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Shweta

College of Agriculture, CCSHAU,
Hisar, Haryana, India

Productivity of wheat (*Triticum aestivum*) as intercrop in poplar based Agroforestry system in semi arid region of Haryana

Shweta

Abstract

Poplar a short-rotation plantation crop, has received wide acceptance during the last 3 decades in India. Due to its fast growing habit, its compatibility with agriculture crops, and high industrial requirements, the species is widely grown in Indo-Gangetic region of the country. The study was carried out at forestry farm area of CCSHAU, Hisar, Haryana, India located at 75°46' longitudes and 29°10' latitudes and elevation of 215 m above mean sea level. Hisar is situated in the semi-arid region of North-Western part of India. The reduction in yield up to 85.48 per cent under 5X2 m spacing and 60.14 per cent under paired row plantation. When we talk about straw yield, 13.18 per cent reduced under paired row and 66.38 per cent reduction under 5 X4m plantation.

Keywords: productivity, agroforestry, semi arid, Haryana

Introduction

Suitable Agriculture land is available only in few areas, whereas Livelihood of 70 % population of India, depend on Agriculture. By increasing population (+1.93 %/year), soil degradation and per person irrigated area, grain area and forest area declining. The other problems of Indian agriculture are the land holding and marketable surplus. About 85% farmers come under small or marginal land holding, so less or no marketable surplus, which is affected by land holding and their family size. The tree species behave differently at different plant densities or spacing. Spacing and planting of tree species influenced growth and yield of field crops. Appropriate selection of crops for intercropping with tree species helps to increase productivity, improve soil fertility and promote resource use efficiency and land sustainability (Dhyani *et al.*, 2009; Antonio and Gama, 2011) [4, 1]. Poplar based agroforestry system are more money-spinning than many of other crop rotations in northern part of India (Chauhan *et al.*, 2015) [2].

Poplar a short-rotation plantation crop, has received wide acceptance during the last 3 decades in India. Due to its fast growing habit, its compatibility with agriculture crops, and high industrial requirements, the species is widely grown in Indo-Gangetic region of the country. Poplar enriches the soil by adding leaf litter. In the rainy season, due to shade and moisture competition reduces the yield, poplar have leaf less period in winter season of 4 to 5 months and due to deciduous in nature facilitates sufficient light penetration to the ground (Kumar and Rajput, 2005) [7]. Therefore winter crops like wheat have little completion during vegetative phase, however during reproductive phase of wheat in April- May crop become mature have light and moisture completion due to new leaves and growth start in March. Wheat (*Triticum aestivum*) is the predominant food grain crop cultivated in India during *rabi* season, which is generally intercropped with poplar in India. Wheat can be taken as intercrop in poplar but need the proper poplar spacing, therefore, the present investigation was under taken to evaluate the productivity of wheat as intercrop in poplar based agroforestry system.

Materials and Methods

The study was carried out at forestry farm area of CCSHAU, Hisar, Haryana, India located at 75°46' longitudes and 29°10' latitudes and elevation of 215 m above mean sea level. Hisar is situated in the semi-arid region of North-Western part of India. The soil of the experimental site was sandy loam in texture and slightly saline in reaction (pH 8.2) with medium in OC, available NP and K. The mean maximum temperatures during the hottest month (May)

Correspondence

Shweta

College of Agriculture, CCSHAU,
Hisar, Haryana, India

reached up to 45°C and mean minimum temperature during the coolest months (December and January) reached up to 0°C. The average annual rainfall is 300-400 mm, most of which is received during the period of June to September. The site received 21.15 mm rain fall during the wheat crop (From November to April, 2014-15).

The sowing of wheat variety HD-2967 was done on 7th November, 2014 with the seed rate of 100 kg/ha. Recommended dose of fertilizer apply, half of nitrogen and full dose of PK at the time of sowing and rest dose of nitrogen at the time of CRI stage apply.

