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Effect of irrigation schedule and fertigation level on growth and development of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin

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Abstract

The trial was conducted on newly established orchard of mandarin plants of cv. Nagpur Mandarin growing under squire planting system (6 x 6 m) with three irrigation levels, *i.e*., 100, 80 and 60 per cent ETc, three fertigation levels, *i.e.*, 100, 80 and 60 per cent recommended dose of fertilizers and putting conventional method as check (Control: Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application). The experiment revealed that among various irrigation schedule treatments, application of treatment I_1 (100% ETc) was observed significantly superior over other treatments with regard to growth and development parameters in which the increase in rootstock girth (50.40%), scion girth (51.26%), number of leaves/shoot (53.63%), number of nodes/shoot (1.87%) and number of internodes/shoot (1.92%). Among treatments of fertigation, maximum percentage increase in rootstock girth (57.10%), scion girth (57.29%), number of leaves/shoot (61.45%), number of nodes/shoot (1.94%) and number of internodes/shoot (2.00%) was observed in the treatment F_1 (100% RDF).With respect to interaction effect of irrigation schedule and fertigation levels, all plant parameters were pointed out in treatment I_1F_1 (Irrigation Scheduling at 100% ETc + Fertigation 100% RDF) which was significantly higher over all other treatments of these combinations through it was found at par with treatment I_2F_1 (Irrigation Scheduling at 80 ETc + Fertigation 100% RDF).

Keywords: Mandarin, irrigation schedule, fertigation, recommended dose of fertilizer

Introduction

Mandarin known as *Citrus reticulata* Blanco is an important fruit in genus citrus. It belongs to the family Rutaceae and Sub-family Aurantioideae. Mostly citrus species are diploid in nature and it has basic chromosomes number n=9, 2n = 2x = 18 (Krug, 1943) [9].

Mandarin is cultivated dominantly in China, Brazil, India, USA, Mexico, Egypt, Spain and Morocco. In India, presently the production of citrus fruits is about 122.53 million tonnes in which mandarin, sweet orange, lime and lemon contribution is about 40.52, 26.29, 23.47 and 9.72 per cent, respectively (Anon., 2019) [2]. Mandarin is commercially grown in many states of India like Madhya Pradesh, Maharashtra, Andhra Pradesh, Rajasthan, Nagaland, Punjab, Karnataka, Gujarat, Assam, West Bengal, Haryana and Tripura. It covers maximum area in Madhya Pradesh followed by Maharashtra and Punjab. The total production of Mandarin in India is 6.36 MT from an area of 0.48 Million hectare with the productivity of 11.08 MT/ha (Anon., 2020) [3]. In Rajasthan, Mandarin covers 0.024 million hectares area with total production of 0.48 million tonnes (Anon., 2020) [3]. In the state, In Jhalawar district Mandarin, is grown over 0.23 lakh ha area and the production is 4.78 lakh tonnes (Anon., 2020) [3].

Among other factors, limitation of water availability comes in big way in cultivation of mandarin. The ground water resource is depleting year after year. Jhalawar, which receives 1200 mm annual rainfall, also comes under dark zone. Water is leading ingredient in plants because it makes almost 90 per cent biomass. The water adds up to 60 to 90 per cent part of roots, 35 to 95 per cent part of plant leaves and 70 to 90 percent part of fleshy fruits. Hence, water is main ingredient of cytoplasm irrespective of plant portion. Water is also necessary in hydraulic process in the plant and acts as a transporter of nutrients from the soil to every green plant tissues. Plant synthesizes their food during photosynthesis in which water is an component. Water is main agent of thermo-regulation and thus form a determinant in growth, development and survival of plants. There is a need of water saving technique.

Application of proper dose of water through drip irrigation is expected to result in water saving and likely to hasten plant growth and development.

Implementation of fertigation has gained popularly in recent years, mainly in case of large spaced high value crops including fruits. Fertigation is a technique of combined application of fertilizers along with irrigation water effecting saving of fertilizers and water and at the same time enhancing growth, yields and quality of crops and minimizing ground water pollution caused by leaching. Drip fertigation is well organized technology of application of water and fertilizer simultaneously, directly into active root zone at right time in right quantum which ultimately helps in better development of plants, Drip fertigation, is beneficial as in this system nutrient use efficiency could be as high as 90 per cent which remains at 40 to 60 per cent in traditional methods (Solaimalai *et al*., 2005) [19]. Drip fertigation technology has been well developed, tested, fine tuned and adapted in large scale field situation and under protected cultivation like poly houses, glass houses, shade net etc.

Now-a-days fertilizers are becoming more expensive input in the market. Therefore, it is felt essential to learn more efficient use of these inputs. This challenge can be minimized by application of fertilizers by fertigation technology with drip irrigation system at slow, measured and controlled rate to the active root zone (Kumar *et al.*, 2008) [11]. Some researchers and growers established the utility of drip irrigation and fertigation system in fruit orchards for enhanced growth and yield with superiority produce. It was observed in acid lime that maximum plant growth parameters like plant height and plant spread was there with 100 per cent (evapotraspiration replenishment) application of irrigation water by micro irrigation and 100 RDF through fertigation (Goramnagar *et al.*, 2017) [6]. Fertigation with 120 per cent RDF in Kinnow mandarin at significant growth stages influenced plant height, stem girth, canopy volume and yield under high density planting condition (Sinha *et al*., 2019) [17]. Keeping these facts in view the present experiment was carried out.

