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Short Note

Influence of Targeted Yield Approach on Yield, Yield Attributes, Nutrient Uptake and Economics of Maize

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The experiment was conducted during *kharif* 2011 in sandy clay loam soil at Zonal Agricultural Research Station, UAS, GKVK campus, Bengaluru, Karnataka to study yield attributes, nutrient uptake and yield of maize (*Zea mays* L.) hybrid NAH 1137 (Hema) and economics of maize cultivation as influenced by nutrient management through various fertilization approaches. The investigation consisted SSNM through fertilizers for targeted yield of 8 and 10 t ha^{-1}, SSNM through INM for targeted yield of 8 and 10 t ha^{-1}, STCR through fertilizers for targeted yield of 8 and 10 t ha^{-1}, STCR through INM for targeted yield of 8 and 10 t ha^{-1}. These eight treatments were compared with 100 per cent RDF and100 per cent RDF + FYM @ 10 t ha^{-1}, and were replicated thrice. Among the treatments, SSNM through fertilizers for targeted yield of 10 t ha^{-1} recorded higher dry matter production (501.4 g), cob length (20.3 cm), number of grain rows cob^{-1} (20.5), number of grains row^{-1} (41.3), number of grains plant^{-1} (891.2) test weight (32.9 g) and significantly higher grain yield (9.77 t ha^{-1}) as compared to other treatments. Whereas, significantly lower cob length (16.5 cm) number of grain rows cob^{-1} (13.6), number of grains row^{-1} (31.4), number of grains plant^{-1} (426.7) test weight (21.4 g), Grain yield (4.04 t ha^{-1}) were recorded in the treatment with the application of 100 % RDF. Significantly higher nutrient uptake (504.8, 103.1 and 212.3 N, P and K kg ha^{-1}) was recorded in SSNM through fertilizers for targeted yield of 10 t ha^{-1} over 100 % RDF (219.4, 32.2 and 73; N, P and K kg ha^{-1}) and economics.

Key words: SSNM, STCR, INM, Targeted yield, Nutrient uptake.

Maize (*Zea mays* L.) is the third most important cereal crop in India after wheat and rice. Currently it is cultivated in an area of 8.49 m ha with a production of 21.28 m t and productivity of 2507 kg ha^{-1} (Anon., 2011). In Karnataka, maize is grown over an area of 1.2 m ha with a production of 3.6 m t and productivity of 3000 kg ha^{-1} (Anon., 2011). Since maize is an exhaustive crop, the nutrient requirement cannot be supplied only through native nutrient reserves; the additional nutrients can be met by fertilizer application. In Karnataka maize yield is low due to imbalanced application of fertilizers. The recommendation of a fertilizer dose is a challenge to scientists as it should meet both nutrient demand of crop and sustain the production system (Shankar and Umesh, 2008). The site specific nutrient management (SSNM) and soil test crop response (STCR) are cost effective and plant need based approaches. The SSNM and STCR approach provide principles and tools for supplying crop nutrients as and when needed to achieve higher yield. The SSNM and STCR approach not specifically aim to either reduce or increase fertilizer use. Instead, they aim to apply nutrients at optimal rates and time to achieve higher yield and high efficiency of nutrient use by the crop, leading to more net returns per unit of fertilizer invested (Shankar and Umesh 2008). 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). Application of 200 per cent recommended dose of nitrogen (RDN) registered significantly higher uptake of NPK and readily available N over 100 per cent RDN and was on par with 150 per cent RDN. Whereas, 150 per cent RDN application in four splits resulted in higher nitrogen use efficiency (NUE) compared to single application (Harikrishna *et al.,* 2005).

