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## Evaluation of Fertility Level in Different QPM Varieties in Maize (*Zea mays* L.)

Snehlata, SK Dhaka and D Singh

**Abstract**

A field experiment was conducted to evaluate performance of quality protein maize varieties under prevailing agroclimatic conditions and to assess efficacy of chemical fertilizers on QPM growth and production. The treatment consisted combinations of four QPM varieties ("Pratap QPM hybrid-1", "Vivek QPM-9", "HQPM-1" and "HQPM-5") and four fertility levels (90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>). These 16 combinations were evaluated under factorial randomized block design with four replications. N and P content of grain and stover was significantly higher under 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> over 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Similarly N, P and K uptake were significantly higher under 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> over 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

**Keywords:** QPM, Nitrogen content, Stover

**Introduction**

Maize is an important cereal crop of the world grown on approximately 140 m ha area under diverse climatic conditions. In India, it is grown on 8.67 m ha with the production and productivity of 21.75 m t and 2566 kg ha<sup>-1</sup>, respectively (Govt. of India, 2014) [3]. Rajasthan ranks first in respect of area, wherein this crop occupies 0.91 m ha area with production of 1.46 m t and productivity of 15.97 kg ha<sup>-1</sup> (Govt. of Raj. 2014) [4]. The maize varieties recommended for zone IV A (Sub-Humid Southern Plain and aravali Hills) of Rajasthan have low protein content with unbalanced composition of essential amino acids. The QPM is a hybridized variety of maize specially bred by addition of *Opaque -2* mutant gene, which improve lysine and tryptophan and reduce leucine and isoleucine contents and produce quality protein with balanced composition of amino acids (Prasanna *et al.*, 2001) [7]. The most important goal of QPM research is to reduce malnutrition through direct human consumption (Sofi *et al.*, 2009) [9]. Presently full maturing variety "HQPM-1" is released for commercial cultivation in maize growing areas of Rajasthan. Quality protein maize is a nitrogen exhaustive crop and requires very high dose of the nutrient (Singh, 2010 and Om *et al.*, 2014) [6]. Thus higher yield of QPM can be obtained through the judicious and higher uses of two major nutrients (N and P) as these two nutrients alone contribute 40-60 per cent of the crop yield (Das *et al.*, 2010) [2]. For enhancing grain yield of single cross hybrids of QPM, nitrogen fertilization has emerged as a serious matter of concern for maize growing farmers. Next to nitrogen, phosphorus is of paramount importance for energy transfer in living cells by mean of high energy phosphate bonds of ATP (Reddy and Reddi, 2002) [8]. The recommendation of nitrogen and phosphorus fertilization for maize is 90 kg N and 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The existing fertilizer recommendation for maize assumes that the need of nutrients is same for composite, hybrids and QPM hybrids.

**Materials and Methods**

The Experiment was conducted in randomized block design with sixteen treatments and four replications. The site is located at at the Instructional Farm, Rajasthan College of Agriculture, Udaipur which is situated at 24° 35' N latitude, 72° 42' E longitude and at an altitude of 579.5 meter above mean sea level falls under Agroclimatic zone IV A (Sub-Humid Southern Plain and Aravali Hills) of Rajasthan. The meteorological observations recorded during the crop season are depicted in Fig. 1. The Figure show that maximum and minimum temperature during crop growth period ranged between 27.8 to 36.4 °C and 19.4 to 27.3 °C, respectively. The maximum and minimum relative humidity ranged from 64.1-92.4 and 34.4-82.9 per cent, respectively. The total rainfall received during crop season was 578 mm. The soil of experimental site was clay loam in texture, having slight alkaline reaction (pH 7.8).

**Table 1:** Treatment Detail

<b>Design</b>	Randomized Block Design
<b>Replications</b>	4
<b>Plot size</b>	Gross : 5.0 m x 3.0 m = 15.0 m <sup>2</sup> Net : 4.5 m x 1.8 m = 8.10 m <sup>2</sup>
<b>Variety</b>	Pratap QPM hybrid-1 Vivek QPM-9 HQPM-1 HQPM-5
<b>Spacing</b>	60 cm x 25 cm

**Table 2:** Experimental details

	<b>QPM Varieties</b>	<b>Symbols</b>
1	Pratap QPM hybrid-1	V <sub>1</sub>
2	Vivek QPM-9	V <sub>2</sub>
3	HQPM-1	V <sub>3</sub>
4	HQPM-5	V <sub>4</sub>
	<b>Fertility levels</b>	
1	90 kg N + 30 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>	F <sub>1</sub>
2	110 kg N + 40 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>	F <sub>2</sub>
3	130 kg N + 50 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>	F <sub>3</sub>
4	150 g N + 60 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>	F <sub>4</sub>

