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Response of growth, yield attributes and yield of cabbage (*Brassica oleraceae* var. *capitata*) to different approaches of fertilizer recommendation in eastern dry zone of Karnataka, India

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Abstract
A field experiment was conducted in *Alfisols* of Zonal Agricultural Research Station, GKVK Bengaluru to study the impact of different approaches of fertilizer recommendation on growth, yield and yield attributes of cabbage (*Brassica oleraceae* var. *capitata*). Significantly higher plant height and plant spread at different intervals (30, 60 DAT and at harvest), yield attributes of cabbage crop such as head weight, head circumference, head diameter, dry matter production and yield of cabbage were recorded in treatment receiving fertilizer nutrients based on LMH approach (STL) followed by STCR inorganic approach using soluble fertilizers and STCR integrated approach using soluble fertilizers for a targeted yield of 33 t ha^{-1} along with sheep manure @ 25 t ha^{-1}. But, yield attributes as well as yield of cabbage was statistically on par with all STCR treatments involving soluble and conventional fertilizers. Whereas, significantly lower yield attributes of cabbage were recorded in absolute control, where no fertilizers and sheep manure was applied.

Keywords: STCR, LMH, cabbage growth and yield, soluble fertilizers, fertigation

Introduction
Efficient use of plant nutrients through chemical fertilizers and organic manures is a good means for increasing food production especially for vegetables. Cost of fertilizers has gone up hence, their optional use in required quantity mainly depends on resources available to farmers. Imbalanced use of chemical fertilizers results in lower nutrient use efficiency and restricts utilization of the genetic potential of a crop to its maximum. The most comprehensive approach of fertilizer application by incorporating soil test values, nutrient requirement of the crop, contribution of nutrients from soil, manures, fertilizers and fixing yield targets is possible only through Soil Test Crop Response (STCR) approach. Soil test based fertilizer nutrient recommendation is based on the hypothesis that an increasing or decreasing the available nutrient in the soil will directly influence crop yield. The targeted yield concept was primarily based on the quantitative idea of the need for fertilizers in line with crop yield and nutritional requirements, the percentage of the soil nutrient available and the fertilizer applied (Ramamoorthy *et al.*, 1967). Cabbage (*Brassica oleraceae* var. *capitata*) is an important cole crop belongs to the family Brassicaceae. It is well recognized for its nutritive value and health benefits. Cabbage leaves contains fat (0.1%), carbohydrates (4.6%) and protein (1.3%). It is rich source of minerals such as calcium (39 mg), iron (0.8 mg), magnesium (10 mg), sodium (14.1 mg), potassium (114 mg) and phosphorus (44 mg). Water is the scarce input which can severely limit the agricultural production unless it was carefully conserved and managed. Therefore, the adoption of modern irrigation techniques is needed to be emphasized to increase water use efficiency and covering more area under cultivation. Fertigation through drip irrigation is the most effective and efficient way of supplying nutrients through water to crop plants and not only conserve the water but also boost the yield of vegetables by achieving higher nutrient use efficiency. Water-soluble fertilizers are fertilizer nutrients with different grades of NPK fertilizers that are completely water-soluble and characterized by high purity and can be applied in lower doses to obtain higher benefits. Considering the above factors, the present experiment was undertaken with the objective to assess the influence of different approaches of fertilizer recommendation on growth, yield and yield attributes of cabbage in eastern dry zone (Zone-5) of Karnataka.

