Original Research Article

Effect of irrigation and fertigation levels on soil fertility and yield of watermelon (*Citrulluslanatus*Thunb.)

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ABSTRACT

Aims: To study the effect of different irrigation and fertigation levels as well as their combination on soil fertility, nutrient uptake, and fruit yield of watermelon.

Study design: Strip-plot design.

Place and Duration of Study:A field experiment was conducted atthe Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the summer season 2018-18 and 2019- 2020.

Methodology: Two factors of irrigation and fertigation and three levels in each factor and the nine combinations of irrigation and fertigation levels were evaluated against the soil fertility, nutrient uptake, and fruit yield of watermelon.

Results: The results revealed that the soil pH was reduced while the organic carbon content increased with an increase in fertigation levels. In general, pooled mean revealed that available nitrogen (N), phosphorus (P), and potassium (K) were higher by 4.8, 16.9, and 4.5%, respectively, in F_1 (125% RDF through fertigation) over F_3 (75% RDF through fertigation) and significantly maximum availability was observed under the treatment combination of I_2F_1. The uptake of N, P, and K under I_1(100% of irrigation water requirement (IWR)) and F_1 were increased by about 12 and 22, 27 and 21, and 32 and 31% over that of irrigation level I_3(60% IWR) and fertigation level F_3, respectively. The pooled data of fruit yield revealed that the I_2(80% IWR) irrigation level and F_1 fertigation level had 35.39 and 36% higher fruit yield of watermelon as compared to I_3 and F_3, respectively. Among the different irrigation and fertigation levels, a significantly maximum fruit yield of watermelon was observed under I_2F_1, followed by I_2F_2.

Conclusion: The study demonstrated the superiority of combining irrigation and fertigation combination of I_2F_1 for improving soil fertility and watermelon yield, potentially saving up to 20% of irrigation water.

Keywords: Watermelon, irrigation, fertigation, soil fertility, fruit yield

1. INTRODUCTION

The sustainability of any agricultural resource, such as water, nutrients, or soil, necessitates optimal utilization. Aside from economic considerations, the negative environmental impact of inappropriate use of water and fertilizers can have far-reaching consequences. As a result, there is a need to develop agro technologies that will aid in the conservation of precious resources and the maximization of crop production while minimizing environmental impact [1]. Vegetables are essential to human nutrition [2]. Watermelons are grown extensively in the Indian states of Uttar Pradesh and Maharashtra. According to research, the yield of this vegetable crop has been declining over the years due to the indiscriminate use of chemical fertilizers [3]. Excessive use of inorganic fertilizers for vegetable crops causes soil and environmental disruption, and inorganic fertilizers cannot sustain high levels of vegetable crop productivity on their own. At the moment, more emphasis is being laid on reducing fertilizer requirements without jeopardizing crop yield potential. Fertigation is one such management option in which any water-soluble fertilizer or chemical can be applied in precise amounts in synchrony with the plant's needs, directly into the crop's root zone [4]. The term "Precision Agriculture" (PA) is now widely used in the context of climate change, to refer to the use of agricultural input as and when needed in a precise manner while taking serious environmental impacts into account. Drip irrigation is one such PA component. It is one of the most efficient methods of supplying water and nutrients to plants, which not only saves water but also increases the yield of fruits and vegetables, especially in arid and semi-arid regions where available water resources are scarce. This may also reduce total water requirements while increasing water use efficiency. To reduce production costs and environmental pollution, it is critical to use water and nutrients wisely. Earlier studies also reported the significance of irrigation and fertigation practices to improve the yield of different vegetable crops. Fontes et al. [5] found that using higher levels of K in conjunction with drip irrigation resulted in the highest tomato yield. Veeranna et al. [6] revealed that drip fertigation of water-soluble fertilizers at the recommended dose resulted in significantly higher dry fruit yield in Chili. Muralikrishnasamy et al. [7] observed that drip irrigation with 50% pan evaporation and 100% N and K through fertigation increased dry pod yield by 67.47%.

