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Effect of integrated nutrient management on productivity and economics of food-fodder cropping system

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Abstract

A field experiment was carried out at Punjab Agricultural University, Ludhiana for 5 consecutive years (2005-06 to 2009-10) to study the effect of integrated nutrient management (INM) on productivity and economics in mung (*Phaseolus aureus*) - fodder oats (*Avena sativa*) - bajra (*Pennisetum glaucum)* + cowpea (*Vigna unguiculata)* fodder cropping system. In the initial years of the study (2005-06 and 2006-07), 100 % recommended dose of fertilizer (RDF) was significantly superior to rest of the treatments. In the later years the soil fertility in the farm yard manure (FYM) treatments improved resulting in almost equal fodder and grain yield of the crops in sequence. In the final year of the study, higher green fodder and grain yields of the cropping sequence were obtained with 75% RDF + 25% N through FYM as compared to 100 % RDF. The average of five years data indicated that the green fodder yield of oat and pearl millet + cowpea and grain yield of mung and fodder equivalent yield recorded with 100 % RDF and 75% RDF + 25% N through FYM were at par. The 75% RDF + 25% N through FYM recorded the highest fodder equivalent yield followed by 100 % RDF. The highest monetary returns (Rs.57985/ ha) and B: C ratio (1.68) were obtained with 100% RDF closely followed by 75% RDF + 25% N through FYM (Rs. 57466/ha net returns and 1.63 B: C ratio).

Key words: Crude fibre, Crude protein, Dry matter, Green fodder, Integrated nutrient management, Nitrogen uptake

Abbreviations: **B:C ratio**: Benefit cost ratio; **FYM:** Farm yard manure; **INM:** Integrated nutrient management; **NPK:** Nitrogen, phosphorus and potash; **RDF**: Recommended dose of fertilizers

Introduction

Pearl millet and oat are the major components of the intensive fodder cropping systems of the country in general and Punjab in particular. Both these crops being cereals are heavy feeders of nutrients and such highly intensive cropping systems cause heavy nutrient removal. Inclusion of a legume in the cropping system is the best option to improve the fertility status of soil through addition of biologically fixed nitrogen (Ali *et al*., 2002). Sidhu *et al.* (2004) observed that the grain yield of succeeding maize and wheat decreased by 11.9 and 3.6 %, respectively, in maize ï wheat - pearl millet cropping system as compared to maize ï wheat cropping system, while, the grain yield of succeeding maize was increased by 35.3 % without affecting the grain yield of succeeding wheat with maize ï wheat ï cowpea than maize ï wheat cropping system. The productivity and stability of soil for sustained production at high level depends greatly on the balanced fertilizer use. The adoption of integrated nutrient management results in higher production due to efficient and judicious use of macro and micro-nutrients. Integrated nutrient management (INM) not only increases the production but also improves the physical, chemical and biological properties of the soil (Kumar *et al*., 2007). Application of 50 % N through FYM + 50 % N through inorganic source was found best in terms of green forage, economics and B: C ratio (Joshi and Kewalanand, 2011).

Usually pearl millet and oat are grown on low fertile soils and the exploitation of rhizospheric nitrogen fixation may prove beneficial for crop performance. Maize has been reported to derive significant amounts of nitrogen through *Azotobacter* (Singh *et al*., 1993). Tiwana *et al.* (2000) observed 7.9 and 8.7 % higher green fodder and dry matter yield, respectively of oat with *Azotobacter* over control. The study conducted at Palampur revealed that the application of 75 % of recommended N + *Azotobacter* + *Azospirillum* recorded significantly higher green fodder yield and net returns compared to 100 % recommended nitrogen (Kumar *et al*., 2011). Therefore, the close monitoring of the effect of cereal-cereal cropping system on

productivity and economics on long term basis is imperative. Keeping this in view, the present study was conducted.