Material and Methods

The field experiment was conducted in *kharif* 2018 at AICRP on STCR field, block 12, ZARS, GKVK and the soil of the experimental site was red soil taxonomically belongs to Vijaypura soil series of great group *kandic paleustalfs*. In this experiment, different fertilizer recommendation approaches including water-soluble fertilizers and conventional fertilizers were compared to assess the response of cabbage crop to various approaches of fertilizer recommendation including the STCR targeted yield equation developed at the same centre for cabbage crop under fertigation. Initial composite soil samples were collected from individual plots prior to initiation of the experiment at 0-20 cm depth after layout of the experimental field. The surface soil was sandy clay loam in texture with acidic pH (5.78) and electrical conductivity of 0.085 dS m^{-1}. The Initial soil organic carbon was low (4.50 g kg^{-1}), available nitrogen was low (266.16 kg ha^{-1}), available Bray's phosphorus (P_2O_5) was medium (56.93 kg ha^{-1}) and ammonium acetate extractable potassium (K_2O) was low (117.90 kg ha^{-1}). The experiment was laid out in randomized complete block design (RCBD) having seven treatments and replicated thrice. The treatments combinations consists of STCR approach of fertilizer recommendations for targeted cabbage yield of 33 t ha^{-1} through inorganics like only soluble fertilizers (Calcium nitrate, Mono potassium phosphate and Mono ammonium phosphate and Sulphate of potash), only conventional fertilizers (Urea, Single super phosphate and Muriate of Potash) and through integrated approach like soluble fertilizers along with sheep manure at the rate of 25 t ha^{-1}, and conventional fertilizer along with sheep manure at the rate of 25 t ha^{-1}. Other treatment combinations include general blanket recommended dose as per standard package of practices, LMH (Low-Medium-High) approach, commonly used in soil testing laboratories and absolute control (Table 1).

Table 1: Treatment details used in the field experiment

Treatments		Details of the treatments
T_1	:	STCR approach at 33 t ha^{-1} through soluble fertilizers (Inorganics).
T_2	:	STCR approach at 33 t ha^{-1} through soluble fertilizers and sheep manure (Integrated).
T_3	:	STCR approach at 33 t ha^{-1} through conventional fertilizers (Inorganics).
T_4	:	STCR approach at 33 t ha^{-1} through conventional fertilizers and sheep manure (Integrated).
T_5	:	Package of practices (Recommended dose of fertilizers)
T_6	:	LMH (Soil Testing Laboratory method)
T_7	:	Absolute control

STCR-NPK alone (Inorganics) STCR integrated plant nutrient supply equations

FN = 4.4750 T - 0.1342 STV FN = 4.1600 T - 0.1209 STV- 0.858 OM

FP_2O_5 = 3.5822 T - 0.1954 STV FP_2O_5 = 2.6736 T - 0.1248 STV - 0.256 OM

FK_2O = 3.8005 T - 0.1140 STV FK_2O = 4.3324 T - 0.1119 STV- 0.870 OM

The quantity of fertilizer nutrients applied through STCR approach using soluble and conventional fertilizers under inorganics and integrated condition was calculated by using the following equations. The quantity of fertilizer nutrients applied under different treatments was given in Table 2.

Where, FN, FP_2O_5 and FK_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1} respectively; T is the yield target in t ha^{-1}; SN, SP and SK are available soil nutrients as $KMnO_4$-N, Bray's-P_2O_5 and NH_4OAc-K_2O in kg ha^{-1} respectively and OM is amount of sheep manure added in t ha^{-1}.

Table 2: Quantity of nutrients applied per hectare through different approaches as per the treatments

Treatment details	Soil test values			Sheep manure 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	260.81	55.01	122.00	0	112	108	112
T_2	270.84	45.22	126.50	25	59	77	104
T_3	261.34	60.57	132.40	0	113	106	113
T_4	270.35	69.97	121.75	25	59	74	109
T_5	254.24	58.45	111.80	25	150	100	125
T_6	275.60	54.08	116.60	25	167	100	163
T_7	269.50	55.22	94.20	0	0	0	0

Note: Soil test values and fertilizer nutrients shown are mean of three replications.

Twenty-two days old cabbage seedlings were transplanted to the experimental plots at a spacing of 45 cm X 30 cm. Conventional fertilizers as per the specific treatments were applied on the day of transplanting. Nitrogen was applied as urea (50% as basal dose), phosphorus as single super phosphate (100% dose) and potassium as muriate of potash (100% dose) before transplanting cabbage and after 30 days top dressing was done with remaining 50 percent of N dose. Soluble fertilizers for the specific treatments were applied through fertigation at 30 percent of recommended fertilizer doses as basal dose and remaining 70 percent dose as 10 percent at each time at 8 days interval. Biometric observations on various growth parameters such as plant height (cm) and plant spread (cm) at 30 DAT, 60 DAT and at harvest, and various yield parameters as head weight, head circumference, head diameter, dry matter production, and yield of cabbage were recorded on five randomly selected and tagged representative plants in each plot and expressed as mean values.

Results and Discussion

Influence of various approaches of fertilizer recommendation on growth parameters of cabbage crop.

