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Original Research Papers

Influence of phenophase based irrigation and fertigation schedule on vegetative performance of chrysanthemum (Dendranthema grandiflora Tzelev.) var. Marigold

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Abstract: **The vegetative performance of chrysanthemum var. Marigold with respect to phenophase based irrigation and fertigation schedule was evaluated. In the vegetative phase, the maximum plant height (62.44 cm), number of secondary branches per plant (42.65), number of primary branches per plant (10.85), leaf area (3793.81 cm2) was recorded in the treatment combination Whereas, the maximum average plant spread (47.98 cm) was in I1F4, number of leaves per plant (217.76) was in I3F1. Scheduling irrigation regime I3-(0.8 ER each at vegetative, bud and flowering phases) in combination with weekly application of (F4) 75:112.5:75 kg NPK/ha in three splits 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) through fertigation recorded maximum loose flower yield (26.27 t/ha) and this can be correlated with increased values for most of the vegetative parameters that directly influence the yield of the crop. Hence the above was observed best treatment over other treatment combinations with respect to vegetative parameters of chrysanthemum var. Marigold.**

Keywords: Chrysanthemum var Marigold, fertigation, irrigation, phenophase and vegetative performance.

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) is one of the important commercial flower crops in India as well as in the world. It is native of the Northern hemisphere, chiefly Europe and Asia. It belongs to family Asteraceae and is commonly called as the "Queen of the East". Its flowers are valued for its long keeping quality, wide array of colours and different forms, which make it suitable for use in floral bouquets, flower arrangements and decorations. Chrysanthemum is the second most important flower crop after rose in India. The area under flower

crops is 339000 ha with an overall production of 19.91 lakh tonnes. The leading chrysanthemum growing state is Karnataka with an area of 5453 ha and production of 59.54 thousand tonnes of loose flowers in 2017- 18 after Tamil Nadu. Water and fertilizer are the two vital inputs for crop production. Apart from the economic considerations, it is also well known that the injudicious use of water and fertilizer can have far reaching deleterious implications on the environment. Therefore, the need arises for technological options, which will help in sustaining the precious resources and maximizing crop production without any pernicious impact on the environment. Optimum plant nutrition is very essential in plant growth and development, if it is not in sufficient amount then it reduces the vigor of the plant and affects yield of flower crops by producing small leaves, light green or off-color foliage, fewer branches and poor flowering (Melvin and James, 2001). Excessive application of nutrients can cause adverse effects on plant growth, increase the potential for environmental contamination through leaching and waste of resources. Method of nutrient application to plants is also a key issue to get the optimum potential of the crop. Fertigation helps in reducing the wastage of nutrients through enhanced use efficiency of fertilizer besides providing flexibility in timing of fertilizer application in relation to crop demand based on phenological stages of growth (Papadopoulos, 1992). It also determines quantity of nutrients, timing of application and most important component of water distribution (Ahmad and Khan, 2017). The amount of nutrient and water requirement of a plant varies according to its phenophase and dispensation of water and nutrients can be scheduled accordingly. The fertigation scheduling should be based on plant, soil-air, plant water relations and growth stage of plant (Sankaranarayanan, 2007).

It is essential to work out an economically feasible and technologically efficient fertigation scheduling for optimum use of water and nutrients for enhanced water productivity with reference to different growth and developmental stages. Hence, it is important to evaluate under phenophase based irrigation and fertigation treatments for improving vegetative performance of chrysanthemum var. Marigold under open field condition.

MATERIAL AND METHODS

The present investigation conducted during two seasons *i.e.* 2018 & 2019, at the Division of Flowers and Medicinal Crops, ICAR-Indian Institute of Horticultural Research (ICAR-IIHR), Bengaluru. The experimental site is situated in eastern dry zone of Karnataka state at 130 7′ north latitude, 770 29′ east longitudes and at an altitude of 890 meters above the mean sea level. The experiment was laid out in split plot design with fifteen treatment combinations along with three replications. The treatment consists of three main plot treatments at phenophases of vegetative phase i.e. I. – (0.8, 1.0 and 1.2 ER at vegetative, bud and flowering phases, respectively), I. - (0.6, 0.8 and 1.0 ER at

vegetative, bud and flowering phases, respectively) and I.- (0.8 ER each at vegetative, bud and flowering phases) and five sub plot treatments (F1: 33.3:33.3:33.3 % NPK (vegetative phase), 33.3:33.3:33.3 % NPK (Bud phase) 33.3:33.3:33.3 % NPK (Flowering phase) @ 100:150:100 Kg NPK/ha (RDF), F2: 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (Bud phase) 30:40:40% NPK (Flowering phase) @ 100:150:100 Kg NPK/ha (RDF), F3: 33.3:33.3:33.3 % NPK (vegetative phase), 33.3:33.3:33.3 % NPK (Bud phase) 33.3:33.3:33.3 % NPK (Flowering phase @ 75:112.5:75 Kg NPK/ ha (75% RDF), F4: 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (Bud phase) 30:40:40% NPK (Flowering phase) @ 75:112.5:75 Kg NPK/ha (75% RDF), F.: Soil application of recommended dose of fertilizer (100:150:100 Kg NPK/ ha) and F.-F.: 25% of fertilizer dose i.e. 100:150:100 and 75:112.5:75 kg NPK/ha was applied as basal dose. The previous day open pan evaporimeter observation was considered for scheduling the irrigation as per the treatment. The

$$\text{Evaporation replenishment (ER)} = \frac{\text{Bed Size (m}^2\text{)} \times \text{pan evaporation rate (mm)}}{\text{Discharge capacity of drip per minute (ml)}}$$

irrigation schedule was calculated by using following formula.

