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RESEARCH PAPER

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

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Abstract : 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,yield response and response yard stick 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 100 per cent soil test crop response (STCR) dose through soluble fertilizer with 3 splits and 3 sprays of 1 per cent 19 all recorded higher growth parameter like plant height (246.07 cm), number of rows per cob (18.20), number of grains per row (44.38), number of sheaths per cob (16.00) and yield parameters like grain yield (98.22 q ha^{-1}) and stover yield (130.96 q ha^{-1}). Similarly, higher crude protein yield (1100.79kg ha^{-1}) and yield response (1566.67 kg ha^{-1}) were recorded in the same treatment whereas higher response yard stick (10.12 kg ha^{-1}) was recorded in the treatment which received 50 per cent STCR dose through soluble fertilizer with 3 splits and 3 sprays followed by 100 per cent STCR dose through soluble fertilizer with 3 splits and 3 sprays of 1 per cent 19 all. Higher response recorded in this treatment may be due to effective utilization of NPK nutrients by the crop through soluble fertilizers due to its easy solubility and better uptake of nutrients under STCR approach.

Key Words : STCR, Soluble fertilizer, Conventional fertilizer, Response yard stick

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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

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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, 2007).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 growth, yield, yield response and response yard stick of hybrid maize in eastern dry zone of Karnataka.

MATERIAL AND 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, yield, yield response and response yard stick 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 combinations include, T_1: Control (RDF through conventional fertilizers), T_2: 100% STCR dose through conventional fertilizer, T_3: 100% STCR dose through soluble fertilizer, T_4: 50% STCR dose through soluble fertilizer, T_5:100% STCR dose through soluble fertilizer with 3 splits, T_6: 50% STCR dose through soluble fertilizer with 3 splits T_7: 100% STCR dose through soluble fertilizer with 3 sprays of 1% 19 all, T_8: 50% STCR dose through soluble fertilizer with 3 sprays of 1% 19 all, T_9: 100% STCR dose through soluble fertilizer with 3 splits and 3 sprays and T_{10}:50 % 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, where as NPK nutrients were applied in different doses through different forms as per the treatments. Three equal splits was done at basal, 30 and 50 DAS for NPK, whereas foliar spray was done with 1% concentration of 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 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 parameter *viz.*, plant height and at harvest yield parameters like number of rows per cob, number of grains per row and number of sheaths per cob 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}.

At harvest of maize crop, soil samples collected from different treatments were processed and analyzed for available nitrogen (Subbaiah and Asija, 1956), available phosphorus (Jackson, 1973), available potassium (Page, 1982) as per the standard procedures.

Protein content (%):

Nitrogen content in the maize grain was estimated

Table A : Quantity of nutrients applied per hectare through different approaches as per the treatments

Treatments	N	P_2O_5	K_2O
		(kg ha^{-1})	
T_1: Control (RDF – CF)	150.00	75.00	40.00
T_2 : 100% STCR dose- CF*	198.05	9.86	33.80
T_3: 100% STCR dose – SF**	204.05	0.00	36.05
T_4 : 50% STCR dose – SF	102.24	0.00	18.00
T_5 : 100% STCR dose - SF - 3 splits	200.08	0.00	34.36
T_6 : 50% STCR dose - SF - 3 splits	98.87	0.00	16.28
T_7 : 100% STCR dose- SF - 3 sprays	206.67	0.00	30.98
T_8: 50% STCR dose - SF - 3 sprays	103.10	0.00	16.44
T_9: 100% STCR dose- SF - 3 splits and 3 sprays	205.57	0.00	33.10
T_{10}: 50% STCR dose - SF - 3 splits and 3 sprays	104.36	0.00	17.50

*CF-Conventional fertilizers **SF-Soluble fertilizers

by Kjeldhal's method (Jackson, 1973). The protein content in the grains was calculated by multiplying the nitrogen content of grain by a factor of 6.25 and expressed in per cent.

