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Influence of different approaches and forms of fertilizer application on growth, yield and economics of hybrid maize in eastern dry zone of Karnataka

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Summary

A field experiment was conducted at Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bangalore to study the influence of soil and foliar application of different forms of fertilizers through different approaches on growth, yield and economics of hybrid maize in eastern dry zone of Karnataka. The experiment was laid out in RCBD with ten treatments and replicated thrice. The results revealed that soil test crop response (STCR) dose through soluble fertilizer with 3 splits and 3 sprays recorded higher growth and yield parameters like plant height (246.07 cm), number of leaves per plant (14.93), test weight (34.7 gm), cob length (19.23 cm) and yield parameters like grain yield (98.22 q ha^{-1}) and stover yield (130.96 q ha^{-1}). However, higher benefit : cost (B:C) was observed in recommended dose of fertilizer (RDF)through conventional fertilizer (4.20) followed by STCR dose through conventional fertilizers (3.62) and lower B:C recorded in treatment receiving soluble fertilizers irrespective of the forms and approaches of fertilizer application was mainly due to higher cost for soluble fertilizers compared to conventional fertilizers.

Key words : STCR, Hybrid maize, Soluble fertilizer, Conventional fertilizer, B:C

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Introduction

Maize (*Zea mays* L.) is one of the important staple food crop of the world and ranks next to wheat and rice. In the world, it is grown in an area of 145 million hectare with an annual production of 695 m t with a productivity of 4820 kg ha^{-1}. In India maize ranks fourth after rice, wheat and sorghum, which is cultivated in an area of 9.43 m ha with a production of 24.35 m t with a productivity of 2583 kg ha^{-1} (Anonymous, 2014). In Karnataka, maize is grown in an area of 1.2 m ha with a production of 3.6 m t with a productivity of 3000 kg ha^{-1} (Anonymous, 2011).

Soil test crop response (STCR) approach plays a vital role as a comprehensive approach of fertilizer utilization, wherein fertilizer nutrients will be applied based on soil test values, yield target, site specification

and crop specification (Ashwini *et al*., 2009). Water soluble fertilizers are those fertilizers with different grades of NPK containing fertilizers which are completely soluble in water and characterised by high purity and can be applied in lower doses to get higher benefits. For efficient use of nutrients for maize production, it is an important management strategy for increasing crop yield and improving nutrient use efficiency (NUE) which can be practiced by split application of fertilizer nutrients (Suphasit *et al*., 2010). Foliar application of fertilizer nutrients is a widely adopted strategy in modern crop management where it is used to ensure optimal crop performance by enhancing crop growth at certain growth stage, correcting the nutrient deficiency in crop and enhancing crop tolerance to adverse conditions for crop growth (Yadav *et al*., 2004). In this context, the present study was carried out to know the influence of different approaches, forms and methods of fertilizer application on crop yieldand economics of maize crop.

Resource and Research Methods

A field experiment was conducted during *Kharif* 2014 at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru, Karnataka to study the influence of different approaches, forms and methods of fertilizer application on growth, crop yield and economics of hybrid maize (*Zea mays* L.) crop. The soil of the experimental site was loamy sand in texture classified as Kandic Paleustalf which was slightly acidic (pH 5.98), with low salt content (0.059 dS m^{-1}) and low organic carbon content (0.39%).The available nitrogen (232.40 kg ha^{-1}) was low and available phosphorus (256.20 kg ha^{-1}) was high, available potassium content (188.40 kg ha^{-1}) was medium. The experiment was laid out in a Randomized Complete Block Design with ten treatments replicated thrice. The treatment combination include, T_1: Control (RDF through conventional fertilizers), T_2: 100 per cent STCR dose through conventional fertilizer, T_3: 100 per cent STCR dose through soluble fertilizer, T_4: 50 per cent STCR dose through soluble fertilizer, T_5:100 per cent STCR dose through soluble fertilizer with 3 splits, T_6: 50 per cent STCR dose through soluble fertilizer with 3 splits T_7: 100 per cent STCR dose through soluble fertilizer with 3 sprays of 1 per cent 19 all, T_8:50 per cent STCR dose through soluble fertilizer with 3 sprays, T_9: 100 per cent STCR dose through soluble fertilizer with 3 splits and 3 sprays and T_{10}: 50 per cent STCR dose through soluble fertilizer with 3 splits and 3 sprays.

