International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 2347-2351

Received: 07-10-2020
Accepted: 19-11-2020

Madhusudhan
Department of Soil Science & Agril. Chemistry, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

K Narayana Rao
Department of Soil Science & Agril. Chemistry, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

MV Ravi
Department of Soil Science & Agril. Chemistry, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

Corresponding Author:
Madhusudhan
Department of Soil Science & Agril. Chemistry, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

Nutrient management approaches (SSNM & STCR) and their economic feasibility in maize (*Zea mays* L.) crop

Madhusudhan, K Narayana Rao and MV Ravi

DOI: https://doi.org/10.22271/chemi.2021.v9.i1ag.11576

Abstract
The SSNM and STCR approaches are 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 through high efficiency of nutrient use by the crop, and thus leading to more net returns per unit of fertilizer invested. The Field experiment was conducted during the *kharif* 2012 at Agricultural college farm, Raichur to study the effect of soil test based nutrient management approaches on maize. The results revealed that, yield and yield components of maize were influenced favourably with application of fertilizer by SSNM for targeted yield 8 t/ha recorded significantly highest grain yield (7.74 t/ha), stover yield (10.76 t/ha), number of grains per cob (701.82), number of grains per row (38.94), number of rows per cob (18.17) and cob length (20.81 cm). The growth parameters of maize were also influenced favorably with application of fertilizer by SSNM for targeted yield 8 t/ha, dry matter production (376.67 g/plant), leaf area per plant (2527.74 cm^2), leaf area index (1.40) and plant height (201.83 cm), over STCR for targeted yield 8 t/ha and RDF. The highest net returns (74,075 ₹ ha^{-1}) and B:C (3.57) was recorded in SSNM for targeted yield 8 t ha^{-1} as compare to RDF, (45,051 ₹ ha^{-1}) and (3.03), respectively.

Keywords: Growth & yield parameters, Nutrient management, SSNM, STCR, RDF and Zea mays

Introduction
Maize (*Zea mays* L.) is one of the important cereal crops next only to wheat and rice in the world. In India, it ranks fourth after rice, wheat and sorghum. Maize is being consumed both as food and fodder and also required by the various industries. In India, about 35 per cent of the maize produced is used for human consumption, 25 per cent each as poultry and cattle feed, 15 per cent in food processing like corn flakes, popcorn *etc.*, and in other industries mainly starch, dextrose, corn syrup and corn oil *etc.* In the world, it is grown over an area of 137.59 million ha with an annual production of 609.18 million tonnes with productivity of 44.27 q ha^{-1}.

In Karnataka, it occupies an area of 5.8 lakh ha producing 15.1 lakh tonnes with an average productivity of 26.09 q ha^{-1}. Important maize growing districts in Karnataka are Davanagere, Haveri, Bellary, Belgaum, Dharwad, Kolar, Mysore and Tumkur. Under irrigated conditions, it is grown mainly in the command area of Malaprabha, Ghataprabha and Tungabhadra projects of North Karnataka. Among the several aspects of soil test based nutrient management approaches, the SSNM and STCR approaches are considered as one of the main approaches. It is the easiest, cheapest and most relevant techniques as far as the Indian farmers are concerned. These days farming has to be treated as any other business and we must try to utilize the available resources in the most efficient manner possible. Owing to its importance in plant nutrition, SSNM and STCR methods influences crop yield and quality also improve the economic and environmental outcome of crop production.

Materials and Methods
The field experiment on "Assessment of soil test based nutrient management approaches in maize" was conducted during the *kharif* 2012 at Agricultural college farm, Raichur situated on the latitude of 16°15′ North, longitude of 77 °21′ East and at an elevation of 389 meters above mean sea level and is located in North Eastern Dry Zone of Karnataka. The experiment was laid out in RCBD. The soil of the experimental site was medium black and clay loam in