The organic manure *i.e.* farmyard manure (20 t/ha) and basal application (Urea, DAP and MOP) was applied as per the treatments as earlier to transplanting. Transplanting was followed with a spacing of 60 cm × 45 cm. The dose of fertilizers was applied based on treatments through fertigation in the form of water-soluble fertilizers (Urea, MAP and SOP). The fertigation was given at weekly intervals from thirty days after transplanting to 120 days.

RESULTS AND DISCUSSION

The vegetative parameters *viz.*, plant height (cm), number of primary and secondary branches per plant, average plant spread (cm) at flowering and leaf area (cm2) as influenced by phenophase based different irrigation and fertigation regimes are discussed below.

The plant height (cm) of chrysanthemum was significantly influenced by different levels of phenophase based irrigation and fertigation. Among interactions effects the maximum plant height (61.19 cm) was recorded in and I.F. (63.68 cm) whereas, the minimum (44.60 cm) was recorded in I.F. during the second year. In pooled interaction, the maximum plant height (62.44 cm) was recorded in I.F. and it was on par with the treatment I2F4 (61.81 cm) and the minimum (46.91 cm) was recorded in I1F2. (Table 1 & 2) (Fig.1).

Table 1
Influence of phenophase based irrigation and fertigation scheduling on plant height (cm) and number of primary branches of chrysanthemum var. Marigold

Treatments	Plant height (cm)			Number of primary branches per plant		
	I year	II year	Pooled mean	I year	II year	Pooled mean
I1	51.42	54.48	52.95	9.64	9.96	9.80
I2	52.32	56.30	54.31	9.74	9.14	9.44
I3	48.88	58.97	53.92	9.43	9.20	9.32
SE. d	0.65	0.40	0.38	0.03	0.08	0.05
CD (P=0.05)	1.83	1.11	1.07	0.10	0.23	0.14
F1	51.70	57.50	54.60	8.71	9.30	9.00
F2	44.14	52.40	48.27	9.77	9.50	9.63
F3	55.33	54.76	55.04	10.13	9.57	9.85
F4	58.83	64.20	61.52	10.61	10.83	10.72
F5	44.36	54.05	49.21	8.80	7.96	8.38
SE. d	0.66	0.58	0.40	0.11	0.11	0.08
CD (P=0.05)	1.14	1.20	0.83	0.22	0.23	0.17

Table 2
Interaction effect of phenophase based irrigation and fertigation scheduling on plant height (cm) of chrysanthemum var. Marigold

Treat-ments	I year						II year						Pooled Mean					
	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean
I1	51.90	49.21	56.79	56.10	43.09	51.42	53.71	44.60	55.60	64.50	54.00	54.48	52.81	46.91	56.20	60.30	48.55	52.95
I2	55.10	41.10	59.10	59.19	47.10	52.32	53.50	56.70	51.27	64.43	55.60	56.30	54.30	48.90	55.19	61.81	51.35	54.31
I3	48.10	42.10	50.10	61.19	42.90	48.88	65.30	55.90	57.40	63.68	52.56	58.97	56.70	49.00	53.75	62.44	47.73	53.92
Mean	51.70	44.14	55.33	58.83	44.36		57.50	52.40	54.76	64.20	54.05		54.60	48.27	55.04	61.52	49.21	
	SE. d			CD (P=0.05)			SE. d			CD (P=0.05)			SE. d			CD (P=0.05)		
I	0.65			1.83			0.40			1.11			0.38			1.07		
F	0.66			1.14			0.58			1.20			0.40			0.83		
I at F	1.22			2.77			0.99			2.15			0.73			1.66		
F at I	1.14			2.37			1.01			2.09			0.69			1.43		

Table 3
Interaction effect of phenophase based irrigation and fertigation scheduling on number of primary branches per plant of chrysanthemum var. Marigold

