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Research Communication

Response of maize (*Zea mays*) hybrids to varying spacing and fertility levels grown during spring season

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ABSTRACT

A field experiment was conducted during the spring season of 2013 at Chatha, Jammu, to study the response of maize (*Zea mays* L.) hybrids to varying spacing and fertility levels. The row spacing of 60 cm resulted in significantly higher grain yield, stover yield, heat-use efficiency (HUE), heliothermal-use efficiency (HTUE) and total NPK uptake by spring maize with higher net returns and benefit: cost ratio than row spacing of 70 cm. Among the hybrids, 'PMH 1' exhibited significantly higher total NPK uptake of spring maize with concomitant significant increase of grain, stover yield and harvest index than 'JH 3459'. However, the HUE and HTUE were significantly higher in 'JH 3459' than 'PMH 1'. Hybrid 'PMH 1' also recorded higher net returns and benefit: cost ratio than 'JH 3459'. Amongst the fertility levels, the application of $N_{140}P_{30.5}K_{29.2}$ kg/ha resulted in the highest grain and stover yields, nutrient uptake and soil-nutrient build up, which was statistically at par with $N_{120}P_{26.20}K_{25}$ kg/ha and significantly higher than $N_{80}P_{17.5}K_{16.7}$ kg/ha and $N_{100}P_{21.8}K_{20.8}$ kg/ha. The highest benefit: cost ratio was recorded with the application of $N_{120}P_{26.2}K_{25}$ kg/ha followed by $N_{140}P_{30.6}K_{29.2}$ kg/ha.

Key words *:* Fertility levels, Hybrid, Nutrient uptake, Row spacing, Spring maize, Yield

In the state of Jammu and Kashmir, maize has special significance because it forms the staple diet of majority of the people. The total area under maize crop in the state is about 308.62 thousand ha, having a production and productivity of 2,735 thousand quintals and 8.86 q/ha respectively (DES, 2015). In Jammu and Kashmir maize cultivation is gaining momentum in spring season because of its productivity and profitability and no disease infestation. Sowing of maize during spring season would provide an opportunity to utilize the fields vacated by potato, *toria*, peas for green pods and early harvested sugarcane, because comparatively warm conditions would provide good environment for growth of spring maize. Meager information for spring-sown maize in terms of production practice is available under Jammu conditions. However, the agro-climatic conditions of sub-tropical plains of Jammu division can provide an option of growing spring season maize. Therefore, it becomes imperative to identify suitable variety, spacing and its optimum fertility levels for spring season.

An experiment was conducted at Research Farm Chatha, SKUAST-Jammu, Jammu and Kashmir, during spring season of 2013 in factorial randomized block design with 3 replications. The soil clay loam, having initial *p*H 8.04, organic carbon (0.55 %) and available N, P and K of 220.40, 18.25 and 118 kg/ha respectively. The treatment consisted of 2 row spacings (60 cm and 70 cm), 2 varieties ('PMH 1' and 'JH 3459') and 4 fertility levels (80:17.47:16.67; 100:21.83:20.83; 120:26.20:25.00 and 140:30.57:29.17 N:P:K kg/ha). The plant spacing of 20 cm was maintained uniformly in all the treatments. The half dose of N and full dose of P and K was applied basal as per treatments. The remaining dose of N was applied in two splits each at knee high stage and silking stage. All recommended agronomic practices were followed throughout the crop period. The grain and stover yields were recorded from the net plot area and expressed as t/ha. The heat-use efficiency (HUE) and helio-thermal-use efficiency (HTUE) were calculated as per the formula given by Monteith (1984).