texture with the available nitrogen (259.00 kg ha^{-1}), phosphorus (25.50 kg ha^{-1}), potassium (265.00 kg ha^{-1}) and organic carbon content (6.80 g kg^{-1}). The hybrid maize Ganga Kaveri (GK 3018) was used in the investigation. It is late maturing hybrid (115-120 days) with the plant height of 168-192 cm, silk purple colour and it takes 57 days in *kharif* and 65 days in *rabi* for 50 per cent silking and 105 days to 50 percent dry husk. The calculated quantity of N, P_2O_5 and K_2O in the form of urea, diammmonium phosphate (DAP) and muriate of potash (MOP), respectively were applied as per the treatments. Half dose of N and full dose of P_2O_5 and K_2O were applied in a circular band at about 5 cm away from each plant and the crop was top dressed with the remaining half dose of N, 30 days after sowing (DAS). All other cultural and plant protection measures were followed as recommended. Five plants per plot were selected randomly in the net plot area and tagged for observations at critical stages (30, 60, 90 DAS and at harvest) for recording growth and yield parameters. Destructive sampling was followed to record dry weights at different stages. The treatment are:

T_1: Control (No NPK).
T_2: RDF.
T_3: Modified RDF (150% RDF).
T_4: SSNM for a target yield 6 t ha^{-1} + deficient secondary and micro nutrients.
T_5: SSNM for a target yield 8 t ha^{-1} + deficient secondary and micro nutrients.
T_6: STCR for a target yield 6 t ha^{-1} + deficient secondary and micro nutrients.
T_7: STCR for a target yield 8 t ha^{-1} + deficient secondary and micro nutrients.
T_8: Farmers practice.

Note: FYM @ 10 t ha^{-1} was applied for all treatments

Results and Discussion

The grain yield as influenced by nutrient management through soil test based nutrient management approach was higher in T_5: SSNM for target yield 8 t ha^{-1} (7.74 t ha^{-1}) and it was on par with T_7: STCR for target yield 8 t ha^{-1} (7.44 t ha^{-1}) and these treatments has significantly higher yield over T_2: RDF (5.06 t ha^{-1}), T_3: Modified RDF (5.36 t ha^{-1}), T_4: SSNM for target yield 6 t ha^{-1} (5.98 t ha^{-1}), T_6: STCR for target yield 6 t ha^{-1} (5.55 t ha^{-1}), and T_8: Farmers practice (5.25 t ha^{-1}). The significantly lower grain yield was observed in T_1: Control (2.53 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 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 leaf area index. All these growth components could have been promoted by more quantity of nutrients made available by the treatments to maize crop. This was evidenced through higher uptake of nutrients. These findings are obtained with those of Heckman *et al.*, 2001 [6], Doberman *et al.* (2002a) [4] and Trinh *et al.* (2008) [11].

