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Research Article

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Effect of different dose of fertilizer application on growth parameter of chilli and uptake and micronutrient concentration after harvest of the crop

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Summary

Field experiment was conducted during *Kharif* 2011 on a farmer's field in Koliwad (Hubli Taluk) village in northern transitional zone of Karnataka between 15°21' N latitude and 75°24' E longitude and at an altitude of 629 m above mean sea level (MSL). In the soil test crop response dose of 216:116:166 N:P_2O5:K_2O kg ha^{-1}, recorded significantly higher plant height (95.4cm) over remaining treatments. This was at par with treatments T_5 (93.5 cm) and lowest plant height (85.8 cm) was recorded in RDF (T_1) at harvest. T_2 (STCR) registered highest number of branches (30.2), which was significantly superior over remaining all the treatments. The application of STCR dose of N, P_2O_5 and K_2O (T_2) recorded higher dry matter production (120.7 g) which was significantly superior over RDF (T_1), STL (T_3) and modified RDF_1 (T_4). The concentration of N, P and K were higher in the treatment T_2 (STCR dose N, P_2O_5 and K_2O) as compared to rest of the treatments. There was significant difference among treatments with respect to zinc concentration in plant as the soil was deficient in zinc.

Key words : Growth parameter, Chilli, Nutrient concentration, Dry matter production

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Introduction

Introduction chilli (*Capsicum annuum* L.) is an important spice as well as vegetable crop. In India, chilli is cultivated in an area of 7.67 lakh hectares and its production is estimated at 12.34 lakh tonnes. Chilli fruits are rich sources of vitamin C, A and E. Pungency of chilli is due to crystalline and volatile alkaloid called capsaicin present in the placenta of fruit, which has diverse prophylactic and therapeutic uses in allopathic and ayurvedic medicines. In Karnataka, the area estimated under chilli is 1,09,185 ha, with a production of 1,05,401 kg and productivity of 1016 kg ha^{-1}. Among the various methods of fertilizer application, the one based on 'yield targeting' is unique in the sense that this method not only indicates soil test-based fertilizer dose but also the levels of yield the farmer can hope to achieve if good agronomic practices are followed in raising the crop. Balanced and precision nutrition is the most important component in modern farming with an aim to achieve better nutrient use efficiency. This necessitates remodelling of our approach to the problem of economic and judicious use of fertilizers based on the soil test. Keeping these views in background, a field experiment was conducted to assess response of chilli to varied soil

test-based fertilizer doses.

Resource and Research Methods

A field experiment was conducted on black clayey soil during *Kharif* 2011 on a farmer's field. Composite soil sample (0-15 cm) was collected from the experimental site before sowing and was analyzed for various physical and chemical characteristics following standard methods. Soil was alkaline (8.10), low in organic carbon (OC) content (4.12 g kg^{-1} of soil) and available nitrogen (N) (246 kg ha^{-1}) content, medium in available phosphorus (P) (23.5 kg ha^{-1}) and high in available potassium (K) (392 kg ha^{-1}) content. Chilli cultivar Dyavnur dabbi was raised on flat bed one month before transplanting and transplanted to the main field on July 24, 2011.

Field experiment was laid out in a Randomized Complete Block Design (RCBD). There were six treatments and four replications. The plant height was measured from the base of the plant to the base of the fully opened top leaf. Height of the randomly selected five plants was recorded, averaged and expressed in centimeters. The numbers of branches per plant were counted from five tagged plants and their mean was recorded as number of branches per plant at 30 and 60 days after transplanting and at harvest.

The five randomly selected plants were used to record dry matter production at 60 days after planting. These samples were dried at 65 to 70°C to constant dry weight in an hot air oven. Dry weight was recorded separately at harvest to assess dry matter accumulation and total dry matter production. Matured fruits were counted in the randomly selected five plants in each of the plots. The average was calculated and expressed as no. of fruits per plant. After the harvesting the matured fruits, the length of five fruits from each plot was recorded, averaged and expressed in cm per fruit. The concentration of zinc, iron copper and manganese in the digested plant samples was determined after proper dilution using atomic absorption spectrophotometer (Jackson, 1973).

