Green Farming Vol. **4** (1) : 33-36 (January-February, 2013) **Research Paper**

Effect of fertigation through low cost drip irrigation system on vegetative growth characteristics in pomegranate cv. Bhagwa

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Received : 25 August 2012 ; Revised accepted : 21 December 2012

ABSTRACT

The experiment was conducted on one year old pomegranate plants which consisted of eight treatment combinations comprising four fertigation levels, *i.e.*, 75%, 100%, 125% and 150% recommended dose of fertilizers (RDF) and two irrigation methods, drip (DI) and hand watering (HW). The results revealed that with fertigation level 100 % RDF (F_1) showed maximum vegetative growth characters namely relative growth rate (RGR) of shoots on 120th day (9.7%), plant spread N-S (1.5m) and Leaf area (55.44 cm^2). Meanwhile, however, maximum value of RGR of shoots at 90th day and plant spread E-W was found in F_3 (150% RDF) and maximum value of plant height, LAI and minimum light interception below canopy was found in F_2 (125% RDF) level of fertigation. F_3 and F_2 were found to be statistically at par with F_1. Similarly, drip irrigation at alternate day significantly increased vegetative growth characteristics against hand watering. Among all the treatment combinations maximum plant spread N-S, leaf area, LAI and minimum light interception below canopy were found in I_1F_3 (DI + 150% RDF) whereas, maximum RGR of shoots at 90th and 120th day were found in I_1F_2 (DI + 125% RDF). I_1F_3 and I_1F_2 were found statistically to be at par with I_1F_1 treatment combination. The designed low cost drip irrigation system was operated excellently as the value of field emission uniformity and absolute emission uniformity were higher than the designed criteria of 90 per cent.

Key words : *Drip Irrigation, Fertigation, Low cost drip, Pomegranate, Punica granatum.*

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the favorite table fruit of tropical and subtropical region and belongs to family Punicaceae. Irrigation and fertilizers are the most important inputs which directly affect the plant growth, development, yield and quality of produce. Application of irrigation water and fertilizers through drip are the most effective ways of supplying water and nutrients to the plant roots. These inputs are effectively utilized by plants as these are placed near crop root zone. Pomegranate requires supplemental irrigation and water itself is a limiting factor for commercial cultivation in arid region (Prasad *et al.,* 1997). Farmers generally irrigate the pomegranate through surface method of irrigation, which needs more water to irrigate the crop and huge quantity of water losses occur through leaching and evaporation. Similarly, farmers are using solid fertilizers for fruit crop production but these are not totally water soluble and hence are less available to plants and some of the fertilizers contain salts of sodium and chloride which not only affect the quality and quantity of crop production but they are also harmful to the soil.

The drip irrigation method is an appropriate answer, particularly for horticultural and cash crops as it permits the irrigator to limit the watering as per water requirement of plants and optimum application of fertilizers through drip irrigation system which will enhance the vegetative growth, production and productivity per unit area to meet the growing demand of the population. However, the information regarding drip irrigation and fertigation in newly planted pomegranate under high density planting system is lacking. Now it is essential to standardize optimum quantity of fertilizers through low cost drip irrigation system in newly planted pomegranate for sub-humid southern plains of Rajasthan. Keeping these in view the present experiment on "Effect of fertigation through low cost drip irrigation system on vegetative growth characteristics in pomegranate cv. Bhagwa" was carried out at Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur.