The same trend was observed in number of grains per cob as in case of number of grains per row. Significantly highest number of grains per cob was recorded in T_5: SSNM for target yield 8 t ha^{-1} (701.82) followed T_7: STCR for target yield 8 t ha^{-1} (647.51). The significantly minimum numbers of grains per plant were observed in T_1: Control (292.46) followed by T_2: RDF (408.60). The grain number per cob is another important yield attribute which differed significantly due to application of nutrients by T_5: SSNM for target yield 8 t ha^{-1} (701.82) followed by T_7: STCR for target yield 8 t ha^{-1} (647.51) over other treatments. Significant difference in the grain number per plant of maize obtained by more amounts of nutrients supplied through targeted yield approaches as evidenced by their nutrient content and more number of seeds per cob. These results are in accordance with the results obtained by Umesh (2008) [12]. The significant difference in cob length was observed due to soil test based nutrient management approach. The longer cobs were observed in T_5: SSNM for target yield 8 t ha^{-1} (20.81 cm) followed by T_7: STCR for target yield 8 t ha^{-1} (19.91 cm). The significantly shorter cobs were observed in T_1: Control (11.95 cm) followed T_2: RDF (15.37 cm). Applications of nutrients by T_5: SSNM for target yield 8 t ha^{-1} (20.81 cm) and T_7: STCR for target yield 8 t ha^{-1} (19.91 cm) recorded significantly higher cob length as compared to the other treatments and were on par with each other. It might be due to better growth attributes *viz.*, Plant height, number of green leaves, leaf area, dry matter production and distribution *etc.* The higher leaf area per plant was responsible to capture of more solar radiation resulting in high photosynthetic rate which in turn resulted in higher dry matter production. All these factors associated with leaf area contributed towards significant improvement in growth and yield attributes and ultimately resulted in higher cob length. The similar interpretation was also reported by Banganwa *et al.* (1988) [3]. The maximum number of grain rows per cob was observed in T_5: SSNM for target yield 8 t ha^{-1} (18.17) which was on par with T_7: STCR for target yield 8 t ha^{-1} (17.46). The significantly minimum number of grain rows per cob was observed in T_1: Control (11.63) followed by T_2: RDF (13.77). The number of grains per row is another important yield attributes which are significantly higher in application of nutrients by T_5: SSNM for target yield 8 t ha^{-1} (38.94) followed by T_7: STCR for target yield 8 t ha^{-1} (37.09). Markedly less number of seeds per row is obtained in T_1: Control (25.03), followed by T_2: RDF (29.04). These results coroborates the findings of Umesh (2008) [12]. The significantly higher plant height was recorded in T_5: SSNM for target yield 8 t ha^{-1} (201.83 cm) which were on par with T_7: STCR for target yield 8 t ha^{-1} (196.89 cm). Significantly lower plant height was observed in T_1: Control (143.41cm) followed by T_2: RDF (158.51cm). The plant height which also contributed for total dry matter was significantly higher in application of nutrients by T_5: SSNM for target yield 8 t ha^{-1} (30.78, 187.13, 200.96 and 201.83 cm) at 30, 60, 90 and at harvest, respectively followed by T_7: STCR for target yield 8 t ha^{-1} (30.07, 183.33, 195.23 and 196.89 cm) at 30, 60, 90 and at harvest, respectively. The reduction in the plant height in T_1: Control (18.55, 127.21, 138.28 and 143.41 cm) may be due to inadequate supply of nutrients resulting in the reduction of growth and yield parameters which ultimately produce lesser grain yield as well as stover yield. These results are in conformity with the findings of Halemani *et al.* (1980) [5]; Setty (1981) [9] and Manish Kumar (1998) [7]. T_5: SSNM for target yield 8 t ha^{-1} recorded maximum number of leaves per plant (8.41) over all other treatments. Significantly lower number of leaf was observed in T_1: Control (4.52) followed by T_2: RDF (5.49) and T_8: Farmers practice (5.66). The number of leaves which is also a contributing factor for dry matter accumulation and finally to the grain yield also differed due to targeted yield approaches. The significantly maximum number of green leaves per plant was observed in T_5: SSNM for target yield 8 t ha^{-1} (7.03, 12.59, 16.02 and 9.08) followed by T_7: STCR for target yield 8 t ha^{-1} (6.69, 12.23, 14.70 and 9.16) at 30, 60, 90 and at harvest, respectively. This helped in accumulation of higher dry matter in stem and also helped in obtaining higher number of seeds per cob, grain weight per cob, number of rows per cob and finally higher grain yield.

Higher leaf area was recorded in T_5: SSNM for target yield 8 t ha^{-1} (2527.74 cm^2 plant^{-1}) followed by T_7: STCR for target yield 8 t ha^{-1} (2367.33 cm^2 plant^{-1}) and T_4: SSNM for target yield 6 t ha^{-1} (2153.82 cm^2 plant^{-1}). Lower leaf area per plant was observed in T_1: Control (1045.73 cm^2 plant^{-1}) followed by T_2: RDF (1668.67 cm^2 plant^{-1}). The higher leaf area index at harvest was recorded in T_5: SSNM for target yield 8 t ha^{-1} (1.40) which were on par with T_7: STCR for target yield 8 t ha^{-1} (1.32). Significantly lower leaf area index was observed in T_1: Control (0.58) followed by T_2: RDF (0.93). The total dry matter accumulation at harvest was found significantly higher in T_5: SSNM for target yield 8 t ha^{-1} (376.67 g plant^{-1}) followed by T_7: STCR for target yield 8 t ha^{-1} (351.53 g plant^{-1}). The significantly lower dry matter accumulation was recorded in T_1: Control (229.17 g plant^{-1}) followed by T_2: RDF (281.63 g plant^{-1}).

