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Original Research Article

Productivity and Profitability of Maize (*Zea mays*) - Indian mustard (*Brassica Juncea*) Cropping System as Influenced by Site Specific Nutrient Management and Maize Hybrids

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A B S T R A C T

Field experiments were carried out at Research farm, Ambikapur in two consecutive *kharif-rabi* seasons of 2012-13 and 2013-14 to work out the effect of nutrient management and maize hybrids on production and profitability of maize (*Zea mays* L.) - Indian mustard (*Brassica Juncea*) cropping system. The nutrient Expert™ for hybrid Maize is a new computer- based decision support tool developed to assist local experts to quickly formulate fertilizer guidelines for hybrid maize based on the principles of site-specific nutrient management (SSNM). SSNM (170:67:86 kg $N:P_2O_5:K_2O$ kg/ha) recorded highest yield attributes, viz., cob length (cm), cob girth (cm), grain rows/cob, grains/row, shelling% and 1000 grain weight (g) significantly higher over 50% RDF but at par with 100% RDF (150:60:40 kg $N:P_2O_5:K_2O$ kg/ha). SSNM recorded significantly highest cob yield and grain yield (kg/ha) over 100% and 50% RDF. Maize hybrids 'PMH 3' recorded yield attributes, viz., cob length (cm), cob girth (cm), grain rows/cob, grains/row, shelling% and 1000 grain weight (g) which was at par with 'PMH 1' but significantly superior to other hybrids. Significantly lowest yield was recorded by 'HQPM 1'. Highest system productivity, net return and B: C ratio recorded under SSNM which was significantly superior to 50% RDF but at par with 100% RDF. Maize hybrids 'PMH 3' recorded higher system productivity, net return and B: C ratio which was at par with 'PMH 1' but significantly superior to other hybrids. Significantly lowest system productivity, net return and B: C ratio was recorded by 'HQPM 1'.

Keywords

Maize, Indian mustard, site specific nutrient management, system productivity

Introduction

Maize crop regarded as a queen of cereals occupies pride place among rainy season (Kharif) crops in India and contributing around 24% of total cereal production (Singh *et al.,* 2011). It is cultivated in India over 8.67 million ha with 22.26 million tonnes production having an average productivity of 2566 kg/ha, contributing nearly 8% in the national food basket (DACNET, 2014). After cereals, oilseeds being the second largest agriculture commodity share 13.5 and 5% gross cropped area and national product respectively. Maize is the predominant kharif crop of North Hills region of Chhattisgarh and maize-mustard is the predominant cropping system of this zone. Though the sustainability of this cropping system is dependent upon several interacting factors, which include climate, soil quality,

weed management, irrigation management, pest incidence and economic factors, of these factors, nutrient management in cropping system mode appears to be the most crucial. Both maize and mustard are exhaustive feeders of plant nutrients and continuous adoption such system results in removal of nutrients in substantial amounts that often exceeds replenishments through fertilizers and manures, leading ultimately to deterioration in soil fertility and reducing the productivity of the system.. Productivity of maize- mustard is also limited by low fertilizer efficiency, inadequacy in existing fertilizer recommendation and ignorance of nutrient balance and hence pausing serious threat. The nutrient Expert™ for hybrid Maize is a new computer- based decision support tool developed to assist local experts to quickly formulate fertilizer guidelines for hybrid maize based on the principles of site-specific nutrient management (SSNM).

There exists significant opportunity to increase fertilizer efficiency and productivity of maize by adopting Nutrient Expert-based field specific fertilizer recommendations (Satyanarayana *et al.*, 2013). Hence present field investigation was carried out to evaluate five top maize hybrids under site specific nutrient management system and recommended dose of fertilizer (RDF).

