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Research Article

Allelopathic Effect of *Echinochloa colona* L. and *Cyperus iria* L. Weed Extracts on the Seed Germination and Seedling Growth of Rice and Soyabean

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The present study was undertaken to assess the allelopathic effect of *Echinochloa colona* L. and *Cyperus iria* L. in relation to the germination and primary growth of *Oryza sativa* L. (rice) and *Glycine max* L. (soyabean). Effects of dichloromethane (DCM) and double distilled water soluble (DDW) fractions of *E. colona* L. and *C. iria* L. root and aerial part extracts reduced germination and suppressed early seedling growth of rice and soyabean. With increase in extract concentration from 1 to 100 mg/mL, a gradual decrease in seed germination and seedling length occurred. The highest growth of *G. max* seedling was recorded in DDW fraction of *E. colona* aerial part extract at 1 mg/mL concentration with 94% germination and the lowest length was found in DCM fraction of *C. iria* root extract at 100 mg/mL concentration with 65% germination. In *O. sativa*, the highest length was noted at 1 mg/mL concentration in DDW fraction of *E. colona* aerial part extract with 82% germination and the lowest length was found in DCM fraction of *C. iria* and *E. colona* root extracts with germination 57% and 62%, respectively, at 100 mg/mL concentration. The results suggested that these weeds had good allelopathic potential which reduces germination and plant growth.

1. Introduction

Allelopathy is the direct or indirect effect of plants with one another through producing chemical compounds [1]. Allelopathic compounds generally occur in natural plant communities and are suggested to be one mechanism by which weeds interfere with crop growth [2]. Several weed species are reported to have allelochemicals that affect germination and growth of crops due to toxicity [3]. Allelopathic effects of weeds on rice as well as competition of weeds with rice for water, light, physical space, and nutrient thus reduce yield, lowering grain quality and cash value of the crop [4].

According to Karim et al. [5], the annual rice yield loss due to weed infestation is about 15–21%. Weed management has been a challenge for the rice farmers as weed is one of the major problems in rice production [6]. Annual loss of 10 million metric tons of rice production due to weed competition has been reported from China [7]. Rice grain yield loss of about 42% has been observed in uncontrolled field due to infestation of *Fimbristylis miliacea* [8].

The most important oilseed crop soyabean is grown worldwide. In soyabean, reduction of yield recorded more than 50% because of variety and intensity of weed [9]. Soyabean and maize were observed to be sensitive to different weed species [10, 11], while sorghum and sunflower showed allelopathic potential against weeds [12, 13].

Cyperus iria L. is one of the three most common weeds of rice in Sri Lanka, India, and Philippines, reported by Holm et al. [14]. It is found to be a host for several pests of rice and rice nematodes: *Pratylenchus zeae* and *Hirschmanniella spinicaudata* [15]. Further, *Criconemella onoensis* is a rice nematode which uses *C. iria* as a host. *Echinochloa colona* is a common weed in many crops (mainly rice, maize, and vegetables), gardens, roadsides, disturbed sites, waste areas, and pastures. *E. colona* is often the dominant weed of rice. Holm et al. [14] have reported that *E. colona* is associated with

35 crops in more than 60 countries and is the second most common weed of rice. To the best our knowledge, no work has been done on allelopathic effect of *E. colona* and *C. iria* weed extract on rice and soyabean in Uttarakhand. Therefore, the present study was carried out to investigate the possible allelopathic effect of *C. iria* and *E. colona* extracts on seed germination and seedling growth of *O. sativa* and *G. max*.

2. Materials and Methods

2.1. Preparation of Plant Extracts. Field-grown rice (*Oryza sativa* L.) and soyabean (*Glycine max* L.) along with weed species Rice Flatsedge (*Cyperus iria* L.) and Cock Spur-Grass (*Echinochloa colona* L.) were collected from the agriculture fields of Nainital district. Plants were chopped into pieces with a fodder cutter and oven-dried at 48°C for 72 hours. The aerial and root part of weed species were crushed into powder form. Fifteen gram powdered plant material was suspended in 150 mL double distilled water (DDW) and dichloromethane (DCM) and mixed for 24 hours by a horizontal rotary shaker for producing uniform extract. The extracts were filtered through filter paper (Whatman number 1).

