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Growth and yield of sunflower *(Helianthus annuus* L.*)* grown in association with nitrogen fixing trees

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ABSTRACT

An agri-silvicultural study was initiated during (1997-99) at the Regional Research Station, Bijapur, Karnataka, under semiarid conditions. The trial consisted of 9 year old two nitrogen fixing trees viz., *Faidherbia albida* and *Hardwickia binata,* planted at 7.2 and 12.6 m row spacing and 3 distances viz., 1, 2 and 3 m away from nitrogen fixing trees and the arable crop sunflower (*Helianthus annuus* L.) was introduced in the interspace of nitrogen fixing trees at 60 cm x 30 cm spacing.

Key words : Sunflower, Nitrogen-fixing trees, Row spacing, distances, Growth and yield attributes

Agri-silviculture is one of the important system of agroforestry. The tree crop interaction influences agricultural production to varying degrees, depending on species and cropping system. In agroforestry system woody plants, particularly nitrogen-fixing trees or shrubs are increasingly integrated into tropical farming system to sustain crop production. In this context present investigation was planned to assess the effect of association of nitrogen fixing trees on growth and yield of sunflower under semiarid conditions.

MATERIALS AND METHODS

A field experiment was carried out during 1997-98 and 1998-99 at Regional Research Station, Bijapur on Verticals. The sunflower was grown between the nitrogen-fixing trees (NFTs), viz., *Faidherbia albida* and *Hardwickia binata,* planted at 7.2 and 12.6 m row spacing during 1988. The land was ploughed and harrowed twice after pre-monsoon rains and smoothened to obtain a fine seed bed to initiate the experiment during both the years. The experiment was laid out in split-split plot design with NFTs as main plots, row spacing as sub-plots and distances as sub-sub plots (Table 1). The experiment was replicated 3 times. The recommended dose of N, P_2O_5 and K_2O (50, 50 and 25 kg/ha) was applied in small furrows opened manually and mixed well. Sunflower seeds were hand dibbled at 90 cm away from the tree line by giving a spacing of 60 cm x 30 cm. Thinning of sunflower was carried out 15 days to maintain optimum plant population. The total rainfall of 470 mm and 1,051 mm was received in 35 and 53 rainy days during 1997-98 and 1998-99 respectively. The amount of rainfall received during crop-growth period of sunflower was 296 mm and 263 mm in 19 and 12 rainy days during 1997-98 and 1998-99 respectively. Plots were kept weed free by 2 intercultivations and 2 hand-weddings. The plant-protection measures were taken as per the recommended package of practices. Observations were recorded on growth and yield components of sunflower at different distances from the tree line (1,2 and 3 m away) and grain yield was expressed in kg/ha.

RESULTS AND DISCUSSION

Effect of tree species on sunflower

Grain yield was significantly higher in association with *F. albida* compared with *H. binata.* The increase in grain yield with *F. albida* was 28.8 % over *H. binata,* owing to significantly higher grain weight / plant and 1,000-grain weight (34.8 g) compared with *H. binata.* The grain weight/plant and 1,000-grain weight were higher in association with *F. albida* by 24.8 and 9.4% respectively over *H. binata* (Table 1). The yield and yield-attributing characters increased owing to increased dry-matter accumulation through increased plant height (Table 1). At 90 days, plant height and dry matter were higher with *F. albida* by 10.7 and 77.9%, respectively over *H. binata* (Table 1). This increased crop growth was accelerated by the lower shade effect and higher interception of incidental solar radiation (ISR) of *F. albida,* as it shed leaves during cropping season and had bare twigs which created favourable microclimate for the crop. *F. albida* and *H. binata* recorded 17.9 and 16.8 % actual soil moisture at 0-45 cm soil depth. The soil moisture was higher nearer (1 m) to the tree line by 13.4, 13.5 and 13.8% at 0-15, 15-30 and 30-45 cm depth respectively.

