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Effect of Different Irrigation Levels on Yield and Physiological-Biochemical Characteristics of Mango cv. Banganpalli

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ABSTRACT

The present study was conducted during 2013-14 and 2014-15 seasons on Banganpalli Mango trees at Amarachintha village as adoptive on farm trail of CRIDA. The irrigation water requirement is determined by using average season wise pan evaporation data for that area. Different irrigation treatments viz.,T_1 – No irrigation; T_2 - RDI at 100 % Ep; T_3 - RDI at 75 % Ep; T_4 - RDI at 50 % Ep;T_5 – PRD at 50 % Ep; T_6 – PRD at 75 % Ep. Among all treatments, The maximum fruit number (139.5 and 129.0), yield per plant (52.9kg and 50.0kg), fruit weight (379.0g and 360.0g), were observed in I_2 (RDI at 100 % Ep) during both the seasons.The maximum total sugars (16.75% and 17.18%) was found with I_6 (PRD at 75% Ep) maximum reducing sugars (5.57% and 5.81%) was noticed in I_5 (PRD at 50% Ep) and the highest non reducing sugars (11.9%) (11.42%) noticed with I_1 and I_6 in 2013-14 and 2014-15 seasons respectively. The highest relative water content (74.95% to 54.04%) was noticed with I_2 throughout the irrigation period whereas the lowest relative water content was found with I_1 (45.86% to 26.76%). The maximum chlorophyll contents were recorded with I_2.

Key words: *Mango yield, PRD and RDI*

INTRODUCTION

Mango (*Mangifera indica* L.) is major fruit crop of the tropical regions of the world and belongs to family Anacardiaceae. Mango occupied an area of 2.5 million hectares with a production of 18 million tonnes and productivity of 7.2 t/ha[3]. It has attracted world market because of its colour and nutritive values. In India, Andhra Pradesh is the leading mango producing state and occupies an area of 0.49 million hectares with a production of 4.41 million tonnes and productivity of 9.0 t/ha[3]. Mango fruit development takes place during the dry season, irrigation is necessary to ensure stable yields of high quality.

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Meanwhile, climate change and expanding land use in horticulture have increased the pressure on water resources. For sustainable water use in agriculture, crop-specific and water-saving irrigation techniques that do not negatively affect crop productivity must be developed. Worldwide, successful attempts have been documented regarding the use of deficit irrigation methods, namely regulated deficit irrigation (RDI) and partial rootzone drying (PRD) to improve water use efficiency (WUE) in various tree crop species[7,22]. The impact of deficit irrigation on fruit quality has been investigated for several fruit species. In many cases, a positive influence on fruit quality was reported[16,18]. However, very little work has been done on role of Partial root zone drying and Regulated deficit irrigation on mango yield and quality. Hence by Keeping these points in view, the present investigation was planned to conduct effect of Partial root zone drying and Regulated deficit irrigation on mango yield and physiological- biochemical characteristics.

MATERIAL AND METHODS

The investigation on the effect of regulated deficit irrigation and partial root zone drying on yield and quality of mango was carried out at on farm research trials of CRIDA at Amarachinta village, Mahaboobnagar district of Andhra Pradesh during 2013-14 and 2014-15. It lies at 16° 22' 0" North latitude, 77° 47' 0" East longitude at an altitude of 311m from mean sea level. Rainfall 1053.2 mm and 658.9 mm rainfall was received during 2013-14 and 2014-15 out of which >93% is during South West monsoon. The minimum temperature was 17.29^{o}C and 16.3^{o}C and maximum temperature was 30.63 and 30.72 ^{o}C. The soil of the orchard selected is a red soils with a pH of 6.7 and electrical conductivity of 0.6 d S m^{-1}. It had 131.63 Kg, 16.7 Kg and 179.84 Kg per hectare of available nitrogen, phosphorus and potassium contents respectively. The orchard has a uniform topography. The daily water requirement for fully-grown plants can be calculated as under. The irrigation water requirement is determined using average season wise pan evaporation data for the area. The average value of 3 or 4 years of corresponding months is taken into account while doing the calculations. Climate data was obtained from the meteorological station of RARS Palem. The daily water requirement for fully-grown plants can be calculated as under[19].

