Indian Journal of Agronomy **47** (4) : 526–530 (December 2002)

Effect of fertility levels on promising hybrid maize (*Zea mays*) under rainfed conditions of Himachal Pradesh

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Received : May 2000

ABSTRACT

An experiment was conducted during the rainy season (*kharif*) 1998–2000 to find out the suitable maize (*Zea mays* L.) hybrid varieties and their fertility requirement under rainfed condition of Himachal Pradesh. Three hybrid varieties ('KH 517', 'KH 101' and 'PSCL 3436') with 1 check ('Early Composite') were tested at 4 levels of fertility. 'Early Composite' produced significantly taller plants compared to hybrids which were statistically at par with one another. Number of days taken for silking were the lowest in compsoite, followed by 'KH 101'. The yield attributes, viz. number of cobs, grains/cob and 1,000-grain weight, were significantly superior in maize hybrids to composite. All hybrids gave significantly higher yield (34.98–61.66%) over composite. Among hybrids, 'KH 517' gave the highest yield, being 7.78, 19.76 and 61.66% higher than 'PSCL 3436', 'KH 101' and 'Early Composite' respectively. Application of additional 50% NPK or 10 tonnes FYM in addition to recommended fertilizer increased the yield by 25.97 or 13.98% respectively. However, reducing fertilizer by 50% NPK even with 10 tonnes FYM, reduced the yield by 10.90%. Nutrient uptake followed the yield level trend and increased with higher fertility levels. There was depletion of NPK compared to initial status of soil with all varieties and at all fertility levels. The harvest index (48.2), net return (Rs 20,951/ha) and benefit : cost ratio (3.03) were maximum from hybrid 'KH 517', followed by 'PSCL 3436'. Benefit : cost ratio was maximum with 150% recommended fertilizer application (2.92), followed by recommended fertilizer + 10 tonnes FYM/ha.

Key words : Hybrid maize, Fertility level, Yield

Maize is the most important rainy-season (*kharif*) crop of Himachal Pradesh, mostly grown under rainfed conditions. Although the state average yield (21.49 q/ha) of maize is more than the national average, there exists an immense potential to increase it when we compare with yield recorded under frontline demonstrations. Though a larger area is under local varieties today, hybrid varieties because of there higher yields are picking up very fast in the state. The hybrid varieties for their opti-

mum potential require different nutritional and management requirements which farmers often wrongly compare with local varieties resulting in lower yield and soil health deterioration. The resources of farmers are scarce and farmer cannot afford to spend more on hybrid seeds and fertilizers until and unless he gets good returns. Hence selection of suitable variety and its fertility level requirement is necessary.

MATERIALS AND METHODS

The field experiment was conducted at Oilseeds Research Station Farm, Kangra during rainy season (*kharif*) 1998 and 1999. The soil was clay loam having pH 6.5, available N 450 kg/ha, available P_2O_5 44.8 kg/ha and available K_2O 128.4 kg/ha. Three maize hybrid ('KH 517', 'KH 101' and 'PSCL 3436') and 1 composite ('Early Composite') were tested at 4 fertility levels, viz. recommended fertilizer N : P : K (120: 60:40 kg/ha), 50% recommended fertilizer + 10 tonnes FYM, recommended NPK+10 tonnes FYM, and 150% recommended fertilizer. The maize crop was sown at 60 cm × 20 cm spacing on 19 and 6 June during 1998 and 1999 respectively. Full dose of P and K and one-third N was applied as basal dose. The remaining N was applied in 2 equal splits : one at knee-high stage and other at silking stage. The treatments were arranged in factorial randomized block design with 3 replications. The observations on yield and yield components and stalk rot disease infestation were recorded as per standard methods. Nutrient analysis in soil and plant samples was done as per prescribed methods.

RESULTS AND DISCUSSION

Effect of varieties

Variety 'Early Composite' produced significantly taller plants compared to

Table 1. Effect of variety and fertility level on growth, yield attributes yield and economics in maize

Treatment	Plant height (cm)	Days to silking	Cobs ('000/ha)	Grains/ cob	1,000-grain weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Net returns (Rs/ha)	Benefit : cost ratio	Stalk rot (%)
Variety											
'Early Composite'	246.5	51.5	35.7	397.5	269.6	3,842	4,581	44.5	11,485	2.04	12
'KH 517'	225.6	66.0	55.6	418.5	276.2	6,211	6,687	48.2	20,951	3.03	14
'KH 101'	222.5	62.7	49.0	418.1	275.3	5,186	5,914	46.8	16,387	2.37	17
'PSCL 3436'	226.2	66.1	54.7	419.7	277.7	5,758	6,602	46.5	19,088	2.76	9
CD (P=0.05)	13.9	1.3	1.8	7.4	1.7	278	564	1.9			
Fertility levels											
Recommended fertilizer (RF)	227.8	61.7	48.7	418.2	274.7	5,009	5,871	46.2	16,207	2.55	9
50% RF+10 tonnes FYM	219.8	62.5	45.5	394.8	266.9	4,012	4,400	47.5	11,736	1.97	8
RF+10 tonnes FYM	233.4	62.9	48.9	419.0	276.9	5,665	6,484	46.4	18,698	2.73	8
150% RF	233.6	63.2	51.8	427.7	279.7	6,310	702.8	47.3	21,192	2.92	11
CD (P=0.05)	NS	NS	1.8	7.4	1.7	278	546	NS			

