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REGULAR ARTICLE

ALLELOPATHIC POTENTIAL OF *ECHINOCHLOA CRUS-GALLI* (L.) P. BEAUV. EXTRACTS ON GROWTH AND DEVELOPMENTAL CHANGES OF *ABELMOSCHUS ESCULENTU S* (L.) AND *SOLANUM LYCOPERSICUM* (L.)

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ABSTRACT

The study was designed to evaluate the growth and developmental changes of bhendi (*Abelmoschus esculentus* L.-cv. CO-1) and tomato (Solanum *lycopersicum* L.-cv. PKM-1) seedlings by using different concentrations of (2g/l, 5g/l, 10g/l, 15g/l and 25g/l) aqueous *Echinochloa crus-galli* (L.) extracts under pot culture experiments. Barnyard grass extracts showed an inhibitory and stimulatory effects on germination, seedling length, biomass, pigments and biochemical constituents of bhendi and tomato. The 2g/l concentration of extract stimulated the seed germination, seedling growth, biomass and biochemical constituents of bhendi and tomato. The higher concentrations (15g/l and 25g/l) showed an inhibitory effect in all the parameters studied in the two economically important vegetable crops. The degree of retardation was dependent on the concentration gradient of the barnyard grass extracts. Root length, Shoot length, Biomass and Biochemical constituents of tomato seedlings were highly reduced at 25g/l concentrations of aqueous leaf extracts of barnyard grass. Between bhendi and tomato seedlings, more allelopathic influence was observed in tomato than bhendi seedlings.

Keywords: Allelopathy, Extracts, *Echinochloa crus*, Inhibitory, Bhendi, Tomato

INTRODUCTION

Allelopathy is the growth inhibiting effect of one plant on another plant [1]. This can be due to different types of exudations or secretions from the plants which may act as an antagonistic factor on growth of other plant [2]. This inhibition in growth of plants by another plants can be a competition or struggle for existence in between the weed flora, and in that sense it can play a significant role in weed-crop interaction [3-5]. Allelopathy in weed management is a widely studied phenomenon. It occurs naturally in all the ecosystems. Recently, the practice of artificially prepared weed extracts in control of other plant growth is getting more attention in researchers, as it paves a way of natural control of weeds.

Banyardgrass (*Echinochloa crus*–galli) is a grass species belongs to family Poaceae. Usually, it is classified as a wild grass species. It is otherwise known barnyard millet, panic grass and water grass. It can be seen in crop growing areas and marginal and waste lands [6]. It is the main reason behind yield loss of many crops. Bhowmik and Reddy [7] reported in a field study that barnyard grass reduced the weight and number of fruits of tomato. The objective of the study was to investigate the allelopathic potential of barnyard grass and their suppressive effects on two important vegetable crops of bhendi and tomato seedlings.

MATERIALS AND METHODS

The fresh, mature barnyard grass weeds were collected from the fields for the present study. The weeds were washed with distilled water thoroughly to remove the adherent dust and soil particle, then dried for two weeks at room temperature and powered with the help of mill blender and stored at room temperature. 25 gram barnyard grass powder soaked in 1000 ml distilled water for 48 h. These extracts were filtered and filtrates were considered as 25g/l concentration. The same method was followed for 2,5,10 and 15 g/l barnyard grass extracts preparation. The obtained barnyard grass extract was analyzed for phytochemical profiles by GC-MS. The freshly prepared extracts were used for the pot culture experiments.

Healthy uniform seeds of bhendi and tomato seeds were collected from Tamil Nadu Agricultural University, Coimbatore. Twenty five seeds each of bhendi and tomato were sown in earthen pots (30× 15 cm) filled with garden soil having silt, humus and sand (pH-7.3, N–0.13, P–0.29, K–0.09 and OC–1.86%). Each pot was added with 200 ml

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of different concentrations of barnyard grass extracts and control was treated with 200 ml of tap water. The experiment was conducted in completely randomized design with three replications. After 15 d of germination, the morphological and biochemical parameters were studied.

