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EFFECT OF CROP RESIDUE MIXED FARM YARD MANURE AND FERTILIZER ON GROWTH, YIELD AND ECONOMICS OF MAIZE

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Abstract

The field experiments were conducted during *kharif* season of 2011 and 2012 with five different treatments in maize (*Zea mays* L.) and wheat (*Triticum aestivum* (L.) *emend* Fiori & Paol.) cropping system. The highest growth, and yield components of maize crop were recorded with the application of 50% RDF + 50% RDN through crop residue mixed farm yard manure which produced significantly higher maize grain yield (4.24 t/ha) over control (2.23 t/ha) during first year, but during second year (5.26 t/ha) it was significantly higher than control (3.07 t/ha) and 50% RDF + 25% RDN + BF (4.83 t/ha) and was at par with remaining treatments. Application of 100% RDF recorded significantly maximum net profit (28.22×10^3, 42.74×10^3/ha) followed by 75% RDF + 25% RDN. But, benefit cost ratio of 1.33 and 1.60 were recorded significantly higher under control over other treatments followed by 100% RDF, during 2011 and 2012, respectively.

Introduction

Maize (*Zea mays* L.), is the world's third most important cereal crop after wheat and rice. It contributes around 24 per cent of total cereal production (Singh *et al.* 2011). Since rice, wheat and maize are staple crops with high consumption, any increase in mineral nutrient content might have significant effect on human nutrition throughout the world (Gunes *et al.* 2007). Due to excessive use of fertilizers, soil health deteorated along with environmental hazards, leads to emphasize on substitution of chemical fertilizers with organic and bio-sources. Application of these nutrient sources alone or in combination with inorganic sources has been found beneficial not only in enhancing the productivity of maize and wheat but also had the beneficial impact on soil properties (Jamwal 2005, Pathak *et al*. 2005). Continuous application of high amounts of only inorganic fertilizers had deleterious effect leading to decline in productivity due to limitation of one or more of micro-nutrients (Nambiar and Abrol 1989). Large amount of plant nutrients are removed from the soil along with the harvest of grain and straw. Hence, it is essential to supply these nutrients in balance quantities to sustain soil productivity.

In Indo-Gangetic plains of India, about 250 million mg of residues are produced annually in rice - wheat cropping systems (Gupta *et al.* 2004). Crop residues of some crops are valued for animal feed and some are generally not used as cattle feed. Consequently, rice and wheat residues are usually burnt on a large scale in the field that pollute the environment and disturb the biological activity of the soil. So, economical and suitable option for waste management and alternative means to utilize these large quantities of nutrients-rich biomass and to recycle them back to the field is composting (Singh and Amberger 1998).

Since, the information on this aspect is lacking in the region, the present study was initiated to assess the appropriate (organic and inorganic) nutrient management for maize crop.

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Materials and Methods

The field experiments were conducted during 2011-12 and 2012-13 in maize-wheat cropping system at Indian Agricultural Research Institute, New Delhi. The experiments were laid out in RBD during first year and in Factorial RBD in succeeding crops with three replications, consisting of five different treatments in *kharif* and *rabi* season each. Five treatments in *kharif* (maize) *viz.*, T_1: Control; T_2: 100% RDF (recommended dose of fertilizer-120, 60, 40 kg NPK/ha.); T_3: 75% RDF + 25% RDN (recommended dose of nitrogen); T_4: 50% RDF + 50% RDN and T_5: 50% RDF + 25% RDN + biofertilizer (BF) and five treatments in *rabi* (wheat) *viz.*, T_1: Control; T_2: 100% RDF; T_3: 75% RDF; T_4: 50% RDF + 25% RDN and T_5: 37.5% RDF +37.5% RDN + biofertilizer (BF) were used.

The experiments were conducted to know the direct effect of different treatments on one crop and residual effect on succeeding crop. Recommended dose of fertilizer (RDF) were applied through chemical fertilizers and recommended dose of nitrogen (RDN) were applied through crop residue mixed farm yard manure (CRFYM). Well rotted crop residue mixed farm yard manure containing 0.45-0.2-0.45% N-P-K was applied at the time of sowing. Crop residue mixed farm yard manure was prepared by using 80% crop residues and 20% fresh cattle dung and urine on weight basis. This manure is prepared by wind-row composting involves placing the mixture of raw materials in long narrow piles called wind rows, that are agitated or turned on a regular basis. The liquid microbial consortium (diluted 1:100 or 1:50 dilution with water) is sprayed on wind-row at the time of first turning. The process of composting takes about 60-65 days. The biofertilizers *viz*., *Azospirillum* for maize and *Azotobactor chroococcum*, phosphate solubulizing bacteria (PSB) i.e. *Pseudomonas striata* for wheat were applied directly to soil in rows during sowing. Other management practices were adopted as per recommendation of the crop grown under irrigated conditions. Leaf-area was measured by using leaf-area meter (1/2-MDL-1000, LICOR Ltd., USA). After harvesting, shelling, cleaning and drying, the grain yield was recorded. The data was statistically analysed (Gomez and Gomez 1984).

