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**Some factors affecting the yield and quality of sweet
pepper (*Capsicum annuum* L.) cv. Domino**

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Abstract

A series of studies were undertaken to examine some of the factors which influence yield and quality in sweet pepper. In the first study the influence of soil moisture status (stress and control) and harvesting regime (Green, Green-Red and Red) on growth, yield and Blossom-End Rot (BER) incidence on sweet pepper (*Capsicum annuum* L.) cv. Domino was carried out alongside a second experiment which examined the effect of water stress on fruit growth, and dry matter production and partitioning of destructively harvested sweet pepper plants.

These studies revealed that water stress reduced fruit number, and fresh and dry weights, increased fruit dry matter and hastened fruit maturity, but the stage of harvesting had no effect on both vegetative and reproductive yields. Water stress and harvesting stage had also little effect on the incidence of BER. An analysis showed that water stressed plants had a slightly higher incidence of BER than control plants. Water stress reduced the Ca concentration of fruit and leaves (which had a higher Ca concentration than fruit).

Sweet pepper fruit were the major assimilate sinks 60 days after transplanting and as plants became generative, there was a steady decline in leaf dry weights. RGR and NAR progressively increased while SLA and LAR decreased with plant ontogeny. At the final harvest control plants had accumulated 58% of the dry matter accumulated in their fruit against 49% for the stressed plants.

Fruit Ca, Mg and K increased throughout fruit development although most of the Ca accumulated during the early fruit growth period. The concentration of all these elements declined during the rapid fruit growth period 2-4 weeks after anthesis. A gradient in accumulation of Ca, Mg and K in the fruit was found with the stem-end of the fruit having more nutrients than the blossom-end. Both waxing and KOH treatments had little effect in the accumulation of nutrients in the fruit. Treatment with KOH however, slightly increased the concentration and contents of the mineral nutrients studied.

Sweet pepper plants were grown under Nutrient Film Technique (NFT) system using a nutrient solution of EC 2 mS.cm⁻¹. Higher nutrient conductivity levels of 4, 6, 8 and 10 mS.cm⁻¹ were achieved by adding concentrated KCl solution to the basic nutrient, and a high Ca solution with an EC of 10 mS.cm⁻¹ was developed with a mixture of KCl and CaCl₂ at a ratio of 3:1 (w/w).

Higher nutrient conductivity induced higher BER incidence which was related to the suppression of Ca uptake and accumulation in the fruit. This was accompanied by an increase in the accumulation of Mg and particularly K. Extra Ca at higher EC level promoted the accumulation of Ca by the fruit and reduced the incidence of BER. The reduction in Ca uptake in the fruit at higher EC was more pronounced at the blossom

end of the fruit. Fractionation of Ca compounds revealed that high EC levels reduced the physiologically active acetic acid soluble Ca compound, particularly during the rapid fruit growth stage when BER was likely to appear. Higher solution conductivity further reduced the accumulation of Ca in the roots and leaves while increasing those of Mg and K.

Higher conductivity of the nutrient solution resulted in small sized fruit, reduced fruit dry weights, decreased vegetative yields in terms of lower leaf area, SLA, diversion of more assimilates to shoots than fruit, decreased water consumption, decreased leaf ψ , decreased fruit firmness, increased leaf stomatal resistance, fruit dry matter content, fruit respiration and ethylene production and advancing fruit colour change.

Enclosing sweet pepper fruit with hygroscopic materials such as CaCl_2 and NaCl reduced the RH around the fruit and promoted Ca accumulation by the fruit. Fruit enclosed in polyethylene bags without the hygroscopic materials however, had higher RH and this suppressed Ca accumulation by the fruit. The use of an air flow system to regulate the RH around the fruit had a similar effect.

High RH treatment particularly reduced the Ca concentration in the distal part of the fruit which resulted in more BER. This incidence was related to fruit Ca concentration and content as well as the ratio of Ca to Mg and K. Humidity however, had little effect on sweet pepper fruit growth and the accumulation of Mg and K.

