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EFFECT OF PLANTING DENSITY AND NUTRIENT MANAGEMENT ON PERFORMANCE OF RABI HYBRID MAIZE

M.V. SINGH[1]

Crop Research Station, Bahraich -271801 (U.P.)

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ABSTRACT

A field experiment was conducted at Crop Research Station, Bahraich (Uttar Pradesh) during rabi seasons of 2012-13 and 2013-14 to study the effect of planting density and nutrient management on the performance of rabi hybrid maize. The two varieties of hybrid maize viz. Shreeram 9682, HM-7705 were located in main plot and two plant geometry viz. 60 x 20 cm, 50 x 20 cm as well as three levels of nutrients viz. RDF (200:60:60 kg NPK ha^{-1}) Soil Test Crop Response (STCR) (250:50:50 kg NPK ha^{-1}) and Site Specific Nutrient Management (SSNM) (225:60:85 kg NPK ha^{-1}) were located in sub-sub plot in split plot design with three replications. Results indicated that the higher yield attributing characters, yield (78.20 q ha^{-1}) and nutrients uptake and economics (` 81973 $ha^{-1}$) were recorded under maize variety HM-7705, The highest grain yield (75.65 q $ha^{-1}$) and net profit of ` 78335 ha^{-1} and uptake of nutrients were recorded under 60 x 20 cm plant geometry. The grain and straw yields of maize were the highest with the application of SSNM which was 19.3 % higher over state recommendation and 12.0 % over STCR practice, respectively. All the yield attributing characters as well as yield of the crop showed beneficial effects of site-specific nutrient management. Higher net return of ` 97481 ha^{-1} was obtained with SSNM treatment.

Keywords: Variety, planting density, nutrients management, economics, yield, rabi maize

INTRODUCTION

Maize is most versatile emerging crop having high yield potential wider adaptability to diverse ecologies and adverse environment. It caters the needs of both human and animals by providing food and feed to them. Amongst various agricultural inputs, selection of suitable hybrid maize variety and plant density have vital role in production of crop as well as economics of crop production. High potential variety and more adoptive nature produce higher yield in comparison to other genotypes. The plant geometry and optimum plant production has an important role in plant growth, yield attributing characters and yield of crop. Fertilizer plays a chief source in achieving the food production targets. For higher productivity, there is a need for the application of higher dose of fertilizers but the increased use of high analysis fertilizers and adaptation of high yielding cultivars demanding more primary, secondary and micro nutrients for enhancing food grain production The stagnation in crop production in India is basically due conventional fertilizer recommendation, low fertilizer use efficiency and imbalanced use of fertilizers. The quantitative evaluation of fertilizer doses may assist in improving yield with simultaneous increase in the nutrient use efficiency. At present, nutrient mining is a great threat to Indian agriculture as there is wide gap between nutrient addition and nutrient removal. One of the reasons for lower production is imbalanced use of fertilizers by the farmers without knowing soil fertility status and nutrient requirement of crop. There is a scope to increase. The production of maize by Soil Test Crop Response (STCR) correlation method, the fertilizer doses are recommended based on fertilizer adjustment equations which are developed after establishing significant relationship between soil test values and the added fertilizers. In Uttar Pradesh much work has not been done on the production technology of rabi maize specially on selection of suitable genotype for specific areas, plant density and NPK doses for rabi maize. Keeping this view in mind, an experiment was undertaken to study the effect of maize variety, plant geometry and levels of nutrients on growth and yield of rabi maize.

