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Fodder production in a Hortipastoral system in rainfed alfisol of Southern India

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Abstract : A hortipastoral experiment was conduced for six years, from 1993 to 1998 with an objective to evaluate the performance of three fodder crops as an understorey in four fruit trees viz., Guava (*Psidium gujava*), Jack (*Artocarpus heterophyllus*), Mango (*Mangifera indica*) and Sapota (*Achrus sapota*) at the National Pulses Research Centre, Vamban, Tamil Nadu. It is observed that when fodder crops are intercropped with fruit trees, the fodder yield was reduced over years from a mean maximum of 7.47 t ha^{-1} in the first year to 5.66 t ha^{-1} in sixth year and the growth of trees showed a differential response. Among the combinations, mango+maize and guava+maize are the best for higher fodder production without reduction in gorwth of fruit trees and also establishing hortipastoral system under rainfed condition in alfisol of southern India.
(Key Words : Fodder production - Hortipastoral system - Understorey - Fruit trees)

The broad objective of agroforestry research is to benefit from ecological and economic interactions that may exist when woody perennials and cereals are grown in close spatial arrangements (Connor, 1991) and the practice of agroforestry is of immense importance to India as it is aiming at increasing food, fodder, fuel and timber production to meet the demands of ever increasing human and livestock population. The hortipastoral system, a sub system of Agroforestry, aims at intergrating livestock and pasture with fruit trees on the same land management unit. This also includes, few works viz., cut and carry fodder production (Nair, 1993). Studies on intercropping have focused attentions on the effect of woody perennials (forest trees, fruit trees, shrubs) on arable crops (grain, fodder, vegetables) in an agroforestry system (Suresh and Vinayarai, 1991; Swaminathan, 1996; Vinayarai *et.al.*, 1990). To evaluate the performance of fodder crops as understorey in fruit fees and to screen the compatible fodder crop for intercropping in rainfed alfisol, the present study was taken up for six years and the results are presented in this paper.

Materials and Methods

The experiment was conducted at the National Pulses Research Centre, Vamban, Tamil Nadu, with a view to determine the fodder crops that are compatible with fruit trees like guava, jack, mango and sapota. This centre is situated at 8°30' latitude N, 78° 24'E longitute and at 120 m.sl. and received an annual (average of 25 years) rainfall of 930 mm in 34 rainy days. The soil type is alfisoil with a pH of 6.0 and available input status of 192.5 kg ha^{-1} of N, 14.1kg ha^{-1} of P_2O_5 and 151 kg ha^{1} of K_2O.

Fruit trees:

a) Mango : *Mangifera indica*
b) Sapota : *Achrus sapota*
c) Guava : *Psidium gujava*
d) Jack : *Artocarpus heterophyllus*

Fodder crops:

a) Sorghum : *Sorghum vulgare* (Pers.) Nas.
b) Maize : *Zea mays.* African tall
c) Stylo : *Stylosanthes hamata*

The grafts of fruit trees (40 cm tall) were planted during North East Monsoon in 1992 at an espacement of 8 X 8m and the interspaces were grown fodder crops at a spacing of 30 X 30 cm every year during the months of October - December (rainy season). The experiment was set up in a split plot design with three replications. The data recorded on the tree growth attributes viz., height, girth and fodder yield were subjected to ANOVA (Panse and Sukhatme, 1967) for their statistical significance.

Results and Discussion

Growth attributes of fruit trees

The data recorded on height of the tree (m) and basal girth (cm) of furit trees are presented in Table 1.

The growth of fruit trees was uniform throughout the study period and showed a linear growth when plotted in a graph. Among the fruit trees, guava had a maximum mean height of 3.72m, which was significantly superior than other fruit trees followed by mango (3.07m) at the end of 6th year. The fast growing nature of guava was spotted during the first year itself as it had the maximum mean height of 1.46m. Ther radial growth (girth) of trees exhibited a trend as that of height and a maximum mean girth of 10.45 cm was observed in guava after six years of study. Sapota had the minimum height and girth throughout the study period. The fodder crops raised in the interspaces of trees influenced the growth of fruit trees. Growing of maize as fodder intercrop had a positive influence on height of trees of all fruit trees. However, the radial growth was influenced by sorghum in all the fruit trees barring sapota. Intercropping of stylo had resulted in poor growth of fruit trees. The relative height growth rate of various combinations are showed in Table 3. A maximum relative growth rate of 0.164 was observed in guava intercropped with sorghum or maize. The relative growth rates of all the fruit trees were higher when they were intercropped with maize.

Fodder productivity

A comparison of fodder yield of sorghum, maize and stylo, grown as understorey, recorded that stylosanthes and maize could do better compared to sorghum. The data presented in table 2 indicate a slow and steady decline in fodder productivity from first year through sixth year. This is in conformity with the reports of Meghuembe and Red Head (1982). A maximum mean fodder yield of 8.73 t ha^{-1} was recorded in sapota grown plots followed by jack (8.02 t ha^{-1}). This pattern continued and at sixth year these combinations registered a fodder yield of 6.84 t ha^{-1} and 6.08 t ha^{-1} respectively. The lowest yield throughout the study was observed in guava grown plots. Amongh the fruit trees the relative fodder productivity was in the order of sapota > jack > mango > guava and the relative performance of the fodder crops was stylo > maize > sorghum in that order and a maximum fodder yield of 11.18 t ha^{-1} was registered in stylo during the first year and 7.94 t ha^{-1} in the sixth year. A comparsion of mean fodder productivity under fruit trees during first year and sixth year revealed a highest yield penalty (27.8%) in mango combination followed by Jack (24.2%), guava (23.5%) and sapota (21.6%). This yield penalty is the indicator of growth suffered by fodder crops when grown in association with fruit trees. The yield of fodder crops and canopy of trees showed a negative trend.

