International Journal of Agricultural Sciences
Volume 8 |Issue 2| June, 2012 | 426-430

RESEARCH PAPER

Influence of fertilizer levels and growth substances on yield attributes and yield of hybrid maize

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Abstract : A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *Kharif* 2008 to study the influence of fertilizer levels and foliar spray of plant growth substances on yield attributes and yield of hybrid maize under irrigated condition. The experiment was laid out in a split plot design replicated thrice. Three fertilizer levels *viz*., 150:75:75, 200:100:100 and 250:125:125 NPK kg ha^{-1} constituted the main plot treatments. Foliar spray of growth substances *viz*., control (no spray), salicylic acid 100 ppm, boric acid 0.3 per cent, PGR consortia 1.5 per cent, TNAU panchagavya 3 per cent and pink-pigmented facultative methylotrophic bacteria (PPFM) 10^6 dilution were assigned to sub plot. The results of the experiment revealed that among fertilizer levels, application 250:125:125 NPK kg ha^{-1} recorded better yield attributes and higher yield. However, the yield was comparable with 200:100:100 NPK kg ha^{-1}. Regarding the growth substances, PGR consortia 1.5 per cent recorded better yield parameters and yield than the other growth substances.

Key Words : Hybrid maize, Fertilizer levels, Growth substances, Yield attributes, Yield

View Point Article : Sekar, S., Mohamed Amanullah, M., Jagathjothi, N. and Ananthi, T. (2012). Influence of fertilizer levels and growth substances on yield attributes and yield of hybrid maize. *Internat. J. agric. Sci.*, **8**(2): 426-430.

Article History : Received : 20.01.2012**; Revised :** 10.04.2012**; Accepted :** 11.05.2012

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat, in the world as well in India. It is called as miracle crop and also queen of cereals. Maize is cultivated both in tropical and temperate regions of the world. In India, maize occupies third place among the cereals after rice and wheat and it is cultivated over an area of 8.26 million hectares with a production of 19.30 million tonnes and the average productivity is 2337 kg ha^{-1} (Agricoop, 2007 - 08). In Tamil Nadu, maize is cultivated in an area of 0.20 million hectares with a production of 0.24 million tonnes and productivity of 1189 kg ha^{-1} (Crop Report, 2006 - 07).

Among the plant nutrients primary nutrients such as, nitrogen, phosphorus and potassium play a crucial role in deciding the growth and yield. The response of crops to nitrogen varies widely from place to place, depending upon the fertility level of soil and other environmental conditions. This necessitates the study on the response of crop to different levels of fertilizer.

Nutrients are important and crucial elements, which are required for the plant for its growth and development. Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance effective partitioning of the accumulates from source and sink in the field crops (Solaimalai *et al*., 2001). Foliar application of growth regulators and chemicals at the flowering stage may improve the physiological efficiency and may play a significant role in raising the productivity of the crop (Dashora and Jain, 2004). Hence, an attempt was made to study the influence of graded levels of fertilizer and plant growth substances on growth and yield during *Kharif* season.

MATERIALS AND METHODS

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *Kharif* 2008 to study the influence of fertilizer levels and foliar spray of plant

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growth substances on yield attributes and yield of hybrid maize under irrigated condition. The experiment was laid out in a split plot design replicated thrice. Three fertilizer levels *viz*., 150:75:75, 200:100:100 and 250:125:125 NPK kg ha^{-1} constituted the main plot treatments. Foliar spray of growth substances *viz*., control (no spray), salicylic acid 100 ppm, boric acid 0.3 per cent, PGR consortia 1.5 per cent, TNAU panchagavya 3 per cent and pink-pigmented facultative methylotrophic bacteria (PPFM) 10^6 dilution were assigned to sub plot. The soil of the experimental field was sandy clay loam in texture belonging to *Typic Ustropept*. The nutrient status of soil during start of the experiment was low in available nitrogen (302.4 kg ha^{-1}), medium in available phosphorus (20.22 kg ha^{-1}) and high in available potassium (540.4 kg ha^{-1}). Maize hybrid, CO H (M) 5, a high yielding single cross hybrid released by department of millets, Tamil Nadu Agricultural University, Coimbatore was chosen for the study.