Materials and methods

A field experiment was carried out at Forage Research Farm, Punjab Agricultural University, Ludhiana (Latitude 30ô90ºN Longitude 75ô85ºE) during *kharif, rabi* and *zaid* for 5 consecutive years (2005-06 to 2009-10) to find out the effect of integrated nutrient management (INM) on productivity and economics in mung (*Phaseolus aureus*) - fodder oats (*Avena sativa*) - bajra (P*ennisetum glaucum)* + cowpea (*Vigna unguiculata)* fodder cropping system. The experiment was laid out in randomized block design with seven fertilizer treatments *viz.*, T_1- control, T_2 -100 % recommended dose of fertilizer (RDF), T_3- 75 % NPK + 25 % N through farm yard manure (FYM), T_4- 50 % RDF + 50 % N through FYM, T_5- 50 % NPK + bio-fertilizer, T_6- 50 % RDF + 25 % N through FYM + bio-fertilizer and T_7- 75 % RDF + bio-fertilizer replicated thrice. The soil of the experimental site was sandy loam in texture, low in organic carbon (0.38 %) and available N (162 kg/ha) and medium in available P (17.5 kg/ha) and K (157 kg/ha) with a pH of 7.9. FYM was mixed in the soil before sowing the crops. Bio-fertilizer, *Azotobacter* was applied to oats and bajra seeds and *Rhizobium* culture to mung seeds at the time of sowing. The recommended dose of fertilizer to mung (12.5 kg N + 40 kg P_2O_5/ha), oats (75 kg N + 20 kg P_2O_5/ha), bajra (75 kg N + 25 kg P_2O_5/ha) and cowpea (20 kg N + 55 kg P_2O_5/ha) were applied in the form of urea and single superphosphate as per the treatments. The mung variety ML-668, oats variety OL-9, bajra variety FBC-16 and cowpea variety CL-367 were used in the trial. All crops were grown in a plot size of 5.0 x 4.0 m^2 during all the years of study. Mung crop was harvested when 80 % of the pods matured and fodder crops were harvested at 50% flowering. Mung crop was infested with *Cercospora* and *Rhizoctonia* blight during 2006-07 and 2007-08 resulting in poor yield. All cultural practices were followed uniformly in all the treatments.

Results and Discussion

Growth and yield parameters: The growth parameters were influenced significantly with the application of inorganic and combination of organic and inorganic fertilizers over control in all the crops in sequence (Table 3). In mung, the plant height, branches/plant, pods/plant, pod length, grains/pod was significantly higher with inorganic fertilizers over control and 50% RDF+ biofertilizer and 50% RDF+25% N through FYM+ biofertilizer. Similar trend was observed in oat, bajra and cowpea fodder crops. These results are in line with those of Tiwana and Puri (2006) in sorghum fodder and; Joshi and Kewalanand (2011) in integrated nutrient management in food ï fodder based cropping system.

Productivity: Integrated nutrient treatments recorded significantly higher productivity of all other crops in sequence over control. During the first two years of the study, the 100 % recommended dose of fertilizer (RDF) recorded significantly higher fodder yield of oat, bajra and cowpea and grain yield of mung in mung (*Phaseolus aureus*) - fodder oats (*Avena sativa*) - bajra (*Pennisetum glaucum)* + cowpea (*Vigna unguiculata)* cropping system among all the treatments. Tiwana and Puri (2006) also recorded higher fodder production in sorghum with 100% RDF over integrated nutrient management treatments. During the third year, the differences in productivity of mung, oat and pearl millet + cowpea in sequence were non-significant between 100 % RDF, 75 % RDF + 25 % N through FYM and 50 % RDF + 50 % N through FYM. But during the fourth year the productivity of food and fodder crops in sequence were higher with 75 % RDF + 25 % N through FYM than with 100 % RDF and 50 % RDF + 50 % N through FYM. In the fifth year, the 50 % RDF + 50 % N through FYM recorded higher productivity of food and fodder crops than 75 % RDF + 25 % N through FYM and 100 % RDF. It might be due to the combined effect of organic and inorganic fertilizers which improved the physical, chemical and biological properties of soil resulting in higher productivity of the sequence (Singh *et al*., 2008). The average of five years data, indicated that all the fertilizer treatments recorded significantly higher productivity of mung, oats and bajra + cowpea in sequence and fodder equivalent yield over control. The grain yield of mung and fodder yield of oat and bajra + cowpea was almost similar with 100 % RDF and 75 % RDF and 25 % N through FYM but was significantly higher than rest of the treatments. Similar trend was also observed in fodder equivalent yield. The present findings revealed that the incorporation of organic fertilizers might be useful in long term. The application of FYM improved the soil physic-chemical properties for better growth and yield of mustard (Chand *et al*., 2007). Joshi and Kewalanand (2011) also reported that the application of 50 % N through FYM + 50 % N through inorganic fertilizers was at par with 100 % N through inorganic fertilizers in terms of green fodder, dry matter and equivalent yield in rice ï berseem - maize + cowpea cropping system. Biofertilizers did not improve the fodder and grain yield of the sequence significantly. The response of biofertilizer *Azotobactor* was also not observed by Tiwana *et al* (2001) in sorghum fodder and Tiwana and Puri (2004) in seed crop of oat.

