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Water relations, growth, yield, and fruit quality of hot pepper under deficit irrigation and partial rootzone drying

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Abstract

We compared two water-saving irrigation practices, deficit irrigation (DI) and partial rootzone drying (PRD), for their effects on growth and quality of 'Ancho St. Luis' hot pepper (*Capsicum annum* L.). The treatments were: commercial irrigation (CI) considered as the control, irrigating both sides of the rootzone with half of the volume of CI considered as DI, and alternating irrigation between two sides of the rootzone with half the volume of CI at each irrigation time considered as PRD. Midday leaf water potentials of PRD and DI plants were lower by 0.15 and 0.30 MPa, respectively, than of CI plants from 130 days after sowing. Total fresh mass of fruit was reduced by 19 and 34.7% in PRD and DI, respectively, compared to CI. Fruit number per plant was reduced by more than 20% in PRD and DI compared to CI. Total dry mass of fruit was similar among the treatments. At harvest, DI fruit had 21% higher total soluble solids concentration and better colour development than other treatments. Although incidence of blossom-end rot was high in PRD and DI fruit, more than 80% of fruit from PRD was not affected. DI and PRD saved 170 and 164 l of water, respectively, compared to CI and they could be feasible irrigation strategies for hot pepper production where the benefit from saving water outweighs the decrease in total fresh mass of fruit.

Keywords: Plant water relations; Water conservation; Blossom-end rot; Dry mass distribution

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1. Introduction

Hot pepper is a high value cash crop and is commercially cultivated in Mexico, China, Korea, East Indies, USA, and many countries of the Indian sub-continent (DeWitt and Bosland, 1993). Total world production of hot pepper has been estimated to be 14–15 million t a year (Weiss, 2002). Hot pepper cultivation is confined to warm and semi-arid countries where water is often a limiting factor for production. This necessitates optimisation of water management.

Deficit irrigation (DI) and partial rootzone drying (PRD) are water-saving strategies. DI involves irrigating the entire rootzone with less than evapotranspiration, while PRD involves irrigating only part of the rootzone leaving the other part to dry to a predetermined level before the next irrigation. DI has been studied on sweet pepper with varied responses. From a glasshouse study on 'Sonar' sweet pepper (*Capsicum annum* L.), Chartzoulakis and Drosos (1997) reported increased fruit dry mass, while Delfine et al. (2000) observed 30% reduction in both fruit fresh and dry masses in the field-grown 'Quadratro d'Asti' sweet pepper. Some aspects of yield response of pepper have been reported from split-root experiments with inconclusive results. Cantore et al. (2000) reported reduction in fruit fresh mass and dry mass of sweet pepper when irrigation was withheld from one half of the split-root system compared to plants irrigated on both halves. In contrast, Kang et al. (2001) did not observe any difference in yield for hot pepper under similar treatments. Information on yield and quality responses to PRD does not exist for glasshouse- or field-grown hot pepper. We are aware of only two reports on the effect of PRD on herbaceous plants, those of Zegbe-Dominguez et al. (2003a,b) for tomato.

The objective of this study was to compare DI and PRD for their effects on water relations, growth, yield, and fruit quality of 'Ancho St. Luis' hot pepper. PRD research on grapevine has shown that water can be redistributed from roots in the wet soil into root in dry soil during the night (Stoll et al., 2000). Plant water status may equilibrate with the wettest part of the rootzone which could contribute to maintenance of plant water balance as suggested by Hsiao (1990). For this reason we expected that our PRD treatment would have a similar plant water status as the control. We therefore hypothesised that the PRD treatment, while saving water by 50% similar to that of DI treatment, would not have any negative effects on the above parameters especially on dry matter yield because pepper is often dried and it is one of the few crops where reduction of fresh yield is acceptable provided dry matter is not reduced.

2. Materials and methods

2.1. Plant material and experimental conditions

The experiment was carried out in a glasshouse at the Plant Growth Unit, Massey University, Palmerston North (latitude 40.2° S, longitude 175.4° E), New Zealand, from October 2002 to April 2003, with main growing period coinciding with the summer in the Southern Hemisphere. 'Ancho St. Luis' hot pepper seeds were sown on 14 October 2002.

