Indian J.L.Sci. 3(1) : 159-162, 2013 **ISSN: 2277-1743 (Print)**
ISSN: 2278-7879 (Online)

INHIBITORY EFFECT OF STEM LEACHATE OF SELECTED WEEDS ON GERMINATION AND SEEDLING GROWTH OF TWO VARIETIES OF WHEAT (*Triticum aestivum*)

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ABSTRACT

This study investigated the allelopathic effects of stem leachates from three common weeds *Amaranthus viridis*, *Echinochloa crus-galli*, and *Eclipta alba* on the germination and early seedling growth of two wheat varieties, UP 2338 and HUW 234. Laboratory bioassays were conducted using varying concentrations (5%, 10%, 15%, and 20%) of aqueous stem leachates. The results demonstrated a significant dose-dependent inhibitory effect on germination percentage, shoot length, and root length across both wheat varieties. Among the weeds tested, *Amaranthus viridis* exerted the most potent phytotoxic effect, while *Echinochloa crus-galli* showed the least interference. Statistical analysis revealed that root development was more sensitive to allelochemical stress than shoot growth and germination. Furthermore, HUW 234 exhibited greater tolerance to the leachates compared to UP 2338, which was highly susceptible. These findings underscore the importance of effective weed management during the early stages of wheat cultivation to mitigate allelopathic interference and ensure optimal crop establishment.

KEYWORDS: Allelopathy, *Triticum aestivum*, Stem leachates, Germination, Seedling growth, Weed management

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops and plays a vital role in ensuring food security. Wheat productivity is highly influenced by biotic stresses, particularly weeds, which not only compete for resources but also release allelochemicals that affect crop growth. (B. C. Curtis et al. 2002,) However, its productivity is often constrained by the presence of weeds, which compete for nutrients, water, light, and space. Besides direct competition, weeds also influence crop growth through the release of toxic chemicals into the environment, a phenomenon known as allelopathy. These allelochemicals may be released through leaching, decomposition of plant residues, or root exudation and can adversely affect seed germination and early seedling growth of crops. *Triticum aestivum* L. is one of the most widely cultivated cereal crops in the world and serves as a major source of carbohydrates and protein for human nutrition. (P. R. Shewry-2009).

Germination and early seedling growth stages of wheat are considered highly sensitive to environmental and chemical stresses, including allelopathic interference. (Farooq, et. al 2009). In laboratory bioassays, aqueous leachates of weed plant parts have been widely used to study their inhibitory or stimulatory effects on crops.

Aqueous extracts and residues of *Amaranthus* species have been reported to inhibit seed germination and reduce root and shoot growth of wheat and other cereal crops. The inhibitory effects are generally concentration dependent, with higher concentrations causing greater reduction in seedling growth (Rice, 1984; Singh et al., 2003). Different wheat varieties exhibit variable responses to allelopathic stress due to genetic and physiological differences. (Weston et al. 2013). UP 2338 and HUW 234.

Echinochloa crus-galli, commonly known as barnyard grass, is one of the most problematic grassy weeds in rice–wheat cropping systems. It is characterized by rapid growth, high adaptability, and prolific seed production. Besides its strong competitive ability, this weed is also known to release allelochemicals that adversely affect the germination and early growth of crops. Several investigations have shown that aqueous extracts of *E. crus-galli* significantly reduce germination percentage and seedling growth, particularly root elongation, indicating its strong allelopathic influence on associated crops (Inderjit & Duke, 2003; El-Rokiek & Eid, 2009).

Eclipta alba (syn. *Eclipta prostrata*), commonly known as false daisy, is an annual weed prevalent in moist and irrigated agricultural fields. The plant contains various bioactive compounds such as alkaloids, flavonoids, and phenolic substances that contribute to its allelopathic properties. Earlier studies have reported that aqueous extracts of *Eclipta alba* adversely affect germination, root length, shoot length, and seedling vigor of wheat. Root growth has been observed to be more sensitive to its allelochemicals than shoot growth, suggesting that this weed may seriously interfere with early crop establishment (Javaid & Bajwa, 2011; Siddiqui et al., 2009).

Among the growth parameters studied, root length appeared to be more sensitive than shoot length, suggesting that allelochemicals primarily interfere with

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root development. Understanding allelopathic interactions in wheat is essential for developing sustainable weed management strategies and improving crop establishment (Javaid and Bajwa, 2011)

Several studies have reported that allelopathic interactions play an important role in crop–weed relationships and can significantly influence seed germination and seedling growth of crops (Rice, 1984; Inderjit & Duke, 2003).

MATERIALS AND METHODS

Experimental Site and Plant Material

The experiment was conducted under laboratory conditions to study the allelopathic effect of stem leachates of selected weeds on germination and seedling growth of wheat. Seeds of two wheat (*Triticum aestivum* L.) varieties, namely UP 2338 and HUW 234, were used for the study. Healthy and uniform seeds were selected and surface sterilized before use.

