ALLELOPATHIC INFLUENCE OF TWO DOMINANT WEEDS ON AGRICULTURAL CROPS OF MIZORAM, INDIA

Munesh Kumar[1], Siiolyne Siangshai[1] and Bhupendra Singh[2]

ABSTRACT

Aqueous leaf of two dominant weeds (Eupatorium odoratum and Ageratum conyzoides) of Mizoram north-east, India were tested for their allelopathic influences on germination and radicle extension of test crops (Oryza sativa, Brassica campestris and Glycine max). The germination and radicle extension of B. campestris was completely inhibited by E. odoratum and A. conyzoides. The germination of G. max was inhibited (8.04%) under E. odoratum and stimulated (14.94%) under A. conyzoides compared with control. The germination of O. sativa was not affected by any of the two weeds studied, however, the radicle growth wa s inhibited to the extent of 41.68% and 17.02% under E. odoratum and A. conyzoides, respectively, compared with control. The radicle growth of G. max was also inhibited by 10.71% under E. odoratum and stimulated by 3.96% under A. conyzoides. E. odoratum was found more toxic weed for the selected test crops. The tolerance of the test crops to the extracts in the decreasing order was Oryza sativa > Glycine max > Brassica campestris.

Key words: Allelopathic effects, aqueous leaf extract, germination, radicle growth.

INTRODUCTION

Under field conditions, weed infestation is one of the major causes of yield reduction in crops. De Candolle (1932), for the first time reported the injurious effects of root exudates of Canada thistle (*Cirsium arvense* (L.) Scop.), on the growth of neighbouring oat plants. Later on, allelopathic potential of numerous weeds on the crops has been reported (Schreiber and Williams, 1967; Buchholtz, 1971; Rasmussen and Einhellig, 1975; Steenhagen and Zimdahl, 1979).

[1] Department of Forestry, Mizoram University, Mizoram Aizwal- 796009 - India,
E mail muneshmzu@yahoo.com (Corresponding author)

[2] Department of Forestry, HNB Garhwal University, Srinagar Garhwal, Uttarakhand - India.
E-mail: butola_bs@yahoo.co.in.

Most of the weed species have inhibitory effects on crops; yet, some weed species also exhibited stimulatory effects on the seed germination, growth and yield of crops. The weeds influence the crop plants by releasing phytotoxins from their seeds, decomposing residues, leachates, exudates and volatiles (Narwal, 2004).

The role of allelopathy in agriculture has been extensively reviewed (Rice, 1974), and studies have been conducted by various workers to demonstrate the nature of allelopathic effects of weeds on crops (Tukey, 1969; Putnam and Duke, 1974).

Generally perennial weeds of field crops in many countries of the world (Holm, *et al.*, 1979), whose allelopathic effects have been studied the most, cause serious reductions in the yields of maize, oat, soybean and potato (Isleib, 1960; Bandeen and Buchholtz, 1967; Kommedahl *et al.*, 1970), because their infested soil and plant residues decrease seed germination and growth of crops.

In north-eastern Himalaya, agricultural crop fields are extensively invaded by weeds. As the phytotoxic studies of weeds on agricultural crops have not yet been documented so far from this part of the world, an attempt has been made to study the phytotoxic influences of some dominant weeds species on growth of some field crops of the region.

Allelopathic interactions in traditional agroforestry systems gained prominent attention of scientists involved in allelopathy research (Todaria, *et al.*, 2005, Singh *et al.*, 2007). The volatile allelochemicals released from many other plant species can effect the growth and productivity of plants in the vicinity (Basotra, *et al.*, 2005, , Singh *et al.*, 2006 and Tahir Nazir, *et al.*, 2007). The allelopathic effects of different weeds *Amaranthus retroflexus, A. gracilis* and *A. blitoides* by Qasem (1995), *Cynodon dactylon* by Oudhia (1999) and *Chenopodium album* by Jafari and Kholdebarin (2002) observed in pot culture, nutrient solution culture, glasshouse and field experiments. Dongre and Singh (2007) also reported that leaves leachates of *Amaranthus viridis, Parthenium hysteroporus* and *Polygonum plebeium* significantly inhibited the growth of *Triticum aestivum*.