Treatment details were as follows :

T_1: Recommended dose of fertilizer (RDF) - 100 kg N + 50 kg P_2O_5 +50 kg K_2O ha^{-1} (Anonymous, 2012). T_2: Soil test crop response fertilizer dose (STCR) - The STCR equations developed for chilli namely, FN = 50.23 T – 0.54 SN, FP_2O_5 = 27.09 T– 3.17 SP_2O_5 and FK_2O = 36.48 T – 0.30 SK_2O (where F is the fertilizer dose, T is the yield target set, and SN, SP_2O_5 and SK_2O are soil tests for available N, P and K) grown on vertisols were used for calculating N, P_2O_5 and K_2O dose (*www.icar. org.in*). The calculated STCR fertilizer dose (T_2) was 216 kg N +116 kg P_2O5 +166 kg K_2O ha^{-1}. T_3 : Karnataka State Department of Agriculture soil testing laboratory

Table 1: Effect of different fertilizer levels on yield parameters

Treatments	Plant height (cm)			No. of branches/plant			Dry matter accumulation per plant (g)	
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	60 DAT	At harvest
T_1 - RDF (recommended dose of fertilizer) (150:75:75 ,N, P_2O_5, K_2O, kg ha^{-1})	31.0	52.0	85.8	11.1	14.1	18.5	56.8	91.5
T_2 - STCR dose of NPK (477:192:343.8,N, P_2O_5.K_20 kg ha^{-1})	42.5	84.2	95.4	13.5	24.6	30.2	84.4	120.7
T_3–STL dose of NPK (175:75:62.5,N, P_2O_5,K_2O kg ha^{-1})	33.1	68.5	86.0	11.8	20.5	22.6	60.0	103.5
T_4- Soil test based NPK ± 25% (187.5:75:56.25, N, P_2O_5,K_2O kg ha^{-1})	37.5	72.1	88.2	11.5	19.4	24.3	62.9	108.5
T_5 - Soil test based N and K± 50% and P 25% (225:75:37.5 N, P_2O_5,K_2O kg ha^{-1})	40.6	80.0	93.5	12.9	23.0	26.7	78.1	119.3
T_6 –N and K as per STL +75% of RDP under medium level of P test values +RD of PSB (175:56.25:62.5 N, P_2O_5,K_2O kg ha^{-1})	39.7	78.5	92.0	12.7	22.1	25.0	74.2	112.5
S.E.±	0.7	0.7	1.3	0.6	0.7	0.7	2.2	0.8
C.D. (P=0.05)	2.3	2.4	3.1	NS	2.1	2.2	4.7	2.4

NS= Non-significant

approach based modified fertilizer dose (KSDA-STL) - Dose was calculated using soil test ratings. As the experimental soil rating was low for nitrogen, 25 kg more nitrogenous fertilizer than recommended dose was applied. Similarly, for medium P, no change in the recommended dose of fertilizer was made. The available potassium content was higher, therefore, the fertilizer K_2O dose was reduced by 12.5 kg ha^{-1}. Hence, the calculated fertilizer dose under T_3 was 125:50:37.5, N, P_2O_5 and K_2O kg ha^{-1} (Prakash *et al.*, 2007). T_4: Soil test-based fertilizer dose modified by +25% - Fertilizer dose was calculated by modifying recommended dose by +25 per cent depending on whether test rating was high or low. Based on soil test results (T_4) nitrogen content in soil was rated as low. Therefore, 25 per cent more nitrogen than the recommended dose of fertilizer was added. Phosphorus content in the soil was medium so there was no need to add more phosphorus than the RDF. Potassium content in the soil was high hence recommended dose of potassium was reduced by 25 per cent. The dose under T_4, therefore, was 125 kg N + 50 kg P_2O_5 + 43.75 kg K_2O ha^{-1}. T_5: Soil test-based fertilizer dose modified by +50% - Fertilizer dose was calculated by modifying recommended dose by +50 per cent depending on whether test rating was high or low. Owing to low nitrogen in the soil, nitrogen dose was increased by 50 per cent compared to the recommended dose of fertilizer and due to high potassium content in soil dose was reduced by 50 per cent. Medium phosphorus content in soil led to no change in the RDF. Therefore, dose under T_5 was 150 kg N + 50 kg P_2O_5 + 25 kg K_2O ha^{-1}. T_6: Karnataka State Department of Agriculture soil testing laboratory approach-based modified fertilizer dose (KSDA-STL) +25% less P_2O_5 than RDF +PSB- Fertilizer dose was same as in the treatment 3 except that P_2O_5 dosage was reduced by 25 per cent and phosphate solubilising bacteria (PSB) was added to scavenge the native soil P. nitrogen and potassium were same as in treatment T_3 but phosphorus being medium it was added at the rate of 75 per cent of the recommended dose of fertilizer along with PSB. Hence, fertilizer dose under T_6 was 125 kg N + 37.5 kg P_2O_5 + 37.5 kg K_2O ha^{-1} + PSB.

