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INFLUENCE OF VARIOUS NITROGEN AND POTASSIUM FERTIGATION LEVELS ON THE QUALITY PARAMETERS OF CAPSICUM (*CAPSICUM ANNUUM* VAR. *GROSSUM* L.) UNDER POLYHOUSE

B. Gouthami*, M. Uma Devi, K. Avil Kumar and V. Ramulu

Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana, India.

*Corresponding author E-mail : basaraveni.gouthami123@gmail.com

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ABSTRACT

Quality parameters such as temperature, humidity, light intensity, and soil temperature are crucial for cultivating capsicum under poly house conditions. Proper management of these factors ensures optimal plant growth, high yield, and superior fruit quality. Effective pest and disease control, along with precise irrigation, further enhance the overall health and productivity of the crop. Regular monitoring and adjustments are essential to maximize the benefits of the controlled environment in a poly house. Keeping in a view a field experiment conducted at the Water Technology Centre, College of Agriculture, Rajendranagar, Hyderabad during 2018-19 period to examine the influence of varying nitrogen (N) and potassium (K) fertigation levels on capsicum (*Capsicum annuum* var. *grossum* L.) in a poly house setting. The study utilized a Factorial Randomized Block Design (FRBD) with three replications, resulting in twelve treatments. Nitrogen levels were tested at four levels (0%, 90%, 135% and 180% of the recommended dosage), while potassium levels were tested at three levels (0%, 50% and 100% of the recommended dosage). The recommended dosage, representing 100% of the Recommended Dose of Fertilizers (RDF), consisted of 180 kg N, 90 kg P_2O_5 and 120 kg K_2O per hectare. Irrigation was managed at 0.8 times the reference evapotranspiration (Epan), with a total water application of 414.8 mm for the crop. The study assessed various fruit quality parameters including Total Soluble Solids (TSS), ascorbic acid content, fruit capsaicin percentage, capsanthin content, fruit oleoresin percentage, and pericarp thickness across multiple picking intervals. Based on the findings, it can be inferred that the application of 180% of the recommended dose of nitrogen (324 kg N ha^{-1}), followed by 150% RDN (270 kg N ha^{-1}) and the application of 100% recommended dose of potassium (120 kg K_2O ha^{-1}) recorded the highest values in fruit quality parameters.

Key words : Capsicum, Poly house, Fertigation, Quality parameters.

Introduction

In both global and Indian contexts, vegetables play a vital role in environmental sustainability, economic development and human nutrition. They contribute to dietary diversity, essential nutrient intake, and global food security, particularly significant for millions of smallholder farmers who rely on them for livelihoods. Additionally, vegetables mitigate the environmental impacts associated with animal agriculture and provide an efficient food source, aligning with the growing emphasis on sustainability. In India, where millions of smallholder farmers cultivate vegetables, they are essential to diets, cultural customs and economic development. India's production of vegetables reached 10 million metric tons in 2022–2023, solidifying its place among the world's top producers of vegetables. Despite obstacles including post-harvest losses and climatic variability, Capsicum (*Capsicum annuum* var. *grossum* L.) also referred to as sweet or bell pepper is a highly priced vegetable crop both in the domestic and international market. It is a cool season crop occupying an area of 32,000 ha, producing 493 thousand metric tonnes of fruit yield in India. In

Telangana it occupies an area of 150.2 ha, with 2873 metric tonnes production (Telangana State Horticulture Mission, 2018-19). The plant are grown under controlled or partially controlled environment resulting in higher yields than that is possible under open conditions (Navale *et al*., 2003).

Basically, capsicum is a cool season tropical crop and lacks adaptability to varied environmental conditions (Yoon *et al*., 1989). Despite its economic importance, growers are not in a position to produce good quality capsicum with high productivity due to various biotic (pest and diseases), abiotic (rainfall, temperature, relative humidity and light intensity) and crop factors (flower and fruit drop). Due to erratic behaviour of weather, the crop grown in open field are often exposed to fluctuating levels of temperature, humidity, wind flow etc., which ultimately affect the crop productivity adversely (Ochigbo and Harris, 1989). Besides this, limited availability of land for cultivation hampers the vegetable production. Hence, to obtain a good quality produce and production during off season, there is a need to cultivate capsicum under protected condition such as green houses or poly houses. In protected cultivation the crops are protected from excessive sunlight by providing uniform shade that result in better yield. These structures will also act as a barrier against heavy rains, hail-storms and other natural calamities, provides protection against insects, birds and helps in reducing the loss of water through evaporation. The use of poly houses for commercial vegetable production and maximum net returns has been most common in Western countries (Chandra, 1985).

