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Performance of Coriander and fenugreek as Intercrops under Different Spacings of Poplar Plantations in North-Western, India

Pardeep Rathee, Naresh Kaushik, Sanjay Khajuria*, Pradyuman Singh and Manjeet

Department Of Forestry, CCS Haryana Agriculture University Hisar-125004, India

*Presently, Scientist (Agroforestry), SKUAST-Jammu

*Corresponding Author E-mail: pardeeprathee2012@gmail.com

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ABSTRACT

The performance of coriander and fenugreek in Poplar plantation established in October, 2012-13 at 5 x 4 m, 10 x 2 m and 18 x2 x 2 m spacings was studied at CCS Haryana Agriculture University, Hisar. Results revealed that the rate of decrease in seed yield of coriander and fenugreek spices crops were more under 5 x 4 m spacing. On an average the seed yield decreased up to 65.44% and 65.21% under 5 m x 4 m spacing as compared to the sole coriander and fenugreek (1.36 and 1.84 t /ha). Yield of the crops increased with increasing spacing of poplar and minimum yield reduction was recorded in fenugreek under poplar based agroforestry system with 18 x 2 x 2 m spacing. Based on experimental data it can be concluded that fenugreek (variety HM-33) should be planted in wider spacing i.e. 18 x 2 x 2 m for better yield in poplar based agroforestry system. Between the spices crops highest net returns and cost benefit ratio were also observed in fenugreek under poplar based agroforestry system with 18 x 2 x 2 m spacing. The net returns for other spices were also higher in poplar based agroforestry system as compared to sole cropping, due to additional returns from poplar.

Key words: *Poplar, spices, Spacing, Coriander, fenugreek.*

INTRODUCTION

Forest area of the Haryana has declined sharply due to heavy pressure of agriculture. Very fast agricultural and industrial development as well as adoption of rice-wheat system for a very long period has deteriorated soil health, lowered the water-table and increased the environmental pollution. The excessive use of agro-chemicals in the soil and crops has further deteriorated the condition of human, animal, soil and environmental health. There is no spare land to increase the area under forest cover without sacrificing the area of cereals, and agroforestry (integration of tree, crop and animal component simultaneously or sequentially on the same land unit) remains the only option to increase the area under trees or forests. Agroforestry can improve the economy of the farmers, besides taking care of the natural resources (soil, water and air). But the component plant species in agroforestry system depends on the same reserve of growth resources such as light, water and nutrients and hence there will be influence of one component of a system on the performance of the other components as well as of the system as a whole[7].

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Some farmers are putting their agricultural land under poplar plantation either in row plantation or block plantation. The farmers have adopted poplar due to its short duration, ease of regeneration, easy availability of quality planting material, good market demand, restricted distribution of species in the country, buy-back policy of some companies and its compatibility with agricultural crops. The demand of various medicinal, aromatic and spice crops is increasing in the national and international markets. The large deficit in the availability of quality material of these crops can be met only through their organized and scientific cultivation. Growing of spice crops in poplar will not only meet the demand of these crops but will also increase the area under forest. Keeping this in view, a study was therefore, planned to the effect of different spacings on fenugreek and coriander performance in *Populus deltoides* based agri-silvicultural system.

Coriander (*Coriandrum sativum*) belongs to family Apiaceae/Umbellifereae. It is a strong odoriferous, hardy annual plant. It has slender, erect, hollow stem with white flowers in a compound umbel. The globular coriander fruit is brownish-yellow in colour with straight and curving ridges. The flavor resembles a mixture of caraway, cumin, sage and lemon peel. The aroma and taste are due to essential oil content which is used for flavoring baked goods, condiments, confectionaries, ice-cream mixes, chewing gums, alcoholic and nonalcoholic beverages. India is the largest producer of coriander in the world. It is mainly cultivated in Rajasthan, Madhya Pradesh and Andhra Pradesh with scattered patches in Tamil Nadu, Orissa, Karnataka, Utter Pradesh and Bihar.

Fenugreek (*Trigonella foenum-graecum* L.), in India is often cultivated as a cover crop in citrus-fruit groves to take advantage of their leguminous nature. It is a multipurpose crop grown during winter season for seed, vegetable and condiment purposes in various parts of the country. Fenugreek is also widely used as fodder crop because of its ability to provide high quality forage at all stages of growth1. It is one of the principle constituents of curry powder. The seeds of fenugreek are used as a spice due to its pleasantly bitter taste and a peculiar odour and flavor. In North' India, its fresh and dried leaves with tender shoots are consumed as most popular leafy vegetable and spice since they make the food more savory and provide major calorie and other nutritional benefits.

