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Popularization of STCR Targeted Yield for Optimum Fertilizer Use and Enhanced Yields of Maize Crop through Field Level Demonstrations

A. Madhavi*, T. Srijaya, P. Surendra Babu and Pradip Dey

Jayashankar Telangana State Agricultural University, Agricultural Research Institute, Rajendranagar, Hydeabad-500030, Telangana State, India

**Corresponding author*

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A B S T R A C T

In Telangana, nineteen FLDs were conducted in maize crop with target yield of 60q/ha to popularize the use of fertilizers through STCR fertilizer prescription equation. The mean initial nutrient status in these locations was 177 kg N, 53 kg P_2O_5 and 288 kg K_2O ha^{-1}. On an average, the fertilizer requirement based on STCR approach for this crop was found to be 161 kg N, 65 kg P_2O_5 and 74 kg K_2O/ha. Use of fertilizer prescription equation for maize based on soil test indicated that an amount of N, P_2O_5 and K_2O in the range of 111 to 212, 43 to 98 and 31 to 114 kg ha^{-1} to be used by farmers to achieve 60 q of maize /ha. However, the farmers realized yield in the range of 50 to 60 in these locations with a mean 56 q/ha due to soil test based fertilizer use. The mean economic gain variation due to change in fertilizer use and yield between use of STCR equation and farmers own method worked out to be Rs 5,885/ha.

Introduction

Maize (*Zea mays* L.) is the third most important food crop after rice and wheat. It is also known as queen of cereals because it has the highest genetic yield potential among the cereals. In India, the maize is used as human food (23%), poultry feed (51 %), animal feed (12 %), industrial (starch) products (12%), beverages and seed (1 % each). In addition, it is basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc., In Telangana, maize occupies an area of 5.73 lakh ha. with a production of 17.51 lakh tones (DES, 2017). The grain yield of maize depends on the genetic potential of the genotype used, the characteristics of the soil, the field management practices, and agro-climatic factors (Van Ittersum *et al.*, 1997 and Liu *et al.*, 2018). To meet the growing demands, enhancement of maize yield in coming years across traditional and non-traditional areas is a big challenge in the era

of climate change. Meeting such challenge will only be possible through science-based technology interventions like application of novel production techniques in maize improvement, specifically the nutrient management. The soil test crop response (STCR) is cost effective and plant need based approach. The STCR approach provides principles and tools for supplying crop nutrients as and when needed to achieve higher yield. It also aim to apply nutrients at optimal rates and time to achieve higher yield and higher efficiency of nutrient use by the crop, leading to more net returns per unit of fertilizer invested. Soil test calibration permits balanced fertilization through right kind and amount of fertilizers. In this regard, targeted yield approach had been found to be beneficial recommending balanced fertilization considering the soil available nutrient status and crop needs (Ramamoorthy *et al.,* 1967). The present investigation was under taken in farmers fields to popularize fertilizer prescription equations of yield target approach in maize. The specific yield equation based on soil health besides ensuring sustainable crop production also steers the farmers towards economic use of costly fertilizer inputs depending on their financial status and market price of the crop under consideration (Bera *et al.*, 2006).

Materials and Methods

A field experiment was conducted in farmer's fields at nineteen different locations of Rangareddy district, Telangana State during *rabi*, 2017-19. The objective of present investigation was to study the influence of different nutrient management approaches on productivity of maize. Treatments comprised of 2 nutrient management approaches *viz.*, Farmers Fertilizer practice (FFP) and STCR. In STCR approach initial soil available nutrients N, P and K are required to compute the target yield equations at a particular field level. A target yield 60 qha^{-1} was taken for a test variety of DHM-117. The required quantity of fertilizers to attain the target yield was calculated based on initial soil fertility status with the equation given below.

$FN = 4.00\ T - 0.49\ SN$
$FP_2O_5 = 2.15T - 2.58SP$
$FK_2O = 2.58T - 0.30SK$

In the above equation, FN, FP_2O_5, FK_2O represents the fertilizer of nitrogen, phosphorus and potassium in kg ha^{-1}. T means the target yield in q ha^{-1}.SN, SP and SK are soil available N, P and K respectively. Initial soil sample are collected at each location and analyzed for pH of the soil in 1:2.5 soil water suspensions (Jackson, 1973), electrical conductivity of the soil in 1:2.5 soil water extract (Jackson, 1973). Available nitrogen in the soil was determined by alkaline permanganate method (Subbiah and Asija, 1956). Available phosphorus content was determined by Olsen's extractant (Olsen *et al.,* 1954). The available potassium in soil was extracted with neutral normal ammonium acetate (Jackson, 1973).Initial nutrient status across the nineteen locations has revealed that the soils are neutral to moderately alkaline in reaction, non-saline and low organic carbon in nature. Available nitrogen was low in the range of 99 – 263 kg ha^{-1}, available phosphorus was medium to high with range of 28 – 72 kg P_2O_5 ha^{-1} and available potassium was medium to high ranging from 165 – 436 kg ha^{-1} (Table 1). The required nitrogen was applied through three splits one third at basal, one third at knee high and last dose of one third at tasseling stage while phosphorus and potassium are applied as basal.

