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Irrigation scheduling and fertigation in pomegranate cv. Bhagwa under high density planting system

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ABSTRACT

The trial was conducted on four-year-old pomegranate plants of cv. Bhagwa growing under high density planting system (2 m × 2 m) with four fertigation levels, *i.e.*, 50, 75, 100 and 125% recommended dose of fertilizers and three drip irrigation levels, *i.e.*, 50, 75 & 100% on pan evaporation basis. It is concluded that 125 per cent RDF markedly enhanced vegetative growth, yield contributing characteristics, yield and leaf N, P & K contents along with minimum acidity. However, levels F_3 (125% RDF) and F_2 (100% RDF) were at par with each other with respect to yield, quality and leaf nutrient status. Juice content, TSS and organoleptic score were maximum at 125 per cent RDF and TSS: acid was maximum at 100 per cent RDF. Similarly, drip irrigation (100%) at alternate day significantly increased vegetative characteristics, yield characteristics, quality characteristics and, leaf N, P & K. Based on statistical analysis of vegetative characteristics it is inferred that the treatment combination comprising 100 per cent recommended dose of fertilizers (RDF) and drip irrigation 100 per cent at alternate day (I_2F_2) resulted in higher profitable yield (net return Rs. 5,96,177 ha^{-1}) with quality fruits.

Key words: Pomegranate, drip irrigation, fertigation, high density planting.

INTRODUCTION

Application of irrigation water and fertilizers through drip is the most effective way of supplying water and nutrients to the plant roots. These inputs are effectively utilized by plants as these are placed near crop root zone. For proper irrigation management, irrigation scheduling is essential, which is the process by which an irrigator determines the timing and quantity of water to be applied to the crop. Pomegranate requires supplemental irrigation and water itself is a limiting factor for commercial cultivation in arid region (Prasad *et al.*, 6). Drip irrigation along with fertigation is an appropriate answer, particularly for horticultural and cash crops as it permit the farmer to limit the watering as per water requirement of plants and optimum application of fertilizers through drip irrigation system, which enhance production and productivity per unit area. This technology saves water and fertilizers from 30 to 50 per cent (Pampattiwar *et al.*, 5). Keeping these facts in view the present experiment was carried out.

MATERIALS AND METHODS

The trial was conducted on 4-year-old pomegranate plants of cv. Bhagwa growing under high density planting system (2 m x 2 m) at Horticultural Farm, Rajasthan College of Agriculture, MPUAT, Udaipur during 2010-11. The experiment was conducted on 36 plants in randomised block design. The experiment comprised of 12 treatment combinations replicated three times. Recommended dose of urea, single super phosphate and muriate of potash used were applied @ 200, 500 and 500 g per plant respectively. Water soluble fertilizers were applied through drip irrigation system (fertigation). Amount of water soluble fertilizes were determined by calculating amount of nitrogen, phosphorus and potassium in recommended dose. All fertilizers were applied in six equal split doses at 15 day intervals (from 16 August to 30 October). Weighed quantity of water soluble fertilizers (19:19:19) along with muriate of potash as per treatment requirement were added in water and injected through ventury meter. Pan Evaporation method was used for estimating crop water requirement (Mane *et al*., 3).

Light interception was measured between 10:00 AM to 12:00 noon by canopy analyzer (LP 80 make) under natural radiation. Leaf area index was taken with the help of canopy analyzer (LP-80, LAI meter make). The aril juice of was extracted by pressing 100 arils in muslin cloth and it was measured in millilitre. The percentage of juice was calculated in relation to weight of arils. Total soluble solids of juice were measured with the help of hand refractometer. The titrable acidity of the fruit juice was determined by the method given by Ranganna (8). Nitrogen was measured by Nesseler's reagent colorimetric method (Linder, 2), phosphorus by ammonium vanadomolybdo phosphoric acid yellow colour method (Richards, 9) and potassium

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by flame photometer method (Richards, 9). The relative economics of different treatments were determined on the basis of cost of treatment. Benefit: cost ratio was calculated with the help of cost of production, gross income and net profit for each treatment.

RESULTS AND DISCUSSION

The results revealed that fertigation and drip irrigation levels had significant effect on vegetative characteristics like plant height, canopy spread, leaf area index and leaf nutrient status (Table 1). Among various fertigation levels at 125% RDF (F_3) showed higher plant height (2.19 m), plant spread (1.89 m E-W × 1.99 m N-S), leaf area index (2.45) and leaf nutrient status, *i.e*. N (1.77%), P (0.19%) and K (1.26%). However, F_3 was at par with 100 per cent RDF (F_2) for leaf area index and leaf nutrient status. It might be due to application of higher dose of fertilizer attributed to better nutritional environment in the root zone as well as in plant system. Nitrogen, phosphorus and potassium are most indispensable of all mineral nutrients for growth and development of the plant. Earlier, Chauhan and Chandel (1) on kiwifruit found that leaf nutrient content (N, P, K) were significantly higher under fertigation compared to recommended dose of N, P, K.