Further, the dry matter production on photosynthetic ability of plants at various growth stages and that can be analyzed through the leaf area and the dry matter accumulation. The leaf area, which is an important growth attribute of plant determine the active photosynthetic ability, dry matter production and intern the yield of the crop. The leaf area of maize varied significantly due to targeted yield approaches and is significantly higher in T_5: SSNM for target yield 8 t ha^{-1} (1452.67, 5745.12, 6157.67 and 2527.74 cm^2) followed by T_7: STCR for target yield 8 t ha^{-1} (1419, 5409.34, 5942.00 and 2367.33 cm^2) at 30, 60, 90 and at harvest respectively. Further it was indicated by LAI, the significantly higher LAI was observed in T_5: SSNM for target yield 8 t ha^{-1} (0.81), followed by T_7: STCR for target yield 8 t ha^{-1} (0.79) at all the growth stages. Leaf area of maize was significantly higher due to development of efficient photosynthetic system, which enabled the plant to intercept higher amount of radiant energy which is linked to higher dry matter accumulation per plant. The reduction in the leaf area of maize registered in T_1: Control (607.41, 1740.16, 2342.59 and 1045.73 cm^2) followed by T_2: RDF (905.67, 3155.33, 3986.67 and 1668.67 cm^2) was mainly attributed to significantly lower number of leaves and lower leaf area index. All these factors together caused significant reduction in dry matter production and its accumulation in reproductive parts and finally the grain yield. These results were in accordance with the findings of Ahlawat *et al.* (1975) [1].

Table 1: Growth parameters of maize as influenced by soil test based nutrient management approaches

Treatments	Plant height (cm)	Number of leaves per plant	Leaf area per plant (cm^2)	Leaf area index	Total dry matter production (g plant^{-1})
T_1: Control	143.41	5.52	1045.73	0.58	229.17
T_2: Recommand dose of Fertiliser	158.51	6.49	1668.67	0.93	281.63
T_3: Modified RDF (150% of RDF)	176.33	7.15	1926.23	1.07	300.67
T_4: SSNM (6 t ha^{-1})	186.27	8.11	2153.82	1.20	347.00
T_5: SSNM (8 t ha^{-1})	201.83	9.16	2527.74	1.40	376.67
T_6: STCR (6 t ha^{-1})	180.82	8.04	2049.33	1.14	325.33
T_7: STCR (8 t ha^{-1})	196.89	9.08	2367.33	1.32	351.53
T_8: Farmers practice	165.59	6.66	1751.00	0.97	282.67
S.Em ±	5.95	0.42	84.29	0.04	10.14
C.D. at 5%	18.06	1.27	255.68	0.14	30.76

Table 2: Yield attributes and yield of maize as influenced by soil test based nutrient management approaches

Treatments	Number of cobs plant^{-1}	Cob length (cm)	Number of rows cob^{-1}	Number of grains row^{-1}	Number of grains cob^{-1}	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1: Control	1.00	11.95	11.63	25.03	292.46	2.53	3.24
T_2: Recommand dose of Fertiliser (RDF)	1.07	15.37	13.77	29.04	408.60	5.06	6.91
T_3: Modified RDF (150%)	1.27	17.25	15.21	31.51	497.28	5.36	7.42
T_4: SSNM (6 t ha^{-1})	1.27	19.07	15.45	33.49	583.67	5.98	8.38
T_5: SSNM (8 t ha^{-1})	1.37	20.81	18.17	38.94	701.82	7.74	10.76
T_6: STCR (6 t ha^{-1})	1.27	18.09	15.25	32.01	541.99	5.55	7.84
T_7: STCR (8 t ha^{-1})	1.27	19.91	17.46	37.09	647.51	7.44	9.93
T_8: Farmers practice	1.15	16.22	14.38	30.55	456.75	5.25	7.40
S.Em ±	0.11	1.42	0.89	1.32	28.26	0.30	0.24
C.D. at 5%	NS	4.31	2.72	4.00	85.71	0.91	0.75

Economics of maize production

The economic parameters of maize production *viz.* cost of cultivation, grass return, net return (₹ ha^{-1}) and benefit cost ratio were calculated and are presented here.

