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ALLELOPATHIC EFFECTS OF *CORCHORUS TRIDENS* L. ON GERMINATION AND GROWTH OF PEARL MILLET

ANSHU KAREL
Department of Botany, S.P.C. Govt. College, Ajmer.
Corresponding Author's Email: anshkarel@gmail.com

The study embodies the results of investigations on allelopathic effects of *Corchorus tridens* L. on Pearl millet. For this purpose, soil samples and plant material were collected from crop fields near Dayanand College, Ramganj, Ajmer. Topographically, Ajmer is characterized by Aravali ranges of varying heights, rocky terrains, valleys, ponds and lakes on one hand, and sandy plains and stabilized dunes on the other. The analyses of physical and mineral properties of weed stand soil and soil of adjacent area revealed that soil moisture percentage was higher in samples collected from depth, whereas soil conductivity and N, P, K content were found to be higher in surface soil samples. The value of pH indicates slightly alkaline nature of the soil. The data obtained from weed stand soil and adjacent area soil also revealed that there were non-significant differences in both physical and mineral properties of the soil due to the presence of *C.tridens* L. The extracts from *C.tridens* L. stand soil samples were found to be more inhibiting than adjacent area soil samples which implied that some allelopathic chemical leached out from the roots of *C. tridens* L. into the soil. The aqueous leachates of *C. tridens* L. leaves showed maximum inhibition followed by roots and stem. The inhibitory effect of leachates increased with increase in their concentration. The methanolic extracts of different plant parts of *C. tridens* L. showed complete inhibition of germination of Pearl millet in comparison to petroleum ether and chloroform extracts. The leaf extract was found to be more inhibiting than root and stem extracts.

Keywords: Allelopathic effect, *Corchorus tridens* L., Germination, Leachates, Pearl millet, Soil samples.

Introduction

There are a number of responses in relation to the interactions between a crop plant and weeds growing around it. Weeds, through their harmful effects rank among the most important enemies to agriculture production. Weeds cause greater losses than either insects or plant diseases. They can affect the crops by allelopathic effect as well as they compete for water, nutrients and light. The term 'allelopathy' for expressing the deleterious effects that one plant species had on another through the formation of chemical retardants was proposed[1]. This concept was further supported and developed[2-4]. The purpose of this study was to explore the concept of allelopathy, with this specific study.

Materials and methods

In the present study, the extracts of soil and different plant parts of *C. tridens* L, which is a dominant weed in the fields of Pearl millet (Bajra) near Dayanand College, Ajmer were procured under laboratory conditions and used to demonstrate the allelopathic effect of *C. tridens* L. on this kharif crop (Fig. 1.).

Pearl millet is an important food grain as well as forage crop, especially in arid and semi- arid regions[5] and occupies 15.6 million hectares of land in India. It is the most drought-tolerant of all the cereal crops and finds its main agricultural niche in regions too dry to support sorghum or maize[6]. Being a rainy season crop, it gets Heavily infested with weeds loss upto 44%.

The most dominant weeds of Pearl millet are as follows: *Amaranthus viridis* L., *Borreria articularis* (L.f.) F.N.Williams, *Celosia argentea* L., *Cenchrus* spp., *Convolvulus arvensis* L., *Corchorus tridens* L., *Cynodon dactylon* (L.) Pers., *Cyperus rotundus* L., *Digitaria* sp., *Echinochloa crus-galli* (L.) P.Beauv., *Indigofera* spp., and *Ipomoea pes-tigridis* L..The genus *Corchorus* probably originated in Africa with a secondary centre of diversity in the Indo- Burmese region. It is an annual herb upto 1m tall, usually erect and branched[7]. It can easily be identified by the 3 small horns at the top of the slender capsules, which split at maturity with 3 valves. Although, the plant grows rapidly in the rainy season and flowering occurs about 6 weeks after germination, it is rather drought resistant.

Sampling of plant materials:

The weed species and Pearl millet seeds were sampled from fields near Dayanand College, Ajmer in the month of September.

Physical and Mineral properties of soil:

Physical properties of soil (soil moisture, pH, EC) and mineral properties (total nitrogen, available, phosphorus, exchangeable potassium) of soil were analyzed to determine if *C. tridens* L. causes change in soil properties which could account for the allelopathic effects.

Soil samples were collected at 0 and 20 cm depths from within *C. tridens* L. soil stand and similar samples were taken from the adjacent areas where *C. tridens* L.was absent.