Sweet pepper is considered to be a non climacteric fruit which is independent of ethylene for ripening. Characterization of the changes in $\text{P}^i\text{C}_2\text{H}_4$, P^iCO_2 , P^iO_2 as well as colour change in mature green fruit at 20°C showed that $\text{P}^i\text{C}_2\text{H}_4$ significantly increased in both attached and detached fruit coincident with colour change. Detached fruit showed a steady decline in P^iCO_2 while attached fruit showed an increase in P^iCO_2 during ripening with out the climacteric. It is speculated that the decline in P^iCO_2 and the lower magnitude of $\text{P}^i\text{C}_2\text{H}_4$ in detached fruit was a result of egress of these gases through the pedicel rather than apparent difference in ripening physiology of attached and detached fruit. It was also suggested that the lack of climacteric respiration in attached fruit could be due to the overlapping of a CO_2 dependent photosynthesis by the fruit which declines with fruit age and fruit respiration which obscured the rise in P^iCO_2 . The association between sweet pepper cv. Domino fruit ripening and the significant increase in $\text{P}^i\text{C}_2\text{H}_4$ may indicate that ethylene may be responsible for ripening of sweet pepper fruit.

The maturity of sweet pepper fruit cv Domino was studied to determine objective maturity indices which correlate with physiological maturity. The attributes evaluated were fruit fresh weight, diameter, length, volume, pericarp thickness, firmness. Changes in surface colour change, TSS, P^iCO_2 , $\text{P}^i\text{C}_2\text{H}_4$, fruit respiration as well as ethylene production.

Fruit size and weight increased slowly during the early growth period and increased rapidly towards maturity. From 8 weeks after anthesis (WAA) until the final harvest

there was no a significant change in fruit size although it increased until 9 WAA. Starting from 8 WAA the hue angle values started to decline accompanied by an increase in chroma. Fruit surface colour change also coincided with a significant increase in $P^iC_2H_4$ and a slight increase in P^iCO_2 , respiration and ethylene production. The change in hue angle values was found to be an effective maturity index due to its correlation with most of the attributes evaluated. This coupled with WAA, TSS and fruit firmness appeared to be good indicators of fruit maturity.

On the other hand, treatment of mature green sweet pepper fruit cv. Domino with $1000 \mu l.l^{-1}$ ethylene promoted ripening by advancing colour change, TSS and acidity of treated fruit as compared with control. The treatment also increased fruit respiration and P^iCO_2 . However, treatment of half ripe fruit of the same cv. had less marked effect than mature green fruit. Treating sweet pepper fruit of the cv Evidence with ethylene at different maturity stage however, had no effect on colour change.

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Contents

	Page
i. Abstract	i
ii. Acknowledgements	iv
iii. Contents	vi
iv. List of Tables	xiv
v. List of Figures	xvi
vi. List of Abbreviations	xx
 1. General Introduction	 1
 2. Literature review	 5
2.1. Introduction	5
2.2. Botany, origin and classification	7
2.3. The food value and uses of capsicum	7
2.4. The physiology of pepper	9
2.4.1. The ontogeny of pepper plants	9
2.4.2. Flowering of sweet pepper	10
2.4.2.1. The influence of temperature on flowering	10
2.4.2.2. Flowering versus light intensity and photoperiod	12
2.4.2.3. Mineral nutrition and flowering	13
2.4.2.4. Flowering versus carbohydrate supply ...	13
2.4.3. Fruiting of sweet pepper	14
2.4.3.1. The effect of temperature on fruit set and development of pepper	14
2.4.3.2. Light intensity versus fruit set and plant development	14
2.4.4. Assimilate partitioning	15
2.5. Physiological effects of water stress	16
2.5.1. Water deficit and growth process	17
2.5.2. Water stress, photosynthesis and dry matter partitioning	19
2.5.3. Salt stress, plant growth and productivity	20
2.5.4. The role of ABA in relation to water stress	22
2.5.5. Stress ethylene production	22
2.6. Blossom-end rot: A physiological disorder	23
2.6.1. Causal agents of blossom-end rot	24
2.6.1.1. Calcium deficiency	24
2.6.1.2. Unfavourable moisture status	26
2.6.1.3. Rate and type of nutrients	28
2.6.1.4. Crop growth rate	30