Five-week-old seedlings were transplanted into 15 wooden boxes, each partitioned into three compartments (0.72 m × 0.70 m × 0.20 m) with one plant per compartment. Boxes were set up in rows facing north–south direction on the floor with a distance of 0.90 m between rows and 0.70 m between plants. Compartments within each box were separated by wooden boards (0.70 m × 0.20 m) and were lined with black polyethylene (125 μm thickness) to avoid movement of water from one compartment to the other. The plastic lining of each compartment was perforated at the sides and bottom to allow drainage. Plants were grown in a mixture of bark:pumice:peat at a ratio of 60:30:10 by volume. They were fertilised with 190 g per compartment with 1:2 (W:W) mixture of short-term (15N:4.8P:10.8K) and long-term (16N:3.5P:10K) slow release osmocote fertiliser (Scotts Australia Pty. Ltd., Baulkam Hills, NSW, Australia). The glasshouse was heated if temperature fell below 15 °C and ventilated above 25 °C by an automated temperature regulator (Automation Engineering, Auckland, New Zealand) for the entire growth period.

2.2. Treatments and experimental design

Irrigation lines were installed on two sides of each compartment and individual plants were drip irrigated through two emitters placed on both sides of the plant, 0.20 m away from the stem. Nineteen days after transplanting (64 days after sowing (DAS)), plants were subjected to the following three irrigation treatments. Full irrigation on both sides of the rootzone similar to commercial irrigation (CI) considered as control, irrigation with half the volume of CI on both sides of rootzone considered as DI, and half of irrigation volume in CI applied to one side of rootzone at each irrigation time designated as PRD. In the PRD treatment, irrigation was shifted from wet to dry rootzone every day. On average, CI plants received 4 l of water per day while DI and PRD received half of this. The experiment had a completely randomised design with the three treatments replicated five times and each replication had three plants.

2.3. Measurements of soil water content, leaf water potential and photosynthesis

Volumetric soil water content (θ) was determined every day at a soil depth of 0.20 m at 0.15 m away from the stem using time-domain reflectometry (Trase Systems-Soil Moisture Equipment Corp., Santa Barbara, California, USA). Leaf water potential (LWP) was determined from two fully exposed mature leaves per plant from the middle of the canopy. Measurements were made on five occasions (78, 92, 103, 130, and 143 DAS) at 05:00 and 13:00 h using a Scholander pressure chamber (Soil Moisture Equipment Corp., Santa Barbara, California, USA). Photosynthetic rate was measured on 12 cm^2 of leaf area on two well-developed leaves per plant between 11:00 and 12:00 h. Measurements were performed on five occasions (88, 100, 124, 136, and 143 DAS) with a portable photosynthesis system (Li-Cor Model 6200, Lincoln, Nebraska, USA). Readings were taken when CO_2 flow was steady at 360 ppm within the cuvette. The temperature and humidity in the cuvette were, respectively, 17 ± 2 °C and 55%. The photosynthetically active radiation varied from 1 day of measurement to the other, but was not less than 1100 μmol m^{-2} s^{-1}.

2.4. Fruit growth

Ten fully opened flowers per plant with similar bloom time were tagged on 75 DAS. Number of flowers aborted from each plant was recorded until fruit set. Two fruit per plant (developed from the tagged flowers) were assessed weekly for growth for 5 weeks. Length and diameter of the fruit were measured once a week on the widest equatorial region using a digital caliper (Mitutoyo Corp., Japan). The fruit volume was estimated by equating it to a circumscribed cylinder.

2.5. Fruit quality at matured green stage and weight loss in storage

Two matured green fruit per plant were harvested on 139 DAS coinciding with the commercial harvest for fresh consumption. The fruit were weighed, assessed for total soluble solids concentration (TSSC), skin colour, internal ethylene concentration, and CO_2 production (respiration) as outlined below. Fruit were oven-dried at 71 ± 1 °C to a constant mass and the dry mass recorded.

