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Quality of chilli (*Capsicum annuum* L.) variety Co-3 as influenced by levels and sources of phosphorus and levels of nitrogen

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Abstract

Nitrogen and phosphorus application increased the ascorbic acid content and capsaicin content in green, ripe and dry chilli. Sources of phosphorus did not have any significant effect on the ascorbic acid content. The maximum ascorbic acid content was recorded in green fruit which decreased gradually with maturity of fruit, recording the lowest value in dry pod, while capsaicin content was lowest in green fruit and maximum in dry pod.

Key words: ascorbic acid, capsaicin, *Capsicum annuum*, chilli, clay loam, rock phosphate, phosphobacteria, quality.

Introduction

Phosphorus is one of the major plant nutrients, the deficiency of which limits plant growth. It plays key function in plant nutrition because of its pivotal role in the normal growth and establishment of root system, seed formation and hastening crop maturity, besides being an essential constituent of nucleic acid. It is estimated that about 98 per cent of Indian soils contain insufficient amount of available phosphorus (Ghosh & Hasan 1979). The production cost of phosphatic fertilizers is high and developing countries like India can not afford to import required quantities of raw materials for the manufacture of phosphatic fertilizers. So naturally available rock phosphate has been put into use as a substitute. Chillies (*Capsicum annuum* L.) occupy an important place among the commercial spice crops of India. Studies on fertilizer response and quality aspect of chilli are scanty. Keeping this in mind, the present investigation was undertaken at the orchard, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.

Materials and methods

Field experiment was conducted using chilli variety CO-3 to study the effect of three levels (0, 20 and 60 kg P_2O_5 ha^{-1}) and three sources (single superphosphate, incubated rock phosphate and rock phosphate with phosphobacteria) of phosphorus along with three levels of nitrogen (0, 60 and 120 kg ha^{-1}) on the quality of chilli in a split plot design with the following 21 treatments replicated thrice.

Main plot treatments

T1 Single superphosphate @ 30 kg P_2O_5 ha^{-1} (SSP P_1)

T2 Single superphosphate @ 60 kg P_2O_5 ha^{-1} (SSP P_2)

T3 Rock phosphate incubated with FYM @ 30 kg P_2O_5 ha^{-1} (IRP P_1)

T4 Rock phosphate incubated with FYM @ 60 kg P_2O_5 ha^{-1} (IRP P_2)

T5 Rock phosphate with phosphobacteria @ 30 kg P_2O_5 ha^{-1} (RP P_1)

T6 Rock phosphate with phosphobacteria @ 60 kg P_2O_5 ha^{-1} (RP P_2)

T7 Control (P_0)

Sub plot treatments (Nitrogen levels)

N_0 Control (N_0)

N_1 60 kg N ha^{-1}

N_2 120 kg N ha^{-1}

The technique for the preparation of enriched FYM was adopted for the preparation of incubated rock phosphate. The required quantity of rock phosphate as per the treatment and FYM were mixed thoroughly and incubated under anaerobic condition for one month before it was applied in the field. The pod samples collected at green fruit stage, harvest stage and dried pods were analyzed for capsaicin and ascorbic acid contents.

Results and discussion

Ascorbic acid

The ascorbic acid content at different stages of the fruit is presented in Table 1. The sources of phosphorus did not have significant effect on ascorbic acid content of green fruit, but application of N had increased the ascorbic acid content significantly, which was maximum in 120 kg ha^{-1}. The maximum ascorbic acid content of 100.4 mg 100 g^{-1} was recorded in the treatment receiving 120 kg N and 60 kg P_2O_5 ha^{-1}. Application of P_2O_5 also significantly increased the ascorbic acid content and the increase being from 75.3 mg 100 g^{-1} in control to 93.1 mg 100 g^{-1} in 30 kg P_2O_5 ha^{-1}. Fertilizing chilli with N had significantly increased the ascorbic acid content of green fruit from 86.6 mg 100 g^{-1} to 93.3 mg 100 g^{-1} at 60 kg N ha^{-1} and further application of N at 120 kg ha^{-1} also increased the ascorbic acid content.

