ALLELOPATHIC POTENTIALITY OF *CHLORIS GAYANA* KUNTH AND *PANICUM ANTIDOTALE* RETZ.

Safia Khanum*, Farrukh Hussain and

Himayat Hussain Naqvi†

Abstract. *Pot and laboratory experiments revealed that* Chloris gayana *Kunth and* Panicum antidotale *Retz. are potentially allelopathic. The root exudates besides inhibiting their own growth reduced growth of* Chloris. *Aqueous shoot extracts inhibited radicle growth of* Chloris gayana, Panicum antidotale, Pennisetum americanum *and* Chrysopogon aucheri. *Both the species exhibited self-toxicity. The toxicity of each species depended upon the amount of material soaked, soaking duration, freshness of the material assayed and the test species used.*

Introduction. *Chloris gayana* Kunth and *Panicum antidotale* Retz, perennial grasses, have fast rate of growth, easy germination and easy establishment of seedlings and provide enough palatable forage. Experiments on its range management aspects are being conducted in Pakistan Forest Institute, Peshawar.

It is observed that most of the grasses exhibit allelopathy either against themselves or other species. Allelopathy, an important ecological phenomenon, governs vegetational composition (Muller, 1966, 1969) and productivity (Lodhi, 1976). *Avena* (Tinnin and Muller, 1971, 1972), *Lolium* (Naqvi and Muller, 1975), *Cenchrus and Chyrsopogon* (Akhtar *et al.*, 1978 , *Sorghum* (Qureshi, 1978), *Hyparrhenia* (Dirvi, 1977) and *Dichanthium* (Dirvi and Hussain, 1979) reduced germination and growth of test species under favourable physical environment, causing allelopathic exclusion of the susceptible species. Similarly Chou and Young (1975) and Bokhari (1978) reported allelopathic effects of subtropical and prairie grasses. Allelopathic effects, besides reducing productivity cause soil toxicity (Lodhi, 1976).

Keeping in mind the importance of allelopathy and aforementioned evidences, the present study was conducted to find allelopathic potential of these two grasses against other species.

Materials and Methods. 1. *Pot Experiment:* The interference ability of both the grasses was tested against each other in pot experiment following Akhtar *et al.*, (1978). Plants were harvested after 8 weeks for fresh and dry weight determination.

2. *Aqueous shoot extract bioassay:* Five and 10 g of dried and crushed shoot of either *Chloris* or *Panicum* was soaked in 100 ml distilled water for 24, 48 and 72 h at room

*Phyto-Ecology Laboratory, Department of Botany, University of Peshawar, Peshawar, Pakistan.
†L.A. State and County Arboretum, Ai adia, Calif, 91006, U.S.A.

temperature (25-30 °C) and filtered. The extracts were used against *Chloris gayana, Panicum antidotale, Pennisetum americanum* and *Chrysopogon aucheri* in a bioassay following Akhtar *et al.*, (1978).

The toxicity of aqueous shoot extracts, from fresh and dry shoots of each grass was compared by using the same aforementioned test species in bioassay following Akhtar *et al.*, (1978). Extracts were made by soaking 5 g of shoot in 100 ml distilled water for 24 h.

There were always 7 replicates, each with 20 seeds unless otherwise stated. The dishes were incubated at 30 °C for 7 days in the case of *Chloris, Panicum* and *Chrysopogon* and 4 days for *Pennisetum*. Radicle growth was taken as an index of phytotoxicity.

The results of the bioassys are expressed as % of control. The results were statistically analysed using "t test" (Cox, 1967).

Results. 1. *Pot Experiment:* The fresh and dry weights of *Chloris* were significantly reduced in root mixed cultures by *Panicum*, while that of *Panicum* remained unaffected. *Chloris* and *Panicum* retarded their own growth in monocultures, suggesting self-interfrerence (Table 1).

The inhibition of growth was due to release of some toxic root exudates by the grasses.

Table 1. Fresh and dry weights of shoot of the interacting species in pot experiment. Each value is the mean of 4 replicates, each with 5 plants in each half of the pot.