2.2. Experimental Treatments. Three different concentrations of weeds, that is, 1, 35, and 100 mg/mL, with double distilled water (DDW) and dichloromethane (DCM) were taken to observe allelopathic effects of weed species on test crops in triplicates.

2.3. Experimental Procedure. The germination of rice and soyabean seeds was studied by Petri dish method. Ten seeds of each test crops were placed in Petri dish lined with double layer of filter paper and treated with weed extracts in three concentrations. These Petri dishes were then kept for 7 days and 15 days for soyabean and rice, respectively, at room temperature (28 ± 1°C) and kept constantly moist with distilled water. After that seed germination and seedling growth were determined for different treatments. Germination percentage was calculated as

$$\text{Germination (\%)} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds tested}} \times 100. \quad (1)$$

2.4. Data Analysis. The data were subjected to one-way analysis of variance, and treatment means were compared $p < 0.05$ by Duncan multiple range test. Statistical analysis was done with SPSS 18 for Windows statistical software package (SPSS, Chicago, IL, USA).

3. Results

Results with respect to the effect of different concentrations of extracts on seed germination performance were measured in terms of growth. With increase in extract concentration, there was a gradual decrease in seedling length and germination percentage. The mean values of seed germination and seedling growth were observed maximum in aerial part extract as compared to root extract in test crops (Figures 1 and 2).

Effects of DDW and DCM Fractions of E. colona L. and C. iria L. Extracts on O. sativa L. and G. max. L. Seed Germination. The allelopathic effect of the DDW and DCM extracts of *E. colona* and *C. iria* on the seed germination of rice and soyabean was given in Figure 1. It was noted that the germination was delayed by increasing the concentration. The time, at which germination started, was recorded maximum in rice as in comparison to soyabean. Among both weeds, rice showed the maximum reduction in seed germination (58%) when treated with root extract of *C. iria* with DCM fraction.

Maximum percent germination was observed in soyabean seeds (94%) in DDW fraction and in DCM fraction (82%) at 1 mg/mL concentration of *E. colona* aerial part extract followed by rice seeds, that is, 82% with DDW fraction and 79% in DCM fraction. In *C. iria* aerial part extract, maximum seed germination was also observed in soyabean seeds (90% in DDW fraction and 88% in DCM) followed by rice seeds (79% in DDW and 74% in DCM). With increasing concentration a gradual decrease in germination percentage was recorded in the aerial and root part extracts of *E. colona* and *C. iria* (Figure 1).

Effects of DDW and DCM Fractions of E. colona and C. iria Extracts on Seedling Length of O. sativa and G. max. The seedling length of rice and soyabean was significantly ($p < 0.05$) reduced by aerial part of *E. colona* in all three concentrations and at 100 mg/mL by root extracts (Figure 1). Seedling length of rice and soyabean was also significantly ($p < 0.05$) reduced by root part of *C. iria* at 100 mg/mL concentration. In *C. iria* root extract, seedling growth of soyabean at 1 mg/mL and rice at 35 mg/mL was significantly ($p < 0.05$) reduced.

Root extract of both weeds with DCM fraction had more adverse effect on the seedling growth of rice. In DDW fraction of both weeds, the seedling growth of soyabean (2.1 ± 0.1 cm) was observed to be the highest in aerial part extract of *E. colona* at 1 mg/mL concentration and lowest in root part extract of *C. iria* (0.7± 0.1 cm) at 100 mg/mL concentration. Similarly, in DCM fraction of both weeds, the seedling growth of soyabean (2.0 ± 0.3 cm) was observed to be the highest in aerial part extract of *E. colona* at 1 mg/mL concentration and the lowest in root extract of *C. iria* (0.6 ± 0.1 cm) at 100 mg/mL concentration.