Table 1. Effect of source and level of phosphorus on ascorbic acid content (mg 100 g^{-1}) at various stages of fruit development in chilli

Source and level	Green fruit				Ripe fruit				Dry pod			
of P	N_0	N_1	N_2	Mean	N_0	N_1	N_2	Mean	N_0	N_1	N_2	Mean
T_1 SSP P_1	87.0	92.0	98.7	92.5	72.0	82.0	83.7	79.2	40.2	48.6	50.2	46.3
T_2 SSP P_2	90.4	92.0	100.4	94.2	73.7	82.0	85.3	80.3	43.5	53.6	56.9	51.3
Mean	88.7	92.0	99.5	93.3	72.8	82.0	84.5	79.7	41.8	51.1	53.5	48.8
T_3 IRP P_1	90.4	95.4	98.7	94.8	72.0	83.8	85.4	80.4	41.9	52.0	53.6	49.1
T_4 IRP P_2	87.0	95.4	98.7	93.7	73.7	82.0	85.3	80.3	41.9	52.0	53.6	49.1
Mean	88.7	95.4	98.7	94.2	72.8	82.9	85.3	80.3	41.9	52.0	53.6	49.1
T_5 RPP P_1	87.0	92.1	97.1	92.0	72.0	78.7	82.0	77.5	41.9	53.6	53.6	49.7
T_6 RPP P_2	88.7	93.7	97.1	93.1	75.3	80.3	83.8	79.8	38.5	52.0	53.6	48.7
Mean	87.8	92.9	95.4	87.6	73.6	79.5	82.9	78.6	40.2	52.8	53.6	48.8
T_7 P_0	72.3	92.1	95.4	87.6	63.6	82.0	83.7	76.4	35.2	52.0	53.6	46.9
N levels (Mean)	86.6	93.3	98.0		71.7	81.6	84.2		40.4	52.0	53.6	
P levels (Mean)	75.3	93.1	93.6		63.6	79.0	80.1		35.2	48.3	49.4	

	SEd	CD	SEd	CD	SEd	CD
P	2.13	4.66	2.02	4.42	1.62	3.53
N	1.24	2.55	0.98	2.00	1.21	2.49
S	2.13	NS	2.02	NS	1.62	NS
N at P	4.04	8.28	3.18	6.51	3.94	8.07
P at N	3.44	7.22	2.93	6.19	3.08	6.43

The ascorbic acid content of ripe fruit was significantly higher in P_2 (60 kg ha^{-1}) level than P_0, but it was on par with P_1 (30 kg ha^{-1}). Ascorbic acid content of ripe fruit also increased with increasing levels of N. In each level of P, addition of N increased the ascorbic acid content over control. In each level of N, phosphorus application did not influence the ascorbic acid content of ripe fruit, on the other hand in each level of P, application of nitrogen significantly increased the ascorbic acid content irrespective of its source. Maximum ascorbic acid content of 85.4 mg 100 g^{-1} was recorded in T_3 N_2.

Increasing the level of P_2O_5 from 0 to 30 kg ha^{-1} had significantly enhanced the ascorbic acid content in dry pods from 35.22 to 52.0 mg 100 g^{-1}, but the difference between 30 and 60 kg P_2O_5 ha^{-1} was not significant. Nitrogen application had favourable influence on the ascorbic acid content but the two levels of nitrogen, N_1 and N_2 were on par. Sources of phosphorus did not have any significant effect on the ascorbic acid content. Comparatively it was low in dry pod than in ripe fruit in which the ascorbic acid content was medium and green fruit had the highest ascorbic acid content. This quality parameter increased with increasing level of nitrogen, recording maximum value at 120 kg N ha^{-1}. This result is in close agreement with those of Roges & Morejon (1989) who also reported increase in levels of ascorbic acid content with increasing levels of N. The difference in the ascorbic acid content between 30 and 60 kg P_2O_5 ha^{-1} was not appreciable, but was higher than in control. The result observed in this study confirmed the earlier work of Mini Raj & Shanmugavelu (1987) who had reported the beneficial effect of P with N and K in increasing the ascorbic acid content of chilli. Similar trend was also observed in green, ripe and dry chilli. The increase in the ascorbic acid content by application of nitrogen and phosphorus might be due to enhanced photosynthetic and metabolic activity, which resulted in the synthesis of glucose. Glucose thus produced might have contributed to the synthesis of ascorbic acid. Similar view on the utilization of glucose for synthesis of ascorbic acid in cassava was also reported by Ogunadana *et al.* (1987). The ascorbic acid content was maximum in the green fruit and decreased gradually as the development of fruit advanced. This might be due to oxidation of ascorbic acid with the advancement in maturity of chilli fruit. This view was in line with that of Lehninger (1982) who also observed decreased ascorbic acid content with fruit maturity.

