Pak. J. Bot., 43(1): 351-355, 2011.

ALLELOPATHIC EFFECT OF SCARLET PIMPERNEL *ANAGALLIS ARVENSIS*) ON SEED GERMINATION AND RADICAL ELONGATION OF MUNG BEAN AND PEARL MILLET

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Abstract

The green house based experiments were conducted in the Department of Botany FUUAST, Karachi to study the allelopathic effects of root and shoot leachates of *Anagallis arvensis* on the two test species viz., bajra and mungbean. The percentage of seed germination, speed of germination and radical elongation of the test species were recorded after 10 days. Both leachates have no effect on seed germination and speed of germination of the test species. Radical elongation of two test species showed different response. Mung radical growth was significantly reduced while bajra radical growth was significantly enhanced by the root leachate of weed.

Introduction

The economy of Pakistan is depending upon the agriculture and most of the important crops are wheat, maize, rice, cotton etc. It is commonly known that weeds are responsible for substantial reduction in the yield of main crops of our country. Weeds are the unwanted plants and any plant competing with cultivated plants or that some other ways interfere with main legitimate activities is considered to be a weed (Nasir & Sultan, 2004). Many weeds and crops are capable of producing phytotoxic chemical compounds that can negatively influence the growth and productivity of surrounding plants (Evenari, 1949). The weed plants also compete with crop plants for light, water, nutrients, space and caused drastic effects on the yield of crops. Plants influence growth of each other by means of exudates, leachates or from the residue incorporated in the growing medium (Alam & Sheikh 2007, Colton & Einhelling, 1980; Rice, 1984). Allelochemicals may reach to the crop by leachates from foliage or by root exudation and the leaf extract also inhibit the germination in the different plants and cause the several root infections (Shaukat & Siddiqui, 2001). According to Jabeen & Ahmed (2009), the plants may exhibit inhibitory or rarely stimulatory effect on germination and growth of other plants in the immediate vicinity.

The phenomenon of allelopathy i.e., one higher plant is exerting a detrimental influence on another through the production of germination growth inhibiting substances have been widely reported (Martin & Rademacher, 1960; Muller & Muller, 1964; Naqvi & Muller, 1975; Friedman *et al.*, 1975; Bukhari, 1978). The possible allelochemicals involved in these interactions are phenols, terpens, glucoside etc. These water soluble allelopathic compounds of weed (leaf and root) are affected drastically on the other plants function, germination, radical elongation and shoot length. These allelochemicals may inhibit or enhance the radical growth and also affect on the germination. Therefore, a study was conducted to see the allelopathic effects of Scarlet pimpernel (*Anagallis arvensis)* on the seed germination and radical elongation of mung and bajra under green house conditions.

Vigna radiata L., mung bean, also known as green bean, mung or moong dal which is a native to Bangladesh, India and Pakistan and also found in hot and dry regions of South Europe and Southern U.S.A. The seeds are small, oval in shape and green in colour. The crop is grown in two seasons one is the Rabi season, (starting from November) and the other in the Kharif season (starting from June). It is a tropical crop. Mung bean also has the carbohydrate, protein, calcium, magnesium and phosphorus as nutritive ingredients.

***Pennisetum americanum* L., (Bajra):** This is a second test crop is commonly known as pearl millet, bajra (India) and dukn (Sudan). It has originated in central tropical Africa, India and widely distributed in the dry region of the world. Season of growth is in early summer. Pearl millet cultivation is dispersed mainly during Kharif (Rainy) season in our whole country. The plant is grown in area with an average annual rainfall of 125–900 mm. Seeds are very small from 3–10 mg in weight. Seeds are ready to harvest just three to four weeks after anthesis. Most crops of pearl millet are sown in rows and where as fodder crops are grown in high densities and thus the crop canopy suppress weed growth. The yield of crop pearl millet vary in different region due to rainfall, soil type and varies from season to season.

Pearl millet is an important grain crop in Africa, the stalks are used in the dry tropics for home building and also used as a cereal. The crop would thus escape drought and could be planted several times in a year, if conditions are favorable.

***Anagallis arvensis* Linn., (Scarlet pimpernel):** A common weed in wheat and winter vegetable. It is much branched weed with 20-45cm height (Alam *et al*., 2001). It is widely distributed throughout the world being found in all temperate regions in both hemispheres. The common varieties of *Anagallis arvensis* are growing in Persia, Nepal, China, Mauritius, USA and Chile. The plants have square stem, have their egg shaped stalkless leaves, sessile and arranged in pairs, the leaves always keep their faces turned to the light. The pimpernel flower initiated in May until late into August. The flower appears singly, solitary axillary, red, blue and purple in colour. Thin stalk which are erect during flowering, but curved backward when the seeds are ripening. As the autumn approached, the fruit in the center of each flower swells and ripens. It is in the form of a little capsule, full of countless tiny seeds. The seeds of the plant, which are very numerous and enclosed in small capsule are brown in colour. The weed produces many thousand seeds per plant. The seeds generally remain viable in the soil for about 10 years. This weed completes with wheat crop in early stage of its growth (Alam *et al*., 2001).