MATERIALS AND METHODS

[1] *Corresponding Author e-mail mvsinghbrh2013@gmail.com*

The experiment was conducted at the Crop Research Station, Bahraich Uttar Pradesh during rabi season of 2012-13 and 2013-14,

with two maize genotypes viz. Shreeram-9682 and HM-7705, two plant geometry (50 cm x 20 cm and 60 cm x 20 cm) along with three levels of nutrients viz recommended dose (200:60:60 kg NPK ha^{-1}). Soil Test Crop Response (250:50:50 kg NPK ha^{-1}) and Site Specific Nutrient Management (SSNM) basis (225:60:80 kg NPK ha^{-1}). The experiment was laid out in split plot design and treatments were replicated thrice. The genotypes were located in main plot, plant geometry located in sub plot and nutrients level in sub-sub plots. The soil of experimental plot was sandy loam in texture having neutral reaction (pH 7.5) low in organic carbon (2.8g kg^{-1} %) and available nitrogen (200 kg ha^{-1}) and medium in phosphorus (11.5 kg ha^{-1}) and potash (240 kg ha^{-1}), respectively. The crop was sown on 15 November in both the years. 1/3 dose of N and full dose of P and K were applied as basal placement at the time of sowing as urea, single superphosphate and muriate of potash, respectively and remaining 2/3 dose of nitrogen was applied as top dressing in two equal splits, first at time the of knee height and second at tassling stage of the crop. The irrigations and weed control measures were adopted in crop according to need of crop from time to time. Intercultur operations were also done two times during the crop season. Biometric observations such as plant height, cobs/plot, length of cobs, grains row/cob, number of grains/row, test weight, grain and stover yield were recorded after harvesting of crop. Economics of each treatment was calculated on the basis of nearest market prices of inputs and outputs. Grain and stover samples were digested in diacid mixture and P and K contents were determined by adopting standard methods (Jackson, 1973). Nitrogen content in grain and stover of maize was determined by modified Kjeldahl method. The data relating to each character were pooled and analyzed as per procedure advocated by (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Effect of maize hybrids

The data (Table 1) indicated that the significant differences were observed in growth and yield attributes in both the hybrids. Highest plant height (180.5 cm) was noted under the variety Shreeram-9682 which was significantly superior to Hybrid-HM-7705 (178.7 cm). Significantly higher plant population (158.2 /plot), number of cobs (174.5 /plot), length of cobs (19.26 cm), number of grains row/cob (18.4), number of grain/row (34.8), test weight (246.8 g) and selling percentage (82.5) were recorded with hybrid-HM-7705 over Shreeram-9682 might be due to genetic characters. The differences between maize hybrids in relation to growth and yield attributes were also reported by Singh *et al.,* (2014), Gozubenli *et al.* (2001), Ramchadrappa *et al.* (2007). Data on grain and stover yield (Table 1) revealed that the maximum grain (78.20 q ha^{-1}) and stover (89.93 q ha^{-1}) yields were recorded under the hybrid HM-7705 which was 10.3 percent higher in grain and 5.8 percent in stover yield over the Hybrid Shreeram-9682. The variation in yields between both the varieties might be due to genetical variation in the varieties. The lowest yields of grains (70.87 q ha^{-1}**)** and stover yield (85.0 q ha^{-1}**)** were noted under hybrid Shreeram-9682. The maximum harvest index (46.5 %) was noted under hybrid HM-7705 while lower (45.4%) in hybrid Shreeram-9682. The differences in harvest index between hybrid maize might be due to yield difference between the varieties. The higher nutrient uptake (175.9, 39.1 and 58.1 kg NPK ha^{-1}**)** was noted in the hybrid HM-7705 as compared hybrid Shreram-9682. The data revealed that higher net income of Rs. 81973 ha^{-1} was noted under hybrid HM-7705. The variation in net income between hybrids might be due to variation in grain and stover yield. The B:C ratio was also noted in similar manner under both hybrids. The Similar findings was also reported by Singh *et al.* (2014), Ramchandrappa *et al.* (2007).

Effect of plant density

The significantly taller plants height (181.8 cm) was noted under plant geometry 50 x 20 cm, while lower (179.6 cm) in geometry 60 x 20 cm (Table 1). Plant population178.7 plot/plot and 156.5/plot were noted under 50 x 20 cm and 60 x 20 cm plant geometry, respectively. The difference between plant population/ plot was due to difference in row spacing. The yield attributes significantly influenced by plant geometry. Highest value of cobs/plot (181.5) was

recorded under the plant geometry 50 x 20 cm which might be due to more plant population. Higher cob yield (17.5 kg), selling percentage (83), length of cobs (20.4 cm), grain/row (33.2) and row (18.6) and test weight (248.4g) was recorded under plant geometry 60 x 20 cm over the plant geometry 50 x 20 cm. The higher value of yield attributes under 60 x 20 cm might be due to more space for plant development over the plant geometry 50 x 20 cm. The finding are in conformity with the result of Sahoo and Mahapatra (2007) and Singh *et al.* (2013).