Soil moisture:-Soil samples were collected from experimental site at depths 0 and 20 cm, packed in polythene bags. Fresh and oven dried (at 110ºC for 24 h) weight of each sample was determined. The percentage moisture content of the soil was determined [8,9] on dry weight basis as follows:

$$\text{Moisture\%} = \frac{\text{Fresh Weight- Dry Weight}}{\text{Dry Weight}} \times 100$$

Soil pH was determined [10]. Soil conductivity was measured[11].

Total Nitrogen in soil:-

Total Nitrogen (%) in soil was determined using Kjeldahl Digestion Method[12]. Available phosphate in soil was estimated [13]. Potassium in soil was determined by Flame photometer[14].

Inhibitory effect of soil within *C. tridens* L. stand:

To study the inhibitory effect, alcoholic extracts of sub-soil samples for 48 h were prepared (1:4). The extracts obtained from the pure stand and without *C.tridens* L. were bioassayed using the seeds of Pearl millet.

Effects of soil leachates of *C. tridens* L.*:*

Leachates of air-dried materials each of root, stem and leaf were prepared separately with distilled water (1:4) & further diluted (0, 25, 50, 75 and 100%) with distilled water. They were used for moistening the filter paper in petridishes and the effects were bioassayed with crop seeds after 5 days.

Effects of organic solvents extracts of *C. tridens* L.:

The air-dried materials each of root, stem and leaf were extracted (hot, 1:4 ratio) for 48h in different organic solvents from lowest to highest polarity. Solvents used were petroleum, ether, chloroform and methanol. Inhibitory effects were bioassayed using 2 ml of each extract separately with crop seeds.

Germination tests:

Germination tests were carried out with soil and weed extracts. Seeds were surface sterilized with 0.1% mercuric chloride solution for two minutes and washed 5-6 times with distilled water.

Sterilized petridishes were lined with 2 layers of filter papers and these filter papers were moistened with 10 ml of respective extracts. The soaked and imbibed seeds were kept for germination on these moistened filter papers in petridishes under lab conditions. In each set, four replicates were kept containing 25 seeds in each petridish. The percentage germination and length of root and shoot was noted after 5 days.

Results and discussion

Soil is the essentialmatrix in which transformations of nutrients occur and on which agriculture is based[15].

Surface soil characteristics are largely the product of the climate and vegetation interactions[16,17]. In addition to temperature and rainfall, plants need nutrients which are mostly obtained from soil. It is a unique gift of nature for the biosphere, more for human race[18]. Soil is the basis and essence of all terrestrial life[19]. Microbes in the soil play a dynamic role by releasing mineral nutrients through organic decomposition and nutrient recycling[20]. These mineralized nutrients are crucial to maintain soil structure and soil quality for sustainable plant growth.

In the present investigation, soil samples were collected from different depths (0 cm and 20 cm), different sites (weed stand soil and adjacent area soil) and systematically analyzed for physical and mineral properties. For this purpose, crop fields near D.A.V. College, Ajmer were selected.

Data in Table 1 show that soil moisture (%) ranges between 3.70 (at 0 cm) to 5.45 (at 20 cm) and depth soil contains higher moisture than surface soil. In agreement with these results, the soil water content of the surface 0 to 7.5 cm was significantly higher as compared with depth[21]. The soil pH ranges from 7.60 to 7.85, revealing a slightly alkaline nature. Soil conductivity ranges between 0.21 m mhos cm^{-1} (at 20 cm) to 0.25 m mhos cm^{-1} (at 0 cm), so surface soil is slightly more conductive than deeper soil.

Total N (%) ranges between 0.055 (at 20 cm) and 0.0060 (at 0 cm)Previous work showed that the Kjeldahl N contents of surface soil (0-7.5 cm) with no-till averaged 1.25 and 1.20 (25 and 20%) times higher, respectively, for no-till than for conventionally tilled soil[21]. Available P ranges between 1.95 mg 100 dry soil (at 20 cm) to 2.10 mg 100 dry soil (at 0 cm) and K in soil ranges between 11.35 mg 100 dry soil (at 20 cm) to 11.95 mg 100 dry soil (at 0 cm). These values show that surface soil samples contain higher N, P, K content than soil samples at depth (Table 1).