For all the treatments 10t FYM ha^{-1} and 10 kg $ZnSO_4$ were applied, whereas NPK nutrients were applied in different doses through different forms as per the treatments. Three splits were done at basal, 30 and 50 DAS for NPK, whereas foliar spray was done with 1 per cent concentrationof 19:19:19 at 20, 40 and 60 DAS. Water soluble fertilizers used were calcium nitrate (15.5 % N and 18.8 % Ca), 00:00:50 and 19:19:19 grades. The following STCR targeted yield equation developed for hybrid maize by AICRP on STCR, Bengaluru centre (Anonymous, 2007) was used for calculating the NPK fertilizer nutrient requirements based on the target fixed (90 q ha^{-1}).

F.N.= 3.84 T – 0.42 S.N ($KMnO_4$-N)

$F.P_2O_{5.}$= 1.57 T – 1.18 $S.P_2O_5$ (Bray's)

$F.K_2O$.= 1.15 T – 0.11 S. K_2O (Am. Ac.).

where,

T = Targeted yield (q ha^{-1}) *i.e*. 90 q ha^{-1}, F.N.= Nitrogen supplied through fertilizer (kg ha^{-1}), $F.P_2O_{5.}$= Phosphorus supplied through fertilizer (kg ha^{-1}), $F.K_2O$. = Potassium supplied through fertilizer (kg ha^{-1}), S.N., $S.P_2O_{5.}$and $S.K_2O$. are the initial available N, P_2O_5 and

Table A: Initial soil test values and quantity of nutrients applied through different approaches

Treatments	Initial soil test values(kg ha^{-1})			Nutrients applied (kg ha^{-1})		
	Av. N	Av. P_2O_5	Av. K_2O	N	P_2O_5	K_2O
T_1: Control (RDF - CF)	226.99	221.66	174.40	150.00	75.00	40.00
T_2 : 100% STCR dose- CF**	244.16	272.33	197.20	198.05	9.86	33.80
T_3: 100% STCR dose – SF*	229.97	279.19	176.80	204.05	0.00	36.05
T_4 : 50% STCR dose – SF	228.48	267.98	177.20	102.24	0.00	18.00
T_5 : 100% STCR dose - SF - 3 splits	239.31	323.52	191.60	200.08	0.00	34.36
T_6: 50% STCR dose - SF - 3 splits	244.91	260.79	208.80	98.87	0.00	16.28
T_7 : 100% STCR - SF - 3 sprays	223.63	265.09	222.80	206.67	0.00	30.98
T_8: 50% STCR dose - SF - 3 sprays	224.75	369.07	205.60	103.10	0.00	16.44
T_9: 100% STCR dose- SF - 3 splits and 3 sprays	226.24	279.88	203.60	205.57	0.00	33.10
T_{10}: 50% STCR dose - SF - 3 splits and 3 sprays	218.77	325.28	186.40	104.36	0.00	17.50

CF**: Conventional fertilizer; SF*: Soluble fertilizer

K_2O kg ha^{-1}, respectively (Table A).

The crop was harvested at physiological maturity from all the plots. At the time of tasseling five plants were randomly selected and growth parameters *viz.*, plant height, number of leaves per plant and at harvest yield parameters like test weight and cob length were recorded. The cobs in each net plot was harvested and threshed separately. Grain and stover were sun dried and weighed separately and the yield was recorded and expressed in q ha^{-1}.

The cost of inputs that were prevailing at the time of their use was considered for working out the economics of various treatment combinations. A net return ha^{-1} was calculated by deducting the cost of cultivation from gross income per hectare. Benefit cost ratio was calculated by using the following formula :

$$\text{Benefit cost ratio (B : C)} = \frac{\text{Gross returns (Rs.)}}{\text{Cost of cultivation (Rs.)}}$$

These data *viz*., growth and yield parameters, grain yield and stover yield were statistically analysed by adopting standard procedures outlined by Gomez and Gomez (1984).

