

DEDICATION

To the Soul of my Beloved Brother-in-Law, Lieutenant General Mohammed Salih Khalil in the Heavens (*Rahmatullah alieh*), who Regretfully did not Live to See this work.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirements of the degree of Doctor of Philosophy

**EFFECT OF RICE STRAW COMPOST AND WATER REGIMES ON GROWTH
PERFORMANCE OF TOMATO (*LYCOPERSICUM ESCULENTUM* L.)**

By

HASSAN IBRAHIM ALI

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Chairman: Associate Professor Mohd. Razi Ismail, PhD

Faculty: Agriculture

The use of low technological agronomic manipulations, such as composted organic amendments and new irrigation techniques can contribute positively in water use efficiency and agriculture sustainability under limited resources. The objective of this study was to evaluate the effect of rice straw compost on plant physiological status, growth, yield, fruit quality and water use of tomato grown under protected environment in humid climatic conditions of Malaysia, using soilless and soil mixture media in combination with water regimes either by withholding or by using partial rootzone drying (PRD) technique.

Rice straw compost treated with chicken manure (2:1) using static aeration pile system has suitable physiochemical properties ranging within compost standards. The use of rice straw compost in combination with a peat based vegetable transplant media, especially with 25% and 50% compost mixture was observed to provide a more appropriate medium compared to rice straw

compost or peat mix alone for production of tomato seedlings and showed improvement in all growth parameters. The addition of rice straw compost at 30%, significantly increased plant dry biomass, fruit diameter, yield and water use efficiency (WUE) in both media, whereas the water deficit significantly decreased these parameters in most of the treatments. The addition of rice straw compost, however, had opposite effects on the two media in terms of total organic matter. The total organic matter significantly increased in the soil mixture, while it significantly decreased in the soilless media. The results indicated that the soilless media was not affected by the stress regime in most of these parameters. This suggests that the soilless media increased the water holding capacity and other physical properties better than the soil mixture. The results also indicated that media drying decreased leaf water potential, stomatal conductance, as well as, plant dry biomass, in addition to increasing proline accumulations, with slight differences between the different growth media.

PRD, on the other hand, was observed to significantly reduce leaf expansion, plant leaf area and stomatal conductance in both media, but severely with soil mixture, whereas proline and sugars namely fructose, glucose and sucrose, were dramatically increased in the leaf especially with soil mixture. Stomatal conductance, leaf expansion and proline accumulation, however, significantly correlated with media drying. Dry matter partitioning showed a significant reduction in total dry matter and plant dry shoot weight with

PRD, but significantly increased root to shoot ratio with no significant differences in plant dry root weight. WUE increased significantly with PRD in both media. The use of soilless media resulted in a significant increase in all biological parameters. Yield was also affected with PRD in both media; there was significant interaction between the two media and irrigation regime. However, there was no significant reduction in marketable yield due to PRD in soilless media. This suggests that PRD application could be effective in soilless media. PRD significantly improved fruit carbohydrates and other fruit quality indices.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN KOMPOS JERAMI PADI DAN REGIM AIR KE ATAS
PELAKSANAAN PERTUMBUHAN TANAMAN TOMATO (*LYCOPERSICON
ESCULENTUM* L.)**

Oleh

HASSAN IBRAHIM ALI

Februari 2005

Pengerusi : Professor Madya Mohd Razi Ismail, PhD

Fakulti : Pertanian

Penggunaan manipulasi teknologi pertanian yang rendah, seperti pemindaan bahan-bahan kompos organik dan teknik pengairan yang baru boleh menyumbang secara positif kepada penggunaan air secara rasional dan keseimbangan pertanian di bawah sumber yang terhad. Objektif kajian ini adalah menilai kesan pembentukan kompos sekampadi terhadap status fisiologi, pertumbuhan, hasil, kualiti buah dan penggunaan air bagi tanaman tomato di bawah persekitaran terkawal dalam keadaan iklim lembap Malaysia. Dua sumber media berbeza dengan kombinasi rejim air samada melalui tanpa pemberian air atau melalui teknik pengeringan sebahagian zon akar (PRD) digunakan.

