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Performance of wheat and mustard under *Eucalyptus tereticornis* based agri-silviculture system

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Abstract

Two crops namely wheat (*Triticum aestivum* L.) cv. WH-542 and Mustard (*Brassica juncea* L.) cv. RH-30 were sown in the inter spaces of two and half years old plantation of *Eucalyptus tereticornis* planted at a spacing of 6 x 2m. The height of wheat and mustard was significantly less under agri-silviculture system as compared to sole cropping. The other parameters such as plants per running meter row length (161.7), spike length (7.7 cm), grains per spike (37.7) and test weight (26.7g) were significantly less under Eucalyptus than in sole cropping. In mustard primary branches per plant and seeds per siliqua was less under Eucalyptus than sole cropping. Yield parameters such as secondary branches per plant, siliqua per plant and test weight were also significantly higher in sole cropping. The grain and straw/stover yields of both the crops under Eucalyptus decreased significantly as compared to sole cropping. Grain yield reduction (63.2%) was less in wheat. Net returns from crop grown with Eucalyptus and sole cropping revealed that higher income (Rs 46,620/ ha) was recorded in sole wheat and Rs 1,890/ ha in wheat- Eucalyptus agroforestry system.

Keywords: Agro-silviculture, *Brassica juncea, Eucalyptus tereticornis,* Net returns, PAR, *Triticum aestivum,* Yield

Introduction

Eucalyptus tereticornis commonly known as ‘red gum’ is native of Australia and Papua New Guinea. It is one of the most widely planted exotic species that has been extended to other parts of the globe. It has been promoted in many tropical countries owing to its fast growth rate, adaptability to wider climatic and edaphic conditions and multiple uses (Zobel *et al.,* 1987; Evans, 1992). Agroforestry is one of the best option to increase the tree cover out side the forest. The need of agroforestry has been necessitated in many parts of the country, which face several agricultural and ecological problems, predominant of which are soil degradation, large scale deforestation, increasing population pressure of human beings and livestock, and decreasing land:man ratio. Intercropping, especially during the tree gestation period, could be economically profitable and is environmentally sound indeed. Trees on farm can be made popular, especially fast growing like eucalypts which also provide fodder, fuel and timber. Thus keeping in view multipurpose uses and role in bio-drainage eucalypts plantation is likely to be adopted on large scale on government and private lands. Therefore, the present study was conducted to assess the performance of eucalypts based agri-silviculture system in north-west India.

Materials and Methods

The field experiment was conducted at Department of Forestry, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana), India located in the low rainfall zone of the southern Haryana (29.10° N, 75.46° E and 215.2 m above mean sea level). The site is characterized by inadequate precipitation (300-550 mm) during monsoon (July – September). The climate of the region is semi-arid, sub tropical with severe cold days during winter and sunny hot days coupled with desiccating winds in summer. During experimentation, the maximum temperature reaches as high as 38.2°C whereas, during peak winter months of December and January, the average minimum temperature was recorded around 2°C accompanied with frost occurrence. Between October and April, weather was almost dry except occasional light showers. The soils of the site are sandy loam and slightly saline with pH 8.1, EC 0.22 dsm^{-1}. The soils were low in available nitrogen (135.0 kg/ha), low in available phosphorus (2.0 kg/ha) and high in available potash (303.0 kg/ha).