Thus it seems from the above literature that fertigation techniques for major vegetable crops have been standardized over the last two decades, there has been little research on the fertigation of watermelon under semi-arid subtropical climatic conditions. Proper fertigation management also necessitates an understanding of soil fertility and crop nutrient uptake. Monitoring soil and plant nutrient status is critical for ensuring maximum crop productivity. Chemical fertilizers in the proper dose, as well as optimal moisture availability, are well known for increasing vegetable crop yield. Fertilizer prices are rising on a daily basis, leaving farmers with only a marginal profit. As a result, it is critical that the use efficiency of applied fertilizers be increased while avoiding harm to the soil and environment. Given the importance of water and nutrients, i.e. irrigation and fertigation, particularly in the summer watermelon in Maharashtra's western Vidarbha region, where summer temperatures can exceed 42°C, the proposed study is very significant and useful for efficient fertilizer and irrigation water utilization. Keeping the foregoing in mind, the current study aims to investigate how different levels of irrigation and fertigation affect soil fertility, nutrient uptake, and watermelon yield, as well as to identify the best combination of irrigation and fertigation level(s) to achieve maximum watermelon yield potential.

2. MATERIAL AND METHODS

2.1 Description of the Study Area

A field experiment was conducted at Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the summer season 2018-19 and 2019- 2020. It is located in the subtropical zone with an altitude of 307.42 m above mean sea level (MSL). The climate of Akola is semi-arid and characterized by three distinct seasons viz. hot and dry summer from March to May, warm and rainy monsoon from June to October, and mild cold winter from November to February. The normal mean monthly maximum temperature is 42.50˚C during the hottest May, while, the normal mean monthly minimum temperature is 10.60˚C in the coldest December. The land used under the experimental layout was fairly uniform with a gentle slope. The soil was medium black with uniform texture, color, and good drainage. The texture of the soil was clay loam with pH 7.8, electrical conductivity (EC) 0.26 dSm^{-1}, organic carbon (OC) 5.1 g kg^{-1}, available N 184.5 kg ha^{-1}, P 17.65 kg ha^{-1}, K 305.6 kg ha^{-1}.

2.2 Experimental Design and Treatments

The experiment was laid out in strip-plot design (SPD) with two factors (i) three irrigation levels and (ii) three fertigation levels replicated three times. The treatment details in irrigation levels were, I_1:100% of irrigation water requirement (IWR); I_2:80% IWR; I_3:60% IWR and in fertigation levels, F_1:125% recommended dose of fertilizer (RDF) through fertigation; F_2:100% RDF through fertigation; F_3:75% RDF through fertigation. RDF were: 200:100:100 kg NPK ha^{-1}. The nine combinations of irrigation and fertigation levels were also evaluated.

2.3 Fertigation methodology

The drip irrigation system was employed for irrigation and fertigation in this experiment. Along the crop rows, lateral lines of 16 mm diameter LLDPE pipes with online drippers of 2 lph discharge capacity and dripper spacing of 1m was laid. For the main and sub-main, 75 mm and 65 mm diameter LLDPE pipe were used. The main line was linked directly to a 7.5 HP pump via a manifold unit equipped with a filter, a pressure gauge, ventury, and a control valve. The duration of water delivery to each treatment was controlled by gate valves installed at the inlet end of each lateral.

2.4Fertilizer Application and Intercultural Operations

The water-soluble fertilizers such as 19:19:19 and urea and drip irrigation systems were used for irrigation and fertigation purposes. Watermelon (Var. F1-hybrid (sugar queen)) seedlings were raised in portrays for 15 days before being transplanted to the main field at a spacing of 2m x 1m. Fruits were harvested when they made a dull sound when tapped or when the fruits surface on the ground level turned yellow. All other management interventions were carried out in accordance with the university's standard package of practices.

2.5 Yield recording and soil and plant analysis

The post-harvest surface (0-15 cm) soil samples were collected from experimental plots. The collected soil samples were processed and analyzed for pH and EC [8], OC [9], N [10], P [11], and K [12]. The N content in plant samples was estimated by the modified Micro-Kjeldahl method [12]. The P content in the vine sample was determined by Vanadomolybdo phosphoric yellow color method using KlettSummerson Photo Electro Calorimeter [9] and K was determined using Flame Photometer [12].