Application of drip irrigation level I_2 (100% D_I) during experiment effectively increased vegetative growth parameters and leaf nutrient status. The favorable influence of I_2 (100% D_I) on plant height, plant spread (E-W & N-S), leaf area index and leaf nutrient status may be due to excess moisture in the soil through drip irrigation. 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 vigour (Subramanian *et al*., 10). Earlier, Rana *et al*. (7) also observed leaf N, P & K contents of peach was influenced with different drip irrigation levels and discharge rates and they found that higher irrigation levels increased the nitrogen, phosphorus and potassium content in leaves.

It is evident from the data presented in the Table 2 that fertigation and drip irrigation levels had significant effect on the yield attributes. Fertigation level F_3 (125% RDF) recorded the maximum number of fruits (52.44), average fruit weight (170.56 g), yield (8.90 kg plant^{-1}), juice content (80.44%), organoleptic rating (7.52) and this level was at par with F_2 (100% RDF). However, maximum TSS: acid ratio (42.66) along with minimum rind thickness (2.70 mm) was recorded in F_2 (100% RDF) and this level was at par with F_3 (125% RDF). The possible explanation for increase in yield by F_3 treatments might be due to increase in balance vegetative growth with maximum harvest of solar light. Higher levels of fertigation, *i.e.*, F_2 and F_3 maximized the growth of the plant and facilitated in accumulation of more carbohydrates into the fruit further, during the subsequent fruit development. Such metabolites (starch) will hydrolyze into sugar that increases the TSS and decrease the acidity.

Similarly, in drip irrigation levels of drip irrigation different irrigation had significant effect on the yield attributes (number of fruits, av. fruit weight) yield and quality components (juice content, TSS: acid ratio, rind thickness and organoleptic rating). Treatment 100 per cent dip level (I_2) registered maximum number of fruits (55.58), average fruit weight (174.00 g), yield (9.67 kg plant^{-1}), juice content (87.08%), TSS : acid ratio (50.87), organoleptic rating (8.31) along with minimum rind thickness (2.39 mm).

Table 1. Effect of fertigation and drip irrigation levels on growth and leaf nutrient status of pomegranate.

Treatment	Plant height (m)	Plant spread (m)		LAI	Leaf nutrient status (%)		
		E-W	N-S		N	P	K
Fertigation level							
F_0 (50% RDF)	2.05	1.77	1.79	2.15	1.65	0.16	1.15
F_1 (75% RDF)	2.09	1.82	1.82	2.30	1.69	0.17	1.18
F_2 (100% RDF)	2.14	1.86	1.87	2.44	1.72	0.18	1.21
F_3 (125% RDF)	2.19	1.89	1.91	2.45	1.77	0.19	1.26
CD (P = 0.05)	0.021	0.020	0.018	0.084	0.034	0.016	0.023
Drip irrigation level							
I_0 (50%)	1.98	1.71	1.71	1.96	1.64	0.16	1.15
I_1 (75%)	2.09	1.81	1.83	2.33	1.69	0.17	1.19
I_2 (100%)	2.28	1.99	2.00	2.72	1.80	0.19	1.27
CD (P = 0.05)	0.019	0.018	0.015	0.073	0.029	0.014	0.020

Table 2. Effect of fertigation and drip irrigation levels on yield attributes, yield and quality of pomegranate.

Treatment	No. of fruits plant^{-1}	Av. fruit weight (g)	Yield plant^{-1} (kg)	Juice content (%)	TSS : acid ratio	Rind thickness (mm)	Organoleptic rating
Fertigation Level							
F_0 (50% RDF)	48	167.22	8.06	76.00	34.25	2.96	6.94
F_1 (75% RDF)	39	168.67	8.33	76.89	37.50	2.89	7.26
F_2 (100% RDF)	51	170.22	8.77	79.67	42.66	2.70	7.46
F_3 (125% RDF)	52	170.56	8.90	80.44	42.44	2.71	7.52
CD (P = 0.05)	1.22	1.00	0.20	1.28	3.06	0.09	0.082
Drip irrigation level							
I_0 (50%)	44	164.08	7.31	69.50	28.59	3.30	6.35
I_1 (75%)	51	169.42	8.57	78.17	38.17	2.75	7.23
I_2 (100%)	56	174.00	9.67	87.08	50.87	2.39	8.31
CD (P = 0.05)	1.06	0.86	0.18	1.11	2.65	0.082	0.071

Drip irrigation at 100 per cent level (I_2) recorded better quality parameters because drip irrigation provides a consistent moisture regime in the soil due to which root remains active throughout the season resulting in optimum availability of nutrients and proper translocation of food materials which accelerated the fruit growth and development of quality characters in the fruits. The increase in juice content might be because of more absorption of water and minerals from the soil resulting into increased juice content (Nath *et al.*, 4).