WR = A x B x C x D x E

Where: WR = Water requirement (l p d /plant)

A = Open Pan evaporation (mm/day)

B = Pan Factor (0.8); this may differ area wise

C = Spacing of plant (m^2)

D = Crop factor (factor depends on plant growth-for fully grown plants = 1)

E = Wetted Area (0.3 for widely spaced crops)

The total water requirement of the farm plot would be WR x No. of Plants

Table 1: Average evaporation values of February, March and April months of last 3 years for calculating water requirement for 2014 and 2015 seasons

Month	2014	2015
	Aerage evaporation value (mm)	Aerage evaporation value (mm)
February	4.87	4.76
March	5.77	5.84
April	6.93	6.97

Table 2: Month wise actual and consumed water requirement during 2013-14 and 2014-15 season

Months	Actual water requirement for 100% irrigation (L/Plant)		Consumed water for 100% irrigation (L/Plant)		Amount of saved water during 2014-15 over 2013-14 (lit/Plant)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
February	3272.64	3198.72	3272.64	3198.72	3186.48	6560.16
March	4292.88	4344.96	2769.6*	2803.2		
April	4989.6	5018.4	3326.4*	NI**		
Total	12555.12	12562.08	9368.64	6001.92		

* irrigation was given only for 20 days

** irrigation was not given because of rain fall occurred during April month of 2014-15.

The treatments were: T_1 – No irrigation; T_2 - RDI at 100 % Ep; T_3 - RDI at 75 % Ep; T_4 - RDI at 50 % Ep;T_5 – PRD at 50 % Ep; T_6 – PRD at 75 % Ep.

The total number of fruits harvested $tree^{-1}$ was counted after harvest and expressed as number of fruits $plant^{-1}$. The total weight of fruits produced by a tree was recorded to obtain the fruit yield $tree^{-1}$ and expressed in kilograms.

An average of 5 fruits per tree was considered for calculating the fruit weight.

Reducing, non-reducing and total sugars present in the mango pulp samples were determined by the method of Lave and Eyoss[1]. The chlorophyll content in the leaves was estimated by dimethly sulfoxide method of Hiscox and Stam. Chlorophyll content was calculated according to the following formula[4].

Chl a (mg g^{-1}) = [(12.7 × A663) - (2.6 × A645)] × ml acetone / mg leaf tissue

Chl b (mg g^{-1}) = [(22.9 × A645) - (4.68 × A663)] × ml acetone / mg leaf tissue

Total (mg g^{-1}) = (A645*20.2+A663*8.02) *Total Vol)/fresh weight)

Relative water content was determined by using the method of Barrs and Weatherley. Relative water content was measured on 0, 15, 30, 45 and 60 days after initiation of irrigation treatments. Youngest fully expanded leaves from each irrigation treatment (3 replications) were used for determination of RWC. The RWC was calculated as

RWC= [(fresh weight-dry weight)/ (turgid weight- dry weight)] x 100.

RESULTS AND DISCUSSION

Yield parameters

A perusal of data presented in Table 3 revealed that significantly the highest number of fruits per plant (139.5, 129.0), yield (52.9, 50.0) was recorded with treatment I_2 (RDI at 100% Ep) followed by I_6 (PRD at 75% Ep.) with respect to both yield parameters (Table 3). The lowest number of fruits per plant (95.0, 86.5) and yield (21.3, 19.5) was recorded with treatment I_1 (No irrigation) during both the seasons. The result showed that, RDI at 100% recorded significantly superior performance in terms of yield per plant. It was followed by PRD at 75% indicating that at higher water application levels, stronger trees were obtained with a record of a high fruit number per plant. Similar results found with Tapia *et al.*[21], Abrisqueta *et al.*[2], Girona *et al.*[10] in almond. Generally, the increase in vegetative parameters showed a parallelism with increase in the water application levels.

Significantly higher mature fruit weight and ripe fruit weight was recorded with treatment I_2 (379.0, 360.0) (363.1, 349.8) respectively which were statistically at par with treatments I_6 (364.1, 348.1).

Biochemical parameters

Treatment I_6 (16.75, 17.18) recorded significantly the highest total sugars in the year 2013-14, 2014-15 respectively, which was statistically at par with treatments I_1 (16.50, 17.05) and I_5 (15.88, 16.23) in the year 2013-14, 2014-15 respectively. Significantly the lowest total sugars was recorded with treatment I_3 (14.63, 15.18) during 2013-14, 2014-15 respectively, whereas with respect to reducing sugars significantly the highest reducing sugars recorded with treatment I_5 (5.57, 5.81) which was statistically at par with treatments I_1 (5.42), I_4 (5.36) and I_6 (5.34) during 2013-14 season, where as I_6 (5.64) during 2014-15 season. The lowest reducing sugars was recorded with treatment I_3 (4.89) during the year 2013-14 and I_2 (5.13) during 2014-15.