The data (Table 1) indicated that significantly higher grain yield (75.65 q ha^{-1}**)** and stover yield (89.25 q ha^{-1}**)** were noted under the plant geometry 60 x 20 while lower values of 70.87 q ha^{-1} and 85.0 q ha^{-1} grain and stover yield, respectively were noted under 50 x 20 cm. The yield of grain and stover under plant geometry 60 x 20 cm might be due to better yield attributing characters noted under some spacing over the 50 x 20 cm plant geometry. Similar finding were also reported by Singh *et al.* (2013), Farnhan *et al.* (2001) and Sahoo *et al.* (2007).

The data on nutrient uptake (Table 2) indicated that higher plant nutrient uptake (170.2, 37.8 and 56.73 kg NPK ha^{-1}**)** were noted under plant geometry 60 x 20 cm which might be due to better root development and plant growth.

The data on economics of treatments (Table 2) revealed that higher net income of `. 78335 ha$^{-1}$ were noted under 60 x 20 cm spacing while `. 70722 ha^{-1} were noted under 50 x 20 cm. The difference between net incomes of plant geometry might be due to yield variation between both plant geometry. The higher B:C ratio (3.14) was noted under plant geometry 60 x 20 cm which might be due to higher net income under same plant geometry but cost of cultivation was same under both plant geometry.

Table 1: Effect of planting density and nutrient management on growth and yield attributes of rabi maize (mean of 2 years

Treatments	Plant height (cm)	Silking 50 % in days	Cobs/ plot	Cobs yield (kg /plot)	Selling Percentage	Length of cobs (cm)	Grain row/cobs	Grain /row	Test weight (g)
Varieties									
Shreeram-9682	180.5	96.5	168.4	16.8	81.0	18.5	17.2	31.5	242.5
HM-7705	178.7	94.4	174.5	18.2	82.5	19.2	18.4	34.8	246.8
CD (P=0.05)	1.35	1.15	2.15	1.85	0.5	0.75	0.65	1.2	0.85
Planting density									
60 x 20 (cm)	197.6	97.2	165.6	17.5	83.0	20.4	18.6	33.2	248.4
50 x 20 (cm)	181.8	95.3	181.5	16.8	81.0	18.2	17.4	30.8	240.2
CD (P=0.05)	1.25	1.14	3.65	1.64	0.45	0.45	0.48	1.14	0.75
Nutrients levels (NPK kg ha^{-1})									
RDF (200:60:60)	181.4	97.6	172.5	17.5	81.0	18.5	16.5	30.5	242.6
STCR (250:50:50)	182.5	95.4	176.8	18.4	82.0	20.4	18.4	33.4	247.8
SSNM (225:60:80)	184.6	94.3	182.4	20.5	82.5	21.2	19.5	33.8	248.2
CD (P=0.05)	0.75	0.65	3.25	1.75	0.3	0.65	0.38	1.27	0.82

Effect of nutrient levels on growth, yield attribute and yield:

The growth and yield attributes were recorded and presented in Table 1. Data indicated that significant variations were recorded under different fertilizer practices to the crop. The highest plant height (184 cm) was recorded with SSNM (225:60:80 kg ha^{-1}**)** which was higher over the RDF (200:60:60 kg NPK) and soil test crop response (250:50:50 kg ha^{-1}**)**. The yield attributes such as plant population/plot, cobs/plot, selling percentage, length of cobs, grains row/cobs, grains/row, test weight were significantly higher with SSNM treatment over state recommendation. The higher plant population (170/plot), cobs (182.4/plot), cobs yield (20.5 kg/plot), selling percentage (82.5), length of cobs (21.2 cm), grains row (19.5), grain/row (33.8) and test weight (248.2 g) were noted under SSNM (225:60:80 kg NPK ha^{-1}). This might be due to availability of more nutrients to the crop ultimately plant yield

attributes increased in comparison to rest of nutrient levels. The similar findings were also reported by Singh *et al.* (2013), Singh *et al.* (2014), Kumar *et al.* (2014). The lowest value of plant height and yield attributes were recorded under state of recommended dose (200:60:60 kg NPK ha^{-1}) which might be low availability of nutrients to the crop for development of height and yield attributes.