2.6.2.	The mineral nutrient calcium	32
2.6.3.	Calcium availability, uptake and translocation	34
2.6.3.1.	Calcium availability	34
2.6.3.2.	Calcium uptake	34
2.6.3.3.	Calcium movement	35
2.6.3.4.	Calcium translocation	36
2.6.4.	Factors affecting calcium uptake and transport	38
2.6.4.1.	Temperature	38
2.6.4.2.	Humidity	39
2.6.4.3.	Salinity	40
2.6.4.4.	Indole Acetic Acid (IAA)	40
2.6.5.	Suggested remedies of control of BER	41
2.7.	Fruit Growth, maturity and ripening physiology	42
2.7.1.	Fruit growth	42
2.7.2.	Maturation and ripening	43
2.8.	Fruit ripening	47
I.	Internal changes	47
2.8.1.	Fruit respiration	47
2.8.2.	Hormonal regulation of ripening	50
2.8.2.1.	The ripening hormone ethylene	51
2.8.2.2.	Ethylene biosynthesis	52
2.8.3.	Carbohydrate changes	54
2.8.4.	Changes in organic acid composition	55
2.8.5.	Changes in aroma	56
II.	External changes	56
2.8.6.	Colour change	56
2.8.7.	Firmness and cell wall components	57
2.9.	Determination of fruit maturity	61
2.9.1.	Maturity indices of various fruit	62
2.10.	Summary	64

3. Growth, development and quality of sweet pepper (*Capsicum annuum* L.) cv. Domino in relation to moisture supply

3.1.	Introduction	66
3.2.	Materials and methods	69
3.2.1.	Treatments and plots, experiment one	69
3.2.2.	Greenhouse Procedures	70
3.2.3.	Recording, sampling and analysis	72
3.2.3.1.	Yield and yield components	72
3.2.3.2.	Blossom-end rot score	72
3.2.3.3.	Tissue mineral analysis of Ca, Mg and K	73
3.2.3.4.	Nitrogen and phosphorous	73
3.2.4.	Determination of minerals	74
3.2.5.	Treatments and procedure, experiment two	75
3.2.6.	Statistical procedure	77

3.3.	Results	79
3.3.1.	Total fresh fruit yield	79
3.3.2.	Total fruit dry weight	80
3.3.3.	Fruit number and average fruit size	80
3.3.4.	Incidence of blossom-end rot	80
3.3.5.	Tissue mineral analysis	84
3.3.6.	Fruit growth of sweet pepper	86
3.3.7.	Dry matter production and distribution	90
3.3.7.1.	Crop growth indices	90
3.3.7.2.	Dry matter distribution during ontogeny	93
3.3.7.3.	Dry matter distribution during the final harvest	96
3.4.	Discussion	98
3.4.1.	Sweet pepper growth and fruit yield	98
3.4.2.	Incidence of blossom-end rot	101
3.4.3.	Accumulation of nutrients	103
3.4.4.	Fruit growth	105
3.4.5.	Dry matter production and distribution	106
3.4.5.1.	Dry matter production	106
3.4.5.2.	Dry matter distribution	109
3.5.	Conclusion	111
4.	Accumulation and distribution of Ca, Mg and K in sweet pepper fruit during ontogeny as affected by chemical treatment	
4.1.	Introduction	112
4.2.	Materials and methods	114
4.2.1.	Greenhouse procedure	114
4.2.2.	Plant growing system and treatment application	114
4.2.3.	Data collection and analysis	115
4.2.4.	Statistical procedure	115
4.3.	Results	116
4.3.1.	Fruit growth	116
4.3.2.	Mineral concentration and content of fruit	116
4.3.3.	Mineral distribution within the fruit	122
4.4.	Discussion	128
4.4.1.	Fruit growth	128
4.4.2.	Mineral nutrient accumulation by sweet pepper fruit	128
4.4.3.	Gradient of minerals in the fruit	130
4.5.	Conclusion	131
5.	The influence of conductivity of the nutrient solution on fruit growth, incidence of BER, dry matter partitioning and gas exchange characteristics of sweet pepper (<i>Capsicum annuum</i> L.) cv. Domino	