MATERIAL AND METHODS

The present study was conducted during 2012-2013 in already established 5.6 years poplar plantation spaced at 5 x 4 m, 10 x 2 m and 18 x2 x 2 m at CCS Haryana Agriculture University, Hisar ($29^0$09' N latitude and 75^0 43' E longitude at an elevation 215 m above mean sea level), situated in the semi-arid region of North-Western India. The climate is subtropical monsoon with an average annual rainfall 350-400 mm, 70-80 percent of which occurs during July to September. The summer months are very hot with maximum temperature ranging from 40 to 45^0C in May and June whereas, December and January are coldest months (lowest January temperature as low as 0^0C). The total rainfall during 2012-2013 from September, 2012 to April, 2013 was 154.00 mm. The experiment was laid out in split plot design with three spacings of poplar and control. There were 12 treatment combinations which were replicated thrice and allotted randomly in each plot. The plot size for each treatment was 5 x 2 m^2.

The trees at random on in all spacings were measured for their top height and girth at breast height (GBH). The total height was measured from ground to top of the trees. The girth at breast height (1.37m above the ground level) was taken. The spread of the canopy was measured in north-sorth direction and east – west direction with the help of a plastic tape and the average of the spread of both the directions was takens the canopy width and the values were expressed in m. The leaf fall in a sq meter quadrant in each spacing of replications in field was collected and weighted at regular interval. Leaf fall was expressed on oven dry weight basis.

The coriander cultivar DH-228 was sown during the last week of October keeping a plant to plant and row to row distance of 30 x 45 cm with a seed rate of 10 kg/ha and 20 kg N, 30 kg P_2O_5 and 20 kg K_2O/ha were applied as a basal dose at the time of sowing. Beside, this 4o kg N/ha was applied in two equal splits at 30 and 60 days after sowing.

The fenugreek cultivar HM-57 was also sown during the last week of October keeping a plant to plant and row to row distance of 30 x 45 cm with a seed rate of 20 kg/ha and applied 40 kg N and 40 kg each of P_2O_5 and K_2O/h at the time of sowing.

The height of ten randomly tagged plants was recorded from ground level to the tip of main stem at 30, 60, 90 and 120 days after sowing (DAS) and at harvest. The average height of ten plants was worked out and was expressed in centimeters (cm). The number of branches /plant was counted on randomly selected ten plants at harvest and the average number of branches per plant was calculated. The total number of umbels in randomly selected ten plants in each treatment was counted and the number of umbels per plant was calculated by averaging the values for each treatment. The number of seeds in unbelted of randomly selected ten plants was counted and the average number of seeds per unbelted was calculated for each treatment.

Using sickle the plants were harvested in each plot separately. The harvested plants were left in the field for few days to sun dry, and later, they were threshed. After cleaning, the weight of seeds (g/plot) was recorded. The values were later converted to tonne/ hectare. The harvest index was calculated by dividing the economic yield (seed yield per plot) with total biological yield and expressed as percentage.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Hundred seeds in three replications were weighed individually and the mean of these observations was worked out. Later, the values were converted into weight of 1000 seeds (test weight) for each treatment, and the test weight was expressed in grams.

RESULTS AND DISCUSSIONS

Tree component:

Poplar planted at 5x4 m spacing recorded significantly more plant height (17.47m), girth (76.67 cm), canopy width (6.80) and leaf fall (5.30 t /ha) than all the poplar spacings. Whereas the paired row planting of poplar resulted in poor growth of poplar in terms of all the growth parameters except that girth of poplar did not different significantly between 10x2 m and 18x2x2 m spacings **(Table 1)**. Maximum growth in terms of plant height, girth, canopy width and leaf fall was recorded at 5x4 m spacing of poplar and minimum in paired row plantation. It was due to the fact that at 5x4 m spacing plants got enough space on both sides whereas in paired row plantation competition for growth resources mainly moisture and nutrients were limited in narrow space. Significant effect of spacing on tree growth of eucalyptus as well as positive effect of increased distance between trees on growth parameters of eucalypts has also been reported by Kirongo *et al.*[10].

