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Effect of maize (*Zea mays*)-based intercropping systems on maize yield and associated weeds under rainfed condition

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ABSTRACT

An experiment was conducted during the rainy seasons of 1998 and 1999 at the research farm of Rajendra Agricultural University, Pusa, Samastipur, to study the effect of maize (*Zea mays* L.)-based intercropping systems on maize yield and associated weeds under rainfed condition. Intercropping systems reduced the values of yield attributes and grain yield of maize than sole cropping of maize, but significant reduction in cob length, kernels/row, grains/cob and grain yield was recorded only with sesame (*Sesamum indicum* L.), turmeric (*Curcuma longa* L.) and forage *meth* [*Phaseolus aconitifolius* (Jacq) Marechal] intercropping systems. All intercropping systems recorded significantly higher maize-equivalent yield, productivity (kg/ha/day) and significant reduction in weed population and weed dry-biomass than sole cropping of maize. Among the intercropping systems, maize + turmeric showed significantly higher maize-equivalent yield and productivity (kg/ha/day), however significantly lower values of these were associated with maize + sesame. Maize + forage *meth* recorded the lowest weed population, weed dry-biomass and highest weed-control efficiency. Highest weed population, weed dry biomass and lowest weed-control efficiency were found with maize + pigeonpea [*Cajanus cajan* (L.) Millsp.] intercropping system.

Key words : Rainfed, Yield equivalent, Productivity, Intercropping

Abnormal occurrence of monsoon is one of the important limiting factors for crop production under rainfed conditions. The principal rainy-season crops, grown as sole crop at times are found to be rather risky due to delayed monsoon accompanied with prolonged intermittent dry spells. A strategy for stabilizing production of dry-land crops through commonly recognized practice of intercropping of compatible crops is considered viable to overcome the situation. The system aimed at increasing productivity per unit area and it guarantee insurance against total crop failure, particularly under aberrant weather conditions. Umrani *et al.* (1987) and Patil and Patil (1989) reported beneficial effects of intercropping principal rainy-season legume with pearl millet and sunflower. Growing intercrops in widely spaced maize crop not only reduces intensity of weeds (Willey, 1979) but also gives additional yield. In view of this, present experiment was conducted to assess the possibility of increasing crop production per unit area by introducing intercrops with rainy-season maize under rainfed situation.

MATERIALS AND METHODS

A field experiment was conducted at research farm of the Rajendra Agricultural University, Pusa (Samastipur), during the rainy seasons of 1998 and 1999. The soil was silt loam, low in organic carbon (0.45%), available N (173.6 kg/ha), P_2O_5 (8.35 kg/ha) and K_2O (96.7 kg/ha) contents, with pH 8.5. The experiment comprised 6 intercropping systems along with sole cropping of maize, viz. maize alone, maize + pigeonpea (1:1), maize + sesame (1:2), maize + groundnut (*Arachis hypogaea* L.) (1:2), maize + blackgram (*Phaseolus mungo* L.) (1:2), maize + turmeric (1:2) and maize + forage *meth* (1:2). The experiment was laid out in randomized block design with 4 replications. The maize variety 'Suwan', pigeonpea 'Bihar', sesame 'Krishna', groundnut 'M 13', blackgram 'T 9', turmeric 'RH 10' and *meth* 'Local' were used. Maize was sown at 75 cm row spacing in sole as well as in intercropping on 26 and 22 June, respectively, in the first and second year of experimentation. One row of pigeonpea at distance of 75 cm and 2 rows of other intercrops at 30 cm distance were accommodated between 2 rows of maize. The intra-row spacing of 30, 30, 10, 15, 10 and 15 cm for maize, pigeonpea, sesame, groundnut, blackgram and turmeric, respectively, were maintained by thinning. The crop received 100 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha, and no additional dose of fertilizers was used for intercrops. The *meth* was harvested for forage 60 days after sowing. For comparison between treatments, the yields of all intercrops were converted into maize-equivalent yield on price basis (Tomar and Tiwari, 1990). Production efficiency values in terms of kg/ha/day were obtained by maize-equivalent yield of systems divided by total duration of crops in that system. Weed population and weed dry-biomass were recorded from 0.25 m^2 randomly selected at 2 places in each plot. Weed data were subjected to square-root transformation ($\sqrt{X+0.5}$) before statistical analysis.

