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Growth, Yield and Economics of Finger Millet (*Eleusine coracana*) in *Melia dubia* based Agro Forestry System

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A B S T R A C T

Field experiment was conducted during *Kharif* from 2010 to 2015 at GKVK, Bangalore to know the feasibility of cultivation of fingermillet in *Melia dubia*. There were six treatment combinations comprising intercrop of finger millet planted in different spacings with *Melia dubia* and finger millet alone as control. Results revealed that, sole finger millet recorded significantly higher grain (26.1 q ha^{-1}) and straw yield (5865 kg ha^{-1}), which was attributed to higher growth and yield attributes like number of productive tillers (6.17 $hill^{-1}$) and 1000 seed weight (3.69 g). Finger millet in association with *Melia dubia* planted at 24 m X 5 m spacing recorded higher grain (13.9 q ha^{-1}) and straw yield (21.40 q ha^{-1}) at five years after Melia planting. Whereas, significantly lower grain and straw yield recorded under tree spacing of 8 m X 5 m (5.10 and 8.47 q ha^{-1}, respectively). Among different tree spacing maximum wood volume of *Melia dubia* was observed in 8 m X 5 m (103.14 m^3 ha^{-1}) spacing. The tree planted at 8 m X 5 m apart in *Melia dubia* based agroforestry system, fingermillet in association with *Melia dubia* recorded higher net returns (Rs. 4,44,169) and B: C ratio (18.64).

Introduction

Agroforestry is a cultivation of woody perennials with arable crops. It is an alternate land use system (Baumer, 1991) to meet the demand of food and fuel for ever growing population. In agroforestry system, silvipastoral system appears to be the most appropriate technology for cultivated soils (Kaushik and Kumar, 2003). In this system forage and firewood yield from the alley components serves as an insurance against total crops failure due to aberrant weather and other conditions. The increased productivity of crop under the tree canopy was believed to be due to improved soil fertility (Young, 1989) and ameliorative influences of shade in a hot dry environment reducing temperature and evaporation (Bunderson *et al.*, 1990). Thus, in dry areas of Indian arid region, introduced trees can reduce the soil and plant water loss by reducing the under storey temperature and evapotranspiration. Agroforestry systems have number of beneficial effect for constitute sustainable land use pattern and some of these are evidence in the world (Nair, 1987 and Young, 1989). Many countries through agroforestry

practices minimize the land degradation as well as increased the production also (Swaminathan, 1987). When the trees are allowed to grow on the arable lands, tree interact with crops either in positive or in negative ways for basic growth resources like light, water and nutrients (Gill, 2000, Gill and Burman, 2002). The negative effects varied with distance from tree, direction in which crops are grown (Burman *et al.*, 2009), age and type of tree species, cropping season and crop species.

Melia dubia a multipurpose perennial tree is an indigenous to north-west India along the sub-Himalayan tract, but now is naturalized throughout the tropics where it is cultivated in the arid and semi-arid and also in the semi-moist areas (Luna, 2005). It is a moderate-sized deciduous tree with a straight cylindrical bole. The bark is dark grey and flowers are lilac or pink colored. Medicinally the tree is used for leprosy, anthelmintic, diuretic, rheumatism and seed oil as antiseptic for sores and ulcers, skin diseases and malaria fever (Ramya *et al.*, 2009). It is gaining importance under semi-arid regions in recent times in order to sustain production and income of the existing system.

In rain fed ecosystem agriculture mostly depends on rainfall, where in finger millet crop being occupied pride place, grown as a rainfed crop due to its resilience and ability to adjust to diverse agro ecological conditions (Sitharam, 1997). In southern districts of Karnataka, finger millet is the major staple food crop, and stands first both in area and production with an average productivity of 1336 kg ha^{-1}. Poor soil fertility and low moisture content are the major factors limiting crop production in arid and semi-arid region. Hence, efforts were made to assess its performance and productivity of finger millet in agroforestry system under rainfed ecosystem.