Gas was collected in test tubes from the fruit cavity using 50 ml syringes (Hamilton, Co., Nevada) while submerging the fruit under water. Gas samples (1 ml) were withdrawn from the test tubes using 1 ml gas-tight syringes and injected into a gas chromatograph (Pye Unicam, GCD) fitted with a flame ionization detector with H_2 and airflow rates of 30 and 300 ml per minute, respectively. The response to sample injection was determined from peak height using a Hewlett Packard integrator (Model 3390 A) calibrated with external ethylene standards (B.O.C. gases, New Zealand Ltd.). Another 1 ml sample of gas was withdrawn and injected into a GC-8A Shimadzu gas liquid chromatogram for determination of CO_2 concentration. Fruit skin colour was measured using a chromameter (CR-200; Minolta, Osaka, Japan) on two opposite sides of the equatorial region of fruit. TSSC was determined on juice extracted from a slice of pericarp from the equatorial region of the fruit using a hand-held refractometer (ATC-1 Atago, Tokyo, Japan) with automatic temperature compensation. To assess the effect of treatments on storage life, two matured green fruit from each plant (30 fruit/treatment) were harvested on the same occasion (139 DAS) and were stored in a storage room maintained at 25 °C with relative humidity of 65%. Weight loss measurements were made every 2 days for a 12-day period by weighing individual fruit. Fruit weight loss was calculated as a percentage reduction from the initial fresh weight.

2.6. Determination of maturity advancement

Two reddest fruit per plant were harvested on 154 DAS and weighed, and measured for TSSC, skin colour, internal ethylene concentration and CO_2 production using the same procedures outlined for the determination of quality at mature green stage. These fruit were oven-dried at 71 ± 1 °C to a constant mass. Fruit water content was determined by subtracting fruit dry mass from fresh mass and expressed as % of fruit fresh mass.

2.7. Measurements of yield and irrigation use efficiency

At final harvest, fruit number and total fresh mass of fruit for each individual plant were recorded. Fruit from individual plant were examined for blossom-end rot (BER) incidence and assessed for the severity of disorder under each treatment. Fruit were oven-dried at 71 ± 1 °C to a constant mass and dry mass determined. Shoots and roots of each individual plant were collected, weighed, and oven-dried to determine the distribution of plant dry mass. Roots were separated from shoot and washed to remove the medium. They were oven-dried at 71 ± 1 °C to a constant mass and dry mass determined. Irrigation use efficiency was determined by dividing the total fresh mass of fruit by the volume of irrigation water (litres) applied to the plant.

2.8. Statistical analysis

The data were analysed by complete randomised design using GLM procedure of SAS software Version 8.2 (SAS Institute, Cary, NC, USA). Treatment means were separated by LSD test at $P < 0.05$. All data were tested for homogeneity and normality using residual test. Fruit number, BER incidence and percentage of floral abortion per plant were square-root transformed and reported after back transforming.

3. Results

3.1. Soil water content and plant water status

Soil volumetric water content (θ) for CI remained 0.07–0.12 $m^3 m^{-3}$ higher than DI for most of the growth period (Fig. 1A). Values of θ for PRD depended on wetting and drying cycle (Fig. 1B). For example, at 100 DAFB, the θ value on wetted side of rootzone was 0.26 while 0.16 $m^3 m^{-3}$ was recorded for the dry side. Mean θ of two sides of PRD treatment remained above 0.19 $m^3 m^{-3}$ for the entire season (Fig. 1B).

Both predawn and midday values of LWP in CI were higher than the DI and PRD plants for the entire season (Fig. 2). Midday LWP started to decrease in all the treatments from 92 DAS reaching the lowest values (MPa) of −1.1 in DI, −0.9 in PRD and −0.71 in CI at 130 DAS (Fig. 2B). A lower LWP was maintained in DI and PRD until harvest. A similar trend was observed for the predawn LWP (Fig. 2A).

3.2. Fruit growth and development

Floral abortion per plant was more than 50% higher in DI than in PRD and CI (Table 1). Total fruit number per plant, including BER fruit, in CI was 23% higher than PRD and 40% higher than DI. There was no difference in fruit growth among the treatments (Fig. 3). Similarly, mean fresh mass of fruit at final harvest was not affected by the treatments (Table 1). Although BER incidence was two folds higher in DI and PRD fruit than in the CI fruit, differences among the treatments were not statistically significant (Table 1) due to variation within the data.

