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Validation of STCR approach of nutrient application for carrot on *Alfisols* of eastern dry zone of Karnataka

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Abstract

A field experiment was conducted during *kharif* 2017 at Devanahalli village, Bengaluru rural district to validate STCR approach of nutrient application for carrot on *Alfisols* of Eastern Dry Zone of Karnataka. The results revealed that significantly higher root yield (27.51 t ha^{-1}) was recorded in STCR target of 25 t ha^{-1} through integrated approach. The per cent deviation of 10.03 under STCR targeted yield of 25 t ha^{-1} through integrated approach indicates that this equation is a best equation for zone 5 of Karnataka as the per cent deviation was within ± 10.00.

Keywords: STCR, carrot, yield, per cent deviation

Introduction

Balanced application of nutrients is one of the most important aspects for sustainable crop production and improvement in quality of produce. Therefore, fertilizer application based on soil testing is being advocated throughout the world. Soil testing helps us to know the nutrients status and their imbalances in the soil and apply required amount of the nutrients to overcome imbalances and sustain yield (Rao and Srivastava, 2000) [7]. However, in conventional soil testing the fertilizer recommendation is usually given for different crops by taking into consideration only the available nutrient status of soil prior to raising crop, by categorizing soil into low, medium and high fertility class. There is a very wide range for particular nutrient within a fertility class, thereby ignoring vast differences in its absolute amount in the soil while giving fertilizer recommendation. However, the STCR based fertilizer recommendations takes into account every bit of nutrient present in soil for achieving specific yield target of crops under a particular agro-climatic situation.

Carrot (*Daucus carota* L.) is a popular cool season root vegetable of umbelliferae family. In India carrot is cultivated in an area of 82,000 hectare with production of 13,38,000 metric tonnes and productivity of 16.3 t ha^{-1}. The main carrot growing states are Uttar Pradesh, Assam, Karnataka, Andhra Pradesh, Punjab and Haryana (Anon, 2015). Carrot is characterized by relatively moderate requirements for climate and soil. Owing to their modest needs for cultivation and storage, they can be produced fresh throughout the year and sold fresh. Ideal temperature for its growth and development is 15.6 ºC to 21 ºC. Carrot roots are rich in nutrients with moisture 86 g, protein 0.9 g, carbohydrate 10.6 g, fat 0.2 g, fiber 1.2 g, energy 48 kilo calorie, mineral 1.1 g, iron 2.2 mg, beta carotene 9.81 mg, thiamine 0.04 mg, riboflavin 0.02 mg, niacin 0.5 mg, vitamin-C 3 mg, folic acid 15 mg, calcium 14 mg and phosphorus 19.8 mg per 100 g of edible portion (Bose *et al.*, 2000) [3].

Material and Methods

A Field experiment entitled "Validation of STCR approach of nutrient application for carrot on *Alfisols* of Eastern Dry Zone of Karnataka" was conducted during *kharif* 2017 at Devanahalli village, Bengaluru rural district located in Eastern Dry Zone of Karnataka at 13° 24' 41.1" N latitude, 78° 08' 01.9" E longitude with an altitude of 880 meters above mean sea level (MSL). The soil of the experimental site was sandy loam in texture and acidic in reaction (pH, 5.48 - 5.58). Electrical conductivity was 0.13 to 0.15 dSm^{-1} with organic carbon content ranged from 0.62 - 0.77%. Available nitrogen was medium (268.65 – 289.56 kg N ha^{-1}), phosphorus was high (913.10 - 985.74 kg P_2O_5 ha^{-1}) and potassium was medium (173.20 – 202.00 kg K_2O ha^{-1}). The experiment was laid out in randomized complete block design (RCBD) with eight treatments replicated thrice comprising T_1 (STCR target 20 tha^{-1} through inorganics), T_2 (STCR target 20 tha^{-1} through integrated), T_3 (STCR target 25 tha^{-1} through inorganics), T_4 (STCR target 25 tha^{-1} through integrated), T_5 (RDF (75: 63: 50) N, P_2O_5, K_2O kg ha^{-1}+ FYM), T_6 (LMH /STL + FYM), T_7 (Farmers practice (92.6:159:0) N, P_2O_5 kg ha^{-1} + FYM), T_8 (Absolute control).

The following STCR fertilizer prescription equation developed by AICRP on STCR, UAS, Bengaluru centre for Zone-5 was used for fertilizer application to STCR treatments.