Treat-ments	I year						II year						Pooled Mean					
	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean	F_1	F_2	F_3	F_4	F_5	Mean
I_1	8.79	9.20	10.80	10.50	8.90	9.64	10.60	9.80	10.20	11.20	8.00	9.96	9.70	9.50	10.50	10.85	8.45	9.80
I_2	8.93	10.40	10.00	10.77	8.60	9.74	8.10	9.60	9.60	10.19	8.19	9.14	8.52	10.00	9.80	10.48	8.40	9.44
I_3	8.40	9.70	9.60	10.56	8.89	9.43	9.20	9.10	8.90	11.10	7.70	9.20	8.80	9.40	9.25	10.83	8.30	9.32
Mean	8.71	9.77	10.13	10.61	8.80		9.30	9.50	9.57	10.83	7.96		9.00	9.63	9.85	10.72	8.38	
	SE. d			CD (P=0.05)			SE. d			CD (P=0.05)			SE. d			CD (P=0.05)		
I	0.03			0.10			0.08			0.23			0.05			0.14		
F	0.11			0.22			0.11			0.23			0.08			0.17		
I at F	0.17			0.36			0.19			0.42			0.14			0.30		
F at I	0.19			0.39			0.19			0.40			0.14			0.30		

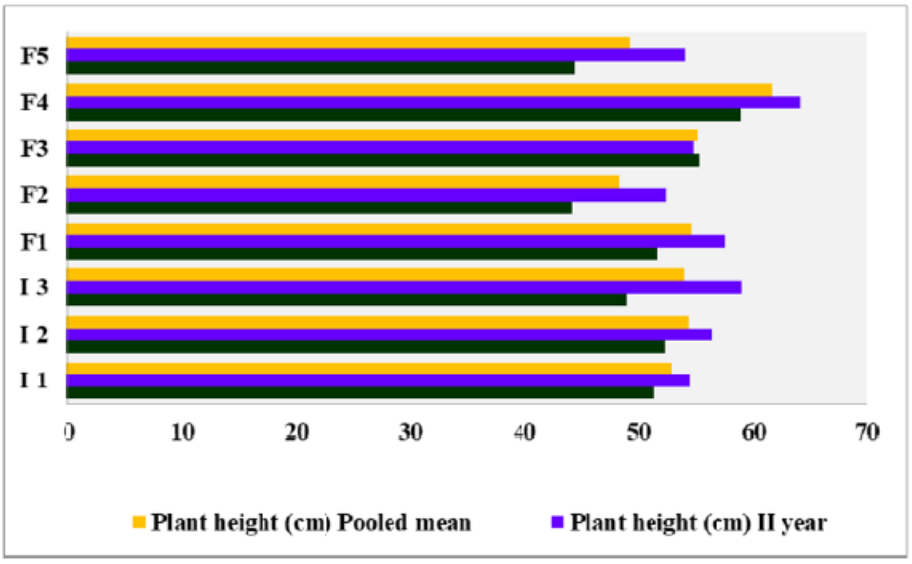

Fig. 1
Influence of phenophase based irrigation and fertigation scheduling on plant height (cm)

The irrigation treatment I.- (0.8 ER each at vegetative, bud and flowering phases) in combination with F. fertigation at 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 75:112.5:75 kg NPK/ha2 recorded the maximum plant height (62.44 cm) in chrysanthemum var. Marigold. The increase in plant height with irrigation at I. might be due to adequate moisture provided in the soil throughout the crop period. Adequate soil moisture resulted in greater development of meristematic tissues leading to higher rate of photosynthesis and assimilation in the plant system in marigold (Chawla, 2008).

In the fertigation treatment F., higher proportion of nitrogen fertilizer at vegetative phase might have increased the plant height because of the synergistic interaction of nitrogen with available endogenous auxin resulting in enhanced cell wall plasticity and increased cell elongation thus resulting in increase in the height of the plant. Further, during the bud and flowering phases, the sustained growth of the plant might have been the result of optimum application of nitrogen. The results from the present investigation could hence be attributed to the frequent and constant application of optimum levels of fertilizers at appropriate intervals at crop phenophases, which increases the available nutrient status in the root rhizosphere at constant levels during all the phases thus increasing the uptake of nutrients rapidly, and further influencing the growth of the plant. Similar observations were earlier reported by Mamata *et al*. (2017) in marigold, Parya *et al.* (2017) in gerbera, Priyanka *et al.* (2017) in gladiolus and Satapathy *et al.* (2016) in marigold, Jamil *et al.* (2016), Zawadzisnka and Janicka (2007) in amaryllis and viola respectively.

The treatment I1F4 was on par with I3F4 for maximum (10.83), number of primary branches per plant (Table 1 & 3) and the maximum number of secondary branches per plant (42.65) was recorded in the

treatment combination I3F4 and it was on par with I1F4 (41.44) and the minimum (17.75) was recorded in I.F..

The treatment I.F. recorded the maximum number of secondary branches per plant (42.65) in chrysanthemum var. Marigold. This increase in number branches might be mainly due to the increased irrigation scheduled favoring longer availability of soil moisture which leads to better growth and development of vegetative part of the plant.

The greater availability of nutrient at optimum proportions at critical growth stages in the present fertigation treatment might have resulted in production of more number of branches per plant as observed by Siraj Ali (1998) in bird-of- paradise. Polara *et al.* (2015) recorded similar results in African marigold. These findings are in conformation with the earlier results of Jawaharlal and Ganesh (2020) in chrysanthemum and Nagaraju *et al*. (2003) in rose (Table 4 & 5).