RESULTS AND DISCUSSION

In the present study revealed the results of allelopathic activity of *Echinochloa crus-galli* (L.) weed against bhendi (*Abelmoschus esculentus* L.-cv. CO-1) and tomato (*Solanum lycopersicum* L.-cv. PKM-1) seedlings. The allelopathic effect was observed in both test seedlings at germination stage and developmental stage. The germination percentage of five different concentrations of barnyard grass extracts (2g/l, 5g/l, 10g/l 15g/l and 25g/l) and water (control) is shown in Table: 1. The results revealed that the 25g/l concentration of extract strongly reduced the germination percentage of bhendi and tomato (54.1% and 60.4%) compared to that of control (98and 96%). The results showed that at 2g/l extract concentration, the percentage of germination (100 and 98%) increased in bhendi and tomato when compared to control. All concentrations of barnyard grass extract did not show the same degree of reducing nature of germination.

Yamamoto *et al.* [8] indicated that barnyard grass inhibited the growth of cress (*Lepidium sativum* L.), amaranth (*Amaranathus viridis* L.), at germination and seeding stages. The residues of these weed species incorporated into the soil affect corn emergence and its early growth. This study is in strongest evidence for the present findings of allelopathic potential of barnyard grass on bhendi and tomato. The barnyard grass extract significantly reduced the root length, shoot length and dry weight of bhendi and tomato at 25g/l extract treatment when compared to the control (Table-2). But at 2g/l concentration of extract treatment, the test corps showed the promoting effects on root length, shoot length and dry weight over to control. The highest reduction percentage of shoot length (68.6%) and root length (63.2) were recorded in tomato at 25g/l extract treatment. Seedling growth of bhendi and tomato reduced progressively with increasing concentrations of extract. The more reduction of dry weight of bhendi and tomato at 25g/l extract concentration was 71.2% and 80.0% respectively. The results of present study were similar to those of Chun *et al.* [9] who have worked with allelopathic cultivars of rice. The results of present study were similar to those of Bhowmik and Reddy [7], Stauber *et al.* [10] who have studied allelopathic effect of barnyard grass extract on germination and seedling growth of some vegetable and crop plants. Vishal Vijayan [11] recorded the highest germination percentage in rice, when field soil is mulched with dry leaves of Acacia.

Fig. 1 and 2 shows the starch, protein and amino acid, carbohydrates, carotenoid and phenol content of the test crops. The higher amount of starch, protein and amino acid, carbohydrates, carotenoid and phenol were observed in 2g/l concentration of barnyard grass extract treated seedlings of bhendi and tomato over control. When increasing the weed extract concentrations (5g/l, 10g/l, 15g/l and 25g/l) there was a decreasing trend of starch, protein, amino acid, carbohydrates, carotenoid and phenol contents both in bhendi and tomato seedlings.

Table 1: Allelopathic Influence of *Echinochloa* weed extracts on germination (%) of bhendi and tomato

Extracts concentrations (g/l)	Bhendi	Tomato
Control	98	96
2	100 (2.0)	98 (2.0)
5	91 (-7.1)	86 (-10.4)
10	80 (-18.4)	73 (-24.0)
[15]	[66] (-327)	[61] (-364)
25	45 (-54.1)	38 (-60.4)

Data in parentheses indicate % increase/decrease over control.

Table 3: Allelopathic Influence of *Echinochloa* grass extracts on root length (cm/seedling), shoot length (cm/seedling), fresh weight (mg/seedling) and dry weight (mg/seedling) of Bhendi seedlings

Extracts Concentrations (g/l)	Root length	Shoot length	Fresh weight	Dry weight
Control	10	17.3	3.14	0.73
2	12 (20)	18.1 (4.6)	3.16 (0.63)	0.78 (6.8)
5	8.1 (-19)	15.2 (-12.0)	3.02 (-3.8)	0.52 (-28.7)
10	7.5 (-25)	12.2 (-29.4)	2.65 (-15.6)	0.41 (-43.8)
15	6.0 (-40)	8.3 (-52.0)	2.02 (-35.7)	0.36 (-50.7)
25	4.9 (-51)	6.3 (-63.6)	1.39 (-55.7)	0.21 (-71.2)

Data in parentheses indicate % increase/decrease over control.