Two winter season crops *viz*. wheat (*Triticum aestivum* L.) cv. WH-542 and Mustard (*Brassica juncea* L.) cv. RH-30 were sown in the inter spaces of two and half years old eucalypts (*Eucalyptus tereticornis*) plantation planted at 6m x 2m spacing. Mustard was sown during the second week of October and wheat was sown during the last week of November. Half of the recommended dose of nitrogen and full dose of phosphorus was applied before sowing. The remaining nitrogen was applied at the time of first irrigation. The sources of nitrogen and phosphorus were urea (46% N) and SSP (16% P_2O_5), respectively. Wheat crop was irrigated after every 22 days whereas two irrigations were applied in mustard. Weeding was done manually twice during the crop period. Both the crops (wheat and mustard) were also sown under control conditions (without Eucalyptus) in the adjacent plot. The observations were recorded on plant height (cm) at 30, 60, 90 and 120 days after sowing (DAS), tillers per plant at 40 days after sowing and effective tillers per plant, spike length, grains per spike, test weight (1000 seed weight), grain yield (q/ha) and straw yield in wheat were recorded at harvest time. In mustard plant height at 20, 60, 90 and 120 days after sowing and primary branches per plant, secondary branches per plant, pods per plant, seeds per siliqua, test weight, grain and stover yields were recorded at harvest time. The growth of Eucalyptus trees was measured at the start and end of the experiment. Photosynthetically active radiation (PAR) reaching the crop surface under the canopy of Eucalyptus and control were measured at three spots at 9:30 am, 11:30 am and 4:30 pm with Lux Meter and average was taken as PAR value. The data was analyzed by the paired t-test (Fisher, 1948).

For economic evaluation of the system, the cost items include the cost of planting, charges for digging pits, planting and training of trees, field preparation and cultivation of crops, material inputs such as seed and fertilizer, labour cost for different field operations, interest on working capital and rental value of land was calculated on the basis of prevailing market prices in nearby villages. For net returns market rates of grain and straw/stover were taken as Rs 1350/q, Rs 300/q for wheat and Rs 3000/q and Rs 100/q for mustard, respectively.

Results and Discussion

The plant height of wheat at 30 and 60 DAS did not differ significantly under eucalyptus and in open (sole wheat). However, at later stages (90 and 120 DAS) it was significantly less under eucalyptus as compared to sole cropping. This might be due to advanced germination under eucalyptus. Maximum plant height (85.5 cm) was recorded in sole cropping (Table 1). Significantly less plant height of mustard was recorded under eucalyptus as compared to sole cropping.

Less height of crops under eucalyptus may be primarily due to reduced light intensity under eucalyptus. The data recorded during the experiment in the month of December has clearly shown that PAR available to crops under eucalyptus was 40.42, 46.32 and 54.25 % at 9:30AM, 11:30 AM and 4:30 PM, respectively of light available to crops in open. Thus more light intensity in sole cropping increased the photosynthetic efficiency of crops resulting in better growth as reported by Wassinck (1954). More height of wheat under eucalyptus after 90 and 120 DAS has also been reported by Deswal and Nandal (2008).

Non significant results were obtained for tillers per plant and effective tillers per plants in wheat, however, more tillers were found in sole cropping. The other parameters such as plants per running meter row length (161.7), spike length (7.7 cm), grains per spike (37.7) and test weight (26.7g) were significantly less under eucalyptus than in sole cropping. However, in mustard primary branches per plant and seeds per siliqua were at par under eucalyptus and sole cropping. Yield parameters such as secondary branches per plant, siliqua per plant and test weight were significantly higher in sole cropping. The numbers of secondary branches recorded in sole cropping were 16.4 as compared to 5.40 under eucalyptus. The corresponding values of siliqua per plant and test weight were 371, 9.3 g in sole cropping and 84.2, 5.3 g under eucalyptus, respectively (Table 2). Reduced value of yield parameters of wheat and mustard may be ascribed to competition for light, moisture and nutrients in addition to allelopethic effect of eucalyptus (Deswal and Nandal, 2008, Prasad *et al*., 2011).

The grain and straw/stover yields of both the crops under eucalypts decreased significantly as compared to open field (crops without eucalyptus) and 63.2% grain yield reduction was observed in wheat (Table 3). The decrease in the straw/ stover yield of wheat and mustard was of the order of 58.2 and 82.2%, respectively.

Yield reduction in wheat and mustard indicated that higher tree density (833 trees/ha) had more suppressing effect on crops, reduced solar radiation on crop canopy and lower availability of moisture and nutrients. Light intensity in wheat and mustard under eucalyptus reduced from 17220, 26100, 16090 to 6960, 12090 and 8730 at 9:30 am, 11:30 am and 4:30 pm, respectively as compared to sole crop.

