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Allelopathic proclivities of *Dalbergia sissoo* on agricultural crops

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Abstract: The allelopathic effect of *Dalbergia sissoo* on agricultural crops was tested with five soil media viz. field soil mulched with dry leaves of *Dalbergia sissoo*, field soil watered with aqueous extract of fresh leaves of *Dalbergia sissoo*, top soil collected from the base of the *Dalbergia sissoo*, rhizosphere soil collected from the base of the *Dalbergia sissoo* and ordinary field soil as control. When compared to the ordinary field soil, the growth behaviour of four test crops viz. carrot, garlic, ginger and turmeric was observed with the *Dalbergia sissoo* associated soil media. The results revealed that all the four receptor crops were not suppressed by the patron tree species like *Dalbergia sissoo*. In fact, the *Dalbergia sissoo* tree showed stimulatory effects on the four receptor crops. Among the four receptor crops taken for the study, carrot was more stimulated in terms of growth when compared to other three crops viz., garlic, ginger and turmeric.

Key words: Allelopathy, *Dalbergia sissoo*, agricultural crops, stimulatory effect.

Introduction

The increasing demand and high prices of wood (fuel, timber, pulp) unlike the agriculture crops is a foremost reason for the farmers of Bangladesh to plant more trees in association with cereals, pulses, vegetables and spices. In recent times, the peasants of this republic are very interested to integrate fast growing trees on their farmland in close alliance with agricultural crops. Sissoo (*Dalbergia sissoo*) has been introduced in farm lands all over the country, because of rapid growth and high yield in stipulated time. The potential benefits of growing trees in blend with annual and perennial crops are to uphold and sustain soil productivity and fertility (Nair, 1984; Singh *et al*., 1989; Chauhan *et al*., 1997). Growing of inter-crops under sissoo is widely popular to ensure regular profits from agroforestry systems. However, it is asserted that a deleterious effect of one plant upon another is ascribable due to competition for light, soil moisture and mineral nutrients. Muller (1966) emphasized that allelopathy, the direct or indirect effect of one plant upon another through the production of chemical inhibitors that are released into the environment should also recognized as another factor in analyzing mechanism of interactions. Considerable progress has been made in understanding the nature of allele-chemicals and the extent of negative effects and potential benefits in annual cropping systems. Some research workers emphasized on the need for investigation of the allelopathy of various tree species used in agroforestry (Rao *et al.,* 1994; Kaur *et al.,*1999). While identifying suitable tree species for agroforestry, efforts should be made to select the species with the least allelopathic activity (Gaba, 1987). Hence, the experiment was conducted to delineate the allelopathic effect of *Dalbergia sissoo* on agricultural crops under pot culture experiment.

Materials and Methods

The experiment was conducted in the net house of BAU GPC (Germplasm Centre), Horticulture Farm, Bangladesh Agricultural University (BAU), Mymensingh during February 2006 to December 2006. The test crops like carrot, garlic, ginger and turmeric were sown /planted in shallow pots using 5 kg soil in each pot having the following germination media viz. (i) field soil mulched with oven dried crushed leaves (20g) of sissoo in the upper layers of each pot , (ii) field soil watered with aqueous extract of fresh leaves of sissoo tree, (iii) top soil collected from the beneath of the 10 years old sissoo tree, (iv) rhizosphere soil collected from the root system of the sissoo tree (after digging 2-3 ft), and (v) field soil watered with ordinary water. Each crop was thus planted in soil under five influences and replicated in five pots containing single plants each. So, the treatments were replicated five in a randomized block design. The treatments were: $T_{1:}$ field soil mulched with dry leaves of *Dalbergia sissoo;* $T_{2:}$ field soil watered with aqueous extract of fresh leaves of *Dalbergia sissoo;* $T_{3:}$ top soil collected from the base of the *Dalbergia sissoo:* $T_{4:}$ rhizosphere soil collected from the base of the *Dalbergia sissoo* and $T_{5:}$ ordinary field soil as control. For the germination test, initially twenty seeds of carrot and five cloves of garlic were sown in each pot. But finally single plants were kept in each pot. Single seed rhizome of ginger and turmeric was planted in each pot. No fertilizer was used but watered regularly. Seed germination of carrot and garlic was recorded after seven days of sowing. Other seedling attributes, such as plant height (cm), no. of leaves, leaf length (cm), leaf breadth (cm), number of tillers etc. were recorded and measured timely. Differences in germination and seedling growth parameters were explored by Analysis of Variance and Least Significance Test (LSD).