Well decomposed farmyard manure at the rate of 12.5 t ha^{-1} was applied uniformly over the field before the last ploughing. $ZnSO_4$ @ 37.5 kg ha^{-1} was applied uniformly as basal to all the plots. Seeds of maize hybrids were sown on the side of the ridges by adopting a spacing of 75 cm x 20 cm. Seeds were dibbled at the rate of one seed $hill^{-1}$. The seeds were pre-treated with ridomil @ 2g kg^{-1} of seeds and *Azospirillum*, 600 g per hectare of seeds before sowing the seeds. As per the treatment schedule, nitrogen was applied in three splits *viz*., 25: 50: 25 per cent as basal, 25 and 45 DAS, respectively. The entire dose of phosphorus was applied basally. The potassium was applied in two equal split doses *viz*., basal and at 45 DAS. The N, P and K fertilizers were applied in the form of urea (46 % N), single super phosphate (16 % P_2O_5) and muriate of potash (60 % K_2O), respectively. The fertilizers were placed at 5 cm depth on sides of the ridges by forming small furrows. Foliar spray of growth substances was given twice on 45 and 55 days after sowing. PGR consortia is a product formulated by the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore. It is a granule formulation mainly consisting of plant growth regulators *viz*., indole acetic acid (IAA), indole butyric acid (IBA), naphthalene acetic acid (NAA), salicylic acid and boric acid etc.

The cobs from the net plot were harvested separately. The cobs were sun dried, shelled, cleaned and grain yield was recorded for individual treatment at 14 per cent seed moisture and expressed in kg ha^{-1}. After the harvest of cobs, the stover in the net plot area were cut close to the ground level and left in the field for three days for sun drying. After drying, weight of stover from each plot was recorded and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield attributes:

Among the fertilizer treatments, the highest cob length, cob girth, number of grain rows cob^{-1}, number of grains row^{-1}, cob weight and test weight was associated with 250:125:125 NPK kg ha^{-1} followed by 200:100:100 NPK kg ha^{-1}. The fertilizer level of 150:75:75 NPK kg ha^{-1} recorded the least cob length (Table 1).

Table 1 : Effect of fertilizer levels and foliar sprays on yield attributes of hybrid maize

Treatments	Cob length (cm)	Cob girth (cm)	Number of grain rows cob^{-1}	Number of grains row^{-1}	Cob weight (g)	Test weight (g)
Fertilizer levels (NPK kg ha^{-1})						
150: 75: 75	17.25	14.32	10.85	34.63	189.8	26.91
200:100:100	18.11	14.61	12.70	38.81	198.7	29.10
250: 125: 125	19.00	15.60	13.78	41.43	203.4	30.00
S.E.±	0.23	0.22	0.32	0.45	3.13	0.52
C.D. (P =0.05)	0.65	0.62	0.90	1.26	8.69	1.45
Foliar sprays						
Control (no spray)	16.78	13.95	11.93	35.37	189.5	26.72
Salicylic acid (100 ppm)	18.04	14.83	12.36	38.30	199.4	29.39
Boric acid (0.3%)	18.11	15.02	12.50	40.15	200.0	29.56
PGR consortia (1.5%)	18.93	15.58	13.58	41.19	201.3	29.90
TNAU Panchagavya (3%)	17.91	14.81	12.18	37.44	197.0	28.52
PPFM 10^6 dilution	17.69	14.79	12.10	37.30	197.0	27.79
S.E.±	0.34	0.31	0.38	0.68	2.10	0.58
C.D. (P =0.05)	0.70	0.63	0.79	1.40	4.32	1.19
Interaction	NS	NS	NS	NS	NS	NS

NS=Non-significant

All the foliar spray treatments recorded higher yield parameters than control. Foliar spray of PGR consortia @ 1.5 per cent recorded the highest cob length, cob girth, number of grain rows cob^{-1}, number of grains row^{-1}, cob weight and test weight followed by the other foliar spray treatments *viz*., boric acid @ 0.3 per cent, salicylic acid @ 100 ppm, pachagavya @ 3 per cent and PPFM 10^6 dilution which were comparable among themselves. The least cob length was recorded with control (no spray) (S_1).

