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Compatibility of legumes, an aromatic crop and a cereal as intercrops in palmarosa (*Cymbopogon martinii* Stapf.)

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Abstract

To utilize the crop growth resources (space, time, water and nutrient) more efficiently during the initial stage, a field experiment was conducted during 1999-2000 in the semi-arid tropical climate of Bangalore, India to explore the feasibility of intercropping (food legumes, aromatic crop and cereal) in palmarosa. The intercropping combination palmarosa + basil resulted in the maximum (17%) increase in land use efficiency followed by palmarosa + blackgram and palmarosa + soybean (16% each) and palmarosa + maize (5%). Palmarosa yield was not influenced by intercropping system. Maximum net return was obtained with palmarosa + basil (Rs. 83635 ha^{-1}) followed by palmarosa + blackgram (Rs.83340 ha^{-1}) and palmarosa + maize was the least remunerative intercropping system (Rs.68960 ha^{-1}).

Key words: crop mixtures, *Cymbopogan martinii*, intercropping

Palmarosa (*Cymbopogon martinii* Stapf., Family – Poaceae) is an important multiharvest aromatic crop cultivated in a number of countries. In India, it is cultivated in an area of 2000 ha with the annual production of 300 t of oil and two-thirds of it now comes from cultivation (Gupta & Chadha 1995). Steam distillation of whole biomass yields an essential oil, palmarosa oil, widely used in flavour and fragrance industries. India is one of the major producers and exporters of palmarosa essential oil. It is a widely spaced (45-60 cm row spacing) aromatic grass that grows slowly in the initial stages in tropical climate. The uncovered interspaces invite large number of weeds in the initial stage of crop growth leading to yield losses and increased cost of cultivation (Singh *et al.* 1998). To utilize these interspaces, resources and initial slow-growth period efficiently, attempts were made to grow short duration legumes and cereals in the interspace (Prakasa Rao *et al.* 1994). Intercropping studies carried out with other related aromatic grasses such as lemongrass (*Cymbopogon flexuosus* (Steud.) Wats) (Singh & Shivaraj 1998), Java citronella (*Cymbopogon winterianus* Jowitt.) (Prakasa Rao *et al.* 1988) and vetiver (*Vetiveria zizianioides* (L.) Nash) (Pareek *et al.* 1991) had shown that food legumes could be successfully grown as intercrops without any adverse effects on the main crop. Therefore an attempt was made to explore the feasibility of intercropping food legumes, aromatic

crop and cereal during the initial slow growth period of palmarosa.

The field experiment was conducted during 1999-2000 at Bangalore, India. The soil of the experimental site was red sandy loam (Alfisol) with pH 6.4, 0.24% organic C, 115 kg ha^{-1} available N, 12.5 kg ha^{-1} available P and 125 kg ha^{-1} exchangeable K. The field study was laid out in a randomized block design with five treatments and four replications. The treatments were, sole crop of palmarosa (cv. Motia), palmarosa + blackgram (cv. T9), palmarosa + soybean (cv. Hardee), palmarosa + basil (cv. Vikarshudha) and palmarosa + maize (Hybrid 4) along with sole crop of blackgram, soybean, basil and maize. Forty-day old seedlings of palmarosa were planted at a spacing of 45 cm between rows and 30 cm between plants on 12 October 1999 in plots of 10.8 m^2. The intercrops were sown/planted on the same day after planting of palmarosa by drilling one row of intercrop between two rows of palmarosa at a spacing of 10 cm between plants in case of blackgram and soybean and 30 cm in case of basil and maize. The experimental plots were irrigated once in every 10 days and kept weed-free through manual weeding. Nitrogen @ 200 kg N (434.8 kg urea) in eight splits at one and half month interval, phosphorus @ 50 kg P_2O_5 (312.5 kg single superphosphate) and 50 kg K_2O (83.3 kg muriate of potash) per hectare were applied to palmarosa. Intercrops received no extra fertilizers. Single superphosphate and muriate of potash were applied prior to planting and thoroughly mixed with the soil. Palmarosa was harvested four times during the crop period (February, May, July and October). Harvest dates for the intercrops were, basil-18 December 1999; blackgram-16 January 2000; soybean-30 January 2000 and maize-17 February 2000. At each harvest, herb yield of palmarosa was recorded and essential oil content was determined by hydro distillation method in Clevenger's apparatus (Langenau 1948). The essential oil yield per unit area (kg ha^{-1}) was calculated by multiplying the biomass yield with essential oil content (%) and a factor of 0.90 (Singh *et al.* 1998). To make a valid comparison in terms of productivity and economic returns, the intercrop yields were converted into palmarosa essential oil equivalent yields by using the following formula suggested by Rajeswara Rao (2000).

$$\text{Palmarosa essential oil equivalent yield (kg ha}^{-1}) = \frac{\text{Monetary value of yield of intercrops}}{\text{Price of palmarosa essential oil kg}^{-1}}$$

Palmarosa herbage and oil yields were subjected to analysis of variance (ANOVA) as applicable to randomized block design (Cochran & Cox 1959). Land Equivalent Ratio (LER), Area x Time Equivalency Ratio (ATER) were calculated as suggested by Mead & Willey (1980) and Hiebsch & Mc Collus (1987), respectively.

