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Response of sweet pepper (*Capsicum annum*) to irrigation and fertigation grown in naturally ventilated polyhouse*

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Maximization of crop yield requires combination of a suitable genotype with an optimum environment. The productivity of a particular crop in an area depend on the environment. Polyhouse farming, also known as protected cultivation is widely used to provide and maintain a controlled environment suitable for optimum crop production (Mahajan and Singh 2006). This technology integrates market driven quality parameters with production system profits (Aldrich and Bartok 1989). In north India, Capsicum is very popular crop for production in polyhouse, because, fruit yield and quality is poor in open field due to very low temperature. Water is an important input for capsicum crop grown in polyhouse and the use of drip irrigation and fertigation saves water, fertilizer and gives better plant yield and quality as it reduces the humidity build-up inside the polyhouse after irrigation due to precise application of irrigation water to the root zone of the crop. Higher and better quality yield of bell pepper (*Capsicum annum* L.) had been reported when irrigation was applied through drip irrigation(Antony and Singhandhupe 2004) and (Sezen *et al.* 2006). The present experiment was conducted to study irrigation and fertigation requirement of drip-irrigated capsicum grown in naturally ventilated polyhouse.

The experiment was conducted during 2006–07 and 2007–08 in a naturally-ventilated polyhouse at the research farm in the Department of Soil and Water Engineering, PAU, Ludhiana, (30°54″ N latitude and 75° 48″ E longitude and altitude of 247 m). A semi-circular shaped polyhouse covering a floor area 6.25 m × 16 m (100 m^2) with sidewall ventilation was used for the study. The orientation of the polyhouse was east-west direction. The polyhouse was covered with an ultra-violet (UV) stabilized low-density polyethylene film having 200-micron thickness. The capsicum cultivar 'Bharath' (F_1 hybrid) widely grown by the farmers in polyhouse was used. The soil was loamy sand in texture, having *p*H 8.2 and electrical conductivity of 0.14 m mhos/cm. The soil was low in organic C (0.36%) and in available N (244.8 kg/ha). It was high in P (26.0 kg/ha) and K (240 kg/ha). The experiment had 6 treatments comprising combination of 3 levels of water supply (0.5 × Epan, 0.75 × Epan and 1.0 × Epan) and one N level (100% of recommended dose) that were tested against check basin method, of irrigation with recommended dose of N applied, when the crops was sown both inside and outside the polyhouse in randomized block design. The details of the treatments are given in Table 1.

The irrigation with drip system was done on alternate day on the basis of pan evaporation value of the previous day, while in check-basin method the irrigation was provided on the basis of 30 mm cumulative pan evaporation (Epan) and the water was applied using syphon tubes. In normal sowing (check basin plots), the distance between the rows was 60 cm and plant-to-plant spacing was 30 cm. However, in paired sowing (drip irrigated plots), the row-to-row space among paired rows was 45 cm and row-to-row space between pairs was 75 cm but plant-to-plant spacing was 30 cm. So, in paired sowing total number of plants were kept same, i e 55 556 plants/ha. In all the treatments, a basal dose of farmyard manure @50 tonnes/ha (on dry weight basis) was also applied before sowing of the crop. As indicated by the soil test, soil was rich in P and K hence these fertilizers were not applied. However, the recommended N fertilizer @ 125 kg N/ha was applied in 3 equal splits (check basin plots). The capsicum seed was sown in the last week of September for raising nursery on a raised-bed inside the polyhouse. The nursery was transplanted in the first week of November and the plot size was 3.6 m^2. Other cultural operations were same to all the treatments and were attended regularly. In drip irrigation system, N was applied at 15 days interval in 10 equal doses of N starting from 30 days after transplanting. In the

*Short note

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polyhouse first picking of capsicum fruit was done in the first fortnight of February and the last picking was done in the second fortnight of May. In all 16 pickings of polyhouse capsicum were done. In the open field only 6 pickings were done during 2006–07, while crop was totally damaged due to frost during 2007–08. The fruits were picked at 45 days after anthesis, at green mature stage for quality testing. Ten fruits were picked at random from each plot. Fruit weight, Capsaicin content, ascorbic acid and chlorophyll content were determined using standard procedure.

In general polyhouse crop resulted in higher yield at all the levels of irrigation and 100% N applied through drip irrigation system than the check basin irrigated crop grown inside (T_5) as well as outside the polyhouse (T_6). Higher yield under polyhouse may be ascribed to favourable environment at the early stages of capsicum (especially in December–January, when the night temperature are very low, i e 0.4–13.2°C during 2007 and –1.6–12.8°C during 2008), resulting in better growth and more pickings of capsicum. Environmental data revealed that the soil and air temperatures in the polyhouse remained on an average 3.2–3.9°C higher than the outdoor environment. The relative humidity inside the naturally ventilated polyhouse and outside ranged from 47.6 to 90.2% and 35.7 to 77.3%, respectively. The light intensity inside the polyhouse and outside ranged from 10 120 to 36 957 and 18 256 to 60 503 lux. (data not given). These results are in agreement with Chandra *et al*. (2000) who reported that during November–February there was 4–7°C more inside temperature than the outside.