2.6 Statistical Analysis

The mean data on various parameters obtained from the analysis were statistically analyzedas per procedure given by Gomez and Gomez [13]. The significance of the difference between treatment means was determined using the least significant difference (LSD) values at P= 0.05. Duncan's multiple range test was used for the multiple comparison of treatment means.

3. RESULTS AND DISCUSSION

3.1 Soil properties

The effect of irrigation and fertigation levels on soil properties viz. pH and OC was significant, while the effect on EC was non-significant during both the years of study (2018-19 and 2019-20) and the pooled mean (Table 1). In irrigation levels, soil pH was statistically at par in all the levels during both the years of study as well as in pooled mean, while in fertigation levels, the soil pH tends to increase with a decrease in fertigation levels from F_1 (125% RDF through fertigation) to F_3 (75% RDF through fertigation). In general, the soil pH in fertigation level F_1 was lower by 1.6% as compared to fertigation level F_3. The interactive effect of irrigation and fertigation revealed that all the irrigation levels in combination with F_1 (I_1F_1, I_2F_1, and I_3F_1) had the significantly lowest soil pH during both the years and in pooled mean too. The lowest pH in F_1 as compared to F_2 and F_3 may be due to acidity produced by the application of higher levels of nitrogen fertilizers through drip irrigation. Further, the application of higher nutrient rates particularly nitrogen in F_1 might have produced residual acidity associated with N-fertilizers during the nitrification process. Similar results were also reported by Chaudhary et al. [14] and Ibrahim et al. [15]. The OC content of the soil in the present investigation ranged from 5.1 to 5.8 g kg^{-1} (Table 1). In irrigation levels, significantly higher OC content was observed under irrigation level I_2 (80% IWR) during the second year and in the pooled mean while it was statistically at par in all three irrigation levels during the first year of experimentation. Among the fertigation levels, significantly maximum OC was found in fertigation level F_1 (125% RDF through fertigation), followed by F_2 (100% RDF through fertigation) and least in F_3 (75% RDF through fertigation), during both the years and inpooled

Table 1. Effect of irrigation and fertigation levels on soil chemical properties

Treatments	2018-19				2019-20				Pooled			
Irrigation levels (I)	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
						pH						
I_1	7.81^{c}	7.89^{b}	7.92^{ab}	7.87^{a}	7.82^{cd}	7.86^{bc}	7.93^{a}	7.87^{a}	7.82^{c}	7.88^{bc}	7.93^{a}	7.87^{a}
I_2	7.82^{c}	7.92^{ab}	7.94^{a}	7.89^{a}	7.81^{d}	7.9^{ab}	7.94^{a}	7.88^{a}	7.82^{c}	7.91^{ab}	7.94^{a}	7.89^{a}
I_3	7.81^{c}	7.86^{b}	7.95^{a}	7.87^{a}	7.83^{cd}	7.88^{b}	7.94^{a}	7.88^{a}	7.82^{c}	7.87^{bc}	7.95^{a}	7.88^{a}
Mean	7.81^{c}	7.89^{b}	7.94^{a}		7.82^{c}	7.88^{b}	7.94^{a}		7.82^{c}	7.89^{a}	7.94^{a}	
SE(m)±	I: .005, F: .01, I X F: .01				I: .01, F: .01, I X F: .01				I: .01, F: .02, I X F: .02			
LSD(*P* = .05)	I: .02, F: .03, I X F: .03				I: .03, F: .03, I X F: .04				I: .03, F: .05, I X F: .06			
						EC (ds m^{-1})						
I_1	0.25	0.28	0.27	0.27	0.27	0.25	0.24	0.25	0.26	0.27	0.26	0.26
I_2	0.26	0.24	0.26	0.25	0.28	0.27	0.28	0.28	0.27	0.26	0.27	0.27
I_3	0.29	0.27	0.29	0.28	0.24	0.27	0.29	0.27	0.27	0.27	0.29	0.28
Mean	0.27	0.26	0.27		0.26	0.26	0.27		0.27	0.26	0.27	
SE(m)±	I: .12, F: .12, I X F: .11				I: .2, F: .15, I X F: .12				I: .11, F: .12, I X F: .11			
LSD (*P* = .05)	I: NS, F: NS, I X F: NS				I: NS, F:NS, I X F:NS				I: NS, F: NS, I X F: NS			
						OC (g kg^{-1})						
I_1	5.8^{a}	5.4^{a}	5.3^{a}	5.5^{a}	5.7^{a}	5.2^{bc}	5.1^{c}	5.3^{b}	5.8^{a}	5.3^{c}	5.2^{de}	5.4^{bc}
I_2	5.5^{ab}	5.7^{a}	5.1^{b}	5.4^{a}	5.9^{a}	5.6^{ab}	5.6^{ab}	5.7^{a}	5.7^{ab}	5.7^{ab}	5.4^{cd}	5.6^{a}
I_3	5.2^{b}	5.1^{b}	5.1^{b}	5.1^{a}	5.8^{a}	5.1^{c}	5.1^{c}	5.3^{b}	5.5^{bc}	5.1^{e}	5.1^{e}	5.2^{c}
Mean	5.5^{a}	5.4^{ab}	5.2^{b}		5.8^{a}	5.3^{b}	5.3^{b}		5.7^{a}	5.4^{ab}	5.2^{b}	
SE(m)±	I: .1, F: .06, I X F: .2				I: .1, F: .1, I X F:.1				I: .06, F: .1, I X F: .06			
LSD (*P* = .05)	I: .4, F: .2, I X F: .5				I: .3, F: .4, I X F:.4				I: .2, F: .3, I X F: .2			

