Influence of Nitrogen and Potassium Fertigation Levels on Economics of Capsicum (Capsicum annuum var. grossum L.) under poly house

B. Gouthami*, M. Uma Devi, K. Avil Kumar and V. Ramulu
Water Technology Centre, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad 500 030, India

ABSTRACT

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. In India capsicum is grouped under non-traditional category of vegetables. Nutritionally it provides vitamin C (283 mg) and zinc, the two nutrients which are vital for a strong and healthy immune system. It also has high content of vitamin A, retinol (a bioflavonoid), ß carotene, iron [1]. And minerals like calcium (13.4 mg), magnesium (14.9 mg) phosphorus (283.3 mg), potassium (263.7 mg), energy (24 Kcal), protein (1.3g), carbohydrate (4.3g) and fat (0.3g) per 100 g fresh weight [24].

The experiment was conducted in a naturally ventilated poly house at Water Technology Centre, Horticulture Farm, Rajendranagar, Hyderabad during rabi 2019-20. The experiment comprised of three replications in Factorial Randomized Block Design (FRBD) with two factors (i.e. N levels (4), K levels [3] and twelve treatments Viz; N fertigation levels of 0 %, 120 % (216 kg N ha-1), 150 % (270 kg N ha-1), 180 % (324 kg N ha-1) and K fertigation levels of 0 %, 80 % (96 kg K2O ha-1), 100% (120 kg K2O ha-1) respectively. The 100 % RDF was 180, 90 and 120 kg N, P2O5 and K2O ha-1. The fertigation schedule was completed in a total of 37 splits. The soil of the experimental site was sandy loam in texture with low in available nitrogen (166.5 kg ha-1), medium in available phosphorus (81.1 kg P2O5 ha-1) and low in available potassium (245.4 kg K2O ha-1). Irrigation was scheduled at 0.8 Epan based on pan evaporation data. The total water applied to the crop was 414.8 mm. Results revealed that N180 (₹ 13,07,160 and ₹ 8,21,800) recorded higher gross and net returns which were significantly superior over other levels and was on par with N150 (₹ 12,16,580 and ₹ 7,31,924), while the lowest gross and net returns were noticed with N0 (₹ 9,93,890 and ₹ 5,12,756) respectively. With regard to potassium fertigation a significant difference was noticed. However K100 (₹ 13,13,757 and ₹ 8,28,461) recorded significantly higher gross and net returns compared to K80 and K0. The significantly lower returns were recorded with K0 (₹ 10,43,503 and ₹ 5,62,007) respectively. The benefit cost ratio ranged from 1.67 to 3.27. As concerned with nitrogen applications N180 (2.69) recorded significantly higher benefit cost ratio followed by N150 (2.51). The lowest was recorded with N0 (2.07). Among potassium doses K100 (2.71) recorded maximum value, while the lowest was recorded with K0 (2.17). Based on the overall performance, application of 180 % N and 100% K2O (324:120 kg N and K2O kg ha-1) can be recommended for green capsicum hybrid grown in poly house under semi-arid tropical climatic conditions of Hyderabad during rabi season.

Keywords: poly house, capsicum, fertigation, gross returns, net returns

INTRODUCTION

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, 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) [3]. The major capsicum producing states in India are Himachal Pradesh, Karnataka, Madhya Pradesh, Haryana, Jharkhand, Uttarakhand and Orissa. Capsicum is native to tropical South America and was introduced in India by the Portuguese in the middle of sixteenth century. Demand for vegetables in India is increasing at a faster
rate of 123.68 MT to about 220 MT from 2011 to 2020 [22]. 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 [3]. It also finds place in preparations like pizza stuffing’s and burger with growing popularity of fast food. Poly house, the latest word in Indian agriculture is one such means, where the plant are grown under controlled or partially controlled environment resulting in higher yields than that is possible under open conditions [6]. The productivity of vegetables can be increased 4 to 5 times more as compared to their open field cultivation [18]. A low-tech naturally ventilated greenhouse for the cultivation of capsicum in a warm and humid climate and reported that the highest benefit cost ratio (2.98) for capsicum in greenhouse compared to open field condition i.e (0.80) [9].

Basically capsicum is a cool season tropical crop and lacks adaptability to varied environmental conditions. 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 [19]. 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. The use of drip fertigation in the poly house, not only saves water and fertilizer, but also gives better yield and quality by precise application of inputs in the root zone [20]. The past research conducted shows that by means of fertigation it is possible to save fertilizers up to 25 per cent [13]. Integrated use of chemical fertilizers and organic manures/sprays for obtaining sustainable crop production, better nutrient availability and efficient nutrient use, besides reducing nutrient losses [11] and improving fruit quality.