In capsicum when same quantity of water ($1.0 \times E_{pan}$) and nitrogen was applied through drip irrigation, a significantly higher capsicum yield (62.0 tonnes/ha) was obtained as compared to 45.6 tonnes/ha and 25.9 tonnes/ha in check basin method of irrigation when the crop was sown both inside (T_5) and outside the polyhouse (T_6), respectively. Nimje and Shyam (1991) also reported that polyhouse crop of capsicum gave 2.5–3.0 times higher yield as compared to open field crop. When the quantity of water applied through drip irrigation, was reduced to 0.75 × Epan, capsicum yield increased further to 63.2 tonnes/ha and was significantly higher as compared to check basin method of irrigation. The yield was significantly reduced when irrigation was applied at $0.5 \times E_{pan}$ along with fertigation of 100% N (56.9 tonnes/ha). The best treatment of drip irrigation at $0.75 \times E_{pan}$ along with fertigation of 100% N resulted in increased fruit yield by 38.6% over the recommended practices inside (T_5) the polyhouse and by 144% outside the polyhouse (T_6) and saving of water by 35.3% over the recommended practices inside (T_5) the polyhouse and by 29% outside the polyhouse (T_6), respectively The increased yield under drip irrigation system might have resulted due to better water utilization higher uptake of nutrients. Drip irrigation both at 0.5 × Epan and 0.75 × Epan registered much higher water-use efficiency as compared to control practices (check basin irrigation and fertilizer application by broadcasting) both inside and outside the polyhouse (Table 1).

Polyhouse environment significantly improved the ascorbic acid content (102.2 mg/100 ml juice) of crop as compared to the outside field crop (96.4 mg/100 ml of juice). The results confirm the findings of Howard *et al.* (1994) who reported that the drip irrigated crop of sweet pepper at green mature stage recorded total ascorbic acid content of 97.5 to 108.7 mg/100 g of the fruit in different varieties of the crop. Further, drip irrigation enhanced the ascorbic acid in the fruit to 108.4 mg/100 ml juice as compared to surface method of irrigation (102.2 mg/100 ml juice) inside the polyhouse. The chlorophyll content in the fruit did not differ significantly among the different drip irrigation treatments inside the polyhouse though it was significantly superior than the surface irrigated crop. Results revealed that polyhouse

Table 1 Effect of treatments on different parameters of polyhouse capsicum (pooled data 2006–08)

Treatment	Fruit yield (tonnes/ha)	Fruit length (cm)	Fruit weight (g)	Pooled water applied (cm)	Pooled WUE (tonnes/ha/cm)	Capsaicin content (%)	Ascorbic acid (mg/100 ml)	Chlorophyll content (mg/g)	Dry matter content (%)
T_1, polyhouse crop + drip irrigation at $0.5 \times E_{pan}$	56.9	6.6	50.6	31.0	1.84	0.26	106.0	0.014	7.3
T_2, polyhouse crop + drip irrigation at $0.75 \times E_{pan}$	63.2	6.8	50.8	44.0	1.44	0.25	108.4	0.013	7.2
T_3, polyhouse crop + drip irrigation at $1.0 \times E_{pan}$	62.0	8.4	48.3	57.0	1.09	0.24	104.1	0.014	7.1
T_4, non-polyhouse crop + drip irrigation at $0.75 \times E_{pan}$	43.5	5.2	43.1	51.0	0.85	0.23	98.1	0.012	7.8
T_5, polyhouse crop + check basin irrigation	45.6	6.2	46.2	68.0	0.67	0.23	102.2	0.012	7.0
T_6, non-polyhouse crop + check basin irrigation	25.9	4.3	40.3	62.0	0.42	0.22	96.4	0.011	8.40
LSD (P=0.05)	3.1	2.5	3.17			0.02	4.27	0.01	0.70

drip irrigated crop was significantly better than the surface irrigated field crop. The dry matter content was comparatively less in the drip-irrigated crop as compared to the surface irrigated crop. Thus, the fruits with less dry matter eventually contained more moisture per cent and remained fresh for longer duration.

SUMMARY

A study was conducted during 2006–08 at Ludhiana to investigate the effect of irrigation (IW/CPE ratio 0.5, 0.75 and 1.0) and fertigation (100% N) on sweet pepper grown in naturally ventilated polyhouse on sandy loam soil. Drip irrigation at $0.75 \times E_{pan}$ along with fertigation of 100% recommended N resulted increase in fruit yield by 38.6% over control (recommended practice) inside the polyhouse and by 144% over outside the polyhouse. The drip irrigation at $0.75 \times E_{pan}$ irrespective of fertigation treatments gave an irrigation water saving of 35.3% and resulted in 38.6% higher fruit yield as compared to recommended practice inside the polyhouse. The fruit weight, capsaicin content, ascorbic acid content and chlorophyll content of the polyhouse crop were found to be superior to the open field crop. Drip irrigation and fertigation further enhanced the quality characteristics. On the basis of above study we recommend irrigation at IW/CPE ratio of 0.75 in polyhouse with100% N applied through drip irrigation.

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