Reduced yield of groundnut under teak due to reduced PAR availability has also been recorded by Venkatarao *et al*., 2006. The moisture content under eucalyptus (3.75%) and in open (7.5%) was also recorded and the data indicated that eucalyptus trees had severe competition for moisture with wheat and mustard. Similar reduction in yield of wheat in association with Eucalyptus due to moisture competition has also been reported by Deswal and Nandal (2008).

Net returns from crop grown with eucalyptus and sole cropping revealed that maximum income (Rs 46,620/ ha) was recorded in sole cropping (monoculture) of wheat, whereas negative returns of Rs 5,567/ ha was recorded in mustard under eucalyptus.

The average girth, height and crown spread of eucalyptus trees at the start of experiment were 19.2 cm, 6.19 m and 2.31 m, respectively. There was no significant variation in the above parameters of eucalyptus till the end of experiment. At the end of the experiment the girth, height and crown spread were 19.6 cm, 6.30 m and 2.40 m, respectively.

Table 1: Effect of eucalyptus on monthly plant height of wheat and mustard

	Plant height (cm)					
	Wheat			Mustard		
DAS	With eucalyptus	Without eucalyptus	Paired t-test value	With eucalyptus	Without eucalyptus	Paired t-test value
30	6.2±1.48	7.9±1.48	2.56	19.3±2.81	69.2±2.81	16.37*
60	22.8±0.48	26.7±0.48	1.91	43.1±8.10	143.0±8.10	11.25*
90	44.6±2.02	54.4±2.02	4.43*	63.7±3.31	174.0±3.31	31.90*
120	58.2±0.96	85.5±0.96	27.67*	67.9±1.15	175.5±1.15	91.90*

* P ≤0.05

Table 2: Effect of eucalyptus on yield parameters of wheat and mustard

Yield parameters	With eucalyptus	Without eucalyptus	Paired t-test value
Wheat			
Plant per running meter row length at 15 DAS	161.7±2.06	170.0±2.06	4.7*
Tillers per plant at 40 DAS	4.2±0.89	5.8±0.89	1.8
Effective tillers per plant at harvest	3.6±1.09	4.8±1.09	1.1
Spike length (cm)	7.7±0.38	9.0±0.38	12.8*
Grains per spike	37.7±6.75	50.2±6.75	5.5*
Test weight (g)	26.7±2.7	31.8±2.7	2.7*
Mustard			
Primary branches per plant	4.4±2.30	7.6±2.30	1.39
Secondary branches per plant	5.4±1.87	16.4±1.87	6.95*
Sliqua per plant	84.2±8.50	371.0±8.50	33.73*
Seeds per sliqua	9.5±1.63	14.5±1.63	3.06
Test weight (g)	5.3±0.03	9.3±0.03	11.73*

* P ≤0.05

Table 3: Effect of eucalyptus on grain, straw yield and net returns of wheat and mustard

Parameters	With eucalyptus	Without eucalyptus	Percent decrease
Wheat			
Grain (q/ha)	14.8	40.2	63.2
Straw (q/ha)	25.0	59.8	58.2
Cost of cultivation (Rs)	25,590	25,590	-
Net returns (Rs)	1,890	46,620	95.9
Mustard			
Grain (q/ha)	3.2	18.2	82.4
Stover(q/ha)	11.2	62.8	82.2
Cost of cultivation (Rs)	16,287	16,287	-
Net returns (Rs)	(-) 5,567	44,593	112.5

Conclusions

Growth and yield parameters of wheat and mustard were lower in crop grown under eucalypts compared to open field. The grain yield, straw yield and net income decreased by 63.2, 58.2 and 95.9 per cent in wheat and 82.4, 82.2 and 112.5 per cent in mustard, respectively. The yield of wheat and mustard were recorded 2.7 and 5.7 times higher in open field as compared to eucalypts based agroforestry system. Wheat crop was found more suitable for cultivation under eucalypts. Lower income under eucalypts could be compensated by income from eucalypts trees at maturity besides other advantages of agroforestry such as supply of fuel, fodder, timber and other ecological services.

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