Campuran kompos hampas padi dengan bahan buangan ayam pada nisbah (2:1) menggunakan sistem pengudaraan statik adalah sesuai dan setanding dengan kompos piawai. Penggunaan sekam padi secara kombinasi dengan media transplant sayuran, terutamanya dengan 25% dan 50% campuran

kompos menyediakan medium yang lebih sesuai berbanding kompos sekam padi atau campuran sekam semata-mata bagi tujuan penghasilan anak pokok tomato dengan parameter pertumbuhan pokok. Pertambahan kompos sekam padi pada kadar 30%, akan meningkatkan hasil kering tumbuhan, diameter buah, hasil dan penggunaan air secara efisien (WUE) pada kedua-dua media. Bagaimanapun pengurangan air secara signifikan akan mengurangkan parameter yang tersebut. Aplikasi kompos sekam padi bagaimanapun memberikan kesan kontra pada jumlah bahan organik di dalam kedua-dua media. Jumlah bahan organik meningkat secara signifikan di dalam rumah kaca dan menurun secara signifikan di dalam media tanpa tanah. Keputusan tersebut menunjukkan media tanpa tanah tidak dipengaruhi oleh pengaruh tekanan air di dalam kebanyakan parameter. Ini menunjukkan bahawa media tanpa tanah dapat meningkatkan kemampuan memegang air (water holding capacity/WHC) dan jisim fizikal lebih baik berbanding tanah di dalam rumah kaca. Keputusan ini juga menunjukkan pengeringan media menurunkan potensi air di dalam daun, konduktiviti stomata selain daripada jisim kering tumbuhan. Selain itu, peningkatan pengumpulan dengan perbezaan yang kecil di dalam media yang berbeza.

PRD menunjukkan hubungan yang bererti di dalam mengurangkan pengembangan daun, keluasan daun dan konduksi stomata di dalam kedua-dua media tetapi dengan standard tanah di dalam rumah kaca di mana prolindan fruktosa, glukosa dan sukrosa meningkat di dalam daun di media

rumah kaca. Walau bagaimanapun, konduksi stomata, pengembangan daun dan pengumpulan prolin mempunyai hubungan beerti di dalam jumlah jisim kering dan berat kering pucuk tumbuhan dengan PRD, akan tetapi pertambahan beerti nisbah akar ke pucuk dengan tiada perbezaan beerti di dalam berat kering akar pokok. WUE meningkat secara beerti sejajar dengan PRD di dalam kedua-dua media. Kegunaan media tanpa tanah memberikan hasil peningkatan beerti di dalam semua parameter biologikal. Hasil juga didapati dipengaruhi dengan PRD di dalam kedua media, terdapat hubungan yang beerti di antara dua media dan pengairan. Walau bagaimanapun, tiada penurunan beerti di dalam hasil pasaran akibat daripada kehadiran PRD di dalam media tanpa tanah. Ini menunjukkan aplikasi PRD adalah berkesan di dalam media tanpa tanah. Kehadiran PRD meningkatkan kandungan karbohidrat dan kualiti indeks kualiti buah.

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I certify that an Examination Committee met on February 15/2005 to conduct the final examination of Hassan Ibrahim Ali on his Doctor of Philosophy thesis entitled “ Effect of Rice Straw Compost and Water Regimes on Growth Performance of Tomato (*Lycopersicon esculentum* L.) ” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Adul Shukor Bin Juraimi, PhD

Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Mohd Rizwan Abdul Halim, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Raziah Othman, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Agamuthu Pariathamby, PhD

Professor
Faculty Science
Universiti Malaya
(Independent Examiner)

GULAM RUSUL RAHMAT ALI, PhD

Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

Mohd. Razi Ismail, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Mohd. Mokhtaruddin Ab. Manan, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Halimi Mohd. Saud, PhD

Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

AINI IDERIS, PhD

Professor/Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I here by declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

HASSAN IBRAHIM ALI

Date:

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	vi
ACKNOWLEDGEMENTS	ix
APPROVAL	xi
DECLARATION	xiii
LIST OF TABLES	xix
LIST OF FIGURES	xxii
LIST OF ABBREVIATIONS AND SYMBOLS	xxv
 CHAPTER	
 1 INTRODUCTION	 1
 2 LITERATURE REVIEW	 6
2.1 Rice Straw Management Potential and Problems	6
2.2 Composting	9
2.2.1 Historical Background	9
2.2.2 Factors Affecting Composting Process	12
2.2.3 Compost Quality and Standards Aspects	21
2.3 Utilization of Compost in Horticultural Cropping Systems	25
2.3.1 Compost Used for Transplant Production	25
2.3.2 Compost Effects on Growth and Yield in Commercial Vegetable Cropping Systems	28
2.3.3 Uses of Compost as Organic Additives for soilless culture	36
2.4 Uses of Composts to Improve Soil Organic Matter and to Alleviate Plant Stress	37
2.5 Partial Rootzone Drying (PRD) as New Irrigation Technique	41
2.5.1 The Physiological and Agronomical Consequences of PRD	43
2.5.2 The Exploitation of Plants Stress System to Increase the Efficiency of Water Use in Agriculture	47
2.6 Tomato and its Importance	49
 3 COMPOSTING OF RICE STRAW TREATED WITH CHICKEN MANURE	 51
3.1 .Introduction	51
3.2 Materials and methods	52

	3.2.1 Preparation of composting materials	52
	3.2.2 Grinding, shredding and sampling of materials	53
	3.2.3 Method for physiochemical determination	53
	3.2.4 Composting process	60
3.3	Results	64
	3.3.1 Preliminary experiment of the different ratios	66
	3.3.2 Factors affecting composting process	70
	3.3.3 Bacterial total plate count	78
	3.3.4 Plant bioassay during composting	78
	3.3.5 Physiochemical characteristics of finished compost	79
3.4	Discussion	86
4	RICE STRAW COMPOST USED AS SOILLESS MEDIA FOR TOMATO TRANSPLANT PRODUCTION	92
	4.1 Introduction	92
	4.2 Materials and methods	94
	4.2.1 Compost material	94
	4.2.2 Treatments and seed material	94
	4.2.3 Parameters measured and statistical analysis	96
4.3	Results	97
	4.3.1 EC and pH of different media combination	97
	4.3.2 Total carbon, ash % and C/N ratio	98
	4.3.3 Some nutrients status of different media combination	99
	4.3.4 Seed germination % in the different media combination	100
	4.3.5 Plant growth performance of the different media combination	101
4.4	Discussion	105
5	EFFECT OF RICE STRAW COMPOST AND WATER DEFICIT ON PHYSIOLOGICAL PARAMETERS, GROWTH, YIELD, FRUIT QUALITY AND WATER USE EFFICIENCY OF TOMATO GROWN IN TWO MEDIA	109
	5.1 Introduction	109
	5.2 Materials and methods	111
	5.2.1 plant materials	111
	5.2.2 Treatments and experimental design	112
	5.2.3 Stomatal Conductance	113
	5.2.4 Leaf water potential (LWP)	114
	5.2.5 Proline assay	115
	5.2.6 Soil moisture content	116
	5.2.7 Plant days to 100% wilt	116
	5.2.8 Plant dry biomass	116