Among different treatments application of nutrients by T_5: SSNM for target yield 8 t ha^{-1} recorded higher gross return (1,03,047 ₹ ha^{-1}) and net return (74,075 ₹ ha^{-1}) followed by T_7: STCR for target yield 8 t ha^{-1} (98,828 ₹ ha^{-1}) and net return (70,059 ₹ ha^{-1}). The cost of cultivation of maize under soil test based nutrient management approach was varied from treatment to treatment due to varied amount of fertilizers application and their cost. The cost of cultivation of maize was high in T_5: SSNM for target yield 8 t ha^{-1} (28,811 ₹ ha^{-1}) followed by T_7: STCR for target yield 8 t ha^{-1} (28,769 ₹ ha^{-1}) due to higher quantity of chemical fertilizer requirement. Benefit cost ratio also has the same trend, the higher benefit cost ration recorded in T_5: SSNM for target yield 8 t ha^{-1} (3.57) followed by T_7: STCR for target yield 8 t ha^{-1} (3.44). T_1: Control observed lower gross returns, net returns and BC ratio (33,617 ₹ ha^{-1}, 16,617 ₹ ha^{-1} and 1.98, respectively). This is due to lesser yield and without application of chemical fertilizer. The results are in close proximity with the findings of Suri *et al.* (1997) [10], Anil Kumar *et al.* (2002) [2], Wang *et al.* (2005) [13] and Milp-Chand *et al*. (2006) [8].

Table 3: Cost of cultivation, Gross returns, Net returns and BC ratio of maize as influenced by soil test based nutrient management approaches

Treatments	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
T_1: Control	17,000	33,617	16,617	1.98
T_2: Recommand dose of Fertiliser (RDF)	22,197	67,249	45,051	3.03
T_3: Modified RDF (150%)	24,451	71,238	46,787	2.91
T_4: SSNM (6 t ha^{-1})	26,142	79,483	53,341	3.04
T_5: SSNM (8 t ha^{-1})	28,811	1,02,886	74,075	3.57
T_6: STCR (6 t ha^{-1})	25,824	73,815	47,990	2.86
T_7: STCR (8 t ha^{-1})	28,769	98,828	70,059	3.44
T_8: Farmers practice	23,517	69,775	46,258	2.97

