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Studies on the effect of different organic and inorganic fertilizers on growth, fruit characters, yield and quality of chilli (*Capsicum annuum* L.) cv. K-1

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ABSTRACT

Chilli is one of the commercial high value crops in our country. It is called as the universal spice of India, since it is cultivated in almost all the states and union territories. It is commercially important for the two qualities, the red colour due to the pigment capsanthin and the biting taste due to the chemical constituent capsaicin. Chilli crop requires a balanced fertilizer management without which growth and development of the crop will be impaired leading to substantial reduction not only in yield but also in the market appeal of the produce namely the colour and quality of the dry chilli. Hence, the present study was carried out to find out the effect of different sources of organic manures along with various levels of inorganic fertilizers on growth, fruit traits, yield and quality improvement of chilli cv.K1. From the study, it was found that growth, yield and quality attributes of chilli were significantly influenced by different treatment combinations. Among the treatments, application of 75% RDF along with humic acid @ 30 kg/ha was superior in increasing the growth characters like plant height (79.30 cm), number of branches/plant (23.62) and dry matter production/ plant (85.81 g) and fruit traits such as fresh pod weight (2.35 g), dry pod weight (0.61 g), number of fruits/plant (147.72) and yield traits such as highest per plant (347.14 and 90.49 g), per plot (7.71 and 2.01 kg) and per hac. (12.86 and 3.35 t) yield of fresh and dry fruits, respectively. Besides, the treatment also produced fruits with maximum quality which is measured in terms of ascorbic acid (140.80 mg/100g), oleoresin (14.12%), capsanthin (45.52 ASTA units) and capsaicin (0.79%). From the study it may be concluded that application of 75 per cent recommended dose of fertilizers along with humic acid @ 30 kg/ ha can help to increase the growth, yield and quality of chilli cv. K-1.

Key words : Chilli, Organic and inorganic fertilizers, Growth, Yield, Quality.

INTRODUCTION

Chilli is one of the commercial high value crops in our country. It is called as the universal spice of India, since it is cultivated in almost all the states and union territories. In India, chilli is cultivated in an area of 9.57 lakh hectares with an annual production of 9.46 lakh tonnes. In Tamil Nadu it is grown in an area of 77,000 hectares with an out put of 38,000 tonnes of dry chilli annually (Anon, 1999). Chilli is commercially important for the two qualities, the red colour due to the pigment capsanthin and the biting taste due to the chemical constituent capsaicin. Capsaicin is a digestive stimulant, which prevents heart diseases and is curative for many rheumatic troubles. Besides, chilli is very useful in our daily diet since it is a rich source of vitamins A and C and rutin. Among the various factors affecting the growth and productivity of chilli, the fertility of the soil is the prime consideration for increasing the crop production. Improvement in growth and yield can be brought about by the application of different doses of essential nutrients. Continuous and unscrupulous use of fertilizers, without the incorporation of organic manure cause environmental degradation especially, in the soil thereby affecting its fertility on long term basis. For maintaining optimum productivity of the land and building up of soil fertility, the addition of organic manures to crops has been suggested. Hence, the present investigation was carried out to find out the effect of different sources of organic manures along with various levels of inorganic fertilizers on growth, fruit characters, yield and quality improvement of chilli CV.K-1.

MATERIALS AND METHODS

Field experiments were conducted during July 2004 to January 2005 at the College orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The seeds of the cultivar K1 were sown in raised beds and forty days old seedlings were transplanted at a spacing of 60×45 cm. The experiment was in RBD with three replications. There were totally eleven treatments with different sources and levels of organic and inorganic fertilizers and the details are as follows : T_1-Recommended dose of NPK fertilizers (Control), T_2 - 75% Recommended dose of NPK fertilizers + FYM (25 t ha^{-1}), T_3 - 75% Recommended dose of NPK + Poultry manure (2 t ha^{-1}), T_4 - 75% Recommended dose of NPK + Vermicompost (10 t ha^{-1}), T_5 - 75% Recommended dose of NPK + Composted coir pith (10 t ha^{-1}), T_6 - 75% Recommended dose of NPK + Humic acid (Keradix-G)(30 kg ha^{-1}), T_7 - 50%

