

Studies on intercropping of medicinal, aromatic and spice crops in poplar plantation

B.S. GILL*, A. SINGH¹, DEVINDER SINGH AND N. GANDHI

Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab 141 004

Received: June 2008

ABSTRACT

The performance of lemongrass, *Tagetes minuta*, turmeric, celery, coriander, fennel, dillseed, fenugreek, *Mentha arvensis*, *Mentha spicata*, sarson (*Brassica napus* L.) and wheat in compact poplar plantation (clone 'Udai') established in March 2004 at 5 m x 4 m spacing, was studied at Ludhiana. Results revealed that an increase in the age of poplar decreased the yield of crops. During 2004-05 the reduction in yield was more in crops like *Mentha arvensis* (64.9%), *M. spicata* (65.5%), coriander (26.7%) and *Tagetes minuta* (16.1%), but was less in lemongrass (2.6%), turmeric (1.1%), fennel (6.8%), dillseed (12.6%), fenugreek (7.1%), sarson (1.84%) and wheat (4.75%). During 2005-06 the reduction in the yield of lemongrass, *Tagetes minuta*, *Mentha arvensis* and *M. spicata*; and yield of turmeric rhizome, seed of coriander, fennel, dillseed, fenugreek, sarson and wheat was 6.55, 7.50, 60.5, 50.0, 40.6, 28.1, 43.9, 27.6, 37.4 and 34.4 and 32.7%, respectively in compact poplar plantation compared with that in sole or pure cultivation of these crops; and in 2006-07 it was 25.4, 39.3, 78.6, 77.0, 56.3, 70.4, 88.5, 79.6, 65.6, 85.9 and 67.2%, respectively.

Key words: Aromatic crops, Intercropping, Medicinal crops, Poplar plantation, Spice crops

Forest area of Punjab 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 (Gill, 2002). 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 medicinal, aromatic and 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 initiated to assess the performance of different crops in compact poplar plantation and the effect of these crops on poplar growth.

MATERIALS AND METHODS

Poplar (clone 'Udai') plantation was established during March 2004 at 5 x 4 m spacing at Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana on an area of about 0.75 ha. The survival percentage of plantation was 99%. Profile samples of plantation site from depths of 0-15, 15-30, 30-60 and 60-90 cm were collected at the time of planting poplar clones. The soil has 8.3 pH and electrical conductivity of 0.44 dS/m, low in organic C (0.41%) and available N (279.4 kg/ha), and medium in available P (39.7 kg/ha) and K (213.0 kg/

*Corresponding author (Email:drbsgill@gmail.com)

¹Present address: Department of Forestry and Natural Resources, PAU, Ludhiana, Punjab 141 004

ha) in the plough layer; and the contents of these nutrients in the soil decreased with increase in depth up to 90 cm of soil profile. The bulk density and particle density increased with increase in the depth of plough layer. Recommended practices were followed for raising the poplar trees. The diameter at breast height (DBH) and height of poplar plants were measured at planting and during March each year. Average crown spread and crown length were measured in the last week of October when crown expansion ceases.

The treatments consisted of 12 medicinal, aromatic and spice intercrops, viz. lemongrass (*Cymbopogon flexuosus*), *Tagetes minuta*, turmeric (*Curcuma longa* L.), celery (*Apium graveolens* L.), coriander (*Coriandrum sativum* L.), fennel (*Foeniculum vulgare* M.), dillseed (*Anethum sowa* R.), fenugreek (*Trigonella foenum-graecum*), *Mentha arvensis*, *Mentha spicata*, sarson (*Brassica napus* L.) and wheat (*Triticum aestivum* L.) in poplar plantation in addition to sole or pure crops without shade during 2004-05, 2005-06 and 2006-07. In agri-silviculture system the plot size was co-terminus with trees planted at 5 x 4 m spacing. Analysis of variance was done following factorial experiments in randomized block design with three replications. Lemongrass root slips were transplanted on 25 May 2004 at 60 x 30 cm and gap filling was done after a month. The establishment of lemongrass root slips was 95%. During 2004-05 only one cutting of lemongrass was taken, whereas during 2005-06 and 2006-07 the crop was harvested by the end of June and end of October for herb. The seedlings of *Tagetes minuta* were transplanted at 60 x 30 cm spacing by the end of June and it was harvested by the end of November. Suckers of *Mentha arvensis* and *M. spicata* were planted in the third week of January and the crop was harvested by the