MATERIALS AND METHODS

To examine the allelopathic influences of *Eupatorium odoratum* (L), and *Ageratum conyzoides* (L) on test crops; *O. sativa, B. campestris* and *G. max* the experiment was conducted in the Department of Forestry, Mizoram University campus, India, which is located between 92^0 38'to 92^0 42' E longitude and 23^0 42' to 23^0 46' N latitude at an elevation of 900 m above sea level.

Mature leaves of *E. odoratum* and *A. conyzoides* were collected and sundried leaves ground separately in a mechanical grinder. A sample of 2 g of each species was weighed and added 100 ml double distilled water for 2% solution and left for 24h at (25±2^{0}C) room temperature in the month of May 2006. The resulting brownish solutions were filtered through three layers of Whatman No.1 filter paper and stored in dark cool place in conical flask.

The effects of the leachate on seed germination and radicle growth were tested at 30^{0}C temperature by placing 20 seeds of *O. sativa*, *B. campestris* and *G. max* in Petri dishes (five replicates) containing three layers of Whatman No.1 filter paper saturated with the leachate. A separate control series was set up using distilled water. Moisture was maintained in Petri dishes by adding leachate or distilled water, respectively when required. The number of seeds germinated was counted 7 days after which the observation ceased. Mean Germination Time (MGT) and Germination Index (GI) were calculated by using the formulae given by Ellis and Roberts (1981) as mean germination time (MGT)= $\sum D_n / \sum_n$ where *n*= number of seeds germinated on day D (D representing the number of days since the sowing of seeds) and Kendrick and Frankland (1969) as germination index (GI)=Total germination percent / time (hours) taken for 50% germination. The seedlings vigour index (SVI) was calculated according to Abdul-Baki and Anderson (1973) as seedlings vigour index (SVI) = Percent germination X radicle length (cm). Duncan's multiple range test and analysis of variance (Sharma, 1998) were also run to record the significance between means of treatments.

RESULTS AND DISCUSSION

Germination percent

The germination percent of *O. sativa* did not show toxic effect under aqueous extract of *E. odoratum* and *A. conyzoides* as compared with control (Table 1). The percent germination of *B. campestris* was completely suppressed under aqueous extract of *E. odoratum* and *A. conyzoides*, whereas, under control the germination was 100 %. The germination of *G. max* was 100% under *A. conyzoide*, 80.0 % *E. odoratum*, while 87% its germination was recorded under the untreated check (Table 1). The cumulative germination of test crops for seven days is given in Fig 1. Untreated seeds (control) germinated comparatively quickly and 100per cent germination was observed in *O. sativa* within 2 day while, in *B. compestris* and *G. max* 55 and 63 % germination was recorded in first day. Germination reached 100 % within next two days in *B. compestris* and 87.0 % in *G. max* after 5 days in control. However, germination started on first day under *E. odoratum* (73.0%) and *A. conyzoides* (71.0 %) in *G. max* on the second day it was 100 % in under *A. conyzoides* and 80 .0 percent under *E. odoratum* at 4 days. The germination percent of *O. sativa* under treatment of *E. odoratum* and *A. conyzoides* reached 100 % within three days, while, leachates of the same species completely inhibited the germination of *B. compestris* (Fig 1).

Radicle length

Similarly, radicle growth of each test crops was recorded under each treatment of *E. odoratum, A. conyzoides* and control. Among the crops the maximum (41.68 %) reduction was recorded for *O. sativa* under *E. odoratum* and *A. conyzoides* it reduce 17.02 % over control. The reduction percent of both weeds was found significant different from each other ($p<0.05$) as compared with to the control (Table 2).

In *B. campestris* none of the seeds was observed for radicle growth under *E. odoratum* and *A. conyzoides*. The radicle growth of *G. max* was 16.01±1.00 under *A. conyzoides* which was stimulated (3.96 %) over control. Similarly radicle growth of same crop under *E. odoratum* was 13.75±4.35 cm which was reduced (10.71 %) as compared with control (Table 2). The cumulative radicle of all test crops as compared with the control is presented in Fig 2. Radicle protrusion was the indicator for seed germination and the growth of the radicle was significantly increased with increasing days or germination periods (Fig 2).