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Recommended dose of NPK + FYM (25 t ha^{-1}), T_8 - 50% Recommended dose of NPK + Poultry manure (2 t ha^{-1}), T_9 - 50% Recommended dose of NPK + Vermicompost (10 t ha^{-1}), T_{10} - 50% Recommended dose of NPK + Composted coir pith (10 t ha^{-1}), T_{11} - 50% Recommended dose of NPK + Humic acid (Keradix-G) (30 kg ha^{-1}).

N, P, K requirement of K1 chilli is 90:60:60 kg ha^{-1}, respectively (Iruthayaraj and Kulandaivelu, 1973). The inorganic fertilizers used were urea, muriate of potash and single super phosphate. Humic acid was applied in the form of humic acid granules manufactured by Akshay chemicals, Ratnagiri and marketed by West Coast Rasayan Pvt. Ltd., Mumbai. All the inorganic fertilizers and organic manures were applied before planting except urea which was applied in two split doses. Half the quantity of nitrogen was applied as a basal dose before planting and the rest was top dressed 60 days after planting.

Observations on growth characters (recorded at 180 DAS) like plant height, number of branches/plant, leaf area/plant and dry matter production/plant and fruit traits such as fresh pod weight, dry pod weight, fruit length, fruit girth, number of fruits/plant were recorded and the data were statistically analysed. Besides, observations on per plant, per plot and per hectare yield of fresh and dry fruits and quality traits like ascorbic acid, oleoresin, capsanthin and capsaicin content of the fruits were recorded and statistically analysed.

RESULTS AND DISCUSSION

From data presented in Table 1and 2, it was observed that the growth, fruit, yield and quality traits were significantly influenced by different treatments.

Growth characters:

The treatment T_6 with 75% RDF + Humic acid @ 30 kg/ha exhibited highest plant height (79.30 cm), number of branches/plant (23.62), leaf area/plant (2442.90 cm^2) and dry matter production/plant (85.81 g). The growth stimulation by humic acid might be due to the effect on prolonged cell elongation. In general, cell elongation is ceased by a rapid increase in wall bound hydroxy proline by complexing iron within the plant, which removes the iron from a key biochemical reaction involving hydroxy proline synthesis. This mechanism reported by Vaughan (1974) could be applied for the effect of humic acid on increased plant height. Numbers of branches per plant is a factor related to the yield and dry mater production of chilli. Higher production of auxin and growth and growth substances by humic acid at early phases of growth could have induced the production of lateral branches (Sharma, 1995). The phenolic groups present in humic acid inhibited the IAA oxidase activity (Mato *et al*., 1972) and promoted the prolonged persistence of IAA in plants, which contributed to the increased number of branches per plant. The increase in leaf are due to application of humic acid is consonance with the findings of Bohme *et al*. (2001) who reported 105 % increase in leaf area of cucumber by humic acid application. Enhanced water and nutrient uptake by plants treated with humic acid contributed to the increased leaf area index (Liu Chunhua *et al.*, 1998). Application of organic manures along with fertilizers resulted in increased dry matter production. Ortho dihydric phenols of humic acid are known to inhibit the IAA oxidase (Mato *et al*., 1972) leading to prolonged

Table 1 : Effect of organic and inorganic fertilizers on growth and fruit characters of chilli