RESULTS AND DISCUSSION

Growth, yield attributes and grain yield

Plant height was unaffected by intercropping systems in both the years. Yield-attributing characters, i.e. length of cob, girth of cob, kernels/row, grains/cob, test weight, and grain yield of maize decreased due to intercropping systems in both the years (Table 1). The reduction in yield attributes and grain yield was of higher magnitude with sesame, while it was of lower magnitude with blackgram intercropping system. Although introduction of intercrops with maize reduced the yield attributes and grain yield of maize, significant reduction in yield attributes and grain yield was observed when it was grown in association with sesame, turmeric and forage *meth* except for cob girth and test weight in the first year with turmeric and with forage *meth* in the second year. The cob girth and test weight recorded in turmeric and forage *meth* intercropping systems in the first and second year, respectively, were at par with sole cropping of maize. Not much reduction could be noted in grain yield of maize in blackgram, pigeonpea and groundnut intercropping systems. It was because blackgram, pigeonpea and groundnut had different peak demand periods for light, nutrient and water and there was optimum utilization of physical resources. This resulted in better growth and development of maize plant which improved the yield attributes and grain yield of maize. Similar result was also obtained by Singh *et al.* (1988).

Sesame, turmeric and *meth* intercropping systems depressed the maize yield to significant extent. Sesame and *meth* plants approached above the mid-height of maize, thus produced shading effect and reduced the penetration of light to the lower leaves of maize plants. The lower leaves export a higher proportion of their assimilates to the roots than the upper leaves, hence there is more active and prolonged root system and more efficient uptake of water and nutrient to shoot. This provides the reason for drastic depression of maize yield. Reduction in maize yield under these intercropping

Table 1. Effect of intercropping systems on plant height, yield attributes and grain yield of maize

Treatment	Plant height (cm)		Length of cob (cm)		Girth of cob (cm)		Kernels/ row		Grains/ cob		Test weight (g)		Yield of maize (q/ha)	
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
Maize	176.15	179.41	15.41	15.93	11.54	11.70	25.94	26.45	316.40	321.80	250.25	252.30	27.91	29.70
Maize + pigeonpea (1:1)	182.13	187.00	14.93	15.20	11.25	11.40	24.13	24.64	301.00	304.10	247.75	249.43	25.83	26.40
Maize + sesame (1:2)	179.65	183.54	14.20	14.50	10.81	11.07	22.70	24.00	287.00	291.00	244.00	247.20	24.16	24.90
Maize + groundnut (1:2)	181.08	185.11	14.68	15.24	11.10	11.50	23.76	24.83	296.75	307.16	246.25	250.00	25.11	27.00
Maize + blackgram (1:2)	179.80	184.43	15.18	15.60	11.36	11.58	24.62	25.10	306.50	312.65	249.06	251.60	26.28	27.90
Maize + turmeric (1:2)	177.89	181.30	14.50	14.57	11.00	11.10	23.00	24.17	290.35	293.24	245.00	247.40	24.72	25.00
Maize + forage *meth* (1:2)	178.7	183.0	13.90	14.76	10.76	11.23	22.50	24.34	285.50	297.50	243.80	248.10	24.06	25.60
CD (P=0.05)	NS	NS	0.96	0.89	0.67	0.59	2.24	2.10	24.39	21.46	5.51	4.34	2.98	3.38

Table 2. Effect of intercropping systems on maize-equivalent yield and associated weeds

