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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (11): 1926-1928, 2000

Allelopathy and VA Mycorrhiza VII: Cultivation of *Vigna radiate* and *Phaseolus vulgaris* Under Allelopathic Stress Caused by *Imperata cylindrica*

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Abstract: Tolerance of *Vigna radiate* (L.) Wilczek and *Phaseolus vulgaris* L. to allelopathic stress caused by aqueous shoot extract of *Imperata cylindrica* was studied. Both the test species were found to be susceptible to the aqueous extract. Root and shoot growth, yield, nodulation and VA mycorrhizal colonization in both the test species were significantly reduced under the allelopathic stress.

Key words: Allelopathy, VA mycorrhiza, *Vigna radiata, Phaseolus vulgaris, Imperata cylindrica*

Introduction

Allelopathy is considered an important ecological process in vegetational composition and agricultural sciences (Muller, 1969; Tukey, 1969) and governs plant productivity (Rice, 1984). It is widely considered a tool of self-defense (Lovett, 1991), helping plants to defend against invading insects, herbivores arid other neighbouring plants (Rice, 1984). All basic plant processes such as hormonal balance, protein synthesis, respiration, photosynthesis, chlorophyll formation, permeability and plant water relations may be disturbed by allelopathy (Yamane *et al.,* 1992). Allelochemicals can also be used as growth regulators and pesticides in agriculture (Cheema *et al.,* 1997; Khaliq *et al.,* 1999).

Imperata cylindrica, an aggressive perennial grass, is a common weed and a wasteland species especially on poorly drained soils. It suppresses the seedling growth and root sprouting of forest trees and associated species to gain dominance in the climax forests *I. cylindrica* reduces the growth of *Styiosanthus guyanensis* in mixed cultures. Reported that *I. cylindrica* hampers the regeneration of forests in Philippine. Hussain and Abidi (1991) have reported that *I. cylindrica* exhibit allelopathy and identified various phenolic acids as allelopathic agents. Allelopathic exudates of this grass are also known to reduce nodulation (Hussain and Abidi, 1991) and VA mycorrhizal colonization (Bajwa *et al.,* 1996) in associated wild leguminous species. When *I. cylindrica* dominated waste-lands and forests are converted into agricultural fields, the allelochemicals present in the soil may reduce the germination and growth of susceptible crop species. The present study was, therefore, undertaken to study the tolerance of two important leguminous crops viz. *Vigna radiata* and *Phaseolus vulgaris* cultivated under allopathic stress of *I. cylindrica.*

Materials and Methods

Pots of 20 cm diameter were filled with sandy loam textured soil obtained from cultivated fields of Punjab University Lahore. In order to render the pot soil allelopathic, the respective pots were supplied with 15 percent wlv aqueous shoot extract of *I. cylindrica* at 300 ml/pot after 15 and 30 days of sowing. The pots, which did not receive the aqueous shoot extract, were used as control. Seeds of *V. radiate* and *P. vulgaris,* surface sterilized with 1.0 percent sodium hypochiorite solution, were sown in all the pots. Each treatment was replicated thrice with two plants each. Pots were kept in wire netting house under natural conditions of light and temperature.

Plants of both the test species were harvested at three growth stages viz. 50, 65 and 80 days after sowing. At each harvest nodules were separated from roots, counted and weighed. Root and shoot fresh and dry weights were recorded. Number and fresh and dry weight of pods of 80 days old plants was also recorded. Data pertaining to number of seeds per pod, yield per plant and weight of 100 seeds was also obtained. All the data were analyzed statistically by applying t-test. A sub sample of fresh root was cleared and stained following the procedure of Phillips and Hayman (1970) for VA mycorrhizal infection study. Extent of VA mycorrhizal infection was measured by slide length method (Giovannetti and Mosse, 1980).

Results and Discussion

Root length as well as foot fresh and dry weight of both the test species was significantly reduced by aqueous shoot extract of *I. cylindrica* at all the growth stages (Fig. 1). Hussain and Abidi (1991) have also reported similar reduction in root growth of *Dicanthium annulatum, Chrysopogon mostanus* and *Medicago polomorpha* by *I. cylindrica.* The reduced root growth of the test species may be attributed to the reduced mitotic activity of root cells under allelopathic stress (Jensen and Welbourne, 1962; Bukolova, 1971).