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 [5]. 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). Poly house temperature plays a major role in phenological development and productivity of crop plants. [4]. High temperature influences crops to mature earlier. Early and higher yield of different vegetable crops inside the poly house was mainly because of better microclimate such as higher temperature (4-9°C) more than nearby open fields observed during winter months [6]. Higher productivity of tomato (93.20 t ha⁻¹) and capsicum (76.40 t ha⁻¹) inside the greenhouse which was mainly due to higher temperature (4-9°C) than the outside observed during December to February and high rate of utilization of carbon-dioxide inside the greenhouse [21]. Photosynthetic rate, number of fruits, individual fruit weight and fruit yield plant⁻¹ significantly decreased with the temperature increase (32 °C) at pre-flowering and flowering stages. The effects of temperature were more pronounced at the flowering stage as compared to the pre-flowering stage. The tomato genotype (CLN2413) showed the best yield performance under temperature stress [12]. Effect of weather parameters (temperature, relative humidity and light intensity) on growth and yield of vegetables under naturally ventilated poly house was conducted at the Department of Horticulture, Agricultural College and Research Institute, TNAU, Madurai in comparison with open field. Results revealed that temperature was 2°C higher in the poly house than in the open field, relative humidity was the highest under poly house, but the light intensity was lower when compared to the open field. (Kumar and Arumugam 2010). [16]. The air temperature inside the poly house was higher compared to open field i.e. ranges from 2.7°C to 3.4°C and 1.4°C to 2°C respectively. The above microclimatic variability causes the higher plant height, inter nodal length, early flower initiation (39 days), the average length of pods were significantly higher under poly house compare to open field [10]. Effect of different capsicum genotypes under two different growing environments such as poly house and open field revealed that, under poly house conditions, Orobole recorded maximum increase in the fruit size (41.85 %) compared to open conditions. The fruit yield plant⁻¹ was recorded maximum (2.426 kg plant⁻¹) by California Wonder under poly house which was on par with Orobole. The incidence of thrips
was significantly reduced by 41.44 % in protected conditions (poly house) than open conditions [17].

**MATERIALS AND METHODS**

A field experiment was conducted at Horticultural Farm, College of Agriculture, Rajendranagar, Hyderabad during rabi season of 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 P₂O₅ ha⁻¹) and low in available potassium (245.4 kg K₂O ha⁻¹).

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; T₁ - Control (No N, K₂O), T₂ - N₀ (No fertilizer) + 80 % RD of K₂O, T₃ - N₀ (No fertilizer) + 100 % RD of K₂O, T₄ - 120 % RD of N + K₂O (No fertilizer), T₅ - 120 % RD of N + 80 % RD of K₂O, T₆ - 120 % RD of N + 100 % RD of K₂O, T₇ - 150 % RD of N + K₂O (No fertilizer), T₈ - 150 % RD of N + 80 % RD of K₂O, T₉ - 150 % RD of N + 100 % RD of K₂O, T₁₀ - 180 % RD of N + K₂O (No fertilizer), T₁₁ - 180 % RD of N + 80 % RD of K₂O, T₁₂ - 180 % RD of N + 100 % RD of K₂O. 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 14 DAT), 10 % of N and K₂O were applied in two splits. During vegetative stage, (15 to 46 DAT) 30 % of N and 20 % of K₂O were applied in eight splits. During flower initiation to fruit development (47 DAT to 74 DAT) 20 % of N and K₂O 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 % K₂O were applied in 20 splits.

Then the fertigation schedule was completed in a total of 37 splits. In addition, the crop had received a common dose of 12.5 t ha⁻¹ vermicompost and 1.5 t ha⁻¹ neem cake and 90 kg P₂O₅ ha⁻¹ and also waste decomposer, vermi wash sprays at every 15 days interval. 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. The weight of mature fruits harvested from the each picking was recorded till final harvest and total yield of fruits per hectare was computed and expressed in kg and tons per hectare.

The microclimatic parameters like temperature, relative humidity and light intensity, evaporation, soil temperature (5, 10 cm depth of soil) were monitored throughout the crop growth period at four times of a day viz., 8.30 AM, 12.00 PM, 2.00 PM and 4.00 PM respectively inside and outside the poly house. Air temperature was recorded by using thermo hygrometer (288 CTH) at different times of a day, and expressed as standard weekly data and monthly mean throughout the crop growth period. The relative humidity was measured by using thermo hygrometer (288 CTH) at different times of a day (i.e 8.30 AM, 12.00 PM, 2.00 PM, 4.00 AM) and expressed as standard weekly data and monthly mean throughout the crop growth period. The light intensity was measured with the help of lux meter (LX 101A) and recorded the data in lux and expressed as standard weekly data and monthly mean throughout the crop growth period. To identify the difference in evaporation between inside and outside the poly house, a measuring beaker was maintained outside and inside the poly house to observe evaporation losses. Beaker specification was 13.5 cm height, 15 cm diameter and 2000 ml was maintained. Data was also collected on soil temperature at 5 and 10 cm depth of the soil.