Table 3: Allelopathic Influence of *Echinochloa* grass extracts on root length(cm/seedling), shoot length (cm/seedling), fresh weight (g/seedling) and dry weight (g/seedling) of tomato seedlings

Extracts Concentrations (g/l)	Root length	Shoot length	Fresh weight	Dry weight
control	6.8	9.6	2.65	0.55
2	7.2 (5.8)	10.3 (7.3)	2.70 (1.9)	0.58 (5.4)
5	6.0 (-11.8)	8.9 (-7.3)	2.56 (-3.4)	0.50 (-9.1)
10	5.1 (-25.0)	7.0 (-27.0)	2.02 (-23.8)	0.39 (-29.1)
15	4.0 (-41.2)	4.6 (-52.1)	1.56 (-41.1)	0.27 (-50.9)
25	2.5 (-63.2)	3.0 (-68.6)	0.99 (-62.6)	0.11 (-80.0)

Data in parentheses indicate % increase/decrease over control.

Table 4: Allelopathic Influence of *Echinochloa* grass extracts on Chl. a, Chl. b and Total chlorophyll (mg/g fr. wt.) of Bhendi and Tomato

Extract concentrations	Bhendi			Tomato		
	Chl. a	Chl. b	Total Chl.	Chl. a	Chl. b	Total Chl.
control	0.23	0.2	0.43	1.51	1.1	2.61
2g/l	0.24 (4.3)	0.21 (5.0)	0.45 (4.7)	1.7 (12.6)	1.2 (9.1)	2.9 (11.1)
5g/l	0.18 (-21.7)	0.18 (-10.0)	0.36 (-16.3)	1.37 (-9.3)	0.97 (-11.8)	2.34 (-10.3)
10g/l	1.15 (-20.7)	0.15 (-25.0)	0.3 (-30.2)	1.18 (-21.9)	0.85 (-22.7)	2.03 (-22.2)
15g/l	0.15 (-34.8)	0.12 (-40.0)	0.24 (-44.2)	0.99 (-34.4)	0.69 (-37.3)	1.68 (-35.6)
25g/l	0.09 (-60.9)	0.07 (-65.0)	0.16 (-62.8)	0.71 (-53.0)	0.48 (-56.4)	1.19 (-54.4)

Data in parentheses indicates % increase/decrease over control.

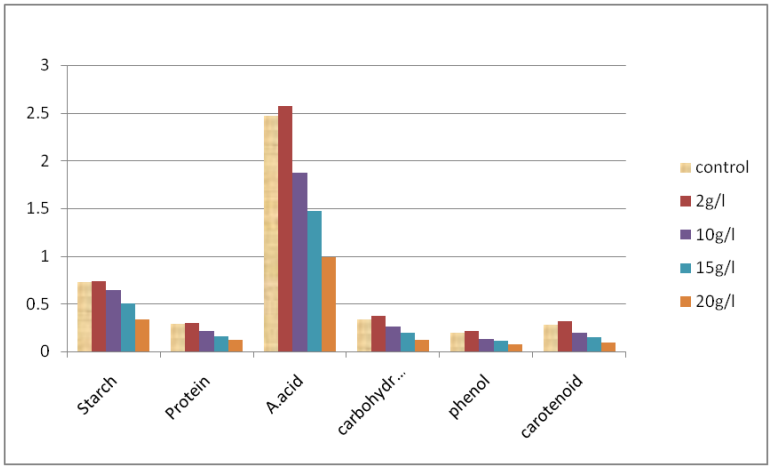

Fig. 1: Allelopathic influence of *Echinochloa* grass extracts on starch, protein, amino acid, carbohydrates, phenol and carotenoid contents (mg/g fr. wt.) of Bhendi

