

Original Research Article

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Effect of Integrated Nutrient Management and Tree Spacing on Production Potential of Maize (*Zea mays*) Under Poplar Based Agroforestry System

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ABSTRACT

The experiment was carried out at experimental farm of Department of Silviculture and Agroforestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) in the year 2016. Experiment was laid out in RBD factorial design in poplar based agroforestry system with three spacing viz., S₁ (6m x 4m), S₂(4m x 4m) and S₃(open control without poplar trees) under which maize crop was grown and six fertilizer treatments viz., T₁ (RDF), T₂ (FYM on N equivalent ratio), T₃ (VC on N equivalent ratio), T₄ (75% FYM and 25% Vermicompost (on N equivalent ratio), T₅ (50%FYM and 50% Vermicompost (on N equivalent ratio) and T₆ (50% (25%FYM + 25% Vermicompost) + 50% chemical fertilizer). Results showed that treatment T₆ reported maximum plant height, cob length, 1000 grain weight, grain yield and straw yield and showed its superiority over other treatments. However, among tree spacing levels, S₃ (without trees) recorded maximum growth as compared to others.

Keywords

Integrated nutrient management, Poplar, FYM, VC, Agri-silviculture system.

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Introduction

Poplar (*Populus deltoides*) is a multipurpose fast growing valuable timber species has emerged as one of the most suitable tree species for agri-silviculture system. Poplar based agroforestry systems are economically viable and more sustainable than many other crop rotations prevalent in North India (Singh and Sharma, 2006). Poplar has become the most preferred cash crop in north-western states (Chandra, 1986). The farmers grow poplar due to its short duration, ease of regeneration, easy availability of quality planting material, good market demand and its compatibility with agricultural crops.

Poplar plantations intercropped with agricultural crops have better growth than those without intercrops and the growth of trees is viable under different intercrops. Almost any crop (cereals, pulses, vegetables, forage, fruit/vegetable crops, etc.) can be grown with it (Chauhan and Mangat, 2006). The number of agricultural crops (wheat, mustard, turmeric, ginger, colocasia, cabbage, potato, spinach, garlic, etc.) including fruit crops (citrus, guava, mango, etc.) can be profitably raised with poplar (Sharma, 1996). Poplar intercropping is a highly lucrative and profitable venture, since market for its

products are readily available because of established processing industries in the region (approximately 1,200 units of all category in Punjab, Haryana, Delhi, Uttarakhand, Uttar Pradesh, etc.). Poplar wood is used in packing cases, hard boards, veneers, sports goods, construction works and as pulp wood and poles. Besides, Indian matchwood industry uses its wood for manufacturing match splints and lops and tops as fuel wood are also not rare. These facts show that poplar wood has huge demand in wood based industries.

Further, soil fertility is decreasing day by day and area under problematic soils is increasing due to the high and injudiciously use of inorganic fertilizers. The long-term use of inorganic fertilizers without organic supplements damages the soil physical, chemical and biological properties and cause environmental pollution (Albiach *et al.*, 2000). To reduce soil deterioration, the only possible way is integration of organic, bio and chemical fertilizers, so as to maintain crop productivity along with improvement and /or maintain soil fertility. Integrated nutrient management and agroforestry land use systems are among the best solution for the ever-escalating price and shortage of chemical fertilizers for small holder farmers, to increase soil fertility, in the developing world. Therefore, an integrated approach inorganic fertilizers, biological sources and organic manures in agroforestry systems will go a long way in building soil fertility and land productivity on a sustainable basis, since the system will supply almost all the nutrients in a judicious way, besides increasing the nutrient use efficiency and improving the soil physico-chemical properties.

Zea mayz is a grass, a member of the monocot family (Poaceae), cultivated for the edible components of its grain, composed of the endosperm, germ and bran. In their natural form, they are a rich source of vitamins,

minerals, carbohydrates, fats, oils and protein. In some developing nations, grain in the form of rice, wheat, millet or maize constitutes a majority of daily sustenance. In developed nation cereal consumption is moderate and varied but still substantial. Maize (*Zea mays*) is one of the most versatile emerging cash crops having wider adaptability under varied climatic conditions. It is called queen of cereals globally. In India, it is the third most important cereal crop after wheat and rice which accounted 26.14 million tones production in 2016 (FAO/GIEWS, 2016).

Cultivation of cereal crop like maize under poplar trees could be ecologically viable option for soil fertility improvement and greater productivity of cereal crops and poplar trees for economic security of farmers adopting the system. However successful cultivation of cereal crops under agri-silviculture system requires information on species compatibility, arrangement of components and nutrient management practices. So far little work has been carried out to test the performance of maize crop with poplar and effect of integrated nutrient management on it under mid-hill sub humid conditions of Himachal Pradesh, which need further investigations. Therefore, in the present study emphasis will be given to test the effect of integrated nutrient management on the performance of maize crop in association with poplar.