The average plant spread was significantly influenced and showed linear increase with irrigation regime and with optimum dosage of water-soluble fertilizers through fertigation. Among interactions effect the maximum average plant spread (53.23 cm) was recorded in the treatment combination I.F. followed by the treatment I.F. (45.76 cm) and the minimum (31.60 cm) was recorded in the treatment combination of I.F. during the first year. The maximum average plant spread (49.33 cm) was recorded in the treatment combination I3F1 followed by I2F3 (44.87 cm) and the minimum (30.80 cm) was recorded in the treatment combination I.F. during the second year. In pooled interaction, the maximum average plant spread (47.98 cm) was recorded in the treatment combination I.F. followed by the treatment I.F. (43.61 cm) and the minimum (32.23 cm) was recorded in the treatment combination of I3F2 (Table 4 & 6).

It was recorded that irrigation regime I.- (0.8, 1.0 and 1.2 ER at vegetative, bud and flowering phases, respectively) in combination with fertigation at 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 75:112.5:75 kg NPK/ha registered maximum average plant spread (47.98 cm). This result clearly showed that higher amount of nitrogen supplied at vegetative phase along with higher soil moisture levels leads to increased vegetative growth of chrysanthemum var. Marigold. According to Paul *et al*. (1996) the plant spread could be attributed to the frequent application of fertilizers with constant supply of nutrients, at regular intervals for better growth which would have resulted in reduced nutrient losses by leaching and efficient use of nutrients through fertigation compared to soil application. This is in accordance with the findings of Deshmukh and Wavhal (1998) in china aster and Ahirwal *et al.* (2012) in African marigold.

The maximum number of leaves (235.03) was recorded in the treatment combination I.F. and it was

Table 4
Influence of phenophase based irrigation and fertigation scheduling on vegetative parameters of chrysanthemum var Marigold

Treatments	Number of secondary branches per plant			Average plant spread (cm)			Number of leaves per plant		
	I year	II year	Pooled mean	I year	II year	Pooled mean	I year	II year	Pooled mean
I1	29.18	30.65	29.91	42.32	39.67	41.00	221.93	136.89	179.40
I2	32.42	27.27	29.85	36.71	41.04	38.88	220.26	141.43	180.82
I3	30.97	29.29	30.13	35.69	40.48	37.43	218.84	156.34	187.59
SE. d	0.78	0.61	0.06	0.34	0.13	0.58	1.23	1.99	3.20
CD (P=0.05)	1.41	1.20	0.12	0.95	0.26	1.62	2.60	4.02	6.98
F1	30.06	34.06	32.06	37.13	43.87	40.50	224.07	159.64	191.86
F2	26.32	23.44	24.88	38.26	35.26	36.76	220.74	136.21	178.47
F3	31.50	27.30	29.40	40.54	40.92	40.73	214.97	143.18	178.57
F4	42.12	39.86	40.99	42.98	41.81	42.39	225.88	154.83	190.36
F5	24.30	20.68	22.49	34.30	38.45	36.37	217.97	130.57	173.77
SE. d	0.89	0.60	0.55	0.53	0.96	0.79	0.26	0.27	0.05
CD (P=0.05)	1.54	1.19	1.02	1.10	2.03	1.64	0.45	0.55	0.10

Table 5
Interaction effect of phenophase based irrigation and fertigation scheduling on number of secondary branches per plant of chrysanthemum var. Marigold

Treatments	I year						II year						Pooled Mean					
	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean
I1	26.82	26.59	31.78	42.04	18.69	29.18	37.24	28.42	29.93	40.84	16.81	30.65	32.03	27.50	30.85	41.44	17.75	29.91
I2	36.48	27.05	31.99	39.91	26.67	32.42	29.15	29.17	17.28	37.84	22.91	27.27	32.82	28.11	24.64	38.88	24.79	29.85
I3	26.88	25.31	30.72	44.40	27.55	30.97	35.78	12.74	34.70	40.89	22.33	29.29	31.33	19.02	32.71	42.65	24.94	30.13
Mean	30.06	26.32	31.50	42.12	24.30		34.06	23.44	27.30	39.86	20.68		32.06	24.88	29.40	40.99	22.49	
	SE. d			CD (P=0.05)			SE. d			CD (P=0.05)			SE. d			CD (P=0.05)		
I	0.78			1.41			0.61			1.20			0.06			0.17		
F	0.89			1.54			0.60			1.19			0.55			1.02		
I at F	1.34			2.68			1.01			2.07			0.89			1.76		
F at I	1.33			2.66			1.00			2.06			0.90			1.75		

Table 6
Interaction effect of phenophase based irrigation and fertigation scheduling on average plant spread cm of chrysanthemum var Marigold