end of June. The essential oil in herb of lemongrass, *Tagetes minuta*, *Mentha arvensis* and *M. spicata* was extracted using Clevenger's apparatus. Turmeric was planted in the first week of May at 60 x 10 cm and was harvested by the end of January. Different crops, viz. celery, coriander, fennel, dillseed, fenugreek, sarson and wheat were sown during winter (*rabi*) season and were raised as per the recommended practices. Wheat-equivalent yield was calculated on the basis of prevailing market price, based on the yield of different intercrops for statistical analysis. The total variable cost and net returns were calculated on the basis of input and output prices of *rabi* 2006-07.

RESULTS AND DISCUSSION

Crop productivity

During 2004-05 one cutting of lemongrass in agri-silviculture system and sole crop gave 116.9 and 120.0 litres/ha oil yield respectively (Table 1). In *Tagetes minuta* the sole crop gave 55.0 litres/ha oil yield, whereas its one cutting under agri-silviculture system gave 46.1 litre/ha. Fresh turmeric rhizome under sole and agri-silviculture system gave 9.44 and 9.33 t/ha yield respectively. *Mentha arvensis* and *M. spicata* as sole crop gave 155.0 and 102.5 litres/ha oil yield compared with 54.4 and 35.3 litres/ha under agri-silviculture system, indicating a reduction of 64.9 and 65.5% oil yield in poplar plantation respectively. The oil yield reduction of *Mentha arvensis* and *M. spicata* can be attributed to the maximum vegetative growth during April, May and June, which coincided with the flush of new leaves of poplar. During winter season (*rabi*) celery, coriander, fennel, dillseed and fenugreek gave respectively 1.47, 0.52, 1.10, 0.62 and 1.43 t/ha seed yield in compact poplar plantation compared with 1.51, 0.71, 1.18, 0.71 and 1.54 t/ha respectively under sole or

Table 1. Yield (t/ha) of medicinal and spice crops as influenced by age of poplar in compact poplar plantation

Treatment	March 2005				March 2006				March 2007			
	Sole or pure	Agri-silvi system	Decrease over sole (%)	Wheat-equivalent yield	Sole or pure	Agri-silvi system	Decrease over sole (%)	Wheat-equivalent yield	Sole or pure	Agri-silvi system	Decrease over sole (%)	Wheat-equivalent yield
Lemon grass*	120.0	116.9	2.6	7.89	200.0	186.9	6.5	13.14	200.0	149.2	25.4	8.00
<i>Tagetes minuta</i> *	55.0	46.1	16.1	6.95	56.0	51.8	7.5	8.09	60.0	36.4	39.3	4.28
Turmeric	9.44	9.33	1.1	8.14	23.50	13.95	40.6	13.08	14.57	6.38	56.3	4.50
Celery	1.51	1.47	2.6									
Coriander	0.71	0.52	26.7	2.64	0.96	0.69	28.1	3.23	0.96	0.28	70.4	1.07
Fennel	1.18	1.10	6.8	5.24	0.57	0.32	43.8	1.62	0.90	0.10	88.5	0.44
Dillseed	0.71	0.62	12.6	3.15	0.98	0.71	27.5	3.88	1.70	0.35	79.6	1.64
Fenugreek	1.54	1.43	7.1	6.35	2.22	1.39	37.3	6.08	1.98	0.68	65.6	2.40
<i>M. arvensis</i> **	155.0	54.4	64.9	4.32	166.7	66.0	60.5	5.15	178.5	38.3	78.6	2.47
<i>M. spicata</i> *	102.5	35.3	65.5	2.80	122.2	61.1	50.0	5.25	60.0	36.8	77.0	2.59
Sarson	1.30	1.28	1.8	3.05	0.64	0.42	34.3	1.11	1.01	0.14	85.9	0.29
Wheat	4.21	4.01	4.7	4.01	5.62	3.78	32.7	3.78	4.05	1.33	67.2	1.33
SEm ±				0.23				0.22				0.17
CD (P=0.05)				0.52				0.51				0.38