STCR equation for inorganics	STCR equation for IPNS
FN = 1.04 T - 0.39 STV-N	FN = 1.04 T - 0.39 STV-N - 0.23 OM
FP_2O_5 = 0.49 T - 0.43 STV-P_2O_5	FP_2O_5 = 0.49 T - 0.43 STV-P_2O_5 - 0.14 OM
FK_2O = 0.87 T - 0.66 STV-K_2O	FK_2O = 0.87 T - 0.66 STV-K_2O - 0.51 OM

Where, T = Targeted yield (q ha^{-1}), FN= Fertilizer nitrogen (kg ha^{-1}), FP_2O_5= Fertilizer phosphorus (kg ha^{-1}), FK_2O = Fertilizer potassium (kg ha^{-1}), STV- N, STV- P_2O_5 and STV- K_2O are initial available N, P_2O_5 and K_2O kg ha^{-1} respectively, where STV is soil test value.

A composite soil sample was collected at 0-15 cm depth from each plot after laying out the plan before the start of experiment. Based on the soil test values NPK fertilizer nutrients were applied for specific yield target in STCR and LMH approach. The quantity of nutrients applied per hectare through different approaches as per the treatments are presented in Table 1. Fifty per cent of nitrogen recommended for each treatment was applied through urea and entire quantity of phosphorus through SSP (single super phosphate) and potassium through MoP (muriate of potash) were supplied at the time of sowing as basal dose to each plot and remaining 50 per cent of nitrogen was applied at 30 days after sowing. At harvest, the root yield recorded from each plot was computed and expressed in tonnes ha^{-1}. Soil samples collected from the experimental plots after harvest were processed and analysed for available nitrogen, phosphorus and potassium by following standard procedures (Jackson, 1973) [5] and nutrient balance was worked out.

Table 1: Soil test values and quantity of nutrients and FYM applied for different approaches as per the treatments.

Treatments	Soil test values*			FYM applied	Fertilizer nutrient applied		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
	kg ha^{-1}			t ha^{-1}	kg ha^{-1}		
T_1	269.69	931.88	186.80	0	101.19	0.00	50.71
T_2	268.65	882.29	196.40	25	92.45	0.00	31.61
T_3	289.56	1013.10	202.00	0	150.60	0.00	84.16
T_4	269.69	951.54	173.20	25	151.60	0.00	90.42
T_5	249.83	933.16	178.40	25	75.00	63.00	50.00
T_6	279.10	982.75	195.20	25	80.56	50.50	50.00
T_7	282.24	985.74	195.20	30	92.60	159.00	0.00
T_8	276.99	919.05	189.20	0	0.00	0.00	0.00

*Soil test values and fertilizer nutrient applied are the mean of three replications

Result and Discussion

The root yield data of carrot in Table 2, revealed a significant difference between the treatments. The significantly higher root yield (27.51 t ha^{-1}) was recorded in STCR target of 25 t ha^{-1} through integrated approach (T_4) which was superior than all the other treatments. All the STCR targeted yield approach treatments were found to be superior over LMH (19.39 t ha^{-1}), RDF (19.28 t ha^{-1}) and Farmer's practice (19.18 t ha^{-1}). The STCR-integrated approach at both the targets (20 and 25 t ha^{-1}) have recorded the carrot yield more than the target fixed and was higher compared to STCR - inorganic approach. However, significantly lower yield (14.75 t ha^{-1}) was noticed in absolute control (T_8). The enhanced nutrient uptake and increased nutrient use efficiency under STCR approach over LMH, RDF and Farmer's practice, resulted in positive effect on growth and yield attributes that have enabled higher root yield of carrot. Also, the favourable complementary influence of organics and inorganics on chemical, physical and biological properties of soil under STCR integrated approach would have resulted in higher yield (Santhi *et al*., 2002) [8].

Per cent (%) deviation

The per cent deviation indicated the yield variation from the target fixed which is generally based on genetic potentiality of the crop (Table 2). The per cent (%) deviation in the present study from the fixed target was found to be positive in STCR target of 25 t ha^{-1} and 20 t ha^{-1} through integrated approach (10.03% and 8.30% respectively) where the yield obtained was higher than the fixed targets and the lower deviation (-0.37% and -1.62% respectively) was noticed in STCR inorganic approaches for the same yield targets. Similarly, the higher negative deviation was recorded in Farmer's practice (-4.07%), RDF (-3.62%) and LMH (-3.05%) indicating that the crop could not achieve the genetic potential yield in these treatments.

