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Growth and yield of wheat (*Triticum aestivum*) under different tree spacings of *Dalbergia sissoo* based agrisilviculture

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ABSTRACT

A field experiment was conducted during the winter seasons of 1994-95 and 1995-96 to find out the response of five wheat (*Triticum aestivum* L.) varieties to two spacings of *Dalbergia sissoo* Roxb. in an agrisilviculture system. Both the tree canopies of 5 × 5 m spacing and 10 × 10 m spacings of *D. sissoo* had adverse effect on plant dry matter production, leaf area index, earheads/m and grains/earhead of intercropped wheat, resulting in 71 per cent decrease in wheat yield under 5 × 5 m spacing and 24 per cent under 10 × 10 m spacing as compared to control (without trees) field. Among the wheat varieties, WH 533 and WH 542 showed greater tolerance to shade and their yield did not differ significantly from control when intercropped with 10 × 10 m spacing of *D. sissoo*.

Key words: Shisham, Wheat varieties, Shade levels, Canopy, Agrisilviculture

Shisham (*D. sissoo* Roxb.) is an important timber and agroforestry tree species of north-west India. It is generally found growing naturally on the field bunds and as scattered tree in the field. Farmers protect this tree even at the cost of crop loss because it provides an income of Rs 5,000 to Rs 10,000 per tree after 15 to 20 years. Besides this, it also enriches the soil by fixing atmospheric nitrogen and through addition of leaf litter. No doubt, due to shade and moisture competition, it reduces the grain yield of rainy season crops but during winter season tree becomes dormant and sheds most of the leaves facilitating sufficient light penetration to the ground. Singh *et al.* (1994) have reported that shisham trees shed leaves between mid November to mid February facilitating sufficient light penetration to the ground. Therefore, winter season crops like wheat face little competition during the vegetative phase, however, growth of new leaves in March causes light competition during the reproductive phase of crops maturing in April-May. Research conducted in India has shown significant variation in the shade tolerance of wheat varieties (Singh *et al.*, 1993, and Gill, 1994). The present experiment was, therefore, planned to identify the wheat varieties being grown in Haryana and adjoining states under different spacings of shisham in an agrisilviculture system.

MATERIALS AND METHODS

Wheat varietal screening studies were conducted during 1994-95 and 1995-96 from November to April at the research farm, CCS Haryana Agricultural University, Hisar. The soil of the experimental fields was sandy loam in texture. The available nitrogen, phosphorus and potassium were 326, 6.8 and 233 in control, 384, 9.0 and 300 in 5 × 5 m spacing and 345, 7.7 and 286 kg/ha in 10 × 10 m spacing, respectively. Shisham plantation was raised in July, 1982 at 5 × 5 m spacing and in 1992 a portion of the plantation was thinned to 10 × 10 m to create an additional spacing. The mean girth at breast height, tree height and crown diameter was recorded during the period of experimentation as 70 cm, 14.1 m and 4.2 m at 5 × 5 m and 72 cm, 11.4 m and 4.7 m at 10 × 10 m spacing, respectively. Photosynthetically active radiation (PAR) reaching the crop surface under the canopy of shisham and control plot was measured at 90 days after sowing with the help of LI-1600 Steady State Photometer.

Five varieties of wheat viz. WH 147, S 308, WH 542, WH 533 (*aestivum* wheat) and WH 896 (*durum* wheat) were sown in two different environments i.e. agriculture and agrisilviculture on November 23 in 1994-95 and November 25 during 1995-96. A uniform seed rate of 125 kg/ha, row spacing of 22 cm and fertilizer dose of 120 kg N/ha and 60 kg P_2O_5/ha was used. The rains amounted to 104.7 mm during first year supplemented with three post-sowing irrigations; whereas, during 1995-96 a rainfall of 72.6 mm was received and thus four post sowing irrigations were applied.

RESULTS AND DISCUSSION

Effect of shade on growth

Due to genetic differences, wheat varieties showed significant variation in some

Table 1. Plant height and dry matter accumulation of wheat varieties under different shade levels in terms of tree spacings of *D. sissoo* (1994-96)

Treatment	Plant height (cm)				Dry matter/m (g)			
	Days after sowing				Days after sowing			
	30	60	90	120	30	60	90	120
Wheat variety								
S 308	6.7	39.2	78.5	104.4	2.21	15.45	178.51	204.86
WH 147	6.8	36.0	64.4	89.1	2.03	10.78	189.18	227.22
WH 896	6.2	27.3	47.8	89.8	1.94	9.85	165.01	196.04
WH 533	6.1	30.1	58.9	93.5	2.41	9.11	162.14	202.75
WH 542	5.5	30.4	57.5	89.9	2.05	10.32	171.03	211.75
CD (P = 0.05)	0.7	3.0	6.4	7.4	NS	2.75	NS	NS
Tree spacing								
Control	4.4	30.3	62.0	96.7	2.50	15.33	229.48	260.26
5 × 5 m	8.9	31.8	56.2	84.6	1.66	6.16	107.75	136.60
10 × 10 m	5.5	35.9	66.1	98.8	2.22	11.82	182.30	228.71
CD (P = 0.05)	0.5	2.3	5.0	5.7	0.36	2.13	20.20	16.99

growth parameters (Tables 1 and 2). S 308 recorded maximum plant height. WH 147 also attained more height than WH 542 at 30 DAS while WH 896, WH 533 and WH 542 at 60 and 90 DAS. Wheat varieties did not differ in dry matter production except at 60 DAS. S 308 recorded significant higher dry matter accumulation. Wheat varieties did not differ significantly in leaf area index but at later stages WH 896 and WH 533 showed significantly higher leaf area index. Durum wheat variety (WH 896) took significantly maximum number of days to maturity, whereas late sown wheat variety S 308 matured earliest.