Protein yield (kg ha^{-1}):

The protein yield per hectare was computed by multiplying the protein content (%) with grain yield and expressed in kg per hectare.

Yield response (YR) and response yard stick (RYS):

Yield response is nothing but yield difference between treated plots and control plot (RDF).

Response yard stick for each treatment was calculated by using the following formula:

$$\text{RYS (kg kg}^{-1}) = \frac{\text{Yield response (kg ha}^{-1})}{\text{Total fertilizer nutrients applied (kg N, P}_2\text{O}_5\text{ and K}_2\text{O ha}^{-1})}$$

Response yard stick is the ratio of yield response (kg ha^{-1}) to total amount of N, P_2O_5 and K_2O fertilizer nutrients applied (kg ha^{-1}).

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

RESULTS AND DISCUSSION

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

Effect on growth and yield parameters:

Significantly higher plant height (246.07cm) at tasseling stage, number of rows per cob (18.20), number of grains in each row (44.38) and number of sheaths per

Table 1 : Influence of different approaches and different forms of fertilizer application on growth and yield parameters of maize

Treatments	Plant height (cm) at tasseling stage	No. of rows cob^{-1}	No. of grains row^{-1}	No. of sheaths cob^{-1}
T_1: Control (RDF - CF)	216.70	14.80	36.33	10.00
T_2 : 100% STCR dose- CF	227.53	16.00	41.33	11.73
T_3: 100% STCR dose – SF	231.20	16.40	42.33	13.00
T_4 : 50% STCR dose – SF	226.00	15.93	39.60	11.80
T_5 : 100% STCR dose - SF - 3 splits	237.57	17.53	43.00	14.33
T_6: 50% STCR dose - SF - 3 splits	222.33	16.07	39.00	12.33
T_7 : 100% STCR - SF - 3 sprays	235.47	17.10	42.00	14.73
T_8: 50% STCR dose - SF - 3 sprays	224.87	16.40	40.33	13.13
T_9: 100% STCR dose- SF - 3 splits and 3 sprays	246.07	18.20	44.38	16.00
T_{10}: 50% STCR dose - SF - 3 splits and 3 sprays	232.53	16.67	41.33	13.53
S.E. ±	3.69	0.39	1.30	0.60
C.D. (P=0.05)	10.97	1.15	3.86	1.79

cob (16.00) was recorded when 100 per cent STCR dose was applied through soluble fertilizers with three splits along with three sprays of 19:19:19 @ 1% concentration whereas lower values were recorded in control plot where recommended dose of fertilizers were applied through conventional fertilizers (Table 1). This increase in growth and yield attributes might be due to increase in fertilizer nutrient levels which could be attributed to adequate nutrient supply, which in turn improved all growth parameters and yield influencing characters. These results are in line with Santhosha (2013); Arun Kumar *et al*. (2007) and Patel *et al*. (2006).

Effect on grain and stover yield:

Application of soluble fertilizers based on STCR approach at three splits along with three sprays of 19:19:19 @ 1% concentration resulted in higher grain and stover yield when compared to other treatments (Table 2). This increased yield might be due to easy solubility and uniform distribution of nutrients in root zone leading to availability of sufficient nutrients for uptake by the crop through soluble fertilizers. These results corroborate with the findings of Hebbar *et al*. (2004) and Shaymaa *et al*. (2009). Split application of soluble fertilizers for three times along with three sprays of 19:19:19 resulted in significantly higher grain and stover yield. This might be due to application of required quantity of nutrients through soluble fertilizers with three splits, so that nutrients are efficiently used 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. These results are in accordance with Chaurasia *et al.* (2006).