Materials and Methods

The experiment was conducted from *kharif* 2010 to 2015 at Agroforestry block, AICRP on Agroforestry, Zonal Agricultural Research Station, GKVK, Bangalore with an objective to find out optimum spacing for higher productivity and growth performance of *Melia dubia* under agroforestry system and its influence on intercrop of fingermillet. There were six treatment combination comprising planting of *Melia dubia* in different spacings *viz*., $T_{1:}$ 8 m X 5 m, T_2: 10 m X 5 m, $T_{3:}$ 12 m X 5 m, $T_{4:}$ 16 m X 5 m, $T_{5:}$ 20 m X 5 m, $T_{6:}$ 24 m X 5 m and finger millet as a sole crop (control). Finger millet crop was grown as intercrop under 94 *Melia dubia* trees in the experimental site. The treatments were replicated thrice with Randomized Complete Block Design (RCBD). The soil was red sandy clay loam with acidic pH (6.01 to 6.52), medium in organic carbon (0.6%), available nitrogen (320 kg ha^{-1}), phosphorus (39 P_2O_5 kg ha^{-1}) and potassium (241 K_2O kg ha^{-1}). The average rainfall was 930 mm received in 55 rainy days. During the cropping season (July-November), an average of 569.33 mm rainfall was received, out of which, an average of 473.5 mm was received from sowing to maturity of associate crop finger millet. Finger millet cv. MR-6 sowing was taken during *kharif* season and harvested at 120 days after sowing. Finger millet was raised as per the recommended package of practices. The growth and yield attributes were recorded by following standard procedures. The results of experiments were subjected to contrast statistical analysis.

Results and Discussion

In *Melia dubia* based agroforestry system, growth of Melia at seventh year of planting as influenced by different planting density is presented in Table 1. The results revealed that, planting of Melia at the spacing of 24 m

X 5 m recorded significantly higher tree height, bole height, girth at breast height (GBH), collar diameter and canopy spread (12.47 m, 7.38 m, 116.30 cm, 108.98 cm and 7.71 to 7.84 m, respectively) and least growth parameters was observed in tree spacing of 8 m X 5 m (11.13 m, 6.44 m, 77.40 cm, 91.28 cm and 6.26 to 6.54 m, respectively). But significantly higher wood volume was recorded at spacing of 8 m X 5 m (103.14 m^3 ha^{-1}) which was mainly due to better competition for above and below ground resources such as sunlight and soil nutrients (Young, 1989). Significantly lower wood volume of 70.13 m^3 ha^{-1} was observed with spacing of 24 m X 5 m. The reduced growth parameters and increased wood volume in *Melia dubia* spacing of 8 m X 5 m was mainly accompanied due to better translocation of photosynthates to cambium region (Vikrant *et al.*, 2009).

The data on number of tillers, 1000 seed weight and yield production including grain and straw of fingermillet was recorded at the time of harvesting. The results revealed that, the number of tillers of finger millet intercropped with *M. dubia* was comparatively less over sole finger millet crop. Pooled data showed that, significantly higher grain and straw yield under sole finger millet cropping (Table 2 & 3) *viz.*, number of tillers, 1000 seed weight, grain and yield straw (6.17, 3.69 g, 26.1 q ha^{-1} and 5865 q ha^{-1}, respectively) and significantly lower was observed under tree planting at the spacing of 8 m X 5 m (1.65, 2.06 g, 5.10 q ha^{-1} and 8.47 q ha^{-1}, respectively) which was attributed mainly due to competition for light and moisture (Burman *et al.*, 2009 and Anusha *et al.*, 2015) in sole crop as compared to intercrops in association with different tree spacing's.

Among different tree spacing maximum yield reduction was noticed in spacing of 8 m X 5 m (80.46 per cent) followed by 10 m X 5 m (78.67 per cent) and comparatively least yield reduction was observed in 24 m X 5 m (46.74 per cent). The main reason for higher yield reduction in wider spacing over narrow spacing is more weed density and competition for both above and below ground resources between tree, crop and weeds (Anusha *et al.*, 2015). The economic viability is the better index of assessing the acceptability of any technology by the farmers. The net returns (Rs. 287395 ha^{-1}) and B:C ratio (2.14) from sole finger millet was lower as compared to finger millet in association with *Melia dubia* at different spacing (Table 4).

Table.1 Growth parameters of *Melia dubia* at seventh year of planting as influenced by different row spacing

Treatments	Tree height (m)	Bole height (m)	GBH (cm)	Collar diameter (cm)	Canopy spread (m)		Wood volume m^3 ha^{-1}
					N-S	E-W	
8 m x 5 m	11.13	6.44	77.40	91.28	6.54	6.26	103.14
10 m x 5 m	11.45	6.70	85.00	92.74	6.86	6.51	97.43
12 m x 5 m	11.67	6.86	97.18	97.34	7.02	6.88	95.25
16 m x 5 m	11.85	7.00	98.16	101.85	7.40	7.22	89.64
20 m x 5 m	12.32	7.26	108.60	105.96	7.68	7.49	76.34
24 m x 5 m	12.47	7.38	116.30	108.98	7.84	7.71	70.13
S.Em±	**0.31**	**0.22**	**6.58**	**3.94**	**2.32**	**2.18**	**6.01**
CD (P=0.05)	**11.13**	**6.44**	**77.40**	**91.28**	**6.54**	**6.26**	**18.93**