Results and Discussion

Growth parameters at different growth stages were influenced significantly due to application of different combinations of treatments during both the years of investigation (Table 1). However, growth parameters of the maize were better during 2012 in comparison to 2011 due to favorable weather conditions and rapid mineralization of CRFYM during second year. Significantly higher values of these parameters were recorded with the application of 50% RDF + 50% RDN which were significantly higher than control but, remained at par with rest of the treatments followed by 75% RDF + 25% RDN. Residual effect of applied nutrients to wheat was not significant with respect to all growth parameters of maize except leaf area index at 60 DAS. Similar results were also reported by Singh (1997).

The crop growth rate (CGR) was significantly higher over control by application of different ratio of CRFYM and fertilizers at different intervals during both the years (Table 2). However, relative growth rate (RGR) was found significant at 30-60 and 60-90 DAS intervals during 2012 and non significant at both intervals during 2011. The differences in treatments with respect to net assimilation rate (NAR) at 30-60 and 60-90 DAS intervals during 2011 were found non significant. CGR recorded gradual increase with enhancement of growth stages with maximum values at 60-90 DAS intervals while RGR and NAR recorded a reverse trend in comparison to CGR and maximum value of these two indices (RGR and NAR) were recorded at 30-60 DAS. The maximum values of these indices were recorded with the application of 50% RDF + 50% RDN followed by 75% RDF + 25% RDN and were significantly higher than control. RGR did not show

any definite trends of response at later intervals (30-60 and 60-90 DAS). The reason for maximum heights, dry matter accumulations, LAI and growth indices of maize with the application of 50% RDF + 50% RDN might be due to, fertilizer source fulfill the nutrient requirements at early growth stages while CRFYM facilitated crop at later stages by providing continuous and uniform supply of nutrients according to need of the crop. Our results are in agreement with those of Baque *et al*. (2006).

Table 1. Effect of CRFYM and fertilizer combinations on plant height (cm) and dry matter accumulation (g) and LAI at different growth stages.

Treatment	Plant height (cm)		Dry matter accumulation (g)		LAI	
	90 DAS		90 DAS		60 DAS	
	2011	2012	2011	2012	2011	2012
Treatment to maize						
MT_1	161.3	166.1	91.1	90.3	3.04	3.23
MT_2	179.7	186.2	109.3	132.0	3.15	3.91
MT_3	181.4	188.0	113.7	136.4	3.25	3.95
MT_4	183.0	189.8	119.0	144.4	3.28	4.00
MT_5	174.3	183.1	103.1	125.3	3.09	3.76
LSD (p = 0.05)	13.05	10.85	8.50	6.29	0.11	0.08
Treatment to wheat						
WT_1		181.9		122.1		3.65
WT_2		182.4		126.0		3.79
WT_3		182.4		125.4		3.78
WT_4		182.8		127.0		3.80
WT_5		183.8		127.8		3.83
LSD (p = 0.05)		NS		NS		0.08
Interaction						
LSD (p = 0.05)		NS		NS		0.17

The maximum values of yield attributes like cob length, grain rows/cob, cob weight (data not shown) and shelling percentage were recorded due to combined application of 50% RDF + 50% RDN during both the years, respectively and these were significantly higher over control but at par with other treatments during both the years except grain rows/cob during 2011 (Table 3). Application of 50% RDF + 50% RDN to maize recorded 20.5 per cent higher cob length than control during 2011 and 2012, respectively. This improvement in yield attributes resulted in increase in grain yield of maize. The grain yield usually depends upon various factors such as soil fertility status, water availability, crop management, agronomic practices, environmental factors and plant genetic characteristics (Nahar *et al.* 1995).

Application of 50% RDF + 50% RDN recorded the highest grain yield (4.24 and 5.26 t/ha) during 2011 and 2012, respectively (Table 3). The grain yield recorded with the application of 50% RDF + 50% RDN was higher by 0.10, 0.17, 0.27 and 2.23 t/ha during first year while 0.10, 0.20, 0.43 and 2.19 t/ha during second year as compared to 75% RDF + 25% RDN, 100% RDF, 50% RDF + 25% RDN +BF and control, respectively. Similar results were also reported by Kumar *et al.* (2005). Grain yields of maize were significantly higher with the application of 37.5% RDF + 37.5% RDN + BF (4.88 t/ha) to wheat and it was at par with 100% RDF and 50% RDF + 25% RDN but significantly higher over control and 75% RDF.