Successive increase in N levels from 150 to 250 kg ha^{-1} had marked influence on the yield attributes of hybrid maize but beyond 200 kg ha^{-1} the increase was comparatively low. Application of higher levels of N at 250 kg ha^{-1} recorded more cob length (19.0 cm), cob girth (15.60 cm), number of grain rows cob^{-1} (13.78), number of grains row^{-1} (41.3), cob weight (203.4 g) and test weight (30.0 g). The increase in N levels increased the yield attributes by better uptake of all the nutrients and increased translocation of photosynthates from source to sink in hybrid maize upto 200 kg as also reported by Parthipan (2000) and upto 225 kg by Singh *et al*. (1997). Higher doses of P and K had marked influence on yield attributes. Saleem *et al*. (2003) observed in hybrid maize that response was upto 150 kg P_2O_5 ha^{-1}. Elevated doses of phosphorus might have increased the forage activity, accumulation of food reserves, increased functional leaves and LAI, higher nutrient uptake which lead to higher yield attributes and yield. Ali *et al*. (2004) reported that with higher dose of K there was enhancement of LAI, better nutrient translocation from source to sink and better nutrient uptake, hence these factors ultimately could have resulted in increase in yield attributes and finally the yield under this investigation.

In maize crop, the important yield parameters are cob length, cob girth, number of grain rows cob^{-1}, number of grains row^{-1}, cob weight and test weight. It was found that the above yield contributing parameters were favourably influenced by foliar spray.

Application of PGR consortia @ 1.5 per cent significantly increased the cob length, cob girth, and number of grain rows cob^{-1}, number of grains row^{-1}, cob weight and test weight. PGR consortia might have helped in transfer of photosynthates from source to sink, thereby increased the size and weight of the sink. Foliar spray of PGR consortia might have increased the availability of photosynthetic material and thus minimum energy was stored in leaves and maximum was translocated to economic parts. Increase in efficiency of translocation with PGR consortia application could also be attributed to shortening the distance between source and sink.

NAA present in PGR consortia might have increased the yield attributes of the treated plants. NAA being an auxin, delayed senescence of leaves and this might have encouraged greater amount of photosynthate translocation from leaves to cobs thus enhanced the yield attributes and yield. NAA might have increased the weight of the economic produce due to increased partitioning of the photosynthates to reproductive parts (Kalita *et al.,* 1995). These results are in agreement with the findings of Muthukumar *et al.* (2007) in baby corn, Kelaiya *et al.* (1991) in groundnut, Chaplot *et al.* (1992) in soybean, Sujatha (2001) in greengram and Upadhyay (2002) in chickpea.

Yield:

Grain and stover yield:

Among the fertilizer levels, fertilizer application at 250:125:125 NPK kg ha^{-1} recorded the highest grain yield of 6546 kg ha^{-1} but was comparable with 200:100:100 NPK kg ha^{-1}. The grain yield increase with 250:125:125 and 200:100:100 NPK kg ha^{-1} was 17.2 and 14.6 per cent, respectively, over the fertilizer level of 150:75:75 NPK kg ha^{-1}.

The crop sprayed with PGR consortia @ 1.5 per cent produced the highest grain yield (6444 kg ha^{-1}) followed by application of boric acid @ 0.3 per cent (6231 kg ha^{-1}). The least grain yield was associated with control. The grain yield

Table 2 : Effect of fertilizer levels and foliar sprays on grain (kg ha^{-1}) of hybrid maize

Foliar sprays	Fertilizer levels (NPK kg ha^{-1})			Mean
	150: 75: 75	200:100:100	250: 125: 125	
Control (no spray)	5226	5829	6079	5711
Salicylic acid (100 ppm)	5536	6262	6543	6114
Boric acid (0.3%)	5528	6563	6603	6231
PGR consortia (1.5%)	5436	6869	7028	6444
TNAU Panchagavya (3%)	5331	6397	6572	6100
PPFM 10^6 dilution	5458	6169	6452	6026
Mean	5419	6348	6546	
	S.E.±	C.D. (P = 0.05)		
M	74.93	208.1		
S	51.61	210.2		
M at S	110.7	263.4		
S at M	89.3	182.5		

Table 3 : Effect of fertilizer levels and foliar sprays on stover yield (kg ha^{-1}) of hybrid maize

