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RESEARCH PAPER

Assessment of best fertilizer application methods for QPM hybrids production in Southern Rajasthan

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Abstract A field experiment was conducted at Instructional Farm, Rajasthan Collage of Agriculture, (MPUAT) Udaipur during *kharif* 2014 and 2015 for "Assessment of best fertilizer application method for QPM hybrids (*Zea mays* L.) production in Southern Rajasthan". The experiment was designated as split-plot design with three replications and treatments comprised of two planting densities *viz*., 50 × 20 cm and 60 × 20 cm (row to row × plant to plant) of two QPM hybrids *viz*., PQPM-1 and HQPM-1 in the main-plots. The four nutrient application methods *viz*., Recommended dose fertilizer (RDF), Green seeker based application, Site specific nutrient management SSNM and Soil test crop response (STCR) approach in the sub-plots, The results of the two-years study, showed that the significantly higher yield was recorded with high planting density (50 × 20 cm) of HQPM-1 over the Pratap QPM hybrid–1 with different planting densities, however yield parameters of maize hybrids were significantly higher observed in normal density (60 cm x 20 cm) over high density (50 cm × 20 cm). The yield was significantly increased by 10.64 per cent while the net returns were increased by 17.75 per cent in HQPM–1 over the PQPM hybrid–1. However, the nutrients application through STCR approach resulted in higher yield of maize (HQPM–1 and PQPM hybrid–1), which was recorded significantly increased by 11.28, 24.78 and 30.99 per cent, and net returns were increased by 15.16, 34.41 and 45.31 per cent, respectively over SSNM, RDF, and green seeker approaches during both the years. Thus, the two years study revealed that the growing of HQPM-1 with high planting density (50 × 20 cm) or (1,00,000 plant ha^{-1}) with application of nutrients application methods using STCR approach followed by SSNM could be adopted for higher production and profitability in Southern Rajasthan and similar agro ecologies.

Keywords: Economics · Nutrient management practices · Planting density · QPM hybrids yield

Introduction

Maize (*Zea mays* L.) is an important cereal crop for diverse uses in food, feed, fodder and as industrial crop cultivated in diverse agro-climatic conditions of the world. Normal maize is poor in protein quality due to the 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 two amino acids allow the body to digest complete proteins; thereby eliminating wet-malnutrition (Kumar *et al.,* 2020). QPM assumes a great significance in overcoming problem of malnutrition in tribal dominated population of southern Rajasthan as well as in many parts of country where maize is raised as staple food crop. Therefore, there is enormous scope to increase cultivation of QPM due to increasing global demand, value addition potential and better prices in market compared to traditional varieties of maize. The most important goal of QPM research is to reduce malnutrition through direct human consumption (Sofi *et al.,* 2009).

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Moreover, the quality protein maize is a nitrogen exhaustive crop and requires very high dose of the nutrient (Singh, 2010). Higher yield of QPM can be obtained through the judicious use of nitrogen as it can alone contribute 40-60 per cent of the crop yield (Das *et al.,* 2010).

Looking to the above facts, it was planned to frame an experiment considering these aspects in view to be conducted at Instructional Farm of Rajasthan Collage of Agriculture, Udaipur.

Materials methods

A field experiment entitled "Assessment of QPM hybrids (*Zea mays* L.) production technology for Southern Rajasthan" was conducted for two consecutive *kharif* season 2014 and 2015. An experiment was laid out in split plot design with sixteen treatment combinations consisting two planting densities and two QPM hybrids in main-plot and four levels of nutrients management practices in sub-plot with three replications. The perusal of data show that maximum and minimum temperature during crop growth period ranged between 27.8ºC to 36.4ºC and 19.4ºC to 27.0ºC, respectively during year 2014. The corresponding fluctuations during second year (2015) of experimentation were 28.5ºC to 35.4ºC and 17.7ºC to 26.2ºC, respectively. The maximum and minimum relative humidity ranged between 64.1-92.4, 34.3-82.9 and 62.6-92.1, 24.0-88.1 per cent, respectively. The total rainfall received crop growth period during 2014 and 2015 was 648.0 and 470.4 mm, respectively. Fertility status of experiment site was clay loam soils having medium fertility status (269.0, 270.5 kg N and 19.0, 19.2 kg P_2O_5 ha^{-1}) but high in available potassium (298.5 and 300.8 kg K_2O ha^{-1}). After layout of field soil samples of individual plots was also taken for estimation of available N, P and K following standard procedure as done for composite sample. Application of fertilizer in STCR approach *viz.*133 kg N + 43 kg P_2O_5 + 62 kg K_2O ha^{-1}, SSNM *viz.* 110 kg N +34 kg P_2O_5 + 41 K_2O ha^{-1}, RDF *viz.*, 90 kg N + 40 kg P_2O_5 ha^{-1} and green seeker based *viz.*75 kg N + 40 kg P_2O_5 ha^{-1}.