Nodulation in both the test species was adversely affected by aqueous shoot extract. Number and biomass of nodules was significantly lower in plants exposed to aqueous extract than control (Fig. 2). Earlier Hussain and Abidi (1991) have reported reduced nodulation in two wild leguminous species viz. *Melllotus* sp. and *Medicago* sp. growing at *Imperata* dominating localities.

Shoot growth in terms of shoot length and biomass production was markedly suppressed by aqueous extract of *I. cylindrica* in both the species. However, the response of the two test species was different. *P. vulgaris* showed a significant negative response at all the three growth stages while negative response of *V. radiate* was significant only at final growth stage i.e. 80 days after sowing (Fig. 3). The species specificity of allelochemicals has also been demonstrated for aqueous extract of *Lolium multiform, Inula grantioides, Azadirachta indica* (Naqvi and Muller, 1975; Shaukat *et al.,* 1983; Hussain *et al.,* 1985) and many others. The varied susceptibility of different species to the extract may be attributed to the inherent differences in physiological and morphological characteristics of the test species (Shaukat *et al.,* 1983). The reduced shoot growth under the allelopathic stress may be attributed to reduced root growth and suppressed nodulation. Furthermore allelochemicals are also known to reduce uptake

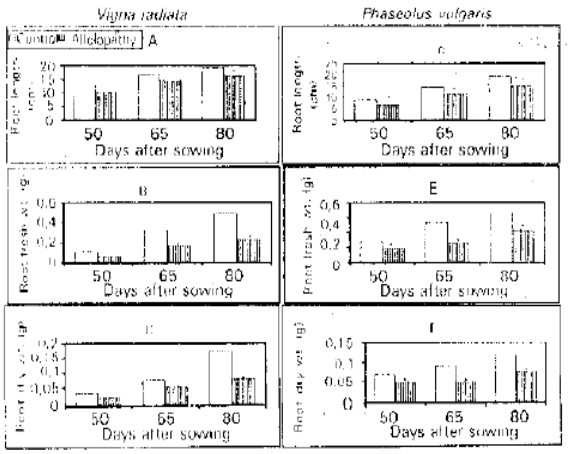

Fig. 1A-F: Effect of aqueous shoot extract of *Imperata cylindrica* on root growth in *Vigna radiate* and *Phaseolus vulgaris.* *Differ significantly (p = 0.05) from control as determined by t-test

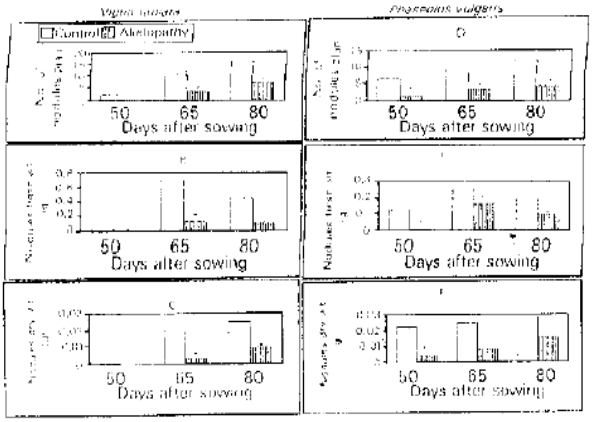

Fig. 2A-F: Effect of aqueous shoot extract of *Imperata cylindrica* on nodulation in *Vigna radiate* and *Phaseolus vulgaris.* *Differ significantly (p = 0.05) from control as determined by t-test

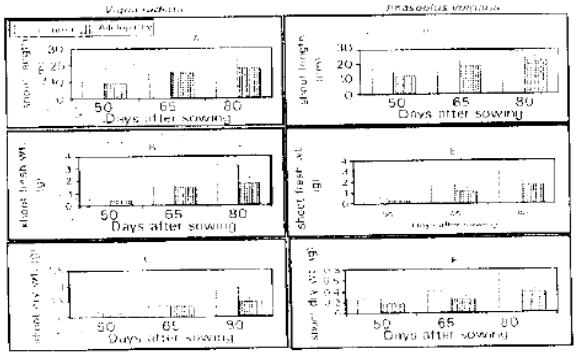

Fig. 3A-F: Effect of aqueous shoot extract of *Impeiara cylindrica* nn shoot growth in *Vigna radiate* and *Phaseolus vulgaris.* *Differ significantly (p = 0.05) front control as determined by t-test