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MATERIALS AND METHODS

The present study was conducted during 2009-10 on one year old pomegranate plants cv. Bhagwa growing under high density planting system (2×2 meter spacing) at the Horticultural Farm, Department of Horticulture, Rajasthan College of Agriculture, Udaipur. The experimental set up of drip and hand watering system was laid out as per the treatment. The experiment comprised of 8 treatment combinations consisting of fertigation levels (75%, 100%, 125% and 150% recommended dose of fertilizers) and irrigation methods (Hand watering and drip irrigation). KB Drip ("KB" stands for the Hindi word "Krishak Bandhu" which means "Farmer's friend") was used as low cost drip irrigation system. KB Drip utilizes lay-flat laterals (that looks like tape when it is in a roll) with a wall thickness of only 125 microns (0.125 mm) or 250 microns (0.25 mm) and is 16 mm in diameter when filled with water. The experiment was laid out in factorial randomize block design with 4 replications. Recommended dose of urea, single super phosphate and murate of potash used were 100g, 250g and 500g per plant, respectively (Shukla *et al*., 2008) and these conventional fertilizers were applied by ring method for plants which were irrigated through hand watering. In conventional method, full quantity of phosphorus and potassium and half quantity of nitrogen were applied just prior to the first irrigation (Oct., 2009). The remaining half quantity of nitrogen was given as top dressing one and half month after the first dose (Nov., 2009). Fertilizers for drip irrigated plants were applied by water soluble fertilizers through drip irrigation system in six equal split doses at fifteen days' interval (from Oct., 2009 to Dec., 2009). Amount of water soluble fertilizes determined by calculating amount of nitrogen, phosphorus and potassium in recommended dose. In drip irrigation system water was applied at one day interval and at weekly interval in case of hand watering. Pan evaporation method was used for estimating crop water requirement (Mane *et al*., 2006).

$$V = \frac{CA\ (m^2)\ x\ PE\ x\ P_c\ x\ K_c\ x\ PWA}{E_u}$$

Where,

V = Volume of water required (l/day/plant),
CA = Crop area (m^2),
PE = Maximum pan evaporation (mm/day),
P_C = Pan coefficient,
K_C = Crop coefficient,
PWA = Percentage wetted area and
E_U = Emission uniformity

Keller and Karmeli (1974) suggested the equation for the evaluation of emission uniformity. "EU" measures the degree of uniformity of application of water in the field. These are denoted as EU_f (field emission uniformity) and EUa (Absolute emmission uniformity).

$$EU_f = \left(\frac{q_n}{q_a}\right)\ x\ 100 \qquad EUa = 100\left[\frac{Q\ min}{Q\ avg} + \frac{Qavg}{Qx}\right]\ 0.5$$

Where,

EU_f = Field emmission uniformity,
EUa = Absolute emmission uniformity,
q_n = The avg. of the lowest 1/4 of the emitter flow rate (l/h),
q_a = The average of all emitters flow rate (l/h),
q_x = The avg. of the highest 1/8 of the emitters flow rate (l/h).

Irrigation time is the ratio of volume of water applied to the plant and discharge rate of emitters.

Three uniform shoots were selected from each experimental plant and tagged. The length of shoots was measured periodically at 30 days interval for the total period of 120 days. Initially (Oct., 2009) uniform plants were selected and at the end of experiment (March, 2010) plant spread (E-W & N-S), plant height and stem girth were measured. Leaf area was measured with the help of leaf area meter and light interception was measured between 10-12 AM by canopy analyzer (LP 80) under natural radiation and expressed in μ mol m^{-2} s^{-1}.

RESULTS AND DISCUSSION

Effect of fertigation levels : The **Table 1** shows the effect of different fertigation levels on vegetative characteristics in pomegranate. Among all the fertigation treatments the maximum growth rate of shoots at 120th day (9.70 %), plant spread North-South (1.50 m) and leaf area (55.44 cm^2) were recorded with F_1 (100% RDF) fertigation level against minimum in F_0 (75% RDF) fertigation level. However, higher plant height (1.66 m), LAI (0.89) and the lowest light interception below canopy (809.24 μ mol m^{-2} s^{-1}) were observed in F_2 (125% RDF) fertigation level whereas, maximum relative growth rate of shoots at 90th day (16.07%) and maximum plant spread East-West (1.57 m) were found in F_3 (150% RDF) fertigation level. F_3 and F_2 were found statistically at par with F_1 fertigation level. Girth of the stem and the relative growth rate of shoots (%) at 30th and 60th day were not significantly affected by different fertigation levels, irrigation methods and their interaction. From the above studies, it is apparent that different fertigation treatments had significant effect on vegetative growth parameters. Both nitrogen and potassium may be important nutrients for leaf growth and development. Total nitrogen and potassium uptake was appreciably higher with increasing nitrogen and potassium rate with more frequent than with less frequent fertigation. Low potassium supply might have been contributed to low leaf area index. Deficiency in potassium may have caused a reduction in total foliage area in banana (Mitra and Dhua, 1988) and subsequently reduced the leaf area index. Baruah and Mohan (1991) have showed that an increase in potassium application can increase leaf area index considerably in banana cv. Jahaji. Klein *et al.* (1989) observed that vegetative growth of apple was positively correlated with the amount of nitrogen applied. The present investigation is in closely agreement with the finding of Shirgure *et al.* (2001) in Nagpur mandarin.