A critical look into the results on growth attributes of trees and fodder productivity of crops, when combined, brought to limelight, higher the growth increment in trees: lower fodder yield and higher the fodder yield: lower the growth increment in trees. This clearly demonstrates that there exists an equilibrium in the growth of two different biological components, say arboreal and arable in this study, while there were a close association. This besides, the competitive nature of crop species grown in association with other species is evident from the results of this study. Guava and mango got relatively higher values of growth attributes but sapota and jack had minimum. On contrary, higher fodder productivity was observed in sapota and jack while guava and mango had lower fodder productivity. Kermani (1980) and Gill et. al. (1982) reported that the yield of crops grown in the interspaces of tree rows was increased. The present study has also revealed the compatibility of fodder crops with fruit trees.

Such compatibility of arable crops with arboreals has already been reported for other dryland crops. Millets with *Prosopis cineraria* in the arid regimes of India (Mann and Saxena, 1980), groundnut and soybean with teak and *Dalbergia sisoo* (Mishra and Prasad, 1980) and sword bean with *Eucalyptus tereticornis* (Swaminathan, et al. 1999). From the study it is conaluded that maize is highly compatible with all the fruit trees and combinations of mango + maize and guava + maize may be grown in the rainfed alfisols of southern India.

Table 1. Growth attributes of fruit trees

Treatments	Height (m)						Girth (cm)					
	1993	1994	1995	1996	1997	1998	1993	1994	1995	1996	1997	1998
Mango + Sorghum	1.17	1.55	1.96	2.36	2.57	3.04	1.75	3.14	4.16	5.58	7.10	8.20
Mango + Maize	1.21	1.60	2.11	2.31	2.71	3.09	1.79	3.19	4.63	5.20	6.69	8.06
Mango + Stylo	1.16	1.55	1.52	2.18	2.81	3.08	1.69	3.04	4.09	5.55	6.83	8.19
Mean	1.16	1.56	1.86	2.28	2.70	3.07	1.74	3.12	4.29	5.44	9.87	8.15
Sapota + Sorghum	0.83	1.16	1.48	2.13	2.37	2.68	1.26	2.58	4.18	5.92	6.07	6.24
Sapota + Maize	086	1.19	1.54	2.23	2.38	2.82	1.29	2.59	4.28	5.81	6.43	6.84
Stylo	0.82	1.16	1.28	2.15	2.30	2.64	1.13	2.48	4.34	5.82	6.24	6.42
Mean	0.83	1.17	1.43	2.17	2.35	2.71	1.22	2.55	4.26	5.85	6.24	6.50
Jack + Sorghum	1.08	1.38	1.73	1.90	2.26	3.04	1.39	2.95	3.09	4.54	7.15	8.69
Jack + Maize	1.10	1.42	1.81	2.01	2.42	3.19	1.48	3.02	3.19	4.38	7.83	8.52
Jack + Stylo	1.09	1.34	1.65	1.89	2.17	2.64	1.29	2.87	2.91	4.42	7.42	8.48
Mean	1.09	1.38	1.73	1.93	2.28	2.95	1.39	2.94	3.06	4.45	7.47	8.56
LSD (P=0.05)												
Trees	0.49	0.58	1.02	0.81	0.76	0.85	0.46	0.63	1.32	1.50	1.42	1.79
Crops	0.61	0.67	1.10	0.92	0.91	0.96	0.29	0.36	0.80	0.86	1.08	1.28

Table 2. Fodder Productivity under fruit trees (t ha^{-1})

Intercrops	1993	1994	1995	1996	1997	1998
Mango + Sorghum	5.73	5.61	5.42	5.19	5.08	4.80
Mango + Maize	6.51	6.43	6.20	6.18	5.80	5.20
Mango + Stylo	8.92	8.89	8.80	8.70	8.50	5.27
Mean	7.05	6.97	6.80	6.69	6.46	5.09
Sapota + Sorghum	6.91	6.81	6.78	6.50	6.28	5.74
Sapota + Maize	8.12	8.09	7.90	7.86	7.65	6.84
Sapota + Stylo	11.18	11.0	10.9	10.80	10.60	7.94
Mean	8.73	8.63	8.52	8.38	8.17	6.84
Guava + Sorghum	4.87	4.84	4.60	4.38	4.20	3.76
Guava + Maize	5.47	5.34	5.20	5.00	4.51	4.19
Guava + Stylo	7.89	7.80	7.70	7.58	7.46	5.98
Mean	6.07	5.99	5.83	5.65	5.39	4.64
Jack + Sorghum	6.72	6.53	6.48	6.21	5.94	5.26
Jack + Maize	7.40	7.31	7.20	6.91	6.72	6.15
Jack + Stylo	9.94	9.80	9.70	9.69	9.39	6.85
Mean	8.02	7.88	7.79	7.60	7.35	6.08
LSD (P<0.05)						
Trees	0.51	0.61	0.65	0.70	0.77	0.82
Crops	0.55	0.65	1.68	0.75	0.82	0.87

Table 3. Relative height growth rate (RGR) of Fruit trees

Intercrops	RGR
Mango + Sorghum	0.147
Mango + Maize	0.147
Mango + Stylo	0.146
Sapota + Sorghum	0.138
Sapota + Maize	0.141
Sapota + Stylo	0.136
Guava + Sorghum	0.164
Guava + Maize	0.164
Guava + Stylo	0.155
Jack + Sorghum	0.146
Jack + Maize	0.150
Jack + Stylo	0.137

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