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$$\text{HUE (kg/ha/}^{o}\text{C/day)} = \frac{\text{Total grain yield (kg/ha)}}{\text{GDD}}$$

where GDD, growing degree days

$$\text{HTUE (kg/HTU)} = \frac{\text{Grain yield (kg)}}{\text{HTU}}$$

where, HTU, helio-thermal unit

Wider row spacing of 70 cm significantly increased in dry-matter accumulation/plant as compared to closer row spacing of 60 cm. Comparatively thicker stem in wider row spacing because of better availability of space and light might have attributed to more dry matter accumulation (Kumar and Puri, 2001). Early maturing hybrid 'JH 3459' had higher plant height than 'PMH 1'. However, trend was reversed at maturity when 'PMH 1' attained higher plant height than hybrid 'JH 3459'. It was due to reason that hybrid 'JH 3459' is early-maturing hybrid and was vigorous in growth during the initial growth, whereas 'PMH 1' is of long duration and attain comparatively more height at maturity because of genetic constitution. A significant variation in dry-matter accumulation by both cultivars was noticed. The 'PMH 1' accumulated significantly higher dry-matter than 'JH 3459'. This might be because of comparatively higher leaf-area index than 'PMH 1' which helps in dry-matter production. Fertilizer application had a significant effect on periodic plant height, leaf-area index and dry-matter accumulation of spring maize. It is evident from the results that though each incremental dose of fertilizers increased the plant height, leaf-area index and dry-matter accumulation, but $N_{140}P_{30.57}K_{29.17}$ kg/ha recorded the highest plant height, leaf-area index and dry-matter accumulation while being statistically at par with $N_{120}P_{26.20}K_{25}$ kg/ha level. Significant increase in growth parameters at different fertility levels might be owing to higher nutrient availability for better nutrient uptake and vigorous vegetative growth. Shivay and Singh (2000) also reported similar findings.

Closer row spacing of 60 cm significantly increased the grain yield and stover yield over wider spacing of 70 cm. This might be because of higher plant population of 83.3 thousand plants/ha in closer spacing as compared to that of 71.4 thousand plants/ha in wider spacing. Similar results were reported by Testa *et al.* (2016), who reported higher grain yield and stover yield with the increase in plant population. Among the hybrids, 'PMH 1' proved superior to 'JH 3459' by giving significantly higher grain and stover yields which were owing due to genetic makeup of plant and highest growth and yield attributes of hybrid 'PMH 1'.

Table 1. Effect of spacings, varieties and fertility levels on growth, yield and economics of spring maize

Treatment	Plant height at 60 DAS (cm)	LAI at 60 DAS	Dry-matter accumulation at 60 DAS (g/plant)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	HUE (kg/ha/ °C/day)	HTUE (kg/HTU)	Cost of cultivation ($\times 10^3$₹/ha)	Net returns ($\times 10^3$₹ /ha)	Benefit: cost ratio
Spacing											
60 cm × 20 cm	119.4	2.20	45.0	3.37	9.38	26.37	2.21	0.267	28.9	43.5	1.49
70 cm × 20 cm	115.8	2.16	47.7	3.17	8.52	27.14	2.06	0.249	28.6	40.2	1.40
SEm±	1.89	0.03	0.61	0.05	0.17	0.45	0.04	0.005	–	–	–
CD (P = 0.05)	NS	NS	1.75	0.16	0.49	NS	0.12	0.014	–	–	–
Variety											
'PMH 1'	114.1	2.19	47.2	3.54	9.55	27.03	2.05	0.253	28.8	45.9	1.59
'JH 3459'	121.1	2.17	45.4	3.01	8.96	25.09	2.22	0.263	28.8	36.8	1.27
SEm±	1.89	0.03	0.61	0.05	0.17	0.45	0.04	0.005	–	–	–
CD (P = 0.05)	5.45	NS	1.75	0.16	0.49	1.31	0.12	0.014	–	–	–
Fertility (N:P:K kg/ha)											
80, 17.47, 16.67	110.4	1.51	43.1	2.67	7.91	25.22	1.74	0.211	27.4	31.1	1.13
100, 21.83, 20.83	115.5	1.92	44.7	2.90	8.30	25.93	1.91	0.230	28.3	34.5	1.22
120, 26.20, 25.00	120.3	2.71	47.7	3.69	10.18	26.59	2.44	0.295	29.2	49.7	1.70
140, 30.57,29.17	124.2	2.84	49.9	3.73	10.42	26.39	2.44	0.295	30.1	50.1	1.66
SEm±	2.67	0.05	0.86	0.08	0.24	0.64	0.06	0.007	–	–	–
CD (P = 0.05)	7.71	0.14	2.47	0.22	0.69	NS	0.17	0.020	–	–	–