Materials and Methods

The present investigations were conducted during two consecutive *kharif- rabi* seasons of 2012-13 and 2013-14 at the Research Farm, RMD Collage of Agriculture & Research Station, Ambikapur (Chhattisgarh) situated at $23^0$18' N latitude and $83^0$15' E longitude and at altitude of 611 meter above mean sea level. The soil of experimental field was sandy loam in texture. Chemical analysis of the soil (top 15 cm) showed an acidic pH (5.7), organic carbon 0.56%, 234 kg/ha nitrogen, 8.4 kg/ha phosphorous, 268 kg/ha potassium. The meteorological data recorded at meteorological observatory of the station indicated that rainfall received during the crop seasons was 1185 mm (60 rainy days) and 1090.2 mm (64 rainy days) in 2012-13 and 2013-14, respectively. The field experiment was laid out in split block design with three treatments of fertility levels, 50% RDF (75:30:20 kg N:P_2O_5:K_2O kg/ha), SSNM based fertilizer dose (170:67:86 kg N:P_2O_5:K_2O kg/ha) and 100% RDF (150:60:40 kg N:P_2O_5:K_2O kg/ha) in main plots and five maize hybrids PMH 1, PMH 3, HQPM 1, CMH-08-350 and CMH-08-292 as sub plot treatments with three replications. The crop was sown in 1st week of July in both the years whereas Indian mustard (Pusa Jaikisan) in November just after harvesting of maize. Nitrogen as per treatment was applied in five splits. Twenty per cent dose of nitrogen along with full dose of phosphorous and potassium were applied at the time of sowing. The remaining dose of nitrogen was applied in four splits at 30 (30%), 45 (30%) and 60 (20%) days after sowing. Indian mustard was taken at 50% of recommended fertilizer dose *i.e.* (60:40:30 kg N: P_2O_5: K_2O kg/ha). Previous maize crop was turned down and mixed in soil for conservation agriculture. Maize hybrids were sown at spacing of 75 cm with plant to plant spacing of 20 cm to maintain the plant population of 66,666 plants/ha using 25 kg seeds/ ha. Gap filling and thinning were done within 10 days after sowing to maintain the optimum plant population. Weeds were controlled by pre-emergence application of atrazine (1.5 kg *a.i.*/ha) to control the initial weed flushes whereas latter weed flushes were controlled by mechanical weeder at 25 days after sowing. Five random plants were tagged randomly from each plot for recording of growth and yield attributes.

Table.1 Effect of nutrient management practices and maize hybrids on yield attributes (pooled data of 2 years)

Treatments	Cob length (cm)	Cob girth (cm)	Grain rows/cob	Grain/row	Cob yield (kg/ha)	Shelling (%)	1000-grain weight (g)
Fertility level (Main Plot)							
50% of RDF	15.6	14.0	12.1	29.4	4972.0	78.4	316.9
SSNM based fertilizer	16.7	14.8	13.1	31.4	8236.0	82.6	350.5
100% RDF	15.9	14.4	12.6	31.3	7151.6	80.7	326.2
SEm±	0.3	0.2	0.2	0.3	254.1	0.7	5.8
CD (P=0.05)	0.9	0.7	0.6	0.8	999.1	2.0	22.7
Variety (Sub Plot)							
PMH 1	16.2	14.6	13.0	30.8	7787.3	78.2	327.8
PMH 3	17.0	14.9	13.0	31.0	7900.0	81.7	336.8
HQPM 1	15.4	14.0	12.2	30.4	5785.3	80.9	335.8
CMH-08-350	15.6	14.2	12.4	30.4	6064.3	80.8	332.4
CMH-08-292	16.1	14.2	12.4	30.8	6395.9	81.4	333.2
SEm±	0.2	0.2	0.2	0.2	257.6	0.5	5.9
CD (P=0.05)	0.7	0.6	0.5	0.6	750.4	1.8	17.2

Table.2 Effect of nutrient management practices and maize hybrids on maize- mustard cropping system (pooled data of 2 years)