3.3. Yield and dry mass distribution

Total fresh mass of fruit per plant in PRD was 586.5 g higher than in DI, but it was 724.1 g lower than CI (Table 2). However, there was no difference in the total fruit dry mass

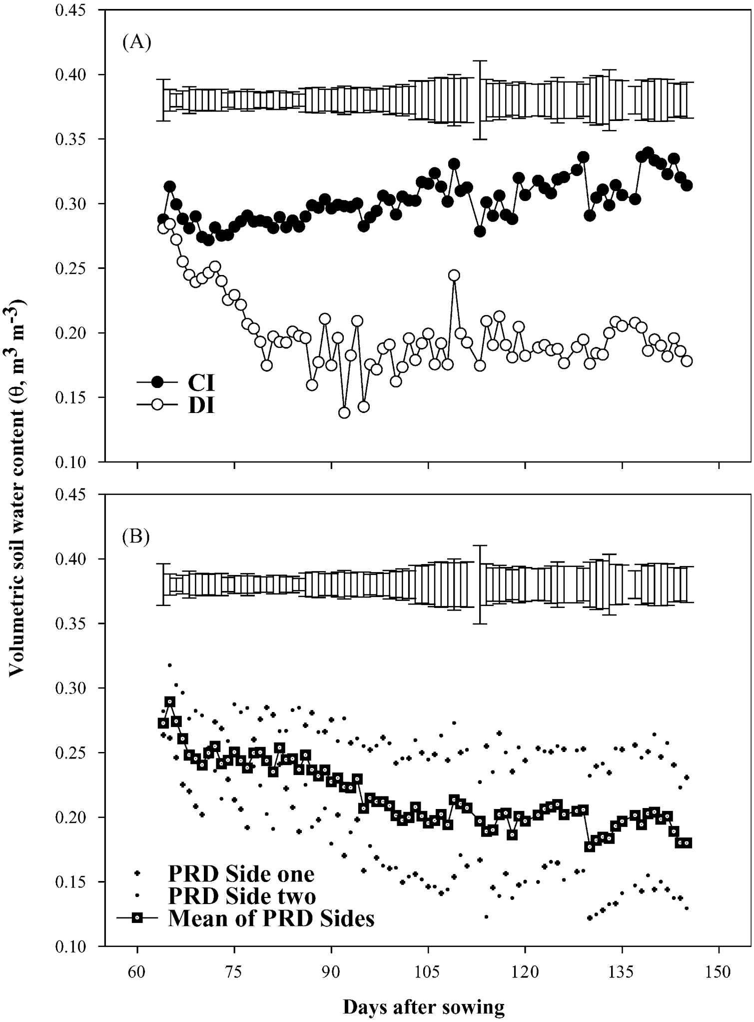

Fig. 1. Changes in volumetric soil water content (θ) in commercially irrigated (CI) and deficit irrigated (DI) (A), in both sides of the root system and means of two sides of partial rootzone drying (PRD) (B) in hot pepper. Each side of PRD root system had either high or low θ depending on whether it was being irrigated or not. Vertical bars represent least significant difference (LSD) at $^*P < 0.05$.

among the treatments. Fruit succulence (total fruit fresh mass per plant divided by the total fruit dry mass per plant) was 10.2, 9.0 and 7.0 for CI, PRD and DI treatments, respectively. Irrigation use efficiency was higher in PRD and DI plants than in the CI plants. Total vegetative dry mass (excluding roots) was similar among the treatments. CI had 23% higher total vegetative fresh mass relative to DI while the difference between CI and PRD was minimal. There was neither a difference in proportion of dry mass distributed among plant organs nor in total plant dry mass among the treatments (Table 3).