In DDW fraction of both weeds, the seedling growth of rice (1.9 ± 0.1 cm) was observed to be the highest in aerial part extract of *E. colona* at 1 mg/mL concentration and the lowest in root part extract of *E. colona* (0.6 ± 0.1 cm) at 100 mg/mL concentration. Similarly, in DCM fraction of both weeds, the seedling growth of rice (1.8 ± 0.1 cm) was noted to be the highest in aerial part extract of *E. colona* at 1 mg/mL concentration and the lowest in root part extract of *E. colona* and *C. iria* both (0.4 ± 0.1 cm) at 100 mg/mL concentration. In control conditions the mean maximum seedling length was observed in *G. max* (2.8 ± 0.2 cm) compared to *O. sativa* (2.4 ± 0.2 cm).

The mean of rice seedling length was significantly different in all three concentration of *E. colona* aerial part extract (DDW and DCM) and in root part extract of *C. iria* (DDW). The mean of soyabean seedling length was observed to be

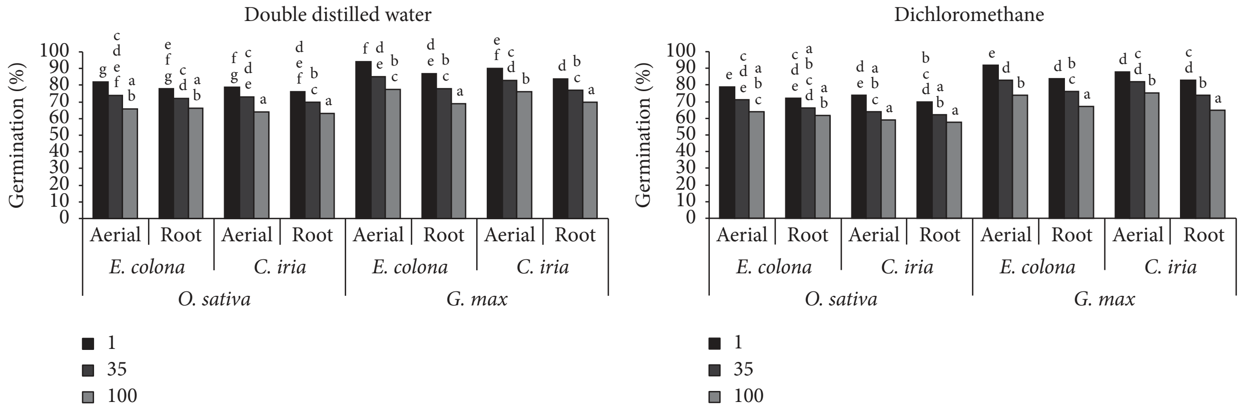


Figure 1: Difference between germination percentage in DDW and DCM extract with respect to different concentration.

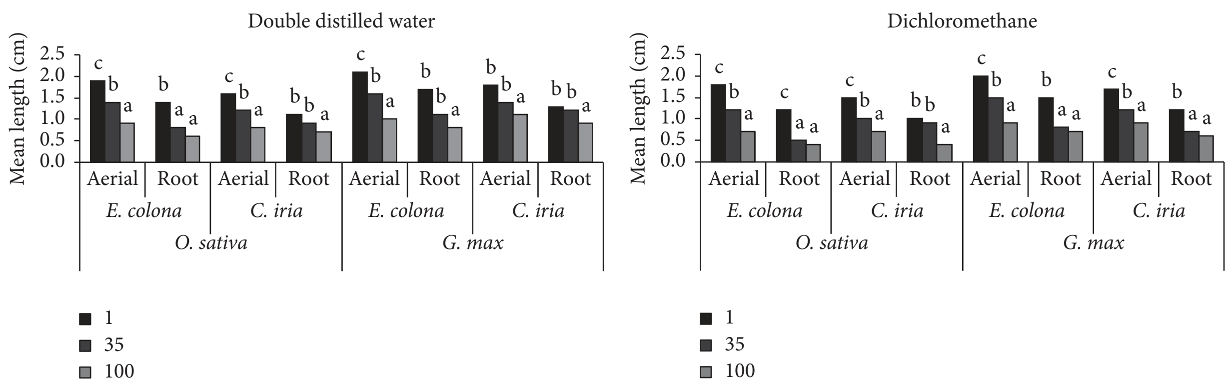


Figure 2: Difference between seedling lengths in double distilled water and DCM extracts with respect to different concentration.

significantly different in all three concentrations of root and aerial part extract of *E. colona* (DDW and DCM) and aerial part of *C. iria* (DCM) (Figure 2).