Intercropping palmarosa with maize led to significant yield reduction in the first harvest in comparison to sole crop of palmarosa (Table 1), which may be due to the aggressive growth behaviour of the maize in the initial stage. But blackgram, soybean and basil had no effect on yield of palmarosa. However, total herbage yield of palmarosa was not affected by the intercrops. The essential oil yield of palmarosa followed the same trend of its biomass yield (Table 2).

Yields of all the intercrops were reduced when intercropped with palmarosa (Table 1). The reduction of the yields in the intercropping systems may be due to either (a) plant population of the intercrops being half of that in pure system or (b) competition with the main crop. The intercropping systems with palmarosa resulted in LER, between 1.27-1.40 (Table 1) which indicate the 27-40% more land would have to be used for sole crops to achieve similar yield levels of palmarosa and the cropping systems tried in this study. However, LERs in the present study, over estimated land use efficiency, since LER does not take the differences in duration of component crops into consideration. In such situations, the use of ATER (Area x Time Equivalency Ratio) suggested by Hiebsch & Mc Collum (1987), calculation of which showed that there was an increase of 5-17% in land use

efficiency in the cropping systems (Table 1). Similar improvement in land use efficiency was observed in our earlier intercropping studies in palmarosa (Prakasa Rao *et al.* 1994). The yields of different intercrops are given in Table 3. Maize registered greater palmarosa oil equivalent yields followed by basil and lowest with blackgram.

Palmarosa intercropped with basil yielded the maximum monetary returns (Rs.83,635), followed by blackgram (Rs.83,340), soybean (Rs.80,560) (Table 3). Palmarosa intercropped with maize (Rs.68,960) was least remunerative. This study showed that intercropping some food legumes and aromatic crop with palmarosa increased the land use efficiency and monetary returns.

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Table 1. Effect of intercrops on herbage yield of palmarosa, intercrop yield, land equivalent ratio (LER) and Area x Time Equivalency Ratio

Cropping system	Palmarosa herbage yield (t ha^{-1})					Intercrop yield (t ha^{-1})	Land Equivalent Ratio (LER)	ATER (Area x Time Equivalency Ratio)
	Harvest number							
	1	2	3	4	Total			
Palmarosa (sole crop)	4.79	13.20	19.47	16.02	53.48	-	-	1.16
Palmarosa + blackgram	5.27	13.11	21.89	17.90	58.17	0.15 (0.50)	1.39	1.16
Palmarosa + soybean	4.44	13.18	21.93	17.12	56.45	0.16 (0.46)	1.40	1.17
Palmarosa + basil	5.59	14.86	20.03	17.62	58.11	0.02 (0.08)	1.34	1.05
Palmarosa + maize	1.71	10.32	20.30	16.39	48.73	1.50 (3.50)	1.27	-
C.D. (P=0.05)	0.57	N.S.	N.S.	N.S.	6.71	-	-	

Figures in parentheses indicate pure crop yields of intercrops

Table 2. Effect of intercrops on essential oil yield of palmarosa

Cropping system	Palmarosa essential oil yield (kg ha^{-1})				
	Harvest number				
	1	2	3	4	Total
Palmarosa (sole crop)	19.16	52.80	77.88	64.08	213.92
Palmarosa + blackgram	21.08	52.44	87.56	71.06	232.68
Palmarosa + soybean	17.76	52.72	87.72	68.48	226.72
Palmarosa + basil	22.23	59.44	84.12	64.48	230.27
Palmarosa + maize	6.84	41.28	81.20	65.56	194.92
C.D. (P=0.05)	2.28	N.S.	N.S.	N.S.	24.84

Table 3. Palmarosa essential oil equivalent yield and economics of treatments as affected by intercropping

Cropping System	Palmarosa essential oil yield (kg ha^{-1} year^{-1})	Palmarosa essential oil equivalent yield	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})
Palmarosa (sole crop)	213.92	-	35,000	1,06,960	71,960
Palmarosa + blackgram	232.68	6.0	36,000	1,19,340	83,340
Palmarosa + soybean	226.72	6.4	36,000	1,16,560	80,560
Palmarosa + basil	230.27	10.0	36,500	1,20,135	83,635
Palmarosa + maize	194.92	15.0	36,000	1,04,960	68,960

Palmarosa oil price @ Rs.500 kg^{-1}, blackgram and soybean @ Rs.20 kg^{-1}, basil oil @ Rs.250 kg^{-1} and maize seed @ Rs. 5 kg^{-1}.

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