The infiltration rate of soil under NFTs increased (11.9 cm/ha) significantly compared with the control treatment . Among the 2 NFTs, *F. albida* enhanced the rate of infiltration more than *H. binata.* The closer row spacing of NFTs favoured the rate of infiltration compared to wider row spacing. The NFTs enhanced the rate of infiltration from 2.4 to 11.9 cm/hr. The reasons are good soil structure and high organic matter content. Bheemaiah (1995) reported that pH and electrical conductivity under 5-year old *F. albida* plantations showed a declining trend. This indicates that alkalinity and salinity can be reduced substantially by growing *F. albida* making the soil more favourable for the growth of associated crops. In a similar way. *F. albida* plantations enhanced the organic carbon content from 0.26 to 0.56 % and available N from 175 to 369 kg/ha.

Poschen (1986) observed that water availability was greater under *F. albida* during anthesis and grain filling because of improvement in soil water-holding capacity, reduced evapo-transpiration and other related factors. Farmers have accepted the *A. ferruginea* (NFT) tree as one of the agroforestry trees in view of positive inte-

Table 1. Growth and yield components of sunflower as influenced by nitrogen-fixing trees, row spacing and distance

Treatment	Grain weight (g/plant)			1,000-grain weight (g)			Grain yield (kg/ha)			Plant hight (cm) 90 DAS	TDMA (g/plant) 90 DAS	ISR (%) 90 DAS
	1997–98	1998–99	Pooled	1997–98	1998–99	Pooled	1997–98	1998–99	Pooled			
Tree species												
T_1	12.3	0.3	11.3	39.2	30.4	34.8	838.6	754.4	796.5	99.8	18.7	94.1
T_2	10.0	8.0	9.0	33.5	30.2	31.8	654.2	582.4	618.3	90.2	10.5	83.1
LSD (P=0.05)	0.7	0.7	0.3	2.4	NS	1.1	40.6	43.5	7.1	7.2	0.5	1.3
Row Spacing												
R_1	10.9	9.0	9.9	36.2	30.7	34.4	729.5	654.4	691.9	91.3	12.6	87.0
R_2	11.4	9.3	10.4	36.5	29.7	32.2	763.3	682.4	722.9	98.6	16.6	88.4
LSD (P=0.05)	NS	NS	0.7	NS	NS	1.4	NS	NS	NS	2.8	0.9	0.7
Distance												
D_1	11.6a*	9.7a	10.6a	36.4a	30.7a	32.5ab	745.1a	663.7a	704.4a	92.2ab	14.8a	87.2b
D_2	10.9a	9.0a	10.0a	35.1a	30.0a	33.1a	756.4a	676.1a	716.2a	95.0a	15.2a	88.7ab
D_3	10.8a	9.8a	9.9ab	37.5a	29.9a	34.4a	737.7a	665.4a	701.5a	97.5a	13.8ab	89.9a
LSD (P=0.05)	NS	NS	0.7	NS	NS	1.7	NS	NS	NS	3.4	1.1	0.8
Treatment combination												
$T_1R_1D_1$	14.3a	12.3a	13.3a	41.4ab	37.2a	39.3a	884.6a	802.6a	843.6a	99.8de	16.5c	93.0b
$T_1R_1D_2$	12.3a-c	10.4a-c	11.4a-c	37.6a-c	33.5b	35.5a-c	869.6a	787.6a	828.6a	101.5a-d	16.4c	94.3b
$T_1R_1D_3$	11.4b-d	9.4b-d	10.4b-e	42.0a	33.5b	37.7ab	787.0a	705.0a-c	746.0ab	94.8b-c	14.9cd	95.6b
$T_1R_2D_1$	12.5ab	10.8ab	11.6ab	40.5a-c	16.0e	28.2d	873.0ab	791.6a	832.3a	100.8a-d	25.8a	92.8b
$T_1R_2D_2$	11.7bc	9.7b-d	10.7b-d	36.5a-d	31.1bc	33.8a-d	807.6ab	726.3ab	767.0ab	102.3a-d	21.9b	94.8b
$T_1R_2D_3$	1.3b-d	9.3b-e	10.3b-e	37.4a-c	31.5bc	34.4a-c	810.0a-b	713.3a-c	761.6ab	103.8ab	16.9c	94.5b
$T_2R_1D_1$	8.9e	7.0e	8.1e	29.1e	31.5bc	30.3cd	576.0eb	494.0e	535.0d	76.6f	7.6f	81.6d
$T_2R_1D_2$	9.2de	7.4d-e	8.3e	30.3d-e	31.1bc	30.7cd	627.0d	546.0de	586.5cd	88.8e	9.6ef	83.3cd
$T_2R_1D_3$	9.3de	7.4d-e	8.4de	36.8a-d	29.5cd	33.2b-d	632.6c-d	591.3c-e	612.0cd	88.0e	10.7ef	85.0c
$T_2R_2D_1$	10.7b-e	8.5b-e	9.6b-e	34.6b-e	30.0bc	32.3b-d	647.0cd	566.6de	606.8cd	88.8e	9.3ef	81.3d
$T_2R_2D_2$	10.6b-e	8.6b-e	9.6b-3	36.2a-d	29.0cd	32.6b-d	721.3cd	644.6b-d	683.0bc	92.5c-e	12.8de	82.6cd
$T_2R_2D_3$	11.4b-d	9.3b-d	10.4b-e	34.1c-e	30.2bc	32.1b-d	721.3b-c	652.0b-d	686.6bc	103.5a-c	12.7de	84.6c
Control	10.1c-e	8.2c-e	9.1c-e	30.3d-e	26.1d	28.2d	645.0d	580.0de	612.5cd	109.5a	10.5ef	100.0a
LSD (P=0.05)	1.9	1.9	2.0	6.1	3.3	4.9	103.6	111.0	110.1	9.8	3.1	2.5