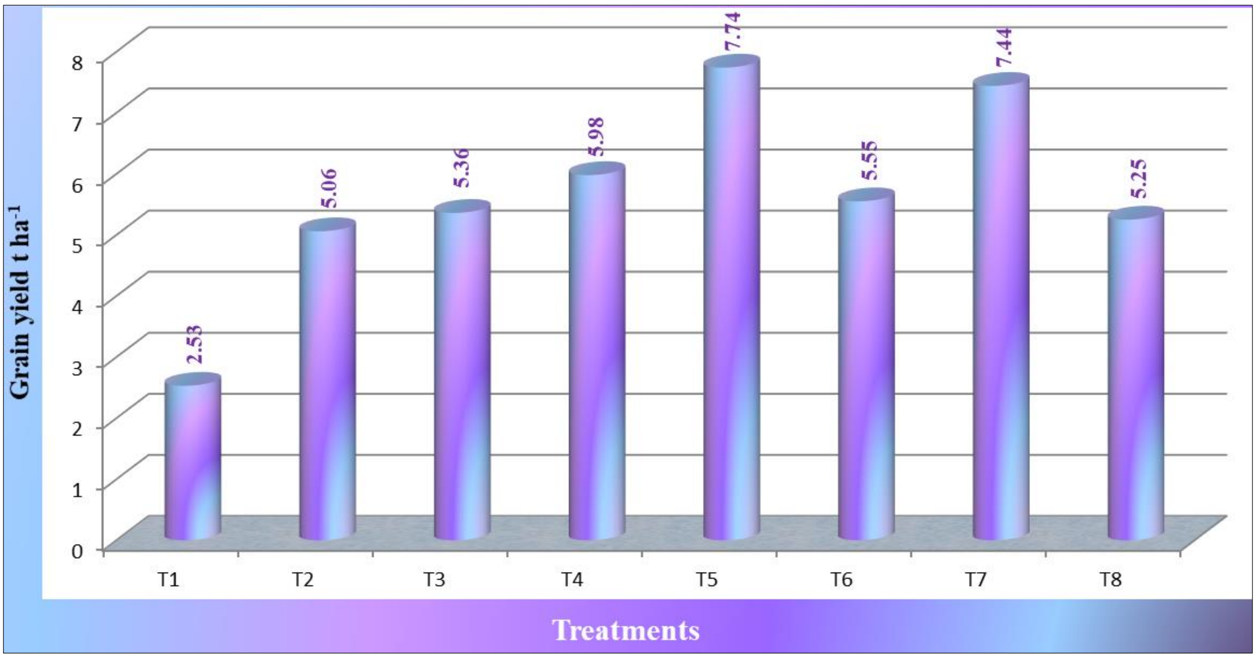

Fig 1: Grain yield as influenced by soil test based nutrient management approaches in maize