Materials and Methods

The present work was conducted deploying 10 treatments in F-RBD with four replication covering 160 plants in all during two successive years commencing from March, 2019 to February, 2021 at the Instructional Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar, Rajasthan. Jhalawar district of Rajasthan is located at 23°4 to 24°52 North-Latitude and 75°29' to 76°56'East-Longitude. It lies in South-Eastern part of Rajasthan and agro-climatically falls under zone-V (Humid South Eastern Plain). The district receives annual rainfall of about 954 mm. In the winter season temperature dips down up to 1 to 2.5 ºC and during summer season it reaches around 45-48 ºC. The texture of the soil of the experiment field was clay loam (Vertisol/Black soil). The soil was poor in organic carbon. The detailed physic-chemical composition of soil of experimental site is furnished as under:

Table 1: Physical and chemical properties of soil of experimental orchard

S. No.	Soil properties	Content (0-15cm depth of soil)
1.	Ph	7.51
2.	Electrical conductivity (dSm^{-1})	0.40
3.	Organic Carbon (%)	0.46
4.	Bulk Density ($Mg.m^{-3}$)	1.37
5	Particle density ($Mg.m^{-3}$)	2.75
6.	Porosity (%)	48.11
7.	Available N ($kg.ha^{-1}$)	299.00
8.	Available P ($kg.ha^{-1}$)	19.00
9.	Available K ($kg.ha^{-1}$)	273.00

There were three levels of irrigation *i.e*., 100 per cent ETc (I_1), 80 per cent ETc (I_2) and 60 per cent ETc (I_3), three levels of fertigation, *i.e*., 100 per cent RDF (F_1), 80 per cent RDF (F_2) and 60 per cent RDF (F_3) and one conventional method (Control: Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application).

In the course of investigation, irrigation water was applied every 3rd day during March, 2019 to February, 2021. During the rainy months (first week of July to first week of October) irrigation water was not applied. The fertigation schedule was decided based on standard recommended dose of fertilizer. The required dose of fertilizer for 1 year old plant of mandarin was taken of 90 g N, 90 g P and 90 g K and for two year plant of mandarins is 180 g N, 180 g P and 180 g K (Anon., 2011) [1]. The doses of fertilizers were supplemented through water soluble fertilizer NPK-18:18:18 and were supplied during March, July and October at active growth phases of plants during both years of experiment. Thus, at one time, of the total recommended dose of fertilizer (RDF), 1/3rddose was given. Further during each specified month, the 1/3rddose calculated for that particular month was fed through equally distributed irrigation schedule during the specified month spltted further in three equal doses. Water soluble fertilizer as per schedule was dissolved and mixed in fertilizer tank. The mixture of fertilizer water was injected into the drip system through the fertilizer Venturiy. The water requirement was estimated by using following equation.

Assume, pan evaporation reading is 10 mm and then volume of to be applied to plant was calculated as under:

ETc = ETo x Kc x A - Re

Where, ETc = Volume of water required in litre per day

ETo = Reference evapotranspiration

Ep = Pan evaporation which has been taken as 10 mm

Kp = Pan co-efficient 0.7 (Kumar *et al.*, 2013) [10] for class A pan evaporimeter.

ETo = Ep × Kp

Kc = Crop co-efficient which is 0.60 (Kc considering, Kc values to be 0.50 in month January, 0.55 in month February to March and November to December, 0.60 in month October and April to May, 0.70 in month of July and August, 0.65 in month June and September, (Kumar *et al.*, 2013) [10].

A = Average canopy area.

Re = Effective rainfall mm.

Likewise, for everyday changing pan evaporation, volume of water (ETc) was calculated for the propose of experiment.

During plant growth period, irrigation was applied uniformly at 100 per cent ETc, 80 per cent ETc and 60 per cent ETc in particular treatments.

For measuring the rootstock girth and scion girth, the mandarin plants under different treatments were marked at a fix point with white colour paint. Initial rootstock girth and scion girth was measured separately with the help of digital vernier caliper (0-450 mm, *Mitutoyo*) before treatment application on first day of March, 2019. Afterward, periodical observation of rootstock girth and scion girth was measured at the marked point at every two months interval right from March, 2019 to February, 2021 as per plan of the experiment. The average increase in rootstock girth and scion girth of plants was calculated according to average increase in initial value. The number of nodes per shoot, number of internodes per shoot and number of leaves per shoot was counted manually at two months interval from the selected shoots and average increase in number of internodes per shoot was computed on the basis of average increase in initial value. The data obtained during the experiment (March, 2019 to February, 2021) were statistically analysed as per analysis of variance technique (Panse and Sukhatme, 1995) [13].