Treatment	Plant height (cm)	No. of branches/ plant	Leaf area/plant (cm^2)	Total dry matter/ plant (g)	Fresh pod weight (g)	Dry pod weight (g)	Fruit length (cm)	Fruit girth (cm)	No. of fruits/plant
T_1	74.20	20.93	1661.30	76.15	1.66	0.44	5.71	2.60	130.97
T_2	76.20	22.62	1838.80	80.94	1.87	0.49	6.43	2.93	139.48
T_3	74.80	21.86	1634.10	78.76	1.77	0.46	6.09	2.77	136.01
T_4	78.20	22.90	1978.10	82.14	1.94	0.51	6.69	3.04	141.56
T_5	75.91	22.22	1757.60	79.32	1.83	0.48	6.30	2.86	137.04
T_6	79.30	23.62	2442.90	85.81	2.35	0.61	8.09	3.68	147.72
T_7	71.49	21.00	1476.90	74.12	1.49	0.39	5.03	2.33	128.11
T_8	70.37	20.93	1435.20	72.15	1.45	0.38	4.99	2.27	124.35
T_9	72.79	21.86	1615.60	76.76	1.54	0.40	5.30	2.41	131.98
T_{10}	70.53	21.00	1463.80	73.00	1.48	0.39	5.09	2.32	126.04
T_{11}	74.00	22.62	1759.10	77.36	1.79	0.47	6.16	2.80	133.32
S.E. $\pm$	0.192	0.061	18.841	0.268	0.017	0.005	0.060	0.027	0.459
C.D. (P=0.05)	0.401	0.126	39.301	0.559	0.036	0.010	0.126	0.056	0.957

Table 2 : Effect of organic and inorganic fertilizers on yield and quality of chilli

Treatment	Yield/plant (g)		Yield/plot (kg)		Yield/ha (t)		Ascorbic acid (mg./100g)	Oleoresin (%)	Capsaicin (%)	Capsanthin (ASTA units)
	Fresh	Dry	Fresh	Dry	Fresh	Dry				
T_1	217.41	56.96	4.83	1.27	8.05	2.11	103.87	12.37	0.75	40.18
T_2	260.83	68.04	5.80	1.51	9.66	2.52	127.84	13.78	0.71	42.45
T_3	240.74	62.83	5.35	1.40	8.92	2.33	111.76	13.22	0.73	41.31
T_4	274.63	71.61	6.10	1.59	10.17	2.65	134.79	13.72	0.72	44.24
T_5	250.78	65.71	5.57	1.46	9.29	2.43	128.75	13.40	0.70	43.56
T_6	347.14	90.49	7.71	2.01	12.86	3.35	140.80	14.12	0.79	45.52
T_7	190.88	49.92	4.24	1.11	7.07	1.85	101.45	12.61	0.62	40.97
T_8	180.31	47.16	4.01	1.05	6.68	1.75	100.94	12.16	0.67	40.88
T_9	203.25	53.18	4.52	1.18	7.53	1.97	102.20	12.29	0.63	41.31
T_{10}	186.54	48.70	4.14	1.08	6.91	1.80	106.30	12.43	0.62	41.26
T_{11}	238.64	62.37	5.30	1.39	8.84	2.31	109.35	13.33	0.72	42.38
S.E.±	3.181	0.826	0.071	0.018	0.118	0.031	0.968	0.045	0.004	0.107
C.D. (P=0.05)	6.634	1.723	0.148	0.038	0.246	0.064	2.020	0.094	0.007	0.224

persistence of IAA in the plant, which might have promoted the dry matter production. Similar findings were also reported by David *et al*. (1994) in tomato and Medeiros *et al*. (2001) in lettuce. Another possible reason by which humic acid increases the dry matter production is the increased respiration caused by humic acid as reported by Piccolo *et al*. (1993). Increased respiration leads to liberation of greater amount of energy, which is utilized for cell division and growth. Increased respiration not only leads to rapid utilization of reserve substances but also leads to more rapid synthesis resulting in rapid growth and increase in dry matter production.