**RESULTS AND DISCUSSION**

The data regarding the cost of cultivation, gross returns, net returns and benefit cost ratio are presented in Table 1.

**Gross returns and net returns**

Among N and K fertigation levels, the highest gross and net returns were noticed in fertigation
treatment with N\textsubscript{180} K\textsubscript{100} (T\textsubscript{12}) followed by N\textsubscript{150} K\textsubscript{100} (T\textsubscript{9}). The lowest were realized in N\textsubscript{0}K\textsubscript{0} (T\textsubscript{1}). With regard to nitrogen fertigation, N\textsubscript{180} (₹ 13,07,160 and ₹ 8,21,800) recorded higher gross and net returns which were significantly superior over N\textsubscript{120} and N\textsubscript{0} and was statistically on par with N\textsubscript{150} (₹ 12,16,580 and ₹ 7,31,924). The N\textsubscript{150} and N\textsubscript{120} were on par with each other. The lowest gross and net returns were noticed with N\textsubscript{0} (₹ 9,93,890 and ₹ 5,12,756) respectively. With regard to potassium fertigation a significant difference was noticed. However K\textsubscript{100} (₹ 13,13,757 and ₹ 8,28,461) recorded significantly higher gross and net returns compared to K\textsubscript{80} and K\textsubscript{0}. The significantly lower returns were recorded with K\textsubscript{0} (₹ 10,43,503 and ₹ 5,62,007) respectively.

B: C ratio

The benefit cost ratio ranged from 1.67 to 3.27. The highest benefit cost ratio was noticed in treatment N\textsubscript{180} K\textsubscript{100} (T\textsubscript{12}) followed by N\textsubscript{150} K\textsubscript{100} (T\textsubscript{9}). The lowest benefit cost ratio was noticed with N\textsubscript{0}K\textsubscript{0} (T\textsubscript{1}). As concerned with nitrogen applications, N\textsubscript{180} (2.69) recorded a significantly higher benefit cost ratio followed by N\textsubscript{150} (2.51). The lowest was recorded with N\textsubscript{0} (2.07). Among potassium doses, a significant difference was noticed. The K\textsubscript{100} (2.71) recorded maximum value which was significantly superior over K\textsubscript{80} (2.38) and K\textsubscript{0} (2.17) while the lowest was recorded with K\textsubscript{0}. Similar results were obtained with [22] [25] [14] [23] [15] [2] [8].

Table 1. Economics of Capsicum as influenced by different N and K fertigation levels under poly house during rabi 2019-2020.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Gross returns (₹ ha\textsuperscript{-1})</th>
<th>Net returns (₹ ha\textsuperscript{-1})</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RD Nitrogen (N)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%-N</td>
<td>9,93,890.6</td>
<td>5,12,756.1</td>
<td>2.07</td>
</tr>
<tr>
<td>120%-N</td>
<td>11,61,989.3</td>
<td>6,78,037.4</td>
<td>2.40</td>
</tr>
<tr>
<td>150%-N</td>
<td>12,16,580.6</td>
<td>7,31,924.4</td>
<td>2.51</td>
</tr>
<tr>
<td>180%-N</td>
<td>13,07,160.6</td>
<td>8,21,800.1</td>
<td>2.69</td>
</tr>
<tr>
<td>SE.m ±</td>
<td>38,367.8</td>
<td>38,367.8</td>
<td>0.08</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>1,12,246.0</td>
<td>1,12,246.0</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>RD Potassium (K)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%-K</td>
<td>10,43,503.0</td>
<td>5,62,007.2</td>
<td>2.17</td>
</tr>
<tr>
<td>80%-K</td>
<td>11,52,456.0</td>
<td>6,67,920.2</td>
<td>2.38</td>
</tr>
<tr>
<td>100%-K</td>
<td>13,13,757.0</td>
<td>8,28,461.2</td>
<td>2.71</td>
</tr>
<tr>
<td>SE.m ±</td>
<td>33,227.5</td>
<td>33,227.5</td>
<td>0.07</td>
</tr>
</tbody>
</table>

CONCLUSION

The results have shown that with an increase in N and K fertigation levels, there was increase in gross, net returns and benefit cost ratio. This might be due to better availability of water and nutrients to crop through fertigation and also the poly house microclimate conditions which favoured better utilization of these water and fertilizers throughout the crop growth period. Finally based on the overall performance, application of 180 % N and 100% K\textsubscript{2}O (324:120 kg N and K\textsubscript{2}O kg ha\textsuperscript{-1}) can be recommended for green capsicum hybrid grown in poly house under semi-arid tropical climatic conditions of Hyderabad during rabi season.

REFERENCES


Department of Horticulture, Telangana. Personal communication.


Kumar, S., Patel, N and Saravaiya, S.N. 2018. Analysis of bell pepper (Capsicum anuum)


Singh, D.K and Peter, K.V. 2014. Protected Cultivation of Horticultural Crops. New India

