

Studies on integrated nutrient requirement of hybrid maize (*Zea mays* L.) under irrigated conditions

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Abstract: Field experiments were conducted during 2001 and 2002 at Tamil Nadu Agricultural University, Regional Research Station, Paiyur, to study the influence of integrated use of soil application of inorganic and organic nutrients and foliar feeding of major and micro nutrients in COH 3 hybrid maize. The results revealed that growth (plant height, total dry matter production) and yield attributes (cob length, cob girth, cob weight and 100 grain weight), grain and stover yields were maximum when maize was applied with 100% recommended NPK (135:62.5:50 kg ha⁻¹) coupled with foliar feeding of 1% DAP, 1% MOP, 0.5% ZnSO₄, 0.2% B and 1% FeSO₄ twice on knee high stage and tasseling stage of the crop, which was followed by the treatment of 125% recommended NPK application (170:78:62.5 kg ha⁻¹). The net return and B:C ratio were also high in the above mentioned treatments. Uptake of nutrients showed similar trend as that of growth and yield. The available nutrient status was marginally improved with at 125% NPK and 100% NPK in addition with FYM 12.5 t ha⁻¹.

Keywords: Hybrid Maize, Nutrients, Micronutrients, Foliar Feeding, Growth, Yield

Introduction

Maize has higher production potential in Tamil Nadu, especially under irrigated conditions. Development of hybrid maize has broken the yield barrier to a greater extent. It is well known that maize that too hybrid maize is heavy feeder on nutrients. Besides soil application of nutrients, it is important to feed the nutrients and micronutrients through foliar application to hybrid maize. Zinc and sulphur are yield limiting factors in many of the All India Co-ordinated Research Project (AICRP) on long-term fertilizer experiments (Nambiar, 1994). Studies on the nutrients requirement of hybrid maize with various integrating factors such as inorganics, organics and foliar feeding of DAP, MOP and micronutrients are scanty. Hence, the present study was proposed to study the effect of above factors on hybrid maize at North Western agro climatic zone of Tamil Nadu.

Materials and Methods

Field experiments were conducted during *rabi* season of 2001 and 2002 at Tamil Nadu Agricultural University, Regional Research Station, Paiyur Farm, in randomized block design with four replications. The treatments included were T₁ - 100% recommended inorganic fertilizer (135:62.5:50 NPK kg ha⁻¹); T₂ - 100% recommended inorganic fertilizer (T₁) + FYM @ 12.5 t ha⁻¹; T₃ - 125% recommended inorganic fertilizer (170:78:62.5 NPK kg ha⁻¹); T₄ - 100% recommended inorganic fertilizer (T₁) + 1% DAP and 1% MOP spray twice at knee high and tasseling stage; T₅ - 100% recommended inorganic fertilizer (T₁) + 1% DAP and 1% MOP (T₄) + 0.5% Zn So₄ and 0.2% B spray twice; T₆ - 100% recommended inorganic fertilizer (T₁) + 1% DAP and 1% MOP (T₄) + 0.5% Zn So₄ and 0.2% B spray twice (T₅) + 1% FeSO₄ spray twice. Full dose of recommended P and K fertilizers were applied at the time

Table 1. Effect of treatments on growth, yield attributes and yield of hybrid maize - Rabi 2001

Treatment	Plant height (cm)	Total DMP (g)	Cob length (cm)	Cob girth (cm)	Cob weight (g)	100 grain weight (g)	Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)
T ₁ - 100% recommended NPK	238.0	91.8	11.6	11.2	34.8	23.1	2944	5400
T ₂ - T ₁ + FYM at 12.5 t/ha	257.5	106.9	12.6	12.1	41.1	24.3	3387	6500
T ₃ - 125% recommended NPK	262.0	120.1	13.2	12.7	41.5	25.6	3341	6700
T ₄ - T ₁ + 1% DAP+1% MOP	247.5	100.4	11.8	11.7	39.9	23.9	3200	5900
T ₅ - T ₄ + 0.5% Zn So ₄ + 0.2%B	255.4	101.9	12.3	12.1	39.1	24.2	3274	6000
T ₆ - T ₅ + 1%FeSo ₄	267.3	126.7	13.5	12.8	44.9	25.9	3498	6900
CD (P=0.05)	13.4	12.5	0.7	0.6	3.5	1.2	332	600

