Indian Journal of Agronomy **67** (1): 26–29 (March 2022)

Research Paper

Effect of nutrient management and plant density on productivity of QPM hybrids of maize (*Zea mays*)

BAHADUR SINGH[1], S.L. MUNDRA[2] AND M.K. KAUSHIK[3]

Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan 313 001

Received: March 2020; Revised accepted: March 2022

ABSTRACT

A field experiment was conducted during the rany season of 2014 and 2015 at the Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan to study the effect of nutrient-management approaches on the performance of quality protein maize hybrids at varying plant densities. The results showed that 'HQPM 1' produced significantly higher yield attributes and yield over Pratap QPM hybrid–1. Significantly higher yield parameters of QPM hybrids were observed in normal density (60 cm × 20 cm) over high density (50 cm × 20 cm) however, the yield was significantly higher with high density than the normal density. Nutrient application through soil-test-crop response (STCR) approach resulted in significantly higher yield parameters and yield over site-specific nutrient management (SSNM), recommended dose of fertilizers (RDF) and green seeker approaches during both the years. Thus, growing of 'HQPM 1' with 1,00,000 plants/ha and STCR approach followed by SSNM approach may be adopted for higher yield.

Key words: Nutrient management approaches, Plant density, QPM hybrids, Yield parameters, Yield

After introduction of hybrid maize cultivation in India, it became competitive to rice and found suitable for crop diversification. Due to higher nutrient demand and differential plant type, the hybrid needs modification in production technology, especially for nutrient and plant geometry. Maize is a versatile crop with uses ranging from industrial products to food preparations as well as direct human consumption. Of the different forms, 45% is used for human consumption as staple food. Normal maize is poor in protein quality due to deficiency of essential amino acids, viz. lysine and tryptophan. Opaque-2 mutation in quality protein maize (QPM) doubles the lysine and tryptophan content in the maize kernel. These 2 amino acids allow the body to digest complete proteins; thereby eliminating wet-malnutrition (Kumar *et al.,* 2020). The most important goal of QPM research is to reduce malnutrition through direct human consumption (Sofi *et al.,* 2009).

New generations of maize cultivars are characterized by a better ability of plant to be grown in denser stand as they were selected under such conditions (Peykarestan and Seify, 2012). Quality protein maize is a nitrogen-exhaustive crop and requires very high dose of the nutrient (Singh, 2010). Soil health is an important consideration, and it is necessary to develop options that improve soil health and fertility as well as enhance and sustain maize productivity (Sarangi *et al*., 2020). Higher yield of QPM can be obtained through the judicious use of nitrogen, as it can alone contribute 40–60% of the crop yield (Das *et al.,* 2010). There is an urgent need to identify the recent nutrient-management approach, which can increase nutrient use efficiency from view point of fertilizer costs and environmental concerns as well as productivity of crops on sustainable basis.

MATERIALS AND METHODS

The field experiment was conducted at instructional farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (230.34'°, N, 73.42°' E, 582.17 m above sea-level). The region has typical subtropical climatic conditions, characterized by mild winters and moderate summers associated with high relative humidity during July–September. The mean annual rainfall of the region is 637 mm, most of which is contributed by South-Western monsoon

Based on a part of Ph.D. Thesis of the first author submitted to Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan in 2020 (unpublished)

[1]Corresponding author's Email: bsinghboya@gmail.com

[1]Ph.D. Scholar, [2,3]Professor, Department of Agronomy, Rajasthan College of Agriculture, Udaipur, Rajasthan