Fruit characters:

Application of 75% RDF + humic acid @ 30 kg/ha resulted in maximum fresh pod weight (2.35 g), dry pod weight (0.61 g), fruit length (8.09 cm), fruit girth (3.68 cm) and number of fruits/plant (147.72). Optimum nutrient availability at fruit development stage boosts the size of fruits. As humic acid addition regulated the nutrient availability in a consistent manner, maximum fruit size was recorded in the treatment which received humic acid @ 30 kg ha^{-1} + 75% RDF. Addition of humic acid released nutrients in a slow but steady manner. Humic acid might have caused consistent regulation of nutrient availability during fruit development, when the uptake of nutrients is more important. Balanced nutrition of organic and inorganic nutrients maintains optimum ratio between the nutrients, which is of considerable importance in improving the yield.

Yield:

The treatment consisting of 75% RDF along with humic acid @ 30 kg/ha (T_6) exhibited highest per plant (347.14 and 90.49 g), per plot (7.71 and 2.01 kg) and per hectare (12.86 and 3.35 t) yield of fresh and dry fruits, respectively. This might be the optimum nutrient availability at fruit development stage boosts the size of fruits. As humic acid addition regulated the nutrient availability in a consistent manner, maximum fruit size was recorded in the treatment which received humic acid @ 30 kg ha^{-1} + 75% RDF. Addition of humic acid released nutrients in a slow but steady manner. Humic acid might have caused consistent regulation of nutrient availability during fruit development, when the uptake of nutrients is more important. Balanced nutrition of organic and inorganic nutrients maintains optimum ratio between the nutrients, which is of considerable importance in improving the yield.

Quality characters:

The treatment T_6 (75% RDF + humic acid @ 30 kg/ha) also produced fruits with maximum quality which is measured in terms of ascorbic acid (140.80 mg/100g), oleoresin (14.12%), capsanthin (45.52 ASTA units) and capsaicin(0.79%).

The highest ascorbic acid content of fruits in the treatment T_6 could be due to the synthesis of ascorbic acid is closely associated with carbohydrate metabolism. The primary precursor is glucose, which is activated by UTP and then oxidized to glucovonic acid, the direct precursor of ascorbic acid. Thus, all the processes which promote the synthesis of UTP and glucose favourably influence the synthesis of ascorbic acid. The invertase activity, enhanced by humic acid (Vaughan and Malcolm, 1979) promoted the hydrolysis of sucrose to glucose and this might have accounted for increased ascorbic acid content of fruits. Another possible reason might be the increased IAA activity due to humic acid application which

in turn enhanced the activity of sucrose synthetase (Mengel, 1979). Sucrose synthetase is an enzyme, which converts sucrose into uridine diphosphate glucose, which is a precursor of glucoronic acid and thereby promotes the ascorbic acid biosynthesis. According to Bangerth (1976), a positive correlation exists between calcium and ascorbic acid. The increased calcium content due to humic acid application explains the increased ascorbic acid content. Whereas Pflunger and Mengel (1972) reported that application of humic acid enhanced Ca level which in turn improves the efficiency of conversion of radiation energy to chemical energy and this may also contribute to increased ascorbic acid biosynthesis. Appreciable increase in capsanthin content in chilli fruits was observed due to humic acid and fertilizer application. The result falls in line with the observation of Selvi and Rani Perumal (1997) and Virgine Tenshia (2003) in tomato. Humic acid applied along with inorganic fertilizers elucidated higher capsaicin content. Calcium is involved in the signal transduction of capsaicin pathway. Higher activity of Ca^{2+} ATPase was observed preceding capsaicin synthesis.

Conclusion:

The results of the study on the effect of different combinations of organic and inorganic fertilizers indicated that the treatment differences for the various growth, fruit and quality characters and yield of chilli cv.K1 were significant. Among the different treatments tried, application of 75 per cent recommended dose of fertilizers (RDF) along with humic acid @ 30 kg/ ha was superior and hence, it may be concluded that application of 75 per cent RDF along with humic acid @ 30 kg/ ha can helps to increase the growth, yield and quality of chilli cv.K1.

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