The Andhra Agric. J 61(4): 836-840, 2014

Effect of Organic Manures, Inorganic Fertilizers and their Integration on Yield and Nutrient Uptake by Maize-Spinach Cropping System

I Usha Rani And G Padmaja
Department of Soil Science and Agricultural Chemistry Rajendranagar, Hyderabad-500 030

ABSTRACT

A field experiment was conducted on a red sandy loam soil (*Alfisol*) during *rabi* (maize) and summer (spinach) seasons of 2009-2010 with a view to study the effect of organic manures, inorganic fertilizers and their integration on soil nutrient uptake and yield of maize-spinach cropping system. Among different combinations application of 75% RDF + 25% through vermicompost recorded significantly highest grain and stover yields (52.38, 60.77 q ha^{-1}) at harvest but was on par with75% RDF + 25% through poultry manure and 75% RDF + 25% through FYM. The spinach crop grown during summer responded favourably to the residual and cumulative treatments and the highest fresh leaf yield (14.68 and 12.37 t ha^{-1}) was recorded in cumulative and residual treatments. Application of 75% RDF + 25% through VC, PM and FYM to the maize crop showed the highest uptake of N, P and K at vegetative, tasseling and at harvesting stages. The highest leaf yield and nutrient uptake of N, P and K by spinach at harvest was recorded in residual and cumulative treatments receiving 100% organic manures.

Key words : Cropping system, Fertilizers, Nitrogen, Maize, Organic manures, Spinach, Uptake.

In recent years, chemical fertilizers played significant role in providing nutrients for intensive crop production. But increased use of chemical fertilizers in an unbalanced manner has created problem of multiple nutrient deficiencies, diminishing soil fertility and unsustainable crop yields. This necessitated a review of various approaches for ensuring effective use of available renewable sources of plant nutrients for supplementing commercial fertilizers. Researchers have been therefore, directed towards integrated nutrient management (INM) involving organics and biofertilizers to find out the feasibility of their use for improving soil health (Sarawad *et al.,* 2005). The fertility of soil gets depleted by growing same crop year after year. This problem can be avoided by changing the crop in a scientific manner selecting appropriate crop rotation.

Keeping in mind the significance of organic manures in maintaining the soil health and improvement in productivity of crops, an attempt has been made to examine critically the use of different sources of nutrients to obtain better yields and to maintain good soil health in maize-spinach cropping system under integrated nutrient management.

MATERIAL AND METHODS

Field experiment was conducted on a red sandy loam soil (*Alfisol)* at College Farm, College of Agriculture, Rajendranagar, Hyderabad during *rabi* (maize) and summer (spinach) seasons of 2009-2010. During *rabi,* the experiment was laid out in randomized block design with 12 treatments, replicated thrice. The treatments include, T_1 (Control), T_2 (50% RDNF through inorganic fertilizer + 50% RDNF through vermicompost), T_3 (75% RDNF through inorganic fertilizer + 25% RDNF through vermicompost), T_4 (100% RDNF through vermicompost), T_5 (100% RDNF through inorganic fertilizer), T_6 (50% RDNF through inorganic fertilizer + 50% RDNF through poultry manure), T_7 (75% RDNF through inorganic fertilizer + 25% RDNF through poultry manure), T_8 (100% RDNF through poultry manure), T_9 (50% RDNF through inorganic fertilizer + 50% RDNF through farm yard manure), T_{10} (75% RDNF through inorganic fertilizer + 25% RDNF through farm yard manure), T_{11} (100% RDNF through farm yard manure), and T_{12} (25% RDNF through inorganic fertilizer + 25% RDNF through vermicompost + 25% RDNF through poultry manure + 25% RDNF through farm yard manure).

Maize was test crop during *rabi* season with RDF applied as N : P_2O_5 : K_2O @120:60:60 kg ha^{-1}. All the manures and fertilizers were applied as per the treatments. In summer season, spinach was taken up as a test crop to that 75 percent of recommended dose of N, P and K were applied in half of the plot pertaining to each treatment. No fertilizers were applied to second half of the plot to know the residual effects. Entire quantity of phosphorus, half of nitrogen and potassium were applied as basal in the form of single super phosphate, urea and muriate of potash. Remaining half of nitrogen and potassium were applied in two equal splits at 15 and 30DAS.