The different growth and yield attributes of wheat viz: number of plants, number of tiller per plant, plant height (cm), thousand grain weights (gm), grain yield, straw yield and biological yield was estimated under poplar tree and open condition with the help of 1X1 M quadrat at various time interval and at harvest. Finally the harvest index (HI) was calculated to determine the fraction of economically useful products of a plant in relation to its total productivity (grain to straw ratio) and calculated using following formula:

$$HI = (EY/BY) \times 100$$

Where; HI = Harvest Index, EY = Economic Yield (grain yield),

BY = Biological Yield (grain + straw)

Results

Wheat growth and yield attributes: Different spacing of plantation showed significantly effect on initial plant germination and thereafter population (15 Days after sowing) of wheat (Table). Significantly higher plant population of wheat under control (without poplar), which was at par with 18X2X2 m spacing of poplar plantation (187.8 m⁻²). Minimum plant population (148.5 m⁻²) in 5X4 M spacing might be due to highest shade effect and less light penetration. Wheat height significantly affected by poplar spacing and significantly higher height was observed under control over to intercropping at different spacing of poplar at all growth stages, except at 120 DAS, which was at par to 18X2X2 m poplar spacing. Plant height increased by the age till 120 days, but rate of increasing in height more during 60 to 90 days in

all the treatments (Fig 1). There were 24.46, 50.45, 37.46 and 9.30 per cent reduction in wheat height after 30, 60, 90 and 120 DAS, respectively, as intercrop in poplar based agroforestry system over to open due to more competition for sun light and nutrient. At harvest number of tillers m⁻² followed the similar trend as plant population. The rate of reduction in number of tillers m⁻² 9.21 in 5X 4 m spacing and 5.33 per cent in paired row plantation of poplar i.e 18X2X2 m. There is non- significant effect on dry matter accumulation, but highest dry matter accumulation under control condition (1016.2 g/m²) and minimum 931.7 g/m² under 5X4 m poplar spacing, which was 8.32 per cent less than control and under paired row plantation of poplar i.e. 18X2X2m spacing 3.75 per cent less dry matter accumulation. Closer spacing have negative impact on intercrop growth, due to more competition for light, moisture and nutrients and tree species utilizes more resources for their growth and development. Perennial crop create more competition for all resource to annual crop because they utilizes more efficiently. Sharma *et al.*, 200 and Chauhan *et al.*, 2015 [2] also reported poplar reduces the wheat growth, under close spacing.

The yield attributing parameters under different spacing have non-significant differences. Higher No of ear head/m², No of grains/ear head and test weight were recorded under control conditions, while minimum of these under 5X4m plantation of poplar intercropping due to more shade effect.

Wheat grain and straw yield: The significantly higher wheat grain yield in open condition i.e. in control was recorded (4.33 t/ha) over to poplar intercropping. Under the plantation wheat yield significantly affected and paired row plantation (18X2X2 m spacing) provides significantly higher grain yield and to 5X4 m and 10X2m spacing. The grain yield of wheat under 5X4 and 10X 2M spacing was at par to each other. The reduction in yield up to 85.48 per cent under 5X2 m spacing and 60.14 per cent under paired row plantation. When we talk about straw yield, 13.18 per cent reduced under paired row and 66.38 per cent reduction under 5 X4m plantation. The poplar crop inter-plantation modified the microclimate by reducing the social radiation, lowering the air temperature and enhancing the humidity. Various poplar inter-plantations have great impact on plant morphology, yield and crop quality.

Table 1: Monthly temperature and precipitation during the crop growing season during 2014-15

Months	Average Temperature (°C)		Precipitation (mm)	RH		Sun shine Hours
	Maximum	Minimum		7 AM	2 PM	
November	26.73	8.67	0	93.23	37.8	7.93
December	21.5	7.1	0	94	52.35	7.9
January	18.22	5.92	0.4	97.22	69.06	3.84
February	21	7.7	0.5	95.15	66.05	3.13
March	27.2	12.6	11.75	88.58	52.18	7.63
April	32.1	15.3	8.5	83.3	39.6	9.5

Table 2: Effect of poplar spacing on wheat initial population and height at different stages