Table 1: Effect of spacing of poplar on plant height, girth, canopy width and leaf fail

Spacing	Plant height (m)	Girth (cm)	Canopy width (cm)	Leaf fall (t/ha)
5x4 m	17.47	76.67	6.80	5.30
10x2m	17.14	67.56	6.10	4.30
18x2x2m	16.93	64.32	5.08	2.70
CD at 5%	0.41	5.66	0.09	0.27

Crop productivity:

In poplar based agroforestry system, the effect of different spacings of poplar on plant height of coriander showed significant variation among the treatments. The plant height (118.17cm) in control was significantly higher than under different spacings of poplar plantations at the time of harvest. At all the

stages of crop growth the plant height of coriander increased significantly with increasing spacing of poplar. On an average, 19.40, 13.40 and 7.30 % decrease in plant height of coriander was observed after 30, 60 and 90 days, respectively under poplar based agroforestry system as compared to the coriander crop in open due to the availability of more sunlight. The sole crop of coriander recorded significantly more number of branches (9.80) than all the poplar spacings (**Table 2**)

The effect of different spacings of poplar on plant height of methi showed significant variation among the treatments. The sole crop of methi registered significantly more plant height (98.49 cm) than methi sown under different spacing of poplar at the time of harvest. The plant height of methi increased significantly with increasing spacing of poplar at all the stages except that the difference between 10 x 2 m and paired of row spacing at 30 days and 5x4 m and 10x2 m spacing at 90 DAS were not significant. On an average, 33.02, 15.20 and 13.32 % decrease in plant height of coriander was observed after 60, 90 and 120 days, respectively under poplar based agroforestry system as compared to the methi crop in open due to the availability of more sunlight. Like plant height the number of branches of methi increased significantly with increasing spacing. The sole crop of methi recorded significantly more number of branches than all the spacings of poplar (**Table 2**).

Growth parameters like plant height, number of branches and yield attributing characters like pods/plant seeds/pod, umbel/plant, umbellate/umbel, seeds/umbel, test weight decreased and consequently seed yield of all the test crops decreased significantly under all the spacings of poplar. This might be attributed to competition of poplar with test crops for growth resources like light, moisture and nutrients. Several authors[11] have reported reduced yield of crops due to decrease light intensity under trees. Gill *et al.*[6] have also reported reduced yield of methi and coriander under poplar plantation. Similarly Islam *et al.*[8] have reported higher yield of tomato, chilli, carrot, onion, garlic, turnip and French bean under full sunlight over guava- coconut based multistrata agro-forestry system allowing 50% photo synthetically active radiation (PAR).

Table 2: Effect of different spacings of poplar on plant height & number of branches of coriander and fenugreek

Coriander cultivar-DH-228						
Spacing	Plant Height (cm)					No. of Branches
	30 DAS	60 DAS	90 DAS	120 DAS	Harvest	
5x4m	6.22	31.22	58.15	88.13	97.20	7.27
10x2m	7.01	34.27	62.30	91.90	101.63	7.33
18x2x2m	7.95	37.22	64.56	95.13	107.37	7.93
Control	8.71	39.53	66.51	99.22	118.17	9.80
CD at 5%	0.31	1.34	1.42	2.03	3.93	0.78
Methi cultivar- HM-33						
5x4m	5.05	18.59	65.38	77.43	81.29	8.43
10x2m	5.71	23.33	67.55	81.02	86.50	9.45
18x2x2m	6.03	26.51	72.54	87.41	91.56	10.55
Control	7.50	34.06	80.77	94.10	98.49	12.62
CD at 5%	0.39	1.01	2.45	1.95	2.36	0.61

Yield and yield attributing characters of coriander and fenugreek:

The effect of different spacings of poplar on all yield and yield parameters of Coriander showed significant variation among the treatments. The sole crop of Coriander recorded significantly higher yield (1.36 t/ha) compared to different spacings of poplar. All

the yield and yield parameters of coriander increased significantly with increasing spacing except that the difference between 5x4 m and 10x2 m spacing were not significant in respect of number of umbels per plant while number of umbelets per umbel did not increase significantly between 10x2 m and paired row treatment, however, the differences between 5x4m spacing and paired row plantation of poplar were significant. The test weight showed no significant variation among different spacings (**Table 3).**

Chauhan *et al.*[4] have also reported, the yield attributes of all the spices also increased significantly with increasing row spacing. However the differences between 5x4 m and 10x2 m spacing in respect of number of pods per plant and number of seeds per plant in methi; number of umbelets per umbel and number of seeds per umbel were not significant. Similarly the differences between 10x2 m and paired row spacing in respect of number of umbelets per umbel in coriander were not significant while test weight showed no significant variations among poplar spacings in methi and coriander.

