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Production potential of summer legumes–maize (*Zea mays*) sequence under varying levels of nitrogen

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ABSTRACT

A 2-year field experiment was conducted at Pantnagar on sandy-loam soil to study the performance of rainy-season (*kharif*) maize (*Zea mays* L.) raised with varying levels of N (0,30,60 and 90 kg/ha) and in sequences with different preceding summer crops, viz. urdbean or blackgram (*Phaseolus mungo* L.), mungbean or greengram (*P. radiatus* L.), cowpea [*Vigna unguiculata* (L.) Walp.] fodder and grain and maize fodder. The maize grown after cowpea for fodder gave the highest grain yield, N uptake, whereas when grown after maize for fodder showed lowest values. The interaction effect showed that maize when grown after cowpea fodder and mungbean and supplement with 30 kg N/ha resulted in significantly higher grain yield than 60 and 90 kg N/ha as well as than other summer crops. Significantly higher net return, benefit : cost ratio were also recorded in cowpea fodder–maize sequence. Grain yield, net return and benefit : cost ratio increased significantly with increasing level of N up to 60 kg/ha.

Since maize (*Zea mays* L.) is a cereal and exhaustive crop, fertilizer nitrogen constitutes an important and costly input in its production. In a crop rotation, inclusion of legumes improves soil fertility particularly N better than cereal—cereal sequence (Yadav, 1985) and consequently the productivity of succeeding cereal (Singh and Awasthi, 1978). Legumes being atmospheric N fixer, not only help in utilizing N in the current growing season but also help in residual nutrient build up of the soil. Further, economic consideration is one of the best criteria to choose the appropriate crop rotation for a particular area. Inclusion of legumes in rotation is profitable (Ramtake *et al.*, 1986). An experiment was therefore conducted to study performance of maize raised with varying levels of nitrogen and in sequence with different preceding summer crops and the economics of different rotations.

MATERIALS AND METHODS

The field experiment was conducted at the Crop Research Centre, Pantnagar, during summer and the rainy seasons (*kharif*) of 1991 and 1992 on sandy-loam soil (Mollisols) (neutral pH), containing 0.066% total N, 21.1 kg P/ha and 339.1 kg K/ha. Treatments consisting of 5 summer crops, viz. urdbean (*Phaseolus mungo* L.), mungbean (*P. radiatus* L.), cowpea [*Vigna unguiculata* (L.) Walp.] for fodder, cowpea for grain and maize for fodder and fallow as main plot and 4 levels of N (0,30, 60 and 90

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kg/ha) applied to maize as subplot were replicated 4 times in split-plot design. Various summer crops were sown in the first fortnight of March with an uniform dose of 100 kg diammonium phosphate (18-46-0)/ha. Composite maize 'Sweta' was sown at a spacing of 60 cm x 20 cm in the last week of June during both the years. Nitrogen was applied to maize as per treatment in 3 equal splits through urea, i.e. one-third at sowing, one-third at knee-high stage and one-third at tasselling stage. A basal application of 60 kg P_2O_5/ha through single superphosphate was also made.

RESULTS AND DISCUSSION

Performance of summer crops

The grain yield was the highest in urdbean and lowest in cowpea. The green fodder was greater in cowpea than in maize but maize accumulated the highest dry matter/plant (Table 1). The fodder cowpea showed the highest N uptake and biological nitrogen fixation. The lowest N uptake was recorded by maize fodder because it was given only 18 kg N/ha to calculate the biological nitrogen fixation.

Yield of maize

The grain yield of maize was affected due to different preceding summer crops. The maize grown after cowpea for fodder gave the highest grain yield which was significant compared with cowpea for grain and maize for fodder (Table 2). The lowest grain yield was recorded when maize was grown after maize. The result confirms the findings of Singh *et al.* (1982). Poor performance of grain cowpea among the summer crops was due to the sub-optimal plant population (0.142 million/ha). Increase in yield of maize by legumes over maize for fodder appeared primarily due to their residual N effect owing to biological nitrogen fixation rather than to rotational effect. The results are in agreement with the findings of Roy Sharma and Singh (1970). The grain yield of maize increased significantly with increasing level of N up to 60 kg/ha. The increase in yield owing to N application could be related to the general improvement in the plant growth.