Treatments	I year						II year						Pooled Mean					
	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean
I1	38.40	42.63	45.76	53.23	31.60	42.32	40.46	30.80	41.46	42.73	42.90	39.67	39.43	36.71	43.61	47.98	37.25	41.00
I2	37.50	35.23	38.73	37.20	34.90	36.71	41.82	41.47	44.87	39.23	37.83	41.04	39.66	38.35	41.80	38.21	36.36	38.88
I3	35.50	30.93	37.13	38.50	36.40	35.69	49.33	33.53	36.43	43.47	33.10	40.48	42.42	32.23	36.78	40.99	34.75	37.43
Mean	37.13	38.26	40.54	42.98	34.30		43.87	35.27	40.92	41.81	38.45		40.50	36.76	40.73	42.39	36.38	
	SE. d			CD (P=0.05)			SE. d			CD (P=0.05)			SE. d			CD (P=0.05)		
I	0.34			0.95			0.13			0.26			0.58			1.62		
F	0.53			1.10			0.96			2.03			0.79			1.64		
I at F	0.89			1.93			2.53			5.59			1.36			2.99		
F at I	0.92			1.90			2.54			5.24			1.37			2.84		

on par with I.F. (229.61) and the minimum number of leaves per plant (205.01) were recorded in I.F. during the first year. The maximum number of leaves per plant (215.50) was recorded in the treatment combination I3F1 and it was on par with I2F2 (192.21), I1F3 (171.61) and I3F4 (175.90) whereas, the minimum (89.61) was recorded in I1F2 during the second year. In pooled interaction the maximum number of leaves per plant (217.76) were recorded in the treatment combination

I3F1 and it was on par with I2F2 (208.41), I1F3 (195.96), I1F4 (197.22) and I3F4 (198.75) whereas, the minimum (154.61) was recorded in I1F2 (Table 4 & 7).

The treatment I3F4 registered maximum number of leaves per plant and maximum leaf area (2404.74 cm2) was recorded in I1F4 and it was on par with I3F4 (2352.18 cm2) and the lowest (1308.31 cm2) was recorded in I3F1 during the vegetative phase (Tables 8 & 9) (Fig. 2a, 2b & 2c). In the present study, the increase in number of leaves and leaf area could be

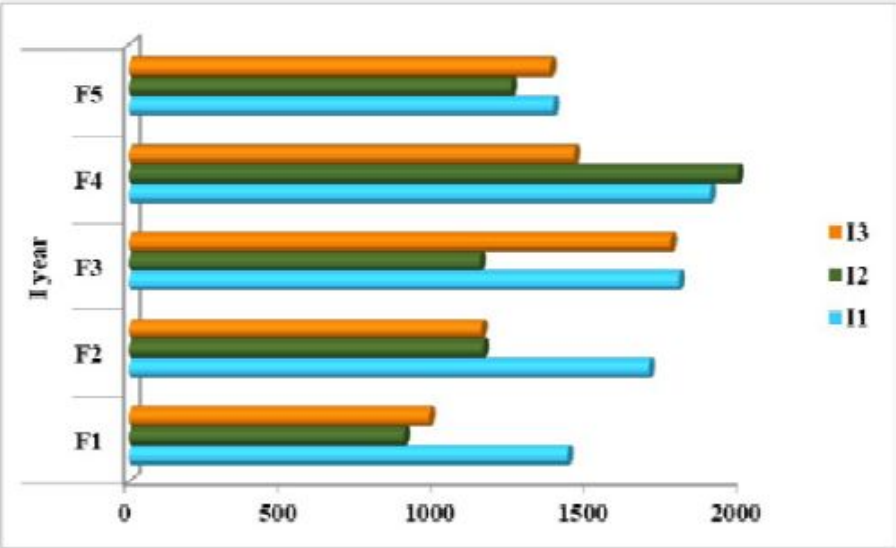

Fig. 2
Influence of phenophase based irrigation and fertigation scheduling on leaf area (cm2) at vegetative phase

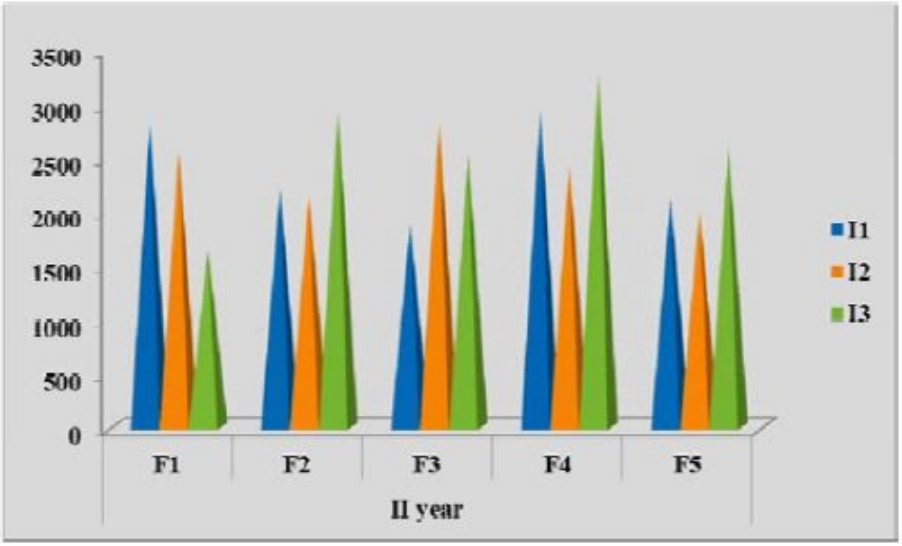

Fig. 2.a
Influence of phenophase based irrigation and fertigation scheduling on leaf area (cm2) at vegetative phase during first year

