ALLELOPATHIC EFFECT OF *EUCALYPTUS* SPECIES ON LEGUME VEGETABLES

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ABSTRACT

Pakistan is deficient in forest resources with only 5.2% area under forests, against requirement of 20-25% for a balanced economy. Consequently we are confronted with variety of problems, including tangible (shortage of timber and firewood) and in-tangible (like poor climate, degrading environment, vanishing wildlife and biodiversity and devastation by floods) ones. A population of over 126 million growing at an alarming rate of 3.1% does not permit to divert area from food crops to arboriculture and necessitates agroforestry (optional growing of trees and crops on the same land unit in temporal or/and spatial arrangement) as a feasible option. This study is continuation of work on allelopathic effect of *Eucalyptus camaldulensis* on two major varieties of wheat by the author for dissertation of M.Sc. Botany during 1991. The object of the study is to establish viable tree-crop combination for agroforestry systems to make up the deficiency of trees in the country. In the current work allelopathic effect of three species of *Eucalyptus* namely *Eucalyptus camaldulensis*, *Eucalyptus citriodora* and *Eucalyptus tereticornis* on two legume vegetables, *Pisum sativum* and *Phaseolus vulgaris* was investigated. There is no significant inhibitory effect due to allelochemicals on various growth parameters including yield (weight and number of pods) of *Phaseolus vulgaris*. However, the growth of *Pisum sativum* was significantly reduced due to allelopathic effect of all the three *Eucalyptus* species, maximum being of the decayed leaves of *Eucalyptus citriodora* followed by *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* respectively. Similarly nodulation of sweet peas was significantly reduced by *Eucalyptii* in the above order.

INTRODUCTION

The plants living in associations, communities or groups interfere with each other either due to competition for light, space, nutrients and moisture or due to production of allelo-chemicals produced by various plant parts, promoting or retarding various growth parameters. Molisch (1937) first coined the word "Allelopathy" for the detrimental, beneficial or reciprocal biochemical interaction of plants in an ecosystem. Pakistan with only 5.2% area under forests is extremely deficient in this natural resource due to which we are confronted with multiple problems like shortage of timber and fuelwood, alarming environmental pollution, vanishing wildlife, devastating floods, deteriorating watersheds and soil fertility etc. Due to an alarming rate of population growth (3.1%) no land can be spared from food crops for making up the shortage of forest area to a desired level of 20-25%. Consequently Agroforestry (AF), as optional growth of woody perennials with annual/biennial agricultural crops or livestock on the same land unit to improve overall economic return from the land resource, is the only option available to us. To establish technically and financially feasible AF Systems, it is imperative to investigate various aspects of tree-crop interactions including competition for nutrients, moisture, light, space etc. and allelopathic effect of trees on food crops. Extensive research has been carried out on the aspect of competition but little work has been undertaken on allelopathic effect of trees on crops. Since Eucalyptus is being extensively grown on the

farms due to its suitability for variety of edapho-climatic conditions and fast growth it has been selected for the study with frequently grown winter legume vegetables. The experiment was laid out in the Silvicultural Research Garden of Pakistan Forest Institute, Peshawar. Three tree species included *Eucalyptus camaldulensis, Eucalyptus citriodora* and *Eucalyptus tereticornis* with Edible Peas (*Pisum sativum*) and French Bean (*Phaseolus vulgaris*) as crop component for the current study. Earlier a similar study had been carriedout by the author to investigate allelopathic effect of *Eucalyptus camaldulensis* on two varieties of wheat (*Triticum aestivum*). This study is continuation of the previous work. The object of the study is to clarify and verify the illusions regarding deleterious effect of trees on crops.

REVIEW OF LITERATURE

Although, the direct or indirect harmful effects of one plant on an other in an ecosystem have much been investigated, yet more work is required to be done on allelopathic effect of trees on agricultural crops in Pakistan. The recent work, on allelopathic effect of *Eucalyptus* species on agricultural crops includes the following:

Verinumbe (1987) reported increase in dry matter production of Maize (*Zea mays*) Guinea Corn (*Sorghum vulgare*) and Groundnut (*Arachis hypogea*) when grown in soil collected from 12 years old plantation of *Azadirachta indica, Eucalyptus camaldulensis* and *Prosopis juliflora*.

Khonje (1989) reported significant reduction in maize yield in an alley cropping experiment with *Gmelina arborea* and *Eucalyptus camaldulensis* while there was no significant reduction in yield with *Leucaena leucocephala*.

Akbar *et al.* (1990) reported that wheat yield was depressed in close proximity of *Eucalyptus camaldulensis, albizzia procera, Morus alba* and *Leucaena leucocephala* due to allelopathic affect.

Malik, F.B. (1991). (unpublished) investigated the allelopathic effect of *Eucalyptus camaladulensis* on two popular varieties of wheat (*Triticum aestivum*) Faisalabad 83 and Faisalabad 85 in nursery conditions at Punjab Forest Research Institute, Faisalabad nursery at Gatwala and observed that there was no reduction in grain and straw yield due to allelopathic effect.