Materials and Methods

The experiment was conducted at experimental farm of Department of Silviculture and Agroforestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) in the year 2016. A structural component of experiment consist of three spacing viz., S₁ (6m x 4m), S₂(4m x 4m) and S₃(open control without trees) and six treatments viz., T₁ (RDF), T₂ (FYM on N

equivalent ratio), T₃ (VC on N equivalent ratio), T₄ (75% FYM and 25% Vermicompost (on N equivalent ratio), T₅ (50% FYM and 50% Vermicompost (on N equivalent ratio) and T₆ (50% (25% FYM + 25% Vermicompost) + 50% chemical fertilizer). The parameters determined were plant height, ear length, 1000 grain weight, grain yield, straw yield and harvest index. Crop growth parameters viz., plant height and ear length were recorded on the bases of ten plants randomly selected from each plant. Yield was calculated by recording weight of grains from each plot. The statistical design RBD factorial was used to analyse the data.

Results and Discussion

Data presented in the table 1 revealed that growth parameters viz., plant height and ear length were significantly influenced by different treatments and tree spacing. Plant height recorded maximum in the treatment T₆ (236.21 cm) while, minimum was recorded in treatment T₁ (215.04 cm). Among tree spacing, maximum plant height was reported in S₃ (248.67 cm) and minimum was recorded under S₂ (210.19). Plant height was maximum in open control area. This might be because of limited light availability for understory crops and light penetration is limited due to canopy interception. Hashim *et al.*, (2015) also reported application of 50% recommended dose of fertilizer (RDF) through chemical fertilizers and 50% recommended dose of nitrogen (RDN) through crop residue mixed farmyard manure recorded the maximum growth attributes of maize.

The maximum cob length (Table 1) among treatments was recorded in T₆ (14.67 cm) while lowest was recorded in T₁ (11.83 cm). Maximum ear length of maize among tree spacing was recorded in S₃ (14.00cm) on the other hand minimum was recorded in S₂

(12.74 cm). Gandhi and Dhiman (2010) also revealed that spikes were significantly smaller under denser tree spacings as compared less dense spacings. Hashim *et al.*, (2015) reported application of 50% RDF through chemical fertilizers and 50% recommended dose of nitrogen (RDN) through crop residue mixed farmyard manure recorded significantly higher cob length over control. Nanjappa *et al.*, (2001) reported that combined application of 50 or 75% recommended dose of fertilizer with 12 t ha⁻¹ FYM or 2.7 t ha⁻¹ vermicompost caused higher productivity of maize compared with the application of either only inorganic fertilizer or organic sources.

Examination of the data presented in the Table 2 indicated that 1000 grain weight was influenced by fertilizer treatments and tree spacing. Highest grain weight was noticed in T₆ (258.89 g) while lowest was noticed in T₁ (220.44 g).

Among tree spacing, S₃ recorded maximum grain weight (244.61 g) followed by S₁ (240.72 g) and minimum grain weight was recorded in S₂ (236.06 g). However, interaction among fertilizer treatments and tree spacing showed no significant effect on grain weight. Grain mass depends on the date of sowing and harvest, quantity of nitrogen fertilizer, conditions for wheat growing, density of sowing, climate etc. 1000 grain weight of wheat and maize was influenced by poplar plantation. Nuberg and Mylins (2002) reported lower 1000-grain weight in sheltered crop (35.6 g) than in exposed crop (40.1 g) because of reduced photosynthetically active radiations.

Perusal of the table 2 depicts that grain yield was significantly influenced by fertilizer treatments, tree spacing and their interaction. Maximum grain yield was recorded in treatment T₆ (23.26 q ha⁻¹) while minimum was recorded in T₁ (13.49 q ha⁻¹).

Table.1 Effect of INM and tree spacing on plant height (cm) and cob length (cm) of maize under Poplar based agroforestry system

Spacing Treatment	Plant height (cm)				Cob length (cm)			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
T ₁	208.97	200.10	236.07	215.04	11.63	11.33	12.53	11.83
T ₂	224.33	212.50	251.97	229.60	13.53	13.00	14.17	13.57
T ₃	227.93	217.23	256.60	233.92	14.47	13.20	14.83	14.17
T ₄	212.27	204.47	242.83	219.86	12.30	12.50	13.10	12.63
T ₅	219.77	207.27	244.33	223.79	13.07	12.80	13.70	13.19
T ₆	228.83	219.60	260.20	236.21	14.70	13.63	15.67	14.67
	220.35	210.19	248.67		13.28	12.74	14.00	
CD _{0.05}								
T	12.40				0.17			
S	8.77				0.12			
T X S	NS				NS			

Table.2 Effect of INM and tree spacing on 1000 grain weight (g) and grain yield (q ha⁻¹) of maize under Poplar based agroforestry system