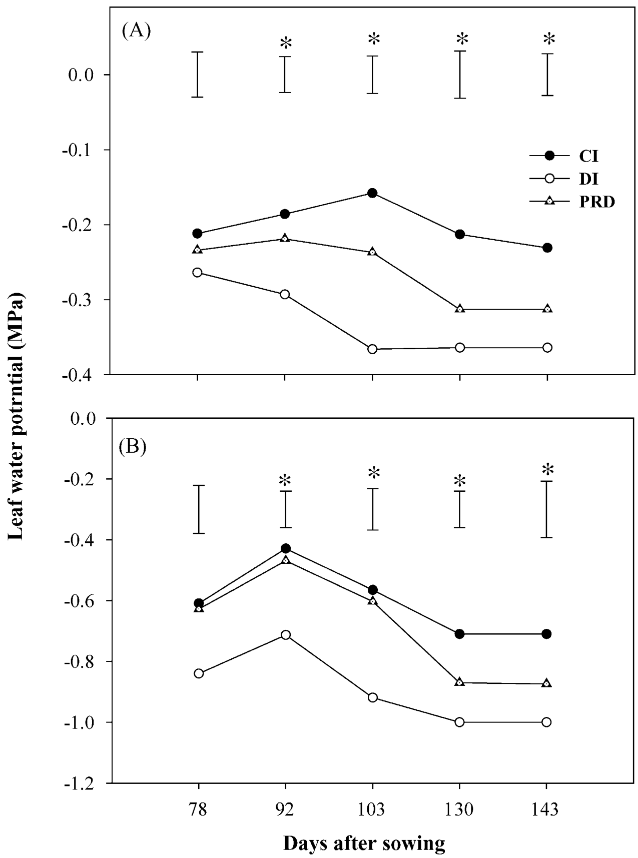

Fig. 2. Seasonal changes of leaf water potential measured at predawn (A) and at noon (B) for hot pepper under commercial irrigation (CI), deficit irrigation (DI), and partial rootzone drying (PRD). Vertical bars indicate LSD and asterisks denote significant differences at $^{*}P < 0.05$.

3.4. Fruit quality at matured green-stage and at firm red stage

TSSC was higher by 8% in DI than the PRD and CI fruit at matured green stage. There was no difference in internal ethylene concentration and in respiration rate among the

Table 1
Effect of irrigation treatments (ITs) on flower abortion (FA), incidence of blossom-end rot (BER) in fruit, total number of fruit (NF) per plant including BER fruit, and mean fresh mass of fruit (MFMF) per plant including BER fruit

ITs[a]	FA (%)	BER (%)	NF	MFMF (g)
CI	5.3b	9.3a	69.0a	55.9a
PRD	16.7ab	20.4a	54.0b	54.3a
DI	34.7a	29.5a	49.0c	50.6a

Means with same letters within columns are not significantly different using LSD at $^{*}P < 0.05$.
[a] CI: commercial irrigation; DI: deficit irrigation; PRD: partial rootzone drying.

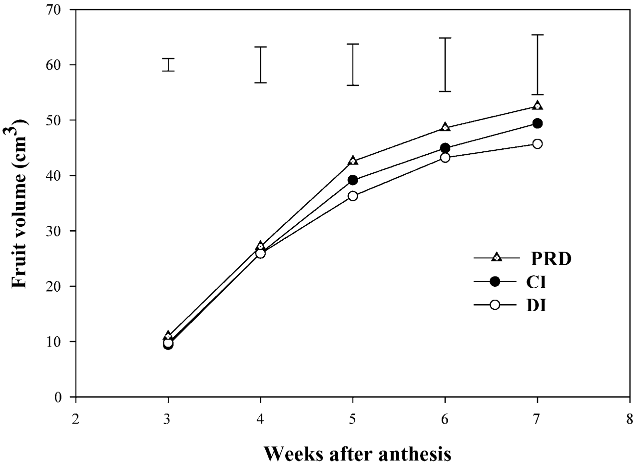

Fig. 3. Changes in fruit volume of hot pepper under commercial irrigation (CI), deficit irrigation (DI), and partial rootzone drying (PRD). Vertical bars represent LSD at $*P < 0.05$.

