Oryza Vol. 45. No.4, 2008 (284-289)

Evaluation of allelopathic potential of *Echinochloa colona* (L) Link on germination and development of rice plant

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ABSTRACT

The allelopathic potential (E. colona (L.) Link. *one of the most temportant weeds of rice, was evaluated by in vitro bioassay techniques. Rice* variety 'Kranti' *seeds were allowed to grow for 5-7 days in petri dishes with filter paper, soil or soil plus activated charcoal along with decomposing or decomposed leachates of the weed (obtained from 20, 30, and 40 or 60 days old plants). Observations of allelopathic effects on germination and root and shoot growth were recorded. The allelopathic effects of leachates increased with increasing concentrations (1, 2.5, 5, and 10% w/v). The decomposed leachates were found to be more toxic than the decomposing ones. Rice root growth was completely inhibited with 10% w/v leachates of 60 days old plant. The decomposing and decomposed leachates reduced rice shoot growth by 57% and 84% respectively. In soil medium the allelopathic effects were considerably reduced. Addition of activated charcoal to soil completely reduced the adverse effects on germination and seedling growth of rice.*

Key words: *Allelopathy, Echinochloa colona, Oryza sativa, germination*

Crops and weeds not only influence each other by competing for space and nutrients but also through the production of chemicals that leach into the environment. This chemical influence is termed as allelopathy (Rice, 1984). It has been observed that *Echinochloa colona*, the most problematic weed associated with rice in upland and medium land situations causes enormous yield loss. This loss, so far, is attributed to be due to crop - weed competition. But the fact remains that apart from competition, allelopathic influence of the weed on the crop also plays a key role in affecting the crop yield (Rizvi *et al.*,1992). The allelopathic effect of plant extracts have been studied on various plants including *E. colona* (Sondhia and Swain, 2002). Laboratory bioassay is the first step to investigate the probable involvement of allelopathy (Foy, 1999). In vitro bioassays experiments under controlled laboratory conditions provide valuable information as it is difficult to isolate allelopathy from competition under field condition. But due to the recent developments in understanding of chemical influences between various species of plants in natural and managed ecosystems and availability of improved bioassay techniques that include soil and activated charcoal (Schmidt, 1990, Inderjit and Dakshini 1995), it is possible to conduct experiments in the laboratory which provide fairly good accounts of determining the extent and nature of allelopathy close to that occurs in terrestrial agro ecosystem. In the present investigation an attempt was made to find out the extent of allelopathic influences of the weed on the crop in vitro, comparable to field situations.

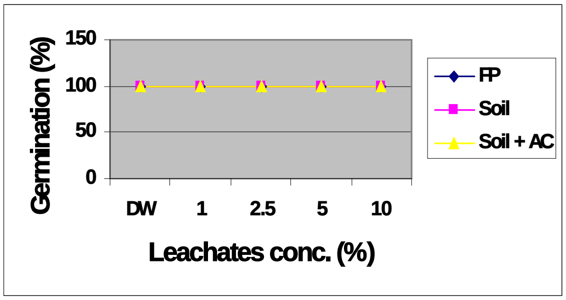
MATERIALS AND METHODS

Seeds of *Echinochloa colona* (L.) Link. were collected from plants growing in the rice fields of the research farm in the previous *wet* season, sun dried and stored in poly bags for future use. *E. colona* plants were grown in monoculture with standard agronomic practices. Plant samples were collected at intervals of 20, 30, 40 and 60 days after sowing (DAS), dried in the oven for 72h at 70 ^{o}C, and powdered with the help of a domestic grinder. The powder was further sieved through 40 mesh sieve and used for the experiment. The weed powder so prepared was soaked in distilled water for different durations and the leachates obtained were used for bioassay study. The effect of leachates in soil and soil with activated charcoal were also evaluated in order to assess the extent of activity in soil and the chemical nature of the allelopathic substance present in the leachates, respectively.