Results and Discussion

The pooled data of the experiment carried out for two consecutive years *i.e.* March, 2019 to February, 2020 and March, 2020 to February, 2021 pertaining to the effect of irrigation schedule and fertigation levels on rootstock girth, scion girth, number of leaves per shoot, number of nodes per shoot and number of internodes per shoot of mandarin plants cv. Nagpur Mandarin are presented in Table 1, Table 2, Table 3, Table 4 and Table 5 respectively and depicted through Fig. 1, 2. The data indicate the significant increase in rootstock girth scion girth, number of leaves per shoot, number of nodes per shoot and number of internodes per shoot of mandarin with the application of different irrigation schedule and fertigation levels. It is reflected that maximum per cent increase in rootstock girth (50.40%), scion girth (51.26%), number of leaves/shoot (53.63%), number of nodes/shoot (1.87%) and number of internodes/shoot (1.92%) was there under the treatment I_1 (100% ETc) which was significantly higher over all other treatments. However, minimum increase in rootstock girth (39.86%), scion girth (41.19%), number of leaves/shoot (42.99%), number of nodes/shoot (1.74%) and number of internodes/shoot (1.79%) was noted in treatment I_3 (60% ETc) at the end of experiment (February, 2021). Present work partially supported by Hendre *et al.* (2020) [8] in sweet orange and Ramniwas *et al.* (2012) [14] in guava.The maximum growth of plant parameters under I_1 treatment (100% ETc) as compared to other treatments might be due to sufficient amount of water supply at alternate days near active root zone of plant through drip method. The sufficient soil moisture at ideal irrigation level has been associated in reducing water stress to the plants which maybe led to enhance in mitotic activity of mesophyll cells in the meristematic region of the plant resulting in increased cell division and ultimately enhanced plant growth (Robertson *et al.,* 1990) [15]. Apart from this, under this treatment there might have been improved cell enlargement triggered by mass flow dependent better translocation of food material like minerals and nutrients (Kumar *et al.,* 2013; Haneef *et al.,* 2014) [10, 7] which perhaps accelerated the growth and development of shoot parameters.

Among treatments of fertigation, maximum percentage increase in rootstock girth (57.10%), scion girth (57.29%), number of leaves/shoot (61.45%), number of nodes/shoot (1.94%) and number of internodes/shoot (2.00%) was observed in the treatment F_1 (100% RDF). Whereas, minimum increase in rootstock girth (35.84%), scion girth (38.08%), number of leaves/shoot (39.81%), number of nodes/shoot (1.69%) and number of internodes/shoot (1.74%) was noted in treatment F_3 (60% RDF) at the end of experiment (February, 2021). Similar explanation for better plant parameters with application of 100 per cent recommended dose of fertilizer through fertigation have been cited by Devil *et al.* (2019) [4] in mango and Singh *et al.* (2018) in banana. likewise, the maximum growth of plant parameters under treatment F_1(100% RDF) over all other treatments might be due to application of appropriate dose of water soluble fertilizer (N, P and K) through fertigation offering better nutritional atmosphere near active root zone as well as in plant system. Shirigure *et al.* 2001 and Suresh *et al.* 2006 observed enhanced absorption of NPK through fertigation and subsequently reported overall enhancement in vegetative growth parameters. NPK are most essential of all mineral nutrients for vegetative growth and development of plants as these are the source of fundamental constituent of all living matter (Throughton *et al.*, 1974) [21]. The well accomplished persistent vegetative growth and development because of prolonged persistent nutrient availability ensuring increase in rate of different physiological and metabolic process like synthesis of proteins, secondary metabolites, coenzymes, enzyme activation, nucleic acid, energy transfer, metabolic products, osmotic regulation, photosynthesis and respiration in plant system have also been expressed as possible reason by Mounashree *et al.* (2018) [12].

With respect to interaction effect of irrigation schedule and fertigation levels, maximum percentage increase in rootstock girth (63.25%), scion girth (63.93%), number of leaves/shoot (68.79%), number of nodes/shoot (2.03) and number of internodes/shoot (2.08%) was observed in treatment I_1F_1 (Irrigation Scheduling at 100% ETc + Fertigation 100% RDF) which was significantly higher over all other treatments of these combinations through it was found at par with treatment I_2F_1 (Irrigation Scheduling at 80% ETc + Fertigation 100% RDF). The minimum percentage increase in rootstock girth (33.11%), scion girth (35.22%), number of leaves/shoot (37.85%), number of nodes/shoot (1.64%) and number of internodes/shoot (1.70%) was observed in treatment I_0F_0(Control, Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application).Alike explanation for encouraging results with irrigation water at 100 per cent ETc and 100 per cent RDF through fertigation have been cited by Hendre *et al.* (2020) [8] in sweet orange and Ramniwas *et al.* (2012) [14] in guava.The maximum growth of shoot parameters under I_1F_1 treatment (Irrigation Scheduling at 100% ETc + Fertigation 100% RDF compared to control might be due to higher dose of combined application of irrigation and fertigation levels which perhaps ensured ample and continuous availability of moisture along with NPK contributing growth and development of plant enabling higher partitioning of photosynthesis, improvement of photosynthetic rate and cell turgidity (Hendre *et al.*, 2020) [8].