An interaction meeting was held with farmers to know the different fertilizer application practices among them. Majority of the farmers following the fertilizer practices was considered as Farmers Fertilizer Practice

(Table 2). It was noticed that farmers are mostly concentrating in the application of nitrogen and phosphorus fertilizers but they are applying less or zero dose of potassium. Plant protection measures were adopted as and when required. The grain yield was recorded at harvest. It was noticed that in all the locations farmers has practiced imbalance fertilizers compared to STCR recommendations.

Results and Discussion

The results has shown that the yield was in the range of 45 to 58 q ha^{-1} with a mean yield of 51 q ha^{-1} in different locations under farmers practice while in case of STCR approach was 50 to 60 q ha^{-1} with a mean yield of 56 q ha^{-1} (Table 3). In STCR technology has recorded an additional mean yield of 5q ha^{-1} over farmer fertilizer practice. The higher grain yield in STCR recommendation may be due to application of fertilizers based on needs of crop. Fertilizers in target yield approach, takes into account the crop needs and nutrients present in the soil. It may be due to coincidence of fertilizers application with critical stages of crop. It might have resulted in better assimilation of photosynthetates to grain. Similar results were obtained by Ray *et al.*, (2000), Meena *et al.*, (2001), Jayaprakash *et al.*, *(*2006), Arun Kumar *et al.*, (2007), Umesh (2008), Vikram *et al.*, (2015), Pradeep kumar and Parmanand, (2018) and Prabhakar Reddy *et al.*, (2018). It was noticed that on an average an excess amount of fertilizer cost in STCR approach was Rs. 907 per hectare over farmers practice. It may be due to balanced application of fertilizers based on soil test values rather than farmers practice of routine fertilizer application which reflects on yield of crop.

Table.1 Physico- chemical properties of selected farmer's fields

Sl.No.	Farmer Name	pH	EC (dS m^{-1})	OC (%)	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
1	M.Goobriya	7.98	0.223	0.41	251	54	289
2	M.Taarya	7.76	0.195	0.19	163	56	247
3	M.Puliya	7.89	0.326	0.34	213	39	236
4	M.Baliya	7.78	0.646	0.22	188	52	173
5	M.Teekiya	7.98	0.406	0.25	188	46	224
6	M.Keshya	8.1	0.192	0.32	188	28	190
7	M.Kishan	7.52	0.112	0.38	254	44	209
8	M.Baashya	7.64	0.12	0.21	150	58	165
9	M.Lali	7.87	0.229	0.39	263	52	222
10	M.Chakriya	7.07	0.096	0.32	201	49	436
11	Mudanath Rathan	7.89	0.326	0.34	213	39	236
12	Mudanath Krishna	7.78	0.646	0.22	188	52	173
13	Mudanath Mangya	7.07	0.096	0.32	201	49	436
14	P.Shankar	7.13	0.418	0.24	113	70	405
15	P.Dhasiya	6.96	0.192	0.18	99	67	357
16	P.Venkataiah	7.25	0.164	0.32	101	63	344
17	Eshwar	8.02	0.433	0.25	145	66	364
18	Mallesh	7.83	0.291	0.19	113	58	402
19	Srinivas	7.67	0.442	0.27	132	72	372
	Mean	**7.64**	**0.292**	**0.28**	**177**	**53**	**288**

Table.2 Fertilizer application rates in FFP and STCR

Sl. No.	Farmer Name	Farmer Fertilizer Practice (FFP) (kg ha^{-1})			STCR Fertilizer Recommendation (kg ha^{-1})		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
1	M.Goobriya	138	58	0	117	68	83
2	M.Taarya	138	88	0	160	66	93
3	M.Puliya	115	28	0	136	85	96
4	M.Baliya	130	30	0	148	70	112
5	M.Teekiya	125	88	0	148	77	99
6	M.Keshya	100	75	0	148	98	107
7	M.Kishan	125	58	0	116	79	103
8	M.Baashya	115	30	0	167	64	114
9	M.Lali	130	75	0	111	70	99
10	M.Chakriya	120	80	0	142	74	46
11	Mudanath Rathan	128	62	35	166	64	58
12	Mudanath Krishna	132	58	30	176	55	66
13	Mudanath Mangya	118	52	35	171	57	31
14	P.Shankar	215	100	30	206	43	35
15	P.Dhasiya	197	82	35	212	45	42
16	P.Venkataiah	189	72	30	211	47	44
17	Eshwar	224	112	44	169	55	64
18	Mallesh	208	94	34	185	64	54
19	Srinivas	245	103	42	175	48	62
	Mean	**152**	**71**	**17**	**161**	**65**	**74**

