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Integrated nutrient management for maize (*Zea mays*)–Indian mustard (*Brassica juncea*) cropping system

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ABSTRACT

A field experiment was carried out under irrigated condition on fixed site during 1986–2001 at Dryland Farming Research Station, Arjia, Bhilwara, Rajasthan, to find out the effect of integrated nutrient supply system in maize (*Zea mays* L.)–Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] cropping system. The highest mustard-equivalent yield (24.88 q/ha) was recorded with the application of 100% recommended N in the rainy season through FYM and 100% recommended NP in the winter season through inorganic fertilizers. Maximum net monetary returns (Rs 15,537/ha), benefit : cost ratio (2.07) and agronomic efficiency (16.1) were obtained from the treatment consisting of 50 and 100% recommended NP through fertilizers to maize and mustard respectively. Amount of available phosphorus increased over initial value when organic manures and crop residues were incorporated. Organic carbon status declined in the control, while there was build up in organic source-incorporated plots.

Key words : Integrated nutrient management, FYM, Crop residue, Mustard–equivalent yield

Presently fertilizer application is based on the nutrient requirement of individual crop and the carry-over effect of the manures or fertilizers applied to preceding crop are generally ignored. Further, application of inorganic fertilizers even in balanced amounts does not sustain the soil fertility and productivity under continuous cropping. Integrated nutrient management involving conjunctive use of organic, inorganic and crop residues may improve the soil productivity (Patra *et al.*, 2000, Kumar *et al.*, 2001) and system productivity becomes sustainable (Raju and Reddy, 2000). Hence a study was initiated to identify the suitable integrated nutrient supply system for maize–Indian mustard cropping system in the sub-humid Southern plain and Aravalli hills zone of Rajasthan.

MATERIALS AND METHODS

The field experiment was conducted at Dryland Farming Research Station, Arjia, Bhilwara, during 1986–87 to 2000–2001 in randomized block design having 4 replications at a fixed site. There were 13 treatments, the details of which are given in Table 1. The soil was clay loam with pH 8.3, EC 1.41 dS/m, organic carbon 0.42% and available P and K 37.5 and 364.0 kg/ha respectively. Maize variety 'Navjot' and mustard variety 'Varuna' were grown as the test crops during all the years. Half of N and full dose of P were given at the time of sowing and remaining N was top-dressed at 35 days after sowing to both the crops as per treatments. Maize was sown with the onset of monsoon and mustard in the second fornight of October to first week of November. Recommended cultural practices were adopted for raising both the crops.

Organic manures and crop residues were applied 10–15 days before sowing. Urea and diammonium phosphate were used as the sources of N and P. Soil was analysed after completion of the experiment for important chemical parameters. Agronomic efficiency was calculated as per the formula suggested by Graswell and Godwin (1984).

RESULTS AND DISCUSSION

Yield components

Growth and yield component viz. plant height, test weight of maize varied significantly with different treatment combinations (Table 2). Application of 100% recommended N through FYM in the rainy season and 100% recommended NP through fertilizer in the winter season recorded the maximum plant height and test weight, followed by application of 100% recommended NP through fertilizer to both crops. Reduction of 50% recommended NP of maize also recorded identical growth and yield components of maize. The lowest values were observed in the control plot.

In mustard, plant height, branches/ plant, siliquae/ plant

and test weight were significantly affected by the different treatments. Treatment consisting of 100% recommended NP through fertilizer to maize and mustard and treatment in which 100% recommended N through FYM to maize and 100% recommended NP through fertilizer to mustard resulted in the maximum growth and yield components and were at par.

Mustard-equivalent yield

The productivity of maize–mustard system in terms of mustard-equivalent yield was significantly influenced by different treatments (Table 3). The highest mustard-equivalent yield (24.88 q/ha) was obtained from the treatment consisting of 100% recommended N through FYM to maize and 100% recommend NP through fertilizers to mustard and the increase over control was 58.0%, followed by 100% recommended NP through fertilizer to both the crops. Highest agronomic efficiency (16.1) was recorded under the treatment consisting of 50 and 100% recommended NP through fertilizers to maize and mustard, respectively, followed by the treatment consisting of 50% recommended N through FYM to maize and 75% recommended NP through fertilizer to mustard (16.0). Treatment consisting of 50% recommended N through crop residues to maize and 75% recommended NP through fertilizer to mustard gave the lowest agronomic efficiency (4.4) of the system.

Economics

Net monetary return and benefit : cost ratio of the system was maximum from 50% recommended NP to maize and 100% recommended NP to mustard through fertilizer

Table 1. Details of treatments used in the experiment

Treatment	Rainy season (maize)	Winter season (mustard)
T_1	Control	Control
T_2	100% RDF of NP through fertilizer	100% RDF of NP through fertilizer
T_3	100% RDF of NP through fertilizer	50% RDF of NP through fertilizer
T_4	50% RDF of NP through fertilizer	100% RDF of NP through fertilizer
T_5	50% RDF of N through non-edible oil-cake	75% RDF of NP through fertilizer
T_6	50% RDF of N through FYM	75% RDF of NP through fertilizer
T_7	50% RDF of N through crop residues	75% RDF of NP through fertilizer
T_8	50% RDF of NP through fertilizer + 50% RDF of N through non-edible oil-cake	50% RDF of NP through fertilizer
T_9	50% RDF of NP through fertilizer + 50% RDF of N through FYM	50% RDF of NP through fertilizer
T_{10}	50% RDF of NP through fertilizer + 50% RDF of N through crop residues	50% RDF of NP through fertilizer
T_{11}	100% RDF of N through non-edible oil-cake	100% RDF of NP through fertilizer
T_{12}	100% RDF of N through FYM	100% RDF of NP through fertilizer
T_{13}	100% RDF of N through crop residues	100% RDF of NP through fertilizer