Table 2
Effect of irrigation treatments (ITs) on total fresh mass of fruit (TFMF) including BER fruit, total dry mass of fruit (TDMF) including BER fruit, total vegetative fresh mass excluding root (TVFM), total vegetative dry mass excluding root (TVDM) and irrigation use efficiency (IUE)

ITs[a]	TFMF (g/plant)	TDMF (g/plant)	TVFM (g/plant)	TVDM (g/plant)	IUE ($g\,l^{-1}$)
CI	3778.6a	370.1a	1237.4a	263.8a	12.0c
PRD	3054.5b	345.0a	1121.8ab	245.9a	20.1a
DI	2468.0c	357.5a	1000.0b	221.3a	17.1b

Means with same letters within columns are not significantly different using LSD at $*P < 0.05$.
[a] CI: commercial irrigation; DI: deficit irrigation; PRD: partial rootzone drying.

treatments (Table 4). Postharvest weight loss in DI and PRD fruit was initially less than CI fruit by, respectively, 30% and 24%. But this difference was lost after 4 days of storage at 20 °C (Fig. 4). However, a trend for lower weight loss was maintained in DI and PRD fruit for the rest of the storage period.

TSSC was higher in DI fruit than PRD and CI fruit at firm-red ripe stage (Table 4). DI fruit were redder as indicated by a lower hue angle (Table 4). But internal ethylene

Table 3
Effect of irrigation treatments (ITs) on dry mass distribution and on total dry mass of plant (TDMP) including roots and fruit in hot pepper plants

ITs[a]	Dry mass distribution (%)			TDMP (g/plant)
	Roots	Shoots + leaves	Fruit	
CI	5.2a	40.0a	57.8a	658.9a
PRD	5.0a	39.1a	55.1a	621.7a
DI	5.0a	37.0a	58.0a	616.4a

Means with same letters within columns are not significantly different using LSD at $*P < 0.05$.
[a] CI: commercial irrigation; DI: deficit irrigation; PRD: partial rootzone drying.

Table 4
Effect of irrigation treatments (ITs) on total soluble solids concentration (TSSC), internal ethylene concentration (IEC), carbon dioxide production (CO_2), and fruit background skin colour in terms of hue angle (HA°) at matured green stage and at firm red stage of fruit

ITs[a]	TSSC (%)	IEC ($\mu l\, l^{-1}$)	CO_2 ($\mu l\, l^{-1}$)	Skin colour (HA°)
Matured green stage				
CI	4.5b	0.112a	2.7a	133.7a
PRD	4.6b	0.177a	2.9a	131.9a
DI	5.0a	0.132a	2.8a	135.8a
Firm red stage				
CI	8.4b	0.113a	2.3a	76.9a
PRD	8.2b	0.104a	2.6a	66.5a
DI	10.2a	0.149a	2.2a	36.5b

Means with same letters within columns are not significantly different using LSD at $^*P < 0.05$.
[a] CI: commercial irrigation; DI: deficit irrigation; PRD: partial rootzone drying.

concentration and respiration rate, which are indicative of fruit maturity, were the same among the treatments. Fruit water content was 2% lower in DI than in CI and PRD. The values (% ± S.E.) were 85 ± 2.3, 87 ± 2.2 and 87 ± 3.5 for DI, CI and PRD fruit, respectively.

4. Discussion

Reduction in θ with DI and PRD was high enough to cause reduction in plant water potential. DI and PRD treatments had reduced LWP throughout the growth period, but

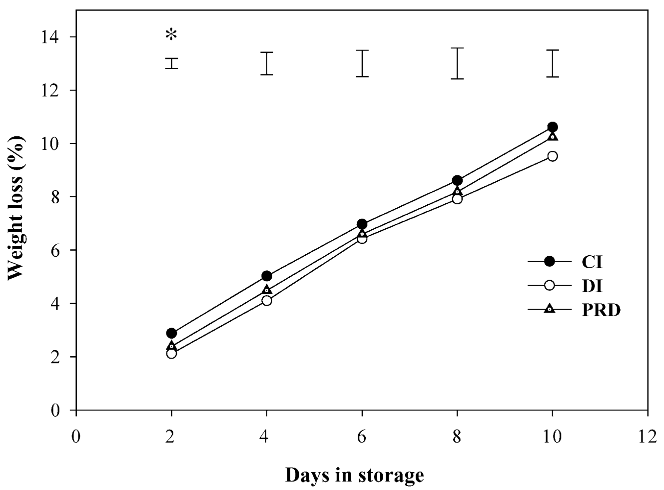

Fig. 4. Cumulative weight loss as percentage of initial weight of hot pepper under commercial irrigation (CI), deficit irrigation (DI), and partial rootzone drying (PRD) during storage at 20 °C for 10 days. Vertical bars represent LSD and asterisk denotes significant difference at $^*P < 0.05$.