Non-reducing sugars was significantly influenced by the different irrigation levels (Table 4). Significantly the highest non-reducing sugars was noticed with treatment I_1 (11.19) which was statistically at par with treatment I_6 (11.16) in 2013-14, whereas in 2014-15 season 1_6 (11.42) which was statistically at par with treatments I_1 (11.37) and I_5 (10.85). Significantly the lowest non-reducing sugars was recorded with treatment I_3 (9.74, 10.04) in the year 2013-14, 2014-15 respectively. Fruit quality, in terms of sugars were improved at lower water application levels over the higher water application levels at final harvest. This may be due to increase in total soluble solids associated with reduced fruit water content and greater hydrolysis of starch into sugars[11]. Similar results in agreement with findings of Stoll *et al.*[20], Dos Santos *et al*[8].

Physiological parameters

The highest relative water content (74.95% to 54.04%) was noticed with I_2 throughout the irrigation period (Table 5) whereas the lowest relative water content was found with I_1

(45.86% to 26.76%). The trend of variation in relative water content of mango leaves at 15 days interval showed that, relative water content decreased significantly as the stress conditions were intensified during irrigation period. Decrease in RWC in plants under water stress may depend on plant vigor reduction and have been observed in many plants[13].

A critical examination of data (Table 6) revealed that chlorophyll a, chlorophyll b and total chlorophyll was significantly influenced by the different irrigation treatments. Significantly the highest chlorophyll a, chlorophyll b and total chlorophyll was noticed with treatment I_2 (2.96, 3.40), (1.25, 1.50), (4.19, 4.39) respectively during 2013-14 and 2014-15. Significantly the lowest chlorophyll a, chlorophyll b and total chlorophyll was recorded with treatment I_1 (1.91, 2.13), (0.78, 0.64), (2.68, 2.85) in the year 2013-14, 2014-15 respectively. These results clearly pointed out a fact that there were significant reductions in chlorophyll contents at relatively high water stress conditions over the RDI at 100% evaporation. A possible reason for reduction in chlorophyll content at high levels of water stress may be due to the production of reactive oxygen species (ROS) such as O^{2-} and H_2O_2 which can lead to lipid peroxidation and consequently, chlorophyll destruction[9,14].These results are in agreement with the findings of Bradford and Hsiao[5] and Chartzoulakis *et al*.[6]. Water stress can destroy the chlorophyll and prevent its synthesis[12]. Also some researchers have reported damage to leaf pigments as a result of water stress[15,17].

Table 3: Effect of regulated deficit irrigation and partial root zone drying on Fruit number plant^{-1}, Yield plant^{-1} and Mature fruit weight of Mango cv. Banganpalli

Treatment	Fruit number plant^{-1}		Yield plant^{-1} (kg)		Mature fruit wt (g)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
I_1 : No irrigation	95.0	86.5	21.3	19.5	223.4	204.4
I_2 : RDI at 100% Ep.	139.5	129.0	52.9	50.0	379.0	360.0
I_3 : RDI at 75% Ep.	119.8	107.3	34.0	31.6	284.3	267.0
I_4 : RDI at 50% Ep.	100.5	91.8	28.4	26.2	281.8	264.1
I_5 : PRD at 50% Ep.	103.8	93.5	28.5	27.4	277.9	257.4
I_6 : PRD at 75% Ep.	130.3	119.3	46.8	45.5	364.1	348.1
Mean	114.82	104.57	35.32	33.37	301.75	283.50
S.Em.(±)	2.4	2.7	1.2	1.2	6.9	6.3
C.D. @ 5%	7.3	8.1	3.6	3.7	21.25	18.95

RDI: Regulated deficit irrigation; PRD: Partial root zone drying; Ep.: Evaporation

Table 4: Effect of regulated deficit irrigation and partial root zone drying on Reducing, Non reducing and Total sugars of Mango cv. Banganpalli