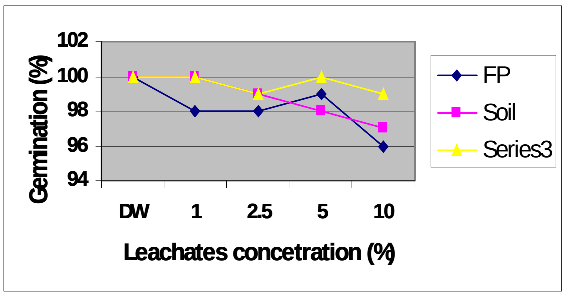
The experiments were conducted in borosilicate glass petri dishes. The decomposing aqueous leachates (10%w/v) were obtained by soaking 10g dry powder of plant material in 100 ml of distilled water for 24h at room temperature, filtered through two layers of cheese cloth and centrifuged at 10000g for 15min. Similarly the decomposed leachates (10%w/v) were prepared by soaking of 10 g of dry plant powder in 100 ml of distilled water for 10 days followed by filtration and centrifugation. The leachates were further diluted to 1-5 %v/v with distilled water. Sole distilled water was used as control. Twenty five seeds were taken on Whatman No. 1 filter paper in 100 x 20 mm borosilicate petri dishes and moistened with 10 ml of desired leachates and incubated in a seed germinator at 25^{o}C. Three replicates for each treatment including control were maintained. In the soil treatment, 50g of dried and powdered farm soil were taken in each petri dish and moistened to saturation with distilled water/weed leachates of appropriate concentration followed by sowing of seeds on the soil surface and incubated in the seed germinator. In the activated charcoal (AC) treatment, 1g of AC was mixed thoroughly with 50g of soil per petri dish. Incubation of petri dishes was done for 5-7 days after which observations were recorded on germination percentage and root and shoot growth and the data were statistically analyzed.

RESULTS AND DISCUSSION

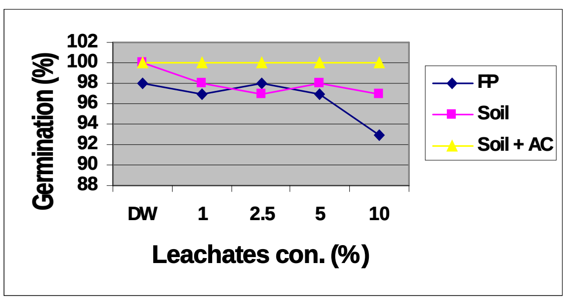
The effects of decomposing leachates of 20 - 60 days old plants (DOP) of *E. colona* (here after called as weed) on germination and root and shoot growth of rice in different media like, filter paper, soil and soil plus activated charcoal in petri dish culture experiments are presented in Fig.1 (a-d). It was observed that 20 and 60 DOP decomposing leachates had no adverse effect on the germination of rice (Figs.1-a and 1-d). In case of the leachates of 30 and 40 DOP the germination of rice was inhibited to a great extent but recovered in soil and, soil with charcoal medium (Figs.1-b and 1- c). However, the effect of decomposed leachates was relatively more severe on germination, the highest being with leachates of 40 and 60 DOP (Figs.1e-h). These adverse effects were also reduced in soil and soil with AC media. The root was found to be the most sensitive organ and was highly affected by the leachates of all concentrations as compared to control (Figs.2a-h). The highest concentrations of both decomposing and decomposed leachates highly affected root growth. Complete inhibition of root growth was obtained with the decomposing leachates of 40 DOP and also with decomposed leachates of 30-60 DOP. The decomposed leachates were more toxic than the decomposing leachates. The adverse effects on root growth also persisted in the soil medium to a great extent and was reduced in soil with AC medium. It might be that the root growth affecting allelopathic chemicals present in the leachates of 40 and 60 DOP were high enough not to be completely adsorbed by the amount of soil or activated charcoal used and the portions in excess present in the soil were toxic enough to severely affect the root growth. Shoot growth was also adversely affected, the decomposed leachates being more toxic than the decomposing ones (Figs.3a-h). The adverse effect on shoot growth increased with increasing concentration and also with increasing age of the weed. The decomposed leachates of 40 DOP showed the highest toxic effect being completely inhibiting the shoot growth. Although the adverse effects on shoot growth reduced considerably in the soil and soil withAC media but the balance toxic effect was quite significant suggesting their persistence in soil in effective concentrations. In agroecosystems, weeds interfere with crops in two important ways, by inhibiting germination and by inhibiting the growth of the crop (Inderjit and Dakshini 1999). In the present study it was inferred that the leachates of *E. colona* in different state of decomposition and concentrations had inhibitory effect on rice germination and seedling growth. The adverse effect on germination was reduced in presence of soil, but not on root and shoot growth, which indicated that root and shoot were more sensitive to allelochemicals present in the weed residue. The use of soil for allelopathy bioassays studies have been emphasized that provides information close to field conditions (Foy 1999, Inderjit and Dakshini 1999). However, in case of soil with AC, the adverse effects were completely reduced. Activated charcoal has also been used in allelopathic experiments to pin point the