*Oil yield in litres/ha

pure crops. Sarson and wheat under agri-silviculture system gave yield of 1.28 and 4.01 t/ha compared with 1.30 and 4.21 t/ha respectively under sole or pure system, indicating a reduction of 1.84 and 4.75% in poplar plantation.

In 2005-06 lemongrass and *Tagetes minuta* intercropping in poplar gave 6.55 and 7.50% less oil yield compared with that as sole crop (Table 1). The yields of fresh rhizome of turmeric in poplar decreased by 40.6% compared with sole crop. In poplar plantation there was maximum reduction of in the herb yield of *Mentha arvensis*, (60.5%) closely followed by that of *Mentha spicata* (50.0%). The seed yield of coriander, fennel, dillseed, fenugreek and sarson decreased by 28.1, 43.9, 27.6, 37.4 and 34.4% respectively in compact poplar plantation compared with that in their sole cultivation. The wheat-grain yield decreased (32.7%) in poplar plantation as compared to pure crop.

During 2006-07 seed or oil yield of all the intercrops grown in poplar plantation decreased greatly compared with their sole or pure treatments (Table 1). The oil yield of lemongrass and to gets minute decreased by 25.4 and percent in poplar plantation compared with that in sole treatment. Singh *et al.* (1990) reported that there was very little reduction in herb as well as oil yield of lemongrass, Citronella jawa and palmarosa during three years in poplar plantation. The fresh rhizome yield of turmeric decreased by 56.3% in poplar plantation compared that of pure or sole crop. Gill *et al.* (2004) reported that fresh-rhizome yield of turmeric decreased significantly with increase in the age of poplar, its maximum reduction (85.9%) was recorded under four year-old plantation and minimum in one year-old plantation (11%) compared with that of pure crop of turmeric.

In poplar plantation *Mentha arvensis* recorded 78.6% decrease in oil yield during 2006-07, and a similar trend

Table 2. Net returns (Rs/ha) from various medicinal and spice crops in poplar plantation

Crop	2004-05	2005-06	2006-07
Lemongrass	6,355	43,581	31,516
<i>Tagetes minuta</i>	22,993	28,648	13,268
Turmeric	24,855	52,575	7,155
Coriander	6,342	11,982	- 978
Fennel	29,600	2,230	- 7,220
Dillseed	15,447	19,047	4,647
Fenugreek	32,875	31,675	10,435
<i>Mentha arvensis</i>	- 4,149	1,248	- 11,771
<i>M. spicata</i>	- 9,269	4,148	- 8,489
Sarson (Hyola)	9,678	- 5,243	-10,570
Wheat	14,793	12,863	7,987

Sale price: Lemongrass (Rs/litre)=450; *T minuta* (Rs/litre)=1,000; turmeric fresh (Rs/t)=6,000; coriander (Rs/t)=32,000, fennel (Rs/t)=36,500; dillseed (Rs/t)=40,000; fenugreek (Rs/t)=30,000; *Mentha arvensis* (Rs/l)=550; *M. spicata* (Rs/t)=6,000; sarson (Rs/t)=17,350; and wheat (Rs/t)= 8500

was observed in *Mentha spicata* (77.0%). The seed yield of coriander, fennel, dillseed, fenugreek and sarson decreased by 70.4, 88.5, 79.6, 65.6 and 85.9% compared with that of sole or pure crops respectively. The yield of wheat of (1.33 t/ha) decreased by 67.2% in poplar plantation compared with that as sole or pure crop (4.05 t/ha).