**Means followed by the same letter in a column are not significantly different at P=.05 according to Tukey's HSD*

EC: electrical conductivity, OC: organic carbon

I_1= 100% of irrigation water requirement, I_2= 80% of irrigation water requirement, I_3= 60% of irrigation water requirement, F_1= 125% recommended dose of fertilizer (RDF) through fertigation, F_2=100% RDF through fertigation, F_3=75% RDF through fertigation

mean. In general, pooled mean revealed that OC content of the soil was increased by 9.6% in F_1 as compared to F_3. Among the different irrigation and fertigation interaction levels, OC content was significantly higher and statistically comparable under all the irrigation levels in combination with F_1 (I_1F_1, I_2F_1, and I_3F_1). Furthermore, treatment combination I_2F_2 also had a higher content of OC, which was statistically at par with all irrigation levels in combination with F_1. The observed highest OC in F_1 level and F_1 in combination with I_1, I_2, and I_3 might be because of improved plant and root growth. Under optimum nutrient supply through fertigation, there was marked enhancement in the above-ground and root biomass of watermelon which ultimately contributed to soil organic matter and thus improved the soil organic carbon. This was further supported by the studies of Morra et al.[16].

3.2 Soil fertility status

The fertility status of soil in terms of available N, P, and K were also significantly affected by different irrigation levels, and fertigation levels as well as the interaction of these two. The available N, P, and K contents under various irrigation and fertigation levels ranged between 294.37-313.81, 21.36-28.39, and 367.86-416.03 kg ha^{-1}, respectively (Table 2). The available N and P content of the soil, under different irrigation levels, were more or less statistically at par during both the years and in pooled mean, while available K content was significantly higher under irrigation level of I_2 (80% IWR), followed by I_1 (100% IWR) and I_3 (60% IWR), which again were statistically comparable. Among the fertigation levels, it was observed that available N, P, and K content tends to increase with an increase in fertigation levels and were significantly higher under F_1 during both the years and in pooled mean. For example, in pooled mean, the available N, P, and K were higher by 4.8, 16.9, and 4.5%, respectively, over F_3. Within the different combinations of irrigation and fertigation levels, all the three irrigation levels (I_1, I_2, and I_3) in combination with fertigation level F_1 had a higher content of available N, P, and K, but among these treatments, the significantly highest content of available N, P, and K was observed under I_2F_1. The higher content of available N, P, and K was observed in the F_1 fertigation level and F_1 in combination with I_1, I_2, and I_3 because, in these treatments, higher doses of N, P, and K were supplied through drip irrigation. In fertigation levels, especially in F_1, 25% more N, P, and K were given through drip irrigation as compared to F_3 which had 25% less N, P, and K than the recommended dose. This help in enriching the soil fertility after satisfying the nutrient needs of the watermelon. Similar results were also reported by Meena et al., [17], Prasad et al., [18], Sood and sharma [19], andBidari et al. [20].