Materials and Methods

An experiment was conducted during *kharif* 2011 at Zonal Agricultural Research Station, UAS, GKVK campus Bengaluru, Karnataka to study growth and yield of maize (*Zea mays* L.) hybrid NAH 1137 (Hema) as influenced by nutrient management through targeted yield approach. The soil of the experimental site was slightly acidic in reaction (pH 5.64). The soil was medium in available nitrogen (550 kg ha^{-1}), available phosphorus (38.5 kg ha^{-1}) and available potassium (175.00 kg ha^{-1}). The organic carbon content was low (0.45 %). The experiment was laid out in randomized complete

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block design with ten treatments and replicated thrice. Basal dose of fertilizers (50 % N and 100 % P and K) were applied and mixed with soil at the base of seed row based on the treatments and two seeds were dibbled in each hill at 30 cm spacing covered with soil. Treatments were set based on soil nutrient status to achieve targeted yield in maize through SSNM, STCR and these treatments were compared with 100% RDF (150: 75:40 NPK kg ha^{-1} and 100% RDF + FYM 10 t ha^{-1}.

The amount of nutrients for SSNM treatments (T_3, T_4, T_5 and T_6) was calculated by using the formulae,

FA = Nutrient uptake by crop per tonne grain yield × T × % EFR %

EFR = 30% more or less fertilizer to be applied as per the soil supply capacity for N, P_2O_5 and K_2O as Low (30 % more than the calculated value), Medium (As per the calculated value) and High (30 % less than the calculated value). The calculated quantity of nutrients per each treatment was presented in table 1.

The amount of nutrients for STCR treatments (T_7, T_8, T_9 and T_{10}) was calculated by using standardized STCR equations as mentioned below

$FN = 3.84\ T - 0.42\ SN\ (KMnO_4 – N) - 0.268 \times OM$

$FP_2O_5 = 1.57T – 1.85\ SP_2O_5$ (Bray's P_2O_5) $- 0.23 \times OM$

$FK_2O = 1.15T – 0.11\ SK_2O$ (Ammo. Acetate K_2O) $- 0.11 \times OM$

Where,

T = Targeted yield (t ha^{-1}), FN = Nitrogen supplied through fertilizer (kg ha^{-1}), FP_2O_5 = Phosphorus supplied through fertilizer (kg ha^{-1}), FK_2O = Potassium supplied through fertilizer (kg ha^{-1}), OM = Organic matter (tonne) and SN, SP_2O_5 and SK_2O are initial available N, P_2O_5 and K_2O, kg ha^{-1}, respectively.

The nutrients to each treatment were applied as per the calculation (Table 1). In INM treatments N was applied 50 per cent through fertilizers and 50 per cent through FYM. P and K were balanced as per the calculation.

Results and Discussion

Effect of targeted yield approaches on yield parameters and grain yield of maize

Significantly higher yield attributing characters (Table 2) *viz.,* cob length (20.3 cm), number of grain rows per cob (20.5), number of grains per row (41.3), number of grains per plant (891.2) 100 grain weight

Table 1. Amount of nutrients (kg ha^{-1}) and FYM (t ha^{-1}) applied per hectare based on calculation for different treatments

Treatment	Nitrogen	Phosphorus	Potassium	FYM
T_1 :100% recommended dose of fertilizer (150:75:40 kg N:P_2O_5:K_2O ha^{-1})	150.00	75.00	40.00	-
T_2: 100% Recommended dose of NPK + FYM (150:75:40 kg N:P_2O_5:K_2O ha^{-1} + 10t FYM)	150.00	75.00	40.00	10
T_3 : SSNM through fertilizers for targeted yield of 8 t ha^{-1} (210:119.2:286.4 kg N:P_2O_5:K_2O ha^{-1})	210.04	111.19	286.39	-
T_4 : SSNM through fertilizers for targeted yield of 10 t ha^{-1}(263:140.4:358 kg N:P_2O_5:K_2O ha^{-1})	263.00	140.43	358.00	-
T_5 : SSNM through INM for targeted yield of 8 t ha^{-1} (210:119.2:286.4 kg N:P_2O_5:K_2O ha^{-1})	210.04	111.19	286.39	17.38
T_6 : SSNM through INM for targeted yield of 10 t ha^{-1}(263:140.4:358 kg N:P_2O_5:K_2O ha^{-1})	263.00	140.43	358.00	21.92
T_7 : STCR through fertilizers for targeted yield of 8 t ha^{-1}(73.4:54.3:71.9 kg N:P_2O_5:K_2O ha^{-1})	73.40	54.30	71.86	-
T_8 : STCR through fertilizers for targeted yield of 10 t ha^{-1}(160.2:85.8:94.9 kg N:P_2O_5:K_2O ha^{-1})	160.20	85.80	94.96	-
T_9 : STCR through INM for targeted yield of 8 t ha^{-1}(73.4:54.3:71.9 kg N:P_2O_5:K_2O ha^{-1})	73.40	54.30	71.86	6.12
T_{10} : STCR through INM for targeted yield of 10 t ha^{-1}(160.2:85.8:94.9 kg N:P_2O_5:K_2O ha^{-1})	160.20	85.80	94.96	13.35