Data (Table 1) indicated that the highest grain yield (88.08 q ha^{-1}), stover yield (105.69 q ha^{-1}) were noted under Site Specific Nutrient Management (225:60:80 kg NPK ha^{-1}) which was 19.3 and 12.0 % higher in grain yield and 19.3, 10.2 % higher in stover yield over the recommended dose (200:60:60 kg NPK) and STCR (250:50:50 kg NPK ha^{-1}). The performance of site specific nutrient management treatment was better over recommended practice for maize. It indicates that we need to the recommendation domain of maize owing to ever declining soil heaith, especially for some of the macro nutrients. Increasing levels of nutrients probably exerted a positive effect on the development of source and sink strength of the plants which ultimately resulted in higher yield.These findings are in conformity with the findings of Parthipan *et al.* (2003), Singh and Singh (2006), Singh *et al.* (2013) and Singh *et al.* (2014).

Table 2: Effect of planting density and nutrient management on yield, economics and nutrient uptake by rabi maize (mean of 2 years)

Treatments	Grain yield (q. ha^{-1})	Stover yield (q. ha^{-1})	Net profit (`. ha^{-1})	B:C ratio	Total Nutrient uptake (kg ha^{-1})		
					N	P	K
Varieties							
Shreeram-9682	70.87	85.00	71218.00	2.95	159.4	35.4	53.0
HM-7705	78.20	89.93	81973.00	3.24	175.9	39.1	58.6
CD (P=0.05)	2.25	2.65	375.00	0.12	6.5	2.25	3.5
Planting density							
60 x 20 (cm)	75.65	89.25	78335.00	3.14	170.2	37.8	56.7
50 x 20 (cm)	70.87	85.04	70722.00	2.91	159.4	35.4	53.1
CD (P=0.05)	2.00	2.50	415.00	0.11	6.15	2.0	2.65
Nutrients levels (NPK kg ha^{-1})							
RDF (200:60:60)	73.82	88.58	75406.00	3.04	166.0	36.9	55.3
STCR (250:50:50)	78.58	95.86	81798.00	3.16	176.8	39.2	58.9
SSNM (225:60:80)	88.08	105.69	97481.00	3.67	178.1	44.0	66.0
CD (P=0.05)	2.45	2.85	520.00	0.10	2.12	2.15	2.45

Data (Table 2) indicated that highest nutrient uptake (N 178.1, P44.0 andK 6600 kg^{-1}) were observed under 225:60:80 NPK (SSNM) kg ha^{-1}. The higher uptake under this treatment might be due to more nutrients availability and grain stover yield. The lower uptake (166.0:36.9:55.3 kg NPK ha^{-1}) was noted under RDF (200:60:60 kg NPK ha^{-1}).

The data on economics of treatments (Table 2) indicated that the higher profit of ` 97481 and B:C ratio (3.67) were recorded under SSNM (225:60:80 kg NPK ha^{-1}) and which was found 29.2, 19.1 % higher in net income and

20.7, 16.1% in B:C ratio over RDF (200:60:60 kg NPK ha^{-1}) and soil test crop response (250:50:50 kg NPK ha^{-1}), respectively. The lower net income (` 75406 ha^{-1}) and B:C ratio (3.04) were reported in RDF (200:60:60 kg NPK ha^{-1}).

On the basis of results, it may be concluded that hybrid HM-7705 with plant geometry (60 x 20 cm) and plant nutrient on the basis of site specific nutrient management produced higher yield and gave more net profits. Thus, SSNM may break the yield barrier of maize by enhancing yield through judicious exploitation of available nutrients by plants.

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