Table.2 Plant height, number of tillers and 1000 seed weight of finger millet as influenced by *Melia dubia* row spacing under agroforestry system. (Pooled data)

Treatments	Plant height (cm)	No. of Tillers hill^{-1}	1000 seed weight (g)
8 m x 5 m	123.30	1.65	2.06
10 m x 5 m	119.54	1.94	2.10
12 m x 5 m	104.36	2.00	2.14
16 m x 5 m	96.05	2.10	2.15
20 m x 5 m	90.18	2.45	2.17
24 m x 5 m	89.61	2.67	2.18
Pure crop	126.63	6.17	3.69
S.Em±	**3.79**	**3.13**	**0.12**
CD (P=0.05)	**10.48**	**9.39**	**0.36**

Table.3 Grain and straw yield of finger millet as influenced by *Melia dubia* row spacing under agroforestry system (2012 to 2015)

Treatments	1000 seed weight (g)	Yield (q ha^{-1})							
		2012		2013		2014		2015	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
8 m x 5 m	2.06	15.89	18.97	14.58	16.97	5.08	8.52	5.10	8.47
10 m x 5 m	2.10	16.83	19.83	15.92	17.29	8.27	11.05	5.57	9.69
12 m x 5 m	2.14	18.64	22.45	19.27	21.76	12.18	14.59	8.83	11.32
16 m x 5 m	2.15	19.67	22.98	20.65	22.61	13.38	18.44	10.00	15.00
20 m x 5 m	2.17	20.54	23.69	23.88	25.73	12.74	20.30	10.50	18.50
24 m x 5 m	2.18	21.26	24.52	25.27	27.52	16.88	24.53	13.90	21.40
Pure crop	3.69	21.50	25.63	29.42	31.24	28.30	56.97	26.1	5865
SEm±	**0.12**	**0.25**	**0.16**	**0.21**	**0.36**	**10.97**	**6.19**	**0.65**	**1.02**
CD (P=0.05)	**0.36**	**0.57**	**0.68**	**0.41**	**0.94**	**1.40**	**1.12**	**1.95**	**3.06**

Table.4 Economics and water productivity of finger millet as influenced by *Melia dubia* spacing under Agroforestry system (Pooled)

Spacing (M)	Production Cost (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C Ratio	Water productivity (kg ha^{-1} mm)
8 m x5 m	25180	469349	444169	18.64	639
10 m x5 m	25223	436378	411155	17.30	594
12 m x5 m	25523	455579	430056	17.85	620
16 m x5 m	25631	387833	362202	15.13	528
20 m x5 m	25677	349805	324128	13.62	476
24 m x5 m	25989	313384	287395	12.06	426
Pure crop	27111	58200	31089	2.14	8.29

Higher net returns of Rs. 4,44,169 and B:C ratio of 18.64 was noticed in *Melia* spaced at 8 m X 5 m followed by tree spacing of 12 m X 5 m (Rs. 4,30,056 and 17.85, Net returns and B:C ratio, respectively) and lower economic return of Rs. 2,87,395 and B:C ratio of 12.06 recorded under 24 m X 5 m spacing. The higher net returns and B: C ratio of finger millet in association with *Melia dubia* under spacing of 8 m X 5 m was attributed to higher accumulation of wood volume (Anusha *et al.*, 2015). Higher water productivity was noticed under *Melia dubia* spacing of 8 m x 5 m (639 kg ha^{-1} mm) and lower was in sole finger millet crop (8.29 kg ha^{-1} mm) as these trees are fast growing and economic yield in terms of wood volume.

In conclusion, the growth performance of finger millet was better under sole crop than intercropped with *Melia dubia* at different spacing. All parameters studied were recorded comparatively higher under control except economic outlay. However, it reduced in intercropped, which might be due to competition for nutrients, light, space, etc. The study revealed that production of finger millet was affected with inter cropping after fourth year. *Melia dubia* planted at the spacing of 8 m X 5 m yields higher wood volume and economic return due to higher wood volume. This can be practiced in larger scale for better monetary generation.

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