Observation of the physical and mineral properties of *C. tridens* L. adjacent area soil (Table 2) reveal that soil moisture (%) is higher at depth of 20 cm and ranges between 3.55 (at 0 cm) to 5.60 (at 20 cm). Analyses of soil pH show slightly alkaline nature of soil and ranges between 7.65 (at 20 cm) to 7.90 (at 0 cm). Soil conductivity is found between 0.24 m mhos cm (at 20 cm) to 0.27 m mhos cm (at 0 cm) and surface soil shows higher conductivity than soil at depth. Total N (%) in soil ranges between 0.052 (at 20 cm) to 0.062 (at 0 cm) and reveal that surface soil layers contain higher N percentage than depth soil layers. Surface soil samples contain higher P (2.15 mg 100 dry soil, at 0 cm,) than depth soil (1.92 mg 100 dry soil, at 20 cm). Potassium content in soil is also found higher at 0 cm (12.10 mg 100 dry soil) than 20 cm (11.60 mg 100 dry soil) depth (Table 2).

The analysis of soil samples from *C. tridens* L. stand soil and adjacent area reveal non - significant differences, both in physical and mineral properties. (Table 1 & Table 2)

The present study included experiments designed to know the allelopathic influences of *C. tridens* L. (i.e. a weed) on Pearl millet (i.e. crop plant). For this purpose soil extracts and aqueous and organic solvent extracts of weed plant were used. In earlier work done, it was reported that the water extracts from leaves and stems of sunflower clearly inhibited the germination of common poppy and common amaranth. Germination of common amaranth was extremely delayed by both extracts[22].

Analyses of *C. tridens* L stand soil extracts reveal that depth soil samples show more inhibitory effect (72% germination at 20 cm) than surface soil Samples (80% germination at 0 cm) (Table 3).

Table 1. Physical and mineral properties of *C. tridens* L. stand soil.

Test	**Within *C. tridens* stand soil**	
	At 0 cm	**At 20 cm depth**
Soil Moisture (%)	3.70 ± 0.25	5.45 ± 1.15
Soil pH	7.85	7.60
EC at 25° C(m mhos cm^{-1})	0.25	0.21
Total N (%)	0.060 ± 0.005	0.055 ± 0.003
Available P (mg 100^{-1} dry soil)	2.10 ± 0.35	1.95 ± 0.10
Exchangeable K (mg 100^{-1} dry soil))	11.95 ± 1.35	11.35 ± 1.25

Table 2. Physical and mineral properties of *C. tridens* L. adjacent area soil.

Test	**Within *C. tridens* stand soil**	
	At 0 cm	**At 20 cm depth**
Soil Moisture (%)	3.55 ± 0.40	5.60 ± 1.25
Soil pH	7.90	7.65
EC at 25° C(m mhos cm^{-1})	0.27	0.24
Total N (%)	0.062 ± 0.004	0.052 ± 0.006
Available P (mg 100^{-1} dry soil)	2.15 ± 0.20	1.92 ± 0.18
Exchangeable K (mg 100^{-1} dry soil))	12.10 ± 1.40	11.60 ± 1.10

Table 3. Effect of *C. tridens* L. stand soil extracts on germination (%) and seedling growth (cm) of Pearl millet.

Depth	**Germination**	**Root**	**Shoot**
0 cm	80 ± 8	6.84 ± 1.70	5.75 ± 1.45
20 cm	72 ± 6	6.10 ± 1.21	5.22 ± 1.18

Table 4. Effect of *C. tridens* L. adjacent area soil extracts on germination (%) and seedling growth (cm) of Pearl millet.

Depth	**Germination**	**Root**	**Shoot**
0 cm	96 ± 4	10.75 ± 1.95	7.10 ± 0.82
20 cm	92 ± 6	8.80 ± 1.05	6.35 ± 1.18

Table 5. Effect of different concentrations (%) of aqueous leachates of roots of *C. tridens* L.on Pearl millet.

Concentration (%)	**Germination**	**Root**	**Shoot**
0	97± 3	9.95 ± 1.12	6.60 ± 1.25
25	95 ± 4	9.63 ± 1.25	6.43 ± 1.01
50	85±6	8.82 ± 1.16	6.14 ± 1.12
75	78 ± 7	7.48 ± 1.54	5.60 ± 0.74
100	70 ± 5	3.82 ± 1.41	3.54 ± 1.60

Table 6. Effect of different concentrations (%) of aqueous leachates of stems of *C. tridens* L.on Pearl millet.