LWP decreased markedly commencing from fruiting stage (92 DAS) in the three treatments (Fig. 1). Fruit are stronger sinks for water than the vegetative parts of plants (Chalmers, 1989). Therefore, competition for water from developing reproductive sinks coupled with increased evaporative demand due to rising temperature during the late growing season may have caused the reduction in LWP, particularly in DI and PRD plants. In general, predawn and noon LWP was higher in PRD than in DI plants over the season. In the PRD treatments part of the rhizosphere was moist all the time and plant water status normally equilibrates with the wetter part of the rootzone (Hsiao, 1990).

Although plant water status was reduced under DI and PRD, individual fruit mass and volume were not affected. This may be attributed to low crop load in PRD and DI plants through flower abortion as reported for processing tomato undergoing similar treatments (Zegbe-Dominguez et al., 2003a). Reduction in fruit number in DI and PRD plants may have enhanced accumulation of available carbohydrate and water in the remaining fewer fruit, maintaining the final fruit mass compared to CI. Pepper plants are most sensitive to water stress during flowering and fruit development (Katerji et al., 1993). Midday leaf water potentials of as low as −0.72 and −0.50 MPa in DI and PRD plants, respectively, were recorded as early as 92 DAS. The corresponding value for CI was −0.41 MPa (Fig. 2A). High floral abortion accompanied by reduction in LWP in DI and PRD plants suggests the development of a water deficit during the reproductive phase. Treatments were started before floral development. Floral abortion might have been due to inhibition of fertilization as reported by Katerji et al. (1993) for glasshouse-grown pepper and by Pulupol et al. (1996) for tomato.

DI and PRD significantly reduced fresh yield in terms of fresh mass of fruit per plant. However, total dry mass of fruit per plant was similar to CI. This indicates that water movement into the fruit may have decreased with progressive development of water deficit without affecting the translocation of dry matter into the fruit. There was no significant difference in photosynthetic rate among the treatments for all the measurement occasions. For example, at 124 DAS the rates (μmol m^{-2} s^{-1}, LSD = 3.3) were, 14.4, 12.4, and 12.0 for CI, PRD, and DI plants, respectively. This measurement was during the rapid fruit growth period. The movement of photoassimilates into the fruit was therefore not affected by source limitation. This differs from a study on a field-grown sweet pepper for which irrigation was withheld for the entire growth period (Delfine et al., 2000). A reduction in photosynthetic rate by 30% in non-irrigated plants was observed which reduced fruit dry mass production.

PRD plants had higher total fresh mass of fruit than the DI plants, although total fruit dry mass was similar between them. DI fruit had 2% less water than PRD fruit. LWP in DI plants was lower than the PRD plants throughout the growth period suggesting that the DI fruit's water relations could have been affected more than those of the PRD fruit. Exposing a portion of the rootzone to drying has been reported to initiate rapid root growth upon rewetting (Gersani and Sachs, 1992) with enhanced hydraulic conductivity. Root growth in terms of final root dry mass was similar among the treatments (Table 3). Spatial pattern of increase in root's hydraulic conductivity upon re-wetting, as reported for apple (Green et al., 1997), may have occurred under PRD regime. Increase in the rate of water uptake by two folds when roots in the dry soil were re-wetted and, sometimes this being even higher than the well irrigated controls, was reported in pear (Kang et al., 2002). This may assist the plant to meet its water requirement when only half of the rootzone is supplied with water (Tan et al., 1981). But such differential effects of DI and PRD on plant water status and fruit water relations, in particular, have not yet been clearly elucidated.