5.2.9	Yield and yield components	117
5.2.10	Plant water use efficiency (WUE)	117
5.2.11	Fruits sampling and samples analysis	118
5.2.12	Fruit quality index determination	118
5.3	Results	124
5.3.1	Stomatal conductance	124
5.3.2	Leaf water potential (LWP)	128
5.3.3	Proline accumulation	131
5.3.4	Media moisture content	134
5.3.5	Plant days to 100% wilt	138
5.3.6	Plant dry biomass	138
5.3.7	Yield and yield components	140
5.3.8	Plant water use efficiency (WUE)	143
5.3.9	Fruit quality indices and carbohydrates	145
5.4	Discussion	145
5.4.1	Stomatal conductance	145
5.4.2	Leaf water potential (LWP)	147
5.4.3	Proline accumulation	148
5.4.4	Media moisture content	150
5.4.5	Plant days to 100% wilt	151
5.4.6	Plant dry biomass	151
5.4.7	Yield and yield components	152
5.4.8	Plant water use efficiency (WUE)	154
5.4.9	Fruit quality indices and carbohydrates	155

6 EFFECT OF PARTIAL ROOTZONE DRYING (PRD) ON DRY MATTER PARTITIONING, YIELD, QUALITY, CARBOHYDRATE ACCUMULATIONS AND WATER USE EFFICIENCY (WUE) OF TOMATO GROWN IN TWO MEDIA 156

6.1	Introduction	156
6.2	Materials and methods	158
6.2.1	plant materials	158
6.2.2	Treatments and experimental design	159
6.2.3	Stomatal Conductance	160
6.2.4	Leaf water potential (LWP)	160
6.2.5	Leaf expansion	161
6.2.6	Proline assay	161
6.2.7	Leaf carbohydrate (sugars)	161
6.2.8	Leaf area and dry matter partitioning	162
6.2.9	Soil moisture content	162
6.2.10	Yield and yield components	162
6.2.11	Harvest quality index (HQI)	163
6.2.12	Plant water use efficiency (WUE)	163
6.2.13	Fruits sampling and samples analysis	163

6.2.14	Fruit quality index determination	164
6.3	Results	166
6.3.1	Stomatal conductance	166
6.3.2	Leaf water potential (LWP)	167
6.3.3	Leaf expansion	168
6.3.4	Proline accumulation	168
6.3.5	Leaf carbohydrate (sugars)	171
6.3.6	Leaf area and dry matter partitioning	173
6.3.7	Media moisture content	175
6.3.8	Relation trends between media drying, leaf expansion and proline accumulation	177
6.3.9	Yield and yield components	179
6.3.10	Harvest quality index (HQI)	181
6.3.11	Plant water use efficiency (WUE)	181
6.3.12	Fruit quality indices and fruit carbohydrates	182
6.4	Discussion	186
6.4.1	Stomatal conductance	186
6.4.2	Leaf water potential (LWP)	187
6.4.3	Leaf expansion	189
6.4.4	Proline accumulation	190
6.4.5	Leaf carbohydrate (sugars)	191
6.4.6	Leaf area and dry matter partitioning	192
6.4.7	Media moisture content	193
6.4.8	Relation trends between media drying, leaf expansion and proline accumulation	194
6.4.9	Yield and yield components	195
6.4.10	Harvest quality index (HQI)	197
6.4.11	Plant water use efficiency (WUE)	198
6.4.12	Fruit quality indices and fruit carbohydrates	199
7	GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS	201
	REFERENCES	212
	APPENDICES	242
	BIODATA OF THE AUTHOR	273