In Telangana since 2014-15 protected cultivation under poly houses by farmers has started. Presently the area under poly houses in Telangana is around 489.26 ha (Department of Horticulture, Telangana). 100 gm of edible portion of capsicum provides 24 Kcal of energy, 1.3 g of protein, 4.3 g of carbohydrate and 0.3 g of fat (Anonymous, 2006). Ascorbic acid content was estimated in fresh green capsicum fruits using 2, 6-dichlorophenol indophenol visual titration method and expressed as mg 100 g^{-1} of samples (Ranganna, 1986). Percentage of oleoresin was estimated as per the procedure outlined by Roserbrook *et al*. (1968), Woodbury *et al*. (1977). Capsicum attained a status of high value crop in India in recent years and occupies a place of pride among vegetables in Indian cuisine, because of its delicacy and pleasant flavour coupled with rich content of ascorbic acid along with other vitamins and quality traits (TSS, capsaicin, capsanthin etc). It is used as vegetable as well as condiment. The plant are grown under controlled or partially controlled environment resulting in higher yields than that is possible under open conditions (Navale *et al*., 2003). Fluctuating levels of temperature, humidity, wind flow etc. which ultimately affect the crop productivity adversely (Ochigbo and Harris, 1989). Kiruthiga *et al*. (2019) in capsicum reported that weekly mean evaporation reduction inside the shade net (50% shade, green coloured and tape type), which ranged from 21.6 to 45.7 per cent. Similarly, the monthly mean reduction in evaporation ranged from 22.9 to 38.4 per cent. Basically, capsicum is a cool season tropical crop and lacks adaptability to varied environmental conditions (Yoon *et al*., 1989).

Materials and Methods

A field experiment was conducted at Horticultural Farm, College of Agriculture, Rajendranagar, Hyderabad during 2019-20. The study was initiated on Response of capsicum (*Capsicum annuum* var. *grossum* L.) to different nitrogen and potassium fertigation levels under poly house. The soil of the experimental site was sandy loam in texture with a pH of 7.6, electrical conductivity of 0.75 dS m^{-1}, medium in organic carbon (0.7%), low in available nitrogen (166.5 kg ha^{-1}), medium in available phosphorus (81.1 kg P_2O_5 ha^{-1}) and low in available potassium (245.4 kg K_2O ha^{-1}).

Field experiment details

Capsicum (pasarella) seeds were sown in pro trays on 5th August 2019 and 35 days old seedlings were transplanted on 10th September 2019 in a zig zag manner in a paired row pattern on raised beds. The experiment comprised of three replications in Factorial Randomized Block Design (FRBD) with two factors {*i.e.* N levels (4), K levels (3) } with twelve treatments *viz*; T_1 - Control (No N, K_2O), T_2 - N_0 (No fertilizer) + 80% RD of K_2O, T_3 - N_0 (No fertilizer) + 100% RD of K_2O, T_4 -120% RD of N + K_0 (No fertilizer), T_5 – 120% RD of N + 80% RD of K_2O, T_6 – 120% RD of N + 100% RD of K_2O, T_7 – 150% RD of N + K_0 (No fertilizer), T_8 -150% RD of N + 80% RD of K_2O, T_9 – 150% RD of N + 100% RD of K_2O, T_{10} – 180% RD of N + K_0 (No fertilizer), T_{11} – 180% RD of N + 80% RD of K_2O, T_{12}- 180% RD of N + 100% RD of K_2O {The 100% (RDF) was 180, 90 and 120 kg N, P_2O_5 and K_2O ha^{-1}}. The source of N is urea, P was single super phosphate (SSP) and K was white muriate of potash (MOP). A common dose of phosphorous was applied uniformly to all the treatments at basal.

The nitrogen and potassium were applied through fertigation by ventury which was carried out at three day interval *i.e.*, on every fourth day. In the fertigation programme during crop establishment stage (10 DAT to

Fig. 1 : Experimental area (poly house).

Fig. 2 : Capsicum seedlings grown in protrays.

14 DAT), 10% of N and K_2O were applied in two splits. During vegetative stage (15 to 46 DAT) 30% of N and 20% of K_2O were applied in eight splits. During flower initiation to fruit development (47 DAT to 74 DAT) 20% of N and K_2O were applied in seven splits. From fruit development and colour formation stage onwards till final stage (75 DAT – 154 DAT) 40% of N and 50% K_2O were applied in 20 splits. Then the fertigation schedule was completed in a total of 37 splits. Irrigation was scheduled based on 0.8 E pan and the total water applied through drip at 0.8 E pan (common to all the treatments) was 384.8 mm, water applied for nursery including special operations (bed preparation, wetting before transplanting) was 30.4 mm. The total water applied was 414.8 mm. Quality parameters such as TSS, capsanthin, capsaicin content (%) and ascorbic acid content were estimated at first, third, fifth and mean of all pickings were estimated immediately after harvesting.