Table 2: Effect of irrigation schedule and fertigation levels on rootstock girth (percentage increase) of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin during two years growth period (March, 2019 to February 2020, and March, 2020 to February, 2021).

Treatments / Month	Rootstock girth (mm) Pooled values					
	March (Initial values)	**May**	**July**	**October**	**December**	**February**
I_1	14.80	13.10 (16.74)	18.04 (17.49)	38.41 (20.51)	45.24 (21.56)	50.40 (22.32)
I_2	14.77	11.96 (16.55)	16.66 (17.27)	36.02 (20.15)	42.25 (21.09)	47.17 (21.82)
I_3	14.61	10.01 (16.07)	13.31 (16.56)	31.97 (19.29)	36.07 (19.90)	39.86 (20.45)
SE (m) ±		0.34	0.37	0.56	0.58	0.53
CD at 5%		0.99	1.08	1.63	1.71	1.55
F_1	15.55	13.99 (17.72)	19.97 (18.66)	43.73 (22.34)	51.42 (23.55)	57.10 (24.43)
F_2	14.58	11.41 (16.25)	15.28 (16.82)	33.92 (19.54)	39.60 (20.38)	44.49 (21.09)
F_3	14.04	9.67 (15.39)	12.76 (15.83)	28.75 (18.08)	32.55 (18.62)	35.84 (19.07)
SE (m) ±		0.34	0.37	0.56	0.58	0.53
CD at 5%		0.99	1.08	1.63	1.71	1.55
I_1F_1	15.48	15.94 (17.91)	23.06 (19.04)	47.61 (22.78)	57.02 (24.27)	63.25 (25.23)
I_1F_2	15.30	13.36 (17.34)	17.81 (18.03)	38.16 (21.14)	45.19 (22.21)	50.43 (23.02)
I_1F_3	13.61	9.99 (14.98)	13.24 (15.42)	29.47 (17.63)	33.51 (18.19)	37.52 (18.72)
I_2F_1	16.08	15.50 (18.56)	22.69 (19.72)	46.43 (23.54)	55.75 (25.03)	61.79 (26.00)
I_2F_2	13.91	10.64 (15.39)	14.44 (15.93)	32.69 (18.46)	38.35 (19.25)	43.32 (19.94)
I_2F_3	14.31	9.75 (15.70)	12.86 (16.15)	28.95 (18.46)	32.66 (18.99)	36.39 (19.52)
I_3F_1	15.09	10.53 (16.68)	14.14 (17.23)	37.16 (20.70)	41.48 (21.34)	46.25 (22.06)
I_3F_2	14.54	10.24 (16.03)	13.61 (16.51)	30.93 (19.03)	35.25 (19.66)	39.72 (20.31)
I_3F_3	14.20	9.26 (15.51)	12.18 (15.93)	27.84 (18.15)	31.49 (18.68)	33.60 (18.97)
SE (m) ±		0.58	0.64	0.97	1.01	0.92
CD at 5%		1.71	1.86	2.82	2.96	2.69
I_0F_0 (Control)	13.5	8.65 (14.66)	11.81 (15.08)	27.26 (17.17)	31.05 (17.67)	33.11 (17.99)

Note:
1. Data in parentheses indicate increase in rootstock girth in mm.
2. CD (Critical difference) has been calculated based on per cent increase values.
3. I_1- (100% ETc Irrigation), I_2- (80% ETc Irrigation), I_3- (60% ETc Irrigation), F_1-(100% RDF through fertigation), F_2-(80% RDF through fertigation), F_3-(60% RDF through fertigation, I_0F_0-(Control- Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application).

Table 3: Effect of irrigation schedule and fertigation levels on scion girth (percentage increase) of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin during two years growth period (March, 2019 to February 2020, and March, 2020 to February, 2021).

Treatments / Month	Scion girth (mm) Pooled values					
	March (Initial values)	**May**	**July**	**October**	**December**	**February**
I_1	12.15	9.31 (13.29)	15.68 (14.06)	37.04 (16.67)	44.29 (17.56)	51.26 (18.41)
I_2	11.79	8.79 (12.84)	14.47 (13.52)	35.19 (15.97)	42.30 (16.82)	48.79 (17.60)
I_3	11.39	7.01 (12.19)	11.63 (12.72)	31.88 (15.03)	36.11 (15.51)	41.19 (16.09)
SE (m) ±		0.11	0.26	0.31	0.45	0.49
CD at 5%		0.33	0.77	0.92	1.30	1.43
F_1	12.05	10.57 (13.33)	17.35 (14.14)	40.77 (16.97)	49.51 (18.04)	57.29 (18.98)
F_2	12.22	7.78 (13.17)	13.63 (13.89)	33.70 (16.34)	39.56 (17.06)	45.88 (17.84)
F_3	11.07	6.76 (11.81)	10.80 (12.26)	29.64 (14.35)	33.63 (14.79)	38.08 (15.28)
SE (m) ±		0.11	0.26	0.31	0.45	0.49