Except increased plant height at 30 days after sowing (DAS) closer tree spacing (5 × 5 m) of shisham had adverse effect on all recorded characters throughout growth. In comparison to control, wider tree spacing of 10 × 10 m stimulated plant height but had harmful effect on dry matter production and leaf area index. Wheat intercropped in 5 × 5 m spacing took significantly more number of days to maturity than the wheat sown in the open and wider tree spacing of 10 × 10 m. Compared to control even partial shade (10 × 10 m) also delayed the maturity by about a week.

Effect of shade on yield and yield attributes

Due to higher number of earheads/m and number of grains/earhead wheat varieties WH 533 and WH 542 recorded significantly higher grain yield (Table 2). Thus minimum number of yield attributes resulted in lowest grain yield of late sown wheat variety, S 308. Poor plant growth resulted in reduced yield and yield attributes in variably spaced shisham than open field (control). Closer tree spacing of 5 × 5 m had maximum adverse effect on yield attributes resulting in 71% yield reduction over control. Such

Table 2. Effect of *D. sissoo* spacings on LAI, maturity, yield attributes and grain yield of wheat varieties (1994-96)

Treatment	Leaf area index (Days after sowing)				Days to maturity	Ear-heads/m	Gains/ear-head	Test weight (g)	Grain yield (q/ha)
	30	60	90	120					
Wheat variety									
S 308	0.16	0.75	3.43	4.11	128.3	62.5	32.1	43.2	24.8
WH 147	0.15	0.57	4.51	4.85	138.0	67.3	44.3	37.8	31.8
WH 896	0.14	0.55	6.16	6.24	150.0	86.6	38.4	34.5	31.1
WH 533	0.17	0.57	5.31	5.34	143.7	82.0	54.1	33.9	37.8
WH 542	0.15	0.60	5.15	5.80	145.7	84.5	51.9	33.0	36.2
CD (P = 0.05)	NS	NS	0.88	0.69	2.6	5.3	6.5	4.8	3.6
Tree spacing									
Control	0.18	0.88	6.08	6.37	135.6	93.1	48.1	40.8	47.3
5 × 5 m	0.12	0.31	3.34	3.92	147.4	56.0	38.3	30.3	13.7
10 × 10m	0.16	0.63	5.32	5.53	140.4	80.6	46.1	38.3	36.0
CD (P = 0.05)	0.01	0.12	0.68	0.53	2.0	4.1	5.1	3.7	2.8

Table 3. Interaction effect of tree spacings and wheat varieties on number of earheads/m and grain yield (q/ha)

Tree spacing	Wheat variety				
	S 308	WH 147	WH 896	WH 533	WH 542
	Number of earheads/m				
Control	77.3	84.5	100.7	99.9	103.2
5 × 5 m	44.5	48.2	68.8	53.2	65.3
10 × 10 m	65.7	69.3	90.4	92.8	84.9
CD (P = 0.05)			8.9		
	Grain yield (q/ha)				
Control	39.2	49.2	47.4	51.7	48.9
5 × 5 m	9.9	13.5	12.5	16.1	16.5
10 × 10 m	25.4	32.6	33.3	45.5	43.1
CD (P = 0.05)			6.4		

adverse effect on wheat yield in shisham based agrisilviculture system might be attributed mainly to reduced availability of PAR to wheat crop, because the rate of biomass production in many cereal crops has been found to be proportional to the intercepted radiation (Boscoe and Gallagher, 1977). In comparison to control the light availability (PAR) at 11 AM, 12 noon, 2 PM and 4 PM was reduced by 57, 72, 56 and 34%, respectively, in 5 × 5 m spacing and 21, 29, 12 and 13%, respectively in 10 × 10 m spaced shisham. Sheikh and Chima (1976) and Sheikh and Haq (1978) have also attributed poor growth of wheat under closely spaced shisham to decreased light availability.

The interaction effect between wheat varieties and shisham spacings on grain yield and number of earheads/m (Table 3) revealed that at closer tree spacing (5 × 5 m) different wheat varieties did not differ much in respect of grain yield except that S 308 produced significantly less grain yield than WH 533 and WH 542 varieties. At wider tree spacing of 10 × 10 m, WH 533 and WH 542 produced significantly higher grain yield than rest of the varieties on account of higher number of earheads/m. Although *durum* wheat variety (WH 896) had significantly higher number of earheads/m than S 308 and WH 147, it could not outyield them due to its poor test weight and grains/ earhead. The grain yield of WH 533 and WH 542 varieties at 10 × 10 m spacing did not differ significantly from control while other varieties gave significantly less grain yield than control. Singh *et al.* (1993) have also reported differential response of wheat varieties sown under poplar.

Based on these results it may be concluded that wheat varieties showed variable performance under agrisilviculture and only those varieties like WH 533 and WH 542 which showed greater tolerance to shade should be grown in agroforestry. Planting of shisham at wider spacing of 10 × 10 m has less harmful effect on intercropped wheat.

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