3.3 Nutrient uptake by watermelon

The uptake of macronutrients (N, P, and K) by watermelon was significantly affected by different irrigations and fertigation levels (Table 3). The uptake of N, P, and K varied between treatments, ranging from 95.58-125.89, 14.79-25.44, and 42.84-75.22 kg ha^{-1}, respectively. In irrigation levels, significantly higher uptake of N, P, and K were recorded under irrigation level of I_2 (80% IWR), followed by I_1 (100% IWR), and least in I_3 (60% IWR). The uptake of N, P, and K under I_1 were increased by about 12, 27, and 32% over that of irrigation level I_3.Among the different fertigation levels, the levels where higher amount of NPK were supplied through fertigation i.e. F_1 (125% RDF through fertigation) had the significantly highest uptake of N, P, and K. For instance, the uptake of N, P, and K were higher by about 22, 21, and 31% in F_1 as compared to fertigation level F_3 (75% RDF through fertigation).The interaction of irrigation and fertigation levels also had a significant influence on the uptake of N, P, and K content by watermelon. It was observed that the combination of I_2 with either F_1 or F_2 (100% RDF through fertigation) had resulted in significantly higher uptake of N, P, and K over rest of the irrigation and fertigation level combinations. The higher nutrient uptake in the I_2 and F_1 plot is primarily due to improved soil properties as a result of the synchrony between nutrient supply and demand by the crop.Further, drip irrigation delivered the water near the crop’s root zone

Table 2. Effect of irrigation and fertigation levels on soil fertility (kg ha^{-1}) status