Available NPK status in soil

The available nitrogen, phosphorus and potassium status of the soil after the harvest of carrot crop differed significantly among the treatments (Table 2). Available N status of the soil was significantly higher (318.72 kg N ha^{-1}) where fertilizer nutrients were applied for the targeted yield of 25 t ha^{-1} through STCR integrated approach (T_4) and it was on par with (T_2 and T_3) STCR targeted yield of 20 t ha^{-1} through integrated approach (314.44 kg N ha^{-1}) and STCR targeted yield of 25 t ha^{-1} through inorganic fertilizers (302.52 kg N ha^{-1}). The available phosphorus was significantly higher (851.94 kg P_2O_5 ha^{-1}) where fertilizer nutrients were applied as per the farmer's practice which received the higher dose of phosphatic fertilizer. However, it was found to be on par with all the other treatments including STCR treatments which did not receive any phosphatic fertilizer except absolute control (T_8) (766.45 kg P_2O_5 ha^{-1}), where no fertilizers were applied. Available potassium was significantly higher (181.60 kg K_2O ha^{-1}) where fertilizer nutrients were applied for a targeted yield 25 t ha^{-1} through STCR integrated approach (T_4) and it was on par with (T_2 and T_6) STCR targeted yield of 20 t ha^{-1} through integrated approach (178.00 kg K_2O ha^{-1}) and LMH approach (166.00 kg K_2O ha^{-1}).

The available nitrogen was found to increase and it was higher in STCR integrated approach at both the targets. This increase in available nitrogen content of soil was due to combined application of inorganic fertilizers and FYM and higher amount of N supplied through this approach than RDF, LMH and Farmer's practice. These results are in conformity with Santhosha (2013) [9], who also observed the increased available N status of the soil due to application of higher amount of nitrogenous fertilizer in combination with FYM. The significantly higher available phosphorus in Farmer's practice might be due to application of higher dose of phosphatic fertilizers and FYM that have lead to the buildup of phosphorus in soil even in STCR treatments plots, where farmers have applied phosphatic fertilizers without working to the soil test values. The soils on which the present study was conducted are acidic in reaction (pH 5.48-5.58) and high in Al and Fe hence, the response to phosphatic fertilizer was high and had higher available phosphorus content in soil. The significantly higher available potassium at harvest under STCR integrated approach is attributed to application of FYM and potassium above the recommended dose due to lower available K in initial soil as per STCR approach, which might have helped to maintain higher soil available K status in the soil. Similar results were obtained by Basavaraja *et al.* (2014) [2] who opined that higher available phosphorus and potassium were recorded due to higher dose of NPK fertilizers application through STCR approach as compared to RDF. Santhi *et al.* (2002) [8] and Manish Singh *et al.* (2017) [6] indicated the buildup and maintenance of post harvest soil fertility despite higher removal of nutrients in STCR- IPNS approach as compared to NPK alone due to prevention of losses of nutrients under IPNS, even after meeting the crop needs.

Table 2: Influence of different approaches of nutrient application on carrot yield and post harvest NPK status of soil

Treatment	Root yield	% Deviation	Available NPK (kg ha^{-1})		
	(t ha^{-1})		N	P_2O_5	K_2O
T_1	19.68	-1. 62	286.42	820.58	143.60
T_2	21.66	8.30	314.44	825.44	178.00
T_3	24.91	- 0.37	302.52	828.43	155.60
T_4	27.51	10.03	318.72	831.85	181.60
T_5	19.28	- 3.62	276.28	843.31	153.47
T_6	19.39	- 3.05	290.29	845.96	166.00
T_7	19.18	- 4.07	288.20	851.94	127.60
T_8	14.75	- 26.23	244.82	766.45	114.00
SEm±	0.77	-	6.20	12.97	5.31
CD @ 5%	2.35	-	18.80	39.04	16.09

Nutrient balance studies in soil

Nitrogen balance in soil

The initial available nitrogen in soil ranged from 249.83 to 289.56 kg N ha^{-1} (Table 3). The maximum uptake of nitrogen (297.07 kg N ha^{-1}) by carrot crop from the soil was recorded where NPK fertilizers were applied as per STCR integrated approach for a targeted yield of 25 t ha^{-1} (T_4) followed by STCR inorganic approach for the same targeted yield of 25 t ha^{-1} (T_3) (250.79 kg N ha^{-1}). Similarly, the actual balance (318.72 kg N ha^{-1}) and net positive balance (194.17 kg N ha^{-1}) was higher with T_4. Even though expected balance was higher (226.02 kg N ha^{-1}) in Farmer's practice, the net gain was very low (62.18 kg N ha^{-1}). The higher actual balance of nitrogen in STCR integrated approaches was due to efficient use of applied nitrogen and more mineralization process where losses were less due to presence of organic matter. These results were in accordance with the findings of Brar and Bhajan Singh (1984) [4] who reported that the increase in available N in the soil might be due to the continuous mineralization of organic sources of N applied along with inorganics.