Treatments	Grain yield of Maize (kg/ha)	Grain yield of Mustard (kg/ha)	System Productivity (t/ha)	Gross system returns	Net system returns	Benefit: cost ratio of system
Fertility level (Main Plot)						
50% of RDF	3995.7	607.6	5570.0	63671.5	35891.5	1.3
SSNM based fertilizer	6759.2	1273.3	9758.1	110933.0	78893.0	2.5
100% RDF	5594.2	932.8	8311.0	94807.8	63877.8	2.1
SEm±	208.9	21.2	203.5	2357.1	2357.1	0.1
CD (P=0.05)	821.2	83.2	800.0	9267.2	9267.2	0.3
Variety (Sub Plot)						
PMH 1	6067.2	959.6	8553.3	97794.5	67544.5	2.2
PMH 3	6439.6	981.0	8981.3	102371.2	72121.2	2.3
HQPM 1	4669.3	895.1	6988.5	79526.2	49276.2	1.6
CMH-08-350	4885.2	912.6	7249.5	82530.3	52280.3	1.7
CMH-08-292	5187.3	941.2	7625.9	86798.2	56548.2	1.8
SEm±	198.7	18.4	208.4	2409.5	2409.5	0.1
CD (P=0.05)	579.0	53.7	607.2	7019.5	7019.5	0.2

Gross returns, net returns and benefit: cost ratios were calculated on the basis of prevailing market price of inputs and produce. All data obtained in the cropping sequence experiment for 2 consecutive year of study were statistically analyzed using *F*-test, the procedure given by Gomez & Gomez (1984), critical difference (CD) values at *P*= 0.05 were used to determine the significance of differences between means.

Results and Discussion

Yield attributes maize hybrids

Fertility level significantly affected the yield attributes and yield of maize hybrids. All the yield attributes, viz., cob length (cm), cob girth (cm), grain rows/cob, grains/row, shelling% and 1000 grain weight (g) were recorded significantly higher by SSNM over 50% RDF but at par with 100% RDF (Table 1).

Maize hybrids 'PMH 3' recorded yield attributes, viz., cob length (cm), cob girth (cm), grain rows/cob, grains/row, shelling% and 1000 grain weight (g) which was at par with 'PMH 1' but significantly superior to other hybrids. Significantly lowest yield was recorded by 'HQPM 1'.

Enhancement in growth attributes lead to photosynthate partitioning and better source-sink relationship, which enhances yield attributes. Kolo *et al.,* (2012) also confirmed similar findings in maize.

Yield maize hybrids, mustard yield and system productivity

Fertility level significantly affected the yield of maize hybrids, mustard yield and system productivity. Yield of maize hybrids, mustard yield and system productivity were recorded significantly higher under SSNM than 50% RDF but at par with 100% RDF (Table 2).

Maize hybrids 'PMH 3' recorded highest yield and system productivity which was at par with 'PMH 1' but significantly superior to other hybrids. Significantly lowest yield was recorded by 'HQPM 1'. Enhancement in growth attributes lead to photosynthate partitioning and better source-sink relationship, which enhances yield attributes. Kolo *et al.,* (2012) also confirmed similar findings in maize.

Economics of the cropping system

Gross system return, net system return and B: C ratio affected significantly by fertility levels. SSNM recorded highest gross system return, net system return and B: C ratio which is significantly higher than 50% RDF but at par with 100% RDF (Table 2).

Maize hybrids 'PMH 3' followed by Indian mustard recorded highest gross system return, net system return and B: C ratio which was at par with 'PMH 1' but significantly superior to other hybrids. Significantly lowest yield was recorded by 'HQPM 1' (Table 2).

Interaction

The system productivity of the maize-mustard system significantly influenced with interaction effect of fertility level and different maize hybrids (Fig 1). Combined effect of SSNM and 'PMH 3' recorded significantly higher grain yield (11.5 t/ha) which was comparable to SSNM and 'PMH 1' (10.7 t/ha) but significantly superior than all other combinations. The higher grain yield with the corresponding treatment combinations could be attributed to the adequate supply of nutrients through balanced nutrient management system,

proper growth and yield attributes. This led to higher system productivity.

It can be concluded from the results that yield attributes and grain yield of maize, mustard yield and system productivity can be enhanced with SSNM-based nutrient management over recommended dose of fertilizer along with use of 'PMH 3' followed by Indian mustard at 50% RDF.

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