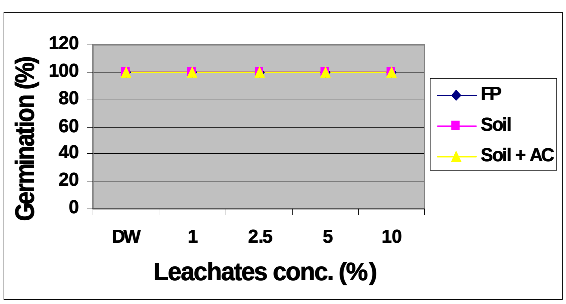
a) Decomposing leachates of 20 DOP



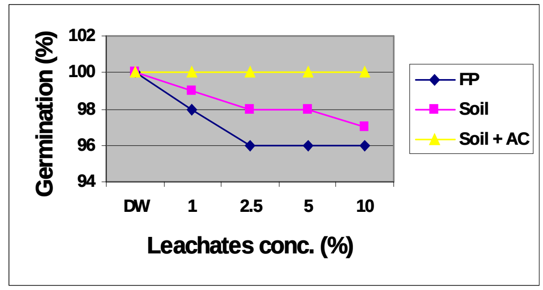
b) Decomposing leachates of 30 DOP



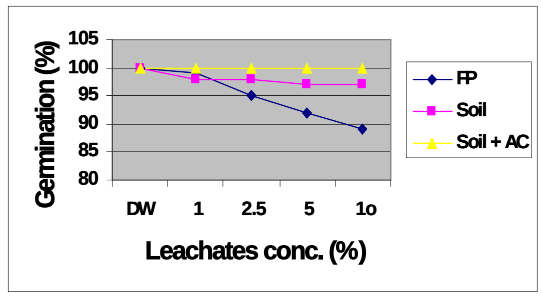
c) Decomposing leachates of 40 DOP



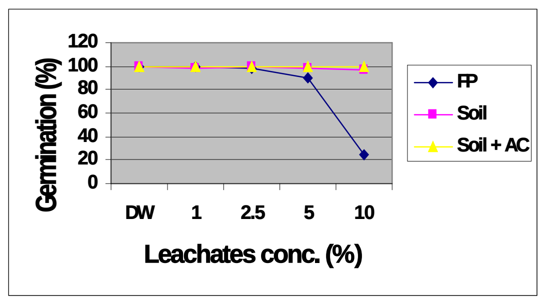
d) Decomposing leachates of 60 DOP



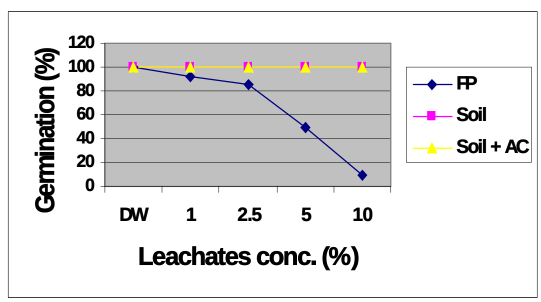
e) Decomposed leachates of 20 DOP



f) Decomposed leachates of 30 DOP



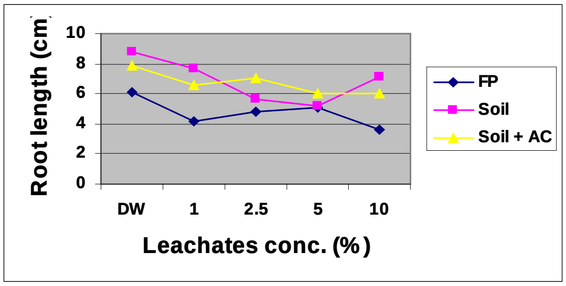
g) Decomposed leachates of 40 DOP



h) Decomposed leachates of 60 DOP

Fig. 1. Effect of decomposing and decomposed leachates of 20, 30, 40 and 60 days old plant (DOP), on germination of rice 'Kranti' in filter paper (FP), soil, and soil + activated charcoal (AC), distilled water (DW) was used as control.