Table 3: Nitrogen balance (kg N ha^{-1}) in soil as influenced by different approaches of nutrient application

Treatment	IAN	FN	TN	CU	EB	AB	G/L
	1	2	3 (1+2)	4	5 (3-4)	6	7 (6-5)
T_1: STCR target 20 t ha^{-1} through inorganics	269.69	101.19	370.88	214.28	156.60	286.42	+129.82
T_2: STCR target 20 t ha^{-1} through integrated	268.65	92.45	361.10	239.39	121.70	314.44	+192.73
T_3: STCR target 25 t ha^{-1} through inorganics	289.56	150.60	440.16	250.79	189.36	302.52	+113.16
T_4: STCR target 25 t ha^{-1} through integrated	269.69	151.93	421.62	297.07	124.55	318.72	+194.17
T_5: RDF + FYM	249.83	75.00	324.83	185.44	139.40	276.18	+136.78
T_6: LMH + FYM	279.10	80.56	359.66	203.53	156.13	290.29	+134.16
T_7: Farmers practice + FYM	282.24	92.60	374.84	148.82	226.02	288.20	+62.18
T_8: Absolute control	276.99	0.00	276.99	105.66	171.34	244.82	+73.48

Legend: IAN = Initial available nitrogen (kg ha^{-1}), TN = Total nitrogen (kg ha^{-1}), FN = Fertilizer nitrogen (kg ha^{-1}), CU = Crop uptake (kg N ha^{-1}), EB = Expected balance (kg ha^{-1}), AB = Actual balance (kg ha^{-1}), G/L = Net gain/ net loss (kg ha^{-1})

Phosphorus balance in soil

The initial available phosphorus in soil ranged from 913.10 to 982.75 kg P_2O_5 ha^{-1} (Table 4). The maximum crop uptake of phosphorus (131.62 kg P_2O_5 ha^{-1}) by carrot crop from the soil was found where NPK fertilizers were applied as per STCR integrated approach for a targeted yield of 25 t ha^{-1} (T_4). But, the expected balance as well as actual balance were higher (1008.67 and 851.94 kg P_2O_5 ha^{-1} respectively) in Farmer's practice (T_7). Whereas the net positive balance was highest (28.19 kg P_2O_5 ha^{-1}) in STCR inorganic approach for the targeted yield of 25 t ha^{-1} and net negative balance was highest (-156.72 kg ha^{-1}) in Farmer's practice. The net positive balance of phosphorus was recorded even though phosphatic fertilizers were not applied due to high level of soil available phosphorus at the experimental site.

Table 4: Phosphorus balance (kg P_2O_5 ha^{-1}) in soil as influenced by different approaches of nutrient application

Treatment	IAP	FP	TP	CU	EB	AB	G/L
	1	2	3 (1+2)	4	5 (3-4)	6	7 (6-5)

T_1: STCR target 20 t ha^{-1} through inorganics	931.88	0.00	931.88	95.24	836.64	820.58	-16.06
T_2: STCR target 20 t ha^{-1} through integrated	922.29	0.00	922.29	108.24	814.05	825.44	+11.39
T_3: STCR target 25 t ha^{-1} through inorganics	913.10	0.00	913.10	112.86	800.24	828.43	+28.19
T_4: STCR target 25 t ha^{-1} through integrated	951.54	0.00	951.54	131.62	819.92	831.85	+11.93
T_5: RDF + FYM	933.16	63.00	996.16	103.36	892.80	843.31	-49.50
T_6: LMH + FYM	982.75	50.50	1033.25	108.90	924.35	845.96	-78.39
T_7: Farmers practice + FYM	945.74	159.00	1104.74	96.07	1008.67	851.94	-156.72
T_8: Absolute control	919.05	0.00	919.05	59.47	859.59	766.45	-93.14

Legend: IAP = Initial available phosphorus (kg ha^{-1}), TP = Total phosphorus (kg ha^{-1}) FP = Fertilizer phosphorus (kg P_2O_5 ha^{-1}), CU = Crop uptake (kg P_2O_5 ha^{-1}), EB = Expected balance (kg ha^{-1}), AB = Actual balance (kg ha^{-1}), G/L = Net gain/ net loss (kg ha^{-1})