Interaction, Non-significant, LAI, Leaf-area index; DAS, days after sowing; HUE, heat-use efficiency; HTUE, heliothermal-use efficiency

Table 2. Effect of spacings, varieties and fertility levels on soil-available N, P, K (kg/ha) and total nutrient uptake (kg/ha) at harvesting of spring maize

Treatment	Soil available nutrients (kg/ha)			Total nutrient uptake (kg/ha)		
	N	P	K	N	P	K
Spacing						
60 cm × 20 cm	208.4	17.4	117.4	111.7	26.2	121.0
70 cm × 20 cm	206.8	17.0	116.6	105.2	23.0	103.2
SEm±	1.66	0.12	0.99	1.68	0.60	1.80
CD (P=0.05)	NS	NS	NS	4.85	1.73	5.18
Variety						
'PMH 1'	207.9	17.3	117.8	119.6	28.3	115.9
'JH 3459'	205.3	17.2	116.1	106.4	24.7	106.8
SEm±	1.70	0.12	0.99	1.68	0.60	1.80
CD (P=0.05)	NS	NS	NS	4.85	1.73	5.18
Fertility (N:P:K kg/ha)						
80, 17.47, 16.67	187.8	16.1	112.0	85.0	18.5	88.3
100, 21.83, 20.83	197.1	17.1	120.0	97.0	22.3	104.2
120, 26.20, 25.00	235.7	18.0	128.2	129.7	31.7	135.9
140, 30.57,29.17	240.9	18.4	132.0	134.1	32.8	139.8
SEm±	2.34	0.17	1.41	2.37	0.84	2.54
CD (P=0.05)	6.80	0.49	4.08	6.86	2.44	7.33
Initial Status	220.40	18.10	118	-	-	-

Interaction, Non-significant

These results confirm the findings of Sharma *et al.* (2016). Significant increase in grain and stover yield of spring maize was recorded up to fertility level $N_{140}P_{30.57}K_{29.17}$ kg/ha and it was statistically at par with $N_{120}P_{26.20}K_{25}$ kg/ha (Table 1). This might be owing to significant improvement of yield attributes, viz. grains/cob, 1,000-grain weight and cobs/plant, under better nutrient supply. Similar results were also reported by Gul *et al.* (2015). Variety 'PMH 1' had higher harvest index than 'JH 3459' which might be because of higher grain yield of 'PMH 1'. The practicability and usefulness of a treatment is judged ultimately in terms of net returns. Among the spacing and varieties, the closer row spacing of 60 cm and variety 'PMH 1' proved more remunerative than wider row spacing of 70 cm and variety 'JH 3459'. Application of $N_{120}P_{26.20}K_{25}$ kg/ha fertility level showed the highest benefit: cost ratio. Similar results were reported by Sahoo and Mahapatra (2007). The higher HUE and HTUE of spring maize was observed at closer row spacing of 60 cm than wider row spacing of 70 cm owing to higher grain yield in closer row spacing (Table 1). Variety 'JH 3459' recorded higher HUE and HTUE than variety 'PMH 1' which might be because of shortened growth period (lesser GDD accumulation) of variety 'JH 3459' (Table 1). However, fertility levels had favourable effects on HUE and HTUE. An improvement in the HUE and HTUE was observed with the increase in fertility level as a result of fertilization that enhanced the ability of the plant to utilize thermal heat for its development (Singh and Hadda, 2014). Post-harvest nutrient status increased with increase in fertility levels (Table 2). This indicates that besides increased uptake of NPK, the availability of N, P and K in soil also got augmented by increase in applied nutrients. The N, P and K uptake increased significantly with increase in plant density (Table 2). So far as varieties are concerned, the total uptake of N, P and K was higher in 'PMH 1' than 'JH 3459'. Significant enhancement in uptake of N, P and K with the increase in fertility was due to higher biological yield as well as content of nutrients with higher dose of fertility levels (Table 2).

It may be concluded that closer row spacing of 60 cm results in significantly higher grain yield than wider row spacing of 70 cm. Among the tested hybrids, 'PMH 1' is the most promising cultivar than the hybrid 'JH 3459'. The fertility level $N_{120}P_{26.20}K_{25}$ kg/ha is the most suitable dose for achieving good yield of spring maize.

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