5.1.	Introduction	132
5.2.	Materials and methods	135
5.2.1.	Plant material and culture	135
5.2.2.	Plant growing system	135
5.2.3.	Plants and treatments	136
5.2.4.	Recording, sampling and analysis	136
5.2.4.1.	Assessment of yield	136
5.2.4.2.	Incidence and severity of BER	137
5.2.4.3.	Fruit Fresh weight	137
5.2.4.4.	Fruit dry weight	137
5.2.4.5.	Fruit diameter and length	137
5.2.5.	Fruit growth analysis	138
5.2.6.	Plant component evaluation	138
5.2.7.	Stomatal resistance	139
5.2.8.	Leaf water potential	139
5.2.9.	Tissue mineral analysis and determination	140
5.2.10.	Fractionation of calcium	140
5.2.11.	Dry matter partitioning	141
5.2.12.	Measurement of respiration and ethylene production (static system)	141
5.2.12.1.	Analysis of gases (CO ₂ and O ₂)	142
5.2.12.2.	Analysis of ethylene	142
5.2.12.3.	Determination of gas concentration from chromatographic data	142
5.2.13.	Measurement of maturity and quality attributes	144
5.2.13.1.	Fruit skin colour	144
5.2.13.2.	Fruit firmness	144
5.2.13.3.	Total Soluble Solids (TSS)	145
5.2.13.4.	Percent dry matter	145
5.2.14.	Statistical procedure	145
5.3.	Results	146
5.3.1.	Fruit growth	146
5.3.2.	Accumulation of Ca, Mg, and K	146
5.3.2.1.	Concentration in the fruit	146
5.3.2.2.	Calcium distribution within the fruit	149
5.3.2.3.	Calcium fractionation	149
5.3.3.	Leaf and root concentration of Ca, Mg, and K	154
5.3.4.	Incidence of BER	154
5.3.5.	Fruit yield and size	161
5.3.6.	Stomatal resistance (r_s) and leaf ψ	161
5.3.7.	Dry matter partitioning	165
5.3.8.	Fruit quality	165
5.3.9.	Fruit ripening	169
5.3.9.1.	Colour change	169
5.3.9.2.	Fruit respiration and ethylene production	171

5.4.	Discussion	174
5.4.1.	Fruit growth	174
5.4.2.	Mineral nutrient accumulation	174
5.4.3.	Longitudinal gradient of Ca	177
5.4.4.	Calcium fractionation	178
5.4.5.	Incidence of BER	179
5.4.6.	Osmotic stress and plant growth and yield	181
5.4.7.	Stomatal resistance and leaf water potential	183
5.4.8.	Dry matter partitioning	183
5.4.9.	Fruit quality	185
5.4.10.	Fruit ripening	186
5.4.10.1.	Colour change	186
5.4.10.2.	Ethylene production	187
5.4.10.3.	Fruit respiration	188
5.5.	Conclusion	188
6.	The effect of relative humidity around the fruit or leaves on the accumulation of Ca, Mg and K by leaves and fruit of sweet pepper grown in NFT	
6.1.	Introduction	190
6.2.	Material and methods	192
6.2.1.	Glasshouse procedures	192
6.2.2.	RH treatment application	192
6.2.2.1.	Experiment one	192
6.2.2.2.	Experiment two	193
6.2.3.	Sampling and mineral analysis	194
6.2.4.	Evaluation of the incidence and severity of BER	195
6.2.5.	Statistical procedure	195
6.3.	Results	196
6.3.1.	Effect of hygroscopic materials or air flow system on RH around the fruit	196
6.3.2.	Fruit growth	196
6.3.3.	Incidence and severity of BER	201
6.3.4.	Accumulation of Ca, Mg, and K during fruit and leaf development	205
6.3.4.1.	Fruit mineral accumulation	205
6.3.4.2.	Longitudinal gradient of Ca, Mg and K in the fruit	206
6.3.4.3.	Leaf mineral accumulation	210
6.4.	Discussion	214
6.4.1.	Fruit dry matter accumulation	214
6.4.2.	Incidence of BER	214
6.4.3.	Mineral nutrient accumulation	215
6.4.3.1.	Fruit mineral accumulation	215
6.4.3.2.	Leaf mineral accumulation	217
6.5.	Conclusion	219

7. The ripening behaviour of attached and detached sweet pepper (*Capsicum annuum* L.) cv. Domino fruit

7.1.	Introduction	220
7.2.	Materials and methods	223
7.2.1.	Fruit source, experiment one	223
7.2.2.	Treatments	223
7.2.2.1.	Measurement from cavity through rubber seal	223
7.2.2.2.	Direct measurement in air	224
7.2.2.3.	Direct measurement under water	224
7.2.3.	Data collection, experiment one	225
7.2.4.	Fruit source, experiment two	225
7.2.5.	Data collection, experiment two	226
7.2.6.	Statistical procedure	226
7.3.	Results	227
7.3.1.	Sampling technique on colour development	227
7.3.2.	Sampling technique on $P^iC_2H_4$	227
7.3.3.	Sampling technique on P^iCO_2 and P^iO_2	231
7.3.4.	Colour change of attached and detached fruit	231
7.3.5.	Changes in P^iCO_2 of attached and detached fruit	235
7.3.6.	Changes in $P^iC_2H_4$ concentration	240
7.4.	Discussion	243
7.4.1.	Sampling technique	243
7.4.2.	Attached and detached fruit	244
7.4.2.1.	Colour change of attached and detached fruit	244
7.4.2.2.	P^iCO_2 and P^iO_2 of attached and detached fruit	245
7.4.2.3.	$P^iC_2H_4$ of attached and detached fruit	248
7.5.	Conclusion	251