Capsaicin

The capsaicin content of the chilli variety at different stages was estimated and the results are presented in Table 2. A significant difference in the capsaicin content of green fruit was observed due to phosphorus application over control, but the variation between P_1 and P_2 levels of phosphorus was not significant. Capsaicin content increased with the increase in N level over control. There was no significant difference in the capsaicin content of green fruit between sources of phosphorus. Keeping N level constant, with varying doses of P in all the three sources, significant increase in capsaicin content was observed due to phosphorus application. In each level of phosphorus, increasing the level of N resulted in significant increase in capsaicin content, the maximum (3.16 mg g^{-1}) recorded in T_2 P_2 and T_3 P_1 at 120 kg N level.

Application of phosphorus increased the capsaicin content in ripe fruits significantly over control but further increase of P from 30 kg to 60 kg ha^{-1} did not increase it significantly. Capsaicin content also increased significantly with increasing level of N. Among the sources of P, single super phosphate recorded the highest capsaicin content followed by IRP P_2 (3.50 mg g^{-1}) and RPP P_1 (3.48 mg g^{-1}). Comparisons of N at P levels and P at N levels were not significant.

The results indicated that application of phosphorus increased the capsaicin content in dry pods significantly over control, but the levels P_1 and P_2 were on par. In each level of P, increasing dose of N had resulted in a signifi-

Table 2. Effect of source and level of phosphorus on capsaicin content (mg g^{-1}) at different stages of fruit development in chilli

Source and level of P	Green fruit				Ripe fruit				Dry pod			
	N_0	N_1	N_2	Mean	N_0	N_1	N_2	Mean	N_0	N_1	N_2	Mean
T_1 SSP P_1	3.11	3.13	3.15	3.13	3.48	3.53	3.59	3.53	30.96	40.03	40.20	40.07
T_2 SSP P_2	3.11	3.14	3.16	3.13	3.47	3.55	3.56	3.53	30.96	40.05	40.22	40.07
Mean	3.11	3.13	3.15	3.13	3.47	3.54	3.57	3.53	30.96	40.04	40.21	40.07
T_3 IRP P_1	3.10	3.14	3.16	3.13	3.46	3.55	3.55	3.52	30.96	40.01	40.20	40.05
T_4 IRP P_2	3.12	3.14	3.15	3.13	3.44	3.48	3.55	3.50	30.97	40.05	40.20	40.07
Mean	3.11	3.14	3.15	3.13	3.45	3.47	3.55	3.50	30.96	40.03	40.20	40.0
T_5 RPP P_1	3.11	3.14	3.15	3.13	3.45	3.49	3.51	3.48	30.91	40.02	40.15	40.02
T_6 RPP P_2	3.11	3.13	3.15	3.12	3.45	3.50	3.53	3.49	30.92	40.05	40.15	40.04
Mean	3.11	3.13	3.15	3.13	3.45	3.49	3.52	3.48	30.91	40.03	40.15	40.03
T_7 P_0	3.03	3.11	3.14	3.09	3.41	3.49	3.51	3.47	30.90	40.00	40.03	40.03
N levels (Mean)	3.09	3.13	3.13		3.45	3.51	3.54		30.94	40.03	40.16	
P levels (Mean)	3.03	3.13	3.13		3.41	3.51	3.50		30.90	40.04	40.06	

	SEd	CD	SEd	CD	SEd	CD
P	0.008	0.17	0.024	0.052	0.021	0.046
N	0.006	0.012	0.012	0.024	0.013	0.027
S	0.001	NS	0.024	NS	0.021	NS
N at P	0.019	0.039	0.039	NS	0.043	NS
P at N	0.015	0.031	0.035	NS	0.036	0.081

cant increase of capsaicin in dry pod. In the green fruit, the capsaicin content was lowest and increased steadily as the fruit ripened and it was maximum at dry pod stage. This study corroborates with that of Ahmed *et al.* (1989), who also established increase of capsaicin content with increasing levels of N. The beneficial effect of N for increasing the capsaicin molecule and the N thus absorbed might have been utilized for synthesis of capsaicin (Dandeagaonker & Simpson 1955). The capsaicin content of green, ripe fruit and dry pod did not vary among the different sources of P.

Ascorbic acid content increased as the level of N and P increased and decreased gradually as the maturity of the fruit advanced, recording the lowest value in the dry pod. The capsaicin content of green, ripe fruit and dry pod did not vary among the sources of P. The capsaicin content also increased steadily from green fruit stage to dry pod stage. The ascorbic acid and capsaicin contents of the fruit in all the stages did not vary significantly among the P sources. Therefore, rock phosphate with phosphobacteria and incubated rock phosphate can be used to produce chillies with better quality.

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