Effects of leaf leachate of various weeds on germination, and radicle and plumule extension of field crops have also been reported earlier (Sugha, 1980; Singh *et al.* (1989). The present findings suggested that *E. odoratum* was most toxic agricultural weed and *B. campestris* was the most suppressed agricultural test crop, whereas *G. max* and *O. sativa* were resistant crops. Singh *et al.* (1989) studied allelopathic effects of aqueous extracts of *Imperata cylindrica*, *Ageratum conyzoides* and *Commelina benghalensis* on germination and vigour of soybean and maize. Aqueous extracts of seeds, leaf, root of *Ageratum conyzoides* reduced the germination of wheat in order of inhibition leaf> root> stem (Sugha, 1980). Its aqueous extracts delayed the germination and decreased the root and shoot elongation and number of leaves in chickpea (Angiras, *et al.*, 1988). Gantzer (1960) has reported that endogenous phenolics posses only stimulatory properties and act as analogues of growth hormones and affect growth and physiological properties. The species *Eupatorium odoratum* (L.) and *E. adenophorum* (Sprengel) showed allelopathic effects in wheat, mustard, chickpea and white clover (Datta and Bandopadhya, 1981; Tripathi *et al.*, 1981; Angiras *et al.*, 1988). Leaf extracts of *Eupatorium odoratum* drastically reduced the growth of wheat and mustard seedlings (Datta and Bandopadhaya, 1981).

Mean germination time (MGT) and germination index (GI) of different test crops were also computed when treated with leaf extracts of weeds.

Mean germination time (MGT) directly expresses the rapidity of the germination and lower the mean germination time faster is the germination. Germination index (GI) is directly correlated with germination percentage. Thus greater the value of GI, the greater will be germination percentage. The results of present investigation reveal that *G. max* was more resistance and *Oryza sativa* was moderately resistant, while, *B. campestris* was more susceptible among the test crops. It is also evident from the data of mean germination time, germination index (Table-1) and seedling vigour (Table-2).

ACKNOWLEDGEMENT

Authors are thankful to the editors of the journal for improvement of paper contents and necessary modifications

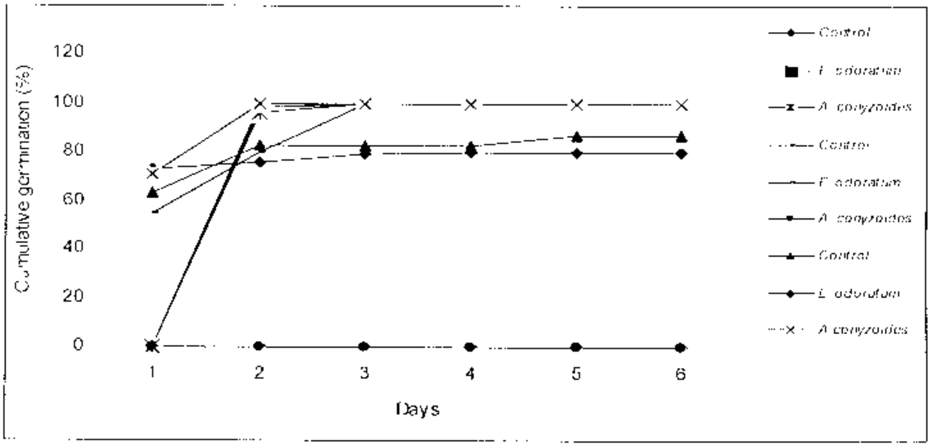

Fig.-1. Cumulative germination of test crops under leaf leachate of weeds.

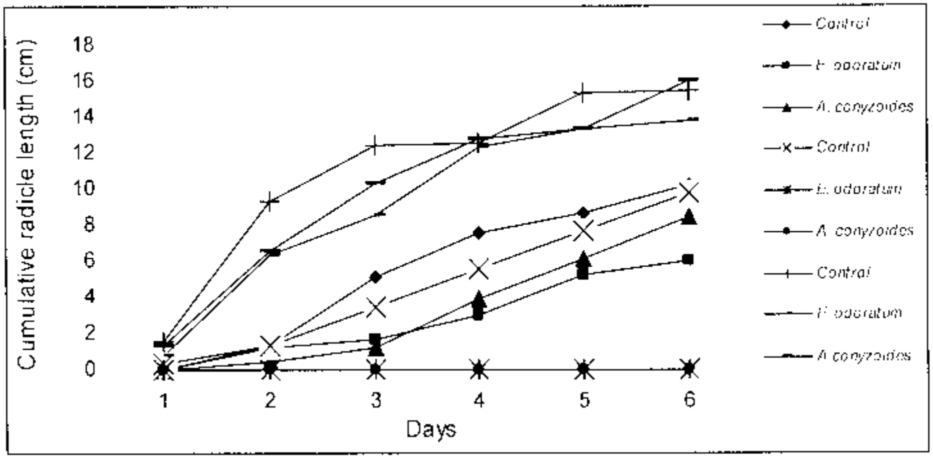

Fig.- 2. Cumulative radicle growth of test crops under leaf leachate of weeds.

