BIOCHEMICAL INHIBITION (ALLELOPATHY) EXHIBITED BY *CENCHRUS CILIARIS* LINN AND *CHRYSOPOGON AUCHERI* (BIOSS) STAPF

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Abstract. Cenchrus ciliaris *and* Chrysopogon aucheri *are important range-grasses found in Pakistan every where upto* 1800 *metres. Field and laboratory experiments showed that beside toxic root exudates, water extracts contained substances which proved to be inhibitory not only to its own growth but also to other species used in the bioassays. The toxicity in both the cases increased with increasing concentration and soaking time.* Cenchrus *had more allelopathic potentiality than* Chrysopogon. *The toxicity in both the cases was species related. The possible effect of allelopathy of these grasses is discussed in relation to the vegetation dynamics.*

Introduction. *Cenchrus ciliaris* and *Chrysopogon aucheri* are range-grasses. Experiments are being conducted on range management aspect in the P.F.I. Peshawar. There are certain characteristics which make these two grasses the choice of range managers. The quick vegetative spread, faster rate of growth, frequent flowering and seeding help in the invasion of area which quickly become dominated by these grasses. Inspite of all the preferable characteristics there is very little work done. The only available informations are Bishop et al (1974), Malik and Khan (1965, 1966, 1967, 1971).

There is almost complete lack of any ecological work on these two grasses. In the following paper an effort is made to provide some ecological facts about them. It is seen that many grasses and plants inspite of favourable nutrient supply inhibit the growth and germination of other species growing in their vicinity. Naqvi (1969, 1972, 1976) and Naqvi and Muller (1975) have shown in a series of field and laboratory experiments that Italian rye-grass inhibited the growth and germination of many species tested in their experiments. They attributed the reduction in growth due to the allelopathic affects of Italian rye-grass. Similarly Tinnin and Muller (1971, 1972) have shown that the *Avena fatua* inhibited the growth and germination of other species by allelopathic mechanism. Muller (1966) has stressed upon the role of allelopathy in vegetation composition. Commendable evidences indicate the allelopathic effects of many other plants (Muller, 1953, 1966, 1968; Abdul-Wahab and Rice, 1967; Lodhi, 1976; Akhtar, 1976; Khanum, 1976).

Having this idea in mind an investigation was carried out to find any allelopathic mechanism in these two grasses. It is ecologically important to find out such possibilities in the species which are either introduced or which may spread as weeds. In the present paper the main stress is on the allelopathy of these species.

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Materials and Methods. (*a*) *Field Experiment.* Equal volume of loamy soil was taken in pots of 9 × 9 inches. Plants of *Cenchrus ciliaris* and *Chrysopogon aucheri* were sown in the following combinations:—

I. *Cenchrus* grown alone.

II. *Chrysopogon* grown alone.

III. *Cenchrus* and *Chrysopogon* grown in mixed culture with following two treatments.

(1) Root mixed in the pots.

(2) Root separated in the pots.

The roots were separated by polythene partitions with in the pots. Each half of the pot contained only roots of one species in the root-separated treatment while the roots were mixed freely in the root-mixed treatment as well as in the monocultures of *Cenchrus* and *Chrysopogon.* The root separated treatment served as the control for the experiment. Each species in each treatment was replicated 4 times. Seedlings were raised from seeds. After germination they were thinned to 10 plants in monoculture and 5 plants per species in mixed cultures. The plants were allowed to grow for two months after thinning. During the experimental period weeds were removed by hand. All the treatments received uniform environmental conditions. They were watered frequently to avoid water deficiency. Nutrient competition was avoided by providing Hoagland's solution fort-nightly. Height and fresh weight determinations were made at the time of termination. The plants were oven dried for 72 hrs. and dry weights were determined for each species separately in treatments.