Results and Discussion

Fruit TSS (^{0} brix) at first, third, fifth picking and mean of all picking

The TSS content of the fruit is usually obtained from assessing the degrees Brix of the fruit. The TSS or sugar content measures and includes the carbohydrates, organic acids, proteins, fats and minerals of the fruit. A Brix value, expressed as degrees Brix (°Bx), is the number of grams of sucrose present per 100 grams of liquid. The TSS varied from 4.84 to 7.82 ^{0} brix at first picking, 6.21 to 8.55 ^{0} brix at third picking, 5.02 to 8.25^0 brix at fifth picking and 5.36 to 8.20 ^{0}brix for mean of all pickings, respectively. Interaction was found to be non significant at all pickings. At first picking, it was observed that, among different

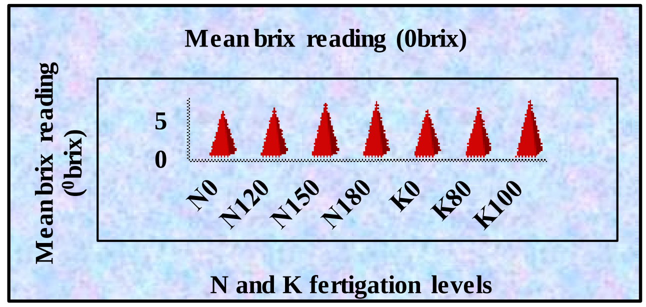

Fig. 3 : Effect of N and K fertigation levels on mean brix reading (^{0}brix) in capsicum under poly.

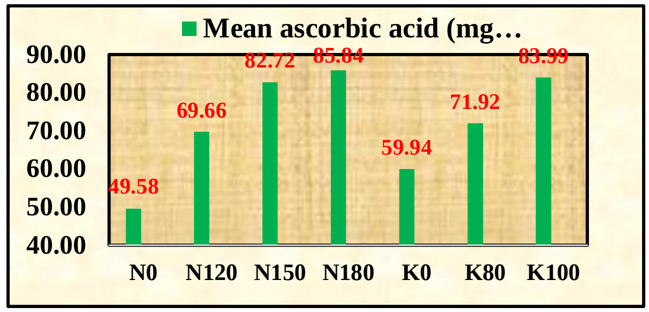

Fig. 4 : Effect of N and K fertigation levels on mean ascorbic acid content (mg 100 g^{-1}) in capsicum under poly house.

doses of nitrogen, maximum TSS was noticed in N_{180} (6.62 ^{0}brix) and it was significantly superior to other levels except N_{150} (6.58 ^{0}brix). However N_{150} recorded higher TSS than N_{120} and $N_{0.}$ The lowest was recorded with N_0 (5.34 ^{0}brix). The N_{180}, N_{150}, N_{120} recorded 24, 23.1 and 11.9% increase in TSS over N_0. A significant difference was observed between potassium levels. Significantly the highest TSS value was found in K_{100} (6.82 ^{0}brix) which was superior over K_{80} and K_0 (5.52 ^{0}brix). There were 23.5, 9.5% increase in TSS observed with K_{100} and K_{80} over K_0.

At third picking, among varied doses of nitrogen, significantly the highest TSS value was noticed in N_{180} (7.53 ^{0}brix) which was significantly superior over N_{120} and N_0 and was on par with N_{150} (7.30 ^{0}brix). However N_{120} and N_0 were on par with each other, the lowest was observed with N_0 (6.41 ^{0}brix). Among potassium fertigation significantly the highest TSS was recorded with K_{100} (7.51 ^{0}brix), while the lowest was observed with K_0 (6.54 ^{0}brix). By the application of different doses of nitrogen, at fifth picking the maximum TSS was observed in N_{180} (6.89 ^{0}brix) which was significantly higher than rest of all except N_{150} (6.48 ^{0}brix), it was followed by N_{120} and N_0 and the lowest was recorded in N_0 (5.13 ^{0} brix). With regard to the application of different doses of potassium, TSS was significantly higher in K_{100} (6.83 ^{0}brix) as compared to K_{80} (5.81 ^{0}brix) and K_0 (5.46 ^{0}brix). Interaction was found to be non significant.

With regard to mean fruit TSS, as concerned with nitrogen doses, the maximum mean fruit TSS was noticed with N_{180} (6.90 ^{0}brix), which was on par with N_{150} (6.78 ^{0}brix), but significantly superior over N_{120} and N_0. However, N_{150}, N_{120} and N_0 were on par with each other, respectively. The lowest mean fruit TSS was recorded with N_0 (5.63 ^{0}brix), which recorded 22.6% decrease in mean fruit TSS over N_{180}. With regard to different potassium doses significantly the highest mean fruit TSS was recorded with K_{100} (7.05 ^{0}brix) compared to K_{80} and K_0. The lowest was recorded with K_0 (5.84 ^{0}brix), which recorded 20.7% decrease over K_{100}.