involvement of alleleo-chemicals (Aldrich 1984, Ridenour and Callaway, 2001) as the causative agent since activated charcoal has the property of strongly adsorbing toxic organic molecules including allelochemicals by electrostatic attraction. It was, therefore, observed that the adverse effect of decomposed leachates was more severe. This might be due to interaction of microbes with the organic matter that helped in the release of higher amount of allelocompounds from the leachates and/or due to their modification after release (Inderjit 2001). Soil to some extent reduced the adverse effect on root growth but



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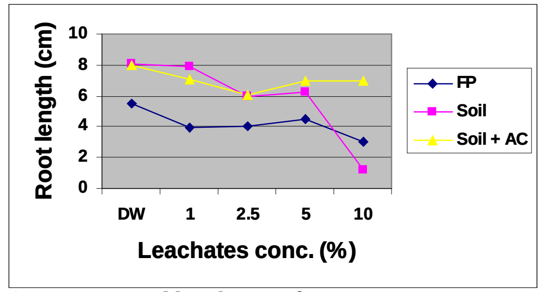

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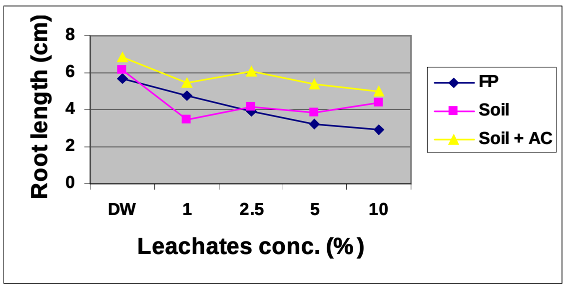
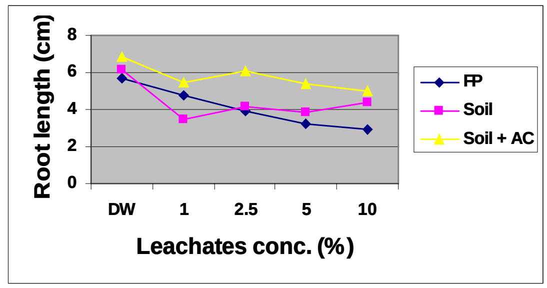