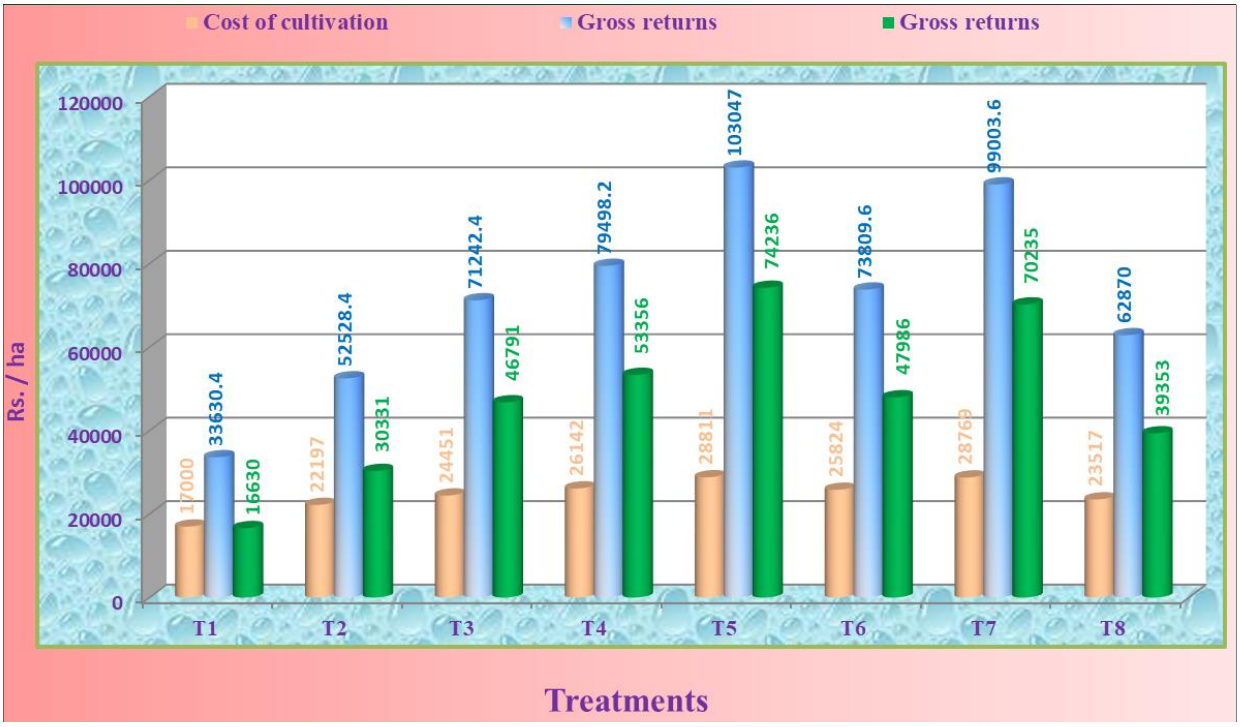

Fig 2: Cost of cultivation, Gross returns and Net returns as influenced by soil test based nutrient management approaches in maize

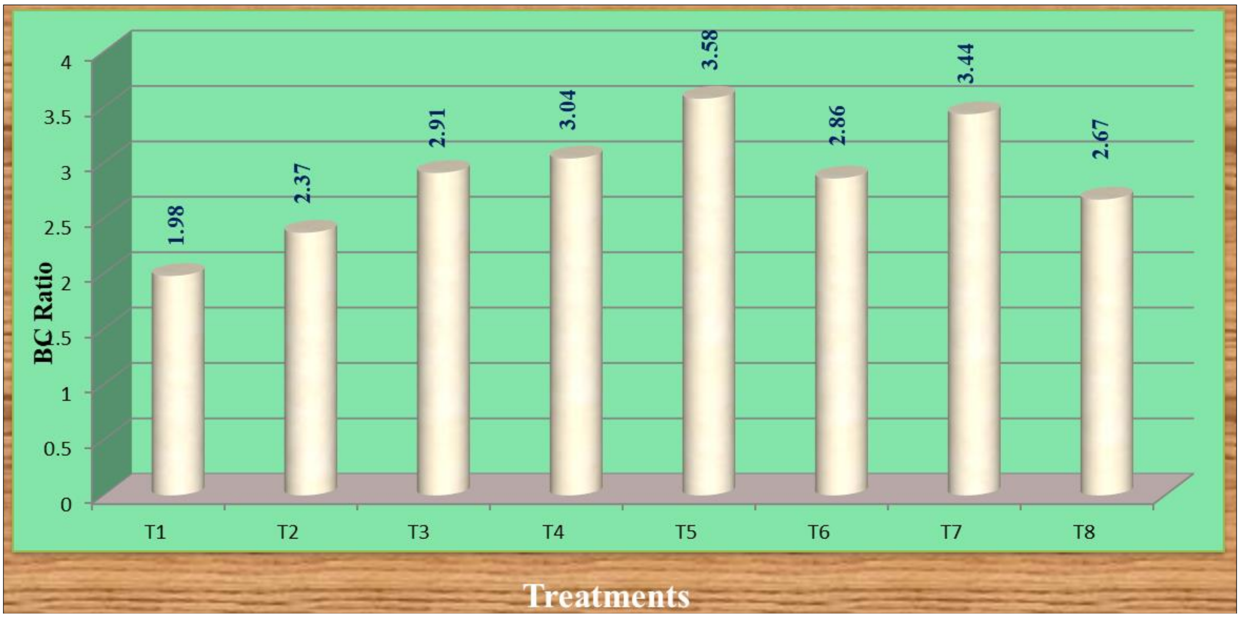

Fig 3: BC ratio of maize as influenced by soil test based nutrient management approaches in maize

Conclusion

The treatments were T_4: SSNM for target yield 6 t ha^{-1}, T_5: SSNM for target yield 8 t ha^{-1}, T_6: STCR for target yield 6 t ha^{-1} and T_7: STCR for target yield 8 t ha^{-1}. These four treatments were compared with T_1: Control, T_2: RDF, T_3: Modified RDF and T_8: Farmer practices. The grain yield of maize was higher with T_5: SSNM for target yield 8 t ha^{-1} (7.74 t ha^{-1}) and it was on par with T_7: STCR for target yield 8 t ha^{-1} (7.44 t ha^{-1}). The yield increased in T_5: SSNM for target yield 8 t ha^{-1} was 205 per cent over T_1: Control and 95.68 per cent over T_2: RDF.