Treatment	Reducing sugars (%)		Non-reducing sugars (%)		Total sugars (%)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
I_1 : No irrigation	5.42	5.37	11.19	11.37	16.50	17.05
I_2 : RDI at 100% Ep	5.00	5.13	9.88	10.12	14.88	15.25
I_3 : RDI at 75% Ep	4.89	5.14	9.74	10.04	14.63	15.18
I_4 : RDI at 50% Ep	5.36	5.39	10.02	10.42	15.38	15.80
I_5 : PRD at 50% Ep	5.57	5.81	10.46	10.85	15.88	16.23
I_6 : PRD at 75% Ep	5.34	5.64	11.16	11.42	16.75	17.18
Mean	5.26	5.41	10.41	10.70	15.67	16.12
S.Em.(±)	0.12	0.13	0.23	0.24	0.34	0.34
C.D. @ 5%	0.35	0.40	0.70	0.72	1.05	1.03

RDI: Regulated deficit irrigation; PRD: Partial root zone drying; Ep.: Evaporation

Table 5: Effect of regulated deficit irrigation and partial root zone drying on Relative water content (RWC) of mango leaves at 15 days intervals

Treatment	Initial RWC (%)		15 Days later RWC (%)		30 Days later RWC (%)		45 Days later RWC (%)		60 Days later RWC (%)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
I_1 : No irrigation	39.61	37.21	45.86	43.58	35.46	33.31	32.21	29.81	29.06	26.76
I_2 : RDI at 100% Ep	69.72	67.15	74.95	72.35	63.47	61.20	59.26	57.06	56.01	54.04
I_3 : RDI at 75% Ep	57.88	54.70	65.13	54.45	51.73	48.90	46.20	43.40	43.95	41.50
I_4 : RDI at 50% Ep	48.42	44.90	56.57	52.70	44.77	41.70	40.53	37.56	37.29	34.89
I_5 : PRD at 50% Ep	48.94	46.86	55.18	52.91	43.38	41.45	40.20	38.15	35.10	33.05
I_6 : PRD at 75% Ep	57.78	55.61	64.53	62.36	51.54	49.64	46.39	44.49	42.64	40.74
Mean	53.73	51.07	60.37	56.39	48.39	46.03	44.13	41.75	40.68	38.50
S.Em.(±)	1.46	1.42	1.46	3.13	1.46	1.43	1.46	1.43	1.46	1.42
C.D. @ 5%	4.45	4.31	4.45	9.52	4.45	4.35	4.45	4.35	4.45	4.33

RDI: Regulated deficit irrigation; PRD: Partial root zone drying; Ep.: Evaporation

Table 6: Effect of regulated deficit irrigation and partial root zone drying on Chlorophyll (a, b and Total) contents in leaves of Mango cv. Banganpalli

Treatment	Chlorophyll a (mg g^{-1})		Chlorophyll b (mg g^{-1})		Total Chlorophyll (mg g^{-1})	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
I_1 : No irrigation	1.91	2.13	0.78	0.64	2.68	2.85
I_2 : RDI at 100% Ep	2.96	3.40	1.25	1.50	4.19	4.39
I_3 : RDI at 75% Ep	2.65	2.43	1.17	1.25	3.81	3.85
I_4 : RDI at 50% Ep	2.41	2.38	0.94	1.19	3.34	3.53
I_5 : PRD at 50% Ep	2.23	2.34	0.87	0.94	3.08	3.28
I_6 : PRD at 75% Ep	2.47	2.37	1.08	1.33	3.54	3.87
Mean	2.44	2.51	1.02	1.14	3.44	3.63
S.Em.(±)	0.06	0.10	0.07	0.05	0.04	0.03
C.D. @ 5%	0.18	0.30	0.20	0.16	0.12	0.09

RDI: Regulated deficit irrigation; PRD: Partial root zone drying; Ep.: Evaporation

REFERENCES

1. A.O.A.C. Official Methods of Analysis. 13th Ed. Association of Official Analytical Chemists, Washington D.C., USA (1980).
2. Abrisqueta, J.M., Mounzer, O., Álvarez, S., Conejero, W., García-Orellana, Y., Tapia, L.M., Vera, J., Abrisqueta, I. and Ruiz-Sánchez, M.C.,Root dynamics of peach trees submitted to partial rootzone drying and continuous deficit irrigation. *Agric. Water Manag.* **95:** 959-967 (2008).
3. Anonymous, All India area, production and productivity of Mango (2014).
4. Arnon and D.I. copper enzymes in isolated chloroplasts, polyphenoxidase in beta vulgaris. *plant physiology* **24:** 1-15 (1949).
5. Bradford, K.J and T. C. Hsiao. Physiological responses to moderate water stress. In: Physiological plant ecology II. Water relations and carbon assimilation. *Encyclop. Plant Physiol.*, Eds. Lange O., Nobel P. S., Osmond C. B., Zeigler H. Springer, Berlin-Heidelberg-New York, **12B:** 263–324 (1982).
6. Chartzoulakis, K, B. Noitsakis and I. Therios. Photosynthesis, plant growth and dry matter distribution in kiwifruit as

influenced by water deficits. *Irrigation Sci.* **14:** 1–5 (1993).