CD at 5%		0.33	0.77	0.92	1.30	1.43
I_1F_1	12.39	12.27 (13.91)	19.85 (14.82)	43.88 (17.81)	54.76 (19.17)	63.93 (20.28)
I_1F_2	12.64	8.68 (13.73)	15.33 (14.58)	36.28 (17.23)	43.11 (18.09)	50.03 (18.96)
I_1F_3	11.43	6.99 (12.23)	11.85 (12.79)	30.95 (14.97)	34.99 (15.43)	39.83 (15.98)
I_2F_1	12.36	12.04 (13.85)	19.19 (14.74)	42.55 (17.62)	53.41 (18.97)	61.90 (20.01)
I_2F_2	12.24	7.54 (13.16)	13.23 (13.86)	33.23 (16.30)	39.71 (17.10)	46.23 (17.89)
I_2F_3	10.77	6.77 (11.50)	10.98 (11.96)	29.78 (13.98)	33.77 (14.41)	38.25 (14.89)
I_3F_1	11.39	7.41 (12.23)	13.00 (12.87)	35.88 (15.48)	40.37 (15.98)	46.03 (16.64)
I_3F_2	11.79	7.11 (12.63)	12.33 (13.24)	31.59 (15.51)	35.86 (16.01)	41.39 (16.66)
I_3F_3	11.00	6.51 (11.71)	9.57 (12.05)	28.18 (14.10)	32.12 (14.53)	36.16 (14.97)
SE (m) ±		0.20	0.46	0.54	0.77	0.85
CD at 5%		0.57	1.34	1.59	2.25	2.48
I_0 F_0 (Control)	11.26	6.40 (11.98)	9.35 (12.32)	27.88 (14.40)	32.08 (14.87)	35.22 (15.22)

Note:
1. Data in parentheses indicate increase in scion girth in mm.
2. CD (Critical difference) has been calculated based on per cent increase values.
3. I_1- (100% ETc Irrigation), I_2- (80% ETc Irrigation), I_3- (60% ETc Irrigation), F_1-(100% RDF through fertigation), F_2-(80% RDF through fertigation), F_3-(60% RDF through fertigation, I_0F_0-(Control- Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application).

Table 4: Effect of irrigation schedule and fertigation levels on number of leaves per shoot (percentage increase) of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin during two years growth period (March, 2019 to February 2020, and March, 2020 to February, 2021).

Treatments / Month	Number of leaves per shoot (Pooled values)					
	March (Initial values)	**May**	**July**	**October**	**December**	**February**
I_1	10.08	24.14 (11.78)	29.04 (12.48)	43.33 (14.82)	50.01 (15.96)	53.63 (16.47)
I_2	9.67	23.05 (11.15)	27.92 (11.80)	41.63 (13.90)	47.82 (14.84)	50.78 (15.26)
I_3	9.94	20.99 (11.22)	24.55 (11.64)	37.76 (13.64)	41.71 (14.33)	42.99 (14.54)
SE (m) ±		0.24	0.25	0.40	0.60	0.68
CD at 5%		0.69	0.72	1.16	1.74	1.97
F_1	9.46	25.62 (11.23)	31.58 (12.08)	48.53 (14.75)	56.64 (15.97)	61.45 (16.59)
F_2	10.35	22.66 (11.90)	26.35 (12.40)	39.41 (14.54)	44.36 (15.42)	46.14 (15.75)
F_3	9.88	19.90 (11.02)	23.58 (11.44)	34.78 (13.08)	38.53 (13.73)	39.81 (13.93)
SE (m) ±		0.24	0.25	0.40	0.60	0.68
CD at 5%		0.69	0.72	1.16	1.74	1.97
I_1F_1	9.88	27.56 (11.98)	31.58 (13.07)	52.10 (16.00)	61.72 (17.52)	68.79 (18.39)
I_1F_2	10.63	24.18 (12.40)	26.35 (12.96)	41.67 (15.33)	48.23 (16.53)	50.58 (16.98)
I_1F_3	9.75	20.68 (10.96)	23.58 (11.42)	36.20 (13.14)	40.08 (13.81)	41.53 (14.05)
I_2F_1	9.13	27.35 (11.04)	31.58 (12.01)	51.09 (14.62)	61.63 (16.07)	67.76 (16.87)
I_2F_2	10.25	22.18 (11.71)	26.35 (12.23)	38.94 (14.30)	43.22 (15.05)	44.73 (15.32)
I_2F_3	9.63	19.63 (10.71)	23.58 (11.15)	34.88 (12.78)	38.61 (13.39)	39.83 (13.59)
I_3F_1	9.38	21.95 (10.68)	31.58 (11.16)	42.40 (13.62)	46.58 (14.33)	47.79 (14.52)
I_3F_2	10.19	21.61 (11.59)	26.35 (12.01)	37.62 (13.99)	41.65 (14.69)	43.11 (14.95)
I_3F_3	10.25	19.40 (11.38)	23.58 (11.75)	33.27 (13.30)	36.91 (13.98)	38.08 (14.14)
SE (m) ±		0.41	0.43	0.69	1.04	1.17