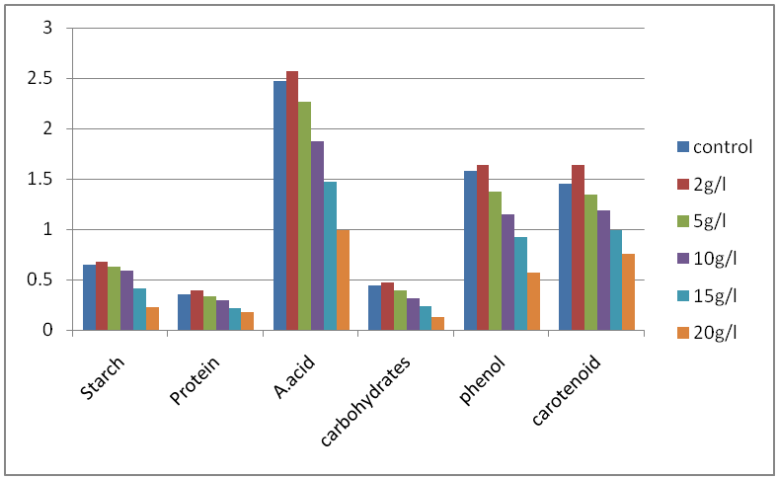

Fig. 2: Allelopathic influence of *Echinochloa* grass extracts on starch, protein, amino acid, carbohydrates, phenol and carotenoid contents (mg/g fr. wt.) of tomato

The 25g/l extract concentration showed more retarding effect on carotenoid (67.9%) followed by phenol (65.0%) content of bhendi seedlings than starch, carbohydrates and protein. In bhendi, more amino acid content was observed than starch and carbohydrates contents in all treatments. But in tomato more carotenoid content was observed in all treatments than starch, protein and amino acids. As the chlorophyll concentration decrease in all concentration ofextract, the metabolite of starch, protein, phenol, carotenoid and amino acid decreased. The present study supports the earlier records [12-14] who have found many weed species such as palmer amaranath (*Amaranathus Palmeri* S. Wats.), broadleaf signal grass (*Brachiaria platyphylla* Griseb. Nash), fall panicum (*Panicum dichotomiflorum* Michx.), crimson clover (*Trifolium incarnatum* L.) and quack-grass (*Agropyron repens* (L.) exhibit the allelopathic effects on crops growth. The allelochemicals of barnyard grass extract significantly reduced the chlorophyll, carotenoid, starch, protein, carbohydrate, phenol and amino acid contents of leaves of bhendi and tomato seedlings. Tripathi *et al.* [15], reported that the lower concentration of leaf extracts of *Acacia nilotica*, *Tectona grandis* and *Albiia procera* showed stimulatory effect on starch, protein and amino acid contents of soybean. But in higher concentration of leaf extract, there was a decreasing trend of these biochemical constituents as observed in the soybean [15].

The decreasing content of biochemical contents may be due to action of trepens, cinnamic acid, ferulic acids, long-chain fatty acids and steroids. Tang *et al.* [16] reported *Bigalta limpograss* contain phytotoxic compounds and release into the environment that inhibit the growth of crops. Kohli [17] reported, that the enzymes like protease, polyphenol oxidase, peroxidase, α-amylase and β-amylase are affected by the Allelochemicals. Yamamoto *et al.* [8] and Li *et al.* [18] who have suggested that phenolics of barnyard grass extract inhibit the growth of crops. Son *et al.* [19] reported that metabolites of barnyard grass has potential antagonistic properties.

The higher degree of adverse effect was observed in tomato treated with barnyard grass 25g/l concentration of extract followed by 15 and 5 g/l. The significantly stimulatory effect was observed in bhendi and tomato seedlings at 2g/l concentraction of barnyard grass extract over control. The results of GC-MS analysis showed the presence of p-hydroxybenzaldehyde, p-hydroxybenzen, phytol, 1,2 Benzenedicarboxylic, Butanic acid, p-Butryloxybenzaldehyde, 1,3-cyclohexanddione, 2,5-Dimethyl-4-hydroxy3(2H)-furanone,2-Hydroxyoctanoic acid, n-Decanoic acid, 2-Methoxy-4-vinylphenol, phenol,2,6-dimethoxy, Methyl acetoxyacetate, etc. in barnyardgrass. Allelochemicals are responsible for the antagonistic action in neighboring plants [20].

CONCLUSION

Present investigation revealed that aqueous barnyardgrass at different concentration levels inhibited seedling growth and at low concentration (2g/l) stimulated the germination, seedling length, biomass, pigments, starch, protein, phenol, carbohydrates and amino acid contents of bhendi and tomato seedlings. Inhibitory effect of different concentrations of extract was not equal and highest inhibition was observed in tomato while the lowest inhibition was observed in bhendi. In both the test crops, the promoting effects were observed at 2g/l concentration of extract. The inhibitory and stimulatory effects of *E. crus-galli* extracts on bhendi and tomato may be due to the special biochemicals present in extracts. Further field study must be carried out to estimate the alleopathic potentiality of *E. crus-galli* on field crops.