8. The physiology of fruit growth, maturity and ripening of sweet pepper (*Capsicum annuum* L.) cv Domino

8.1.	Introduction	252
8.2.	Materials and methods	255
8.2.1.	Plant material, experiment one	255
8.2.2.	Fruit growth attributes	255
8.2.2.1.	Fruit fresh weight	255
8.2.2.2.	Fruit diameter and length	255
8.2.2.3.	Fruit volume	256
8.2.2.4.	Pericarp thickness	256
8.2.3.	Measurement of maturity attributes	256
8.2.3.1.	Fruit skin colour	256
8.2.3.2.	Fruit firmness	257

8.2.3.3.	Total Soluble Solids (TSS)	257
8.2.3.4.	Titrateable acidity	257
8.2.3.5.	Fruit respiration and ethylene production	258
8.2.3.6.	Internal gas samples of carbon dioxide and ethylene	258
8.2.4.	Prediction of fruit growth	258
8.2.5.	Fruit materials, experiment two	259
8.2.6.	Ethylene treatment in a static system	260
8.2.7.	Ethylene treatment in a flow system	260
8.2.8.	Fruit assessment	261
8.2.9.	Statistical procedure	261
8.3.	Results	262
8.3.1.	Fruit growth pattern	262
8.3.2.	Physicochemical changes	266
8.3.2.1.	Fruit firmness	266
8.3.2.2.	Total soluble solids content	266
8.3.2.3.	Colour change	266
8.3.3.	Physiological changes	270
8.3.4.	Assessment of fruit maturity	270
8.3.5.	Effect of ethylene treatment on colour change	273
8.3.6.	Rate of respiration	282
8.3.7.	P^iCO_2 and $P^iC_2H_4$	282
8.3.8.	Fruit quality	282
8.4.	Discussion	286
8.4.1.	Fruit growth	286
8.4.2.	Colour change during fruit growth and development	288
8.4.3.	Changes in fruit quality	288
8.4.3.1.	Fruit firmness	288
8.4.3.2.	Total soluble solids	289
8.4.3.3.	Fruit respiration and ethylene production	289
8.4.4.	Indicators of fruit maturity	290
8.4.5.	Ethylene treatment and fruit colour change	291
8.4.6.	Ethylene treatment and fruit respiration	292
8.4.7.	Ethylene treatment and fruit quality	293
8.5.	Conclusion	294
9.	General Discussion	296
9.1.	Calcium uptake and accumulation in fruit during ontogeny	296
9.2.	Seasonal trends in the incidence of blossom-end rot	301
9.3.	Dry matter production and partitioning	306
9.4.	Fruit maturity and ripening	309
9.4.1.	Fruit maturity	309
9.4.2.	Fruit ripening	311
10.	References	315

	Page
Appendices	
Appendix 1 Stock solution for the NFT growing system	357
Appendix 2 The parameter values for the curves fitted to Richards function	358