7. Cifre, J., Bota, J., Escalona, J.M., Medrano, H. and Flexas, J. Physiological tools for irrigation scheduling in grapevine (*Vitis vinifera,* L.) - an open gate to improve water-use efficiency. *Agric. Ecosyst. Environ*. **106:** 159–170 (2005).
8. Dos Santos, T.P, Lopes, C.M, Rodrigues, M.L, de Souza, C.R, Maroco, J.P, Pereira, J.S, Silva, J.R, Chaves and M.M., Partial rootzone drying: effects on growth and fruit quality of field-grown grapevines (Vitis vinifera*). Funct. Plant Biol.* **30:** 663–671 (2003).
9. Foyer, C.H, Descourvieres, P, Kunert and K.J., Photo oxidative stress in plants. *Plant. Physiol.*, **92:** 696-717 (1994).
10. Girona, J, Mata, M. and Marsal, J.,Regulated deficit irrigation during the kernel-filling period and optimal irrigation rates in almond. *Agric. Water Manag*. **75:** 152-167 (2005).
11. Kramer, P.J., Water Relations of Plants. Academic Press, London (1983).
12. Lessani, H and Mojtahedi M. Introduction to *Plant Physiology* (Translation). 6th Edn.,Tehran University press, Iran, ISBN: 964-03-3568-1, 726 (2002).
13. Liu, Y, Fiskum, G and Schubert D., Generation of reactive oxygen species by mitochondrial electron transport chain. *J. Neurochem.*, **80:** 780-787 (2002).
14. Mirnoff, N., The role of active oxygen in the response of plants to water deficit and desiccation. *New Phytol.* **125:** 27-58 (1993).
15. Montagu, K.D, Woo and K.C., Recovery of tree photosynthetic capacity from seasonal drought in the wet-dry tropics: The role of phyllode and canopy processes in Acacia auriculiformis. *Aust. J. Plant Physiol.*, **26:** 135-145 (1999).
16. Motilva, M.J., Tovar, M.J., Romero, M.P., Alegre, S. and Girona, J. Influence of regulated deficit irrigation strategies applied to olive trees (*Arbequina cultivar*) on oil yield and oil composition during the fruit ripening period. *J. Sci. Food Agric.* **80:** 2037–2043 (2000).
17. Nilsen, E.T, Orcutt and D.M. *Physiology of Plants Under Stress, Abiotic Factors.* 2nd Edn. John Wiley and Sons Inc., New York, ISBN: 0471170089, 689 (1996).
18. Pickering, A.H., Behboudian, M.H. and Mills, T.M. Stress physiology of the grapevine: an overview. In: Pandalai, S.G. (Ed.), *Recent Research Developments in Plant Biology*. Part 2. Research Signpost, Kerala, India. 303–320 (2002).
19. Singh, H.S., Vishal Nath, Abha Singh and Shash Dhar Pandey. In; Lithci preventive practices and curative measures. *Satish serial publishing house*. ISSN. 978-93-81226-04-9. 122 (2012).
20. Stoll, M, B. Loveys and P. Dry. Hormonal changes induced by partial rootzone drying of irrigated grapevine. *J. Exp. Botany*. **51:** 1627-1634 (2000).
21. Tapia, L.M, Larios, A, Abrisqueta, I, Mounzer, O, Vera, J, Abrisqueta, J.M, Ruiz-Sánchez and M.C. Peach deficit irrigation. Fruit yield and water use efficiency analysis. *Rev Fitotec Mex* **33(4):** 1-5 (2009).
22. Tognetti, R.., Andria, R.., Morelli, G. and Alvino, A. The effect of deficit irrigation on seasonal variations of plant water use in *Olea europaea* L. *Plant Soil*, **273:** 139–155 (2005).