CD at 5%		1.20	1.25	2.00	3.02	3.42
I_0 F_0 (Control)	9.12	18.96 (10.11)	22.56 (10.46)	33.12 (11.83)	36.44 (12.36)	37.85 (12.52)

Note:
1. Data in parentheses indicate increase number of leaves per shoots.
2. Data indicate *Arc sine* transformed values. The variation not varying between 0 to 30 or 70 to100 were subjected to *Arc Sine* Transformation (Gomez and Gomez, 1984).
3. CD has been calculated based on per cent increase values.
4. I_1- (100% ETc Irrigation), I_2- (80% ETc Irrigation), I_3- (60% ETc Irrigation), F_1-(100% RDF through fertigation), F_2-(80% RDF through fertigation), F_3-(60% RDF through fertigation, I_0F_0-(Control- Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application).

Table 5: Effect of irrigation schedule and fertigation levels on number of nodes per shoot (percentage increase) of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin during two years growth period (March, 2019 to February 2020, and March, 2020 to February, 2021).

Treatments / Month	**Number of nodes per shoot (Pooled values)**					
	March (Initial values)	**May**	**July**	**October**	**December**	**February**
I_1	8.50	1.25 (9.98)	1.48 (11.08)	1.69 (12.73)	1.80 (14.01)	1.87 (15.03)
I_2	8.33	1.19 (9.60)	1.44 (10.62)	1.65 (12.13)	1.76 (13.24)	1.83 (14.17)
I_3	8.67	1.10 (9.68)	1.35 (10.52)	1.58 (11.92)	1.67 (12.70)	1.74 (13.34)
SE (m) ±		0.006	0.007	0.005	0.006	0.005
CD at 5%		0.018	0.021	0.016	0.017	0.014
F_1	8.50	1.29 (10.12)	1.53 (11.39)	1.76 (13.45)	1.87 (14.82)	1.94 (16.11)
F_2	8.42	1.16 (9.58)	1.41 (10.51)	1.62 (11.86)	1.74 (12.99)	1.80 (13.72)
F_3	8.58	1.09 (9.57)	1.33 (10.32)	1.54 (11.48)	1.63 (12.14)	1.69 (12.72)
SE (m) ±		0.006	0.007	0.005	0.006	0.005
CD at 5%		0.018	0.021	0.016	0.017	0.014
I_1F_1	8.75	1.38 (10.76)	1.61 (12.28)	1.83 (14.56)	1.94 (16.35)	2.03 (17.97)
I_1F_2	8.50	1.26 (9.97)	1.48 (10.98)	1.68 (12.49)	1.81 (13.88)	1.87 (14.74)
I_1F_3	8.25	1.11 (9.23)	1.34 (9.99)	1.55 (11.14)	1.64 (11.82)	1.71 (12.39)
I_2F_1	8.25	1.37 (10.08)	1.60 (11.45)	1.81 (13.54)	1.92 (15.04)	2.01 (16.57)
I_2F_2	8.00	1.12 (8.98)	1.38 (9.88)	1.60 (11.14)	1.74 (12.33)	1.80 (13.01)
I_2F_3	8.75	1.09 (9.74)	1.33 (10.53)	1.54 (11.72)	1.62 (12.34)	1.69 (12.93)
I_3F_1	8.50	1.11 (9.53)	1.37 (10.44)	1.65 (12.24)	1.74 (13.06)	1.80 (13.79)
I_3F_2	8.75	1.11 (9.79)	1.36 (10.68)	1.57 (11.95)	1.67 (12.76)	1.73 (13.40)
I_3F_3	8.75	1.08 (9.73)	1.31 (10.46)	1.52 (11.58)	1.61 (12.27)	1.68 (12.84)
SE (m) ±		0.011	0.012	0.009	0.010	0.008
CD at 5%		0.031	0.036	0.028	0.029	0.024
I_0 F_0 (Control)	8.25	1.06 (9.13)	1.29 (9.79)	1.50 (10.82)	1.59 (11.42)	1.64 (11.92)

Note:
1. Data in parentheses indicate increase number of nodes per shoot.
2. CD (Critical difference) has been calculated based on *Log* transformed values. (Gomez and Gomez, 1984).
3. CD (Critical difference) has been calculated based on per cent increase values.
4. I_1- (100% ETc Irrigation), I_2- (80% ETc Irrigation), I_3- (60% ETc Irrigation), F_1-(100% RDF through fertigation), F_2-(80% RDF through fertigation), F_3-(60% RDF through fertigation, I_0F_0-(Control- Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application).

Table 6: Effect of irrigation schedule and fertigation levels on number of internodes per shoot (percentage increase) of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin during two years growth period (March, 2019 to February 2020, and March, 2020 to February, 2021).