List Of Tables

	Page
Table 2.1. Capsicum production in 1993	6
Table 2.2. Average nutritional value of sweet pepper and hot pepper	8
Table 2.3. Comparison of sources of vitamin C and A	9
Table 2.4. Calcium regulated physiological processes in plants	33
Table 2.5. List of fruits showing different patterns of growth	44
Table 2.6. Methods of maturity determination	63
Table 3.1. Mineral analysis of the nutrient feed	70
Table 3.2. Effects of water stress and harvesting regimes on total fresh fruit weight	79
Table 3.3. Total dry weight and percent dry matter content of sweet pepper fruit	81
Table 3.4. Effect of water stress on fruit number, average fruit size and fruit length:diameter ratio	82
Table 3.5. Effects of irrigation treatment and fruit harvest maturity on the incidence and severity of BER	83
Table 3.6. Effects of watering level on the incidence of BER on early and late harvested fruit	85
Table 3.7. Major nutrient concentration of sweet pepper fruit and leaves	86
Table 3.8. Effect of water stress on vegetative growth and quality	97
Table 4.1. Coefficients of the Richards function for sweet pepper fruit fresh weights	118
Table 4.2. Distribution of Ca and K in different portions of KOH treated sweet pepper fruit	124
Table 4.3. Distribution of Ca and K in different portions of wax treated sweet pepper fruit	125
Table 4.4. Distribution of Ca and K in different portions of control sweet pepper fruit	126
Table 5.1. Calcium concentration of different Ca fractions in the blossom-end of sweet pepper fruit	152
Table 5.2. Calcium concentration of different Ca fractions in the stem-end of sweet pepper fruit	153
Table 5.3. The effect of conductivity of the nutrient solution on BER incidence	160
Table 5.4. Correlation between the incidence of BER and fruit Ca, Mg and K	160
Table 5.5. Effect of EC levels on total number, average size, water content and yield of sweet pepper	162
Table 5.6. Water consumption of sweet pepper plants under different levels of conductivity	163
Table 5.7. Leaf water potential of plants grown under different levels of conductivity	163

Table 5.8.	Effect of conductivity of the nutrient solution on total dry weight and partitioning of dry matter in sweet pepper at harvest	166
Table 5.9.	Effect of conductivity of the nutrient solution on the growth components of sweet pepper plants	167
Table 5.10.	Effect of conductivity of the nutrient solution on some quality attributes	169
Table 6.1.	Effect of RH treatment on sweet pepper log _e fruit fresh weight, dry weight, moisture content and Ca concentration (Experiment one)	202
Table 6.2.	Effect of RH treatment on sweet pepper log _e fruit fresh weight, dry weight, moisture content and Ca concentration (experiment two)	203
Table 6.3.	The incidence and severity of BER as affected by RH (experiment one)	204
Table 6.4.	The incidence and severity of BER as affected by RH (experiment two)	204
Table 6.5.	Correlation coefficient between BER and levels of mineral nutrients (experiment one)	205
Table 6.6.	Correlation coefficient between BER and levels of mineral nutrients (experiment two)	205
Table 7.1.	Effect of treatment on the rate of colour and gas exchange of sweet pepper fruit	236
Table 8.1.	Correlation matrix between the variables analyzed	272
Table 8.2.	Percentage of variance explained by each component	275
Table 8.3.	Correlation coefficients of variables with the two principal components	275
Table 8.4.	Fruit quality of sweet pepper fruit of the cv Domino as affected by ethylene treatment compared with plant ripened fruit	285
Table 9.1.	A summary of factors affecting Ca uptake and incidence of BER	305

List of Figures

	Page
Fig. 2.1. Cross section of a pepper flower	11
Fig. 2.2. Pathway of calcium transport in plants	36
Fig. 2.3. Stages of development and senescence of horticultural crops	46
Fig. 2.4. The two classes of respiratory patterns in fruits	49
Fig. 2.5. Pathway of ethylene biosynthesis	53
Fig. 2.6a. Cross section of capsicum fruit	60
Fig. 2.6b. Stained pericarp tissue of pepper	60
Fig. 3.1. Seasonal accumulation of Ca in sweet pepper fruit (A) and leaf (B)	87
Fig. 3.2. Cumulative diameter growth (A) Log _e diameter (B) and RGR (C) of sweet pepper fruit	88
Fig. 3.3. Cumulative length growth (A) Log _e length (B) and RGR (C) of sweet pepper fruit	89
Fig. 3.4. Cumulative dry weight (A) Log _e dry weight (B) and RGR (C) of sweet pepper	91
Fig. 3.5. LAR (A) and NAR (B) derived from a fitted curve	92
Fig. 3.6. SLA (A) and LWR (B) derived from a fitted curve	94
Fig. 3.7. Dry matter partitioning in sweet pepper plants during ontogeny	95
Fig. 3.8. Dry matter partitioning of sweet pepper plants at the final harvest	95
Fig. 4.1. Sweet pepper fruit log _e fresh weight (A) and log _e dry weight (B) growth over time	117
Fig. 4.2. Sweet pepper fruit Ca concentration (A) and Ca content (B) over time	119
Fig. 4.3. Sweet pepper fruit Mg concentration (A) and Mg content (B) over time	120
Fig. 4.4. Sweet pepper fruit K concentration (A) and K content (B) over time	121
Fig. 4.5. Sweet pepper log _e Ca (A) Mg (B) and K (C) content plotted against fruit log _e dry weight	123
Fig. 5.1. Cumulative fresh weight (A) and Log _e fresh weight (B) of sweet pepper fruit as affected by the EC levels	147
Fig. 5.2. Fruit Ca concentration (A) and Ca content (B) as affected by the EC levels	148
Fig. 5.3. Fruit Mg (A) and K (B) concentrations as affected by the EC levels	150
Fig. 5.4a. Fruit Ca concentration at the blossom-end of sweet pepper fruit	151
Fig. 5.4b. Fruit Ca concentration at the stem-end of sweet pepper fruit	151