The experimental soil is sandy loamin texture slightly alkaline in reaction (pH: 7.21), non saline (EC : 0.19 dS m^{-1}), medium in organic carbon (0.46%) available nitrogen (217.8 kg ha^{-1}) P_2O_5 (28.7 kg ha^{-1}) and K_2O (285.6 kg ha^{-1}). Apart from the initial soil analysis, the organic manures used for the study *viz.,* FYM, poultry manure and vermicompost were also analyzed for their nutrient contents. Among all the organic manures was poultry manure found to have highest nitrogen (1.84%), phosphorus (0.82%) and potassium (1.12%) followed by vermicompost (1.18, 1.07 and 0.85%) and FYM (0.50, 0.75 and 0.75%).

RESULTS AND DISCUSSION

Grain and stover yield of maize

The grain and stover yield of maize was significantly influenced by different levels of organic manures and inorganic fertilizers (Table 1). The lowest and the highest grain and stover yields were recorded in control (21.52, 29.94 q ha^{-1}) and 75% RDNF + 25% VC (52.38, 60.77 q ha^{-1}) respectively. However, the yield recorded at 75% RDNF + 25% VC was on par with that recorded at 75% RDNF + 25% PM (51.28, 59.53 q ha^{-1}), 75% RDNF + 25% FYM (50.46, 58.49 q ha^{-1}) and 100% RDNF (49.26, 57.23 q ha^{-1}) and significantly superior over all other treatments. The percent increase in yield of 75% RDNF + 25% VC over the control, 100% RDNF, 100% VC, 100% PM and 100% PM was 143.4, 6.33, 18.9, 20.5, and 22.0, respectively. Conjunctive use of different levels of chemical fertilizers with any one of the organics produced higher yields as compared to their individual applications. This was due to the direct availability of nutrients from inorganic fertilizers and also the vermicompost containing higher available N, P and K contents. The enrichment of biological activity and release of organic acids might have degraded and mobilized the occluded soil nutrients to available from Reddy and Reddy (1998). Thus, favourable effect of poultry manure and vermicompost in the root zone resulted in increased availability and uptake of nutrients by the plants which in turn was reflected through increase in maize grain and stover yield.

Fresh leaf yield of spinach

The spinach crop grown during summer responded favourably to the residual and cumulative treatments after harvest of maize crop and the highest leaf yield (t ha^{-1}) were recorded in cumulative treatments than their respective residual treatments (Table 2). Among the cumulative and residual effects, the green leaf yield of spinach ranged from 6.71 to 14.68 t ha^{-1} and 4.89 to 12.37 t ha^{-1}, respectively. In both cumulative and residual effects, the treatments which received 100% organic manures (VC/PM/FYM) during preceding maize crop showed higher leaf yields of spinach than those with combined application of organic manures and inorganic fertilizers.

Among the cumulative treatments, the lowest and the highest green leaf yield were observed with the treatments T_1 (6.71 t ha^{-1}) and T_4 (14.68 t ha^{-1}), respectively. The latter treatment (T_4) which received, 100% VC during previous *rabi* and 75% RDF to spinach recorded highest fresh leaf yield but was on par with T_8 and T_{11}.

Among the residual effects, the green leaf yield of spinach varied from 4.89 to 12.37 t ha^{-1}. The lowest green leaf yield (4.89 t ha^{-1}) was recorded in control where no fertilizers were applied. Though application of 100% VC to *rabi* maize (T_4) resulted in highest green leaf yield of 12.37 t ha^{-1}, it was on par with 100% PM (T_8) and 100% FYM (T_{11}). But it was significantly superior to all the other combined treatments.

The results clearly indicated that application of 75% RDF to spinach apart from the application of inorganic and organic manures to maize crop was sufficient as it ensured ample supply of nutrients and favoured better growth. The additional fresh green leaf yield under cumulative effects might be due to the fact that an adequate and

Table 1. Effect of INM on grain and stover yield (q ha^{-1}) of maize.

Treatments	Grain yield	Stover yield
T_1 Control	21.52	29.94
T_2 50% N + 50% VC	48.16	55.47
T_3 75% N + 25% VC	52.38	60.77
T_4 100% VC	44.04	48.13
T_5 100% RDNF	49.26	57.23
T_6 50% N + 50% PM	47.34	53.48
T_7 75% N + 25% PM	51.28	59.53
T_8 100% PM	43.46	47.41
T_9 50% N + 50% FYM	46.84	53.02
T_{10} 75% N + 25% FYM	50.46	58.49
T_{11} 100% FYM	42.90	46.89
T_{12} 25% N + 25% VC + 25% PM +25% FYM	44.64	50.15
SE(m) ±	1.70	1.90
CD (0.05)	3.53	3.94

Table 2. Cumulative and residual effects of INM on fresh green leaf yield (t ha^{-1}) of spinach.