(*b*) *Laboratory Bioassays.* These series of experiments consisted of determination of allelopathic effects under more controlled laboratory conditions by using the cold water extract of the plants as the moistening media for germination and growth of the seeds of the tests species. The grass straw was oven dried at 60°C for 72 hrs. and used for extract formation.

(I) *Straw Extract Bioassay.* Five and 10 gm. fresh straw of either *Cenchrus* or *Chrysopogon* was soaked in 100 ml. of distilled water for 24, 48, and 72 hrs. The extract was filtered and stored at 5-10°C when not in use. The seeds of *Cenchrus ciliaris, Chrysopogon aucheri* and *Pennisetum typhoideum* were used as test species. Ten seeds of the test species were placed on twice folded whatman filter paper No. 1 in petri-dishes. The dishes were moistened with either grass extract or distilled water for test and control respectively. All the dishes were sealed with parafilm "M" to avoid moisture loss. Each species in each case was replicated three times. After 72 hrs. incubation at 30°C the percent germination and average radicle growth was recorded to the nearest milimeter. The experiment was repeated several times with the same level of results.

(II) *Relative toxicity of Cenchrus and Chrysopogon.* The experiment was aimed to know the relative toxicity of the 2 grasses. The extract was made in 2 concentration of 5gm : 100 ml. and 10 gm. : 100 ml. (Plant material: Distilled Water) for 24 and 72 hrs.

The extracts were used against the same three test species in a standard filter paper bioassay, described earlier.

Results. (*a*) *Field Experiment.* Table I shows the results of the experiment. It was clear that heights in both the interfering species has been reduced in the mixed culture, especially that of *C. aucheri.* The dry weights showed that *Cenchrus* has gained in the fresh and dry weights in the mixed culture at the cost of *Chrysopogon.* It was clear from the experiment that *Cenchrus* has suppressed the growth of *Chyrsopogon.* In the monoculture the reduction in the dry weights was the result of self-interference in both the cases, especially in *Chrysopogon.*

TABLE I

Determinations	Cenchrus ciliaris			Chrysopogon aucheri		
		Mixed Culture			Mixed Culture	
	Mono-culture	Root Mixed	Root Separated	Mono-culture	Root Mixed	Root Separated
Heights (Cm)	239	217	178	82	97	182
Fresh Weights (gms.)	1.98	2.96	1.63	0.57	0.94	1.46
Dry Weights. (gms.)	0.70	0.94	0.62	0.23	0.10	0.58

Table I. Showing the results of Field Experiments. Each value is a mean of 4 pots, each with 10 plants in monoculture and 5 plants per species in the mixed culture.

(*b*) *Laboratory Bioassays.* (I) *Straw Extract Bioassay.* Table 2 shows the average radicle growth of the test species. The radicle growth of *Pennisetum* has been reduced to 30, 25 and 19 percent of control in 24, 48 and 72 hrs, extracts in 5 gm. concentration respectively. In the case of 10 gm. concentration the growth was 2, 1.6 and 1.4 percent of control. The average radicle growth determined per germinated and total seeds decreased with increasing concentration and soaking time. *Cenchrus* and *Chrysopogon* even did not germinate in extracts obtained after 48 and 72 hrs. at both the concentration levels. In 24 hrs. extract, both the species showed a very reduced growth in lower concentrations. The germination was completely inhibited in 24 hrs. extraction at 10 gm. concentration. The self-toxicity of the species was very clear.

TABLE 2

Extract Concentration	Test Species.	SOAKING HRS.					
		Av/germinated			Av./total seeds.		
		24	48	72	24	48	72
5 : 100	*Pennisetum*	30	25	19	26	20	16
	Cenchrus	35	—	—	18	—	—
	Chrysopogon	3	—	—	3	—	—
10 : 100	*Pennisetum*	2	1.6	1.4	1.6	1.4	1.2
	Cenchrus	—	—	—	—	—	—
	Chrysopogon	—	—	—	—	—	—

Table 2 Showing the average radicle growth (mm.) of the test species grown in *Cenchrus* extract. Each value is a mean of 3 replicates, each with 10 seeds in it, expressed as percent of control.