The distribution of dry mass between root, shoot and fruit was similar among the treatments (Table 3). Although, proportion of dry mass partitioned into fruit was similar irrespective of treatments, both PRD and DI fruit accounted for more than 55% of total plant dry mass which is substantially higher than that of 39% reported from split-root experiment on pot-grown pepper (Cantore et al., 2000). The extent of water deficit developed in their study was very high, with LWP being below −3.4 MPa, which may have altered partitioning of assimilates into fruit. In our study, the lowest midday LWP (MPa) of −1.10, −0.85, −0.65 was recorded in DI, PRD and CI plants, respectively, from 130 days after sowing (Fig. 2B). The pepper fruit remained as the major sink for assimilates, maintaining optimum dry mass under the water deficit conditions imposed in our experiment.

Quality improved in DI fruit in terms of higher TSSC compared to PRD and CI fruit at final harvest. Reduced fruit water content and greater hydrolysis of starch into sugars (Kramer, 1983, p. 264) may have contributed towards increased TSSC in DI fruit. As internal ethylene concentration and respiration rate were small and similar among the treatments, differences in TSSC due to respiratory loss of sugars as speculated for tomato by Zegbe-Dominguez et al. (2003b), would have been negligible in our study. Ascorbic acid, an important source of Vitamin C, has been shown to have strong positive correlation ($r^2 > 90\%$) with changes in dry mass and TSSC in sweet pepper fruit (Niklis et al., 2002). Thus, the increase in TSSC associated with low fruit water content, as observed in DI, may have additional benefits through improvement in nutritional value of pepper fruit.

DI advanced fruit maturity in terms of colour development at harvest. DI fruit had the lowest hue angle and hence were redder than the other treatments. ‘Chooraehong’, a Korean hot pepper cultivar, has been reported to exhibit significant increases in respiration rate and ethylene production corresponding with colour development (Gross et al., 1986). In this study, the levels of ethylene production and respiration rate were similar among the treatments and between the matured green fruit and firm red-ripe fruit at final harvest (Table 4). Thus, enhancement of colour in DI fruit cannot be attributed solely to endogenous ethylene-induced ripening processes as reported in some pepper cultivars (Villavicencio et al., 2001). ABA concentration, which tends to increase during water stress conditions, has been observed to increase with maturation in ‘California’ sweet pepper, suggesting a possible role of ABA in colour development in pepper fruit (Serrano et al., 1995).

Reducing irrigation volume increased the incidence of BER in fruit. The magnitude of BER incidence was highest in DI followed by PRD (Table 1). Average number of BER fruit per plant for CI, PRD and DI were 6, 11 and 14, respectively. Approximately 9% of the total CI fruit had blossom-end rot showing some degree of susceptibility for this cultivar, which could have been aggravated in DI and PRD plants possibly by local deficiency of calcium in the fruit induced under water deficit conditions (Adams and Ho, 1992). Localized wetting of soil under drip irrigation leaves greater proportion of rhizosphere to dry. This may have increased the incidence of BER as reported for tomato by Obreza et al. (1996).

Although DI and PRD reduced yield in terms of total fresh mass and number of fruit per plant, total dry mass was maintained compared to well-irrigated control. Ground hot pepper is commonly used as spice, flavour, and colouring agent in food preparation. Therefore reduced fruit water content, hence reduced drying cost in processing, and better development of red colour are beneficial in terms of quality and marketing value. Higher TSSC and lower fruit weight loss in DI fruit are indicative of better quality and longer shelf life, which are important for consumption of green pepper as a fresh vegetable. PRD and DI saved water by 50% and improved irrigation use efficiency. Fruit quality attributes such as colour and TSSC were improved in DI while PRD had higher fresh fruit yield than the former treatment. Occurrence of BER in well-watered control suggests 'Anchos St. Luis' to be a susceptible cultivar, and high incidence of blossom-end rot in DI and PRD plants may be attributed to calcium deficiency in fruit induced by water deficit conditions. Despite the high incidence of BER, yield was within an acceptable commercial range. In view of a high water-saving potential, maintenance of dry matter yield, and positive effects on some fruit quality attributes, we conclude that both DI and PRD can be feasible irrigation strategies where water shortage is acute.

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