Spacing Treatment	1000 grain weight (g)				Grain yield (q ha ⁻¹)			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
T ₁	220.00	216.33	225.00	220.44	10.50	10.50	19.47	13.49
T ₂	249.00	243.33	251.00	247.78	20.47	18.13	28.60	22.40
T ₃	253.00	247.67	255.33	252.00	19.70	17.53	27.67	21.63
T ₄	224.33	220.33	227.00	223.89	18.40	17.97	23.03	19.80
T ₅	240.00	237.33	242.00	239.78	18.80	17.00	25.33	20.38
T ₆	258.00	251.33	267.33	258.89	21.83	18.43	29.50	23.26
	240.72	236.06	244.61		18.28	16.59	25.60	
CD _{0.05}								
T	3.66				0.26			
S	2.59				0.18			
T X S	NS				NS			

Table.3 Effect of INM and tree spacing on straw yield (q ha⁻¹) and harvest index (%) of maize under Poplar based agroforestry system

Spacing Treatment	Straw yield (q ha ⁻¹)				Harvest index (%)			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
T ₁	62.40	60.03	65.67	62.70	14.39	14.88	18.03	15.77
T ₂	69.00	67.53	72.97	69.83	26.88	26.62	26.84	26.78
T ₃	70.47	68.77	74.00	71.08	21.85	21.83	23.84	22.51
T ₄	64.67	62.10	68.60	65.12	22.15	22.44	23.01	22.53
T ₅	66.73	62.90	70.40	66.68	21.98	22.73	23.28	22.66
T ₆	72.77	71.65	75.67	73.36	26.47	51.01	27.32	34.93
	67.67	65.50	71.22		22.29	26.58	23.72	24.20
CD _{0.05}								
T	6.40				7.56			
S	4.53				5.34			
T X S	NS				NS			

On the other hand, S₃ reported maximum grain yield (25.60 q ha⁻¹) and minimum grain yield (16.59 q ha⁻¹) was reported in S₂. Mahesh *et al.*, 2010 revealed that combined application of recommended dose of NPK (150:75:40 kg ha⁻¹) + FYM 10 t ha⁻¹ recorded higher grain yield in maize. The results corroborate with the finding of Kumar *et al.*, 2013 and Das *et al.*, (2017). Newaj *et al.*, (2003) showed that the grain yield of pure crop was higher than that from the tree crop systems in *Albizia procera* based agroforestry system.

Table 3 revealed that significantly highest straw yield among fertilizer treatments was recorded in T₆ (73.36 q ha⁻¹) while lowest was recorded in T₁ (62.70 q ha⁻¹) which was statistically at par with T₄ (65.12 q ha⁻¹) and T₅ (66.68 q ha⁻¹). Straw yield among tree spacing was reported significantly higher in T₃ (71.22 q ha⁻¹) on the other hand minimum was reported in S₂ (65.50ha⁻¹). Straw yield of crop is basically a product of number of tillers, plant height and dry matter accumulation which affect the straw yield significantly. It was lower under poplar plantations as compared to open. This difference was due to above and below ground competition hence shades of trees and root development of trees adversely affect the yield of associated crops. Straw yield was significant among spacings and was maximum in S₃ followed by S₁ and S₂. Kumar *et al.*, (2006) also observed lower straw productivity under narrow tree spacing as compared to broader spacing. Likewise, Kakraliya *et al.*, 2017 reported that integration of chemical fertilizers with organic manures increased straw yield significantly over chemical fertilizers alone.

Harvest index was found to be significant in relation to fertilizer treatments and tree spacing. Maximum harvest index was reported in T₆ (34.93%) and minimum was

reported in T₁(15.77%). Among tree spacing highest harvest index was noted in S₂ (26.58%) and minimum was under S₁ (22.29).The results are in confirmation with Chaudhary *et al.*, (2016) who reported that the combination of FYM, chemical fertilizers and inoculation had pronounced effect on soil fertility that resulted in better vegetative growth in plant height, no. of branch plant⁻¹, seeds pod⁻¹, pods plant⁻¹, stover yield, grain yields, biological yield and harvest index.

In conclusion, integrated nutrient management and tree spacing influenced the growth parameters of *Zea mays* in terms of plant height, cob length, 1000 grain weight, grain yield and straw yield. Growth parameters were found higher in S₃ (without trees) and lowest in S₂ (4m X 4m). Combined use of organic manures with inorganic fertilizers improved the growth parameters of *Zea mays*. Treatment T₆ was more effective in improving production potential of *Zea mays*. From this investigation it can be concluded that maize crop perform better in integration of organic and inorganic fertilizers as compare to sole organic and inorganic fertilizers. Further being a C₄ plant it flourish better in open conditions as compare to under trees. Its adoption in agroforestry requires various canopy management practices to reduce light competition.

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