Results

Germination and growth of carrot as influenced by allelopathic properties of sissoo: The result revealed that carrot seed germination percentages were appreciably stimulated by different treatments and the highest stimulation (+28.57%) was found in soil mulched with dry leaves, which was followed by the top soil (Table 1). On the other hand, the lowest stimulation (+14.29%) was occurred in soil watered with aqueous leaf extract. Again, rhizosphere soil shown inhibitory effect of germination percentages and the inhibition was 7.14%. It was also observed that plant height of carrot was significantly stimulated by sissoo tree and the highest stimulation (+29.98%) was found in rhizosphere soil, which was followed by the soil mulched with dry leaf and top soil, respectively. Significantly, the lowest stimulation (+11.76%) was observed in soil watered with aqueous leaf extract. Furthermore, it was observed that leaf number per plant of carrot notably stimulated by sissoo tree. Similarly,

in case of leaf length, highest stimulation (+23.02%) was occurred in rhizosphere soil and the lowest stimulation (+2.29%) was observed in soil watered with aqueous leaf extract.

Table 1. Germination and plant growth of carrot as influenced by the *Dalbergia sissoo*

Treatments	% germination	Plant height (cm)	No. of leaves	Length of leaves (cm)
T_1	90.00 (+28.57)	35.64 (+26.61)	7.40 (+15.63)	21.52 (+16.83)
T_2	80.00 (+14.29)	31.46 (+11.76)	6.40 (0.00)	18.86 (+2.29)
T_3	85.00 (+21.43)	35.02 (+24.40)	6.80 (+6.25)	21.84 (+18.57)
T_4	65.00 (-7.14)	36.56 (+29.88)	7.80 (+21.88)	22.66 (+23.02)
T_5	70.00	28.15	6.40	18.42
$Lsd_{0.01}$	7.36	4.08	0.86	3.05
CV (%)	5.07	6.62	6.66	8.00

Values in parenthesis indicate % inhibition (-) or stimulation (+) in comparison to control (T_5) treatments.

Germination and growth of garlic as influenced by allelopathic properties of sissoo:

The differences in germination percentages and growth of garlic as influenced by different soils treated by different parts of sissoo tree were statistically significant (Table 2). Germination percentages of garlic showed the stimulatory effect in comparison to control treatment and the highest (+25.00%) was in soil watered by aqueous leaf extract. The lowest was in rhizosphere soil. Data in Table 2 suggest that plant height (cm) of garlic significantly stimulated by different growth medium and the highest stimulation (+43.43%) was found in rhizosphere soil, which was followed by the soil mulched by dry leaf and in top soil, respectively. Significantly, the lowest stimulation (+22.17%) was observed in soil watered by aqueous leaf extract. It was also observed that leaf number per plant of garlic was considerably stimulated by the sissoo tree and the highest stimulation (+35.12%) was found in rhizosphere soil as well as the lowest stimulation (+13.30%) was observed in top soil. In case of fresh weight of leaves, the trend of stimulation pattern was same as leaf number per plant of garlic.

Table 2. Germination and plant growth of garlic as influenced by *Dalbergia sissoo*

Treatments	% germination	Plant height (cm)	No. of leaves	Fresh wt. of leaves (g)
T_1	80.00 (0.00)	26.80 (+34.40)	4.02 (+19.64)	67.11 (+11.66)
T_2	100.00 (+25.00)	24.36 (+22.17)	3.24 (-3.57)	62.46 (+3.93)
T_3	80.00 (0.00)	25.89 (+29.84)	3.80 (+13.30)	64.93 (+8.04)
T_4	90.00 (+12.50)	28.60 (+43.43)	4.54 (+35.12)	71.65 (+19.22)
T_5	80.00	19.94	3.36	60.10
$Lsd_{0.01}$	8.90	4.17	0.68	7.21
CV (%)	5.56	8.98	9.84	5.97

Values in parenthesis indicate % inhibition (-) or stimulation (+) in comparison to control (T_5) treatments.

Growth of ginger as influenced by allelopathic properties of sissoo tree: The differences in growth of ginger as influenced by different soils treated by different parts of sissoo trees were statistically significant (Table 3). Plant height of ginger showed stimulatory outcome in comparison to control treatment. The perusal of data showed that significantly maximum stimulation of plant height (+17.61%) was recorded in soil mulched with dry leaf and the minimum stimulation (+2.04%) was found in top soil. Data in Table 3 also suggest that number of leaves per plant of ginger significantly stimulated by *Dalbergia sissoo*. Highest stimulation (+32.21%) was found in soil mulched with dry leaf, which was followed by the soil watered by aqueous leaf extract. Appreciably, the lowest stimulation (+18.12%) was observed in top soil. Similarly, highest stimulation of leaf length (+28.84%) was found in soil mulched with dry leaf and lowest stimulation (+10.99%) was observed in top soil. In case leaf breadth, the highest stimulation (+15.00%) was also occurred in soil mulched with dry leaf, which was followed by the soil watered by aqueous leaf extract. On the other hand, the lowest stimulation of leaf breadth of ginger was found in rhizosphere soil. Tiller number per plant of ginger also considerably stimulated by the sissoo tree. The highest stimulatory effect (+34.78%) of tiller number was observed in soil mulched with dry leaf and. The lowest (+13.04%) was found in top soil.