LIST OF TABLES

Table		Page
2.1	Rice Straw Characterization	9
2.2	Relative Importance of Compost Quality Measurements for Horticultural Applications	22
2.3	Suggested Compost Quality Guidelines for Horticultural Applications	23
2.4	Evaluation of Feedstocks for Composts Used in growing Media for Vegetable Transplants	27
2.5	Effects of Partial Rootzone Drying (PRD) on Yield, Amount of Water and Water Use Efficiency (WUE) of Two Grapevine Varieties	46
2.6	Effects of PRD on Shoot Growth, Water Use and Fruit Quality Components of Control (C) and Treated (T) Cabernet Sauvignon Field Vines	46
3.1	Chemical and Physical Properties of Ground Rice Straw Used as Compost Materials	65
3.2	Chemical and Physical Properties of Chicken Manure Used as Compost Materials	66
3.3	Selected characteristics of three composting mixtures of rice straw and chicken manure at beginning and end of composting process	69
3.4	Chemical and Physical Properties of Finished Rice Straw Compost Treated with Chicken Manure	84
3.5	Total nitrogen, heavy metal content and some other quality indices of rice straw compost treated with chicken manure (RSCM) compare to German standards, Eu states and USA limits	85
4.1	Rice straw compost to peat combination percentages and ratios	95
4.2	Chemical and physical properties of peat	95

4.3	Initial and final EC and pH for different treatment combination used as media for tomato transplant production	98
4.4	Initial and final total C, ash % and C/N ratio for different treatment combination used as media for tomato transplant production	99
4.5	Initial and final total N%, P%, K% and Ca% for different treatment combination used as media for tomato transplant production	100
4.6	Rice straw compost used as vegetable transplant soilless media effects on germination % of tomato	101
5.1	Chemical and physical properties of coconut coir dust	121
5.2	Selected Physiochemical characteristics of the topsoil (Serdang Series) used in soil mixture media	122
5.3	Particle size distribution in the sand samples used in greenhouse media	122
5.4	Selected physical and chemical properties of different growing media amended with rice straw compost	123
5.5	Summary of ten parameters of ANOVA tables for different growing media amended with rice straw compost in combination with water regimes and their interactions	140
5.6	Effect of different growing media amended with rice straw compost in combination with water regimes on plant dry biomass, yield and quality components, carbohydrates and water use efficiency (WUE) of tomatoes	142
5.7	Effect of water regime on the different media on plant dry biomass, total yield per plant, fruit diameter and water use efficiency (WUE ²).	144

6.1	Summary of twenty-two parameters of ANOVA tables for different growing media amended with rice straw compost in combination with partial rootzone dry (PRD) system and their interactions	174
6.2	Plant leaf area, dry matter partitioning and water use efficiency (WUE ¹) as affected by growing media amended by rice straw compost and partial rootzone drying system of tomatoes	175
6.3	Yield and yield components, harvest quality index and water use efficiency (WUE ²) as affected by two growing media amended by rice straw compost and partial rootzone drying system of tomatoes	180
6.4	Some fruit quality indices and carbohydrates as affected by two growing media amended by rice straw compost and partial rootzone drying system of tomatoes	183
6.5	Effect of partial rootzone drying systems on the different media on plant leaf area, no of flowers, marketable yield, harvest quality index and water use efficiency (WUE ²).	185

LIST OF FIGURES

Figure		Page
3.1	Diagram shows the composting process of rice straw with chicken manure with aeration system and 3 PVC tubes inside the bin with the compost mixture	61
3.2	Temperature trends during composting of three mixtures of rice straw and chicken manure. Bars represent standard errors.	68
3.3	Compost piles and air temperature trends during composting of rice straw treated with chicken manure	71
3.4	Electrical conductivity (EC) variation during composting of rice straw treated with chicken manure	73
3.5	pH trend during composting of rice straw treated with chicken manure	74
3.6	Variations of O ₂ % during composting of rice straw treated with chicken manure	75
3.7	Moisture content trend during composting of rice straw treated with chicken manure	76
3.8	Total carbon, N% and C/N ratio trend during composting of rice straw treated with chicken manure	77
3.9	Accumulation of nutrients during composting of rice straw treated with chicken manure	80
3.10	Heavy metals accumulation during of composting of rice straw treated with chicken manure	81
3.11	Bacterial count trend during of composting of rice straw treated with chicken manure	82
3.12	Evaluation of phytotoxicity using seed germination test during composting of rice straw treated with chicken manure	83
4.1	Effect of rice straw compost used as transplant media on plant height of six weeks tomato seedlings	102