from June to September. The soil was clay loam, having *p*H 7.6, organic carbon 0.65%, available N 270 kg/ha, phosphorus 19.1 kg/ha and available potassium 299.5 kg/ha. The treatment consisting of 2 QPM hybrids 'HQPM 1' and 'Pratap QPM hybrid 1' and 2 plant densities (normal: 60 cm × 20 cm and high density: 50 cm × 20 cm) in main plots and 4 nutrient management approaches, [recommended dose of fertilizer (RDF): 90 : 40 kg/ha N : P_2O_5; site-specific nutrient management (SSNM); soil-test-crop response (STCR) and green seeker approach] in subplots. All the treatments were replicated 4 times in split-plot design. The crop was sown on 9 July 2014 and 29 June 2015. Atrazine at 0.50 kg/ha was sprayed as pre-emergence for weed control. The fertilizer nitrogen as per treatment in all the approaches except green seeker approach was applied in 4 splits, viz. 25% at sowing, 25% at 6–8-leaf stage, 25% at knee-high stage and remaining 25% at 50% tasseling stage. In case of green seeker approach, 50% N of the recommended dose was applied at sowing and remaining was applied on the basis of green seeker reading at knee high and 50% tasseling stage. The yield parameters were observed from 5 random plants from each plot at maturity and yield was recorded from net plot at 12% moisture content.

RESULTS AND DISCUSSION

Yield parameters

Amongst various yield attributing parameters number of rows/cob (14.91 and 15.14), number of grains/row (17.85 and 17.49) and number of grains/cob (240.93 and 242.61) were the highest under 'HQPM-1' compared to Pratap QPM hybrid-1 across the years (Table 1). The maximum cob weight 90.89 g and 101.72 g and grain weight 54.43g and 55.01g recorded under 'HQPM-1' compared to 'Pratap QPM hybrid 1' 84.35, 92.33 g and 50.70, 51.21 g respectively during 2014 and 2015. This seems to be on account of overall improvement in growth as evidenced from higher production of dry matter as well as N and P uptake at harvest subscribe to the view that there was greater availability of growth inputs matching with formation and development of yield attributes. Our result confirms the findings of Suthar *et al.,* (2013) and Sharma (2017).

All the yield parameters of 'QPM hybrid' varied significant due to different plant densities. Cob weight and grain weight/cob of maize hybrids showed (Table 1) a declining trend with increase in planting density from 83,333 to 1, 00,000 plants/ha during 2014 and 2015. However, number of rows/cob, number of grains/row and number of grains/cob did not vary statistically under both plant densities. More severe competition for light and higher intra- row competition for nutrient and water due to overcrowding of plants might be responsible for declining the value of yield attributes at high planting densities (Table 1). The similar findings were reported by Kumar (2008) and Sahoo and Mahapatra (2007).

Table 1. Effect of QPM hybrids, plant densities and nutrient management on yield attributes of maize

Treatment	Rows/cob		Grains/row		Grains/cob		Cob weight (g)		Grain weight/cob (g)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
QPM hybrids										
'Pratap QPM hybrid 1'	13.30	13.74	16.14	16.02	235.50	237.68	84.35	92.33	50.70	51.21
'HQPM 1'	14.91	15.14	17.85	17.39	240.93	242.61	90.89	101.72	54.43	55.01
SEm±	0.22	0.17	0.15	0.09	1.64	1.49	1.07	2.13	0.81	0.77
CD (P=0.05)	0.71	0.55	0.47	0.29	5.25	4.76	3.44	6.81	2.60	2.45
Plant densities										
Normal (60 cm × 20 cm)	14.22	14.54	16.90	16.68	239.02	241.32	89.56	100.69	51.21	51.74
High (50 cm × 20 cm)	13.98	14.33	17.08	16.74	237.41	238.97	85.68	93.36	53.91	54.48
SEm±	0.22	0.17	0.15	0.09	1.64	1.49	1.07	2.13	0.81	0.77
CD (P=0.05)	NS	NS	NS	NS	NS	NS	3.44	6.81	2.60	2.45
Nutrient-management approaches										
RDF (90 : 40 N : P_2O_5 kg/ha)	13.99	14.27	16.66	16.46	231.52	233.28	80.09	87.69	50.11	50.58
SSNM	14.16	14.45	17.23	16.99	243.61	245.23	90.08	98.93	53.67	54.11
STCR	14.35	14.65	17.40	17.16	248.24	250.47	99.98	111.19	57.41	57.94
Green seeker	13.92	14.37	16.67	16.22	229.50	231.59	80.32	90.30	49.06	49.80
SEm±	0.16	0.15	0.10	0.13	1.24	1.25	1.08	2.21	0.58	0.55
CD (P=0.05)	NS	NS	0.29	0.37	3.55	3.58	3.09	6.34	1.68	1.57