Interacting species	Mixed Culture			% of control	
	Root-separated	Root-Mixed	Mono-culture	Mixed Culture	Mono-culture
			Fresh Weight (g)		
Chloris gayana	11.30	9.49	8.72	83.98*	77.16*
Panicum antidotale	6.60	5.97	4.86	90.49	73.63*
			Dry Weight (g)		
Chloris gayana	7.06	5.45	4.89	77.19*	69.26*
Panicum antidotale	5.29	4.97	3.25	93.95	61.43*

*Significant at P = 0.05.

Table 2. Effect of aqueous shoot extract of *Chloris gayana* and *Panicum antidotale* on radicle growth of test species. Each value is the mean of 7 replicates, each with 20 seeds, expressed as % of control.

Test species	Chloris Extract			Panicum Extract		
	Soaking Durations (h)					
	24	48	72	24	48	72
	Radicle growth					
	5 *g shoot:* 100 *ml distilled water*					
Chloris gayana	88.5	60.1	50.6	87.5	79.3	70.1
Panicum antidotale	55.9	46.8	30.7	50.0	28.5	23.6
Pennisetum americanum	93.5*	42.1	30.2	85.3	67.3	60.1
Chrysopogon aucheri	85.5	56.9	35.8	78.5	60.5	25.8
	10 *g shoot:* 100 *ml distilled water*					
Chloris gayana	60.3	53.8	40.7	70.6	64.3	59.8
Penicum antidotale	45.8	39.6	29.5	40.0	27.3	19.8
Pennisetum americanum	50.2	34.4	31.3	83.2	32.3	25.5
Chrysopogon aucheri	65.5	40.8	27.7	71.3	49.8	20.0

All values are significant at P=0.05 except astrike*.

2. *Aqueous shoot extract bioassay.* The aqueous extracts of both the grasses significantly inhibited radicle growth of all the test species, except *Pennisetum* in 24 h extract of *Chloris* in low concentration, suggesting the presence of water soluble growth inhibitors in the shoot of *Chloris* and *Panicum* (Table 2). The toxicity increased with the soaking duration and amount of material used.

The comparison of fresh and dry shoot extracts revealed fresh shoot extract to be more inhibitory than dried shoot extract of both the species (Table 3). All the species were inhibited more by fresh shoot extract than by dry shoot extract. In both the bioassays the toxicity depended upon the test species used.

Discussion. Biochemical ecology of grasses is an important aspect of range management. Many grasses exhibit allelopathy against associated species under favourable physical environment. The inhibitory mechanism involves addition of some toxins to environment, differentiating it from competition which is active through depletion of a habitat factor (Muller, 1969). The reduced growth of *Chloris* and *Panicum* in root-mixed treatments could not simply be due to competition for physical factors, since all the plants received similar treatments. Naqvi (1972), Naqvi and Muller (1975), Drivi (1977) and Dirvi and Hussain (1979) observed retarded growth of test species through toxic root exudates of grasses. Rovira (1969) recognised the role of root exudates in ecology, and inhibition of growth by root exudates is one of the possible mechanisms in allelopathy.

The radicle growth of all the test species was significantly inhibited by extracts, suggesting the presence of water-soluble toxins in *Chloris* and *Panicum* shoots. Our results agree with Naqvi and Muller (1975), Akhtar *et al.*, (1978) and Dirvi and Hussain (1979) who observed water-soluble toxins in various grasses. Bokhari (1978) reported more inhibited growth of test species by fresh shoot extract than by dry shoot extract, confirming our results regarding more toxicity of fresh shoot extracts than by dried shoot extracts of *Chloris* and *Panicum.* The toxicity of each grass was related to the species. Similarly, that of *Lolium* (Naqvi and Muller, 1975), *Cenchrus* and *Chrysopogon* (Akhtar *et al.*, 1978) and *Dichanthium* (Dirvi and Hussain, 1979) was also related to test species used. The toxicity depended upon the amount of material soaked and duration of soaking. It seems that the allelopathic effects would be enhanced with the prolonged soaking and increase in the amount of litter deposition by these grasses.