Table-1. Effects of weed extracts (2%) on germination, mean germination time (MGT) and germination index (GI) of test crops.

Test crops	Germination (%)			MGT			GI		
	Eupatorium odoratum	*Ageratum conyzoides*	Control	*Eupatorium odoratum*	*Ageratum conyzoides*	Control	*Eupatorium odoratum*	*Ageratum conyzoides*	Control
Oryza sativa	100.0a3 (0.00)	100.0a (0.00)	100.0a	2.02ab	2.04a	2.00^b	2.08^a	2.08^a	2.08^a
Brassica compestris	0.00 (0.00)	0.00 (0.00)	100.0	0.00	0.00	1.65	0.00	0.00	4.17
Glycine max	80.0b (8.04)	100.0a (+14.94)	87.0ab	1.15b	1.29ab	1.47a	3.33b	4.17a	3.63^b

The data in parenthesis indicate % inhibition/ +stimulation over control.

Table-2. Effects of weed extracts (2%) on radicle length (cm) and seedling vigour index (SVI) of test crops.

Test crops	Radicle growth (cm)			SVI		
	Eupatorium odoratum	*Ageratum conyzoides*	Control	*Eupatorium odoratum*	*Ageratum conyzoides*	Control
Oryza sativa	5.96±1.18c4 (41.68)	8.48±1.37b (17.02)	10.22±1.05a	596.0b	848.0a	1022.0a
Brassica campestris	0.00 (100.0)	0.00 (100.0)	9.79±1.90	0.00	0.00	979.0
Glycine max	13.75±4.35a (10.71)	16.01±1.00a (+3.96)	15.40±2.71a	1100.0b	1601.0a	1339.80^{ab}

The data in parenthesis indicate % inhibition/ +stimulation over control.

[3,4]Means in a row sharing different letter indicate statistical difference by LSD test at $P \leq 0.05$.

EFERENCES CITED

Abdul-Baki, A. A. and J. D. Anderson. 1973. Relationship between decarboxylation of glutamic acid and vigour in soybean seeds. Crop Sci. 13: 222-226.

Angiras, N. N., S. D. Singh, and C.M. Singh. 1988. Allelopathic effects of some weeds on germination and growth of chickpea. Ind. J. Weed Sci. 20: 85-87.

Bandeen, J. D. and K.P. Buchholtz. 1967. Competitive effects of quack grass upon corn as modified by fertilization. Weeds 15: 220-224.

Basotra, R., Shashi Chauhan and N.P. Todaria. 2005. Allelopathic effects of medicinal plants on food crops in Garhwal Himalaya. J. Sust. Agric. 26(3):43-56.

Buchholtz, K. P. 1971. The influence of allelopathy on mineral nutrition. *In*: Biochemical Interactions among Plants, Pp. 86-89. Environmental Physiology subcommittee for the International Biological Programme, Div. Biol. Agric., National Res. Council, National Acad. Sci. Washington DC.

Datta, S. C. and A.K. Bandyopadhaya. 1981. Proc. 8th Asian Pacific Weed Sci. Soc. Conf. 1: 391-399

De Candolle, M.A.P. 1932. Physiologie Vegetale. Tome III, Bechet Jeune, Paris pp. 1474-1475.

Dongre, P.N. and A.K Singh. 2007. Inhibition effects of weeds on growth of wheat seedlings. Allelopathy J. 20(2): 387-394.

Ellis, R.H. and E. H.Roberts. 1981. The quantification of aging and survival in orthodox seeds. Seed Sci. & Technol. 9: 373-409.

Gantzer, E. 1960. Wirkungen Von kumarin anf wachstums and Entmicklung svorgang and since wanderrungs. Fahigkeit in pjinzengewelc. Planta 55:235.