Fig. 5.5.	Acetic acid soluble (A) and hydrochloric acid soluble (B) Ca fractions	155
Fig. 5.6.	Non extractable (A) and total fractionated (B) Ca fractions	156
Fig. 5.7a.	Leaf Ca concentration as affected by EC levels	157
Fig. 5.7b.	Root Ca concentration as affected by EC levels	157
Fig. 5.8a.	Leaf Mg concentration as affected by EC levels	158
Fig. 5.8b.	Root Mg concentration as affected by EC levels	158
Fig. 5.9a.	Leaf K concentration as affected by EC levels	159
Fig. 5.9b.	Root K concentration as affected by EC levels	159
Fig. 5.10.	Leaf stomatal resistance of sweet pepper plants	164
Fig. 5.11.	Effect of EC levels on dry matter partitioning between different plant organs	168
Fig. 5.12.	Chroma (A) and hue angle (B) with time as affected by EC levels	170
Fig. 5.13.	Lightness of sweet pepper fruit with time as affected by EC levels	172
Fig. 5.14.	Fruit respiration (A) and ethylene production (B) with time as affected by EC levels	173
Fig. 6.1.	The system used to humidify flow through chambers	194
Fig. 6.2.	Day time (A) and night time (B) RH, experiment one	197
Fig. 6.3.	Day time (B) and night time (B) RH, experiment two	198
Fig. 6.4.	Cumulative fruit fresh weight (A) and \log_e fresh weight (B) as affected by the level of RH around the fruit, experiment one	199
Fig. 6.5.	Cumulative fruit fresh weight (A) and \log_e fresh weight (B) as affected by the level of RH around the fruit, experiment two	200
Fig. 6.6a.	Fruit Ca concentration as affected by the level of RH around the fruit, experiment one	207
Fig. 6.6b.	Fruit Ca concentration as affected by the level of RH around the fruit, experiment two	207
Fig. 6.7.	Total fruit Mg (A) and K (B) concentration as affected by RH around the fruit, experiment one	208
Fig. 6.8.	Total fruit Mg (A) and K (B) concentration as affected by RH around the fruit, experiment two	209
Fig. 6.9.	Fruit blossom-end (A) and stem-end (B) Ca concentration, experiment one	211
Fig. 6.10.	Fruit blossom-end (A) and stem-end (B) Ca concentration, experiment two	212
Fig. 6.11.	Sweet pepper leaf Ca (A) Mg (B) and K (C) concentration as affected by RH	213
Fig. 7.1.	Lightness (A) and chroma values (B) of fruit as influenced by method of gas extraction, experiment one	228
Fig. 7.2.	Hue angle (A) and \log_e $P^iC_2H_4$ (B) of sweet pepper fruit as influenced by method of gas extraction, experiment one	229
Fig. 7.3.	\log_e $P^iC_2H_4$ and hue angle (A) and $P^iC_2H_4$ and P^iCO_2 (B) of	