Medicinal purpose: The ancient reputation of Scarlet pimpernel has survived to the present day especially in dealing with disease of brain and epilepsy. The flowers have also been found useful in epilepsy. It is of a cordial sudorific nature and a strong infusion of it has been considered an excellent medicine in feverish complaints. Modern authorities consider that caution should be exercised in the use of this herb for dropsy, rheumatic affection, hepatic and renal complaints. The objective of present work was to investigate any possible role of allelopathy on the germination and length of radical of mung and bajra, using root and shoot leachates of this weed and to compare the rate of germination and the radical elongation of the test crops by the application of root and shoot leachates of weed *Anagallis arvensis*. The test crops were mung bean and pearl millet and the weed was *Anagallis arvensis*.

Materials and Methods

The experiments were conducted at the green house and in the laboratory of the Department of Botany, Federal Urdu University, Karachi. Weed plants were grown in the pots and before flowering, root leachate was obtained by adding 500ml distilled water in each pot. A beaker was kept below each pot and the solution obtained was of root leachate. The mixture was filtered by the Whatman No. 42 filter paper. The filtrate or root leachate was stored in a refrigerator at 20˚C for further experimentation.

Similarly, the leaf leachates of the weed plants were obtained in the pots, and before the flowering, 500ml distilled water was sprayed gradually which lasted for 30-40 minutes and then the leaf leachates collected (Shoukat *et al.*, 1983). The leachate was filtered and kept for the further experimentation in a refrigerator.

Healthy seeds of moong (*Vigna radiata* or *Phaseolus aureus*) and bajra (*Pennistum americanum*) were collected from local Agriculture store. Seeds were surface sterilized with 1% sodium hypochlorite solution for 5-10 minutes then rinsed thoroughly with distilled water for many times to remove the excess amount of chemical, before use for the experimental work.

Seed germination under both root and shoot leachates and control condition was performed in the laboratory with five replicates. The trial was completed in ten days, and data on germination and radical elongation were recorded.

Ten sterilized seeds were evenly placed on the filter paper in sterilized Petri dishes (9cm). The Petri dishes were placed in growth chamber. Germination was determined by counting the number of germinated seeds at 48-h intervals and radical length was measured after every alternate days. Root length of the seedlings were recorded. Seed germination in percentage, speed of germination 'S' (Khandakar & Bradbeer, 1983), root lengths were calculated by the following formula.

$$S = [\ N1/1 + N2/2 + N3/3 \ldots.. N/n\ ] \times 100/1$$

where N1, N2, N3, …..N = Proportion of seed which germinate on days 1, 2, 3 …. N following setup of the experiment.

Mean and standard error were compared and presented in Tables 1 & 2.

Statistics and data analysis: The treatments in all experiments were laid out in RMD (Repeated Measured Design) by SPSS version 10 with five replicates. Data of germination percentage and root length analyzed by Wilks' Lambeda, Pillai's trace occur in multi variate test.

Results and Discussion

Table 1 showed that leaf leachate and root leachate have no effects on percentage germination of both test species. Speed of germination index of mung increased under shoot leachate (rainfall) compared to control, while showed no effect with root leached. In pearl millet the speed of germination showed no significant difference with control and other treatments. This showed that for germination phenomenon, there was a tolerance behavior in mung and bajra seeds. Seed germination is considered to be the most critical stage of plant development and growth; the necessities of seed germination of any crop area water for hydrolysis of reserves, hydration of enzymes for operational confirmation of cell membrane and organelles and finally to provide the force for cell expansion induced by germination (Alam & Shaikh, 2007). After the germination test, the data of radical elongation was used as an indicator of test species response (Barnes & Putnam, 1987; Leather & Einhelling, 1986). Radical length of mung decreased under root leachate, which showed allelopathic effect of the weed, while the leaf leachate did not show any considerable difference compared with control. Root and shoot leachates of weed positively affected and enhanced the radical length of bajra. Both species showed different response with leaf and root leachates. Root leachate of weed suppressed the radical growth of mung while enhanced the growth of bajra. Similar findings have been reported by other. Rice (1986) reported that the stimulatory effect were likely to emerge either from growth promoting compounds in the tissues themselves or enhanced microbial activity.

Table 2 shows multivariate test in repeated measured design. The observations at different time periods were not independent, therefore factorial analysis of variance (FANOVA) was not applicable so the repeated measure design was chosen, because it was more suitable for this situation. The significant differences among treatments for radical elongation in ten days ($F = 183$, $p<0.001$) in bajra have indicated the allelopathic effects of the weed. These results showed that root leachate of weed significantly enhanced the radical growth of bajra. Jabeen *et al*., (2011) reported the allelopathic effect of bajra on weed *Asphodelus tenuifolius,* where the weed growth was suppressed by this crop species. In our case, the growth of weed *Anagallis arvensis* was also suppressed by bajra. This gives additional support to the opinion that some crops reduce the growth of some weeds due to their allelopathic ability. On the basis of this trial it was suggested that presence of *Anagallis arvensis* should be ignored for growing bajra crop, while control measures should be taken in mung field. Mung radical elongation was significantly ($F=107$, $p<0.001$) suppressed by allelopathic effect of this weed.