b) Decomposing leachates of 30 DOP



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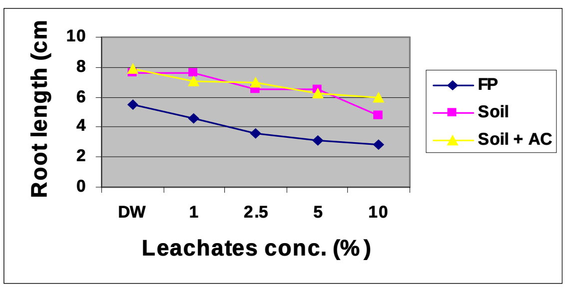
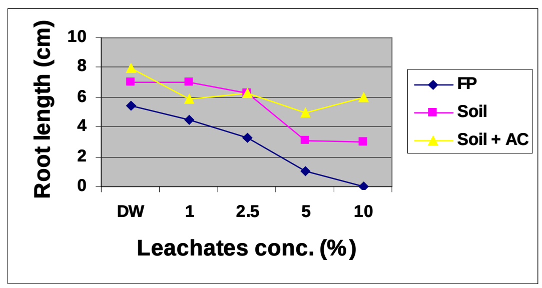
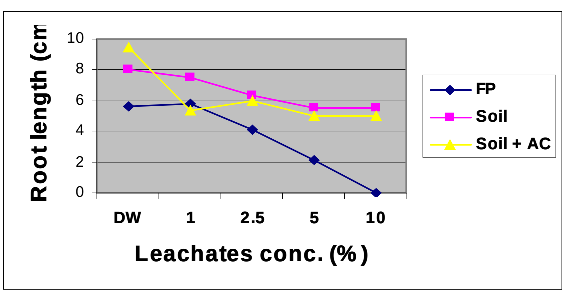


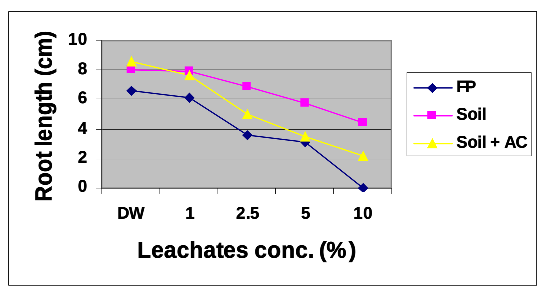
c) Decomposing leachates of 40 DOP



g) Decomposed leachates of 40 DOP



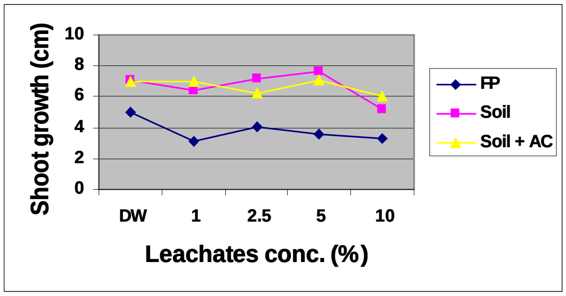
d) Decomposing leachates of 60 DOP



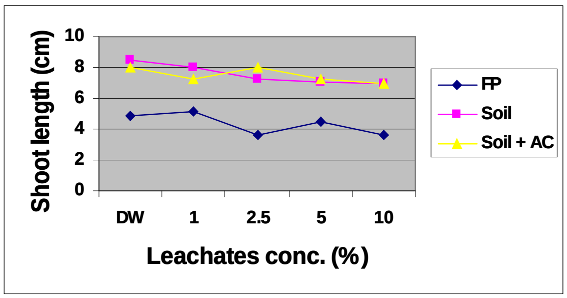
h) Decomposed leachates of 60 DOP

Fig. 2. Effect of decomposing and decomposed leachates of 20, 30, 40 and 60 days old plant (DOP), on root growth of rice 'Kranti' in filter paper (FP), soil, and soil + activated charcoal (AC), distilled water (DW) was used as control.

soil with AC completely neutralizes it. It means that, soil contains humus which are like activated charcoal has the property of adsorbing organic molecules and the adverse effect that persisted in soil, might be due to the excess of allelochemicals that affected the root and shoot growth of rice. Therefore, a higher concentration is needed to have adverse effect on germination of rice. The neutralization of allelopathic effect by activated charcoal indicated that the toxic factor(s) present in the weed leachates and causing the allelopathic effect were organic chemicals and might be secondary plant metabolites which were released into extracts/leachates during the process of extraction (Inderjit and Nilsen, 2003).