Foliar sprays	Fertilizer levels (NPK kg ha^{-1})			Mean
	150: 75: 75	200:100:100	250: 125: 125	
Control (no spray)	8758	9788	9921	9489
Salicylic acid (100 ppm)	8982	9791	10604	9792
Boric acid (0.3%)	9285	9926	11291	10167
PGR consortia (1.5%)	9182	10037	12428	10549
TNAU Panchagavya (3%)	9321	9880	10842	10014
PPFM 10^6 dilution	9035	9869	10588	9830
Mean	9094	9882	10946	
	S.E.±	C.D. (P = 0.05)		
M	216.6	601.6		
S	51.61	210.2		
M at S	396.8	892.2		
S at M	364.1	743.7		

increase with PGR consortia @ 1.5 per cent and boric acid @ 0.3 per cent was 11.3 per cent and 8.3 per cent, respectively, over control (*i.e.*) crop without foliar spray (Table 2).

Among the treatment combinations, the highest grain yield (7028 kg ha^{-1}) was recorded under 250:125:125 NPK kg ha^{-1} with foliar spray of PGR consortia @ 1.5 per cent. However, the yield recorded under this combination was comparable with the yield obtained under 200:100:100 NPK kg ha^{-1} along with foliar spray of PGR consortia @ 1.5 per cent (6869 kg ha^{-1}). The least grain yield (5226 kg ha^{-1}) was obtained under 150:75:75 NPK kg ha^{-1} without any foliar spray.

This increase in yield was probably due to effective utilization of applied nutrients, increased sink capacity and nutrient uptake by crop. The yield potential of maize is mainly governed by the growth and yield components. The positive and significant improvement in LAI and DMP and increased yield attributes would have resulted in enhanced grain yield. The present findings are in line with the findings of Siva (2007) and Maddonni *et al*. (2006). The positive responses of hybrid maize upto 250 kg N ha^{-1} as reported by Srikanth *et al*. (2009) lend support to the present findings.

The increase in grain yield with PGR consortia spray might be due to effective translocation of photosynthates from source to sink. PGR consortia @ 1.5 per cent application might have facilitated effective translocation of assimilates from source to sink which has resulted finally in the cob yield. The increase in grain yield might also be due to increased mobilization of reserve food materials to sink through increase in hydrolyzing and oxidising enzyme.

NAA promoted vegetative growth by active cell division, cell enlargement and cell elongation and thus helped in improving growth characteristics and also facilitated reproductive growth (Pareek *et al.,* 2000). NAA present in PGR consortia could have increased grain yield of the treated plants. Similar results of increase in yield due to NAA application were also reported earlier by Muthukumar *et al.* (2007) in baby corn.

The fertilizer level of 250:125:125 NPK kg ha^{-1} recorded the highest stover yield (10946 kg ha^{-1}) followed by 200:100:100 NPK kg ha^{-1}. The least stover yield (9094 kg ha^{-1}) was recorded with 150:75:75 NPK kg ha^{-1} (Table 3). Application of foliar spray exhibited significant influence on stover yield also. PGR consortia @ 1.5 per cent recorded the highest (10549 kg ha^{-1}) stover yield but was comparable with boric acid @ 0.3 per cent. Among the treatment combinations, the highest stover yield (12428 kg ha^{-1}) was recorded under the treatment combination 250:125:125 NPK kg ha^{-1} with foliar spray of PGR consortia @ 1.5 per cent.

The positive and significant improvement in LAI and DMP due to higher doses of fertilizer would have resulted in enhanced stover yield. These results are in conformity with the findings of Srikanth *et al*. (2009) and Siva (2007). NAA present in PGR consortia might have increased the stover yield of treated plants, due to increase in plant height, leaf area index and total biomass as evidenced in the present investigation. Similar results of increase in stover yield due to NAA application were also reported earlier by Muthukumar *et al.* (2005) in baby corn and Lakshmamma and Rao (1996) in blackgram.

Conclusion:

The results of the experiment revealed that among the fertilizer levels, application of 250:125:125 NPK kg ha^{-1} recorded better yield attributes and higher yield. However, the yield was comparable with 200:100:100 NPK kg ha^{-1}. Regarding the growth substances, PGR consortia 1.5 per cent recorded better yield parameters and yield than the other growth substances. Among the treatment combinations, the highest grain yield was recorded under 250:125:125 NPK kg ha^{-1} with foliar spray of PGR consortia @ 1.5 per cent but, was comparable with

200:100:100 NPK kg ha^{-1} along with foliar spray of PGR consortia @ 1.5 per cent.

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