RDF, Recommended dose of fertilizer: 80 and 30 kg N and P/ha in rainy season and 60 and 40 kg N and P/ha in winter season

Table 2. Yield components of maize and Indian mustard as influenced by integraded nutrient management (average data of 15 years)

Treatment	Maize		Mustard			
	Plant height (cm)	Test weight (g)	Plant height (cm)	Branches/ plant	Siliquae/ plant	Test weight (g)
T_1	130.5	145.56	127.8	4.3	155.7	3.89
T_2	155.9	170.56	160.9	6.6	380.8	4.92
T_3	150.7	166.16	154.2	6.2	307.8	4.29
T_4	153.9	171.17	160.4	6.6	358.4	4.71
T_5	141.6	157.61	154.9	6.0	296.4	4.41
T_6	146.5	164.12	158.9	6.3	328.1	4.85
T_7	134.2	149.65	150.8	5.9	274.0	4.55
T_8	149.8	166.15	154.3	6.2	309.3	4.40
T_9	146.4	163.52	154.4	5.9	289.4	4.83
T_{10}	145.8	164.01	154.8	5.8	290.8	4.53
T_{11}	137.4	152.21	154.5	6.3	302.6	4.75
T_{12}	158.4	175.01	162.7	6.4	379.0	5.00
T_{13}	136.0	151.68	159.8	6.1	327.2	4.65
CD (P=0.05)	5	4.2	4	0.3	19.9	0.24

Details of treatments are given in Table 1

Table 3. Yield, equivalent yield, agronomic N-use efficiency, net return and benefit: cost ratio of maize–Indian mustard sequence (average data of 15 years)

Treatment	Grain yield (q/ha)		Mustard-equivalent yield (q/ha)	Stover yield (q/ha)		Agronomic efficiency of system	Net returns (Rs/ha)	Benefit : cost ratio
	Maize	Mustard		Maize	Mustard			
T_1	9.82	5.52	10.44	33.09	19.60	-	2,821	1.23
T_2	19.72	12.76	22.63	51.95	40.97	12.2	15,366	2.01
T_3	18.72	11.51	20.50	48.76	37.01	13.5	14,010	1.97
T_4	18.88	12.52	21.97	48.57	40.99	16.1	15,537	2.07
T_5	13.33	10.00	16.67	39.86	33.01	9.4	7,165	1.45
T_6	17.36	11.55	20.23	43.88	37.70	16.0	8,925	1.48
T_7	10.64	8.48	13.79	32.84	28.48	4.4	2,702	1.17
T_8	16.17	10.95	19.04	45.28	34.99	10.7	9,827	1.61
T_9	16.19	10.80	18.90	44.94	33.25	10.6	6,956	1.37
T_{10}	14.75	9.93	17.31	41.56	33.43	8.5	7,614	1.47
T_{11}	12.53	10.26	16.53	38.60	33.79	5.3	4,232	1.23
T_{12}	21.96	13.89	24.88	53.21	43.61	14.7	9,689	1.41
T_{13}	13.12	11.00	17.53	36.28	36.68	6.3	5,100	1.27
CD (P=0.05)	1.37	1.04	1.55	3.01	3.08			

Details of treatments are given in Table 1

Table 4. Effect of integrated nutrient management on physico-chemical properties of soil

Treatment	pH	EC (dS/m)	Organic carbon (%)	Infiltration rate (cm/hr)	Available (kg/ha)	
					P_2O_5	K_2O
T_1	8.39	1.53	0.30	0.72	32.4	302
T_2	8.24	1.20	0.43	0.93	36.8	346
T_3	8.22	1.27	0.43	0.93	36.5	344
T_4	8.21	1.22	0.43	0.75	37.1	348
T_5	8.22	1.26	0.44	0.90	38.3	351
T_6	8.16	1.18	0.48	0.87	39.2	353
T_7	8.27	1.31	0.46	0.80	38.2	369
T_8	8.19	1.21	0.49	1.00	38.5	346
T_9	8.16	1.23	0.52	1.00	38.8	349
T_{10}	8.25	1.28	0.49	0.80	38.6	354
T_{11}	8.23	1.21	0.50	0.77	39.5	356
T_{12}	8.14	1.16	0.55	0.80	40.1	360
T_{13}	8.22	1.21	0.46	0.75	39.6	372
Initial value	8.30	1.41	0.42	0.74	37.5	364

Details of treatments are given in Table 1

(Table 3). The second best remunerative treatment was the application of 100% recommended NP through fertilizer to both crops.

Soil properties

The soil pH and EC declined after 15 years of continuous cropping in all treatments except the control (Table 4). Maximum reduction was recorded in plot receiving 100% recommended N through FYM in the rainy season and 100% recommended NP through fertilizer in winter season which may be ascribed to the formation of acids during decomposition of organic matter (Kumar *et al.*, 2001). Integrated use of organic and inorganic fertilizers improved the organic carbon and infiltration rate and declined in the control plot. Among the fertilized plot, more organic carbon was present in FYM-incorporated plots. This result confirms the findings of Kumar *et al.*, (2001).

Available P was enhanced in organic manured plots, whereas it was slightly decreased in inorganic fertilized plots. The maximum build-up was with FYM. There was a decline in availability of K in all the treatments except in 100% recommended N through crop residue-incorporated plots. The magnitude of decline was high in inorganic but low in organic added plots. The findings corroborated the results of Raju and Reddy (2000).

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