Table 1. Effect of INM on yield of crops in mung-oats-bajra + cowpea cropping system (pooled over 5 years)

Treatments	Mung			Oats		Bajra + Cowpea		
	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index	Green fodder yield (q/ha)	Dry matter yield (q/ha)	Green fodder yield (q/ha)	Dry matter yield (q/ha)	Fodder equivalent yield (q/ha) of system
T_1	3.33	17.4	0.19	460.6	95.2	449.4	84.6	1181
T_2	6.42	24.9	0.26	667.2	138.0	630.2	118.8	1762
T_3	6.39	25.1	0.25	662.0	136.0	638.4	114.4	1764
T_4	6.10	24.6	0.25	654.4	134.4	629.6	114.0	1736
T_5	4.50	20.2	0.22	555.8	114.6	525.0	95.8	1435
T_6	5.14	21.7	0.24	616.2	127.2	578.6	104.2	1596
T_7	5.41	22.5	0.24	610.2	125.8	570.0	101.8	1584
SEM ±	0.25	1.46	-	26.0	6.51	22.8	4.89	79.3
CD (P=0.05)	0.77	4.49	-	80.2	20.1	70.4	15.1	143.3

Table 2. Effect of INM on the economics of mung-oats-bajra + cowpea cropping system (pooled over 5 years)

Treatments	Cost of cultivation (Rs./ha)	Gross monetary returns (Rs./ha)	Net monetary returns (Rs./ha)	Benefit:Cost ratio
T_1	30076	61705	31629	1.04
T_2	34201	92186	57985	1.68
T_3	35276	92742	57466	1.63
T_4	36362	91396	55034	1.51
T_5	32426	75240	42214	1.32
T_6	34714	83896	49182	1.42
T_7	33437	82934	49497	1.47
SEM ±	1518.3	4751.1	291.3	0.08
CD (P=0.05)	4676.3	14633.3	6963.7	0.23

Table 3. Effect of INM on the yield attributes of mung in mung-oats-bajra + cowpea cropping system (pooled over 5 years)

Treatments	Plant population	Plant height (cm)	Branches Per plant	Pods/ plant	Pod length (cm)	Grains/ pod	1000 grain wt (g)
T_1	10.7	44.2	5.8	10.7	7.9	8.1	34.4
T_2	10.6	54.4	6.9	17.1	8.5	9.2	35.3
T_3	10.4	52.7	7.2	17.3	8.6	9.6	35.5
T_4	10.5	51.3	7.4	17.8	8.6	9.3	35.3
T_5	10.8	46.2	5.2	13.2	8.0	8.3	35.0
T_6	10.6	47.8	6.2	15.2	8.3	8.8	35.2
T_7	10.7	49.6	6.4	15.1	8.4	8.7	35.1
SEM ±	0.46	1.69	0.24	0.52	0.24	0.26	1.47
CD (P=0.05)	NS	5.21	0.74	1.61	NS	0.81	NS

Table 4. Effect of INM on the growth characteristics of fodder crops in mung-oats-bajra + cowpea cropping system (pooled over 5 years)

Treatments	Oat			Bajra			Cowpea		
	Plant height (cm)	Tillers/ meter	Leaf: stem ratio	Plant height (cm)	Tillers/ meter	Leaf: stem ratio	Plant height (cm)	Tillers/ meter	Leaf: stem ratio
T_1	89.9	44.1	0.62	135.8	33.2	0.51	144.2	10.4	0.64
T_2	104.1	48.0	0.75	165.2	33.6	0.66	165.8	10.8	0.81
T_3	107.6	48.8	0.78	168.9	33.8	0.65	168.1	10.7	0.82
T_4	106.0	47.8	0.78	168.2	33.9	0.63	170.0	10.9	0.82
T_5	99.1	45.3	0.66	148.1	31.2	0.53	150.6	10.6	0.71
T_6	102.7	46.6	0.72	151.7	32.8	0.60	159.9	10.7	0.78
T_7	100.6	46.3	0.72	152.2	32.6	0.59	160.3	10.9	0.78
SEM ±	4.75	1.29	-	7.12	1.34	-	7.82	0.46	-
CD (P=0.05)	14.6	3.96	-	21.9	4.13	-	24.1	NS	-

T_1-Control, **T_2**-100% of NPK through inorganic fertilizer, **T_3**-FYM 25% N+75% NPK through inorganic fertilizer, **T_4**-FYM 50% N+50% NPK through inorganic fertilizer, **T_5**-50% NPK through inorganic fertilizer + Biofertilizer, **T_6**-FYM 25% N+50% NPK through inorganic fertilizer + Biofertilizer, **T_7**-75% NPK through inorganic fertilizer + Biofertilizer

Economics: Monetary returns of the system also increased with the application of fertilizer treatments over control. The highest monetary returns (Rs. 57985/ha) and B: C ratio (1.68) were obtained with 100% RDF which were at par with 75% RDF + 25% N through FYM (Rs. 57466/ha and 1.63) and 50 % RDF + 50 % N through FYM (Rs. 55034/ha and 1.51) and was significantly higher over rest of the treatments. On par net returns and B:C ratio with 100 % RDF and 75% RDF + 25% N through FYM were might be due to low cost of inputs in 100 % RDF and greater yield with 75% RDF + 25% N through FYM in the sequence. Bio-fertilizers did not influence the economics of mung (grain) - oats (fodder) - bajra + cowpea fodder cropping system. The higher B:C ratio with 100 % RDF has also been reported by Chandrika *et al.* (2011) in sorghum ï cowpea cropping system.

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