Treatments	Initial plant population/m ²	Plant height (cm)			
		30DAS	60 DAS	90 DAS	120 DAS
5X4	148.50	23.45	26.6	55.2	78.7
10X2	173.50	23.61	28.1	56.3	79.7
18x2x2	187.83	26.31	29.9	55.3	87.3
Control	194.50	30.33	57.5	88.9	90.3
CD at 5%	38.5	3.9	4.1	5.7	5.0

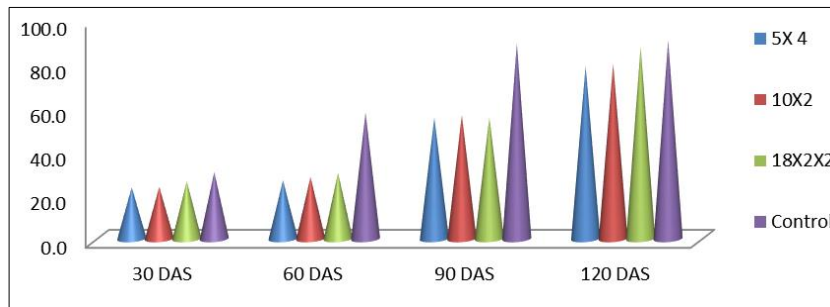


Fig 1: Effect of poplar spacing on wheat height at different stages

Table 3: Effect of different spacing of poplar on winter season yield and yield attributes during 2014-15

Treatments	At harvest Tillers/m ²	Dry weight (g)/m ²	No. of ear heads/m ²	No of grains/ear head	Test weight (g)	Grain Yield t/ha	Straw Yield t/ha	HI (%)
5X4	311.7	931.7	305.7	38.0	41.2	0.629	1.771	0.26
10X2	323.3	977.6	315.0	38.3	43.4	0.850	2.317	0.27
18x2x2	325.0	978.1	319.7	40.0	43.9	1.727	4.573	0.27
Control	343.3	1016.2	337.2	43.3	47.2	4.333	5.267	0.45
CD at 5%	29.3	NS	NS	NS	NS	0.751	1.03	-

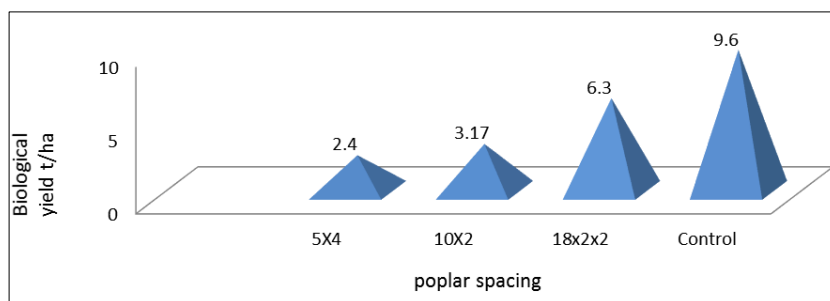


Fig 2: Biological yield of wheat affected by different poplar spacing

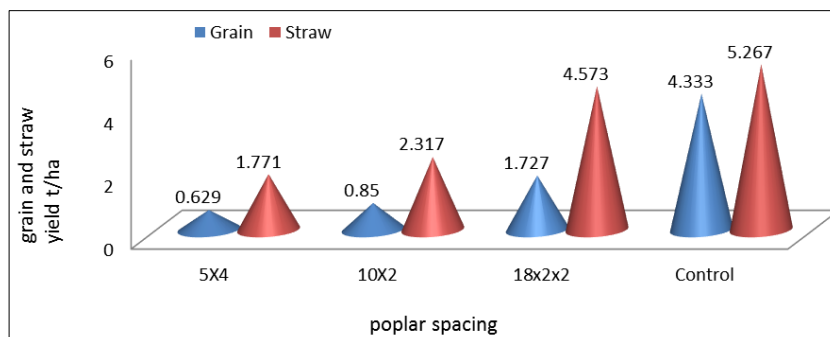


Fig 3: Wheat grain and straw yield under different poplar spacing

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