Table 3. Relative toxicity of fresh and dried shoot extract of *Chloris gayana* and *Panicum antidotale* against the radicle growth of test species. Each value is a mean of 7 replicates, each with 20 seeds, expressed as % of their control

Extract	Test Species	Fresh Shoot	Dried Shoot
Chloris gayana	*Chloris gayana*	43.6	50.5
	Panicum antidotale	25.9	37.3
	Pennisetum americanum	40.9	71.2
	Chrysopogon aucheri	55.6	75.5
Panicum antidotale	*Chloris gayana*	57.3	86.5
	Panicum antidotale	29.5	40.6
	Pennisetum americanum	37.6	83.8
	Chrysopogon aucheri	63.9	78.2

All values significantly different from control and from each other at $P = 0.05$.

The findings suggest the presence of water soluble toxins in shoots of *Chloris gayana* and *Panicum antidotale* which would be transported to soil through leaching from living plant parts or during the decay of litter by any soaking agency in nature. The grasses, besides inhibiting growth of other species, reduced their own growth. Therefore, they would not only exhibit allelopathy against other species but also against themselves. Ecologically speaking they are not recommended for cultivation in mixed cultures with the species susceptible to them. Their monocultures would also show self-declination after some time due to self-toxicity. However, they may be used after thoroughly analysing their biochemical ecology in relation to other species.

Acknowledgements. The authors are grateful to Dr. Ihsan Illahi for going through the manuscript and making useful suggestions. They are also obliged to Mr. Sultan Maqsood Khan, Range management Officer, Pakistan Forest institute, Peshawar, for his help and co-opertion. Thanks are also due to Miss Bushra, Miss Nasim and Miss Ghazala for their sincere help. They also thank Chairman, Botany Department for providing the facilities.

References

AKHTAR, NASIM; HIMAYAT H. NAQVI and FARRUKH HUSSAIN. 1978 Bio-chemical inhibition (Allelopathy) exhibited by *Cenchrus ciliaris* Linn. and *Chrysopogon aucheri* (Bioss) Stapf. Pak. J. For., 28: 196-200.

BOKHARI, U.G. 1978. Allelopathy among prairie grasses and its possible ecological significance. Ann. Bot., 42: 127-136.

CHOU, C. and C. YOUNG. 1975. Phytotoxic substances in twelve sub-tropical grasses. J. Chem. Ecol., 1:183-193.

COX, G.W. 1967. Laboratory manual of general ecology. M.C. Brown Co. Pub. Iowa. pp. 1-10.

DIRVI, G.A. 1977. Germination and allelpoathic studies on *Dichanthium annulatum* (Forsk.) Stapf. and *Hyparrhenia rufa* (Nees) Stapf. M.Sc. Thesis. Univ. Pesh., Peshawar.

——— and FARRUKH HUSSAIN. 1979. Allelopathic effects of *Dichanthium annulatum* (Forsk.) Stapf. on some cultivated plants. Pak. J. Sci. Ind. Res., 22 (1 & 2) in press.

LODHI, M.A.K. 1976. Role of allelopathy as expressed by dominating trees in a Lowland forest in controlling the productivity and pattern of herbaceous growth. Amer. J. Bot., 63:1-8.

MULLER, C.H. 1966. The role of chemical inhibition (Allelopathy) in vegetational composition. Bull. Torrey Bot. Club. 93: 332-361.

——— 1969. Allelopathy as a factor in ecological process. Vegetatio, 18: 348-357.

NAQVI, HIMAYAT H. 1972. Preliminary studies of interference exhibited by Italian Ryegrass. Biologia, 18: 201-210.

——— and C.H. MULLER. 1975. Biochemical inhibition (Allelopathy) exhibited by Italian Ryegrass (*Lolium multiflorum* L.). Pak. J. Bot., 7: 39-147.

QURESHI, HUSSAN ARA. 1978. The allelopathic potential of Columbus Grass (*Sorghum almum* (Piper) Parodi.) M.Sc. Thesis, Univ. Peshawar.

ROVIRA, A.D. 1969. Plant root exudates. Bot. Rev., 35: 35-59.

TINNIN, R.O. and C.H. MULLER. 1971. The allelopathic potential of *Avena fatua:* Influence on herb distribution. Bull. Torrey Bot. Club, 98: 243-250.

——— 1972. The allelopathic influence of *Avena fatua:* The allelopathic mechanism. Bull. Torrey Bot. Club, 99: 287-292.