4. Discussion

Seed germination and seedling growth were more affected by root extract with DCM fraction than the aerial part, whereas with increase in concentration from 1 to 100 mg/mL, there was a decrease in germination percentage and seedling growth. Germination of both crops was affected slightly by the lower concentration of weed extracts but at next one, the germination and seedling length of rice and soyabean were more affected by the highest concentration.

From the results, it appeared that the germination and primary growth differed significantly due to the effect of extracts of different plant parts of two weed species (Figures 1 and 2). Primary growth of soyabean seedlings was reduced significantly by the allelopathic effect of different plant parts. In DDW fraction, the highest mean growth of soyabean seedling was observed in *E. colona* aerial part extract at 1 mg/mL concentration and the mean lowest length was found in *C. iria* root extract at 100 mg/mL concentration. In DCM fraction of *E. colona* aerial part extract, the highest mean growth of soyabean seedling was observed at 1 mg/mL concentration and the mean lowest length was found in *C. iria* and *E. colona* root extract at 100 mg/mL concentration.

Rice seedling in DDW fraction showed the highest mean growth in aerial part extract at 1 mg/mL concentration and the mean lowest length was found in root extract of *E. colona* at 100 mg/mL concentration. While considering the DCM fraction, the highest primary growth of rice was observed in aerial part extract of *E. colona* at 1 mg/mL concentration and the lowest length was found in the root extract of *E. colona* and *C. iria* at 100 mg/mL concentration.

The results indicated that the effects of weed extracts on the test species were concentration-dependent. Our results agree with the findings of some earlier studies. Swain et al. [16] pointed out that rice root growth was completely inhibited with 10% w/v leachates of 60-day-old plant and that the decomposing and decomposed leachates reduced rice shoot growth by 57% and 84%, respectively, which indicated that lower concentrations can stimulate plant growth, while higher concentrations cause inhibition [8, 17]. This can be attributed to the fact that low dose of phenolic compounds stimulates protein synthesis and activation of antioxidant

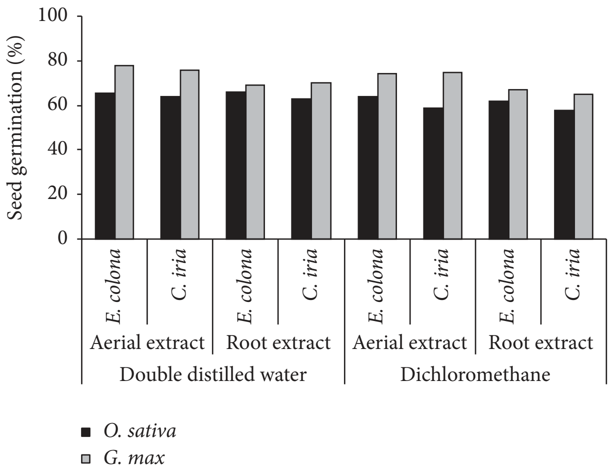


Figure 3: Effect of extracts (100 mg/ml) of *E. colona* and *C. iria* on seed germination.