Ascorbic acid content (mg 100 g^{-1}) at first, third, fifth picking and mean of all pickings

The ascorbic acid content values ranged from 40.39 to 89.64 mg 100 g^{-1}, 48.64 to 113.92 mg 100 g^{-1} and 44.66 to 104.40 mg 100 g^{-1} 44.56 to 102.65 mg 100 g^{-1} at first, third, fifth and for mean of all pickings, respectively. A significant difference was observed between potassium levels at every picking. Interaction was found to be non significant. At first picking with the different doses of nitrogen, significantly the highest amount of ascorbic acid was noticed in N_{180} (71.56 mg 100 g^{-1}), which was statistically on par with N_{150} (70.09 mg 100 g^{-1}) and it was followed by N_{120} (62.53 mg 100 g^{-1}). The N_{180}, N_{150}, and N_{120} recorded significantly higher ascorbic acid content over N_0 (42.42 mg 100 g^{-1}). There were 68.7, 65.2 and 47.4% increase in ascorbic acid content was observed in N_{180}, N_{150} and N_{120} over N_0. By the application of different potassium doses the maximum ascorbic acid content was recorded in K_{100} (72.49 mg 100 g^{-1}) and the lowest value was observed with K_0 (50.77 mg 100 g^{-1}). The K_{100} and K_{80} recorded 42.8 and 21.5% increase over K_0. At third picking, with regard to different nitrogen levels, the highest ascorbic acid content was noticed in N_{180} (96.64 mg 100 g^{-1}) which was significantly superior over N_{120}, N_0 and on par with N_{150} (90.88 mg 100 g^{-1}). The lowest ascorbic acid content was observed with N_0 (55.47 mg 100 g^{-1}). Among potassium fertigation levels significantly the highest ascorbic acid content was recorded with K_{100} (92.48 mg 100 g^{-1}) when compared to other levels. While, the lowest was observed with K_0 (65.12 mg 100 g^{-1}).

At fifth picking, with respect to nitrogen fertigation, maximum ascorbic acid content was noticed in N_{180} (89.32 mg 100 g^{-1}) and significantly superior than other levels except N_{150} (87.19 mg 100 g^{-1}). The lowest was recorded in N_0 (50.85 mg 100 g^{-1}). There was a significant difference between potassium levels, the highest value was found in K_{100} (87.00 mg 100 g^{-1}), which was

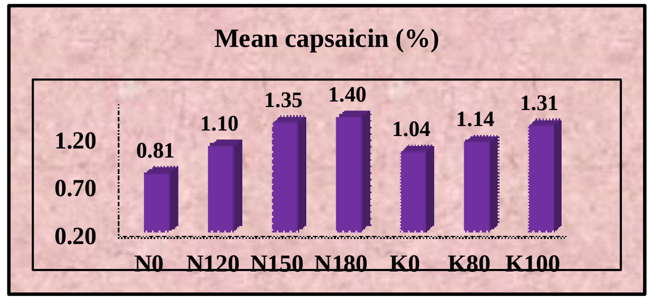

Fig. 5 : Effect of N and K fertigation levels on mean capsaicin (%) in capsicum under poly house.

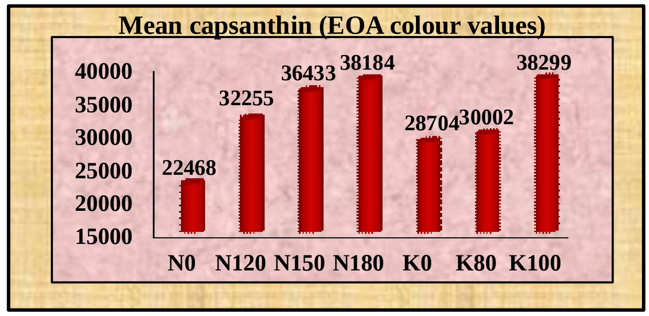

Fig. 6 : Effect of N and K fertigation levels on mean capsanthin (EOA colour values) in capsicum under poly house.

significantly superior to K_{80} (74.53) and K_0 (63.95 mg 100 g^{-1}).

Among the different nitrogen doses, the highest overall mean ascorbic acid content was noticed in N_{180} (85.84 mg 100 g^{-1}), which was statistically on par with N_{150} (82.72 mg 100 g^{-1}), but significantly superior over N_{120} (69.66 mg 100 g^{-1}) and N_0 (49.58 mg 100 g^{-1}). The lowest was recorded with $N_{0.}$ There were 73.1, 66.8 and 40.5% increase in mean ascorbic acid content was observed with N_{180}, N_{150} and N_{120} over N_0. By the application of different potassium doses, significantly the highest mean ascorbic acid content was recorded with K_{100} (83.99 mg 100 g^{-1}) and the lowest was recorded with K_0 (59.94 mg 100 g^{-1}). The K_{100} and K_{80} recorded 40.1, 20.0% increase in mean ascorbic acid content over K_0.