Research Findings and Discussion

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

Growth and yield parameters :

Growth and yield parameters such as plant height (246.07 cm), number of leaves per plant (14.93) at tasseling stage, test weight (34.87 g) and cob length (19.23 cm) were significantly higher when 100 per cent STCR dose was applied as soluble fertilizers with three splits along with three sprays of 19:19:19 @ 1% concentration when compared to other treatments (Table 1). However, it was at par with treatment receiving 100 per cent STCR dose through soluble fertilizers with 3 splits or 3 sprays of 19 all. This increased growth and yield parameters might be due to increased fertilizer application of nitrogen through soil test crop response (STCR) approach, that attributed to the increased physiological processes through enhanced chlorophyll concentration in crop plants and better utilization of nutrients leading to higher plant height, number of leaves per plant, test weight and cob length (Arun Kumar *et al*., 2007).

Yield parameters :

Application of soluble fertilizers based on STCR approach at three splits along with three sprays of 19:19:19 @ 1% concentration (T_9) resulted in highest grain (98.22 q ha^{-1}) and stover yield (130.96 q ha^{-1}) compared to all other treatments (Table 2). However, it was at par with the grain yield (94.87 qha^{-1}) and stover yield (119.63 q ha^{-1}) recorded in (T_{10}) 50 per cent STCR dose of soluble fertilizers in 3 splits along with 3 sprays. This higher grain and stover yield in these treatments might be due to addition of exact quantity of NPK fertilizers through STCR approach compared to blanket recommendation or RDF (Vidyavathi *et al*., 2012). This might also be due to increased efficiency of nutrients, when applied in lesser quantity, which helps in even distribution of these nutrients in root zone leads to

Table 1: Growth and yield parameters of maize as influenced by different approaches and different forms of fertilizer application

Treatments	Plant height (cm)	No. of leaves $plant^{-1}$	Test weight (g)	Cob length (cm)
	At tasseling stage			
T_1: Control (RDF - CF)	216.70	13.03	29.84	16.13
T_2 : 100% STCR dose- CF	227.53	13.93	32.46	18.47
T_3: 100% STCR dose – SF	231.20	14.10	33.82	19.07
T_4 : 50% STCR dose – SF	226.00	13.67	31.78	17.97
T_5 : 100% STCR dose - SF - 3 splits	237.57	14.60	33.97	18.97
T_6: 50% STCR dose - SF - 3 splits	222.33	13.87	31.77	17.99
T_7 : 100% STCR - SF - 3 sprays	235.47	14.57	33.86	18.67
T_8: 50% STCR dose - SF - 3 sprays	224.87	14.03	31.76	18.01
T_9: 100% STCR dose- SF - 3 splits and 3 sprays	246.07	14.93	34.87	19.23
T_{10}: 50% STCR dose - SF - 3 splits and 3 sprays	232.53	14.30	32.40	18.63
S.E. ±	3.69	0.26	1.30	0.40
C.D. (P=0.05)	10.97	0.77	3.86	1.19

sufficient supply of nutrients from soil through soluble fertilizers for uptake by the crop (Anitta Fanish, 2013a). Similarly, application of these fertilizers with three splits helped in efficient use of nutrients without fixation or leaching losses (Tadesse *et al*., 2013). In addition spraying with 19:19:19 at three stages helps in better translocation and uptake of these nutrients without any losses (Yadav *et al*., 2004).