Three common weed species, *Amaranthus viridis***,** *Echinochloa crus-galli***,** and *Eclipta alba*, were collected from nearby agricultural fields. The weed samples were washed thoroughly with tap water followed by distilled water to remove soil and other impurities.

Preparation of Stem Leachates

Fresh stems of each weed species were chopped into small pieces and air-dried under shade. A known quantity of dried stem material was soaked in distilled water for 24 hours at room temperature to prepare the stock solution (100%). The extract was filtered through muslin cloth followed by Whatman No. 1 filter paper. From the stock solution, different concentrations of stem leachates viz., 5%, 10%, 15%, and 20% were prepared using distilled water. Distilled water without leachate served as control**.**

Germination Test

The experiment was laid out in a completely randomized design (CRD) with three replications. Ten seeds of each wheat variety were placed in sterilized Petri dishes lined with filter paper. Each Petri dish received an equal volume of respective weed stem leachate concentration. Control treatments received only distilled water. The Petri dishes were kept under laboratory conditions. Observations on germination percentage**,** shoot length (cm)**,** and root length (cm) were recorded 5 days after sowing (DAS)**.** Germination percentage was calculated based on the number of seeds germinated. Shoot and root lengths were measured using a centimeter scale.

The data obtained were statistically analyzed using standard procedures. Percent deviation from control was calculated to assess the inhibitory or stimulatory effects of weed stem leachates. Critical Difference (CD) at 5% level of significance was worked out to compare treatment means.

RESULTS AND DISCUSSION

The effect of stem leachates of selected weeds on germination and seedling growth of two wheat varieties (UP 2338 and HUW 234) was studied at 5 DAS (Table1, Figure1). In general, all weed leachates exhibited an inhibitory effect on germination percentage, shoot length, and root length of both wheat varieties, and the magnitude of inhibition increased with increasing concentration of leachates.

Among the weed species, *Amaranthus viridis* caused the maximum reduction in all growth parameters. In variety UP 2338, germination decreased from 87.2% in control to 51.2% at 20% concentration, accompanied by a marked reduction in shoot length (6.9 to 3.8 cm) and root length (5.6 to 2.2 cm). A similar trend was observed in HUW 234, where germination declined from 94.0% to 74.8%, and root length showed a sharp reduction from 7.12 to 1.72 cm at the highest concentration.

Leachates of *Echinochloa crus-galli* showed comparatively milder inhibitory effects. Germination percentage remained relatively high even at 20% concentration, though a gradual decline in shoot and root length was evident in both varieties. Root length was more affected than shoot length, particularly in HUW 234.

Eclipta alba exhibited moderate to severe phytotoxic effects, especially at higher concentrations. In UP 2338, germination was reduced by 50.8% at 20% concentration, while shoot and root lengths decreased drastically compared to control. However, HUW 234 showed comparatively less sensitivity, with smaller reductions in germination and seedling growth parameters.

Overall, root length was more sensitive to weed leachates than shoot length in both wheat varieties. The variety UP 2338 was more susceptible to allelopathic stress than HUW 234.

Table 1: Effect of stem leachates of selected weeds on germination and seedling growth of wheat (5DAS)

Treatment (%)	Germination (%) UP 2338	Shoot length (cm)	Root length (cm)	Germination (%) HUW 234	Shoot length (cm)	Root length (cm)
Amaranthus viridis						
Control	87.2	6.9	5.6	94.0	8.18	7.12
5	72.8 (-16.5)	5.5 (-20.3)	4.5 (-19.6)	92.0 (-2.1)	7.80 (-4.8)	6.64 (-6.7)
10	67.2 (-22.9)	4.3 (-37.6)	2.2 (-60.7)	88.4 (-5.9)	7.30 (-10.9)	5.60 (-21.3)
15	60.2 (-30.9)	4.1 (-40.5)	2.2 (-60.7)	83.2 (-11.5)	6.20 (-24.4)	3.80 (-46.6)
20	51.2 (-41.2)	3.8 (-44.9)	2.2 (-60.7)	74.8 (-20.4)	4.58 (-43.9)	1.72 (-75.8)
CD at 5%	4.0	0.33	0.27	5.07	0.05	0.19
Echinochloa crus-galli						
Control	94.4	7.14	4.3	94.0	8.18	7.12
5	92.0 (-2.1)	6.92 (-3.1)	4.14 (-3.7)	93.6 (-0.4)	8.18 (0.0)	6.80 (-4.5)
10	88.8 (-5.5)	6.82 (-4.5)	4.24 (-1.4)	93.6 (-0.4)	8.04 (-1.7)	5.62 (-21.0)
15	88.0 (-6.3)	6.62 (-7.3)	3.98 (-7.4)	91.2 (-2.7)	7.90 (-3.4)	5.32 (-25.2)
20	88.0 (-6.3)	6.56 (-7.7)	3.42 (-20.4)	90.0 (-4.2)	7.40 (-9.5)	3.36 (-52.8)
CD at 5%	3.1	0.19	0.11	2.71	0.22	0.27
Eclipta alba						
Control	90.4	9.0	7.9	92.0	8.00	7.22
5	88.0 (-2.6)	8.2 (-8.8)	5.9 (-25.3)	93.6 (+1.7)	7.24 (-9.5)	6.90 (-4.4)
10	86.4 (-4.4)	7.1 (-21.1)	3.4 (-56.9)	91.6 (-0.4)	7.10 (-11.2)	6.44 (-10.8)
15	64.0 (-29.2)	6.2 (-31.1)	2.8 (-64.5)	90.3 (-1.8)	6.82 (-15.0)	4.68 (-35.2)
20	44.4 (-50.8)	4.1 (-54.4)	1.5 (-81.0)	90.0 (-2.1)	6.76 (-15.5)	3.36 (-53.4)
CD at 5%	6.3	0.20	0.20	1.62	0.26	1.33