Fruit capsaicin (%) at first, third, fifth picking and mean of all picking

The fruit capsaicin (%) varied from 0.40 to 1.56, 0.71 to 1.63 and 0.62 to 1.47, 0.57 to 1.55 at first, third, fifth and mean of all pickings, respectively. With regard to different nitrogen levels, N_{180} (1.49) recorded significantly higher capsaicin content compared to N_{120} and N_0 and was statistically on par with N_{150} (1.45). The lowest capsaicin content was recorded with N_0 (0.69), which recorded 115.6% decrease over N_{180}. Among the potassium fertigation, significantly higher capsaicin content was observed with K_{100} (1.33) compared to K_{80} and K_0. However, K_{80} and K_0 were on par with each other, while

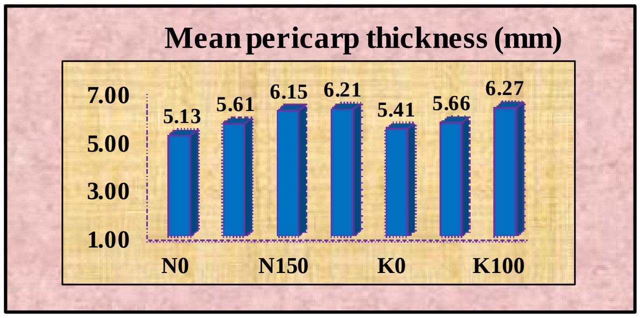

Fig. 7 : Effect of N and K fertigation levels on mean pericarp thickness (mm) in capsicum under poly house.

the lowest was observed with K_0 (1.10), which recorded 20.7% decrease over K_{100}. The interaction effect was found to be non significant. The highest capsaicin content of (1.38) was recorded by N_{180}, followed by N_{150} (1.31) they were significantly superior over N_{120} and N_0, whereas the lowest was recorded with N_0 (0.88) at third picking among different doses of nitrogen. With regard to varying doses of potassium, K_{100} (1.29) recorded significantly the highest capsaicin content over K_{80} and K_0. However, K_{80} and K_0 were on par with each other. The lowest was recorded with K_0 (1.03). Interaction was found to be non significant. Among different nitrogen levels applied at fifth picking, the highest capsaicin content was recorded with N_{180} (1.35), which was significantly superior over rest except N_{150} (1.29) and the lowest was recorded with N_0 (0.87). Potassium fertigation of K_{100} (1.32) recorded significantly higher capsaicin content while the lowest was recorded with K_0 (0.99), which was on par with K_{80} (1.13).

Over all mean capsaicin content varied significantly among different potassium fertigation levels. With regard to nitrogen doses N_{180} (1.40) recorded significantly higher mean fruit capsaicin content followed by N_{150} (1.35) and they were significantly superior over N_{120} (1.10) and N_0 (0.81). Among varied doses of potassium K_{100} (1.31) recorded higher mean fruit capsaicin content and the lowest was recorded with K_0 (1.04). A 73.3, 66.2, 35.6% increase in mean capsaicin (%) was observed in N_{180}, N_{150} and N_{120} over N_0. While 26.3, 9.9% increase was observed in K_{100} and K_{80} respectively over K_0.

Fruit capsanthin (EOA Colour values) at first, third, fifth picking and mean of all pickings

Fruit capsanthin values varied from 18,727 to 46,197, 20,313 to 51,830, 18,503 to 45,221 and 19,181 to 47,749 at first, third, fifth and mean of all pickings, respectively. At first picking, the highest capsanthin content was observed with N_{180} (35,373), which was significantly superior over all other levels except N_{150} (34,153) it was followed by N_{120} (30,337) and the lowest was recorded with N_0 (20,808). N_{180}, N_{150} and N_{120} recorded 70, 64.1 and 45.8% increase in capsanthin value over $N_{0.}$ By the application of different potassium doses significantly the highest capsanthin was noticed with K_{100} (36,381) compare to K_0 (26,535) and was on par with K_{80} (27,587). K_{100}, K_{80} recorded 37.1, 4.0% increase in capsanthin over $K_{0.}$ The interaction of fertigation levels on the capsanthin values was found to be non significant. Nitrogen fertigation with N_{180} (43,202) recorded significantly the highest capsanthin at third picking and it was statistically on par with N_{150} (40,809). The N_{120} and N_0 recorded significantly lower capsanthin value than N_{180}. Among the potassium doses, significantly the highest capsanthin value was recorded with K_{100} (42,426) compared to K_{80} and K_0. The lowest was recorded with N_0 (32,330). The interaction of fertigation levels on capsanthin was found to be non significant. At fifth picking, there was a significant difference observed for the capsanthin among potassium fertigation levels and it was no significant for interactions. Significantly the highest capsanthin was recorded with N_{180} (35,976) and it was on par with N_{150} (34,336) and was followed by N_{120} (31,198) while the lowest was recorded with N_0 (21601). With respect to potassium fertigation, significantly the highest capsanthin was recorded with K_{100} (36,092) and the lowest value was recorded K_0 (27,247).