Table.3 Grain yield and change in grain yield of maize between FFP and STCR

Sl. No	Farmers Name	Grain Yield (q ha^{-1})		Change in grain yield over FFP	Total cost of fertilizers (Rs. ha^{-1})		Difference in amount of fertilizers in FFP over STCR
		FFP	STCR		FFP	STCR	
1	M.Goobriya	45	50	5	4870	6763	-1893
2	M.Taarya	58	60	2	6487	7398	-911
3	M.Puliya	53	60	7	2963	8168	-5205
4	M.Baliya	50	58	8	3290	7837	-4547
5	M.Teekiya	50	56	6	6326	7937	-1611
6.	M.Keshya	53	58	5	5330	9233	-3903
7	M.Kishan	48	52	4	4709	7735	-3026
8	M.Baashya	54	60	6	3097	7751	-4654
9	M.Lali	48	54	6	5717	7130	-1413
10	M.Chakriya	55	57	2	5857	6678	-821
11	Mudanath Rathan	50	54	4	4369	5274	-905
12	Mudanath Krishna	52	53	1	4040	5118	-1078
13	Mudanath Mangya	49	59	10	3862	4135	-273
14	P.Shankar	53	59	6	10038	7402	+2636
15	P.Dhasiya	51	57	6	9018	7568	+1450
16	P.Venkataiah	54	56	2	8476	7674	+802
17	Eshwar	47	56	9	10679	7475	+3204
18	Mallesh	50	53	3	9685	8074	+1611
19	Srinivas	48	52	4	10552	7244	+3308
	Mean	**51**	**56**	**5**	**6282**	**7189**	**+ 907**

Table.4 Comparative study of grain yield, gross return and net profit of maize between FFP and STCR

S.No	Farmer Name	Seed yield (q ha^{-1})		Total cost of fertilizers (Rs. ha^{-1})		Gross Returns (Rs. ha^{-1})		Gross Returns over Fertilizer cost (Rs. ha^{-1})		Relative income (Rs. Over FFP)
		FFP	STCR	FFP	STCR	FFP	STCR	FFP	STCR	
1	M.Goobriya	45	50	4870	6763	54000	60000	49130	53237	4107
2	M.Taarya	58	60	6487	7398	69600	72000	63113	64602	1489
3	M.Puliya	53	60	2963	8168	63600	72000	60637	63832	3195
4	M.Baliya	50	58	3290	7837	60000	69600	56710	61763	5053
5	M.Teekiya	50	56	6326	7937	60000	67200	53674	59263	5589
6	M.Keshya	53	58	5330	9233	63600	69600	58270	60367	2097
7	M.Kishan	48	52	4709	7735	57600	62400	52891	54665	1774
8	M.Baashya	54	60	3097	7751	64800	72000	61703	64249	2546
9	M.Lali	48	54	5717	7130	57600	64800	51883	57670	5787
10	M.Chakriya	55	57	5857	6678	66000	68400	60143	61722	1579
11	Mudanath Rathan	50	54	4369	5274	55000	59400	50631	54126	3495
12	Mudanath Krishna	52	53	4040	5118	57200	64900	53160	59782	6622
13	Mudanath Mangya	49	59	3862	4135	53900	58300	50038	54165	4127
14	P.Shankar	53	59	10038	7402	90865	101235	80827	93833	13006
15	P.Dhasiya	51	57	9018	7568	86785	96348	77767	88780	11013
16	P.Venkataiah	54	56	8476	7674	91503	95710	83027	88036	5009
17	Eshwar	47	56	10679	7475	79900	95200	69221	87725	18504
18	Mallesh	50	53	9685	8074	85000	90100	75315	82026	6711
19	Srinivas	48	52	10552	7244	81600	88400	71048	81156	10108
	Mean	51	56	6282	7189	68345	75136	62063	67947	5885

Relative income gain due to fertilizer use and yield between the two treatments was found to be in the range of Rs 1489 to 18,504/- with a mean of Rs 5,885/ha (Table 4). This may be due to higher productivity and gross returns in the STCR treatment over the farmer fertilizer practice treatment. It might be also due to nutrient balance in soil due to soil test based fertilizer application and nutrient reserves in the soil. Similar results are reported by Pradeep kumar and Parmanand (2018).

This study indicated that the soil test based fertilizer application gave better outcome over farmers fertilizer recommendation due to balanced nutrient management.

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