Treatments / Month	**Number of internodes per shoot (Pooled values)**					
	March (Initial values)	**May**	**July**	**October**	**December**	**February**
I_1	7.50	1.30 (8.98)	1.53 (10.08)	1.74 (11.73)	1.85 (13.01)	1.92 (14.03)
I_2	7.33	1.25	1.49	1.71	1.82	1.89

		(8.60)	(9.62)	(11.13)	(12.24)	(13.17)
I_3	7.67	1.15 (8.68)	1.40 (9.52)	1.64 (10.92)	1.73 (11.70)	1.79 (12.34)
SE (m) ±		0.006	0.007	0.006	0.006	0.005
CD at 5%		0.018	0.020	0.017	0.017	0.014
F_1	7.50	1.34 (9.12)	1.58 (10.39)	1.82 (12.45)	1.92 (13.82)	2.00 (15.11)
F_2	7.42	1.22 (8.58)	1.46 (9.51)	1.67 (10.86)	1.79 (11.99)	1.86 (12.72)
F_3	7.58	1.14 (8.57)	1.38 (9.32)	1.59 (10.48)	1.68 (11.14)	1.74 (11.72)
SE (m) ±		0.006	0.007	0.006	0.006	0.005
CD at 5%		0.018	0.020	0.017	0.017	0.014
I_1F_1	7.75	1.43 (9.76)	1.67 (11.28)	1.88 (13.56)	2.00 (15.35)	2.08 (16.97)
I_1F_2	7.50	1.31 (8.97)	1.53 (9.98)	1.74 (11.49)	1.86 (12.88)	1.92 (13.74)
I_1F_3	7.25	1.16 (8.23)	1.40 (8.99)	1.61 (10.14)	1.70 (10.82)	1.76 (11.39)
I_2F_1	7.25	1.42 (9.08)	1.65 (10.45)	1.87 (12.54)	1.98 (14.04)	2.06 (15.57)
I_2F_2	7.00	1.18 (7.98)	1.44 (8.88)	1.66 (10.14)	1.80 (11.33)	1.86 (12.01)
I_2F_3	7.75	1.14 (8.74)	1.38 (9.53)	1.60 (10.72)	1.68 (11.34)	1.74 (11.93)
I_3F_1	7.50	1.17 (8.53)	1.43 (9.44)	1.71 (11.24)	1.79 (12.06)	1.85 (12.79)
I_3F_2	7.75	1.16 (8.79)	1.41 (9.68)	1.63 (10.95)	1.72 (11.76)	1.79 (12.40)
I_3F_3	7.75	1.13 (8.73)	1.36 (9.46)	1.57 (10.58)	1.67 (11.27)	1.73 (11.84)
SE (m) ±		0.011	0.012	0.010	0.010	0.008
CD at 5%		0.031	0.035	0.030	0.030	0.024
I_0 F_0 (Control)	7.25	1.12 (8.13)	1.35 (8.79)	1.56 (9.82)	1.64 (10.41)	1.70 (10.92)

Note:

1. Data in parentheses indicate increase number of internodes per shoot.
2. CD (Critical difference) has been calculated based on *Log* transformed values (Gomez and Gomez, 1984).
3. I_1- (100% ETc Irrigation), I_2- (80% ETc Irrigation), I_3- (60% ETc Irrigation), F_1-(100% RDF through fertigation), F_2-(80% RDF through fertigation), F_3-(60% RDF through fertigation, I_0F_0-(Control- Irrigation at 100% ETc by surface irrigation and 100% RDF as soil application).