The interaction between fertigation and drip irrigation levels were found to be quite superior to their individual effect. Among the treatment combinations I_2F_3 (100% DI + 125% RDF) exhibited significantly higher values of plant height (2.37 m) and plant spread (2.07 m E-W x 2.10 m N-S). The combined treatment I_2F_2 (100%DI + 100% RDF) recorded significantly higher fruit weight (176 g) and yield (10.03 kg plant^{-1}). The present results are supported by the findings of Chauhan and Chandel (1). The combined supplementation of 100 per cent fertilizer through drip and 100 per cent drip irrigation (I_2F_2) registered higher quality attributes like juice content (87%), TSS: acid ratio (58.12) and organoleptic rating (8.60). The increase in juice content might be because of more absorption of water and minerals from the soil resulting into increased juice content (Nath *et al.*, 4).

The net profit per hectare ranged from Rs. 3,50,625 to Rs. 5,96,177 (Table 4). The highest profit (Rs. 5,96,177) was obtained with 100 per cent fertilizers and 100 per cent drip irrigation levels (I_2 F_2) followed by 75 per cent fertilizers and 100 per cent drip irrigation (I_2 F_1). The 125 per cent fertilizers and 50 per cent drip irrigation (I_0 F_3) gave the least net profit of Rs. 2,82,948.70 followed by 100 per cent fertilizers and 50 per cent drip irrigation (I_0 F_2). The benefit: cost ratio ranged from 1.06 to 3.94 depending upon the treatment and it was found to be the highest (3.94) with 50 per cent fertilizers and 100 per cent drip irrigation (I_2 F_0) followed by 50 per cent fertilizers and 75 per cent drip irrigation (I_1 F_0). The 125 per cent fertilizers and 50 per cent drip irrigation (I_0 F_3) gave the least B: C ratio of (1.06) followed by 125 per cent fertilizers and 75 per cent drip irrigation (I_1F_3).

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Table 3. Combined effect of fertigation and drip irrigation levels on growth parameters, yield attributes, yield and quality components of pomegranate.

Treatment combination	Plant height (m)	Plant spread (m)		Fruit wt. (g)	Yield plant^{-1} (kg)	Juice content (%)	TSS : acid ratio	Organoleptic rating	Net return (Rs.)
		E-W	N-S						
$I_0 F_0$	1.95	1.67	1.68	161.67	6.84	67.00	25.78	6.13	3,50,625
$I_0 F_1$	1.96	1.70	1.71	163.67	7.09	68.67	27.37	6.30	3,21,209
$I_0 F_2$	1.99	1.72	1.72	164.67	7.46	70.33	29.30	6.41	3,00,660
$I_0 F_3$	2.04	1.74	1.74	166.33	7.87	72.00	31.93	6.55	2,82,948
$I_1 F_0$	2.04	1.76	1.78	167.67	7.99	75.00	31.75	6.75	4,28,657
$I_1 F_1$	2.08	1.78	1.80	169.00	8.39	76.33	36.17	7.10	4,10,208
$I_1 F_2$	2.09	1.83	1.85	170.00	8.84	79.00	40.58	7.38	3,94,793
$I_1 F_3$	2.16	1.85	1.88	171.00	9.06	82.33	44.17	7.68	3,64,014
$I_2 F_0$	2.17	1.90	1.90	172.33	9.36	86.00	45.21	7.95	5,22,321
$I_2 F_1$	2.23	1.97	1.94	173.33	9.53	85.67	48.95	8.37	5,82,805
$I_2 F_2$	2.32	2.02	2.05	176.00	10.03	89.67	58.12	8.60	5,96,177
$I_2 F_3$	2.37	2.07	2.10	174.33	9.76	87.00	51.21	8.32	5,08,378
CD (P = 0.05)	0.038	0.036	0.032	NS	NS	2.22	NS	0.142	

Table 4. Relative economics and benefit : cost ratio of different fertigation and drip irrigation levels in pomegranate.

Treatment	Total cost of production (Rs./ha)	Total marketable yield (t ha^{-1})	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
$I_0 F_0$	1,28,175.00	11.97	4,78,800.00	3,50,625.00	2.74
$I_0 F_1$	1,74,857.10	12.40	4,96,066.70	3,21,209.60	1.84
$I_0 F_2$	2,21,539.20	13.05	5,22,200.00	3,00,660.80	1.36
$I_0 F_3$	2,67,951.30	13.77	5,50,900.00	2,82,948.70	1.06
$I_1 F_0$	1,30,409.50	13.97	5,59,066.70	4,28,657.20	3.29
$I_1 F_1$	1,77,091.60	14.68	5,87,300.00	4,10,208.40	2.32
$I_1 F_2$	2,23,773.70	15.46	6,18,566.70	3,94,793.00	1.76
$I_1 F_3$	2,70,185.80	15.85	6,34,200.00	3,64,014.20	1.35
$I_2 F_0$	1,32,645.50	16.37	6,54,966.70	5,22,321.20	3.94
$I_2 F_1$	1,79,327.60	19.05	7,62,133.30	5,82,805.70	3.25
$I_2 F_2$	2,26,009.70	20.55	8,22,186.70	5,96,177.00	2.64
$I_2 F_3$	2,72,421.80	19.52	7,80,800.00	5,08,378.20	1.87

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