(32.9) were recorded in SSNM through fertilizers for targeted yield of 10 t ha^{-1} over 100 per cent RDF and100 per cent RDF + FYM @ 10 t ha^{-1} and it was on par with STCR through fertilizers for targeted yield of 10 t ha^{-1} and SSNM through INM for targeted yield of 10 t ha^{-1}. The grain yield of maize was significantly higher with SSNM through fertilizers for targeted yield of 10 t ha^{-1} (9.77 t ha^{-1}) followed by STCR through fertilizers for targeted yield of 10 t ha^{-1} (8.56 t ha^{-1}). The yield increased in SSNM through fertilizers for targeted yield of 10 t ha^{-1} was 142 per cent over 100 per cent RDF and 65 per cent over 100 per cent RDF + FYM @ 10 t ha^{-1}. Grain yield is governed by the factors which have direct or indirect impact. The factors which have direct influence on the grain yield are the yield components *viz.,* grain weight per cob, test weight, cob length, number of rows per cob, number of grains per cob and dry matter production per plant and its accumulation into various plant parts have an indirect influence on grain yield through the yield components, which intern depends on different growth components *viz.,* plant height, number of leaves, leaf area and LAI. All these growth components could have been promoted by more quantity of nutrients made available by the treatments to maize crop. However the grain yield was significantly higher in SSNM treatments due to higher dose of nutrients, especially nitrogen, since doses of SSNM treatments are set based on level of soil nutrient status such as low, medium and high. But for STCR treatments it is set based on numerical value of soil nutrient status. This was evidenced through higher uptake of nutrients; these findings are confirmation with those of Doberman *et al.* (2002), Heckman *et al.,* 2001 and Trinh *et al.*, 2008. The treatments of SSNM and STCR through fertilizers recorded higher grain and stover yield than through INM because of fertilizers supply readily

Table 2. Grain yield and yield parameters of maize at harvest as influenced by targeted yield approach

Treatment	Grain yield (t ha^{-1})	%YA	Cob length (cm)	NGRC	NGR	NGP	100 GW (g)
T_1:100% recommended dose of fertilizer (150:75:40 kg N:P_2O_5:K_2O ha^{-1})	4.04	—	16.5	13.6	31.4	426.7	21.4
T2: 100% Recommended dose of NPK + FYM (150:75:40 kg N:P_2O_5:K_2O ha^{-1} + 10t FYM)	5.93	—	16.7	14.7	33.4	489.6	22.9
T_3: SSNM through fertilizers for targeted yield of 8 t ha^{-1} (210:119.2:286.4 kg N:P_2O_5:K_2O ha^{-1})	7.69	96.17	18.4	16.2	35.0	569.3	26.6
T_4: SSNM through fertilizers for targeted yield of 10 t ha^{-1} (263:140.4:358 kg N:P_2O_5:K_2O ha^{-1})	9.77	97.67	20.3	20.5	41.3	891.2	32.9
T_5: SSNM through INM for targeted yield of 8 t ha^{-1} (210:119.2:286.4 kg N:P_2O_5:K_2O ha^{-1})	7.53	94.13	18.3	16.1	34.9	564.4	25.3
T_6: SSNM through INM for targeted yield of 10 t ha^{-1} (263:140.4:358 kg N:P_2O_5:K_2O ha^{-1})	8.43	84.33	18.8	19.0	38.5	797.8	29.5
T_7: STCR through fertilizers for targeted yield of 8 t ha^{-1} (73.4:54.3:71.9 kg N:P_2O_5:K_2O ha^{-1})	7.16	89.54	17.3	15.1	34.5	517.3	25.1
T_8: STCR through fertilizers for targeted yield of 10 t ha^{-1} (160.2:85.8:94.9 kg N:P_2O_5:K_2O ha^{-1})	8.56	85.57	19.8	19.2	39.0	802.9	29.8
T_9: STCR through INM for targeted yield of 8 t ha^{-1} (73.4:54.3:71.9 kg N:P_2O_5:K_2O ha^{-1})	6.87	85.88	17.3	14.7	33.9	498.9	24.0
T_{10}: STCR through INM for targeted yield of 10 t ha^{-1} (160.2:85.8:94.9 kg N:P_2O_5:K_2O ha^{-1})	8.06	80.63	18.5	16.6	38.0	796.8	28.1
S.Em±	0.77	—	0.6	0.6	1.2	32.2	2.0
CD (*P= 0.05*)	2.32	—	1.9	1.8	3.5	96.6	6.1