Treatments	2018-19				2019-20				Pooled			
Irrigation levels (I)	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
Available Nitrogen												
I_1	307.88^{bc}	304.51^{d}	296.14^{e}	302.85^{a}	312.67^{a}	307.27^{c}	297.70^{e}	305.88^{a}	310.28^{b}	305.89^{c}	296.92^{d}	304.36^{b}
I_2	311.68^{a}	305.20^{cd}	295.23^{e}	304.04^{a}	313.81^{a}	308.39^{c}	299.37^{d}	307.19^{a}	312.75^{a}	306.79^{c}	297.30^{d}	305.61^{a}
I_3	309.01^{b}	305.91^{cd}	291.75^{f}	302.22^{a}	310.68^{b}	307.10^{c}	299.32^{d}	305.70^{a}	309.85^{b}	306.51^{c}	295.53^{e}	303.96^{b}
Mean	309.52^{a}	305.21^{b}	294.37^{c}		312.39^{a}	307.59^{b}	298.80^{c}		310.96^{a}	306.40^{b}	296.59^{c}	
SE(m)±	I: .31, F:.28, I X F: .44				I: .30, F:.45, I X F: .43				I: .17, F:.30, I X F: .37			
LSD (*P* = .05)	I: 1.20, F: 1.09, I X F: 1.43				I: 1.16, F: 1.75, I X F: 1.40				I: 0.68, F: 1.20, I X F 1.20			
Available Phosphorus												
I_1	24.70^{ab}	23.27^{c}	21.36^{d}	23.11^{a}	26.30^{b}	24.89^{de}	22.01^{f}	24.40^{ab}	25.50^{b}	24.08^{d}	21.68^{g}	23.75^{b}
I_2	25.31^{a}	24.17^{b}	22.05^{d}	23.84^{a}	28.39^{a}	25.49^{cd}	22.86^{f}	25.58^{a}	26.85^{a}	24.83^{c}	22.45^{f}	24.71^{a}
I_3	24.91^{ab}	22.30^{d}	22.11^{d}	23.10^{a}	26.04^{bc}	23.99^{e}	22.69^{f}	24.24^{b}	25.47^{b}	23.14^{e}	22.40^{f}	23.67^{b}
Mean	24.97^{a}	23.24^{b}	21.84^{c}		26.91^{a}	24.79^{b}	22.52^{c}		25.94^{a}	24.02^{b}	22.18^{c}	
SE(m)±	I: .14, F:.26, I X F:.27				I: .27, F:.31, I X F:.31				I: .16, F:.17, I X F:.17			
LSD (*P* = .05)	I: 1.05, F: 1.04, I X F: .89				I: 1.05, F: 1.23, I X F: 1.01				I: .64, F: .68, I X F: .54			
Available Potassium												
I_1	378.32^{c}	376.62^{d}	367.86^{h}	374.26^{b}	384.47^{c}	382.57^{cd}	377.93^{de}	381.66^{b}	381.40^{c}	379.59^{cd}	372.89^{f}	377.96^{b}
I_2	398.26^{a}	389.93^{b}	375.18^{e}	387.79^{a}	416.03^{a}	397.82^{b}	380.14^{c}	398.00^{a}	407.15^{a}	393.88^{b}	377.66^{de}	392.89^{a}
I_3	379.96^{c}	372.87^{f}	369.28^{g}	374.04^{b}	384.78^{c}	375.19^{e}	374.73^{e}	378.23^{b}	382.37^{c}	374.03^{ef}	372.00^{f}	376.14^{b}
Mean	385.52^{a}	379.81^{b}	370.77^{c}		395.10^{a}	385.19^{b}	377.60^{c}		390.31^{a}	382.50^{b}	374.19^{c}	
SE(m)±	I: .35, F:.26, I X F:.51				I: .79, F:.38, I X F:2.09				I: .50, F:.21, I X F:.14			
LSD (*P* = .05)	I: 1.37, F: 1.02, I X F: 1.65				I: 3.12, F: 1.51, I X F: 6.81				I: 1.97, F: .81, I X F: 3.72			

**Means followed by the same letter in a column are not significantly different at P=.05 according to Tukey's HSD*

I_1= 100% of irrigation water requirement, I_2= 80% of irrigation water requirement, I_3= 60% of irrigation water requirement, F_1= 125% recommended dose of fertilizer (RDF) through fertigation, F_2=100% RDF through fertigation, F_3=75% RDF through fertigation

Table 3. Effect of irrigation and fertigation levels on nutrient uptake (kg ha^{-1}) by watermelon