RDF, Recommended dose of fertilizer; SSNM, site-specific nutrient management; STCR, soil-test-crop response

Nutrient management approaches significantly influenced yield attributes of QPM hybrids. Application of STCR approach significantly improved yield components, viz. number of grains/row (17.40 and 17.16), number of grains/cob (248.24 and 250.47) and grain weight (57.41g and 57.94 g) over rest of nutrient management approaches. However, there was not much impact on the number of grain rows/cob of QPM hybrid during both the years. Maximum cob weight recorded under treatment of STCR approach (99.08 and 111.19 g) and minimum recorded under RDF approaches (80.09 and 87.69 g) during the years 2014 and 2015 respectively. Application of STCR approach enriched soil with N, P and K to the level of sufficiency. The better availability of nutrient is well established and evenly distributed maize plant again caused vigorous growth of individual plants as reflected through increase yield attributes (Table 1). These findings are in close conformity with those of Kumar (2008), Sahoo and Mahapatra (2007) and Sharma (2017).

Yield

In QPM hybrids, 'HQPM 1' gave the highest test weight, grain and stover yield indicating significant superiority to Pratap QPM hybrid 1 during both the years. The extent of increase in test weight, grain and stover yield was to the tune of 9.03 g , 458 & 681 kg/ha in 2014 and 8.74 g , 428 and 716 kg/ha in 2015 compared to 'Pratap QPM hybrid 1', respectively. Both of QPM hybrids failed to record a significant variation in harvest index (Table 2). The higher biomass accumulation and improvement in yield attributes seems to improved grain and stover yield of 'HQPM 1'. The result of the present investigation is in close accordance with findings of Snehlata *et al.* (2016) and Sharma (2017). In general, planting density 50 × 20 cm (1,00,000 plants/ha) recorded higher grain and stover yield of 454 and 475 kg/ha in 2014 and 381 and 492 kg/ha in 2015 compared with 60 × 20 cm (83,333 plants/ha) but highest test weight recorded under 60 × 20 cm (83,333 plants/ha) 14.09 g in 2014 and 14.42 g in 2015, respectively. However, harvest index was not affected significantly owing to plant densities in either of the years (Table 2). At higher planting densities, more number of cobs might have compensated to poor value of yield attributes, which consequently improved the grain yield. The results are in close conformity with those of Kumar (2008) and Sharma (2017).

Identical trend of result was obtained in either of years and the extent of increase over Green seeker was to the tune of 18.29, 30.78 and 31.16 in 2014 and 18.48, 31.37 and 31.97%, respectively owing to STCR approach, respectively. Nutrient management approaches significantly influenced test weight, grain and stover yield of QPM hybrids. STCR approach significantly increased test weight, grain and stover yield over SSNM, and RDF and Green seeker during both the years. All the nutrient management approaches failed to record a significant variation in harvest index (Table 2). The higher test weight, grain and stover yield were obtained in the STCR plots in maize crop is responding which led to getting higher grain yield. These results are in accordance confirmation with Trinh *et al.* (2008).

Table 2. Effect of QPM hybrids, plant densities and nutrient-management on test weight, yield and harvest index (%) of maize

Treatment	Test weight (g)		Grain yield (kg/ha)		Stover yield (kg/ha)		Harvest index (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
QPM hybrids								
'Pratap QPM hybrid 1'	211.30	212.35	4,057	4,288	6,159	6,368	39.69	40.30
HQPM-1	220.33	221.09	4,515	4,716	6,840	7,084	39.78	39.99
SEm±	2.51	2.47	85	87	98	121	0.55	0.76
CD (P=0.05)	8.03	7.92	271	279	314	387	NS	NS
Plant densities								
Normal (60 × 20 cm)	222.86	223.93	4,059	4,311	6,262	6,480	39.54	39.94
High (50 × 20 cm)	208.77	209.51	4,513	4,692	6,737	6,972	41.14	40.30
SEm±	2.51	2.47	85	87	98	121	0.55	0.76
C D (P=0.05)	8.03	7.92	271	279	314	387	NS	NS
Nutrient management approaches								
RDF (90 : 40: N : P_2O_5 kg/ha)	203.68	205.09	3,952	4,182	5,996	6,229	39.74	40.20
SSNM	227.89	229.00	4,461	4,665	6,763	6,978	39.73	40.23
STCR	233.94	234.70	4,949	5,201	7,512	7,793	39.66	40.03
Green Seeker	197.76	198.08	3,784	3,959	5,727	5,905	39.80	40.13
SEm±	1.62	1.68	70	70	75	130	0.41	0.61
CD (P=0.05)	4.66	4.83	202	200	214	372	NS	NS