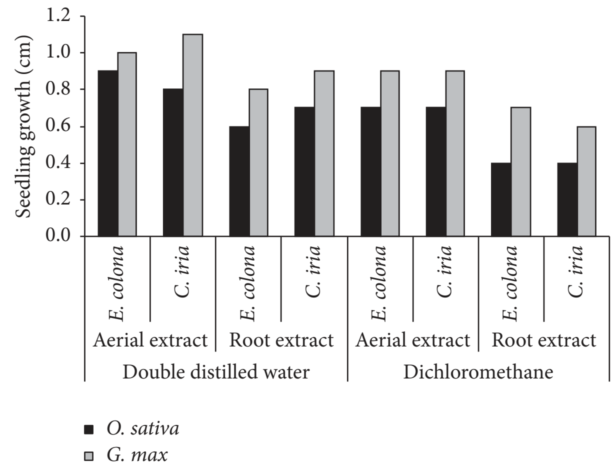


Figure 4: Effects of extracts *E. colona* and *C. iria* on seedling growth.

enzymes [18] which are effective in plant protection [19], while high levels of phenolic application result in plant damage [20].

Ashfaq et al. in 2014 [21] reported that the interaction between *C. esculentus* and *P. hysterophorus* showed a significant effect on germination rate, plumule length, radicle length, fresh weight, and dry weight of seeds. Awan et al. [22] suggested that the growth of *C. iria* can be suppressed by high rice density (400 plants/m^2) even at high N rates. V. Singh and H. Singh [23] concluded that *Caesulia axillaris* Roxb. was found to be the most phytotoxic weed, followed by *Echinochloa cruss galli* L. Beauv and *Echinochloa colonum* L. Link, while *Fimbristylis miliacea* L. Vahl and *Cyperus iria* L. were observed moderate weeds of the rice fields.

The germination and seedling growth responses of rice and soyabean to root and aerial part extracts of *E. colona* and *C. iria* was significantly different. This uneven suitability to both extracts could be due to inherent differences in various biochemicals involved in the process.

5. Conclusion

The present study revealed that the extracts of *E. colona* and *C. iria* weed were highly effective against seed germination and seedling growth of rice and soyabean. From the above findings of the present experiment it could be suggested that *E. colona* and *C. iria* had strong and moderate detrimental effect on rice and soyabean, respectively. Results showed that seed germination and seedling growth were highly affected in rice, root part, and DCM rather than soyabean, aerial part, and DDW, respectively (Figures 3 and 4). There is a high need to carry out such type of studies to test the efficacy of these weed extracts under field conditions. Therefore, the cited weeds must be taken into better care and should be avoided in seed bed for growing rice and soyabean seedlings. Furthermore, the allelochemicals responsible for germination and growth reduction of different crops should be isolated and identified.

Competing Interests

The authors declare no conflict of interests regarding the publication of the paper.

References

[1] S. J. H. Rizvi and V. Rizvi, *Allelopathy: Basic and Applied Aspects*, Chapman and Hall, London, UK, 1st edition, 1992.

[2] D. T. Bell and D. E. Koeppe, "Noncompetitive effects of giant foxtail on the growth of corn," *Agronomy Journal*, vol. 64, no. 3, pp. 321–325, 1972.

[3] N. H. Fischer and L. Quijano, "Allelopathic Agents from Common Weeds," in *The Chemistry of Allelopathy*, vol. 268 of *ACS Symposium Series*, pp. 133–148, American Chemical Society, Washington, DC, USA, 1985.

[4] W. J. Florkowski and G. Landry, *An Economic Profile of Golf Courses in Georgia: Course and Landscape Maintenance*, University of Georgia, Griffin, Ga, USA, 2002.

[5] R. S. M. Karim, A. B. Man, and I. B. Sahid, "Weed problems and their management in rice fields of Malaysia: an overview," *Weed Biology and Management*, vol. 4, no. 4, pp. 177–186, 2004.

[6] A. S. Juraimi, M. S. Ahmad-Hamdani, A. R. Anuar, M. Azmi, M. P. Anwar, and M. K. Uddin, "Effect of water regimes on germination of weed seeds in a Malaysian rice field," *Australian Journal of Crop Science*, vol. 6, no. 4, pp. 598–605, 2012.

[7] Z. P. Zhang, "Agricultural weeding in conjunction with herbicide application in rice," in *Proceedings of the 18th Asia Pacific Weed Science Society Conference*, pp. 211–214, Beijing, China, May-June 2001.