Research Findings and Discussion

The different levels of fertilizer influenced the height of chilli plant at all growth stages (Table 1). At harvest, among the treatments, fertilizer application as per STCR dose (T_2, STCR) recorded significantly highest plant height of 95.4 cm higher than RDF and STL treatments, This was obviously due to considerably higher level of fertilizer application (477:233.6:321, N: P_2O_5: K_2O kg ha^{-1}, respectively) than rest of the treatments which encouraged carbohydrate synthesis and resulted in the taller plant in the above said treatment. A significant and positive relation between fertilizer doses and plant height was also observed by Medhi *et al.* (1990) and Rafiq *et al.* (2010).

The number of leaves per plant was not influenced by different levels of fertilizer application at 30 DAT. However, data on plant height recorded at 60 DAT (Table 1) revealed significantly higher number of branches per plant in STCR treatment (T_2) over T_1 (RDF) and T_4 (modified RDF_1). It was 24.6 and 15.2 per cent higher than modified RDF_1 (+25% N, -25% P_2O_5 and K_2O) and RDF, respectively. The increase in number of branches was due to the application of higher doses of nutrients especially in T_2 which led to higher photosynthetic activity and vegetative growth. These

Table 2 : Effect of different fertilizer levels on yield parameters

Treatments	Yield parameters	
	Number of fruits/plant	Fruit length(cm)
T_1 - RDF (recommended dose of fertilizer) (150:75:75 ,N, P_2O_5, K_2O, kg ha^{-1})	36.0	8.4
T_2 - STCR dose of NPK (477:233:321,N, $P_20_5.K_20$, kg ha^{-1})	65.0	13.8
T_3- STL dose of NPK (175:75:62.5,N, P_2O_5,K_2O kg ha^{-1})	43.0	10.6
T_4- Soil test based NPK±25% (187.5:75:56.25, N, P_2O_5,K_2O kg ha^{-1})	47.25	9.25
T_5 - Soil test based N and K± 50% and P 25% (225:75:37.5 N, P_2O_5,K_2O kg ha^{-1})	56.5	12.6
T_6 –N and K as per STL +75% of RDP under medium level of P test values +RD of PSB(175:56.25:62.5 N, P_2O_5,K_2O kg ha^{-1})	51.0	11.7
S.E.±	0.6	0.4
C.D. (P=0.05)	1.9	1.4

results are in accordance with the findings of Vadhana (2003).

Different levels of fertilizer application influenced the dry matter accumulation per plant (Table 1). At 60 DAS, the STCR treatment recorded significantly higher dry matter accumulation per plant (84.4) than rest of the treatments. But T_5 was at par T_2 and this was due to higher growth rate of plants under STCR dose which also evidenced higher plant height and number of leaves. Similar results obtained with higher amounts of nutrients applied in these treatments, increased dry matter production through enhanced photosynthetic efficiency in the chilli plant. The role of N, P_2O_5 and K_2O in enhancing photosynthesis was reported by Arun Kumar (2007).