	sweet pepper fruit, experiment one	230
Fig. 7.4.	P^iCO_2 (A) and P^iO_2 (B) with time as influenced by method of gas extraction, experiment one	232
Fig. 7.5.	Lightness (A) and chroma (B) of attached and detached sweet pepper fruit	233
Fig. 7.6.	Hue angle (A) and $\log_e P^iC_2H_4$ (B) of attached and detached sweet pepper fruit	234
Fig. 7.7.	Hue angle and chroma values of attached (A) and detached (B) sweet pepper fruit	237
Fig. 7.8.	P^iCO_2 (A) and P^iO_2 (B) of attached and detached sweet pepper fruit	238
Fig. 7.9.	Hue angle and P^iCO_2 of attached (A) and detached (B) sweet pepper fruit	239
Fig. 7.10.	Hue angle and $\log_e P^iC_2H_4$ of attached (A) and detached (B) sweet pepper fruit	241
Fig. 7.11.	P^iCO_2 and $\log_e P^iC_2H_4$ of attached (A) and detached (B) sweet pepper fruit	242
Fig. 8.1.	Cumulative growth of sweet pepper fruit in terms of fresh weight (A) volume (B) diameter (C) and length (D)	263
Fig. 8.2.	Cumulative growth of \log_e fresh weight (A) and RGR (B) of sweet pepper fruit	264
Fig. 8.3a.	Fitting data of the fresh weight and diameter of sweet pepper fruit	265
Fig. 8.3b.	Validation data of fresh weight and diameter of sweet pepper fruit	265
Fig. 8.4a.	Sweet pepper fruit volume calculated from diameter and length against measured volume	267
Fig. 8.4b.	Measured fresh weight and calculated fresh weight of sweet pepper fruit	267
Fig. 8.5.	Fruit pericarp thickness (A) firmness (B) TSS (C) and shape (D) of sweet pepper fruit during ontogeny	268
Fig. 8.6.	Sweet pepper fruit lightness (A) chroma (B) and hue angle (C) plotted against time	269
Fig. 8.7.	Sweet pepper fruit respiration (A) and ethylene production (B) internal CO_2 (C) and internal ethylene (D) concentrations during ontogeny	271
Fig. 8.8.	Principal component analysis of the physicochemical and physiological attributes of sweet pepper fruit	274
Fig. 8.9.	Lightness (A) chroma (B) and hue angle values (C) of sweet pepper fruit over time as a result of ethylene treatment	276
Fig. 8.10.	Lightness (A) chroma (B) and hue angle values (C) of sweet pepper fruit over time as a result of ethylene treatment compared with plant ripened fruit	278
Fig. 8.11.	Lightness (A) chroma (B) and hue angle values (C) of field grown sweet pepper fruit as a result of ethylene treatment	279
Fig. 8.12.	Hue angle values of sweet pepper fruit of the cv Evidence	

	over all maturity class in time as a result of ethylene treatment	280
Fig. 8.13.	Lightness (A) chroma (B) and hue angle values (C) of sweet pepper fruit over time at different maturity period	281
Fig. 8.14a.	Sweet pepper fruit respiration of ethylene treated and control fruit	283
Fig. 8.14b.	Respiration of ethylene treated fruit compared to plant ripened fruit	283
Fig. 8.15.	Internal CO ₂ concentration of ethylene treated, control and plant ripened greenhouse grown sweet pepper fruit	284
Fig. 8.16.	Internal CO ₂ (A) and internal ethylene (B) concentrations of ethylene treated and control field grown sweet pepper fruit	284

List of Abbreviations

BER	Blossom end rot
DM	Dry matter
AASP	Atomic absorption spectrophotometer
LAR	Leaf area ratio
NAR	Net assimilation rate
RGR	Relative growth rate
SLA	Specific leaf area
LWR	Leaf weight ratio
FWR	Fruit weight ratio
SWR	Stem weight ratio
RWR	Root weight ratio
HI	Harvest index
C	Cytoplasm
V	Vacuole
ER	Endoplasmic reticulum
CS	Casparian strip
ANOVA	Analysis of variance
a.i.	Active ingredient
kg	kilogram
g	gram
P	Probability
SE	Standard error
SEM	Standard error of means
t	time
Ln	natural logarithm
DAA	Days after anthesis
WAA	Weeks after anthesis
C ₂ H ₄	Ethylene
CO ₂	Carbon dioxide
O ₂	Oxygen
STD	Standard
TSS	Total soluble solids
P ⁱ C ₂ H ₄	Internal C ₂ H ₄ concentration
P ⁱ CO ₂	Internal CO ₂ concentration
mm	millimetre
cm	Centimetre
cc ³	Cubic centimetre
Pa	Pascal
kPa	Kilo pascal
Ca	Calcium
Mg	Magnesium
K	Potassium

°C	Degree celsius
EC	Electrical conductivity
pH	Measure of acidity or alkalinity of a solution
ψ	Leaf water potential
NFT	Nutrient film technique
RH	Relative humidity
VPD	Vapour pressure deficit
RCBD	Randomized complete block design
GLM	General linear model
SAS	Statistical analysis system
°	Degree angle
r	Partial correlation
R ²	Coefficient of determination
v/v	volume ratio
w/w	weight ratio
N.D.	no date given