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Effect of Integrated Nitrogen Management and Intercropping Systems on Yield Attributes and Yield of Maize

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ABSTRACT

The field experiments were conducted to study the **e**ffect of integrated nitrogen management (INM) and intercropping systems on yield attributes and yield of maize during *kharif* seasons of year 2009 and 2010 at KVK, Chomu, Jaipur (Rajasthan). The treatments included cropping patterns *viz.* sole maize, maize + one row mung bean, maize + two row mung bean and sole mung bean and integrated nitrogen management i.e. control, 60 kg N/ha, 60 kg N/ha + biofertilizer (*Rhizobium + Azospirillium* + PSB), 120 kg N/ha, 120 kg N/ha + bio-fertilizer (*Rhizobium + Azospirillium* + PSB) and biofertilizer (*Rhizobium + Azospirillium* + PSB). Intercropping maize and mung bean markedly influenced cobs/ plant, length of cobs, grains/cob, 1000-grains weight, grain yield/ha and stover yield/ha of maize. Higher stover and grain yield was found with maize + two rows of mung bean over maize + one row of mung bean and sole maize in both the years. The INM also significantly affected yield attributes and yield of maize in both the years of experimentation. Application of 120 kg N/ha + biofertilizers (*Rhizobium + Azospirillium* + PSB), produced maximum number of cobs/plant, number of grains/ cob, cob length, 1000-grains weight, grain and stover yield of maize in both the years.

Keywords: Biofertilizers, Intercropping, Maize, Mung bean, Nitrogen, Yield

INTRODUCTION

The production of food grains need to be substantially enhanced to meet the prescribed quantitative and qualitative standards of nutrition of our more than one billion population. Horizontal expansion of the cultivated area constitutes a very remote possibility since the country has already reached the maxima of expansion of area to augment the production. Maize is known to be very responsive to better management. However, the package of practices not only differs for various cropping systems in different regions of the country but also require some adjustment to meet the specific needs of the individual farmer so as to help him to increase his productivity and profit.

Maize provides sufficient inter-row space, which can be profitably utilized for raising a short duration pulse crop. Short duration varieties of mung bean can be successfully intercropped with maize and the resource utilization efficiency can be greatly enhanced. However, it should be borne in mind that the cultivars of both maize and mung bean should be compatible in terms of growth rhythm, nutrient and water requirement. Efforts should be made to maintain the recommended optimum population of both these intercrops components. The intercropping systems generally involve the simultaneous cultivations of legumes and cereals in various adoptable combinations on the same piece of land. The growth rhythm also constitutes a kingpin so far as the success of an intercropping system concerned. Inclusion of legume in an intercropping system has assumed added significance in recent past particularly in India since it provides the way to sustainable crop production. Cropping system based research received attention of researchers for utilizing the beneficial effects of

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growing crops of dissimilar nature in mixed/ intercropping (Abbas et al.1995)

Mung bean is an important pulse crop, extensively cultivated under varying agro climatic condition. Being a short duration crop and having wide adaptability, it is grown all over the year as a pure crop, double crop and as an inter crop. Mung bean can be grown successfully under most adverse arid and semi arid conditions where other crops shown very poor performance. But in intercropping system both the crops give higher yield in comparison to sole crops.

Integrated nutrient management including application of organic and inorganic fertilizers, and biofertilizers are warranted for sustainable food production and maintaining soil health (Patil et al. 1992). De et al. (1986) indicated that utilization of nitrogen was more in maize + green gram intercropping system than sole crop of maize.

The current availability of pulses in India is 36 g/head/day as against the minimum and optimum requirement of 80 and 104 g/head/day, respectively. It may be noted that there is no possibility of bringing more area under pulse crops and the future prospects in this regard appear remote. Under such difficult and demanding situations, spatial and /or temporal intensification of cropping, particularly in the form of intercropping, provides an alternative of immense relevance and potential.

Choudhary and Rasario (1994) reported that yield of maize increased by 60% in the sole cropping and 71% in the intercrop as the N application rate was increased from 0 to 90 kg/ha. Mishra et al. (1995) observed that in maize, grain yield and net returns were the highest with combination of NPK + *Azotobactor*. Nanda et al. (1995) reported that green fodder yield and benefit:cost ratio were the highest with combination of 75 kg N / ha and seed inoculation with *Azosprillium*. The nutrient requirement of these crops particularly in intercropping system will be different than that for their sole crops. The maintenance and/or augmentation of productivity of this system call for balanced use of nutrients. The survey of available research information has shown that there is only scanty and sparse information available on nutrition aspects of intercropping system for sandy loam soil and semi arid climatic condition. Therefore, it was deemed necessary to conduct the field studies on nutritional aspects of maize + mung bean intercropping system.