Treatments	Fresh yield (t ha^{-1})	
	Cumulative	Residual
T_1 Control	6.71	4.89
T_2 50% N + 50% VC	12.82	10.78
T_3 75% N + 25% VC	9.85	8.57
T_4 100% VC	14.68	12.37
T_5 100% RDNF	8.84	7.24
T_6 50% N + 50% PM	12.24	10.39
T_7 75% N + 25% PM	9.73	8.42
T_8 100% PM	14.55	12.14
T_9 50% N + 50% FYM	12.79	10.47
T_{10} 75% N + 25% FYM	9.46	8.27
T_{11} 100% FYM	14.30	12.04
T_{12} 25% N + 25% VC + 25% PM +25% FYM	13.38	11.68
SE(m) ±	0.60	0.57
CD (0.05)	1.25	1.19

balanced supply of nutrients with 75% RDF application had favourable effect on leaf and root growth resulting in improvement in the yield attributes. Thus, the results of the present study revealed that though spinach yield can be taken without applying fertilizers (residual treatments), there is a scope for increasing its production potential just by applying 75% RDF and saving 25% inorganic fertilizers. Similar observations were made by (Reddy, 2007).

Nutrient uptake by maize and spinach

The nutrient content of N, P and K and dry matter production values were used to compute nutrient uptake by plants at different growth stages. Nutrient uptake with regard to N, P and K were

Table 3. Effect of INM on N, P and K uptake (kg ha^{-1}) at different growth stages of maize.

Treatments	Vegetative stage			Tasseling stage			Grain			Stover		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1 Control	22.18	2.56	18.54	41.55	5.10	34.78	24.54	3.64	14.23	19.45	3.60	32.02
T_2 50% N + 50% VC	48.36	7.30	40.65	78.93	11.88	66.00	66.45	13.46	36.08	45.03	9.42	63.93
T_3 75% N + 25% VC	59.36	10.76	49.85	91.90	17.18	77.27	77.07	17.84	42.47	55.25	14.04	73.62
T_4 100% VC	38.55	4.61	31.27	67.93	8.60	55.27	58.56	9.70	30.79	36.00	6.85	53.89
T_5 100% RDNF	51.28	8.43	43.96	82.36	14.03	70.64	68.50	14.77	36.88	48.10	10.88	67.53
T_6 50% N + 50% PM	46.07	6.98	38.19	78.35	11.87	64.47	64.80	13.27	35.46	43.25	9.13	61.87
T_7 75% N + 25% PM	57.34	9.70	47.99	89.74	15.77	75.24	74.94	16.97	40.55	53.02	13.05	72.10
T_8 100% PM	36.74	5.09	30.04	66.64	8.47	54.25	57.37	9.11	30.00	38.39	6.70	52.67
T_9 50% N + 50% FYM	44.56	6.55	36.77	75.98	11.64	62.38	63.66	12.14	34.56	43.51	8.98	61.49
T_{10} 75% N + 25% FYM	55.52	9.16	47.17	88.05	15.59	73.32	72.66	16.13	39.36	52.70	12.31	70.24
T_{11} 100% FYM	36.15	4.34	29.88	65.48	7.93	53.73	56.20	8.92	29.62	34.69	6.04	52.19
T_{12} 25% N + 25% VC + 25% PM +25% FYM	41.12	5.46	33.57	72.30	10.05	59.04	59.76	10.69	32.59	39.65	7.59	56.81
SE(m) ±	3.05	0.92	2.43	3.35	1.52	3.32	2.99	1.01	1.66	2.57	1.33	2.59
CD (0.05)	6.33	1.91	5.04	6.95	3.15	6.89	6.19	2.09	3.44	5.33	2.76	5.37

presented in tables 3. Nutrient uptake increased from vegetative stage to harvest as it is a function of dry matter production and nutrient content.

The N, P and K uptake varied from 22.18 to 59.36, 2.56 to 10.76 and 18.54 to 49.85 kg ha^{-1} in different treatments at vegetative stage. The values ranged from 41.55 to 91.90, 5.10 to 17.18 and 34.78 to 77.27 kg ha^{-1} at tasseling stage and varied from 24.54 to 77.07, 3.64 to 17.84 and 14.23 to 42.47 kg ha^{-1} in grain and 19.45 to 55.25, 3.60 to 14.04 and 32.02 to 73.62 kg ha^{-1} in stover at harvest stage., and In all the stages the lowest and highest N uptake values were recorded in control and 75% RDNF + 25% VC, respectively. However 75% RDNF + 25% VC was on par with 75% RDNF + 25% PM and 75% RDNF + 25% FYM treatments indicating the importance of integrated use of organic and inorganic fertilizers in nutrient uptake. At harvest, partitioning of nutrients took place between grain and stover.