Table 2. Effect of treatments on growth, yield attributes and yield of hybrid maize - Rabi 2002

Treatment	Plant height (cm)	Total DMP (g)	Cob length (cm)	Cob girth (cm)	Cob weight (g)	100 grain weight (g)	Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)
T ₁ - 100% recommended NPK	211.9	90.4	7.3	9.3	32.1	22.2	2721	5000
T ₂ - T ₁ + FYMat 12.5 t/ha	219.5	105.8	8.1	11.0	38.5	23.1	2922	6100
T ₃ - 125% recommended NPK	230.3	114.8	8.2	11.0	39.8	23.2	3219	6400
T ₄ - T ₁ + 1% DAP+1% MOP	212.7	99.8	7.8	10.0	37.5	22.8	2789	5600
T ₅ - T ₄ + 0.5% Zn So ₄ + 0.2%B	213.8	100.5	8.0	11.0	37.9	23.0	2842	5800
T ₆ - T ₅ + 1%FeSo ₄	234.5	124.5	8.4	11.6	42.8	24.4	3388	6700
CD (P=0.05)	16.4	11.8	0.6	0.5	3.8	1.1	318	500

Table 3. Pooled analysis of grain and straw yield and economics of hybrid maize as influenced by the treatments (2001 and 2002)

Treatments	Grain yield t ha ⁻¹	Straw yield kg ha ⁻¹	Net income Rs. ha ⁻¹	B:C ratio
T ₁ - 100% recommended NPK	2833	5200	19897	3.1
T ₂ - T ₁ + FYMat 12.5 t ha ⁻¹	3155	6300	18337	2.3
T ₃ - 125% recommended NPK	3280	6600	22279	2.9
T ₄ - T ₁ +1% DAP+1% MOP	2995	5800	21127	3.1
T ₅ - T ₄ + 0.5% Zn So ₄ + 0.2% B	3058	5900	21677	3.1
T ₆ - T ₅ + 1%FeSo ₄	3443	6800	25507	3.5
CD (P=0.05)	284	450	NA	NA

of sowing. Half of the N was applied at the time of sowing and the remaining quantity was applied in two equal splits *viz.* knee high and tasseling stages. The soil was sandy clay loam (Typic ustorthent) having pH 8.2, EC 0.14 dSm⁻¹, organic carbon 0.35%, available N, P₂O₅ and K₂O of 185, 11.8 and 246 kg ha⁻¹ respectively. Seeds of COH 3 hybrid maize (15kg/ha) were sown at 60cm x 20cm spacing (80,600 plants/ha) on 5th December and 8th December in 2001 and 2002 respectively. The crops were harvested on 26th March and 1st April during the respective crop seasons of 2001 and 2002. Over night soaked 2% DAP spray was given as per treatment schedule and the foliar nutrient sprays such as muriate of potash (MOP) 1%, zinc sulphate (ZnSo₄) 0.5%, boran (B) 0.2% and ferrous sulphate (FeSo₄) 1% were prepared from the commercial grade materials and were sprayed according to the treatment schedule. The data on plant height, cob length, cob girth, cob weight, total dry matter production (TDMP), 100 grain weight, grain yield and stover yield of maize was recorded at the time of harvest. The nutrient uptake (NPK) of grain and stover was analysed by adopting standard procedures from the plant samples collected at harvest. Pooled analysis of the yield data and economy analysis were also

done. Soil available nutrient status was also estimated from the soil samples collected at harvest.