The overall mean fruit capsanthin values ranged from 19,181 to 47,749. As concerned with nitrogen fertigation levels, N_{180} (38,184) recorded significantly the highest capsanthin and it was significantly superior over N_{120}, N_0 and was on par with N_{150} (36,433), followed by N_{120} (32,255) and the lowest was recorded with N_0 (22,468). There were 69.9, 62.2 and 43.6% increase in mean capsaicin (%) was observed in $N_{180,}$ N_{150} and N_{120} over $N_{0.}$ Potassium fertigation of K_{100} (38,299) recorded significantly the highest value compared to K_{80} (30,002) and K_0 (28,704). However they were on par with each other. There was 33.4, 4.5% increase in K_{100} and K_{80} respectively over K_0.

Oleoresin (%) at first, third, fifth picking and mean of all pickings

The fruit oleoresin (%) varied from 7.33 to 9.80% at first picking, 7.17 to 10.00% at third picking, 7.17 to 9.63% at fifth picking and 7.34 to 9.81% for mean of all pickings, respectively. At first picking, there was significant difference observed for oleoresin (%) among the nitrogen and potassium fertigation levels. The N_{180} (8.81) recorded significantly the highest fruit oleoresin (%) which was on par with N_{150} (8.54). It was followed by N_{120} (7.83) and N_0 (7.46). And the lowest was observed with N_0 (7.46).

Table 1 : Effect of N and K fertigation levels on Mean Fruit TSS (^{0}brix) and ascorbic acid content (mg 100 g^{-1}) of capsicum under poly house during *rabi* 2019-20.

Mean fruit TSS (^{0}brix)					**Mean fruit ascorbic acid content (mg 100 g^{-1})**				
	K_0	**K_{80}**	**K_{100}**	**Mean**		**K_0**	**K_{80}**	**K_{100}**	**Mean**
N_0	5.36	5.70	5.82	**5.63**	**N_0**	44.56	50.72	53.45	**49.58**
N_{120}	5.83	6.03	6.30	**6.05**	**N_{120}**	59.06	70.94	78.97	**69.66**
N_{150}	6.00	6.47	7.88	**6.78**	**N_{150}**	67.37	79.92	100.88	**82.72**
N_{180}	6.16	6.34	8.20	**6.90**	**N_{180}**	68.78	86.09	102.65	**85.84**
Mean	**5.84**	**6.14**	**7.05**		**Mean**	**59.94**	**71.92**	**83.99**	
	S.E.m ±	**C.D (P=0.05)**				**S.E.m±**	**C.D (P=0.05)**		
N	0.29	0.84			**N**	2.35	6.86		
K	0.25	0.73			**K**	2.03	5.94		
(N*K)	0.50	NS			**(N*K)**	4.06	NS		

Table 2 : Effect of N and K fertigation levels on Mean Fruit capsaicin (%) and capsanthin (EOA colour values) of capsicum under poly house during *rabi* 2019-20.

Mean fruit capsaicin (%)					**Mean fruit capsanthin**				
	K_0	**K_{80}**	**K_{100}**	**Mean**		**K_0**	**K_{80}**	**K_{100}**	**Mean**
N_0	0.57	0.78	1.09	**0.81**	**N_0**	19,181	22,550	25,674	**22,468**
N_{120}	1.04	1.10	1.15	**1.10**	**N_{120}**	29,998	31,801	34,967	**32,255**
N_{150}	1.27	1.30	1.47	**1.35**	**N_{150}**	32,615	31,876	44,808	**36,433**
N_{180}	1.27	1.39	1.55	**1.40**	**N_{180}**	33,021	33,780	47,749	**38,184**
Mean	**1.04**	**1.14**	**1.31**		**Mean**	**28,704**	**30,002**	**38,299**	
	S.E.m ±	**C.D (P=0.05)**				**S.E.m ±**	**C.D (P=0.05)**		
N	0.03	0.10			**N**	1664	4869		
K	0.03	0.09			**K**	1441	4216		
(N*K)	0.06	NS			**(N*K)**	2883	NS		

There was 18.1, 14.5 and 5.0% increase in oleoresin (%) was observed in N_{180}, N_{150} and N_{120} over N_0. With respect to different potassium doses, K_{100} (8.70) recorded significantly the highest value and the lowest fruit oleoresin (%) was observed with K_0 (7.79). K_{100} and K_{80} recorded 11.7, 2.6% increase over K_0. The K_{80} and K_0 were on par with each other. Interactions effect was found to be non significant. At third picking, significant difference was observed for the oleoresin (%) among the N and K fertigation level, but interaction was found to be non significant. Among nitrogen levels significantly the highest value was observed with N_{180} (8.74) and on par with N_{150} (8.44), which was followed by N_{120} and N_0 while the lowest oleoresin (%) was recorded with N_0 (7.42). Among varied potassium doses K_{100} (8.81) recorded significantly the highest value and the lowest fruit oleoresin (%) was observed with K_0 (7.57).