Shivanna *et al.* (1992) found that seed germination of Ragi (*Eleusine coracana*), Cowpeas (*Vigna unguiculata*) and Sesmum (*Sesamum indicum*) was inhibited with *Eucalyptus camaldulensis* at different spacing.

Igboanugo (1988) found inhibiting effect of decomposed leaves of *Eucalyptus camaldulensis* on shoot length, number of branches, leaves, opened/unopened flowers and fruits of chilli (*Capsicum annuum*).

Kohli *et al.* (1991) reported that crude volatile oils from leaves of *Eucalyptus globulus* and *Eucalyptus citriodora* affected germination of *Phaseolus aureus*, barley and oats adversely.

Singh *et al.* (1992) observed that aqueous extract of air dried leaf litter of *Eucalyptus citriodora* had inhibitory effect on germination, seedling growth and enzyme activity of gram (*Cicer arietinum*), wheat (*Triticum aestivum*), and mustard (*Brassica campestris*).

Puri *et al.* (1991) found inhibition in seedling development of *Phaseolus vulgaris* due to water extract of leaves and bark of 6 years old *Eucalyptus tereticornis* trees.

Puri (1992) observed total mortality after germination of *Phaseolus vulgaris* sown with *Eucalyptus tereticornis* planted at 3×3 m spacing. The laboratory investigations showed that 25-100%

leaf and bark leachates were toxic to the germination and growth of *Phaseolus vulgaris* in descending order by brown leaves, green leaves, decayed leaves and bark.

Bhaskar *et al.* (1992) reported that powdered or burned leaf litter of *Eucalyptus tereticornis* did not inhibit germination, seedling height and number of leaves of finger millet (*Eleusine coracana*) and felt that burning destroyed the allelopathic properties of the tree.

Joshi and Prakash (1992) concluded that germination of wheat, maize, pea and mustard was reduced with application of fresh litter extract of *Eucalyptus tereticornis* due to phenolic compounds which are more in fresh leaves than in partially decomposed leaves.

MATERIAL AND METHOD

The study was undertaken to find out the allelopathic effect of three eucalyptus species on two winter legume vegetables. The three tree species included *Eucalyptus camaldulensis, Eucalyptus citriodora* and *Eucalyptus tereticornis* and winter vegetables included Edible Pea (*Pisum sativum*) and French Bean (*Phaseolus vulgaris*).

The experiment was laid out on Randomized Complete Block (RCB) design with four treatments and three replications. Six rows having four plots of 90×40 cm were prepared for sowing seeds of the vegetables. Twenty seeds of *Pisum sativum* and *Phaseolus vulgaris* each were sown along 90 cm side at 10 cm spacing. No treatment was used for irrigation. The treatments included ermination and ordinary tap water was used for irrigation. The treatments included the leaves and their extract from three eucalyptus species.

The parameters studied included number of leaves, flowers, branches, pods, nodules, weight of pods at harvest and germination percentage in Petri dish test. The data for number and weight of pods were collected plot wise. Other data were collected for each plant separately.

RESULTS AND DISCUSSION

This study were designed to investigate the allelopathic effect of these *Eucalyptus* species on two winter legume vegetables: Edible peas (*Pisum sativum*) and French Bean (*Phasedus vulgaris*) in nursery conditions. The data, for various parameters recorded at the time of harvest, one as under:

Table 1. Data for number of pods per plant of Edible Pea (*Pisum sativum*).

Treatment replication	T1	T2	T3	T4	Total
R1	3.880	2.470	2.720	3.315	12.385
R2	7.290	1.714	2.330	2.530	13.864
R3	3.077	2.400	1.357	1.385	8.219
Total	14.247	6.584	6.407	7.230	34.468
Average	4.749	2.190	2.135	2.410	

T1 = Control - tap water
T2 = Decayed leaf extract of *Eucalyptus camaldulensis*
T3 = Decayed leaf extract of *Eucalyptus citriodora*
T4 = Decayed leaf extract of *Eucalyptus tereticornis*

Table 2. Data for number of pods per plant of French Bean (*Phaseolus vulgaris*)

Treatment replication	T1	T2	T3	T4	Total
R1	20.80	3.00	12.44	8.25	44.49
R2	7.20	2.09	1.39	18.875	29.55
R3	6.69	8.42	5.40	6.875	27.38
Total	24.69	13.51	19.23	34.00	101.43
Average	11.56	4.50	6.41	11.33	

Table 3. Data for weight in grams of pods per plant of Edible Pea (*Pisum sativum*)

Treatment replication	T1	T2	T3	T4	Total
R1	13.11	6.25	6.29	12.35	37.99
R2	24.32	4.50	6.50	6.83	42.15
R3	9.31	8.05	3.14	3.47	23.96
Total	46.74	18.79	15.93	22.64	104.10
Average	15.58	6.26	5.31	7.55	