Effect of irrigation methods : The results in Table 1 show that drip irrigation at alternate day significantly increased vegetative growth characteristics viz. RGR of shoot at 90th and 120th day, plant spread (E-Wand N-S), plant height, leaf area, LAI and minimum light interception below canopy against hand watering. Application of water through drip irrigation (DI) during experiment effectively increased vegetative growth parameters

Table 1. Effect of fertigation levels and irrigation methods on vegetative growth characteristics of newly planted pomegranate

Treatments	RGR of shoot (%)		Plant spread (m)					
	90th day	120th day	E-W	N-S	Plant height (m)	Leaf area	Light interception (cm^2) below canopy	Leaf area index
Fertigation levels								
F_0 (75% RDF)	14.99 (22.68)	8.00 (16.34)	1.41	1.36	1.63	51.79	837.38	0.77
F_1 (100% RDF)	15.93 (23.49)	9.70 (18.04)	1.45	1.50	1.64	55.44	820.25	0.87
F_2 (125% RDF)	15.67 (23.24)	9.51 (17.81)	1.53	1.43	1.66	55.38	809.24	0.89
F_3 (150% RDF)	16.07 (23.58)	9.28 (17.70)	1.57	1.46	1.66	53.91	820.75	0.89
CD P=0.05	0.37	0.13	0.06	0.09	0.02	1.81	15.39	0.02
Irrigation methods								
I_0 (HW)	13.24 (21.33)	7.19 (15.54)	1.32	1.38	1.48	50.88	840.50	0.77
I_1 (DI)	18.08 (25.16)	11.05 (19.40)	1.65	1.50	1.81	57.38	803.30	0.95
CD P=0.05	0.26	0.09	0.04	0.07	0.02	1.28	10.88	0.011

HW = Hand weeding DI = Drip irrigation Values in bracket are arc sin transformed values

compared to hand watering (HW). The increase in the plant height and canopy in drip irrigation might be due to the constant supply of water to the plant. This maintains the soil moisture at optimum level eliminating water stress to the plant resulting in greater vigor (Subramanian *et al*., 1997). Agrawal and Agrawal (2007) recorded that the growth parameters like plant height and spread of pomegranate was better under trickle irrigated plant as compared to control (surface irrigation). Prasad et al. (2003) also reported that pomegranate plants irrigated through drip were vigorous than basin irrigation system. Plant height and canopy spread were significantly better under alternate day drip irrigation over conventional method in aonla (Chandra and Jindal, 2001).

Interaction effect : Among the interaction effects (in **Table 2**) I_1F_3 (DI + 150% RDF) show the maximum value of plant spread (N-S), leaf area, LAI and minimum light interception below canopy. The RGR of shoots at 90th and 120th day were found higher under I_1F_2 (DI + 125% RDF) treatment combination. The treatment combination I_1F_1 (DI + 100% RDF) found to be at par with I_1F_2 (DI + 125% RDF) and I_1F_3 (DI + 150% RDF) for above vegetative characters and also shows higher value of plant spread (E-W). On the basis of the studies described above it is observed that the interaction between fertigation levels and irrigation methods were found to be quite superior. When water is applied through drip irrigation, plant may benefit most from frequent fertigation as opposed to conventional basal dose. In banana plant height, leaf area and leaf area index increased with nitrogen fertigation applied through drip (Srinivas, 1997). Similarly, Sharma *et al.* (2005) observed that growth attributes were higher in plants where fertilizers were applied through drip as compared to soil application in pomegranate. The present study is in line of the worker Agarwal *et al.* (2005) in papaya and Singh *et al.* (2006) in pomegranate.