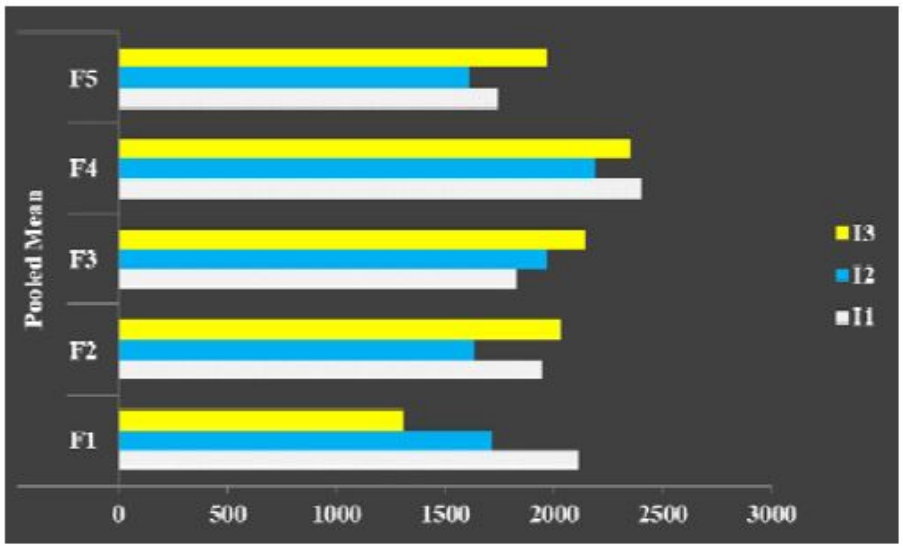

Fig. 2.b
Influence of phenophase based irrigation and fertigation scheduling on leaf area (cm2) at vegetative phase during second year

Table 7
Interaction effect of phenophase based irrigation and fertigation scheduling on number of leaves per plant of chrysanthemum var Marigold

Treat-ments	I year						II year						Pooled Mean					
	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean
I1	229.61	219.60	220.31	235.03	205.01	221.93	124.21	89.61	171.61	159.40	139.60	136.89	176.91	154.61	195.96	197.22	172.31	179.40
I2	222.60	224.61	208.60	221.00	224.30	220.26	139.21	192.21	104.21	129.20	142.30	141.43	180.91	208.41	156.41	175.10	183.30	180.82
I3	220.01	218.00	213.00	221.60	221.60	218.84	215.50	126.80	153.71	175.90	109.80	156.34	217.76	172.40	183.36	198.75	165.70	187.59
Mean	224.07	220.74	214.97	225.88	217.97		159.64	136.21	143.18	154.83	130.57		191.86	178.47	178.57	190.36	173.77	
	SE. d			CD (P=0.05)			SE. d			CD (P=0.05)			SE. d			CD (P=0.05)		
I	1.23			2.60			1.99			4.02			3.20			6.98		
F	0.26			0.45			0.27			0.55			0.05			0.10		
I at F	4.27			9.08			23.26			52.41			12.39			27.79		
F at I	4.58			9.45			22.28			45.98			11.99			24.76		

Table 8
Influence of phenophase based irrigation and fertigation scheduling on leaf area (cm2) at vegetative phase of chrysanthemum var. Marigold

Treatments	I year	II year	Pooled mean
I1	1640.80	2373.74	2007.27
I2	1286.42	2362.97	1824.68
I3	1345.88	2575.28	1960.58
SE. d	8.89	45.52	5.30
CD (P=0.05)	24.68	101.36	10.50
F1	1102.67	2319.68	1711.18
F2	1334.65	2408.43	1871.54
F3	1569.73	2388.75	1979.24
F4	1778.79	2851.51	2315.15
F5	1336.00	2218.27	1777.14
SE. d	20.81	26.44	135.35
CD (P=0.05)	42.96	59.02	279.33

Table 9
Interaction effect of phenophase based irrigation and fertigation scheduling on leaf area (cm2) at vegetative phase of chrysanthemum var. Marigold