REFERENCES

1. Hierro JL, Callaway RM. Allelopathy and exotic plant invasion. Plant and soil. 2003;256:29-39.
2. Ferguson JJ, Rathinasabapathi B. Allelopathy: How plants suppress other plants. University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, EDIS; 2003.
3. Zimdahl RL. Weed-crop competition: a review. John Wiley and Sons; 2007 Nov 19.
4. Wilson, R. E. and Rice, E. L. 1968. Allelopathy as expressed by *Helianthus annuus* L., and its role in old-field succession. Bull. Torrey bot. Club., 95:432-448.
5. Rasmessen. J. A. and Rice, E. L. 1971. Allelopathic affects Sporobolus pyramidalis on vegetational patterning. Amer. Midl. Nat., 86:309-326.

6. Bosnic AC, Swanton CJ. Influence of barnyardgrass (*Echinochloa crus-galli*) time of emergence and density on corn (*Zea mays*). Weed Science. 1997;45:276-82.
7. Bhowmik, P. C. and Reddy. K. N. (1988). Effects of baryarnd grass (*Echinochloa crus-galli*) in growth, yield, and nutrient status of transplanted tomato (*Lycopersicon esculentum*). Weed Sci. 36:775-778.
8. Ymamoto T, Tomita KY, Kosemura S, Yakamura S Yamada K, Hasegawa K. 1999. Allelopathic substance exuded from a serious weed, germinating barnyardgrass (*Echinochloa crusgalli*) root. J Plant Growth Regul 18:65-67
9. Chun. M. M, Golomb. J. D, Turk-Browne N. B. (2011). A taxonomy of external and internal attention. Annu. Rev. Psychol. 62:73-101.
10. Stauber. L. G., Smith, Jr., R. J. and Talbert, R. E. 1991. Density and spatial inference of barnyard grass with rice. Weed sc. 39:193-168. Alam, S. M. 1991. Weed Science Problem in Pakistan. Pak. Gulf. Eco., 3:25-29.
11. Vishal Vijayan, 2015. Evaluation for allelopathic impact of *Acacia auriculiformis* A. Cunn. Ex Benth on seed germination and seedling growth of rice (*Oryza sativa* L), a widely cultivated Indian crop species. Research journal of Agriculture and forestry sciences. Vol. 3, 1-5.
12. Johnson III, W. C. and Coble. H. D. 1986. Effects of three weed residues on weed and crop growth. Weed Sci. 34:403-408.
13. Weston. L. A. and Putnam, A. R. 1986. Inhibition of legume seedling growth by residues and extracts of Quackgrass (*Agrophron repens*). Weed Sci. 34:366-372.
14. White, R. H., Worshan, A. D. and Blum. U. 1989. Allelopathic potential of legume debris and aqueous extracts. Weed Sci. 37:674-679.
15. Tripathi. S, Tripathi. A. and Kori, D. C. 1998. Allelopathic evaluation of *Tectona grandis* leaf, root and soil aqueous extracts on soybean. Ind. J. Forestry., 22:366-74.
16. Tang CS, Young CC.1982. collection and identification of allelopathic compound from undisturbed root system of Bigalta lipograss (*Hemaryhria altissima*). Plant Physi 69:155-160
17. Kohli, R. K., Singh, D. and Verma, R. C. 1990. Influence of Eucalyptus shelter belt on winter season. Agro-ecosystems. Agriculture, Ecosystems and Environment, 33:23–31.
18. Li HH, Urashima M, Amamo M, Lajide L, Nishimura H, koji H, Mizutani j. 1992. Allelopathy of barnyardgrass (*Echinocbola crusgalli* L. Beauv var c rus-galli). Weed res japan 37:146-152
19. Son DH, Thil HL, Kato-Noguchi H.2010. Allellopathic poetenial and isolation process of allelopathic substancae in barnyardgrass (*Echinochloa crus-galli*) Omonarice 17:143-146.
20. Rejila S, Vijayakumar N. Allelopathic effect of Jatropha curcas on selected intercropping plants (Green Chilli and Sesame). Journal of Phytology. 2011;3(5):1-3.