The interaction effect showed that maize grown after cowpea for fodder and mungbean and received 30 kg N/ha resulted in significantly higher grain yield over 60 and 90 kg N/ha, whereas maize grown after other summer crops gave significantly higher grain yield at 60 kg N/ha (Table 2). At 30 and 60 kg N/ha only, there was significant differences in grain yield due to different summer crops. The grain yield recorded after cowpea for fodder and mungbean were significantly higher than

Table 1. Growth parameters of summer crops (mean data of 2 years)

Summer crop	Grain yield (kg/ha)	Fodder yield (tonnes/ha)	Dry matter (g/plant)	N uptake (kg/ha)	BNF (kg/ha)
Urdbean	697.5		8.8	46.6	24.6
Mungbean	645.5		14.3	40.0	18.0
Cowpea (fodder)		17.0	23.8	81.5	59.5
Cowpea (grain)	419.0		33.3	45.2	23.2
Maize (fodder)		12.0	50.0	22.0	

BNF, Biological nitrogen fixation

Table 2. Interaction between summer crops and nitrogen applied to maize for grain yield of maize (kg/ha)

Summer crop	N applied to maize (kg/ha)				
	0	30	60	90	Mean
Urdbean	3,145	3,704	4,229	4,602	3,920
Mungbean	2, 628	4,452	4,830	4,921	4,208
Cowpea (fodder)	3,460	4,907	4,617	4,631	4,404
Cowpea (grain)	2,340	2,970	4,335	4,733	3,594
Maize (fodder)	2,356	3,281	3,950	4,317	3,476
Fallow	2,810	3,333	4,747	4,900	3,947
Mean	2,790	3,774	4,451	4,684	
CD (P = 0.05)					
Summer crops		504			
N applied to maize		279			
For 2 N levels under same summer crops		623			
For 2 summer crops at same or different levels of N		701			

other crops at 30 kg N/ha, whereas yield of maize grown after rest of the summer crops was superior to maize for fodder at 60 kg N/ha. Thus, interaction effect indicated that maize responded less to N when grown after leguminous crops.

Nitrogen uptake

The residual effect of cowpea for fodder was more prominent resulting in significantly higher N uptake in maize compared with the other summer crops (Table 3). Higher yield and N% in maize grown after cowpea for fodder might be responsible for higher total N uptake. Further, the higher N uptake by maize after legumes may be attributed to the improvement in fertility status of soil through biological N fixation. Singh *et al.* (1970) also made similar inferences. Increasing level of N up to 90 kg/ha applied to maize resulted in significant increase in uptake of Nitrogen.

Economics

Significantly higher net return and benefit : cost ratio were recorded in cowpea fodder–maize sequence. The may be attributed to higher yield of maize (Table 2) and low cost of cultivation under this sequence (Table 3). Net return was higher under mungbean–maize sequence than all the other sequences except cowpea fodder–maize sequence. This could be ascribed to higher grain yield of maize after mungbean and higher commodity price of mungbean. Higher benefit : cost ratio obtained under fallow–maize compared with blackgram–maize, grain cowpea–maize and maize–maize sequences could be possibly due to very low cost of cultivation and high yield of maize. Lower yield of maize and higher cost of cultivation under cowpea grain–maize sequence perhaps be the possible reason of lowest net return and benefit : cost ratio. Higher net return and benefit : cost ratio ob-

Table 3. N uptake by maize and economics under different crop sequences (mean data of 2 years)

Treatment	N uptake (kg/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio
Sequence				
Urdbean–maize	92.0	8,689	7,261	0.83
Mungbean–maize	100.1	8,635	9,150	1.04
Cowpea (F)-maize	109.0	7,381	10,363	1.40
Cowpea (G)–maize	83.2	8,617	5,392	0.63
Maize (F)–maize	77.8	7,467	6,094	0.81
Fallow–maize	94.3	4,471	5,922	1.31
CD (P = 0.05)	8.6		1,020	0.08
N applied to maize (kg/ha)				
0	64.5	7,176	4,955	0.71
30	89.3	7,412	6,975	0.98
60	105.3	7,716	8,622	1.16
90	111.5	7,868	8,920	1.17
CD (P = 0.05)	5.1		406	0.05

Price (Rs/q) : Cowpea grain, mungbean and urdbean 875, 950 and 750 respectively; cowpea and maize fodder 40

tained from the sequences with legumes except cowpea grain–maize if compared with maize–maize sequence may be due to higher grain yield of maize obtained after legumes. Faroda and Singh (1983) also obtained higher net return from legume–cereal sequences over cereal–cereal sequence. Net return and benefit : cost ration also increased significantly with increasing level of N up to 60 kg/ha.

Thus maximum yield, N uptake, net return and benefit : cost ratio could be obtained if cowpea fodder–maize sequence is practised where preceding cowpea could save 30–60 kg N/ha for the succeeding maize.

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