Table 4. Data for weight in grams of pods per plant of French Bean (*Phaseolus vulgaris*)

Treatment replication	T1	T2	T3	T4	Total
R1	84.57	9.40	59.53	34.74	188.24
R2	28.64	7.53	8.10	90.68	134.95
R3	28.11	29.45	16.97	27.82	102.35
Total	141.32	46.38	84.60	153.24	425.54
Average	47.11	15.46	28.20	51.08	

Table 5. Data for weight in grams per plant of Edible Pea (*Pisum sativum*) at harvest

Treatment replication	T1	T2	T3	T4	Total
R1	12.22	5.14	4.12	10.17	31.65
R2	23.69	6.78	6.24	5.33	42.05
R3	12.50	8.20	4.16	4.82	29.68
Total	48.41	20.12	14.53	20.32	103.38
Average	16.14	6.71	4.84	6.77	

Table 6. Data for weight in grams per plant of French Bean (*Phaseolus vulgaris*)

Treatment replication	T1	T2	T3	T4	Total
R1	496.86	127.08	293.05	229.77	1146.75
R2	152.79	142.48	106.13	315.88	717.28
R3	148.49	102.07	215.47	198.77	744.80
Total	798.14	451.63	614.65	744.42	2608.83
Average	266.05	150.54	204.88	248.14	

Table 7. Data showing number of nodules per plant of Edible Pea (*Pisum sativum*) at harvest

Treatment replication	T1	T2	T3	T4	Total
R1	1.529	0.118	-	0.032	2.2782
R2	0.235	0.143	-	0.067	0.4445
R3	0.067	-	0.077	-	0.1436
Total	1.831	0.261	0.077	0.099	2.8663
Average	0.610	0.087	0.026	0.033	

Table 8. Data showing number of nodules per plant of French Bean (*Phaseolus vulgaris*) at harvest

Treatment replication	T1	T2	T3	T4	Total
R1	6.400	4.187	1.444	2.667	14.698
R2	0.667	2.360	4.278	2.500	9.805
R3	0.312	2.417	2.500	2.750	7.979
Total	7.379	8.964	8.222	9.917	32.480
Average	2.459	2.988	2.741	2.639	

Table 9. Data showing survival percentage of plants of French Bean (*Phaseolus vulgaris*)

Treatment replication	T1	T2	T3	T4	Total
R1	100	100	100	92.3	392.3
R2	100	91.67	85.7	88.89	366.26
R3	100	80.00	100	1000	380
Total	300	271.67	285.7	281.19	1138.56
Average	100	90.56	95.23	93.73	

The following are some of the main inferences drawn from the study:

1. All the three *Eucalyptus* species had no significant inhibitory effect on average number of pods and weight of pods per plant of Edible Peas (*Pisum vulgaris*).

2. The three species of *Eucalyptus* did not show significant inhibitory allelopathic effect on number and weight of pods of French Bean (*Phaseolus vulgaris*).

3. The plant biomass of Edible Peas (*Pisun sativum*) was significantly reduced due to allelopathic effect of leaf extract of all the three *Eucalyptus* species. The maximum reduction was with *Eucalyptus citriodora* followed by *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* in descending order.

4. There was no significant inhibitory allelopathic effect of the three *Eucalyptus* species on the total plant biomass production of the French Bean (*Phaseolus vulgaris*).

5. The shoot biomass of *Pisum sativum* was significantly reduced with all the three *Eucalyptus* species, whereas shoot biomass of *Phaseolus vulgaris* was not effected.

6. Root biomass and root length of both vegetables remained unaffected with all the three tree species. Similarly there was no significant allelopathic effect on leaf count except in case of *Pisum sativum* which showed allelopathic effect in descending order with *Eucalyptus citriodora, Eucalyptus camaldulensis* and *Eucalyptus tereticornis*.

7. Reduction in nodulation was observed. Least number of nodules were observed in case of *Pisum sativum* due to allelopathic effect of the leaf extract of *Eucalyptus citriodora*. The plants of *Phaseolus vulgaris* were healthy and vigorous with no reduction in nodulation.

8. The survival percentage was not affected and germination was affected with leaf extract in case of both the vegetable species. Germination was higher in case of French Bean in laboratory test.

CONCLUSION

From the study it can be concluded that there was no allelopathic effect of leaves of three *Eucalyptus* species on the growth of *Phaseolus vulgaris* but *Pisum sativum* was affected by decayed leaves of the three *Eucalytus* species. The maximum effect was by decayed leaves of *Eucalyptus citriodora* followed by *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* respectively. The root nodulation was significantly reduced due to allelopathic effect of decayed leaves of Eucalyptii on edible peas, with maximum reduction due to *Eucalyptus camaldulensis* and *Eucalyptus tereticornis*. It is encouraging to note that there was no allelopathic effect on yield of pods nor pods yield was reduced. A suitable combination of tree-legume vegetables needs to be found out for a feasible Agroforestry option.

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