With increase in the age of poplar, the yield of all the crops decreased. The crown diameter during March 2005 was 2.55-3.18 m, which increased to 3.9-4.5 m during March 2006 and there was complete overlapping during March 2007. Similar trend was observed in the crown length of poplar, which resulted in complete shade. This increased canopy of poplar with age resulted in reduced availability of light and increased competition for nutrients. It greatly decreased the yield of all the crops except of lemongrass, *Tagetes minuta* and turmeric grown as intercrop. Maximum reduction in yield (65.6-88.5%) was observed in 2006-07. Sreekala and Jaychandran (2002) reported that under heavy shade levels (60 and 80%) crop-growth rate as well as was yield of ginger low. Nandal *et al.* (1999) also reported that yield and yield attributes of wheat decreased in *Dalbergia sissoo* plantation due to reduced availability of photosynthetically active radiation and competition for light increases with age and density of plants (Basavaraju and Rao, 2000). Wheat-equivalent yield of turmeric treatment was maximum, followed by that of lemongrass, *Tagetes minuta*, fenugreek and fennel, and all were significantly better than wheat during 2004-05 (Table 1). Lemongrass, turmeric, *Tagetes minuta*, fenugreek, *Mentha arvensis* and *M. spicata* gave significantly higher wheat-equivalent yield than wheat during 2005-06 and 2006-07.

During 2004-05 the net returns from *Mentha arvensis* and *M. spicata* were negative due to decreased oil yield (Table 2). Lemongrass takes 6-8 months to establish in the first year of plantation and only one cutting was taken and thus the net returns were low from lemongrass during the first year of plantation. The returns were higher than of wheat in all crops except lemongrass and coriander. During 2005-06 lemongrass, *Tagetes minuta*, turmeric, dillseed and fenugreek gave higher net returns than wheat, whereas the returns from coriander were comparable. In the third year of poplar plantation, the net returns from lemongrass, *Tagetes minuta* and fenugreek were higher than wheat but those from turmeric were comparable. The data revealed that in the first year of compact poplar plantation, lemongrass, *Tagetes minuta*, turmeric, coriander, fennel, dillseed, fenugreek and sarson can be grown successfully. In the second year of poplar, lemongrass, *Tagetes minuta*, turmeric, coriander, dillseed, fenugreek and wheat should be raised; and in the third year, lemongrass, *Tagetes minuta*, turmeric and fenugreek can be raised successfully and economically.

Table 3. Diameter at breast height (DBH) (cm) and height of poplar (m) plants as influenced by different agrisilviculture systems

Treatment	2004		2005		2006		2007		2005			2006		
	DBH	Height	DBH	Height	DBH	Height	DBH	Height	Crown height	Crown length	Crown diameter	Crown height	Crown length	Crown diameter
Lemon grass	1.8	4.4	6.2	6.6	14.5	11.7	18.5	13.5	2.30	4.50	2.78	2.6	9.1	4.5
<i>T. minuta</i>	1.7	4.5	6.2	6.7	12.3	11.7	18.0	14.4	2.43	4.26	3.03	2.6	8.9	4.0
Turmeric	1.9	4.5	5.8	6.2	14.7	12.2	15.9	12.6	2.70	3.46	2.88	2.9	9.3	4.2
Celery	1.8	4.4	5.8	6.4	11.0	10.2	13.5	12.6	2.60	3.83	2.93	2.8	7.0	4.3
Coriander	1.8	4.6	6.1	6.6	11.1	10.7	13.8	12.0	2.51	4.06	3.18	2.8	7.9	3.9
Fennel	1.8	4.6	5.6	6.3	12.2	10.3	13.7	12.5	2.50	3.76	2.76	2.9	7.4	4.4
Dillseed	1.8	4.5	6.0	6.3	11.5	10.8	13.3	12.5	2.50	3.86	3.03	2.9	7.9	4.2
Fenugreek	1.9	4.6	5.5	6.2	11.3	11.2	14.3	11.8	2.43	3.70	2.79	3.0	8.2	4.2
<i>M. arvensis</i>	1.6	4.1	5.6	6.0	11.5	10.2	13.8	11.5	2.50	4.30	3.05	2.8	7.4	4.0
<i>M. spicata</i>	1.8	4.4	5.4	6.2	12.0	10.0	14.4	12.5	2.70	3.76	2.55	3.0	7.0	4.4
Sarson	1.8	4.4	5.5	6.3	12.3	10.3	13.3	12.6	2.66	4.30	2.83	2.9	7.4	4.5
Wheat	1.9	4.6	5.6	5.8	9.5	9.0	14.5	12.6	2.60	3.13	2.90	3.0	6.3	4.3
SEm±	0.1	0.2	0.3	0.3	0.9	0.4	0.4	0.8	0.15	0.31	0.15	0.1	0.5	0.3
CD (P=0.05)	NS	NS	NS	0.6	2.0	1.0	0.9	1.92	NS	0.64	NS	NS	NS	0.4