Irrigation Performance Efficiencies (Uniformity) : Emission uniformity is a major parameter for evaluation of performance of micro irrigation systems. The emission

Table 2. Effect of interaction on vegetative growth characteristics of newly planted pomegranate

Treatments	RGR of shoot (%)		Plant spread (m)					
	90th day	120th day	E-W	N-S	Plant height (m)	Leaf area	Light interception below canopy	Leaf area index
Interaction								
I_0 F_0	11.99 (20.26)	6.30 (14.54)	1.19	1.29	1.43	46.83	849.56	0.71
I_0 F_1	14.00 (21.97)	7.5 (15.90)	1.22	1.53	1.47	53.75	835.50	0.80
I_0 F_2	13.00 (21.13)	6.96 (15.13)	1.43	1.33	1.50	53.23	823.46	0.81
I_0 F_3	14.00 (21.97)	8.00 (16.43)	1.45	1.36	1.51	49.73	853.50	0.76
I_1 F_0	17.99 (25.09)	9.69 (18.14)	1.63	1.43	1.83	56.76	825.20	0.84
I_1 F_1	17.86 (25.00)	11.90 (20.18)	1.69	1.46	1.82	57.13	805.00	0.94
I_1 F_2	18.34 (25.36)	12.06 (20.32)	1.62	1.54	1.81	57.53	795.01	0.97
I_1 F_3	18.14 (25.20)	10.57 (18.97)	1.68	1.55	1.80	58.09	788.00	1.03
CD P=0.05	0.52	0.18	0.09	0.13	0.03	2.56	21.76	0.02

Values in bracket are arc sin transformed values

Table 3. Hydraulic performance & field emission uniformity

1. Crop : Pomegranate
2. Time of observation : 10 minute

Location on Lateral (A&B)		Lateral location on the submain (4nd, 8th, 12th & 16th)								Qvar %
		Inlet end		1/3 down		2/3 down		Far end		
		2th Emitter		4th Emitter		6th Emitter		8th Emitter		
		ml	l/h	ml	l/h	ml	l/h	ml	l/h	
Inlet end	A	172	5.16	170	5.10	174	5.22	164	4.92	
4nd Lateral	B	176	5.28	175	5.25	165	4.95	160	4.80	
Average			10.44		10.35		10.17		9.72	6.90
1/3 down	A	175	5.25	171	5.13	168	5.04	162	4.86	
8th Lateral	B	170	5.10	170	5.10	162	4.86	158	4.74	
Average			10.35		10.23		9.90		9.60	7.25
2/3 down	A	165	4.95	160	4.80	158	4.74	146	4.38	
12th Lateral	B	160	4.80	162	4.86	159	4.77	155	4.65	
Average			9.75		9.66		9.51		9.03	7.38
Far End	A	155	4.65	158	4.74	150	4.50	148	4.44	
16th Lateral	B	162	4.86	156	4.68	161	4.83	141	4.23	
Average			9.51		9.42		9.33		8.67	8.83
Average of all			10.01		9.92		9.73		9.26	7.59
Total Avg (Q)										9.73
EUf (%)										95.14
EUa (%)										93.14

uniformity was determined before plantation so as to see whether the emitter devices are applying water uniformly or otherwise. The average and minimum discharge of emitting device (micro tube) for the drip irrigation treatments was observed. Field emission uniformity and absolute uniformity value (%) for drip irrigation system were 95.14 per cent and 93.14 per cent, respectively (**Table 3**). The designed low cost drip irrigation system was operated excellently as the value of field emission uniformity was higher than the designed criteria of 90 per cent (Keller and Karmali, 1974) whereas absolute emission uniformity rated excellently as the value of absolute emission uniformity was also higher than the designed criteria of 90 per cent.