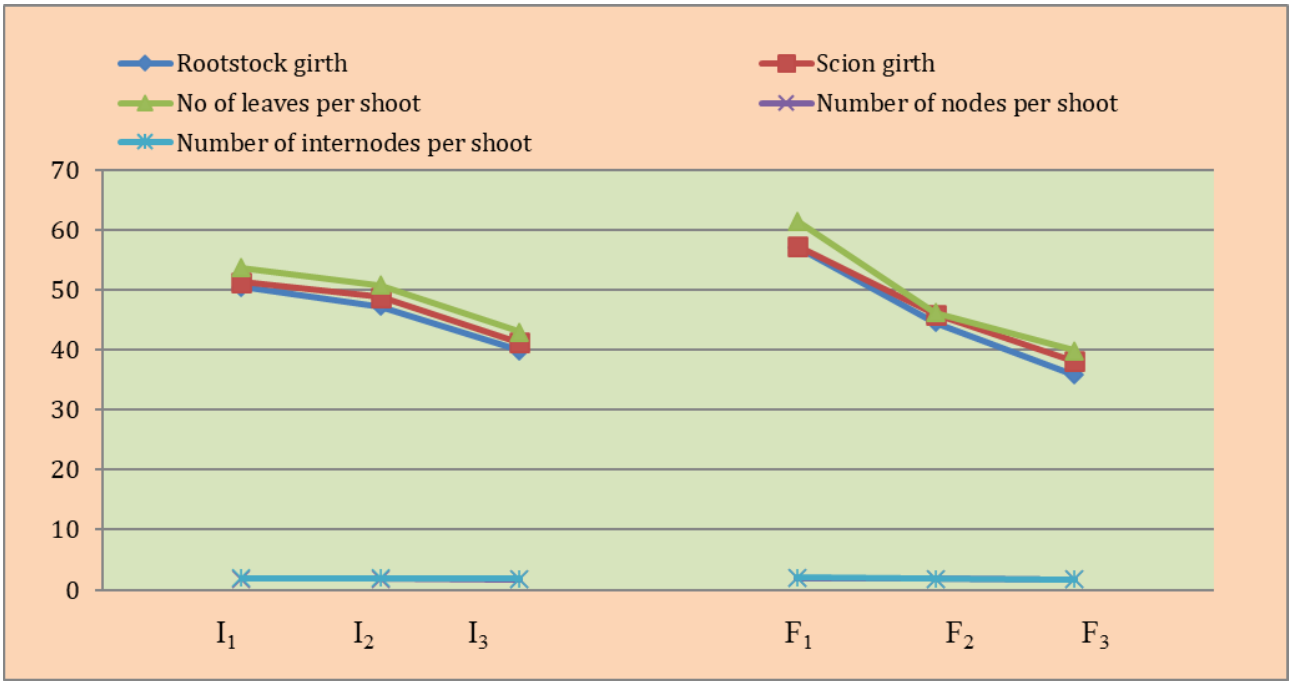

Fig 1: Effect of irrigation schedule and fertigation levels on plant parmeters (percentage increase) of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin during two years growth period (March, 2019 to February 2020, and March, 2020 to February, 2021).

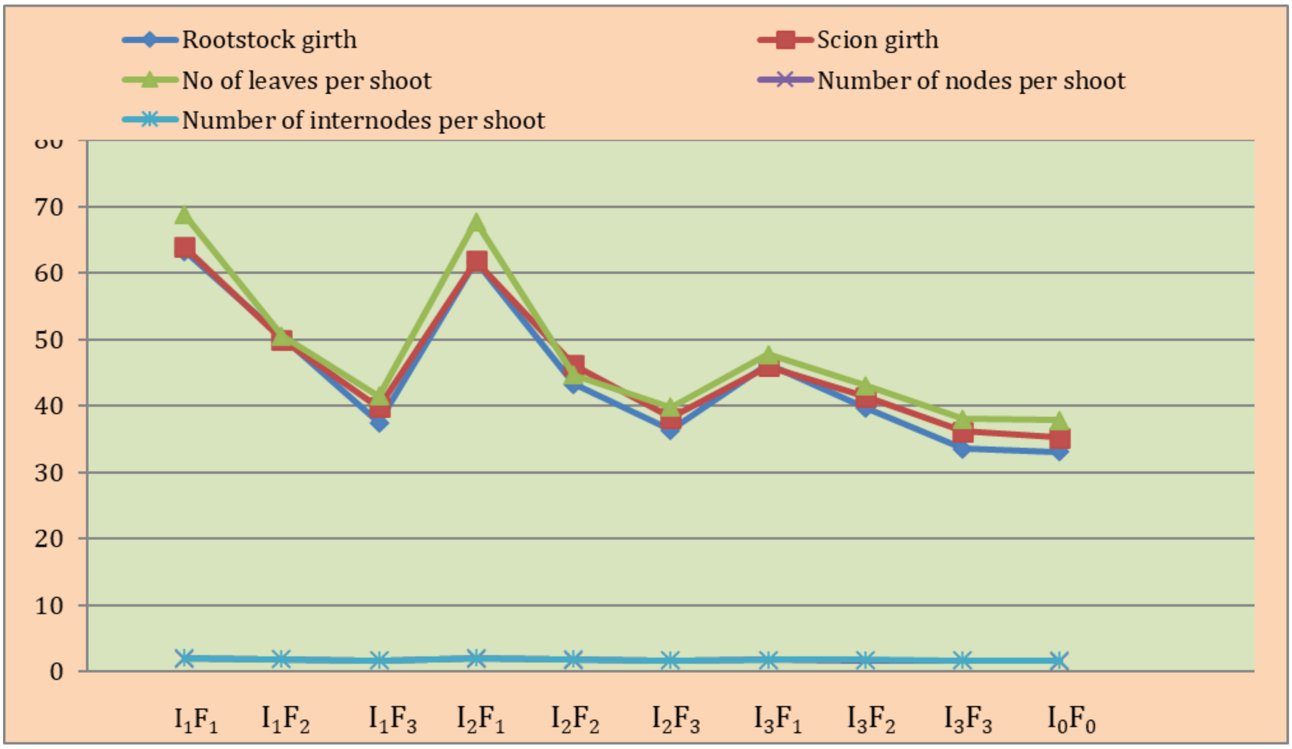

Fig 2: Interaction **e**ffect of irrigation schedule and fertigation levels on plant parmeters (percentage increase) of mandarin (*Citrus reticulata* Blanco.) cv. Nagpur Mandarin during two years growth period (March, 2019 to February 2020, and March, 2020 to February, 2021).

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