RDF, Recommended dose of fertilizer; SSNM, site-specific nutrient management; STCR, soil-test-crop response

Present investigation revealed that profitable QPM hybrid production, 'HQPM 1' is more productive with STCR based nutrient management (133 : 43 : 62 : N : P : kg/ha) with a density of 1,00,000 plants /ha followed by SSNM approach application of (110 : 34 : 4 : N : P : kg/ha).

REFERENCES

Das, A., Patel, D.P., Munda, G.C. and Ghosh, P.K. 2010. Effect of organic and inorganic sources of nutrients of yield, nutrient uptake and soil fertility of maize (*Zea mays* L.)–mustard (*Brassica juncea*) cropping system. *Indian Journal of Agricultural Sciences* **80**: 85–88.

Kumar, R., Kaul, J., Kaur, Y., Das, A.K., Singode A., Choudhary, M., Dubey, R.B., Sravani, D., Mukri, G. and Rakshit, R. 2020. Response of quality protein maize (QPM) hybrids for grain yield in diverse environments. *Indian Journal of Agricultural Sciences* **90**(4): 756–761.

Kumar, A. 2008. Productivity, economics and nitrogen-use efficiency of speciality corn (*Zea mays*) as influenced by planting density and nitrogen fertilization. *Indian Journal of Agronomy* **53**: 306–309.

Peykarestan, B. and Seify, M. 2012. Impact of sowing date on growth and yield attributes of popcorn under different density. *International Research Journal of Applied and Basic Sciences* **3**: 85–91.

Sahoo, S.C. and Mahapatra, P.K. 2007. Yield and economics of sweet corn (*Zea mays*) as affected by plant population and fertility levels. *Indian Journal of Agronomy* **52**: 239–242.

Sarangi, S.K., Singh, S., Srivastava, A.K., Choudhary, M., Mandal, U.K., Lama, T.D., Mahanta, K.K., Kumar, V., Sharma, P.C. and Ismail, A.M. 2020. Crop and residue management improves productivity and profitability of rice–maize system in salt-affected rainfed lowlands of East India. *Agronomy* **10**(12): 2019. DOI: 10.3390/agronomy10122019.

Sharma, N. 2017. Response of quality protein maize hybrids (*Zea mays*) under varying plant population and nutrient management. M.Sc. (Ag.) Thesis, Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (unpublished).

Singh, D. 2010. Impact of scheduling on nitrogen on productivity of single cross maize (*Zea mays*) hybrids. *Indian Journal of Agricultural Sciences* **80**: 649–651.

Snehlata., Singh, D. and Nepalia, V. 2016. Performance of quality protein maize (*Zea mays* L.) varieties at varying fertility levels. *Annals of Agriculture Research: New Series* **37**: 20–25.

Sofi, A.P., Wani , S.A., Rathore , A.G. and Wani, S.H. 2009. Quality protein maize: Genetic manipulation for the nutritional fortification of maize. *Journal of Plant Breeding and Crop Science* **1**: 244–253.

Suthar, M., Singh, D. and Nepalia, V. 2013. Performance of sweet corn (*Zea mays.* L. sp. *saccharata*) varieties at varying fertility levels. *Forage Research* **38**: 115–118.

Trinh Q.K., Pham, S.T. and Christian, W. 2008. Improving of maize yield and profitability through site-specific nutrient management (SSNM) and planting density. *Omonrice* **16**: 88–92.