Treat-ments	I year						II year						Pooled Mean					
	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean	F1	F2	F3	F4	F5	Mean
I1	1430.34	1698.00	1794.19	1896.34	1385.15	1640.80	2792.27	2198.03	1857.80	2913.13	2107.47	2373.74	2111.31	1948.02	1826.00	2404.74	1746.31	2007.27
I2	897.36	1154.90	1145.80	1986.50	1247.54	1286.42	2530.47	2118.10	2794.03	2390.57	1981.67	2362.97	1713.92	1636.50	1969.92	2188.54	1614.61	1824.68
I3	980.32	1151.04	1769.20	1453.53	1375.31	1345.88	1636.30	2909.17	2514.43	3250.83	2565.70	2575.28	1308.31	2030.11	2141.82	2352.18	1970.51	1960.58
Mean	1102.67	1334.65	1569.73	1778.79	1336.00		2319.68	2408.43	2388.75	2851.51	2218.27		1711.18	1871.54	1979.24	2315.15	1777.14	
	SE.d			CD (P=0.05)			SE.d			CD (P=0.05)			SE.d			CD (P=0.05)		
I	8.89			24.68			45.52			101.36			5.30			10.50		
F	20.81			42.96			26.44			59.02			135.35			279.33		
I at F	33.45			70.72			37.86			65.41			23.49			50.01		
F at I	36.05			74.41			35.78			71.36			23.51			57.89		

attributed to Application of higher proportion of nitrogen fertilizer and optimum irrigation regimes at vegetative phase might have increased the number of leaves and leaf area. It may be due to the fact that the vegetative growth increased with nitrogen application and hence nitrogen is an essential part of nucleic acid, which plays a vital role in promoting vegetative growth. The present results were also in line with the reports of Maharnor *et al.* (2011) and Polara *et al.* (2014) in African marigold, Karam *et al*. (2007) in sunflower and Jaleel *et al*. (2009) in *Catharanthus*. Rawat and Mathpal (1984), Paul *et al*. (1996) and Khan *et al*. (1996) in various crops.

CONCLUSION

In the vegetative phase of chrysanthemum var. Marigold, the irrigation treatment I.-(0.8 ER each at vegetative, bud and flowering phases) in combination with fertigation treatment F. at 40:20:20 % NPK (vegetative phase), 30:40:40 % NPK (bud phase) 30:40:40% NPK (flowering phase) @ 75:112.5:75 kg NPK/ha was found adequate to cater the demand of water as well as nutrient requirement for vegetative phase of chrysanthemum var. Marigold. This can be correlated with the maximum loose flower yield (26.27 t/ha) registered by the same treatment. Further better plant growth as recorded during the investigation is indicative of better uptake of nutrients which in turn are involved in basic reaction of photosynthesis and in synthesis of metabolites required for plant growth with above irrigation and fertigation schedule. Hence it is concluded that the above treatment combination I.F. was registered as the best treatment to improve the vegetative growth of chrysanthemum var. Marigold.

REFERENCES

Ahirwar, M.K., Ahirwar, K. and Megha, Sukla. 2012. Effect of plant densities, nitrogen and phosphorus levels on growth, yield and quality of African marigold. *Annals of Plant and Soil Research*, **14(2):**153- 155.

Ahmad, A., and Khan, S. 2017. Water and energy scarcity for agriculture: Is irrigation modernization the answer. *Irrigation and Drainage*, **66**: 34-44.

Chawla, S.L. 2008. Effect of irrigation regimes and mulching on vegetative growth, quality and yield of flowers of African marigold. Thesis, Doctor of Philosophy in Horticulture, Maharana Pratap University of Agriculture and Technology, Udaipur.

Deshmukh, A.S., Shinde, P.P. and Jadhav, S.B. 1996. Fertigation under drip irrigation for sugarcane**. In:**All India Seminar on Modern Irrigation Techniques, Proceedings .June). pp. 217-219.

Deshmukh, R. and Wahal, N. 1998. Effect of iron on growth and flowering of aster. *Journal of Maharashtra Agricultural University*, **23**(2): 99-101.

Hatwar, G.P. Gondane, S. V. Urkude, S.M. and Gahukar, O.V. 2003. Effect of micronutrients on growth and yield of chilli. *Soil and Crops,* 13:123-1254.

Jaleel, C.A., P. Manivannan, B. Sankar, A. Kishorekumar, R. Gopi, R. Somasundaram and R. Panneerselvam. 2007. Induction of drought stress tolerance by ketoconazole in *Catharanthus roseus* is mediated by enhanced antioxidant potentials and secondary metabolite accumulation. *Colloids Surf. B: Biointerfaces*, 60: 201-206

Jamil, M. K. J., Ahman, M. M. I. R., & Ossain, M.M. O. H. 2016. Response of N, P and K On The Growth and Flowering of Hippeastrum (*Hippeastrum hybridum* Hort.). *Journal of Agriculture*, 41(1), 91–101.

Jawaharlal, M and Ganesh, S. 2020. Studies on the effect of fertigation in greenhouse chrysanthemum. *Journal of Pharmacognosy and Phytochemistry*, Sp.9(2): 254-259.

Karam, F., Lahoud, R., Masaad, R., Kabalan, R., Breidi, J., Chalita, C., Rouphael, Y. 2007. Evapotranspiration, seed yield and water use efficiency of drip irrigated sunflower under full and deficit irrigation conditions. *Agricultural Water Management* 90(3), 213– 223.