Concentration (%)	**Germination**	**Root**	**Shoot**
0	100± 0	11.10 ± 1.67	6.75 ± 0.54
25	98 ± 2	8.68 ± 1.44	6.15 ± 1.44
50	95±3	7.74 ± 1.20	5.94 ± 0.98
75	87 ± 5	7.18 ± 1.62	5.45 ± 1.36
100	84 ± 4	5.60 ± 1.35	4.95 ± 1.14

Table 7. Effect of different concentrations (%) of aqueous leachates of leaves of *C. tridens* L.on Pearl millet.

Concentration (%)	Germination	Root	Shoot
0	96± 4	9.75 ± 1.35	6.48 ± 0.74
25	80 ± 7	8.56 ± 1.71	6.15 ± 0.62
50	64± 6	7.28 ± 1.55	5.34 ± 0.56
75	60 ± 3	6.68 ± 0.45	4.36 ± 0.92
100	57 ± 5	0.85 ± 0.34	0.72 ± 0.95

Table 8. Effect of sequential extracts of organic solvents of *C. tridens* L. (root) on Pearl millet.

Organic Solvent	Germination	Root	Shoot
Petroleum ether	62± 4	1.84± 0.15	1.38± 0.50
Chloroform	80±7	0.92± 0.13	0.80 ±0.21
Methanol	0	0	0

Table 9. Effect of sequential extracts of organic solvents of *C. tridens* L. (stem) on Pearl millet.

Organic Solvent	Germination	Root	Shoot
Petroleum ether	55 ± 13	1.50± 0.55	1.34 ±0.16
Chloroform	73± 5	0.87± 0.38	0.75± 0.30
Methanol	0	0	0

Table 10. Effect of sequential extracts of organic solvents of *C. tridens* L. (leaves) on Pearl millet.

Organic Solvent	Germination	Root	Shoot
Petroleum ether	28± 5	1.42± 0.28	1.20 ±0.35
Chloroform	43± 6	0.77± 0.11	0.65± 0.40
Methanol	0	0	0

Fig.1. *C. tridens* L. in association with Pearl millet.

Analyses of soil extracts from adjacent area of *C. tridens* L. show 86% germination by surface soil extracts (0 cm) and 92% by depth soil extracts (20 cm) (Table 4).

Observation Table 3 and 4 and Text Fig. 1 and 2 reveal that *C. tridens* L stand soil extracts inhibit the germination of Pearl.

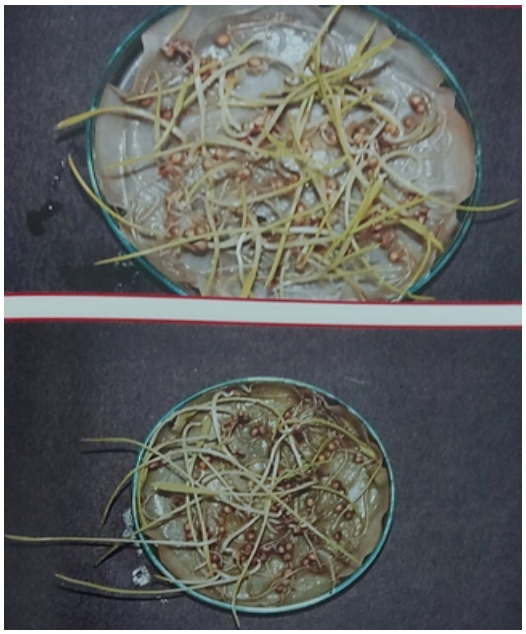

Fig. 2. Effect of aqueous leachates of roots of *C. tridens* L. on germination of Pearl millet.

millet more than the adjacent area soil extract. The inhibitory effect of soil extract is found higher on shoot growth than root growth.

The aqueous leachates of roots of *C. tridens* L. show greater inhibition in the germination of Pearl millet at higher concentration than lower concentration (97% germination at 0% and 70% germination at 100% concentration) (Table 5).

The observation of Table 6 shows that inhibitory effect of aqueous leachates of stem of *C. tridens* L. on germination of Pearl millet are lower than roots and higher concentrations are more effective (100% germination at 0% concentration and 84% germination at 100% concentration) (Table 6).

The aqueous leachates of leaves of *C. tridens* L. show greater inhibition than root and stem and maximum inhibition was seen at higher concentrations (64% germination at 50% concentration , 60% germination at 75% concentration and 57% germination at 100% concentration) (Table 7).