CONCLUSION

On the basis of results and discussion it may be concluded that in newly planted pomegranate under high density planting system, 100 per cent RDF markedly enhanced vegetative growth. Similarly, drip irrigation at alternate day significantly increased vegetative growth characteristics. Based on statistical analysis of relative growth rate of shoots, plant spread, plant height, leaf area, light interception below canopy, it is interred that the treatment combination comprising 100 per cent recommended dose of fertilizers (RDF) and drip irrigation at alternate day (I_1F_1) resulted in encouraging trends. The hydraulic performance of low cost drip system under study was found to be satisfactory and it was scheduled on alternate day basis.

REFERENCES

Agrawal N and Agrawal S. 2007. Effect of different levels of drip irrigation on the growth and yield of pomegranate under Chhattisgarh region. *Orissa J. Hort.* **35** (1) **:** 38-46.

Agrawal N, Sharma H G, Dudey P and Dixit A. 2005. Effect of fertigation through water soluble fertilizers on growth, yield and quality of papaya. *National Seminar on Commercialization of Horticulture in Non-Traditional Area.* CIAH, Bikaner. pp. 45.

Baruah P J and Mohan N K. 1991. Effect of potassium on LAI, phyllochrom and number of leaves of banana. *Banana Newsletter*. **14 :** 21-22.

Chandra A and Jindal P C. 2001. Sustainable fruit production in arid regions for export. *Current Agric.* **25 :** 13-16.

Keller J and Karmeli D. 1974. Trickle irrigation design parameters. *Trans. American Soc. Agric. Eng.* **17:** 678-684.

Klein I, Levin I, Bar-Yosef B, Assaf R and Berkovitz A. 1989. Drip nitrogen fertigation of Starking Delicious apple trees. *Plant Soil.* **119** (2) **:** 305-314.

Mane M S, Ayare B L, Magar S S. 2006. *Principles of Drip Irrigation System*, Jain Brothers, New Delhi. pp. 24-87.

Mitra S K and Dhua R S. 1988. Banana. (*in*) Bose, T.K., Mitra, S.K. and Sadhu, M.K. (Eds). *Mineral Nutrition of Fruit Crops.* pp. 186-229.

Prasad R N, Bankar G J and Vaishishtha B B. 1997. Problems and prospects of pomegranate cultivation in arid region. *Symposium on Recent Advances in Management of Arid Ecosystems*, Jodhpur, March 3-5.

Prasad R N, Bankar G J and Vashishtha B B. 2003. Effect of drip irrigation on growth, yield and quality of pomegranate in arid region. *Indian J. Hort.* **60** (2) **:** 140-142.

Sharma H, Agrawal A, Dixit A and Dudey P. 2005. Effect of fertigation through water soluble fertilizers on growth, yield and quality of pomegranate. *National Seminar on Commercialization of Horticulture in Non-Traditional Area.* CIAH, Bikaner. p. 35.

Shirgure P S, Srivastava A K and Singh S. 2001. Fertigation and drip irrigation in Nagpur mandarin (*Citrus reticulate* Blanco). *South Indian Hort.* **49** (Special) **:** 95-97.

Shukla A K, Kaushik R A, Mahawar L N, Pareek S, Pandey D. and Sarolia D K. 2008. *Adhunik phal Utpadan*. Communication centre, MPUAT, Udaipur. P: 221.

Singh P, Singh, A K and Sahu K. 2006. Irrigation and fertigation of pomegranate cv. Ganesh in Chhattisgarh. *Indian J. Hort.* **63** (2) **:** 148-151.

Srinivas K. 1997. Growth, yield and quality of banana in relation to N-fertigation. *Tropical Agric.* **74 :** 260-264.

Subramanian P, Krishnaswamy S and Devasagayam M M. 1997. Study on the evaluation of drip irrigation in comparison with surface irrigation (basin) in coconut. *South Indian Hort.* **45 :** 255-258.