At fifth picking with respect to various nitrogen fertigation levels, N_{180} (9.02) recorded significantly the highest fruit oleoresin (%) among all the levels except N_{150}, which was statistically on par with N_{150} (8.64) it was followed by N_{120} and N_0. The lowest was observed with N_0 (7.97). As concerned with potassium fertigation K_{100} (9.04) recorded significantly the highest value and was found to be superior over other treatments. However K_{80} (8.37) was on par with K_0 (7.89). With regard to mean fruit oleoresin (%), nitrogen fertigation of N_{180} (8.86) recorded the highest value, which was significantly superior over other levels and was found to be on par with N_{150} (8.54), followed by N_{120} and N_0. The N_0 (7.61) recorded the lowest value. However 16.4, 12.3 and 3.8% increase in mean oleoresin (%) was observed in N_{180},

Table 3 : Effect of N and K fertigation levels on pericarp thickness (mm) and oleoresin (%)f capsicum under poly house during *rabi* 2019-20.

Overall Mean pericarp thickness (mm)					**Mean fruit Oleoresin (%)**				
	K_0	K_{80}	K_{100}	**Mean**		K_0	K_{80}	K_{100}	**Mean**
N_0	4.85	5.11	5.43	**5.13**	N_0	7.34	7.67	7.83	**7.61**
N_{120}	5.20	5.67	5.98	**5.61**	N_{120}	7.49	7.89	8.32	**7.90**
N_{150}	5.82	5.98	6.66	**6.15**	N_{150}	8.07	8.13	9.43	**8.54**
N_{180}	5.75	5.88	7.01	**6.21**	N_{180}	8.10	8.67	9.81	**8.86**
Mean	**5.41**	**5.66**	**6.27**		**Mean**	**7.75**	**8.09**	**8.85**	
	S.Em. ±	**C.D (P=0.05)**				**S.Em.±**	**C.D (P=0.05)**		
N	0.23	0.68			**N**	0.24	0.69		
K	0.20	0.59			**K**	0.21	0.60		
(N*K)	0.40	NS			**(N*K)**	0.41	NS		

N_{150} and N120 over N_0. Among different doses of potassium, K_{100} (8.85) recorded significantly the highest mean fruit oleoresin (%) compared to other levels however K_{80} and K_0 are on par with each other. K_0 (7.75) recorded the lowest mean fruit oleoresin (%). While 14.2, 4.4% increase was observed in K_{100} and K_{80}, respectively over K_0.

Pericarp thickness (mm) at first, third, fifth picking and mean of all pickings

The pericarp thickness (mm) varied from 5.34 mm to 7.39 mm at first picking, 4.97 mm to 6.32 mm at third picking and 4.25 mm to 7.32 mm at fifth picking and 4.85 mm to 7.01 mm for overall mean of all pickings, respectively.

At first picking, by the application of different doses of nitrogen, the pericarp thickness was the highest in N_{180} (6.42 mm), which was significantly higher over rest of all except N_{150} (6.36 mm) and the lowest was recorded in N0 (5.58 mm). There was 15.0, 14.1 and 6.8% increase in pericarp thickness was observed in N_{180}, N_{150} and N_{120} over N_0. With regard to application of different doses of potassium, the pericarp thickness was significantly higher in K_{100} (6.54 mm) as compared to K_{80} (6.09 mm) and K_0 (5.69 mm). While 14.9, 5.7% increase was observed in K_{100} and K_{80} respectively over K_0. Interaction effect was found to be non significant. At third picking among different nitrogen levels, N_{180} (6.07 mm) recorded significantly the highest pericarp thickness compared to N_{120} and N_0, but was on par with N_{150} (5.97 mm). The lowest was obtained with N_0 (5.28 mm). Among different potassium doses, K_{100} (6.00 mm) recorded significantly the highest fruit width while the lowest was recorded with K_0 (5.52 mm), which was on par with K_{80} (5.72 mm).

At fifth picking among different nitrogen fertigation levels, the highest pericarp thickness was noticed in N_{180} (6.15 mm), which was significantly superior over all other except N_{150} (6.13 mm), while the lowest was recorded in N_0 (4.52 mm). With respect to varied potassium doses the pericarp thickness was significantly higher in K_{100} (6.27 mm) as compared to K_0 (5.01 mm). However, K_{80} and K_0 were on par with each other, and the interaction was found to be non significant Among the different nitrogen doses, the highest overall mean pericarp thickness was noticed in N_{180} (6.21 mm) which was statistically on par with N_{150} (6.15 mm) but significantly superior over N_{120} (5.61 mm), N_0 (5.13 mm, however N_{150} was on par with N_{120} and it was followed by N_0. The lowest mean pericarp thickness was recorded with N_0. A 21.1, 20.0, 9.4% of increase in mean pericarp thickness was observed in N_{180}, N_{150} and N_{120} over N_0. Among different potassium doses, significantly the highest mean fruit thickness was recorded with K_{100} (6.27 mm) and the lowest was recorded with K_0 (5.41 mm), which was on par with K_{80} (5.66 mm). There were 15.8, 4.6% increase was observed in K_{100} and K_{80} respectively over K_0.