Table 3: Effect of different spacings of poplar on yield and yield parameters of coriander

Spacing	Dry matter at harvest (g)	No. of umbels per plant	No. of umbelets per umbel	No. of seeds per umbel	No. of seeds per umbellet	Test weight (g)	Harvest index (%)	Biological yield (t/ha)	Seed yield (t/ha)
5x4m	23.48	23.15	5.13	27.40	5.31	7.41	31.76	1.48	0.47
10x2m	25.72	24.17	5.27	29.67	5.63	7.53	32.73	1.65	0.54
18x2x2m	29.87	25.87	5.36	33.13	6.16	7.81	33.16	1.96	0.65
Control	48.17	35.48	6.11	43.66	7.15	8.78	34.69	3.92	1.36
CD at 5%	1.23	1.78	0.11	2.03	0.09	0.46	0.27	0.13	0.03

The effect of different spacings of poplar on yield parameters of methi showed significant variation among the treatments (**Table 4**). No. of pods/ plant, No. of seeds per pod, No. of seeds/ plant, Test Weight (g), Harvest index (%), Biological yield (t/ha), Seed yield (t/ha) were recorded significantly lesser under 5 x 4 m spacing due to more shade and competition for moisture and nutrients between annual and perennial plants. However, yield and yield parameters of methi increased significantly with increasing spacing of poplar except that differences between 5x4 m and 10x2 m spacing were non-significant in respect of number of pods/ plant, number of seeds /plant and biological yield while test weight showed no significant difference among different spacings.

Nandal and Hooda[13] have reported increased yield of sorghum, cowpea, moong bean, ground nut, turmeric, wheat, oat, berseem, lentil and potato with increased row distance of poplar.

Gill *et al.*[6] have also recommended the cultivation of fenugreek under three year old poplar. Nandal and Hooda[13] have also reported variable performance of crops under different spacing of poplar. The comparative seed yield of different spices crops presented in table 3 showed that between spices crops methi recorded minimum decrease (60%) under poplar.

Table 4: Effect of different spacings of poplar on yield parameters of fenugreek

Spacing	No. of pods per plant	No. of seeds per pod	No. of seeds per plant	Test Weight (g)	Harvest index (%)	Biological yield (t/ha)	Seed yield (t/ha)
5x4m	102.41	8.23	843.21	8.16	44.14	1.45	0.64
10x2m	106.57	8.30	876.74	8.29	44.72	1.61	0.72
18x2x2m	118.63	8.38	990.79	8.37	45.40	1.85	0.84
Control	149.68	12.29	1839.67	10.03	48.93	3.76	1.84
CD at 5%	9.91	0.06	106.13	0.38	0.43	0.21	0.07

The economics of the system

The data on economics of the spices based on agro-forestry system is present in table 5. The monocropping of all the spices proved less economical than cultivation of these species with poplar as expressed in terms of net return and cost benefit ratio values .The data showed that both net return and cost benefit ratio increased with increasing the spacing of poplar and the maximum returns were recorded under paired row plantation of poplar. The differences in net return and cost benefit ratio between 5x4 m and 10x2 m spacing were marginal.

Bari and Rahim3 have also reported higher income from coconut and Aloe vera combination than sole Aloe vera cultivation. Higher net returns from *Melia* + dhaincha-berseem crop rotation have also been reported by Nandal and Kumar[12] and in similar way Kaushik *et al.*[9] reported that yield of different crops was not affected by different tree combinations during initial two years. Among the spices crops maximum return was recorded from methi and coriander. The return from spice crops increased with increasing spacing of poplar due to increased yield of spices crops with increasing row spacing.

Table 5: Net returns from spices crops in intercropping system with poplar plantation

Economics of coriander under poplar based agroforestry system						
Spacing	**Gross return (Rs./ha)**	**Total cost of cultivation (Rs./ha)**	**Discounted Cost (Rs./ha)**	**Net returns (Rs./ha)**	**Discounted returns (Rs./ha)**	**B:C**
Control	136000	58685	26544	72815	34984	1:1.31
5x4m	182000	71910	32538	110090	49814	1:1.58
10x2m	189000	71910	32538	117190	53027	1:1.63
18x2x2m	200000	71910	32538	128090	57959	1:1.78
Economics of methi under poplar based agroforestry system						
Control	147200	59285	26826	87915	39781	1:1.48
5x4m	186200	72510	32810	113690	51443	1:1.57
10x2m	192600	72510	32810	120090	54339	1:1.66
18x2x2m	202200	72510	32810	129690	58683	1:1.79

CONCLUSION

It may be concluded that the yield reduction in the spices crops was recorded under different poplar spacings as compared to sole cropping. Yield of all the crops increased significantly with increasing in poplar spacing except that in the biological yield of methi , when raised in 5x4 m and 10x2 m spacings. Minimum yield reduction was recorded in methi under poplar based agroforestry system with18 x 2x 2 m spacing.

Between the spices crops highest net returns and cost benefit ratio were also observed in methi under poplar based agroforestry system with18 x 2 x 2 m spacings. The net returns for other spices were also higher in poplar based agroforestry system due to additional returns from poplar. Based on experimental data it can be concluded that fenugreek (variety HM-57) should be planted in wider spacing i.e. 18 x 2 x 2 m for better yield per hectare under poplar based agrofrestry system.

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