Table 1. Effects of leachate of *Anagallis arve*nsis on the germination and radical length of radical of bajra/ mungbean.

Treatments	Germination (%)		Speed of germination index “S”		Mean length of radical (cm)	
	Mung	Bajra	Mung	Bajra	Mung	Bajra
Control	100 ± 0.0	100 ± 0.0	96	94	6.676, ± 0.16036	1.9095, ± 0.10460
Rainfall	100 ± 0.0	100 ± 0.0	100	94	6.0384, ± 0.23800	2.4004, ± 0.04860
Root leachate	100 ± 0.0	100 ± 0.0	95	96	3.4028, ± 0.10871	2.448, ± 0.16102

Table 2. General Linear model effect of weed (*Anagallis arvensis*) on radical elongation of test species of bajra and mung.

Test species		Effect	Value	F	Hypothesis	Error df	Sig.
Bajra	Day	Pillai’s Trace	0.836	183.757[a]	4.000	144.000	0.001
		Wilks’ Lambda	0.164	183.757[a]	4.000	144.00	0.001
Mung	Day	Pillai’s Trace	0.750	107.045[a]	4.000	143.000	0.001
		Wilks’ Lambda	0.250	107.045[a]	4.000	143.00	0.001

References

Alam, S.M. and A.H. Shaikh. 2007. Influence of leaf extract of common purslane (*Portulaca oleracea* L.) and Sodium chloride salinity on germination and seedling growth of rice (*Oryza sativa*, L.cv.IR-8). *Int.J.Biol. Biotech*., 4(4): 407-409.

Alam, S.M., S.A. Ala, R. Ansari and M.A Khan. 2001. Influence of weed seed of *Scarlet pimpernel, Anagallis arvensis*, Primulaceae on wheat seedling growth. *Balochistan. J. Agric. Sci*., 2: 45-47.

Barnes, J. and A.R. Putnam. 1987. Role of benzoxazinoues in allelopathy by rye (*Secale cereal* L.). *J. Chem. Ecol*., 13: 889-906.

Bukhari, U.G. 1978. Allelopathy among Prairie grasses and its possible ecological significance. *Ann. Bot*., (5)42: 127-137.

Colton, C.E. and F.A. Einhellig. 1980. Allelopathic mechanism of velvetleaf (*Abutilon theophrastic* Medic. Malvaceae) on soyabean. *Am. J. Bot*., 67: 1407-1413.

Evenari, M. 1949. Germination inhibitors. *Bot. Rev*., 15: 153-194.

Friedman, J., G. Orshan and Y. Ziger-Cfir. 1975. Suppression of annuals by *Artemisia berba-alba* in Negev desert of Israel. *J. Ecol*., 65: 426-431.

Jabeen, N. and M. Ahmed. 2009. Possible allelopathic effect of three different weeds on germination and growth of maize. *Pak. J. Bot*., 41(4): 1677-1683.

Jabeen, N., M. Ahmed and S.S. Shaukat. 2011. Interactive activity of *Asphodelus tenuifolius* on germination and growth of wheat (*Triticum aestivum* L.) and Sorghum (*Sorghum bicolor* L.). *Pak. J. Bot*., In Press.

Khandakar, A.L. and J.W. Bradbeer. 1983. Jute seed quality. Dhaka, Bangladesh Agricultural Research Council.

Leather, G.R. and F.A. Einhellig. 1986. Bioassays in the study of Allelopathy. In: *The science of Allelopathy*. (Eds.): A.R. Putnam and C.S. Tang, Jhon Wiley and sons: pp. 133-145.

Martin, P and B. Rademacher. 1960. Studies on the mutual influences of weeds and crops. In: *The Biology of Weeds* (Ed.): J.L. Harper, 143-152.

Muller, W.H. and C.H. Muller. 1964. Volatile growth inhibitors produced by *Salvia* species. *Bull. Torrey Bot. Club*, 91: 327-330.

Naqvi, H.H. and C.H. Muller. 1975. Biochemical inhibition (Allelopathy) exhibited by Italian ryegrass(*Lolium multiflorium* L.). *Pak. J. Bot*., 7(2): 139-147.

Nasir, Z.A. and S. Sultan. 2004. Survey of weeds in mustard fields of district Chakwal. *Pakistan. J. of Biological Sciences*, 7(2): 279-286.

Rice, E.L. 1984. *Allelopathy* 2nd Ed. Academic Press, Orlando, Florida, USA.

Rice, E.L. 1986. Allelopathic growth stimulation. In: *The Science of Allelopathy*. (Eds.): A.R. Putnam and C.S.Tang. NewYork. John Wiely & Sons.

Shaukat, S.S., D. Khan and I.A. Siddiqui. 2001. Effect of some phenolic compounds on survival, infectivity and population density of *Meloidogyne javanica* in mungbean. *Nematol Medit*., 29(2): 123-126.

Shaukat, S.S., D. Khan and S.T. Ali. 1983. Suppression of herbs by *Inula grantioides* Bioss., in the Sindh desert, Pakistan. *Pak. J. Bot*., 15 (1): 43-67.

(Received for publication 28 April 2010)