Discussion

Fruit TSS (^{0}brix)

Investigation in the total soluble solids (TSS) revealed that there was increase in TSS content of fruit with higher doses of nitrogen, potash and their combinations. Application of higher doses of nutrients and combination might have resulted in formation of more carbohydrates leading to increase in TSS. This was also reported by Singh *et al*. (1995) in brinjal, Nanda and Mahapatra

(2004), Pradeep Kumar *et al*. (2004), Gupta and Sengar (2000) in tomato.

Fruit ascorbic acid content (mg 100 g^{-1})

Much of the nutritional value of pepper fruits resides in their low calorie content and high antioxidant levels, especially ascorbic acid (vitamin C). The availability of nutrients for a longer period of time at the root zone area with high frequency fertigation could be responsible for the improvement of ascorbic acid. The ascorbic acid is composed of carbohydrate constituting compound and as carbohydrate production is influenced by both N and K application, the increase in ascorbic acid content with higher doses of N and K and their combination was apparent. A similar trend was also reported by Nanda and Mahapatra (2004), Pradeep *et al.* (2004) in tomato, Sharu and Meerabai (2001) in chilli, Das *et al*. (1972) in capsicum.

Fruit capsaicin (%)

Capsaicin renders it pungency and spiciness. Capsaicin (8-methyl-N-vanillyl-6-nonenamide) is an active component of chili peppers. It is a chemical irritant for mammals, including humans, and produces a sensation of burning in any tissue with which it comes into contact. Capsaicin and several related compounds are called capsaicinoids and are produced as secondary metabolites by chili peppers, probably as deterrents against certain mammals and fungi. Pure capsaicin is hydrophobic. With an increase in the N and K fertigation levels, capsaicin content increased because it is known for its pungency trait in pepper which is composed of 3-hydroxy, 4-methoxy benzylamine and decylenic acid. Hence, this might be the reason for increased capsaicin content. Similar findings were seen by Mujumdar *et al*. (2000) and Mounika (2016) in chilli in open field.

Fruit capsanthin (EOA colour values)

Capsanthin is a natural red dye of the xanthophyll class. Used as a food coloring. Capsanthin is the main carotenoid in red bell pepper (*Capsicum annuum*) and a component of paprika oleoresin. Capsanthin is an anthocyanin pigment in capsicum responsible for colour and it is used for the synthesis of food colour and in pharmaceuticals. Nutrients play a major role in pungency and colour development and especially potassium is highly responsible for enhancing fruit quality. Association of K nutrition with increased yields, fruit size, increased soluble solids and ascorbic acid concentrations, improved fruit color and increased shelf life as reported by several scientists (Prabhavathi *et al*., 2008 and Bhuvaneshwari, 2013). Higher doses of N and K recorded higher capsanthin content. Supporting results were observed by Suresh (2000) and Mounika (2016) in chilli.

Fruit Oleoresin (%)

Capsicum oleoresin is the name of the active ingredient responsible for making these peppers taste hot. Oleoresin is commonly marketed as spice drops and contains the total pungency and flavor constituents of pepper. It is a mixture of complex soluble phenols known as capsaicinoids, Capsaicin (trans-8-methyl-N-vanillyl-6-nonenamide) and dihydrocapsaicin make up 80–90% of oleoresins. The oleoresin (%) increased with an increase in fertigation levels and it is used mainly in the pharmaceutical industry and in the production of some foods and beverages because it contains all the flavouring ingredients soluble in the particular solvent used, and is much closer to the original clove odour and flavour. Similar findings were observed by Mounika (2016) in chilli under open field conditions.

Fruit pericarp thickness (mm)

Investigation revealed that pericarp thickness increases with increase in nutrient doses and their combination in poly house conditions. It was also reported by Sasikala *et al*. (2004) in sweet pepper.

Conclusion

The findings of this study can help farmers and agricultural practitioners optimize nitrogen and potassium fertigation practices to achieve desired capsicum quality attributes. This optimization can lead to increased crop yields and better economic returns. Marketability and Consumer Acceptance: High-quality capsicum fruits with desirable attributes are more likely to be accepted in the market, leading to increased demand and profitability for growers. Understanding the impact of fertigation on quality parameters can enable producers to meet consumer preferences and market demands effectively. Efficient nutrient management practices contribute to sustainable agriculture by reducing resource wastage and environmental impacts. By determining the optimal nutrient levels required for maximizing capsicum quality, this research can promote environmentally friendly cultivation practices. Based on the overall performance, it can be concluded that, among different nitrogen fertigation levels application of 180% of recommended dose of N (324 kg N ha^{-1}) recorded the highest values in fruit quality parameters (TSS, ascorbic acid, oleoresin, capsaicin, capsanthin) followed by 150% RD (270 kg N ha^{-1}) of N. Among different potassium doses, application of 100% RD (120 kg K_2O ha^{-1}) of K_2O recorded significantly higher values.

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