T_1, *F. albida*; T_2, *H. binata*; R_1, 7.2 m; R_2, 12.6 m; D, distances from treeline (1–3 m)
*Mean followed by same letters do not differ significantly

ractions with all field crops (Nadagoudar, 1990).

Effect of row spacing of NFTs on sunflower

Row spacing did not cause significant variation on grain yield (Table 1), but numerically higher grain yield was noticed with wider row spacing of 12.6 m. The 1,000-grain weight was significantly higher in closer row spacing of 7.2 m, while grain weight/plant did not vary significantly. The growth parameters were significantly superior at wider row spacing (12.6 m) compared with closer row spacing of 7.2 m (Table 1).

Ramshe *et al.* (1994) observed reduction in grain yield of sunflower, pigeonpea and pearlmillet crops in association with nitrogen-fixing tree under close row width of 5.0 m than under wider row width of 10.0 m.

Effect of distance from NFTs on sunflower

The grain yield/ha did not differ significantly due to various distances from the NFT (Table 1). The grain weight/plant and 1,000-grain weight were significantly higher at 2 m distance (Table 1). The total dry-matter accumulation/plant differed significantly and was higher at 2 m away than 1 m away (Table 1). The reasons for decreased yield nearer to the tree line was due to reduced light penetration with one of the nitrogen-fixing trees, viz. *H. binata,* which recorded significantly lower incidental solar radiation. Mutanal (1999) noticed significant decrease in pod and haulm yields of groundnut at close distance from teak alley in an agroforesty system.

Interaction effect between NFTs, row spacing and distance on sunflower

The treatment combination effect between NFT, row spacing and distance was significant. Significantly higher seed yield was noticed in association with *F. albida* in 7.2 m row spacing at 1 m away distance from NFT (843.6 kg/ha). The increased seed yield at 1 m away from *F. albida* was due to increased 1,000-seed weight and seed weight/plant (Table 1). The yield components in turn depend on growth attributes. Sunflower in association with *F. albida* recorded significantly higher plant height and total dry-matter accumulation nearer the tree line at different stages of crop growth (Table 1). The reason was higher availability of natural resources. The seed yield, yield components and growth parameters were significantly lower nearer the *H. binata* tree line in closer row spacing of 7.2 m. The decreased seed yield nearer to *H. binata* was due to lower light interception (Table 1). The seed yield in association with *F. albida* in either of the row spacings at any distance and with *H. binata* in wider row spacings at 2 and 3 m away noticed higher yield compared to open area (no tree species). The results are in accordance with the findings of Munna Ram *et al.* (1997).

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