The increased number of fruits per plant in STCR and modified RDF(T_5) treatments were due to positive influence of higher levels of nutrients (477: 233.6: 321 and 225: 75: 37.5 N, P_2O_5 and K_2O kg ha^{-1} in STCR and modified RDF_2 treatments, respectively) as compared to other treatments. Increased number of fruits with increased fertilizer application could be attributed to the increased physiological processes leading to higher growth and increased transport of photosynthates to sinks. This might be due to better utilization of supplied N, P_2O_5 and K_2O by chilli plants (Selvaraju and Iruthayaraj, 1994).

Similar trend was noticed in the fruit length. The fruit length was again significantly higher in STCR and modified RDF_2 treatments as compared to rest of the treatments. This was due to higher rate of fertilizer application which enhanced photosynthetic rate. Less number of fruits was recorded in modified RDF (150:75:75 N, P_2O_5 and K_2O) due to decreased photosynthetic rate and lesser nutrient uptake by crop. Similar trend was observed with number of rows per cob and number of seeds per row as incase of girth and length of cob. Similar results were reported by Arun kumar *et al.* (2007).

At harvest of chilli crop (35.6 mg kg^{-1}) zinc uptake was observed under STCR dose of NPK (T_2). However, which had the same value as that of soil test based N and K ± 50 % and P ± 25 % (T_5) (34.8 mg kg^{-1}). The RDF (T_1) had lowest uptake of zinc (32.6 mg kg^{-1}) and it was at par with soil test based NPK ± 25 % (T_4) (33.5 mg kg^{-1}) and STL dose of NPK ± 25 % (T_3) (32.8 mg kg^{-1}). Uptake of copper by chilli plant was not deferring dose of soil test based fertilizer. At harvest of crop, as high as (72.6mg kg^{-1}) iron uptake was observed under STCR dose of NPK (T_2). However, it was at par with soil test based N and K ± 50 % and P ± 25 % (T_5) (71.9 mg kg^{-1}) the STL dose of NPK (T_3) had (64.2 mg kg^{-1}) uptake of iron which was higher compared to RDF (T_1) (62.2 mg kg^{-1}). Soil test based N and K ± 50 % and P ± 25 % (T_5) (52.9 mg kg^{-1}) and STCR dose of NPK as per STL NPK + 75 %of RDP under medium level of P test values + RD of PSB (T_6) values are depicted in Table 3.

Table 3 : Effect of different fertilizer levels on available Zn, Fe, Mn, and Cu status after harvest

Treatments	Soil available nutrients			
	Soil available Zn (mg kg^{-1})	Soil available Fe (mg kg^{-1})	Soil available Mn (mg kg^{-1})	Soil available Cu (mg kg^{-1})
T_1 - RDF (recommended dose of fertilizer) (150:75:75 ,N, P_2O_5, K_2O, kg ha^{-1})	0.64	1.42	3.63	0.54
T_2 - STCR dose of NPK (477:233.6:1321,N, $P_20_5.K_20$ kg ha^{-1})	0.95	1.62	5.92	0.76
T_3- STL dose of NPK (175:75:62.5,N, P_2O_5,K_2O kg ha^{-1})	0.82	1.42	4.24	0.62
T_4- Soil test based NPK±25% (187.5:75:56.25, N, P_2O_5,K_2O kg ha^{-1})	0.92	1.64	4.74	0.84
T_5 - Soil test based N and K± 50% and P 25% (225:75:37.5 N, P_2O_5,K_2O kg ha^{-1})	0.97	1.54	3.92	0.81
T_6 - N and K as per STL +75% of RDP under medium level of P test values +RD of PSB(175:56.25:62.5 N, P_2O_5,K_2O kg ha^{-1})	1.15	1.97	5.32	0.74
S.E.±	0.012	0.021	0.057	0.008
C.D. (P=0.05)	0.037	0.062	0.172	0.024

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