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Influence of Fertilizer Levels and Growth Substances on Yield and Economics of Hybrid Maize

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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 and economics 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%, PGR consortia 1.5%, TNAU Panchagavya 3% and Pink-pigmented facultative methylotrophic bacteria (PPFM) 10^{6} dilution were assigned to sub plot. The results revealed that yield, gross return and net return were higher under the treatment combination 250:125:125 NPK kg ha^{-1} along with the foliar spray of PGR consortia @ 1.5% twice at 45 DAS and 55 DAS. However, the highest benefit cost ratio was recorded under the treatment combination 200:100:100 NPK kg ha^{-1} along with the foliar spray of PGR consortia @ 1.5%.

Key words: Hybrid maize, fertilizer levels, growth substances, yield, economics

Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat, in the world as well as in India. It is a versatile crop and can be grown in diverse environmental conditions and has multiple uses. 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).

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. Maize has high yield potential and responds greatly to applied fertilizers. Therefore, proper management of nutrients is essential to realize maximum potential of the crop and to get higher economic benefit.

Nutrients are important and crucial elements, which are required for the plant for its growth and development. The translocation of photosynthates from source to sink is very important for the development of economic part. Plant growth regulators are chemical substances and when applied in small amounts, they bring rapid changes in the phenotypes of the plant and also influence the plant growth, right from seed germination to senescence either by enhancing or by stimulating the natural growth regulatory system. Plant growth regulators are known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crops.

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, with these ideas in view, an attempt was, therefore, made to study the effect of different fertilizer levels and foliar spray of growth regulating substances on yield and economics of hybrid maize 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 growth substances on yield and economics in hybrid maize under irrigated condition. The experiment was laid out in a split plot design

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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%, PGR consortia 1.5%, TNAU Panchagavya 3% 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, COH (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 last ploughing. Zn SO_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 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,

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

Foliar spray	Fertilizer level (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	
	SEd	CD (P = 0.05)		
M	74	208		
S	51	210		
M at S	110	263		
S at M	89	182		

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}. Economics viz., gross return, net return, benefit cost ratio was worked out, considering the current market price for inputs and outputs and expressed in Rs. ha^{-1}.

Results and Discussion

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% produced the highest grain yield (6444 kg ha^{-1}) followed by application of boric acid @ 0.3% (6231 kg ha^{-1}). The least grain yield was associated with control. The grain yield increase with PGR consortia @ 1.5% and boric acid @ 0.3% was 11.3% and 8.3%, respectively, over control (i.e.) crop without foliar spray (Table 1).

Among the treatment combinations, the highest grain yield (7028 kg ha^{-1}) was recorded at 250:125:125 NPK kg ha^{-1} with foliar spray of PGR consortia @ 1.5%. However, the yield obtained 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% (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.

Since N is the major structural constitute of cells, as N level increased, the rate of vegetative and reproductive growth also increased in plants due to increase in assimilating surface of plants as well as total photosynthesis. In physiological terms, the grain yield of maize is largely governed by source (photosynthesis) and sink (grain) relationship which is directly related to N. These resulted in more grain yield when N was higher.

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 % 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.

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

Foliar spray	Fertilizer level (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	
	SEd	CD (P = 0.05)		
M	216	601		
S	51	210		
M at S	396	892		
S at M	364	743		

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 2). Application of foliar spray exhibited significant influence on stover yield also. PGR consortia @ 1.5% recorded the highest (10549 kg ha^{-1}) stover yield but was comparable with boric acid @ 0.3%. 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%.

The positive and significant improvement in LAI and DMP noticed at different stages and higher nutrient uptake due to higher dose of fertilizer would have resulted in enhanced stover yield. These results are in confirmity 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. 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.

Economics

On comparing the net return of various treatment combinations, it was found that the fertilizer dose of 250:125:125 NPK kg ha^{-1} along with the foliar spray of PGR consortia @ 1.5% recorded the highest net return (Rs.28, 758 ha^{-1}) followed by the treatment combination 200:100:100 NPK kg ha^{-1} along with the foliar spray of PGR consortia @ 1.5% (Rs. 28, 260 ha^{-1}). The least net return was recorded under

Table 3. Effect of fertilizer levels and foliar sprays on economics of hybrid maize