Data pertaining to plant height (cm) and plant spread (cm) of cabbage at 30 DAT, 60 DAT and at harvest as influenced by different approaches of nutrient application are presented in

Table 3. Plant height differed significantly at all the growth stages among the treatments. Plant height increased progressively with increase in age of the crop up to 60 days after transplanting and thereafter increase was slightly lower. Significantly higher plant height of 23.97 cm, 27.46 cm and 27.73 cm was recorded in LMH (Low-Medium-High) approach at 30 DAT, 60 DAT and at harvest respectively (T_6), followed by STCR target of 33 t ha^{-1} through inorganic approach using soluble fertilizers (T_1) at 30 DAT (23.73 cm), 60 DAT (25.85 cm) and at harvest (26.70 cm), respectively. However, it was found to be on par with all the treatments except T_7 (absolute control) at 30 DAT and at harvest. But, at 60 DAT it was found to be on par with all treatments except T_4 (STCR target of 33 t ha^{-1} through integrated approach using conventional fertilizers) and T_7 (absolute control).

The plant spread was found to be significantly higher (29.37 cm) in LMH approach (T_6) which received the nutrient doses as per soil testing laboratory method at 30 DAT followed by T_5 (package of practices) and STCR target of 33 t ha^{-1} through inorganic approach using soluble fertilizers (T_1) at 30 DAT. Similar trend was observed at 60 DAT (38.18 cm) and at harvest (36.47) where, significantly higher plant spread was recorded in LMH approach followed by STCR target of 33 t ha^{-1} through inorganics using soluble fertilizers (T_1). However, it was found to be on par with all the treatments except with absolute control (T_7). The plant spread was gradually increased from 30 DAT to 60 DAT whereas, at harvest slight decrease in plant spread was noticed (Table 3). This was mainly due to translocation of photosynthates from older leaves to younger leaves during head formation at harvest followed by drying and dropping of older leaves. Similar findings were reported by Naher *et al.* (2014) [4] in cabbage crop.

Table 3: Influence of different approaches of nutrient application on plant height and plant spread of cabbage at different intervals

Treatment details	Plant height** (cm)			Plant spread** (cm)		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest
T_1 – STCR* (Inorganics through soluble fertilizers)	23.73	25.85	26.70	26.58	37.38	36.15
T_2 - STCR (Integrated through soluble fertilizers and SM)	22.97	25.60	26.13	25.78	36.94	35.11
T_3 - STCR (Inorganics through conventional fertilizers)	22.80	25.41	25.83	27.08	35.85	34.93
T_4 - STCR (Integrated through conventional fertilizers and SM)	22.37	24.47	24.98	26.39	35.75	35.41
T_5 - Package of practices	23.43	25.56	26.07	28.18	36.17	34.93
T_6 - LMH (STL)	23.97	27.46	27.73	29.37	38.18	36.47
T_7 - Absolute control	15.09	16.80	17.03	21.11	25.52	25.07
SEm±	1.15	0.89	1.04	1.20	0.96	1.16
CD @ 5%	3.55	2.76	3.21	3.70	2.95	3.56

Note: *STCR (Soil Test Crop Response) targeted yield of cabbage at 33 t ha^{-1}, SM: sheep manure, LMH: Low, Medium and High, STL= Soil testing laboratory method, DAT- Days after transplanting, **: Five plants average

The increased plant height and plant spread of cabbage in LMH approach (T_6) was mainly due to increased nutrient application (167:100:163 kg NPK ha^{-1} along with sheep manure at 25 t ha^{-1}) which might have enhanced physiological activities in crop. The increased availability of nutrients and their better utilization by crop plants was due to the conjunctive use of organics and inorganics that enhanced vegetative growth. The results of this study are in accordance with Santhosha (2013) [6] in maize crop and Ashok (2013) [1] in finger millet crop.

The STCR treatments recorded slightly lower plant height and plant spread as compared to LMH approach was mainly due to lower application of fertilizer nutrients as per the crop nutrient requirements based on soil test values with respect to available N, P_2O_5 and K_2O.