Effect on crude protein yield:

Significantly higher crude protein yield (1100.79 kg ha^{-1}) in maize grain was recorded with the application of 100 per cent STCR dose in the form of soluble fertilizers with three splits along with three sprays of 19:19:19 @ 1% concentration and lower crude protein yield (815.81 kg ha^{-1}) was recorded in control plot to which RDF was applied through conventional fertilizers (Table 2). Protein is the major nutritive constituent of seed, which determines the quality of seed. The crude protein content increased significantly with increase in nitrogen fertilizer application because a direct relation exists between nitrogen and protein content of maize grain. Maize hybrids need large amount of nitrogen for production of dry matter which also might have augmented protein synthesis (Srikanth *et al*., 2009). It might also be due to higher level of K which act as catalytic agent in turn enhanced the protein content and sulphur containing amino acids in grains (Li, 2003).

Effect on yield response and response yardstick:

The yield response was higher (1566.67 kg ha^{-1}) in 100 per cent STCR dose applied through soluble fertilizers with three splits along with three sprays of 19:19:19 @ 1% concentration (Table 2), was because of higher yield and least was observed in (740.97 kg ha^{-1}) in 50 per cent STCR dose applied through soluble fertilizers. The higher yield response could be mainly

Table 2: Influence of different approaches and different forms of fertilizer application on grain and stover yield, crude protein yield, yield response and response yard stick of maize

Treatments	Grain yield	Stover yield	Crude protein yield	YR*	RYS**
	(q ha^{-1})			(kg ha^{-1})	
T_1: Control (RDF - CF)	82.56	84.37	815.81	-	-
T_2 : 100% STCR dose- CF	90.48	99.21	894.54	792.82	3.30
T_3: 100% STCR dose – SF	92.59	112.29	931.66	1003.47	4.20
T_4 : 50% STCR dose – SF	89.97	90.41	905.24	740.97	6.22
T_5 : 100% STCR dose - SF - 3 splits	97.59	123.24	1021.42	1470.60	6.28
T_6: 50% STCR dose - SF - 3 splits	92.26	110.76	958.31	970.37	8.50
T_7 : 100% STCR dose- SF - 3 sprays	96.83	123.00	1053.94	1427.32	6.08
T_8: 50% STCR dose - SF - 3 sprays	94.34	115.54	1007.15	783.27	6.55
T_9: 100% STCR dose- SF - 3 splits and 3 sprays	98.22	130.96	1100.79	1566.67	6.56
T_{10}: 50% STCR dose - SF - 3 splits and 3 sprays	94.87	119.63	1053.70	1231.71	10.12
S.E. ±	1.67	3.56	30.70	-	-
C.D. (P=0.05)	4.96	10.57	91.22	-	-

YR*- Yield response RYS**- Response yard stick

because of effective utilization of nutrients by the crop through soluble fertilizers in three splits along with three sprays of 19:19:19 @ 1% concentration (Basavaraja *et al*., 2017).

The higher response yardstick was recorded (10.12 kg kg^{-1}) when 50 per cent of STCR dose was applied through soluble fertilizers in three splits along with three sprays of 19:19:19 @ 1% concentration. The treatment receiving 100 per cent STCR dose through conventional fertilizers recorded lower response yard stick (3.30 kg kg^{-1}). Higher response recorded in50 per cent of STCR dose treatment may be due to effective utilization of NPK nutrients by the crop through soluble fertilizers at lower dose due to its easy solubility and better, and balanced uptake of NPK nutrients under STCR approach. Basavaraja *et al*. (2014) also reported that application of NPK fertilizers were effectively utilized by the crop under STCR approach compared to other approaches in maize crop.

From this study, it was concluded that application of soluble fertilizers based on STCR targeted yield approach with three equal splits at basal, 30 and 50 DAS along with three sprays of 19:19:19 @ 1% concentration at 20, 40 and 60 DAS was not only helpful for getting higher growth and yield of maize crop but also helpful in getting higher crude protein yield, yield response and response yard stick indicating that STCR approach of fertilizer recommendation can be well adopted through soluble fertilizers for enhancing the hybrid maize productivity.

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