Holm, L., J.V. Pancho, J. P. Herberger and D.L. Plucknett. 1979. A Geographical Atlas of World Weeds. John Wiley and Sons, New York.

Isleib, D. R. 1960. Quackgrass control in potato production. Weeds 8: 631-635.

Jafari, L. and B. Kholdebarin. 2002. Allelopathic effects of *Chenopodium album* L. extracts on nitrification. J. Plant Nutr. 25:671-678.

Kalita, D., H. Chaudhary and S.C. Dey 1998. Assessment of allelopathic potential of some common upland rice weed on morphophysiological properties of rice (*Oryza sativa* L.) plant. Current Res. (Hisar) 17: 41-45.

Kendrick R.E. and B. Frankland. 1969. Photocontrol of germination in *Amaranthus caudatus*. Planta 85: 326-329.

Kommedahl, T., K.M. Old, J.H. Ohman and E.W. Ryan 1969. Quackgrass and nitrogen effects on succeeding crops in the field. Weed Sci. 17: 29-32.

Narwal, S. S. 2004. Allelopathy in crop Production, Scientific Publishers, Jodhapur, India.

Nazir, T. A.K. Uniyal and N.P. Todaria. 2007. Allelopathic behavior of three medicinal plant species on traditional agriculture crops of Garhwal Himalaya, India. Agroforestry Systems 69:183-187.

Oudhia, P. 1999. Allelopathic effects of some obnoxious weeds on germination and seedling vigour *Lathyrus sativus*. Fabis Newsl. 42: 32-74.

Putnam. A. R. and W.B. Duke. 1974. Biological suppression of weeds: Evidence for allelopathy in accessions of cucumber. Science 185: 370-71.

Qasem, J.R. 1995. The allelopathic effects of three *Amaranthus* spp. (pigweeds) on wheat (*Triticum durum*). Weed Res. 35:41-49.

Rasmussen, J. A. and F.A. Einhellig. 1975. Non competitive effects of common milkweed, *Asctepias syriaca* L., on germination and growth of grain sorghum. American Midl. Nat. 94: 478-483.

Rice, E. L. 1974. Allelopathy. Academic Press, New York.

Schreiber, M. M. and J.L. Williams Jr. 1967. Toxicity of root residues of weed grass species. Weeds 15: 80-81

Sharma, J.R. 1998. Statistical and Biometrical Techniques in Plant Breeding, New Age Int'l Publication, p. 432.

Singh Bhupendra, A.K. Uniyal, B.P. Bhatt, and Sunil Prasad. 2006. Effects of agroforestry tree spp. on crops. Allelopathy J. 18(2): 355-362.

Singh, Bhupendra, A.K. Uniyal and N.P. Todaria. 2007. Studies on allelopathic influence of *Zanthoxylum armatum* D.C. on important field crops seeking its sustainable domestication in existing agroforestry systems of Garhwal Himalaya, India. J.Sust. Agric. 30(3):87-95.

Singh, S. P., U.R. Pal and K. Luka. 1989. Allelopathic effects of three serious weeds of Nigerin savanna on germination and seedling vigour of soybean and maize J. Agron. Crop Sci. 162: 236-240.

Steenhagen, D. A. and R. H. Zimdahl.1979. Allelopathy of leafy spurge (*Euphorbia esula*). Weed Sci. 27: 1-3.

Sugha, S. K. 1978. Allelopathic potential of superb lily (*Gloriosa superba* L.). Sci. and Cult. 44: 461-462.

Sugha, S. K. 1979. Effect of weed extracts on wheat germination. Sci. and Cult. 45: 65-66.

Sugha, S. K.1980. An assessment of allelopathic potentials of three common weeds. Food Far. and Agric. 11: 261-262.

Todaria, N.P., B. Singh and C. S. Dhanai. 2005. Allelopathic effects of tree extract, on germination and seedling growth of filed crops. Allelopathy J. 15(2):285-294.

Tripathi, R. S., R.S. Singh and J.P.N. Rai. 1981. Allelopathic potential of *Eupatorium adenophorum-a* dominant ruderal weed of Meghalaya. Proc. Ind. Nat. Sci. Acad. 847: 458-565

Tukey, H. B. Jr. 1969. Implications of allelopathy in agricultural plant science. Bot. Rev. 35: 1-17.