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Compatibility of aromatic crops as intercrops in maize (*Zea mays* L.) in semi-arid region of Karnataka, India

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Abstract

An experiment was carried out at Bangalore (Karnataka) to investigate the effect of methods of planting (solid row and paired row) and three cropping systems [maize + palmarosa (*Cymbopogon martinii),* maize + South American marigold (*Tagetes minuta*) and maize + basil (*Ocimum basilicum*)] on growth and yield of maize (*Zea mays*). Grain yield of maize, harvest index and biomass were not affected by intercrop treatments. Land use efficiency in terms of Land Equivalent Ratio ranged between 1.11 to 1.20, the maximum being with maize paired row + palmarosa and maize paired row + South American marigold (20%). There was no effect of method of planting on yield of maize. Palmarosa, South American marigold and basil did not affect the yield of maize. Maximum net returns (Rs. 20,870 ha^{-1}) and benefit : cost ratio (2.26) was obtained with maize paired row + South American marigold.

Key words: basil, cropping system, maize, marigold, palmarosa, *Zea mays*.

There is ample scope to utilize the inter-row spaces of maize (*Zea mays* L.) during the initial slow growth period of the crop by introducing compatible crops and adjusting the crop geometry for increased productivity (Singh & Singh 1993). Growing of one row of *urd* bean inbetween two rows of maize (60 cm spacing) gave an increase of about 40% yield over the pure crop of maize (Varshney 1985). No information is available on the suitability of aromatic crops as intercrops in maize especially in Karnataka where the crop has a high yield potential (45–60 q ha^{-1}) and the area under the crop has increased tremendously. Therefore, field experiments were conducted during 2000 and 2001 at Central Institute of Medicinal and Aromatic Plants, Resource Centre, Bangalore, Karnataka, to study the compatibility of aromatic crops such as South American marigold (*Tagetes minuta* L.) cv. Vanful, palmarosa (*Cymbopogon martinii* Roxb. Wats) cv. Motia and basil (*Ocimum basilicum* L.) cv. Vikarshudha, as intercrops in maize in semi-arid climate.

The treatments were, two methods of planting (solid row and paired row) and three cropping systems (maize + palmarosa, maize + South American marigold and maize + basil). Besides these intercropping systems, pure crop of maize, palmarosa, South American marigold and basil were also raised and the experiment was laid out in a Randomized Block Design with four

replications. The soil of the experiment site was red sandy loam (*alfisol*) having pH 6.4 with available N 150–160 kg ha^{-1}, available P 10.0–11.5 kg ha^{-1} and exchangeable K 150.5–165.0 kg ha^{-1} respectively, and organic carbon content 0.35–0.40%. The water holding capacity of the soil was low and the mean annual rainfall was 890 mm and minimum and maximum temperatures varied from 12°C to 38°C, respectively.

Individual gross treatment plots measured 3.6 m x 3.6 m. Maize variety, 'Ganga 105' was planted in solid row spaced at 60 cm x 30 cm and one row of intercrops were transplanted after germination of maize in between the two rows of maize. In paired row planting spaced at 45/135 cm x 30 cm three rows of South American marigold and basil with spacing of 30 cm x 30 cm, and two rows of palmarosa with spacing of 45 cm x 30 cm were transplanted between paired rows of maize. Maize crop was maintained weed-free by hand weeding twice, 30 days and 60 days after sowing. The crop was irrigated once in 10 days during non-rainy season. Phosphorus and potassium were applied before seed sowing @ 50 kg P_2O_5 and K_2O ha^{-1} and nitrogen @ 150 kg N ha^{-1} in three equal splits (first after germination, second at knee stage and third at the time of flowering). The intercrops received no extra fertilizers. Pure crop of palmarosa, South American marigold and basil were fertilized with recommended doses of fertilizers. In both planting systems, plant population was maintained the same by adjusting the plant spacing. The planting and harvesting schedules of various crops are given in Table 1. The biomass of crops was recorded at harvest and dry weight $plant^{-1}$ was recorded after drying samples at 70°C for 48 h. Harvest index (HI) was calculated based on the ratio between grain yield and biomass yield. Cobs were dried in sun and seeds were separated and net plot yield was recorded. Land Equivalent Ratio (LER) was calculated according to method described by Mead & Willey (1986). The yields of aromatic intercrops were recorded and oil was distilled in Clevenger apparatus and total herbage yields were recorded.

Grain yield, HI, dry weight and biomass yield of maize were not affected by intercrops (Table 2). Maize plant height was measured in both experiments and did not differ between monocrop and intercrop systems (data not shown). Several workers (Mohta & Ded 1980; Chui & Shibles 1984; Hikam *et al.* 1992) have reported variable responses of maize as intercrop components in soybean and winged bean, whereas in the present study, the yields of maize were not affected by intercropping with aromatic crops, which may be due to fast growth of maize compared with palmarosa, South American marigold and basil and low height of the intercrops.