Data in parentheses indicate percent decrease from control.

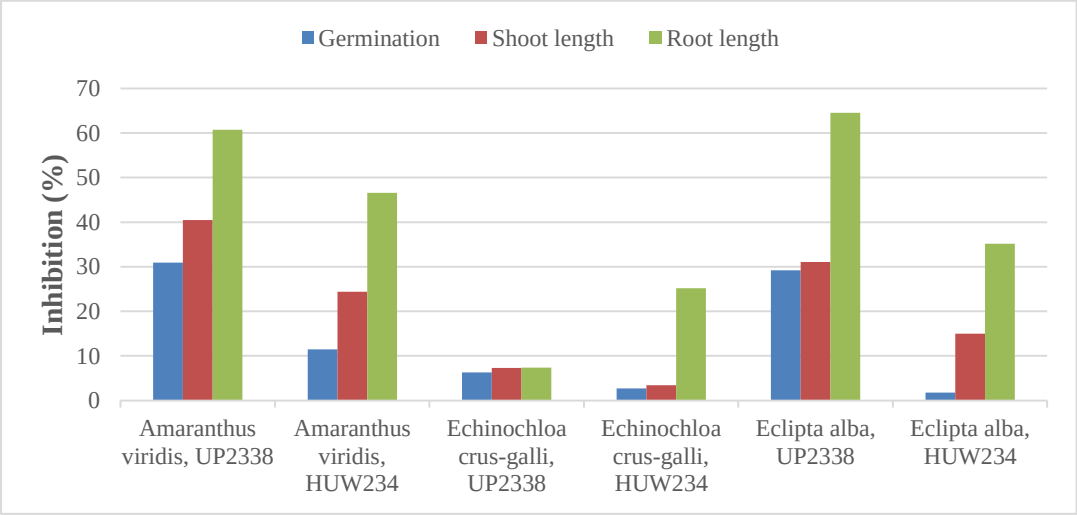

Figure1: Inhibitory effect of Stem Leachates of different weeds spp. on germination, shoot length and root length of Wheat Varieties at 5DAS

The inhibitory effects of weed stem leachates on wheat germination and seedling growth indicate the presence of allelopathic compounds that interfere with early plant development. The progressive reduction in germination and seedling growth with increasing leachate concentration suggests a dose-dependent allelopathic response. Root growth was more severely affected than shoot growth, possibly due to direct exposure of roots to allelochemicals, resulting in impaired cell division and elongation.

Among the weeds tested, *Amaranthus viridis* exerted the strongest allelopathic effect, followed by *Eclipta alba*, while *Echinochloa crus-galli* was least inhibitory. Differential responses of wheat varieties indicate varietal variation in tolerance to allelopathic stress, with HUW 234 showing greater resistance compared to UP 2338. These findings highlight the

potential role of weed-derived allelochemicals in crop–weed interactions and emphasize the importance of effective weed management during early stages of wheat growth.

CONCLUSION

The present study clearly indicates that stem leachates of selected weeds had a significant inhibitory effect on germination and early seedling growth of wheat (*Triticum aestivum* L.). The magnitude of inhibition increased with increasing concentration of leachates (5–20%). Among the tested weeds, *Amaranthus viridis* and *Eclipta alba* showed stronger allelopathic effects compared to *Echinochloa crus-galli,* particularly on root length, which was more sensitive than shoot length and germination percentage.

Both wheat varieties (UP 2338 and HUW 234) responded negatively to higher concentrations of weed leachates; however, UP 2338 was generally more affected than HUW 234, indicating varietal differences in tolerance. At the highest concentration (20%), maximum reduction in germination, shoot length, and root length was observed, especially under *Eclipta alba* leachate treatment.

Overall, the results confirm that allelochemicals released from these weeds can adversely affect wheat establishment at the seedling stage, highlighting the importance of effective weed management in wheat fields to minimize allelopathic stress and ensure better crop growth.

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