Treatments	2018-19				2019-20				Pooled			
Irrigation levels (I)	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
Nitrogen												
I_1	117.56b	99.43d	94.46e	103.81b	122.45b	101.21f	96.26h	106.64b	120.00b	100.32d	95.36f	105.23b
I_2	123.86a	118.33b	95.58e	112.59a	125.89a	120.29c	97.72gh	114.64a	124.88a	119.31b	96.65ef	113.61a
I_3	106.94c	98.11d	96.72de	100.59c	114.38d	103.05e	98.20g	105.21c	110.66c	100.58d	97.46e	102.90c
Mean	116.12a	105.29b	95.58c		120.91a	108.19b	97.39c		118.51a	106.74b	96.49c	
SE(m)±	I: .44, F: .28, I X F:.62				I: .23, F:.19, I X F: .57				I: .16, F: .12, I X F:.52			
LSD (*P* = .05)	I: 1.72, F: 1.11, I X F: 2.01				I: .90, F: .74, I X F:1.87				I: .63, F: .49, I X F:1.70			
Phosphorus												
I_1	18.84b	15.88d	15.54d	16.75b	19.26cd	18.67d	16.85e	18.26b	19.05c	17.27e	16.20f	17.51b
I_2	22.52a	20.27b	18.03bc	20.27a	25.44a	21.86b	19.94c	22.41a	23.98a	21.07b	18.99cd	21.34a
I_3	17.55c	15.69d	14.79d	16.01c	19.55cd	16.15e	16.40e	17.37b	18.55d	15.92g	15.60g	16.69b
Mean	19.64a	17.28b	16.12c		21.42a	18.89b	17.73b		20.53a	18.09b	16.93c	
SE(m)±	I: .24, F: .09, I X F:.29				I: .25, F: .35, I X F:.36				I: .24, F: .15, I X F:.25			
LSD (*P* = .05)	I: .95, F: .34, I X F: .95				I: .97, F:1.39, I X F:1.16				I: .95, F: .58, I X F: .83			
Potassium												
I_1	58.33c	50.06d	47.16de	51.85b	60.88c	52.19d	49.97e	54.35b	59.61c	51.12d	48.56de	53.10b
I_2	71.40a	64.24b	46.68de	60.77a	75.22a	66.05b	48.21f	63.16a	73.31a	65.14b	47.44de	61.96a
I_3	49.20d	45.10de	42.84e	45.71c	51.69d	48.60f	43.97g	48.09c	50.44d	46.85ef	43.41f	46.90c
Mean	59.64a	53.13b	45.56c		62.60a	55.61b	47.38c		61.12a	54.37b	46.47c	
SE(m)±	I: .63, F: .92, I X F:1.76				I: .23, F:.15, I X F:.41				I: .32, F: .44, I X F:.94			
LSD (*P* = .05)	I: 2.47, F: 3.62, I X F: 5.73				I: .92, F: .57, I X F:1.33				I:1.27, F:1.73, I X F:3.07			

**Means followed by the same letter in a column are not significantly different at P=.05 according to Tukey's HSD*
I_1= 100% of irrigation water requirement, I_2= 80% of irrigation water requirement, I_3= 60% of irrigation water requirement, F_1= 125% recommended dose of fertilizer (RDF) through fertigation, F_2= 100% RDF through fertigation, F_3= 75% RDF through fertigation

resulting in the better utilization of these nutrients. All of these processes led to increased N, P, and K uptake by the watermelon. Further, Muthumanickam and Anburani[21], Bidari and Hebsur[22], Feleafel and Mirbad[23],and Imamsaheb et al. [24] also reported similar results.

3.4 Fruit yield of watermelon

As discussed above, the different irrigation and fertigation levels, as well as their combinations had significantly improved soil fertility and nutrient uptake by watermelon, and so does the fruit yield of watermelon, ranging from 23.07 to 45.84 kg ha^{-1} (Fig 1). The fruit yield of watermelon was significantly highest under irrigation level I_2 (80% IWR) and statistically at par in I_1 (100% IWR) and I_3 (60% IWR). In general, the pooled data revealed that the I_2 irrigation level had a 35.39% higher fruit yield of watermelon as compared to I_3. This results in the saving of an additional 20% of irrigation water requirement. Among the irrigation levels, significantly highest fruit yield was observed under the fertigation level of F_1 (125% RDF through fertigation), followed by F_2 (100% RDF through fertigation) and least under F_3 (75% RDF through fertigation). In F_1, the fruit yield of watermelon was higher by 36.10% as compared to fertigation level F_3. Among the combinations of different irrigation and fertigation levels, a significantly maximum fruit yield of watermelon was observed under I_2F_1, followed by I_2F_2 during both the years of experiments as well as in pooled mean. This yield improvement was mainly because of improvement in the fertility status of soil and the indirect effect of fertigation. The drip irrigation helped in maintaining the nutrients in soluble form and facilitated the steady and continuous supply of nutrients and enhanced the nutrient uptake during the critical crop growth period. Similar results were also reported by Karthick et al. [25],Leghari et al. [26], Hazarika et al. [27], Rolviecki et al. [28], andTanaskovik et al. [29].