Table 3 shows the effects of water extract of *Chrysopogon*. *Pennisetum* showed an almost equal response to different extracts in the lower concentration while the growth was 14% of control in the case of higher concentration, after 72 hrs. *Cenchrus* has shown a gradual decrease in the growth with increasing soaking time, specially in the higher concentration extracted after 72 hrs. The germination was also affected. *Chrysopogon* was the most susceptible species. The plant was auto-toxic, specially at higher concentration level with prolonged soaking time.

TABLE 3

Extract Concentration	Test Species	SOAKING DURATION					
		Av./germinated			Av./total seeds		
		24	48	72	24	48	72
5 : 100	*Pennisetum*	84	84	80	82	80	75
	Cenchrus	83	76	65	50	27	27
	Chrysopogon	69	49	39	25	38	38
10 : 100	*Pennisetum*	84	80	75	70	38	14
	Cenchrus	61	52	30	14	14	4
	Chrysopogon	46	23	23	23	18	13

Table 3 showing the average radicle growth (mm) of the test species grown in *Chrysopogon* extract. Each value is a mean of 3 replicates, each with 10 seeds in it, expressed as percent of their control.

(II) *Relative Toxicity of Cenchrus and Chrysopogon.* Table 4 shows the relative toxicity of the 2 grasses against 3 different species at 2 concentration levels, each with 2 soaking durations. It was clear that *Cenchrus* was more toxic than *Chrysopogon*. The two test species even could not germinate in 72 hrs. extract of *Cenchrus* at lower concentration level while at the higher concentration there was complete inhibition of germination at both the soaking durations. In the case of *Chrysopogon*, there was some germination even at higher concentration. The comparison of the average radicle growth also confirms the greater toxicity of *Cenchrus* as compared to *Chrysopogon*. The radicle growth of the test species in both the grass extracts were significantly different from each other.

TABLE 4

Extract Concentration	Test Species	*Cenchrus* Extract		*Chrysopogon* Extract	
		Soaking Hours			
		24	72	24	72
5 : 100	*Pennisetum*	30	19	84	80
	Cenchrus	35	—	83	65
	Chrysopogon	3	—	69	39
10 : 100	*Pennisetum*	2	1.4	84	75
	Cenchrus	—	—	61	30
	Chrysopogon	—	—	46	23

Table 4 showing the relative toxicity of *Cenchrus* and *Chrysopogon*. Each value is a mean of 3 replicates, each with 10 seeds in it, expressed as percent of their control.

Discussion. Studies by McKell et al (1969) and Naqvi (1969, 1972) have shown that competition alone cannot explain the reduction of growth under favourable physical environment. They considered some other mechanism involved which is partially or wholy responsible for the observed suppression. In nature different toxins are leached from dead and living parts of the grasses through rain, fog and many other agencies. The laboratory bioassays and water extract more or less approached the natural conditions. This is what would be expected under natural conditions.

The results of the experiments can be subjected to two diverse views: If we take the range management point of view, then the grasses are very much suitable for its palatability and easy spread due to certain advantageous characters. However if a pure ecological view is taken into account then we would suggest to avoid the grasses because they have adverse effects on the native vegetation of the area. They may invade an area and due to their allelopathic effects may dominate the site because soil once favourable for the growth of other species will no more be suitable to their growth. Depending upon the susceptibility of the species they will be eliminated or reduced from the common habitat.

The auto-toxic nature, as shown in the laboratory and field experiments, also points out the decline of the pasture or range if the grasse are allowed to grow for a longer time. Such a phenomena has been pointed out by Bishop et al (1974) for *Cenchrus* and our findings are in agreement with them.

Allelopathy, therefore plays a significant role in the distribution of vegetation and association of different species will occur only if they balance the activity of each other or if they get adapted to the existing conditions.

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