The nutrient uptake of N, P and K by spinach at final harvest were found to be significantly highest with 100% organic manures (VC, PM, FYM). All cumulative treatments showed the highest leaf yield and nutrient uptake values than their residual treatments (Table 4). The results clearly indicate that organic manures and nitrogen application applied to the preceding maize crop could not meet the complete nutrient requirement of spinach. Succeeding crop requires a minimum fertilization to sustain the yield levels, which was evident by the lower yields under residual treatments. The results are in agreement with the findings of Patiram and Singh (1993).

It was found that several enzymes and hormones present in organic manures were responsible for stimulating the growth and development of maize crop, through their favourable effect in the root zone, which might have resulted in increased availability and uptake of nutrients by the plants. The results further support the hypothesis that the organic manures in the root rhizosphere release a number of enzymes which enhances the transformations and release of nutrients (Reddy, 2007).

Table 4. Cumulative and residual effects of INM on uptake of N, P and K (kg ha^{-1}) by spinach.

Treatments	Nutrient uptake (kg ha^{-1})					
	Nitrogen		Phosphorus		potassium	
	Cumulative	Residual	Cumulative	Residual	Cumulative	Residual
T_1 Control	15.61	10.66	1.18	0.73	12.08	8.07
T_2 50% N + 50% VC	38.70	31.51	2.88	2.26	29.91	23.69
T_3 75% N + 25% VC	29.11	24.24	2.37	1.88	22.65	18.38
T_4 100% VC	49.62	40.62	3.92	3.16	38.30	31.11
T_5 100% RDNF	23.06	18.45	1.72	1.31	17.93	14.14
T_6 50% N + 50% PM	38.88	31.94	2.99	2.29	30.06	24.02
T_7 75% N + 25% PM	28.05	23.67	2.14	1.75	21.64	17.76
T_8 100% PM	48.20	39.57	3.67	3.02	37.97	30.67
T_9 50% N + 50% FYM	37.01	30.39	3.05	2.30	29.07	22.96
T_{10} 75% N + 25% FYM	27.03	23.06	2.07	1.71	21.44	17.79
T_{11} 100% FYM	47.38	38.92	3.77	3.08	36.60	29.95
T_{12} 25% N + 25% VC + 25% PM +25% FYM	44.20	38.14	3.45	2.89	34.14	29.09
SE(m) ±	2.07	1.21	0.22	0.16	1.60	0.89
CD (0.05)	4.29	2.50	0.45	0.33	3.32	1.85

Though the organic manures had positive effects, it was found that 100% organic manures application could not meet the nutrient requirement of plant, which was clear from nutrient contents and dry matter production values also. The lower uptake of N, P and K in organic manure treated plots alone might be attributed to the non-availability of adequate nutrients throughout the crop growth period, because of their low nutrient composition and slow release of nutrients (Reddy and Reddy, 2008).

Application of 75% RDF to spinach apart from application of 75% RDF along with 25% VC, PM, FYM to maize is sufficient as this combination has ensured sufficient supply of nutrients and favoured better growth and yield of both maize and spinach crops.

LITERATURE CITED

Patiram N and Singh K A 1993 Effect of continuous application of manures and nitrogenous fertilizers of some properties of acid Inceptisol. *Journal of the Indian Society of Soil Science,* 41: 430-433.

Reddy B G and Reddy M S 1998 Effect of organic manures and nitrogen levels on soil available nutrient status in maize-soybean cropping system. *Journal of the Indian Society of Soil Science,* 46(3): 474-476.

Reddy K P C 2007 Effect of integrated use of inorganic and organic sources of nutrients in maize-groundnut cropping system of Alfisols. Ph.D thesis submitted to Acharya N G Ranga Agricutural University, Hyderabad.

Reddy R U and Reddy M S 2008 Uptake of nutrients by tomato and onion as influenced by integrated nutrient management in tomato-onion cropping system. Crop Research *(Hisar)*. 2008. 36 (1/3): 174-178.

Sarawad I M, Guled M B and Gundlur S S 2005 Influence of integrated nutrient supply system for rabi sorghum- chickpea crop rotation on crop yields and soil properties. *Karnataka Journal of Agricultural Sciences,* 18: 673-679.

(Received on 26.12.2012 and revised on 18.02.2013)