hybrids which were statistically at par with one another (Table 1). Minimum numbers of days to silking were taken in 'Early Composite' followed by 'KH 101'. The yield attributes, viz. number of cobs, grains/cob and 1,000-grain weight, were significantly superior in maize hybrids in order of 'KH 517'>'PSCL 3436'>'KH 101' compared to 'Early Composite'. As grain yield is also the function of yield attributes, the expression of these in order was also reflected in yields of the varieties. Among hybrids, 'KH 517' gave significantly highest yield, followed by 'PSCL 3426' and 'KH 101'. The 'Early Composite' gave the lowest yield. The hybrids gave 34.98–6166% higher yield than composite. Among hybrids, 'KH 517' the highest yielder gave 61.66, 7.87 and 19.76% higher yield over 'Early Composite', 'PSCL 3436' and 'KH 101' respectively. The straw yield almost followed the same trend. The harvest index of variety 'Early Composite' was the lowest, while the hybrids were at par with each other. The incidence of stalk rot was highest in 'KH 101', followed by 'KH 517' and 'Early Composite'.

The lowest yield of 'Early Composite' may be attributed partly to its taller plant type, making it susceptible to lodging, poor expression of yield attributes and lowest harvest index. Among hybrids, 'KH 101' because of its greater susceptibility to stalk rot disease and lower expression of attributes gave lower yield. Although variety 'KH 517' was also susceptible to stalk rot good expression of yield attributes compensated the yield losses.

Fertility level

Plant height and numbers of days taken for silking were not influenced significantly by fertility levels applied (Table 1). Appli-

Table 2. Effect of varieties and fertility levels on nutrient uptake (average data of 2 years) and available nutrient content in the soil (at harvest)

Treatment	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	Available nutrient status (kg/ha)		
				N	P	K
Variety						
'Early Composite'	77.21	20.06	57.43	414	42.2	124.9
'KH 517'	118.68	31.71	89.46	406	39.8	118.4
'KH 101'	102.65	25.72	75.74	418	46.4	126.2
'PSCL 3436'	114.68	32.32	86.40	412	41.8	124.9
CD (P=0.05)	3.65	2.64	2.98	6	2.4	1.4
Fertility level						
Recommended fertilizer (RF)	98.45	27.52	76.37	426	44.8	126.4
50% RF+ 10 tonnes FYM	74.06	17.88	55.68	432	46.4	127.2
RF + FYM	114.74	29.69	84.60	446	48.2	129.6
150% RF	126.55	34.54	92.24	431	42.8	124.4
CD P=0.05)	3.65	2.64	2.98	6	2.4	1.4

cation of 150% recommended fertilizer resulted in significant increase in yield-contributing factors which resulted in significantly highest grain and straw yields. In percentage term addition of 50% more of fertilizer over recommended increased the yield by 25.97%. Similar results showing response of maize to higher NPK fertilization were also reported by Suri and Verma (1999), Ahmed (2000) and Singh and Sarkar (2001). The next best yield level was obtained when recommended fertilizer + 10 tonnes FYM was applied. Reducing the fertilizer by 50% recommended + 10 tonnes FYM resulted in lowest grain and straw yield. Application of 10 tonnes FYM/ha to recommended fertilizer increased the maize yield by 13.18%, whereas its application with 50% of recommended fertilizer decreased the yield by 19.90% compared to recommended fertilizer. Increase in maize yield with addition of 10 tonnes FYM to recommended fertilizer may be attributed to fact that FYM being store-house of nutrients also made release of applied nutrients at its optimum, at the same time improved the soil physical condition. However, 10 tonnes FYM could not substitute for 50% of fertilizer requirement. Najappa *et al.* (2001) also reported that combined application 75% NPK with 12 tonnes FYM causes higher productivity in maize compared to only inorganic fertilizer application.

Nutrient uptake

Nutrient uptake in grain and straw (Table 2) showed that N, P and K uptake followed the yield level trend and was maximum in 'KH 517' and 'PSCL 3436'. The N, P and K uptake was lowest in 'Early Composite'. The fertility levels significantly influenced the nutrient uptake. Application of 150% recommended fertilizer resulted in the highest uptake followed by recommended NPK + 10 tonnes FYM and recommended NPK only. Singh and Sarkar (2001) also reported increased nutrient uptake with increasing fertilizer level. Application of FYM recommended NPK increased the uptake because of increase in availability of nutrient to plant. The higher yield obtained with higher levels was supported by higher uptake also.

Soil nutrient status

The nutrient N, P and K status of soil after harvest of crops (Table 2) showed that there was depletion of N, P and K compared to initial status with varieties tested and fertility levels applied. However, the available N, P and K content was higher when 10 tonnes FYM was applied in addition to inorganic fertilizer compared to inorganic fertilizer application only. Nanjappa *et al.* (2001) reported reduced nutrient loss when inorganic and organic fertilizer was applied in combination which confirms our findings. Similarly, Beillaki *et al.* (1998) also reported significantly improvement in soil availabile N, P and organic carbon with the use of FYM either alone or in combination.

Economics

Maximum net return and benefit : cost ratio (Table 1) were obtained from 'KH 517', followed by 'PSCL 3436'. Among different fertility levels, application of 150% recommended fertilizer resulted in

the maximum net returns and benefit : cost ratio. This was followed by recommended fertilizer + 10 tonnes FYM application.

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