### Varietal Details

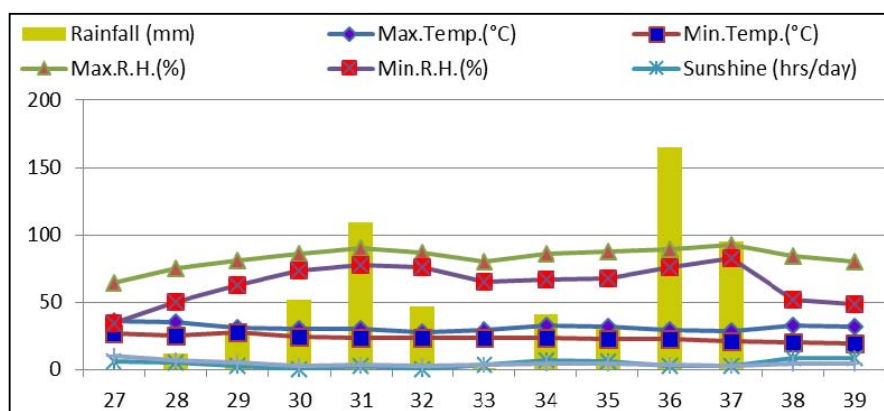
“Pratap QPM hybrid-1”:- The variety is medium maturing

QPM hybrid. It was bred by crosses of DMR “QPM 106” x “HKI 193-1” by scientist of MPUAT, Udaipur and released for commercial cultivation during 2013. The variety is fertilizer responsive, moderately tolerant to water stress and suitable for rainfed situation.

“Vivek QPM-9”:- The variety is early maturing QPM hybrid bred by crossing “VQL 1” x “VQL 2” by scientist of Almora (H.P.) and recommended for commercial cultivation from 2008. The yield potential of the variety is 40 to 50 q ha<sup>-1</sup> and suitable for rainfed situation.

“HQPM-1”:- “HQPM-1” is late maturing QPM variety. This variety was developed by crosses of HKI-193-1 x HKI 163 and recommended throughout India. The yield potential of the variety is 45 to 55 q ha<sup>-1</sup> and suitable for rainfed and irrigated conditions.

“HQPM-5”:- HQPM-5” is medium to late maturing QPM variety. This variety was developed by crosses of HKI 163 x HKI 161 and recommended throughout India. The yield potential of the variety is 45 to 55 q ha<sup>-1</sup> and suitable for rainfed as well as irrigated conditions.



**Fig 1:** Mean weekly meteorological parameters during the crop growth period of *kharif*

### Results

The N, P and K content and their uptakes are presented in Table 3 and 4. Amongst QPM varieties, the highest N concentration was estimated in grains of variety “HQPM-5” and Amongst fertility levels, increasing fertility level from 90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> resulted in significant improvement in N content of grain to the extent of 12.26, 1.51 and 0.578 per cent, respectively (Table 3). The stover of QPM variety “HQPM-5” contain highest nitrogen and It is evident from data that minimum nitrogen content of stover was registered with application of 90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Application of 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> brought about significant increase in nitrogen content of stover over their preceding fertility level by 2.84, 5.56 and 4.72 per cent, respectively (Table 3). Grains of QPM Variety “HQPM-5” registered highest P content. The QPM grains produced under 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> contained significantly higher phosphorus over 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> by 2.98 and 7.14 per cent, respectively. Amongst QPM varieties, stover of “HQPM-1”, “HQPM-5”

“Pratap QPM hybrid-1” registered statistically equal phosphorus content and Application of 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded highest P content in stover which was significantly higher. The potassium content of grain and stover did not vary significantly amongst QPM varieties and varying fertility levels (Table 3). The maximum N uptake was registered under “HQPM-1”. Increasing fertility level from 90 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly enhanced N uptake over preceding level (Table 4). Increasing fertility level from 90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> up to 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> brought about significant improvement in nitrogen uptake by stover over preceding fertility levels by 5.76, 8.23 and 14.46 kg ha<sup>-1</sup>, respectively (Table 4). The QPM variety “HQPM-1” recorded significant superiority over “HQPM-5”, “Vivek QPM-9” and “Pratap QPM hybrid-1” by 8.00, 57.90 and 11.80 kg higher uptake, respectively. : Increasing fertility level from 90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly increased total N uptake over preceding fertility level (Table 4). The highest P uptake in grain and stover was recorded under variety “HQPM-1”. Highest K uptake was recorded by grains of variety “HQPM-1” which was significantly higher over rest of the varieties. increasing level of fertility from 90 kg N + 30

kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly increased K uptake by 17.54, 12.33 and 7.51 per cent, respectively (Table 4). Highest potassium uptake was recorded by stover of variety “HQPM-1”. increasing level of fertility from 90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>

and 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> to 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly increased potassium uptake by 16.10, 14.05 and 9.88 per cent, respectively (Table 4). highest total phosphorus uptake was recorded under application of 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> which was significantly higher over 130 kg N + 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 110 kg N + 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 90 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> by 9.40, 24.41 and 44.79 per cent, respectively (Table 4).