Growth of turmeric as influenced by allelopathic properties of sissoo trees

The differences in growth of turmeric as influenced by different soils treated by different parts of sissoo trees were statistically significant (Table 4). It in clear from the table 4 that noticeably maximum stimulation of plant height (+25.86%) was recorded in rhizosphere soil, which was followed by soil watered by aqueous leaf extract. The minimum stimulation (+8.80%) was found in soil mulched with dry leaf. It was also pragmatic that number of leaves

per plant of turmeric was stimulated by rhizosphere soil, which was followed by the top soil. But inhibition of leaf number was also observed in soil mulched with dry leaf and watered by aqueous leaf extract. Furthermore, leaf length of turmeric was stimulated and the highest stimulation (+22.43%) was found in rhizosphere soil and lowest stimulation (+6.20%) was observed in soil mulched with dry leaf. In case leaf breadth, the highest stimulation (+14.02%) was occurred in rhizosphere soil. On the other hand, the lowest stimulation of leaf breadth (+1.88%) was found in top soil. Tiller number per plant of turmeric significantly stimulated by the different treatments. Highest stimulation (+40.91%) was found in rhizosphere soil. Radically, the lowest stimulation (+22.73%) was found in both top soil and soil watered with aqueous leaf extract.

Table 3. Plant growth of ginger as influenced by *Dalbergia sissoo*

Treatments	Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf breadth (cm)	No. of tillers
T_1	36.86 (+17.61)	39.40 (+32.21)	10.32 (+28.84)	2.30 (+15.00)	6.20 (+34.78)
T_2	32.48 (+3.64)	38.40 (+28.86)	9.95 (+24.22)	2.20 (+10.00)	5.40 (+17.39)
T_3	31.98 (+2.04)	35.20 (+18.12)	8.89 (+10.99)	1.98 (-1.00)	5.20 (+13.04)
T_4	34.76 (+10.91)	38.00 (+27.52)	9.54 (+19.10)	2.18 (+9.00)	5.40 (+17.39)
T_5	31.34	29.80	8.01	2.00	4.60
Lsd $_{0.05}$	3.80	4.02	0.66	0.28	0.81
Lsd $_{0.01}$	5.24	5.54	0.91	0.38	1.12
Level of	**	**	**	*	**
CV (%)	8.47	8.29	5.24	9.77	11.27

Values in parenthesis indicate % inhibition (-) or stimulation (+) in comparison to control (T_5) treatments.

Table 4. Plant growth of turmeric as influenced by *Dalbergia sissoo*

Treatments	Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf breadth (cm)	No. of tillers
T_1	40.56 (+8.80)	6.80 (-8.11)	30.49 (+6.20)	7.23 (+4.48)	4.40 (0.00)
T_2	45.06 (+20.87)	7.20 (-2.70)	33.50 (+16.68)	7.40 (+6.94)	5.40 (+22.73)
T_3	42.74 (+14.65)	8.20 (+10.81)	31.68 (+10.34)	7.05 (+1.88)	5.40 (+22.73)
T_4	46.92 (+25.86)	8.40 (+13.51)	35.15 (+22.43)	7.89 (+14.02)	6.20 (+40.91)
T_5	37.28	7.40	28.71	6.92	4.40
Lsd $_{0.01}$	6.25	1.46	4.76	0.60	1.22
CV (%)	7.96	10.40	8.07	4.47	12.86

Values in parenthesis indicate % inhibition (-) or stimulation (+) in comparison to control (T_5) treatments.

Discussion

The phenomenon of allelopathy arises because growth inhibiting or stimulating, plant and microbial produce and release chemicals into the environment. These allelopathic chemicals are one or more influence in an assortment of potential stress conditions such as moisture, temperature etc. In fact, abiotic and biotic factors transform allelochemicals, for example, phenolics to nontoxic phenolic polymers (Inderjit and Dakshini, 1999). Nonetheless, the findings of the experiment indicate that all the four receptor crops like carrot, garlic, ginger and turmeric were not suppressed by the patron tree species named *Dalbergia sissoo*. Actually the sissoo tree showed stimulatory effects on the four receptor crops. These results corroborate the findings of Tripathi and Tripathi (1999). They reported that leaf and root extract of sissoo promoted germination up to 63 per cent and also enhanced growth, nodulation and seed protein in *Vigna radiata.* Sing and Sumon (2007) also reported that leaf extract of sissoo promote fresh and dry weight, enhanced root length of sorghum, oat, mustard and maize. Furthermore, Devaranavadai *et al.* (2003) also observed that sissoo based agrosilviculture system had no inhibitory effect on rabi sorghum.

The findings of the present investigation indicate that the *Dalbergia sissoo* tree showed stimulatory effect on the tested four agricultural crops and the stimulatory effect was more prominent on carrot followed by turmeric. Thus, it may be recommended that carrot as well as turmeric can be two ideal crops component for *Dalbergia sissoo* under agroforestry systems.

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