Kaushik, H., Singh, J.P., Mohan, B., Rajbeer and Nathiram. 2013. Effect of inorganic fertilize (nitrogen) and bio-fertilizer (*Azospirillum*) on growth and flowering in African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda*. International Journal of Agricultural Sciences*, **9(1):**189-192.

Khan, M.M., Sujatha, K., Krishna, R., Manohar, M., Kariyanna, A. A., Farooqui and Shivshankar. 1996. Fertigation studies in Horticultural crops In: Proc. All India Seminar on MIT, Bangalore, Ed Khan, M. M., pp. 178-186.

Maharnor, S.I., Chopde, N., Thakre, S. and Raut, P.D. 2011. Effect of nitrogen and pinching on growth and yield of African marigold. *Asian Journal of Horticulture,* **6(1)**: 43-45.

Mamta Kumawat, S.K., Khandelwal, M.R., Choudhary, P.K., Kumawat, G. Sharma and Paru Panwar. 2017. Effect of integrated nutrient management on growth, flowering and yield of African marigold (*Tagetes erecta* L.). *International Journal of Current Microbiology and Applied Sciences,* **6(8)**: 60-65.

Marchner, H. 1983. Introduction to the mineral nutrition of plants. *Handbook Plant Physiology*, **154**: 31 - 38.

Marschner, H. and Cakmak, I. 1986. Mechanism of phosphorus-induced zinc deficiency in cotton. II. Evidence for impaired shoot control of phosphorus uptake and translocation under zinc deficiency. *Physiologia Plantarum*, **68:** 491-496.

Melvin, R.K. James, J.K. 2001. Fertilizing shade and ornamental trees, MSU Extension Forestry Bulletin, Bozeman.

Nagaraju, C.G., Reddy, T.V. and Madaiah, D. 2003. Effect of plant density, irrigation and oil cakes on growth, production and quality of field grown rose cultivar Landora. *Journal of Ornamental Horticulture*, .(3). 172-179.

Pafli, G. 1965. Relations between abundant N supply and amino acid concentration on leaves of rice plants. *Plant and Soil,* **23:** 275- 284.

Papadopoulos, I. 1992. Phosphorus fertigation of trickle-irrigated potato. *Fertilizer Research*, **31**: 9-13.

Parya, C. 2017. Effect of integrated plant nutrient system for gerbera flower production under protected cultivation. *Journal of Applied Horticulture,* 19(2), 139-142.

Paul, J., Joseph, J. and Kabeer, A. 1996. Fertilizer irrigation - an overview. In proceedings of All India Seminar on MIT, Bangalore, 196-204.

Paul, J., Joseph, J. and Kabeer, A. 1996. Fertilizer irrigation - an overview. In proceedings of All India Seminar on MIT, Bangalore, 196-204.

Polara, N.D., Gajipara, N.N. and Barad, A.V. 2014. Effect of nitrogen and phosphorus on nutrient content and uptake in different varieties of African marigold (*Tagetes erecta* L.). *International Quarterly Journal of Life Sciences,* .(1):115-119.

Priyanka Tirkey, Lagamanna R Kullur and VM Prasad. 2017. Effect of organic and Inorganic source of N.P.K on growth and yield parameters of gladiolus *(Gladiolus grandiflorus*) cv. Jester. *Journal of Pharmacognosy and Phytochemistry*, 6(5): 1004-1006.

Rawat, P.S. and Mathpal, K.N. 1984. Effect of micronutrients on yield and sugar metabolism of some of the vegetables under Kumaon hill conditions. *Scientific Culture,* **50:** 243-244.

Sankaranarayanan. 2007. Integrated water management system for better fibre quality and high production. TMC Annual Report, 2006- 2007.

Satapathy, S.P., Toppo, R., Dishri, M., and Mohanty, C.R. 2016. Impact of integrated nutrient management (INM) on flowering and corm production in gladiolus. *Biometrics & Biostatistics International Journal,* **4**(7): 296 298.

Singatkar, S.S., Swant, R.B., Ranpise, S.A. and Wavhal, K.N. 1995. Effects of different levels of N, P and K on growth and flower production of gaillardia. Journal of Maharashtra Agriculture University, **20(3):** 392-394.

Siraj Ali, M.S. 1998. Effect of singral and nitrophoska fertilizers on growth, flowering and mineral composition of bird-of-paradise (*Strelitzia reginae* Ait.) plants. *Indian Journal of Horticulture*, **55(3):** 257-262.

Terangpi, H. and Paswan, L. 2003. Effect of NPK on growth and flowering of Gerbera. *Journal of Ornamental Horticulture.* .(1): 71-72.

Zawadzisnka, A., & Janicka, D. 2007. Effects Of Compost Media On Growth and Flowering Of Parviflorous Garden Pansy (*Viola Wittrockiana* Gams. *Acta Agrobotanica*, **60(2)**: 161–166.