The treatment of T_5: SSNM for target yield 8 t ha^{-1} recorded maximum cost of cultivation (₹ 28,811 ha^{-1}) because of higher rate of inputs, at the same time lower cost of cultivation observed in T_1: Control (₹ 17,000 ha^{-1}). Maximum gross returns (₹ 1,02,886 ha^{-1}) was observed in T_5: SSNM for target yield 8 t ha^{-1} while minimum gross returns was observed in T_1: Control (₹ 33,617 ha^{-1}). Significantly higher net return (₹ 74,075 ha^{-1}) obtained in T_5: SSNM for target yield 8 t ha^{-1} over other treatments and it was found to be on par with T_7: STCR for target yield 8 t ha^{-1} (₹ 70,059 ha^{-1}). Lower net returns recorded in T_1: Control (₹ 16,617 ha^{-1}), this is because of lower yield obtained in the T_1: Control. Treatment T_5: SSNM for target yield 8 t ha^{-1} recorded significantly higher BC ratio (3.57) as compared to rest of the treatments except T_7: STCR for target yield 8 t ha^{-1} (3.44) and the lower BC ratio was obtained in T_1: Control (1.98).

SSNM and STCR approach recorded significantly high yield, net returns and BC ratio over all other nutrient management approaches.

References

1. Ahlawat RPG, Saxena MC, Sharma KC. Dry matter accumulation in spring hybrid maize as affected by NPK fertilization. Indian J Agron 1975;20(3):274-277.
2. Anil Kumar KS, Thakur, Sandeep Mamba. Effect of fertility levels on promising hybrid maize under rainfall conditions of Himachal Pradesh. Indian J Agron 2002;47(4):526-530.
3. Banganwa AS, Kairon MS, Singh K. Effect of plant density and proportion of nitrogen fertilization on growth, yield and yield components of winter maize. Indian J Agric. Sci 1988;58:854-856.
4. Doberman A, Witt C, Dawe D. Performance of site-specific nutrient management in intensive rice cropping systems of Asia. Better Crops Int 2002a;16(1):25-30.
5. Halemani HL, Hegde DM, Kudosomannavar BT. Response of maize *(Zea mays* L.) genotypes to nitrogen application under irrigated conditions. Mysore J Agric. Sci 1980;14:200-205.
6. Heckman JR, Sims JT, Beegle DB, Coale FJ, Herbert SI, Bruulsema TW. Phosphorus and potassium removal in Corn. Better Crops Int 2001;85(1):4-6.
7. Manish Kumar. Growth, yield and water use efficiency of different winter maize *(Zea mays* L.) varieties as influenced by nitrogen and irrigation scheduling. *M.Sc. (Agri.) Thesis.* Indira Gandhi Agril. Univ. Raipur 1998.
8. Milp-Chand, Benbi DK, Benipal DS. Fertilizer recommendations based on soil tests for yield targets of mustard and rapeseed and their validations under farmers field conditions in Punjab. J Indian Soc. Soil Sci 2006;54(3):316-321.
9. Setty RA. Agronomic investigations on irrigated rabi maize (*Zea mays* L.) *Ph.D. Thesis*, Univ. Agric. Sci., Bangalore 1981.
10. Suri VK, Jha S, Verma TS. Efficient and economic fertilization of rainfed maize for its specific yield through soil testing and integrated nutrient management. Crop Res 1997;13(1):56-67.
11. Trinh QK, Pham Sy Tan, Christian Witt. Improving of maize yield and profitability through site-specific nutrient management (SSNM) and planting density. Omanrice 2008;16:88-92.
12. Umesh MR. Investigation on balanced fertilization for maize–pegeonpea cropping sequence in *Alfisols* of Karnataka. *Ph.D. Theses.* Univ. Agric. Sci., Bangalore 2008.
13. Wang H, JI-Yun Jin, Bin Wang. Improvement of soil nutrient management via information technology. Better Crops Int 2005;90:12-13.