MATERIAL AND METHODS

Field experiments were conducted during *kharif* seasons of 2009 and 2010 at KVK-Chomu-Jaipur (Rajasthan) to study the effect of INM and intercropping systems on yield attributes and yield of maize. The experimental soil was sandy loam with slight alkaline having pH 8.2 poor in organic carbon (0.17%), available nitrogen (141 kg/ha), phosphorus (17.0 kg/ha and medium in potassium (152.0 kg/ha) content. The experiment was laid out in a split plot design with three replications. The experiment consisted of four cropping pattern viz; sole maize (60 cm row spacing), maize paired row (40/80 cm row spacing) + one row of mung bean, maize paired row + two rows of mung bean and mung bean sole (30 cm row spacing) and six integrated nitrogen management management viz; 60kg N/ha, 60 kg N/ha + biofertilizer (*Rhizobium* + *Azosprillium* + PSB), 120 kg N/ha, 120 kg N/ha + biofertilizer (*Rhizobium* + *Azosprillium* +PSB), biofertilizer (*Rhizobium* + *Azosprillium* + PSB) and control. The plot size was 22.5 m^2 in gross and net size was 14.0 m^2. The variety of maize was HQPM-1 and that of mung bean was RMG-668 for the experiment. The maize seed was sown @ 20 kg/ha at an inter-row spacing of 60 cm in maize sole, maize + one row of mung bean and maize+ two rows of mung bean. Mung bean seed was sown @ 15 kg/ha. The inter-row spacing in maize was kept 20 cm. The nitrogenous fertilizer was applied as per treatment in three times i.e., 1/3 dose of N at the time of sowing as basal, 1/3dose at knee-high stage and rest of 1/3 dose at the time of tasseling stage, where phosphorus and potassium fertilizers were applied as per recommended dose as basal. The crops were sown on 22 and 24 June 2009 and 2010, respectively. The observations on yield attributes and yield of maize were recorded at harvest and statistical analysis was performed using standard tools.

RESULTS AND DISCUSSION

Data presented in Table 1 revealed that yield attributes of maize as cobs/plant, length of cobs, no. of grains/cob and 1000-grains weight were influenced significantly by the different cropping patterns. Number of cobs/plant (1.15 and 1.19) increased significantly with maize + one row of

Table 1: Effect of integrated nitrogen management and intercropping system on yield attributes of maize

Treatment	Number of cobs/plant		Length of cobs (cm)		Number of grains/cob		Grain weight / cob(gm)		Test Weight (gm)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Cropping pattern										
Sole maize (60 cm row spacing)	1.07	1.11	16.4	16.79	364.6	376.7	87.6	90.7	246.0	247.8
Paired row (40/80 cm) + 1 row of mung bean	1.15	1.19	17.3	17.89	380.2	399.8	95.2	98.8	248.9	251.4
Paired (40/80 cm) + 2 row of mung bean	1.18	1.20	17.5	17.98	384.3	401.1	97.0	101.8	251.6	253.7
SEm±	0.01	0.01	0.1	0.12	2.15	2.8	0.63	0.72	1.42	1.66
CD at 5%	0.02	0.02	0.3	0.35	6.46	8.3	1.88	2.16	NS	NS
Integrated nitrogen management										
Control	1.02	1.05	15.6	16.1	333.7	347.0	72.3	75.6	225.6	227.8
60 kg N/ha	1.12	1.14	16.8	17.4	366.6	385.0	89.2	92.5	246.2	249.0
60 kg N/ha + Biofertilizers*	1.14	1.18	17.5	17.8	387.7	409.3	99.1	103.9	257.3	258.3
120 kg N/ha	1.18	1.21	17.7	18.3	395.6	415.7	103.1	107.4	258.7	260.8
120 kg N/ha + Biofertilizers	1.20	1.23	17.8	18.3	405.0	446.7	105.3	109.6	260.6	263.5
Biofertilizers	1.14	1.15	17.0	17.4	369.7	382.0	90.5	93.9	244.3	246.3
SEm±	0.01	0.13	0.2	0.19	3.60	4.6	1.03	1.17	2.36	2.78
CD at 5%	0.03	0.36	0.4	0.54	10.18	13.0	2.91	3.32	6.68	7.88