a) Decomposing leachates of 20 DOP



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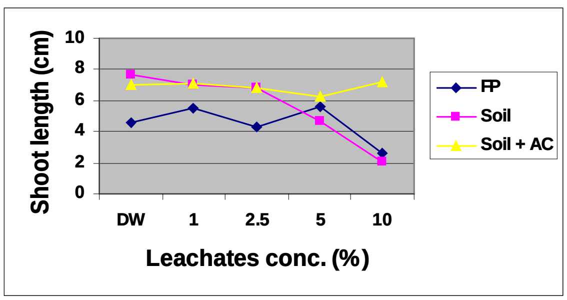
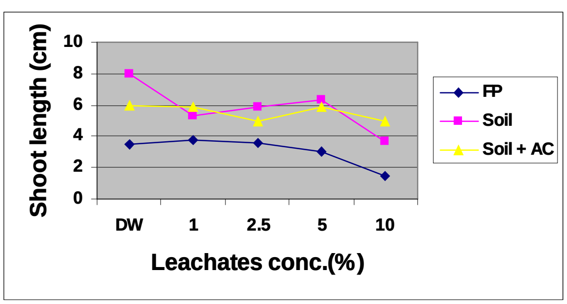
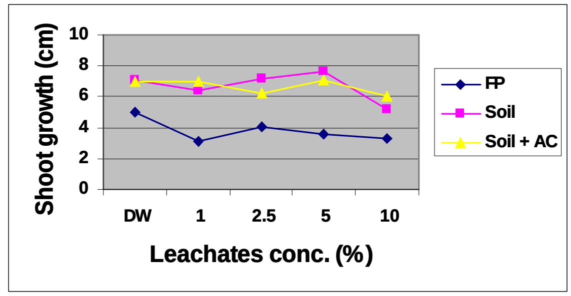


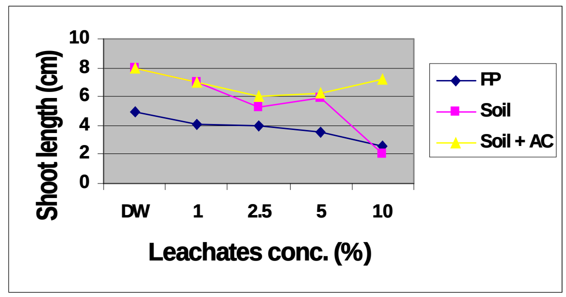
c) Decomposing leachates of 40 DOP



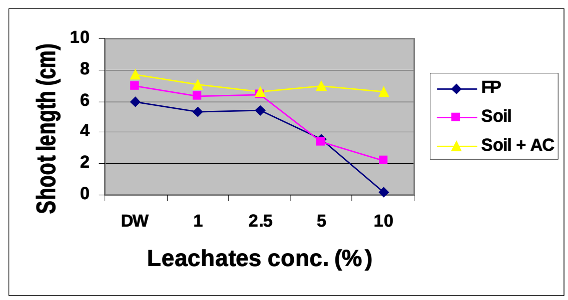
d) Decomposing leachates of 60 DOP



e) Decomposed leachates of 20 DOP



f) Decomposed leachates of 30 DOP



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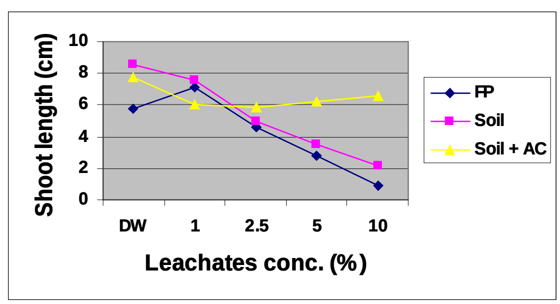

h) Decomposed leachates of 60 DOP

Fig.3. Effect of decomposing and decomposed leachates of 20, 30, 40 and 60 days old plant (DOP), on shoot growth of rice 'Kranti' in filter paper (FP), soil, and soil + activated charcoal (AC), distilled water (DW) was used as control.

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