Potassium balance in soil

The initial available potassium in soil ranged from 186.80 to 202.00 kg K_2O ha^{-1} (Table 5). The maximum uptake of potassium (304.58 kg K_2O ha^{-1}) by carrot crop from the soil was recorded where NPK fertilizers were applied as per STCR integrated approach for a targeted yield of 25 t ha^{-1} (T_4), followed by STCR-inorganic approach for the target yield of 25 t ha^{-1} (T_3) (280.80 kg K_2O ha^{-1}). Similarly, the actual balance (181.60 kg K_2O ha^{-1}) and net positive balance (222.56 kg K_2O ha^{-1}) was higher with T_4 treatment. The lowest gain of potassium was recorded in control plot (75.32 kg K_2O ha^{-1}) where no fertilizers were applied. The higher actual balance of potassium might be due to incorporation of FYM along with fertilizer nitrogen which increased the cumulative non-exchangeable K release and maintained greater amounts of potassium in solution and on exchange sites by re-establishing the equilibrium among the forms of potassium (Santhosha, 2013) [9].

This study clearly indicates that STCR approach of fertilizer application specially with IPNS approach is more suitable not only for getting higher yield but also helps in efficient and balanced use of fertilizer nutrients to get a higher positive balance of applied major nutrients in the soil.

Table 5: Potassium balance (kg K_2O ha^{-1}) in soil as influenced by different approaches of nutrient application

Treatment	IAK	FK	TK	CU	EB	AB	G/L
	1	2	3 (1+2)	4	5 (3-4)	6	7 (6-5)
T_1: STCR target 20 t ha^{-1} through inorganics	186.80	50.71	237.51	238.16	-0.65	143.60	+144.25
T_2: STCR target 20 t ha^{-1} through integrated	196.40	31.61	228.01	265.02	-37.01	178.00	+215.01
T_3: STCR target 25 t ha^{-1} through inorganics	202.00	84.16	286.16	280.80	5.36	155.60	+150.24
T_4: STCR target 25 t ha^{-1} through integrated	173.20	90.42	263.62	304.58	-40.96	181.60	+222.56
T_5: RDF + FYM	178.40	50.00	228.40	224.13	4.27	142.80	+138.53
T_6: LMH + FYM	195.20	50.00	245.20	261.12	-15.92	166.00	+181.92
T_7: Farmers practice + FYM	195.20	0.00	195.20	172.60	22.60	127.60	+105.00
T_8: Absolute control	189.20	0.00	189.20	150.52	38.68	114.00	+75.32

Legend: IAK = Initial available potassium (kg ha^{-1}), TK= Total potassium (kg ha^{-1}), FK = Fertilizer potassium (kg K_2O ha^{-1}), CU = Crop uptake (kg K_2O ha^{-1}), EB = Expected balance (kg ha^{-1}), AB = Actual balance (kg ha^{-1}), G/L = Net gain/ net loss (kg ha^{-1})

References

1. Anonymous. National Horticulture Database-2015. National Horticulture Board, Govt. of India, Gurgaon, India. www. nhb.gov.in.
2. Basavaraja PK, Kumara Naik, Nethradhani RAJ CR, Yogendra ND. Effect of soil test based fertilizer application on yield and nutrient uptake by hybrid maize under dry land condition. Mysore J Agric. Sci. 2014; 48(4):514-521.
3. Bose TK, Kabir J, Das P, Joy PP. Tropical Horticulture, Naya Prokash, Calcuta. 2000, 1:145.
4. Brar SP, Bhajan Singh. Effect of long term application of N, P, K and zinc on crop and soil in maize-wheat rotation. J. Res., Punjab Agril. Uni. 1984; 26(4):572-580.
5. Jackson ML. Soil Chemical Analysis; Prentice Hall of India, Pvt. Ltd., New Delhi, 1973, 498.
6. Manish Singh YV, Singh SK, Singh, Pradip Dey LK, Ram RL. Validation of soil test and yield target based fertilizer prescription model for rice on Inceptisol of eastern zone of Uttar Pradesh, India. Inter. J Curr. Microbio. App. Sci. 2017; 6(2):406-415.
7. Rao S, Srivastava S. Soil test based fertilizer use-A must for sustainable agriculture. Fertilizer News. 2000; 45:25-38.
8. Santhi R, Natesan R, Selvakumari G. Soil test based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu. Agropedolog. 2002; 12:141-147.
9. Santhosha VP. Yield maximization in maize through different forms of fertilizers and approaches of nutrient recommendations. M.Sc (Agri.) Thesis. University of Agricultural Sciences, Bangalore, 2013.