**Rhizobium* + *Azospirillium* + phosphorus solubilizing bacteria

mung bean and maize + two rows of mung bean (1.18 and 1.20) over sole maize (1.07 and 1.11) in both the years. Whereas, length of cobs and grains/cob influenced markedly with maize + two rows of mung bean. The maize + two rows of mung bean treatment increased length of cobs (17.51cm and 17.98 cm) and grains/cob (384.3 and 401.13) significantly over sole maize (16.62 cm and 16.79 cm cob length) and 364.6 and 367.7 grains/cob) and non-significantly over maize + one row of mung bean in both the year. The cropping patterns could not affect 1000-grains weight significantly over sole maize (246.0 and 247.8 g) but maximum was recorded with maize + two row of mung bean (251.6 and 253.7 g) in both the years. The improvement in yield attributes was assigned to the synergistic effect of maize and mung bean association (Singh and Bajpai 1991). Further, the yield attributes also exhibited an improvement on account of the association of maize with mung bean. It is presumed that there was a better source to sink relationship which finally improved of these parameters. These findings corroborated with the results of Singh et al. (1988) in maize + legumes and Ibrahim et al. (1990) in maize + cowpea intercropping systems.

Grain and stove yield of maize were influenced by different cropping patterns (Table 2). Maize + one row of mung bean (3767 kg and 3989 kg/ha) and maize – two rows of mung bean increased grain yield (3909 kg and 4118 kg/ha) significantly over sole maize (3516 kg and 3756 kg/ha) in both the years. Maize + two rows of mung bean also influenced grain yield markedly over maize + one row of mung bean in both years. Maize + two rows of mung bean significantly increased stover yield (6576 kg and 6840 kg/ha) over sole maize (5992 kg and 6161 kg/ha) and remained at par with maize + one row of mung bean (6515 kg and 6736 kg/ha) in both the years. Improvement in yield attributes under intercropped stand over pure stand contributed to significant increase in grain yield under intercropping systems. This increase in grain yield was in order of 11.18 and 9.64 % in maize + two rows of mung bean and maize + one row of mung bean over sole maize, respectively. Similar results were also obtained by Singh et al. (1988) and Gangwar and Kalra (1983).

Number of cobs/plant, length of cob/plant, number of grains/cob and 1000-grain weight were greatly influenced by the integrated nitrogen

Table 2: Effect of integrated nitrogen management and intercropping system on yield of maize

Treatment	Grain yield (kg/ha)		Stover yield (kg/ha)	
	2009	2010	2009	2010
Cropping patterns				
Sole maize (60 cm row spacing)	3516	3756	5992	6161
Paired row (40/80 cm) + 1 row of mung bean	3767	3989	6515	6736
Paired (40/80 cm) + 2 row of mung bean	3909	4118	6576	6840
SEm±	0.20	0.32	0.34	0.48
CD 5%	0.62	0.97	1.03	1.44
Integrated nitrogen management				
Control	2901	3027	5402	5611
60 kg N/ha	3684	3823	6122	6358
60 kg N/ha + Biofertilizers*	3945	4190	6695	6850
120 kg N/ha	4062	4340	6831	7076
120 kg N/ha + Biofertilizers	4141	4433	6915	7166
Biofertilizers	3649	3920	6200	6414
SEm±	0.34	0.52	0.57	0.78
CD 5%	0.96	1.48	1.62	2.22

**Rhizobium* + *Azospirillium* + phosphorus solubilizing bacteria

management. Maize yield parameters were maximum with 120 kg N/ha + bio-fertilizers (*Rhizobium* + *Azospirillium* + PSB) compared to rest of the treatments in both years (Table 1). Nitrogen plays an important role in plant metabolism since it is an essential constituent of a number of metabolically active components, finally resulting in the improvement in growth, development and productivity of maize. Similar results were also reported by Shivey et al. (2002), Singh and Pareek (2003), and Gosavi and Bhagat (2009).

Maximum grain and stover yield was obtained with application of 120 kg N/ha + bio-fertilizers (4141 kg and 4433 kg/ha grain and 6915 and 7166 kg/ha stover) which was significantly higher compared to other treatments but remained at par with 120 kg N/ha (4062 kg and 4340 kg/ha grain and 6831 kg and 7076 kg/ha stover) in both the year. This increase could be assigned to the improvement of yield attributes namely cobs/plant, grain weight/cob and number of grains/cob (Ogunlela et al. 1988; Singh et al. 1988; Kumar and Singh 1992) and similar results were also reported by Guggari and Kalaghatagi (2005) for pearl millet and pigeon pea intercropping system.

In maize mung bean intercropping system at Jaipur (Rajasthan) maize + two rows of mung bean were found most suitable and productive than sole maize. Maize + one row of mung been was also found superior to sole maize. Integrated nitrogen management involving application of 120 kg N/ha + biofertilizer was recommended for higher productivity of maize rather than sole of 120 kgN/ha.

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