[8] M. A. Hakim, A. S. Juraimi, M. M. Hanafi, A. Selamat, M. R. Ismail, and S. M. Rezaul Karim, "Studies on seed germination and growth in weed species of rice field under salinity stress," *Journal of Environmental Biology*, vol. 32, no. 5, pp. 529–536, 2011.

[9] Twenty Sixth Annual Progress Report. A.I.C.R.P., Weed Control, Publications by Department of Agronomy, GBPUAAT, Pantnagar, 95, 2004.

[10] A. Aleksieva and P. Marinov-Serafimov, "A study of allelopathic effect of *Amaranthus retroflexus* (L.) and *Solanum nigrum* (L.) in different soybean genotypes," *Herbologia*, vol. 9, no. 2, pp. 47–58, 2008.

[11] R. Baličević, M. Ravlić, M. Knežević, and I. Serezlija, "Allelopathic effect of field bindweed (*Convolvulus arvensis* L.) water extracts on germination and initial growth of maize," *Journal of Animal and Plant Sciences*, vol. 24, no. 6, pp. 1844–1848, 2014.

[12] I. S. Alsaadawi and F. E. Dayan, "Potentials and prospects of sorghum allelopathy in agroecosystems," *Allelopathy Journal*, vol. 24, no. 2, pp. 255–270, 2009.

[13] I. S. Alsaadawi, A. K. Sarbout, and L. M. Al-Shamma, "Differential allelopathic potential of sunflower (*Helianthus annuus* L.) genotypes on weeds and wheat (*Triticum aestivum* L.) crop," *Archives of Agronomy and Soil Science*, vol. 58, no. 10, pp. 1139–1148, 2012.

[14] L. G. Holm, D. L. Plucknett, J. V. Pancho, and J. P. Herberger, *The World's Worst Weeds: Distribution and Biology*, University Press of Hawaii, Honolulu, Hawaii, USA, 1977.

[15] M. Fernandez and J. Ortega, "Weeds as hosts of rice nematodes," *Ciencias de la Agricultura*, vol. 12, pp. 114–116, 1982.

[16] D. Swain, M. Singh, S. Paroha, and H. N. Subudhi, "Evaluation of allelopathic potential of *Echinochloa colona* (L) Link on germination and development of rice plant," *ORYZA-An International Journal on Rice*, vol. 45, no. 4, pp. 284–289, 2008.

[17] H. R. A. Ghareib, M. S. Abdelhamed, and O. H. Ibrahim, "Antioxidative effects of the acetone fraction and vanillic acid from Chenopodium murale on tomato plants," *Weed Biology and Management*, vol. 10, no. 1, pp. 64–72, 2010.

[18] R. Baziramakenga, G. D. Leroux, and R. R. Simard, "Effects of benzoic and cinnamic acids on membrane permeability of soybean roots," *Journal of Chemical Ecology*, vol. 21, no. 9, pp. 1271–1285, 1995.