Results and Discussion

Growth attributes

Growth parameters such as plant height (cm) and total dry matter production (g) at harvest were influenced by the treatments tried. During 2001, the plant height was maximum in T₆ (267.3cm), which was comparable to the plant height recorded in T₃ (262.0cm), T₂ (257.5cm) and T₅ (255.4cm). Significantly the lowest plant height of 238 cm was recorded in T₁. Similar trend was observed in 2002 season also (Tables 1 and 2). The higher TDMP of 126.7 g/plant was recorded in T₆, which was comparable to the TDMP recorded in the treatment T₃ (120g/plant). Significantly the lowest TDMP of 91.3 g/plant was recorded in T₁ during 2001. Similar trend was observed in 2002 also. The growth was favourably influenced by soil application 100% NPK + DAP 1% spray + MOP 1% spray + ZnSo₄ 0.5% spray + B 0.2% spray + Feso₄ 1% spray twice at knee high stage and tasseling stage of the crop, indicating the favourable influence of foliar spray of nutrients to hybrid maize. Similarly, Abou El - Nour (2002) reported that foliar

Table 4. Effect of treatments on nutrient uptake and soil available nutrient status of hybrid maize (2001 and 2002)

Treatment	Grain nutrient uptake (kg ha ⁻¹)			Stover nutrient uptake (kg ha ⁻¹)			Soil available nutrient availability (kg ha ⁻¹)		
	N	P	K	N	P	K	N	P	K
T ₁ - 100% recommended NPK	37.1	8.8	20.7	47.2	5.9	77.6	158	14.2	333
T ₂ - T ₁ + FYMat 12.5t/ha	46.1	10.0	23.7	68.0	7.9	88.8	170	15.9	353
T ₃ - 125% recommended NPK	52.4	11.1	25.4	74.7	8.2	95.7	172	14.9	353
T ₄ - T ₁ + 1% DAP+1% MOP	42.2	9.8	23.5	53.4	6.5	79.3	161	15.3	340
T ₅ - T ₄ + 0.5% Zn So [^] + 0.2%B	44.0	10.1	22.7	62.6	6.6	93.3	158	14.4	340
T ₆ - T ₅ + 1%FeSo ₄	55.7	12.7	27.2	75.6	13.0	95.2	168	15.2	344
CD (P=0.05)	4.8	1.2	2.7	8.2	1.1	8.4	NS	NS	NS

sprays with EDTA- micro nutrient compound containing Fe, Mn, Zn and N had significant effect on growth and nutrient content of maize.

Yield attributes

The yield attributes such as cob length, cob girth, cob weight and 100 grain weight are presented in Tables 1 and 2. During 2001, significant variations among the treatments were observed indicating the highest values of cob length (13.5 cm), cob girth (12.8 cm), cob weight (44.9 g) and 100 grain weight (25.9 g) were recorded with T₆ treatment (100% NPK + 1 % DAP + 1 % MOP + 0.5% ZnSo₄ + 0.2% B + 1 % FeSo₄). The above parameters were comparable to T₇ (125% NPK.) registering the values of 13.2, 12.7, 41.5 and 25.6 of cob length, cob girth, cob weight and 100 grain weight respectively. Significantly the lowest values of yield attributes were observed with T₁ (100% NPK) registering 11.6, 11.2, 34.8 and 23.1 of cob length, cob girth, cob weight and 100 grain weight respectively. During the year 2002, similar results were observed with respect to yield parameters. Foliar feeding of Zn and Mn along with enhanced doses of NPK favourably influenced the growth parameters of maize as reported by Mahmoud M. Shaaban(2001).

Yield of maize

Grain and stover yields of maize (Tables 1 and 2) varied significantly among the treatments tried. The higher grain yield of 3498 kg ha⁻¹ was recorded with T₆ (100% NPK + 1% DAP + 1% MOP + 0.5% ZnSo₄ + 0.2% B + 1% FeSo₄), which was comparable to the treatments T₂, T₃, T₄ and T₅, recording 3387, 3341, 3200 and 3274 kg ha⁻¹ respectively. Significantly the lowest grain yield of 2944 kg ha⁻¹ was recorded with T₁ (100 %NPK), which was 18.8 % lower than T₆. The stover yield was high in T₆ treatment (6900 kg ha⁻¹), which was comparable to the treatments of T₂ and T₃ registering the yield of 6700