Tree component

Diameter at breast height (DBH) of poplar plants at the time of planting varied from 1.6-2.0 cm and height from 4.1-4.6 m, indicating that statistically identical poplar plants were planted (Table 3). During 2005 the effect of different medicinal, aromatic and spice crops on DBH was not significant, whereas height improved in all the intercropped treatments compared with that of wheat. In 2006 the effect of intercrop treatments was significant and the DBH and height were more in all the treatments compared with that in wheat treatment. During 2007 the DBH was significantly more in lemongrass, *Tagetes minuta* and turmeric than in wheat. DBH decreased significantly in sarson and dillseed treatments indicating their adverse effect. The height in all intercrop treatments was at par.

Intercropping of lemongrass, *Tagetes minuta*, turmeric, celery, coriander, fennel, dillseed, fenugreek, *Mentha arvensis*, *M. spicata* and sarson improved the crown length of poplar compared that of wheat though the differences were significant during 2005 only (Table 3). The effect of different intercrop treatments on height was not significant due to general pruning of poplar during February. The differences in crown diameter were significant during 2007, and crown diameter of poplar intercropped with lemongrass, turmeric, fenugreek and wheat treatments was at par.

From the study it was concluded that in the first year of poplar plantation lemongrass, *Tagetes minuta*, turmeric, coriander, fennel, dillseed, fenugreek and sarson can be grown successfully. In second year of poplar lemongrass, *Tagetes minuta*, turmeric, coriander, dillseed, fenugreek and wheat should be raised, and in the third year lemon-

grass, *Tagetes minuta*, turmeric and fenugreek can be raised successfully and economically. Intercropping of lemongrass, *Tagetes minuta*, turmeric, celery, coriander, fennel, dillseed, fenugreek, *Mentha arvensis*, *M. spicata* and sarson in poplar improved the DBH and height of poplar in the first and second years of plantation, whereas in the third year the intercropping of lemongrass, *Tagetes minuta* and turmeric had favourable effect on DBH and height of poplar.

REFERENCES

- Basavaraju, T. B. and Rao, Gururaja. 2000. Tree crop interactions in agro-forestry systems: a brief review. *Indian Forester* **126**(11): 1155-1163.
- Gill, B.S., Singh, A., Singh, Gursharan and Saini, S.S. 2004. Effect of age of poplar on growth and yield of turmeric (*Curcuma longa* L.) intercrop. *Indian Journal of Forestry* **7**(3): 313-315.
- Gill, B.S. 2002. Evaluation of productivity potential of crops in association with trees. In: *Tree-Crop Interface*, pp 14-20. Chauhan, S.K. and Gill, S.S. (Eds). Department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana.
- Nandal, D.P.S., Kumar, Anil and Hooda, M.S. 1999. Performance of wheat varieties in association with Eucalyptus and poplar windbreaks and *Sissoo* block plantation. *Indian Journal of Forestry* **22**(1): 73-77.
- Singh, Kamla, Singh, Virendra, Husain, A. and Kothari, S.K. 1990. Aromatic plants as efficient intercrops under poplars (*Populus deltoids*) Bartram Marshall. *Indian Forester* **116**(3): 189-193.
- Sreekala, G.S. and Jaychandran, B.K. 2002. Influence of shade regimes on the physiological parameters of ginger. *Journal of Spices and Aromatic Crops* **11**(1): 30-34.