Treatment	Cost of cultivation(Rs. ha^{-1})	Gross return(Rs. ha^{-1})	Net return(Rs. ha^{-1})	Benefit costratio
M_1S_1	13748	33988	20239	2.47
M_1S_2	14243	35911	21667	2.52
M_1S_3	14513	35958	21444	2.48
M_1S_4	14790	35375	20584	2.39
M_1S_5	15428	34786	19358	2.25
M_1S_6	14508	35461	20952	2.44
M_2S_1	14923	37939	23015	2.54
M_2S_2	15418	40514	25095	2.63
M_2S_3	15688	42360	26671	2.70
M_2S_4	15965	44225	28260	2.77
M_2S_5	16603	41346	24743	2.49
M_2S_6	15683	39953	24269	2.55
M_3S_1	16098	39453	23354	2.45
M_3S_2	16593	42441	25848	2.56
M_3S_3	16863	43007	26144	2.55
M_3S_4	17140	45898	28758	2.68
M_3S_5	17778	42685	24906	2.40
M_3S_6	16858	41889	25030	2.48

the treatment combination 150:75:75 NPK kg ha^{-1} without any foliar spray (Table 3).

In any investment economics, it is the B: C ratio which is more important to compare the profitability of the treatments to identify input technologies to improve the yield. From the study conducted, it is found that application of fertilizer at 200:100:100 NPK kg ha^{-1} along with foliar spraying of PGR consortia @ 1.5 % recorded the highest B: C ratio followed by 200:100:100 NPK kg ha^{-1} along with foliar spraying of boric acid @ 0.3%.

The enhancement in fertilizer application to the tune of 25-50 per cent above the recommended level increased the gross return, net return and BC ratio. This might be due to improvement in growth parameters, yield attributes and yield recorded under this treatment combination.Similar findings were also reported by Singh *et al*. (1997).

It could be concluded that application of fertilizer at 200:100:100 NPK kg ha^{-1} along with foliar spraying of PGR consortia @ 1.5 % recorded the highest B: C ratio followed by 200:100:100 NPK kg ha^{-1} along with foliar spray of boric acid @ 0.3%.

References

Agricoop. 2007-08. *http://agricoop.nic.in.*

Crop report. 2006 - 07. Ministry of Agriculture. 2006. *www.tn.gov.in.*

Dashora, L.N. and Jain, P.M. 2004. Effect of growth regulators and phosphorus levels on growth and yield of soybean. *Madras Agric. J.,* **81:** 235-237.

Lakshmamma, P. and Rao, I.V.S. 1996. Response of Blackgram (*Vigna mungo* L.) to shade and Napthalene acetic acid. *Indian J. Plant Physiol.,* **1:** 63-64.

Maddonni, G.A., Cirilo, A.G. and Otegui, M.E. 2006. Row width and maize grain yield. *Agron. J.,* **98:** 1532-1543.

Muthukumar, V.B., Velayudham, K. and Thavaprakaash, N. 2005. Growth and yield of baby corn (*Zea mays* L.) as influenced by plant growth regulators and different time of nitrogen application. *Res. J. Agric. Biol. Sci.,* **1:** 303-307.

Muthukumar, V.B., Velayudham, K. and Thavaprakaash, N. 2007. Plant growth regulators and split application of nitrogen improves the quality parameters and green cob yield of baby corn (*Zea mays* L.). *J. Agron.,* **6:** 208-211.

Pareek, N.K., Jat, N.L. and Pareek, R.G. 2000. Response of coriander *(Coriandrum sativum* L.*)* to nitrogen and plant growth regulators. *Haryana J. Agron.,* **16:** 104-109.

Singh, D., Tyagi, R.C., Hooda, I.S. and Verma, O.P.S. 1997. Influence of plant population, irrigation and nitrogen levels on the growth of spring maize. *Haryana J. Agron.,* **13:** 54-58.

Siva, P. 2007. Optimization of nitrogen dose and spacing in hybrid maize (*Zea mays* L.). *M.Sc. (Ag.) Thesis,* Tamil Nadu Agric. Univ., Coimbatore.

Solaimalai, A., Sivakumar, C., Anbumani, S., Suresh, T. and Arulchelvan, K. 2001. Role of plant growth regulators in rice production – A Review, *Agric. Rev.,* **22:** 33-40.

Srikanth, M., Mohamed Amanullah, M., Muthukrishnan, P. and Subramanian, K. S. 2009. Nutrient uptake and yield of hybrid maize (*Zea mays* L.) and soil nutrient status as influenced by plant density and fertilizer levels. *Inter. J. Agric, Sci.,* **5:** 193-196.

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