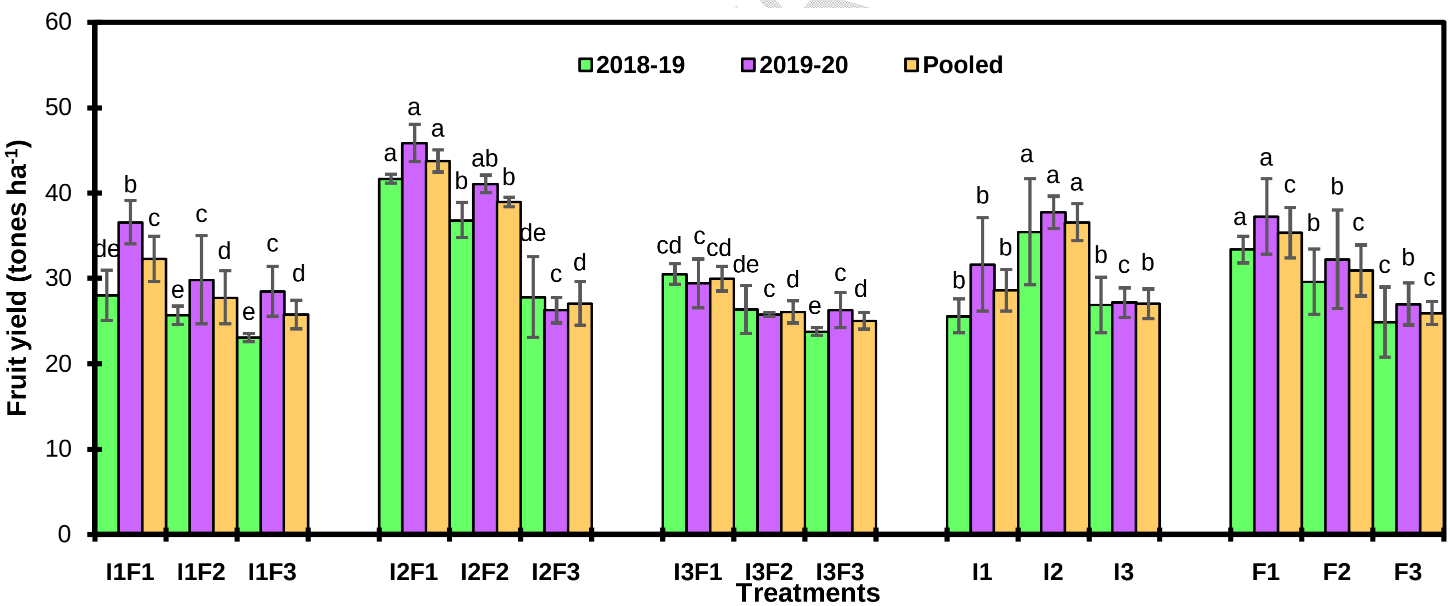

Fig. 1. Effect of irrigation and fertigation levels on fruit yield of watermelon.

Vertical bars are the standard errors of the mean and the bars followed by a different letter are significantly different at P=.05 according to Tukey's HSD

I_1= 100% of irrigation water requirement, I_2= 80% of irrigation water requirement, I_3= 60% of irrigation water requirement, F_1= 125% recommended dose of fertilizer (RDF) through fertigation, F_2=100% RDF through fertigation, F_3=75% RDF through fertigation

4. CONCLUSION

According to the findings of this study, watermelon responded significantly to irrigation level I_2 (80% IWR) and F_1 (125% RDF through fertigation) fertigation level, as well as the combination of I_2F_1. The fertigation level F1 had lowest soil pH, higher OC, and available nutrients.Available N, P, and K content tends to increase with an increase in fertigation levels and were significantly higher under F_1. Further, all the three irrigation levels (I_1, I_2, and I_3) in combination with fertigation level F_1 had a higher content of available N, P, and K, but among these treatments, the significantly highest content of available N, P, and K was observed under I_2F_1. In addition, it was also observed that the combination of I_2 with either F_1 or F_2 (100% RDF through fertigation) had resulted in significantly higher uptake of N, P, and K over rest of the irrigation and fertigation level combinations. These treatments ultimately resulted in the highest watermelon fruit yield. In unique approach the current study demonstrated the superiority of combining irrigation and fertigation for improving soil fertility and watermelon yield, potentially saving up to 20% of irrigation water.

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