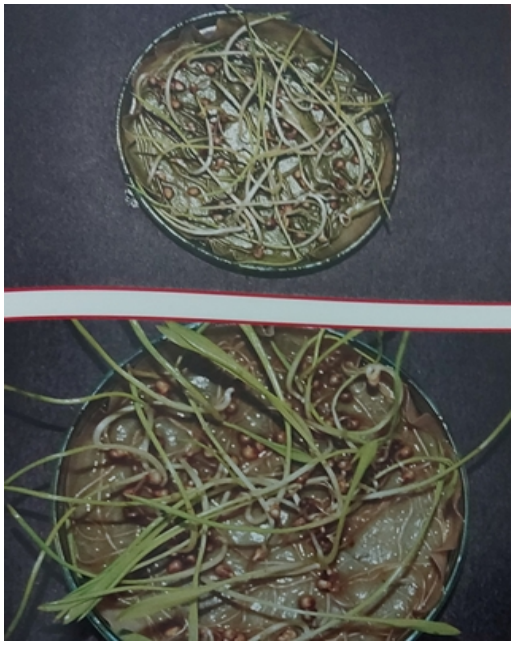

Fig. 3. Effect of aqueous leachates of stems of *C. tridens* L. on germination of Pearl millet.

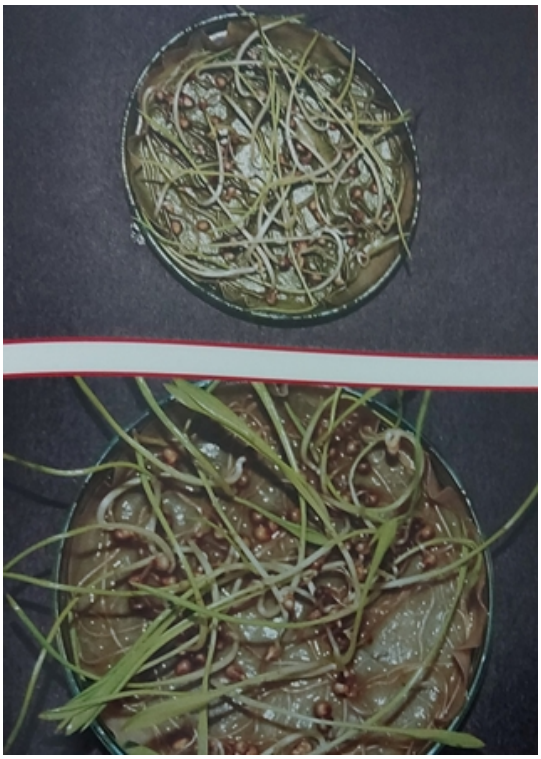

Fig. 4. Effect of aqueous leachates of leaves of *C. tridens* L. on germination of Pearl millet.

In all of these leachates shoot growth is more affected than root growth.

The methanolic extracts of roots of *C. tridens* L. show complete inhibition of germination (i.e. no germination at all) followed by petroleum ether (62% germination) and chloroform (80% germination). Shoot growth is affected more than root growth (Table 8).

The organic solvent extracts of stem of *C. tridens* L. also show complete inhibition in methanol, followed by petroleum ether (55% germination) and chloroform (73% germination). Growth of the shoot is slightly more affected than growth of root (Table 9).

The analyses of organic solvent extracts of leaves of *C. tridens* L. show that methanolic extracts severely affect the germination (no germination) than petroleum ether (28% germination) and chloroform (43% germination). Here also, the growth of the shoot is affected more than the growth of the root (Table 10). Similarly, leaf aqueous extract of

sunflower was more toxic than root extracts to germination and seedling growth of wheat and sunflower [23].

Tables 8,9,10 also reveal that organic solvent extracts of leaves are more inhibiting than root and stem.

Conclusions

The analyses of physical and mineral properties of weed stand soil and soil of adjacent area revealed that soil moisture percentage was higher in samples collected from depth, whereas soil conductivity and N, P, K content were found to be higher in surface soil samples. Soil samples were slightly alkaline in nature. There were non-significant differences in both physical and mineral properties of the weed stand soil and adjacent area soil. Implications of presence of some allelopathic chemical leachate from the roots of *C. tridens* L. in the soil was revealed due to stand soil samples, which were found to be more inhibiting than adjacent area soil samples. The aqueous leachates of *C. tridens* L. leaves showed maximum inhibition followed by roots and stem. The inhibitory effect of leachates increased with increase in their concentration. The methanolic extracts of different plant parts of *C. tridens* L. showed complete inhibition of germination of Pearl millet in comparison to petroleum ether and chloroform extracts. The leaf extract was found to be more inhibiting than root and stem extracts.

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