NGRC: Number of grain rows per cob, %YA: per cent yield achieved over 100% RDF, NGR: Number of grains per row, 100 GW: 100 Grain weight (g) and NGP: Number of grains per plant

available nutrients. Since in INM organic manures are applied they supply nutrients slowly, it may not supply nutrients at peak demand of crop.

Effect of targeted yield approaches on total nutrient uptake

Significantly higher NPK uptake was noticed in SSNM through fertilizers for targeted yield of 10 t ha^{-1} (504.7, 103.1 and 212.3 kg N, P_2O_5 and K_2O ha^{-1} at harvest) followed by STCR through fertilizers for targeted yield of 10 t ha^{-1} (433.47, 82.9 and 184.5 kg N, P_2O_5 and K_2O ha^{-1} at harvest) as compared to other treatments as compared to other treatments. The significantly lower uptake was recorded in 100% RDF (219.4, 32.2 and 73.9 kg N, P_2O_5 and K_2O ha^{-1} at harvest) (Table 3). This is mainly due to balanced application of NPK through targeted yield approach and higher availability of nutrients in soil (Doberman *et al.,* 2002). Further the higher uptake was evidenced by higher grain and stover yield.

Table 3. N, P and K uptake by grain and Stover of maize and total up take as influenced by nutrient management through various fertilization approaches

Treatment	Grain			Stover			Total		
	N	P	K	N	P	K	N	P	K
T1	122.0	17.0	16.05	97.3	15.2	57.8	219.4	32.2	73.9
T2	131.5	22.3	20.57	123.1	22.3	61.3	254.6	44.6	81.9
T3	183.9	38.8	33.03	185.9	31.6	124.2	369.8	70.4	157.2
T4	263.0	51.0	44.10	241.8	52.5	168.2	504.8	103.1	212.3
T5	175.5	34.1	32.34	152.4	27.7	121.7	327.9	61.8	154.0
T6	213.1	40.8	37.25	204.1	35.7	126.8	417.1	76.5	164.0
T7	172.5	34.1	29.51	144.9	26.5	64.1	317.4	60.6	93.6
T8	224.5	44.5	41.29	208.9	38.5	143.2	433.5	82.9	184.5
T9	171.9	32.4	29.13	142.9	24.2	63.9	314.8	56.6	93.0
T10	199.9	40.6	34.27	198.7	34.7	125.8	398.6	75.3	160.1
S.Em±	29.8	7.1	7.73	32.2	8.6	34.3	61.2	15.0	40.4
CD(*P= 0.05*)	89.2	21.4	23.17	96.6	25.8	102.8	183.4	44.8	121.2

T1: (150:75:40 kg N:P_2O_5:K_2O ha^{-1})
T2 : (150:75:40 kg N:P_2O_5:K_2O ha^{-1} + 10t FYM)
T3: (210:119.2:286.4 kg N:P_2O_5:K_2O ha^{-1})
T4: (263:140.4:358 kg N:P_2O_5:K_2O ha^{-1})
T5:(210:119.2:286.4 kg N:P_2O_5:K_2O ha^{-1})
T6: (263:140.4:358 kg N:P_2O_5:K_2O ha^{-1})
T7: (73.4:54.3:71.9 kg N:P_2O_5:K_2O ha^{-1})
T8: (160.2:85.8:94.9 kg N:P_2O_5:K_2O ha^{-1})
T9: (73.4:54.3:71.9 kg N:P_2O_5:K_2O ha^{-1})
T10: (160.2:85.8:94.9 kg N:P_2O_5:K_2O ha^{-1})