Economics of maize crop :

Higher gross returns were recorded (Rs.150279.54) in (T_9) 100 per cent STCR dose applied through soluble fertilizers in three splits along with three sprays of 19:19:19 @ 1% concentration (Table 3). Higher gross returnsin plots where soluble fertilizers were applied wasmainly due to higher yield in these treatments compared to conventional fertilizers. However, net returns recorded (Rs.104447.97) were highest in (T_2) 100 per cent RDF applied plot through conventional fertilizers. The higher net returns might be due to lower cost of cultivation (Rs. 32706.18) including the cost of these fertilizers in this treatment. The higher B:C was (4.20) recorded in treatment (T_2) receiving 100 per cent STCR dose applied through conventional fertilizers. Whereas, lower B:C were observed in the treatments receiving water soluble fertilizers compared to normal conventional fertilizers, could be due to subsidized cost for the conventional fertilizers when compared to the soluble fertilizers (Anitta Fanish, 2013b).

Among the treatments higher B:C (4.20) was

Table 2: Grain and stover yield of maize as influenced by different approaches and different forms of fertilizer application

Treatments	Grain yield	Stover yield
	($q\ ha^{-1}$)	
T_1: Control (RDF - CF)	82.56	84.37
T_2 : 100% STCR dose- CF	90.48	99.21
T_3: 100% STCR dose – SF	92.59	112.29
T_4 : 50% STCR dose – SF	89.97	90.41
T_5 : 100% STCR dose - SF - 3 splits	97.59	123.24
T_6: 50% STCR dose - SF - 3 splits	92.26	110.76
T_7 : 100% STCR dose- SF - 3 sprays	96.83	123.00
T_8: 50% STCR dose - SF - 3 sprays	94.34	115.54
T_9: 100% STCR dose- SF - 3 splits and 3 sprays	98.22	130.96
T_{10}: 50% STCR dose - SF - 3 splits and 3 sprays	94.87	119.63
S.E. ±	1.67	3.56
C.D. (P=0.05)	4.96	10.57

Table 3: Economics of maize production as influenced by different approaches and different forms of fertilizer application

Treatments	GY	COF	COS	Total COF	COC	GR	NR	B:C
	($q\ ha^{-1}$)	($Rs.\ ha^{-1}$)						
T_1	82.56	1132.88	0.00	6226.48	34426.48	124767.83	90341.36	3.62
T_2	90.48	957.38	0.00	4506.06	32706.18	137154.16	104447.97	4.20
T_3	92.59	1225.70	0.00	53660.88	81860.88	141960.03	60099.16	1.73
T_4	89.97	612.11	0.00	26884.09	55084.09	135874.51	80790.41	2.47
T_5	97.59	1168.35	0.00	52583.37	80783.37	148423.97	67640.60	1.84
T_6	92.26	553.63	0.00	25959.63	54159.63	140421.60	86261.97	2.60
T_7	96.83	1053.32	490.00	54650.90	84950.90	147781.62	62830.73	1.74
T_8	94.34	558.96	490.00	27542.79	57842.79	143726.01	85883.22	2.49
T_9	98.22	1125.29	490.00	54441.05	84741.05	150279.54	65538.48	1.77
T_{10}	94.87	594.89	490.00	27901.21	58201.21	144743.13	86541.91	2.49

GY= Grain yield; COF = Cost of fertilizer; COS = Cost of spraying; COC = Cost of cultivation; GR=Gross returns; NR= Net returns and B:C= Benefit:Cost

recorded in (T_2) 100 per cent STCR dose applied through conventional fertilizers followed by treatment (T_1) receiving 100 per cent RDF applied through conventional fertilizers (3.62). This higher B:C might be due to lower amount of phosphorus application based on soil test value under STCR approach as compared to blanket (RDF) method of application. These results are supported by Basavaraja *et al*. (2015) who reported that the cost of phosphatic fertilizer can be saved when phosphorus is applied based on STCR approach under high available phosphorus containing groundnut growing areas in Pavagada taluk of Tumkur district.

From this study, it was concluded that application of soluble fertilizers based on STCR targeted yield approach with three splits at basal, 30 and 50 DAS along with three sprays of 19:19:19 @ 1% concentration at 20, 40 and 60 DAS was helpful for getting higher growth and yield of maize crop, even though benefit:cost was lower in these treatments, due to subsidized cost for the conventional fertilizers when compared to soluble fertilizers. If the same subsidy is given to soluble fertilizers, B:C will be higher in soluble fertilizers treatment due to higher grain yield.

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