and 6500 kg ha⁻¹ respectively. Significantly the lowest yield of 5400 kg ha⁻¹ of stover yield was recorded with T₁ (100% NPK), which was 27.8% lower than the T₆ treatment. For the season 2002, the highest grain yield of 3388 kg ha⁻¹ was recorded in T₆ followed by T₃, which registered 3219 kg ha⁻¹. Both were comparable to each other. The lowest grain yield was recorded with T₁ (2721 kg ha⁻¹), which was 24.5% and 18.3% lower than T₆ and T₃ treatments respectively. The stover yield varied significantly and the results showed that 6700 kg ha⁻¹ was recorded in T₆ and was on a par with T₅ treatment. Lower stover yield of 5000 kg ha⁻¹ was recorded with T₁ (100% NPK), which was 34% and 28% less compared to T₁ and T₃ treatments. Surendra Singh and Sarkar (2001) also reported a yield increase of 33 % with higher dose of NPK application (210:90:150 NPK kg ha⁻¹) over recommended level (100:60:40 NPK kg ha⁻¹). Significant increase in yield (18.9%) due to 2% DAP spray to cowpea was also reported by Parasuraman (2001).

Pooled analysis

The pooled analysis of the grain and straw yield was calculated and presented in Table 3. It was observed that the T₆ recorded the highest grain yield of 3443 kg ha⁻¹ followed by T₃ with 3280 kg ha⁻¹. These yields were 21.5% and 15.8% increase over T₁ which recorded the lowest grain yield of 2833 kg ha⁻¹. The treatments T₆ and T₃ were comparable to each other. The straw yield exhibited similar trend as that of grain yield registering 30.7% and 26.9% increase in T₆ and T₃ respectively over T₁. This indicates the superiority of the increased NPK and micronutrients effect on yield of maize.

Economics of maize

The economic analysis of the treatments were undergone and presented in Table 3. The results revealed that the highest net income

of Rs.25507/ha was realized with the treatment T₆ (100% NPK + 1% DAP + 1% MOP + 0.5% ZnSO₄ + 0.2% B + 1% FeSO₄) with highest B:C ratio of 3.5. It was followed by the treatment T₃ (125% recommended NPK) registering Rs.22279/ha and 2.9 of net income and B:C ratio respectively. The lowest net return of Rs.18337/ha and B:C ratio of 2.3 was recorded in the treatment of T₂ (100% NPK + 12.5 t/ha FYM) indicating the increased cost involved due to FYM application.

Uptake of nutrients

The influence of treatments on nutrient uptake was analyzed and the mean of two years data is presented in Table 3. The NPK uptake by grain and stover varied with the treatments tried, and was maximum in T₆ (100% NPK + 1% DAP + 1% MOP + 0.5% ZnSO₄ + 0.2% B + 1% FeSO₄), while it was the lowest in T₁ (100% NPK). Variations in the nutrient uptake by the crop could be attributed due to the extent of its drymatter production. Such a variation in nutrient uptake by maize was also observed by Srinivas and Satyanarayana (1996), Balyan and Idnani (2000) and Mundra *et al.* (2002).

Soil available nutrients

The mean soil available nutrients such as nitrogen, phosphorus and potassium did not show any significant differences among the treatments (Table 3). However, there was a marginal increase in the available nutrient status in the treatment applied with 25% extra dose of recommended NPK (T₃) and FYM @ 12.5 t/ha (T₂). In general, loss of nutrients was more in chemical fertilizers compared to organic sources. But the loss was less when organic and inorganics were applied in combination due to slow mineralisation of nutrients. Such an increase of soil available nutrients with application of added fertilizers and organics were also reported by Nanjappa *et al.* (2001) and Parasuraman *et al.* (2003).

From this experiment, it could be concluded that soil application of 100% NPK coupled with foliar spray of 1% DAP + 1% MOP + 0.5% ZnSO₄ + 0.2% B + 1% FeSO₄ twice at knee high and tasseling stages influenced the growth, yield attributes, yield, nutrient uptake, net return and B:C ratio of hybrid maize favourably under irrigated conditions of North Western agro climatic zone of Tamil Nadu.

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