Treatment	Yield of intercrops (q/ha)		Maize-equivalent yield		Productivity (kg/ha/day)		Weed populaltion/ m^2 (60 DAS)		Weed dry bio-mass (g/m^2) (60 DAS)		Weed-control efficiency (%)	
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
Maize			27.91	29.70	28.48	29.41	23.59 (556.25)	23.05 (531.90)	12.92 (166.30)	12.62 (158.70)		
Maize + pigeonpea (1:1)	23.39	21.90	113.55	108.53	41.59	40.19	19.93 (396.75)	19.31 (372.50)	11.04 (121.50)	10.85 (117.20)	26.70	25.83
Maize + sesame (1:2)	3.70	4.10	40.81	43.35	37.79	39.06	17.37 (301.50)	17.09 (291.50)	10.33 (106.30)	9.85 (96.50)	35.88	38.88
Maize + groundnut (1:2)	8.49	7.90	59.08	58.60	42.81	42.16	18.79 (352.75)	18.54 (334.30)	10.63 (112.60)	10.28 (105.30)	32.00	33.52
Maize + balckgram (1:2)	6.31	6.80	51.51	55.10	52.56	54.56	18.63 (346.75)	18.17 (329.80)	10.54 (110.50)	10.14 (102.60)	33.45	34.85
Maize + turmeric (1:2)	212.07	221.60	210.28	218.90	93.88	96.86	19.02 (361.25)	18.59 (345.20)	10.78 (115.60)	10.50 (109.70)	30.40	30.78
Maize + forage *meth* (1:2)	175.28	188.30	59.12	63.25	60.37	62.67	17.11 (292.25)	16.72 (279.30)	10.11 (101.70)	9.63 (92.30)	38.76	41.65
CD (P=0.05)			6.69	4.44	4.53	2.46	0.80	0.96	0.45	0.54		

Original values are given in parentheses; DAS, days after sowing systems might be due to more competition for sunlight, CO_2, nutrient and space. The result confirms the finding of Singh (1997).

Productivity

Inclusion of intercrops with maize gave significantly higher maize-equivalent yield and productivity (kg/ha/day) compared with sole cropping of maize in both the years (Table 2). Among the intercropping systems, maize + turmeric showed significantly higher maize-equivalent yield and productivity. However, significantly lower values of maize-equivalent yield and productivity were obtained under maize + sesame. Maize + pigeonpea although gave significantly higher maize-equivalent yield than maize + groundnut, both the systems showed at par productivity. Similarly, maize + groundnut recorded higher maize-equivalent yield than maize + blackgram. Productivity recorded under maize + groundnut was significantly lower than maize + blackgram, because pigeonpea and groundnut occupied the field for longer duration. The highest maize-equivalent yield and productivity under maize + turmeric was owing to better production of component crops.

Weeds

The major weed flora observed in the experimental plots included *Eleusine indica* (L.) Gaertn., *Setaria glauca* (L.), P. Beauv., *Echinochloa colonum* (L.) Link. and *Cynodon dactylon* (L.) Pers. in grasses; and *Ageratum conyzoides* L., *Amaranthus viridis* L. *Euphorbia hirta* L. *Phyllanthus niruri* L., *Trianthema monogyna* L., *Leucas aspera* and *Cyperus rotundus* L. among the non-grasses. Intercropping systems significantly reduced the weed population and weed dry biomass than sole cropping of maize in both the years (Table 2). Among the different intercropping systems, maize + forage *meth*, was the most effective in suppressing weeds and recorded the minimum weed population and weed dry biomass. However, the maximum weed population and weed dry biomass were recorded in maize + pigeonpea intercropping system. This might be due to slow initial growth and wider row spacing of pigeonpea, providing conducive conditions for growth of weeds (Singh *et al.*, 1980). The weed population recorded with maize + forage *meth* and maize + sesame were at par and both were significantly lower than other intercropping systems. Similarly, a lower weed dry biomass was also recorded with maize + forage *meth* but it was at par with maize + sesame and maize + blackgram and significantly lower than other intercropping systems.

The maximum weed-control efficiency also was associated with forage *meth* intercropping, however it was minimum with pigeonpea intercropping system. The reduction in weed population and weed dry biomass in intercropping systems may be attributed to shading effect and competition stress created by the canopy of more number of crop plants in an unit area having suppressive effect on associated weeds, thus preventing the weeds to attain full growth. Similar results were reported by Kumar and Reddy (2000).

The intercropping systems studied showed higher maize-equivalent yield, productivity (kg/ha/day) and lowered weed population and weed dry biomass to a significant extent than sole cropping of maize. Among the intercropping systems, maize + turmeric showed the highest maize-equivalent yield and productivity and maize + forage *meth* recorded the lowest weed population, weed dry-biomass and highest weed-control efficiency.

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