Results and discussion

Amongst various yield attributing parameters number of rows/cob, number of grains/rows, number of grains/cobs, grain weight/cob and cob weight were the highest under HQPM-1 compared to Pratap QPM hybrid-1 across the years (Table 1). This seems to be on account of overall improvement in growth as evidenced from higher

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

Treatments	Number of rows/cobs		Number of grains/rows		Number of grains/cobs		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

production of dry matter as well as N & 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 & 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). Nutrient management approaches significantly influenced yield attributes of QPM hybrids. Application of STCR approach significantly improved yield components *viz.* number of grains/row, number of grains/cob and cob weight 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. 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).

The two-years study revealed that the significantly higher yield was recorded with the growing of HQPM-1 as compared to PQPM-1. However, the two-years pooled basis yield was recorded significantly higher with high planting density (50 cm × 20 cm) QPM than normal planting density (60 cm × 20 cm). Thus, the pooled basis grain and stover yield increased significantly by 0.42 and 0.48 t ha^{-1} respectively. The QPM hybrids "HQPM-1" resulted in the highest grain yield and exhibited a significant superiority over "Pratap QPM hybrid-1" on pooled basis. On pooled basis the extent of increase in grain yield was to the tune of 0.44 t ha^{-1} and stover yield 0.70 t ha^{-1} over "Pratap QPM hybrid-1" (Table 2). Similarly, the highest yield under higher plant density may be due to direct effect of higher plant at harvest is in close conformity with findings of Sharma (2017).

Application of nutrients in different proportions resulted in significant variation in the yield of the QPM

Table 2. Effect of different QPM hybrids, planting density and nutrients management practices on grain, stover yields and production economics

Treatments	Grain yield (t ha^{-1}) Pooled data	Stover yield (t ha^{-1}) Pooled data	Net returns (000 ha^{-1}) Pooled data	BC ratio Pooled data
QPM hybrids				
Pratap QPM hybrid-1	4.17	6.26	35841	1.51
HQPM-1	4.61	6.96	42207	1.78
SEm ±	0.61	0.78	713	-
C.D. (P=0.05%)	1.81	2.31	2117	-
Plant densities				
Normal (60 cm × 20 cm)	41.85	63.71	36983	1.56
High (50 cm × 20 cm)	46.03	68.55	41065	1.72
SEm ±	0.61	0.78	713	-
C.D. (P=0.05%)	1.81	2.31	2117	-
Nutrient management approaches				
RDF	40.67	61.12	35186	1.54
SSNM	45.63	68.71	41068	1.71
STCR	50.75	76.52	47295	1.89
Green Seeker	38.71	58.16	32547	1.44
SEm ±	0.49	0.75	605	-
C.D. (P=0.05%)	1.39	2.11	1706	-

hybrids. The maximum grain and stover yield were recorded under STCR approach which significantly enhanced SSNM, RDF and Green seeker on pooled basis with the enhancement of grain yield by 0.51, 1.01 and 1.20 t ha^{-1} and 11.18, 24.87 and 31.00 per cent, respectively on pooled basis (Table 2). The results of present investigation indicated higher production under influence of N, P and K fertilization are in close conformity with findings of Kumar *et al.* (2015); Vikram *et al.* (2015). The data presented in Table 2 revealed that the net returns and BC ratio which was significantly higher in HQPM-1 over "Pratap QPM hybrid-1". Which was significantly increased by 17.76 per cent and 0.27 in, "HQPM-1 over Pratap QPM hybrid-1. The pooled basis increase in plant density from 83,333 to 1,00,000 plants ha^{-1} increased net returns and B C ratio. The net returns and B:C ratio was significantly higher under high density by 11.03 per cent and 10.25 per cent compared to normal density on pooled basis (Table 2). The pooled basis increased in net returns and B:C ratio under STCR over the SSNM, RDF and Green seeker approach by 15.16 per cent (41068), 34.41 per cent (35186), 45.31 per cent (32547), respectively and the BC ratio was increased by 10.52, 22.72 and 31.25 per cent under STCR over SSNM, RDF and Green seeker approach, respectively (Table 2). This may be due fact that the grain and stover yield obtained under this treatment was maximum which resulted into maximum net returns and even nullified its higher variable cost. The result corroborate with findings of Sharma (2017) and Mali (2017).

Conclusion

Based upon results it is recommended that for profitable QPM hybrid production, "HQPM-1" may be grown by fertilizing STCR based recommendation (133 kg N + 43 kg P_2O_5 + 62 kg K_2O ha^{-1}) keeping a density of 1,00,000 plants ha^{-1} recorded maximum grain yield 5.48 t ha^{-1}, net returns Rs 52222 and BC ratio 2.07.

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