4.2	Effect of rice straw compost used as transplant media on plant leaf area of six weeks tomato seedlings	103
4.3	Effect of rice straw compost used as transplant media on root to shoot ratio of six weeks tomato seedlings	104
4.4	Growth performance of different media combination of six weeks tomato seedlings	105
5.1	Mean day temperature inside the experimental site measured during the two drying cycles	124
5.2	Stomatal conductance as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the first water stress cycle	126
5.3	Stomatal conductance as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the second water stress cycle	127
5.4	Leaf water potential (LWP) as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the first water stress cycle	129
5.5	Leaf water potential (LWP) as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the second water stress cycle	130
5.6	Proline accumulation as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the first water stress cycle	132
5.7	Proline accumulation as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the second water stress cycle	133

5.8	Media moisture content as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the first water stress cycle	135
5.9	Media moisture content as affected by two growing media amended with or without rice straw compost under well watered or water deficit conditions and re-watered after symptoms of wilting during the second water stress cycle	136
5.10	Relationships between media drying, stomatal conductance and proline accumulation of tomato plants as affected by two growing media amended with or without rice straw compost under water deficit conditions and re-watered after symptoms of wilting during the first water stress cycle	137
5.11	Plant days to 100% wilt as affected by different media amended by rice straw compost under the first stress cycle	139
6.1	Stomatal conductance as affected by two growing media and PRD application for tomato plants grown under protected environment	166
6.2	Leaf water potential (LWP) as affected by two growing media and PRD application for tomato plants grown under protected environment	167
6.3	Leaf expansion as affected by two growing media and PRD application for tomato plants grown under protected environment	169
6.4	Proline as affected by two growing media and PRD application for tomato plants grown under protected environment.	170
6.5	Plant leaf sugars (fructose, glucose and sucrose) as affected by two growing media and PRD application for tomato plants grown under protected environment	172
6.6	Media moisture content as affected by two growing media and PRD application for tomato plants grown	176

under protected environment

6.7 Relationships between media drying, proline accumulation and leaf expansion of tomato plants as affected by two growing media and PRD 178

6.8 Growth performance of four tomato plants grown in two growing media amended with rice straw compost (soilless Ss1 or greenhouse soil St1) as affected by continuous irrigation (C) or PRD (P). 184

LIST OF ABBREVIATIONS AND SYMBOLS

%	Percentage
<	Less than
>	More than
°C	Degree-centigrade
ABA	Abscisic acid
ANOVA	Analysis of variance
BD	Biodynamic
C	Carbon
C/N	Carbon/ Nitrogen
Ca	Calcium
Cd	Cadmium
cm	Centimetre
CO ₂	Carbon dioxide
Cu	Copper
d	Day
e.g.	For example
EC	Electrical Conductivity
Fe	Iron
g L ⁻¹	Gram per litre
GA	Gebberallic acid
h	Hour

H ₂ O	Water
ha	Hectare
K	Potassium
Kg ha ⁻¹	Kilogram per hectare
l	Litre
LSD	Least significant differences
m	Meter
M Pa	Mega Paskal
M ²	Meter square
Mg	Magnesium
Mg ha ⁻¹	Mega per hectare
mg kg ⁻¹	Milligram per kilogram
Mn	Manganese
MSW	Municipal solids waste
N	Nitrogen
Ni	Nickel
°	Degree
O ₂	Oxygen
p	Probability
P	Phosphorus
pb	Bulk density
Pb	Lead
pH	Hydrogen ion
PRD	Partial rootzone drying

R^2	Coefficient of variation
SAS	Statistical package for sciences
SOM	Soil organic matter
st	Standard error
t	Ton
$t \text{ ha}^{-1}$	Ton per hectare
v/v	Volume per volume
W/v	Weight per volume
WUE	Water use efficiency
Zn	Zinc
$\mu \text{ g g}^{-1}$	Microgram per gram
$\mu \text{ m}$	Micro meter