Effect of targeted yield approaches on economics of maize production:

Among different treatments application of nutrients by SSNM through fertilizers for targeted yield of 10 t ha^{-1} recorded higher gross return (Rs. 96633 ha^{-1}) and net return (Rs. 61903 ha^{-1}) followed by STCR through fertilizers for targeted yield of 10 t ha^{-1} (Rs. 84730 ha^{-1}) and (Rs. 53713 ha^{-1}). The cost of cultivation of maize under targeted yield approaches was varied from treatment to treatment due to varied amount of fertilizer application and their cost. The cost of cultivation of maize was high in SSNM through INM for targeted yield of 10 t ha^{-1}

Table 4. Economics of maize as influenced by nutrient management through various fertilization approaches

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T$_1$:100% recommended dose of fertilizer (150:75:40 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	20386	41214	17525	2.0
T$_2$: 100% Recommended dose of NPK + FYM (150:75:40 kg N:P$_2$O$_5$:K$_2$O ha^{-1} + 10t FYM)	27386	59546	29441	2.2
T$_3$: SSNM through fertilizers for targeted yield of 8 t ha^{-1} (210:119.2:286.4 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	24899	77024	42249	3.1
T$_4$: SSNM through fertilizers for targeted yield of 10 t ha^{-1}(263:140.4:358 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	27492	96633	61903	3.5
T$_5$: SSNM through INM for targeted yield of 8 t ha^{-1} (210:119.2:286.4 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	32003	75443	39355	2.4
T$_9$: SSNM through INM for targeted yield of 10 t ha^{-1}(263:140.4:358 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	36477	83588	49771	2.3
T$_6$: STCR through fertilizers for targeted yield of 8 t ha^{-1}(73.4:54.3:71.9 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	18643	71814	44250	3.9
T$_7$: STCR through fertilizers for targeted yield of 10 t ha^{-1}(160.2:85.8:94.9 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	21443	84730	53713	4.0
T$_8$: STCR through INM for targeted yield of 8 t ha^{-1}(73.4:54.3:71.9 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	20993	68707	42263	3.3
T$_{10}$: STCR through INM for targeted yield of 10 t ha^{-1}(160.2:85.8:94.9 kg N:P$_2$O$_5$:K$_2$O ha^{-1})	22393	80189	43114	3.6

(Rs. 36477 ha $^{-1}$) followed by SSNM through INM for targeted yield of 8 t ha^{-1} (Rs. 32003 ha $^{-1}$) due to utilization of higher quantity of FYM (22.92 and 17.38 t ha^{-1} respectively). However benefit cost ratio is higher in STCR through fertilizers for targeted yield of 10 t ha^{-1} (4) followed by STCR through fertilizers for targeted yield of 8 t ha^{-1} (3.9). This is mainly due to low quantity of fertilizers used in these treatments. Further, it was evidenced by low cost of cultivation (Table 4). Application of 100 per cent RDF observed lower gross returns, net returns and B:C ratio (41214 Rs. ha^{-1}, Rs. 17525 ha^{-1} and 2, respectively) (Table 3). This is due to lesser nutrient uptake and retained more nutrients in the soil. The results are in close proximity with the findings of Suri *et al.* (1997), Anilkumar *et al.* (2002), Hongting Wang *et al.* (2005) and Milp-Chand (2006).

Conclusion

The grain yield was higher in SSNM through fertilizers for targeted yield of 10 t ha^{-1} (9.77 t ha^{-1}) due to higher yield attributing characters and higher nutrient uptake. The yield increased in SSNM through fertilizers for targeted yield of 10 t ha^{-1} was 142 per cent over 100 per cent RDF and 65 per cent over and 100 per cent RDF + FYM @ 10 t ha^{-1}. However the SSNM through fertilizers for targeted yield of 10 t ha^{-1} may be recommended for maize to maximize the yield with higher B:C ratio (4.0).

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