Intercrop yields were adversely affected by the maize crop. The reduction in aromatic crop yields in intercropping systems ranged between 80.4%–83.6% in various combinations which was due to lower plant population than pure crop stand and competition with the main crop (Table 3). A decreased production of intercrops such as cowpea, ragi, soybean, moong and black gram was reported earlier in citronella and lemongrass (Singh & Shivaraj 1998; Singh *et al.* 2001).

The intercropping systems with maize resulted in LERs between 1.11–1.20 (Table 3)

Table 1. Planting and harvesting schedule of various crops

Crop	2000		2001	
	Date of planting	Date of harvesting	Date of planting	Date of harvesting
Maize	15 July	10 November	3 August	20 November
Palmarosa	31 July	30 October	19 August	20 November
South American marigold	31 July	16 September	19 August	28 September
Basil	31 July	30 September	19 August	20 November

Table 2. Influence of intercrops on yield parameters and yield of maize in maize + aromatic crops intercropping systems

Treatment	Biomass yield (t ha^{-1}) of maize/aromatic crops			Dry matter plant^{-1} of maize			Harvest index (HI) of maize			Maize grain yield (t ha^{-1})/ intercrop oil yield (kg ha^{-1})*		
	2000	2001	Mean	2000	2001	Mean	2000	2001	Mean	2000	2001	Mean
Maize-Pure solid row	19.79	20.71	20.25	233.4	235.4	234.4	0.26	0.30	0.28	5.15	6.25	5.70
Maize-Pure paired row	16.85	17.85	17.35	273.1	274.3	273.7	0.30	0.34	0.32	4.99	6.09	5.54
Palmarosa-Pure crop	4.40	6.40	5.40	-	-	-	-	-	-	22.00*	28.00*	25.00*
South America marigold-Pure crop	9.30	13.90	11.60	-	-	-	-	-	-	33.16*	50.04*	41.60*
Basil-Pure crop	24.00	26.40	25.20	-	-	-	-	-	-	40.00*	44.00*	42.00*
Maize-Solid row + Palmarosa	18.07	18.75	18.41	239.5	240.6	240.1	0.29	0.34	0.32	5.19	6.42	5.80
Maize-Paired row + Palmarosa	15.45	16.90	16.18	209.9	215.4	212.7	0.31	0.37	0.34	4.80	6.24	5.52
Maize-Solid row + South American marigold	14.91	15.80	15.35	196.2	201.2	198.7	0.31	0.39	0.35	4.65	6.15	5.40
Maize-Paired row + South American marigold	17.12	18.40	17.76	210.9	211.4	211.2	0.27	0.35	0.31	4.70	6.35	5.53
Maize-Solid row + Basil	14.32	15.38	14.85	205.0	208.2	206.2	0.34	0.38	0.36	4.83	5.90	5.37
Maize-Paired row + Basil	13.19	14.81	14.00	220.1	215.6	217.9	0.38	0.40	0.39	5.18	5.87	5.53
CD (P=0.05)	NS	NS	-	NS	NS	-	NS	NS	-	NS	NS	-

NS=Not significant

Table 3. Mean grain yield, intercrop oil yield, Land Equivalent Ratio, cost of cultivation and returns in maize + aromatic crops intercropping systems

Treatment	Mean maize grain yield (t ha^{-1})	Mean intercrop oil yield (kg ha^{-1})	Land Equivalent Ratio	Cost of cultivation (Rs ha^{-1})	Total return (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit : cost ratio
Maize-Pure solid row	5.70	-	-	15,000	28,500	13,500	1.90
Maize-Pure paired row	5.54	-	-	15,000	27,700	12,700	1.85
Maize-Solid row + Palmarosa	5.80	4.1 (25.0)	1.18	16,500	31,050	14,550	1.88
Maize-Paired row + Palmarosa	5.52	4.9 (25.0)	1.20	16,500	30,050	13,550	1.82
Maize-Solid row + South American marigold	5.40	6.9 (41.6)	1.11	16,500	35,280	18,780	2.14
Maize-Paired row + South American marigold	5.53	8.1 (41.6)	1.20	16,500	37,370	20,870	2.26
Maize-Solid row + Basil	5.37	7.5 (42.0)	1.12	16,500	28,725	12,225	1.74
Maize-Paired row + Basil	5.53	8.0 (42.0)	1.19	16,500	29,650	13,150	1.80

Figures in parantheses are pure crop yields; Maize seed price=Rs. 5 kg^{-1}, Palmarosa oil=Rs. 500 kg^{-1}, South American marigold oil=Rs. 1200 kg^{-1}, Basil oil=Rs. 250 kg^{-1}

which indicate that 11%–20% more land would have to be planted with the sole crop to achieve similar yield levels of maize and the cropping systems tried in this study. Similar results were reported on maize in earlier studies with moong bean (Varshney 1985).

Paired row maize intercropped with South American marigold yielded maximum monetary returns (Rs. 20,870 ha^{-1}) followed by solid row maize + South American marigold (Rs.18,780) (Table 3); the beneft : cost ratio was also high in these intercrop combinations.

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