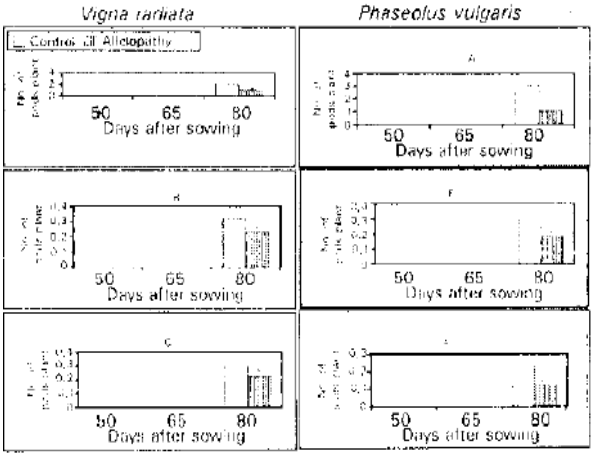

Fig. 4A-F: Effect of aqueous shoot extract of *Imperara cylindrica* on pod yield in *Vigna radiate* and *Phaseolus vulgaris.* *Differ significantly (p = 0.05) from control as determined by t-test

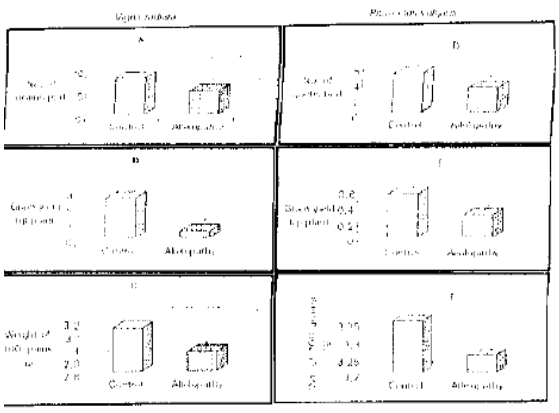

Fig. 5A-F: Effect of aqueous shoot extract of *Imperata cylindrica* ctrl grain yield in *Vigna radiate* and *Phascolus vulgaris.* *Differ significantly (p = 0.05) from control as determined by t-test

of nutrients (Kolesnichenko and Aleiktna, 1976), suppress the activity of growth hormones such as IAA and gibberellin (Kefeli and Turetskaya, 1967) and disturb the process of photosynthesis (Barkosky *et al.,* 1999), which may result in declined shoot growth.

The declined root growth and suppressed nodulation coupled with reduced shoot growth under the allelopathic stress adversely affected the reproductive growth. Consequently the pod and grain yield in both the test species was significantly reduced in plants supplied with aqueous shoot extract of *I. cylindrica* (Fig. 4).

The extent of VA mycorrhizal infection was significantly reduced by extract of *I. cylindrica.* All the mycorrhizal structures viz, mycelium, arhuscules and vesicles were found to be adversely affected by extract (Table 1). Similar reduction in VA mycorrhizal colonization in wild leguminous plants associated with *I. cylindrica* has also been reported by Bajwa *et al*. (1996). Javaid *et al.* (1996) also observed similar adverse impact of allelopathic exudates of *Dicanthium annulatum* on associated annual and perennial weeds. Since VA mycorrhizal fungi have the ability to increase the nutrient

Table 1: Effect of aqueous extract of *Imperata cylindrica* on VAM colonization in *Vigna radiata* and *Phaseolus vulgaris*

Treatments	*Vigna radiata*				*Phaseolus vulgaris*			
	% VAM infection			Extent of VAM (cm/100 cm)	% VAM infection			Extent of VAM (cm/100 cm)
	Mycelium	Arbuscule	Vesicle		Mycelium	Arbuscule	Vesicle	
50 days after sowing								
Control	80	55	65	60	95	45	65	70
Allelpoatrry	70	40	35	45	70	30	35	40
65 days after sowing								
Control	100	90	70	80	100	75	70	85
Allelopathy	95	60	50	60	90	50	40	50
80 days after sowing								
Control	100	20	95	65	100	30	85	85
Allelopathy	100	17	85	40	95	20	50	30

uptake and thereby enhance crop growth and yield (Jeffries and Rhodes, 1987), the suppression of VA mycorrhizal colonization may also have contributed to crop growth depression and yield losses under the allopathic stress (Fig. 5). The present study concludes that leguminous crops are not suitable for cultivation at places which were previously dominated by *I. cylindrica.*

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