**Table 3:** Effect of treatments on nitrogen, phosphorus and potassium content

Treatments	N content (%)		P content (%)		K content (%)	
	Grain	Stover	Grain	Stover	Grain	Stover
<b>Varieties</b>						
Pratap QPM hybrid-1	1.730	0.678	0.338	0.167	0.414	1.123
Vivek QPM-9	1.531	0.653	0.328	0.164	0.414	1.122
HQPM-1	1.728	0.685	0.341	0.168	0.415	1.122
HQPM-5	1.734	0.707	0.342	0.168	0.415	1.124
SEm±	0.003	0.002	0.001	0.0003	0.003	0.001
CD (P = 0.05)	0.008	0.005	0.003	0.0010	NS	NS
<b>Fertility levels (kg ha<sup>-1</sup>)</b>						
90 kg N + 30 kg P <sub>2</sub> O <sub>5</sub>	1.525	0.635	0.322	0.155	0.414	1.122
110 kg N + 40 kg P <sub>2</sub> O <sub>5</sub>	1.712	0.665	0.335	0.165	0.415	1.122
130 kg N + 50 kg P <sub>2</sub> O <sub>5</sub>	1.738	0.702	0.345	0.172	0.415	1.122
150 kg N + 60 kg P <sub>2</sub> O <sub>5</sub>	1.748	0.722	0.347	0.176	0.415	1.124
SEm±	0.003	0.002	0.001	0.0003	0.003	0.001
CD (P = 0.05)	0.008	0.005	0.003	0.0010	NS	NS

**Table 4:** Effect of treatments on nitrogen phosphorus and potassium uptake

Treatments	N uptake (kg ha <sup>-1</sup> )			P uptake (kg ha <sup>-1</sup> )			K uptake (kg ha <sup>-1</sup> )		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
<b>Varieties</b>									
Pratap QPM hybrid-1	67.63	38.34	106.0	13.19	9.45	22.6	16.06	63.26	79.33
Vivek QPM-9	37.16	22.73	59.9	8.00	5.76	13.8	10.00	38.74	48.73
HQPM-1	74.04	43.72	117.8	14.58	10.68	25.3	17.71	71.00	88.72
HQPM-5	68.07	41.76	109.8	13.42	9.94	23.4	16.23	65.92	82.15
SEm±	0.37	0.23	0.5	0.10	0.06	0.15	0.10	0.32	0.40
CD (P = 0.05)	1.05	0.65	1.5	0.28	0.17	0.43	0.27	0.91	1.14
<b>Fertility levels (kg ha<sup>-1</sup>)</b>									
90 kg N + 30 kg P <sub>2</sub> O <sub>5</sub>	45.32	27.45	72.8	9.54	6.70	16.2	12.20	48.36	60.57
110 kg N + 40 kg P <sub>2</sub> O <sub>5</sub>	59.78	33.39	93.2	11.66	8.29	19.9	14.35	56.15	70.49
130 kg N + 50 kg P <sub>2</sub> O <sub>5</sub>	68.01	40.26	108.3	13.45	9.82	23.3	16.12	64.04	80.16
150 kg N + 60 kg P <sub>2</sub> O <sub>5</sub>	73.77	45.46	119.2	14.54	11.01	25.5	17.33	70.37	87.70
SEm±	0.37	0.23	0.5	0.10	0.06	0.15	0.10	0.32	0.40
CD (P = 0.05)	1.05	0.65	1.5	0.28	0.17	0.43	0.27	0.91	1.14

## Discussion

The N and P contents of grain and stover of “HQPM-1” were significantly higher over rest of the QPM varieties (Table 3). Similarly, N and P uptake by grain and stover, total uptake of grain was higher in variety “HQPM-1” compared to other varieties. The uptake of nutrients by the crop is primarily on dry matter production and secondarily their content in plant parts. Thus, improvement in both these by variety “HQPM-1” ultimately led to higher accumulation of nutrients. Amongst mineral nutrients, N and P are considered to be most important for exploiting genetic potential of crop through growth and development (Halvin *et al.*, 2005) [5]. In general QPM varieties utilize nutrient slowly and thus required very high doses of fertilizer (Singh., 2012., Choudhary *et al.*, 2013 and Om *et al.* 2014 ) [1, 6]. The results of significant improvement in overall growth of crop under the influence of 150 kg N + 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> are in close conformity with findings of Kumar (2009), Suther *et al.*, (2013) [11] and Choudhary *et al.*, (2013) [1].

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