. Xuan and I.M. Chung, 2007. Rice allelopathy and the possibility for weed

management. Annals of Applied Biology, 151: 325-339.
10. Makkizadeh, M., M. Salimi and R. Farhoodi, 2009. Study of medicinal plant rue allelopathic effect on seed germination of three species of weeds. Iranian Journal of Medical and Aromatic Plants, 24(4): 463-471.
11. Mandava, N. B., 1985. Chemistry and biology of allelopathy agents. In A. C. Thomson (Ed.) The chemistry of allelopathy: Biochemical interactions among plants. Am. Chem. Soc., Washington DC, pp: 33-54.
12. Molisch, H., 1937. Der einfluss einer pflanze auf die andere allelopathie. Jena, Germany: Gustav Fischer.
13. Moosavi, A., R. Tavakkol Afshari, A. Asadi and M.S. Gharineh, 2011. Allelopathic effects of aqueous extract of leaf stem and root of sorghum bicolor on seed germination and seedling growth of *Vigna radiate* L. Notulae Scientia Biologicae, 3(2): 114-118.
14. Murthy, B.C., N.C. Prathibha and N. Thammaiah, 1995. Studies on alleloapthic effect of parthenium on sunflower and sorghum. World Weeds, 2: 161-164.
15. Oussama, O., 2003. Allelopathy in two durum wheat (*Triticum Durum* L.) varieties. Agric. Ecos. Eniviron, 96: 161-163.
16. Piskorz, B., 1997. Allelopathic effect of barnyard grass (*Echinocloa Crusgalli* L.) on some vegetable crops. I. Effect of aqueous extracts from *Echinocloa Crusgalli* L. on seed germination of cucumber, tomato and radish. Journal of Poolish Academy of Science, 452:153-165.
17. Rice, E.L., 1984. Allelopathy. 2nd Eds., Academic Press, New York, pp: 421.
18. Sasikumar, K., K.T. Prathiban, T. Kalaiselvi and Jagatram, 2002. Allelopathic effects of parthenium hysterophorus on Cyperus Rotundus on germination and growth of vegetables. Allelopathy Journal, 10(2): 147-152.
19. Siddiqui, S., Sh. Bhardwaj, Sh. Saeed Khan and M. Kumar Meghvanshi, 2009. Allelopathic effect of different concentration of water extract of Prosopsis Juliflora leaf on seed germination and radicle length of wheat (*Triticum Aestivum* Var-Lok-1). American-Eurasian Journal of Scientific Research, 4(2): 81-84.
20. Tanveer, A., M. Tahir, M.A. Nadeem, M. Youniss, A. Aziz and M. Yaseen, 2008. Allelopathy Journal, 21, 317-328.
21. Tanveer, A., A. Rehman, M.M. Javaid, R.N. Abbas, M. Sibtain, A. Ahmad, U.H. Ibin, M.S. Zamir, K.M. Chaudhary and A. Aziz, 2010. Allelopathic potential of *Euphorbia Helioscopia* L. against wheat (*Triticum Aestivum* L.), chickpea (*Cicer Arietinum* L.) and lentil (*Lens Culinaris Medic* L.). Turkish Journal of Agriculture, 34: 75-81.
22. Tinnin, R. and Ch. Muller, 2006. The allelopathic influence of Avena Fatua. The allelopathic mechanism. Bulletin of the Torrey Botanical Club, 99: 287-292.
23. Tomaszewski, M. and K.V. Thimann, 1966. Plant Physiology, 41: 1443-1454.
24. Vughan, D., and Ord, B. G. 1991. Extraction of potential allelochemicals and their effects on root morphology and nutrient content, pp. 399-421, *in* D. Atkinson (ed.). Plant Root Growth. Blackwell Scientific Publications, London.
25. Yarnya, M., A. Farajzadeh, V. Ahmadzadeh and N. Nobari, 2009. Lesser bind allelopathy effect on germination and growth of the wheat. Journal of New Agricultural Sciences, 4(11): 83-99.