Influence of various approaches of fertilizer recommendation on yield attributes and yield of cabbage crop

The yield parameters of cabbage recorded from randomly selected five plants average *viz.*, head weight, head circumference, head diameter, number of outer leaves, dry matter production, cabbage yield influenced by different approaches of fertilizer nutrient application are presented in Table 4. Significantly higher head weight of cabbage (0.859 g) was recorded in T_6 which received the nutrient doses as per LMH approach (167:100:163 kg NPK ha^{-1} along with sheep manure @ 25 t ha^{-1}) followed by STCR target of 33 t ha^{-1} (0.847 g) through inorganic approach using soluble fertilizers (T_1). However, it was found to be on par with all the treatments except T_7 (absolute control) which recorded the lowest head weight of 0.168 g was recorded, where no fertilizers or sheep manure was added.

The head circumference of cabbage was significantly higher (40.96 cm) in LMH approach (T_6) followed by T_1, which received fertilizer nutrients as per STCR target of 33 t ha^{-1} (40.29 g) through inorganic approach using soluble fertilizers. But, it was on par with all the treatments except absolute control (T_7). The lower head circumference was recorded in T_7 (absolute control), where no fertilizers or sheep manure was applied.

Significantly higher head diameter of cabbage (13.04 cm) was recorded in LMH approach (T_6) followed by STCR target of 33 t ha^{-1} (12.83 cm) through inorganic approach using soluble fertilizers (T_1). But, it was found to be on par with all the fertilizer applied treatments of various methods except in absolute control (T_7), where it was found to be lowest (7.77 cm)

Significantly lower number of outer leaves per cabbage (9.31) was recorded in LMH approach (T_6) followed by STCR target of 33 t ha^{-1} (10.34) through inorganic approach using soluble fertilizers (T_1). Although, it was found to be on par with all the treatments except T_7 (absolute control). Dry matter production of cabbage varied significantly among the treatments. Significantly higher dry matter accumulation by cabbage crop (34.36 g) was recorded in LMH approach (T_6) followed by STCR target of 33 t ha^{-1} (33.80 g) through inorganic approach using soluble fertilizers (T_1). But, it was statistically on par with all the treatments including recommended dose of fertilizers (Package of practices) except with absolute control. Where, significantly lower dry matter accumulation (14.18 g) was reported.

Significantly higher marketable cabbage yield was recorded in T_6 (62.55 t ha^{-1}) which received the nutrient dose as per LMH approach (167:100:163 kg NPK ha^{-1} along with sheep manure at 25 t ha^{-1}) followed by STCR inorganic approach (T_1) through soluble fertilizers (62.03 t ha^{-1}). However, it was found to be on par with all the STCR target of 33 t ha^{-1} treatments (both soluble and conventional fertilizer application through inorganic and integrated approach) including fertilizer nutrient application through package of practices (T_5) except absolute control (T_7) where no fertilizers or sheep manure was added.

Table 4: Influence of various approaches of fertilizer recommendations on yield parameters and yield of cabbage

Yield parameters	Head weight (kg)	Head circumference (cm)	Head diameter (cm)	No. of outer leaves	Dry matter (g plant^{-1})	Cabbage yield (t ha^{-1})
	(Five plants average)					
T_1 – STCR* (Inorganics through soluble fertilizers)	0.847	40.29	12.83	10.34	33.80	62.03
T_2 - STCR (Integrated through soluble fertilizers and SM)	0.830	40.11	12.77	10.70	32.12	61.31
T_3 - STCR (Inorganics through conventional fertilizers)	0.793	39.37	12.54	11.04	29.53	59.09
T_4 - STCR (Integrated through conventional fertilizers and SM)	0.768	39.94	12.72	10.89	30.72	58.52
T_5 - Package of practices	0.802	40.19	12.80	10.78	29.02	60.42
T_6 - LMH (STL)	0.859	40.96	13.04	9.31	34.36	62.55
T_7 - Absolute control	0.168	24.41	7.77	14.54	14.18	18.84
SEm±	0.041	0.67	0.21	0.91	2.69	2.89
CD *(P = 0.05)*	0.126	2.07	0.66	2.79	8.30	8.92

Note: *STCR (Soil Test Crop Response) targeted yield of cabbage at 33 t ha^{-1}, SM: Sheep manure, LMH: Low, Medium, High. STL: Soil testing laboratory method

Yield parameters such as head weight, head circumference, head diameter, dry matter production and yield of cabbage recorded higher values in T_6 which received nutrient doses as per LMH approach followed by STCR inorganic approach through soluble fertilizers. But, all these yield parameters and yield of cabbage was found to be statistically on par with all the treatments of different fertilizer nutrient recommendation approaches except with absolute control.