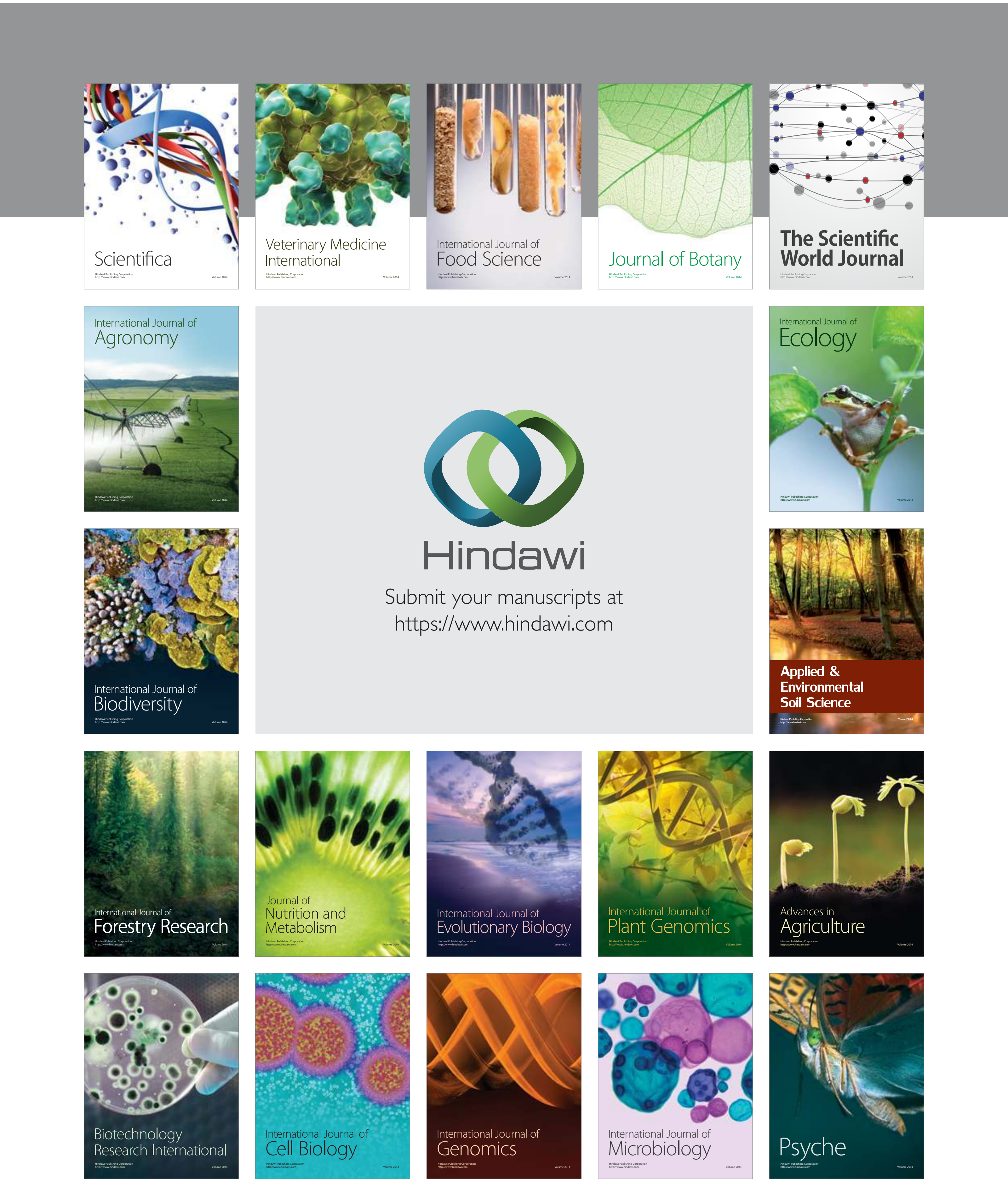
[19] K. W. Kleiner, K. F. Raffa, and R. E. Dickson, "Partitioning of ^{14}C-labeled photosynthate to allelochemicals and primary metabolites in source and sink leaves of aspen: evidence for secondary metabolite turnover," *Oecologia*, vol. 119, no. 3, pp. 408–418, 1999.

[20] B. Politycka, M. Kozłowska, and B. Mielcarz, "Cell wall peroxidases in cucumber roots induced by phenolic allelochemicals," *Allelopathy Journal*, vol. 13, pp. 29–36, 2004.

[21] M. Ashfaq, A. Ali, M. S. Haider et al., "Allelopathic association between weeds extract and rice (*Oryza sativa* L.) seedlings," *Journal of Pure and Applied Microbiology*, vol. 8, pp. 573–580, 2014.

[22] T. H. Awan, P. C. S. Cruz, and B. S. Chauhan, "Growth analysis and biomass partitioning of Cyperus iria in response to rice planting density and nitrogen rate," *Crop Protection*, vol. 74, pp. 92–102, 2015.

[23] V. Singh and H. Singh, "Leaf construction cost and related ecophysiological parameters of rice crop and its important weeds," *Rice Science*, vol. 19, no. 3, pp. 233–240, 2012.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