Table 2. Effect of CRFYM and fertilizer combinations on mean CGR, RGR and NAR of maize at different growth stages.

Treatment	CGR (g/plant/day)		RGR (g/g/day)				NAR ($\times 10^{-3}$ g/plant leaf area/day)			
	60-90 DAS		30-60 DAS		60-90 DAS		30-60 DAS		60-90 DAS	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Treatment to maize										
MT_1	1.24	1.18	0.030	0.028	0.017	0.017	0.43	0.40	0.40	0.36
MT_2	1.56	1.90	0.032	0.033	0.019	0.019	0.49	0.51	0.48	0.46
MT_3	1.61	2.00	0.032	0.033	0.018	0.019	0.50	0.52	0.49	0.48
MT_4	1.71	2.13	0.032	0.033	0.019	0.020	0.52	0.54	0.51	0.50
MT_5	1.46	1.80	0.031	0.032	0.018	0.019	0.47	0.50	0.46	0.46
LSD (p = 0.05)	0.26	0.18	NS	0.002	NS	0.002	NS	0.04	NS	0.05
Treatment to wheat										
WT_1		1.75		0.032		0.018		0.49		0.45
WT_2		1.81		0.032		0.019		0.49		0.45
WT_3		1.80		0.032		0.019		0.49		0.45
WT_4		1.83		0.032		0.019		0.49		0.45
WT_5		1.82		0.032		0.018		0.50		0.45
LSD (p = 0.05)		NS		NS		NS		NS		NS
Interaction										
LSD (p = 0.05)		NS		NS		NS		NS		NS

Table 3. Effect of CRFYM and fertilizer combinations on yield attributes yields and economics of maize.

Treatment	Grain yield (t/ha)		Shelling (%)		Net returns ($\times 10^3$ /ha)		B : C ratio	
	2011	2012	2011	2012	2011	2012	2011	2012
Treatment to maize								
MT_1	2.23	3.07	72.09	73.00	24.17	29.92	1.33	1.60
MT_2	4.07	5.06	80.58	82.62	28.22	42.74	1.06	1.25
MT_3	4.14	5.16	81.25	83.08	24.42	40.65	0.76	1.07
MT_4	4.24	5.26	82.19	83.81	19.56	39.05	0.53	0.95
MT_5	3.97	4.83	80.11	81.53	23.85	39.02	0.78	1.13
LSD (p = 0.05)	0.34	0.21	NS	7.51	2.94	2.81	0.11	0.09
Treatment to wheat								
WT_1		4.35		79.42		33.08		0.97
WT_2		4.72		81.12		39.15		1.24
WT_3		4.66		80.96		38.22		1.20
WT_4		4.76		81.31		39.75		1.26
WT_5		4.88		81.23		41.16		1.33
LSD (p = 0.05)		0.21		NS		2.81		0.09
Interaction								
LSD (p = 0.05)		0.48		NS		6.29		0.19

Direct applications of 50% RDF + 50% RDN to maize and application of 37.5% RDF + 37.5% RDN + BF to wheat found the best combination and were recorded significantly highest grain yield (5.30 t/ha) over other combinations. Sharma and Subehia (2003) reported that integrated use of FYM with balanced chemical fertilizers gave higher yield of maize compared to 100% NP and 100% NPK fertilizers. The improvement in yield attributes was due to applied

nutrients through various combinations of CRFYM and fertilizer. The combined effect of increased level of balanced nutrients and beneficial effect of CRFYM help in increasing higher yield. Net returns and B: C ratio increased significantly with each successive decrease in the dose of CRFYM (Table 3). Maximum net profit (28.22, 42.74 /ha) were recorded with the application of 100% RDF followed by 75% RDF + 25% RDN (24.42, 40.65 /ha) during both the years, respectively. But maximum benefit cost ratios (1.33, 1.60) were recorded under control followed by 100% RDF (1.06, 1.25) during both the years, respectively.

The net returns of maize were higher during 2012 as compared to 2011. It might be due to more crop growth, yield and minimum support price. Our results confirm the findings of Kumar *et al.* (2007), and Islam and Munda (2012). Hence, application of 50% RDF through fertilizers and 50% RDN through CRFYM in maize and 37.5% RDF through fertilizers 37.5% RDN through CRFYM and use of biofertilizers in wheat was found better nutrient management practice using fertilizers and crop residue mix FYM for higher growth, yield, and net returns from maize-wheat cropping system.

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