Higher values of yield parameters and yield of cabbage in LMH approach was mainly due to increased nutrient application (167:100:163 kg NPK ha^{-1} along with sheep manure @ 25 t ha^{-1}) as compared to all other treatments. Increased fertilizer nutrient application along with 25 t ha^{-1} of sheep manure results in increased nutrient availability at the vicinity of root surface of cabbage which leads to increased uptake of all the essential plant nutrients. All these favourable conditions might have resulted in greater translocation and accumulation of carbohydrates and protein in cabbage, ultimately resulted in improved yield parameters and yield of cabbage in LMH approach followed by STCR inorganic and integrated approach using soluble fertilizer for the target yield of 33 t ha^{-1}. These results are in close agreement with those of Verma and Maurya (2013) [8] and Harpal *et al.* (2018) [3] in cabbage crop. They reported that increased application of NPK fertilizers along with FYM enhances the availability of essential macro nutrients in soils which resulted in increased nutrient uptake and finally improves the yield of cabbage.

However, when compared with STCR target of 33 t ha^{-1} through inorganics or integrated approach using soluble fertilizers (T_1 and T_2), yield and yield parameters of cabbage increased slightly. Interestingly, T_1 received 112:108:104 kg N, P_2O_5 and K_2O ha^{-1} which is 32.93% reduction of N, 8% increase in P_2O_5 and 31.28% reduction of K_2O as compared to LMH approach. Whereas, T_2 received 59 :77:104 kg N, P_2O_5 and K_2O ha^{-1} along with sheep manure at 25 t ha^{-1},which is 64.67% reduction in N, 23% reduction in P_2O_5 and 36.19% reduction of K_2O as compared to LMH approach. Even though in LMH approach despite increased application of fertilizer doses increase in yield was very low T_1 (0.83%) and T_2 (2.02%). This may be due to in STCR treatments (T_1 and T_2) of targeted yield 33 t ha^{-1} through both inorganics and integrated approach, application of soluble fertilizers at split doses of 10% of NPK at 7 times at 8 days intervals resulted in increased nutrient use efficiency of NPK, and effective translocation of nutrients from source to sink without any considerable loss of nutrients as compared to LMH approach. Hence, recommended doses of fertilizer nutrients reduced proportionally in STCR approach through soluble fertilizers. Similar findings were reported by Beyaert *et al.* (2007) [2] in cucumber crop, Shinde *et al.* (2006) [7] in cabbage crop, who reported application of nutrients through fertigation enhances fertilizer use efficiency by 40-60%. Therefore, recommended doses of fertilizers may be reduced proportionately.

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References

1. Ashok B, Maximization of maize productivity through targeted yield approach. M.Sc. (Agri) Thesis, University of Agricultural Sciences, Bangalore, 2013.
2. Beyaert RP, Roy RC, Coelho BBR. Irrigation and fertilizer management effects on processing cucumber productivity and water use efficiency. Canadian, J. Plant Sci., 2007; 87:355-363.
3. Harpal S, Pradeep KB, Joginder S, Pawan K. Effect of integrated nutrient management on growth and yield of cabbage (*Brassica oleraceae* var. *capitata*) and soil fertility, J. Pharmacogn. Phytochem. 2018; 7(2):1767-1769.
4. Naher MNA, Alam MN, Jahan N, Effect of nutrient management on the growth and yield of cabbage (*Brassica oleraceae* var. *capitata*.) in calcareous soils of Bangladesh, The Agriculturists. 2014; 12(2):24-33.

5. Ramamoorthy B, Narasimham RL, Dinesh RS. Fertilizer application for specific yield targets of sonara-64 wheat. Indian Farm. 1967; 17(5):43-45.
6. 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.
7. Shinde P, Chavan MG, Newase VB. Fertigation in cabbage, J. Maharashtra Agric. Uni., 2006; 3(3):255-257.
8. Verma R, Maurya BR. Effect of bio-organics and fertilizers on yield and nutrient uptake by cabbage, Ann. Plant Soil Res. 2013; 15(1):35-38.