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Original Research Paper

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 cm^2) was recorded in the treatment combination. Whereas, the maximum average plant spread (47.98 cm) was in I_1F_4, number of leaves per plant (217.76) was in I_3F_1. Scheduling irrigation regime I_3-(0.8 ER each at vegetative, bud and flowering phases) in combination with weekly application of (F_4) 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.

Key words: 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 13^0 7′ north latitude, 77^0 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_1 – (0.8, 1.0 and 1.2 ER at vegetative, bud and flowering phases, respectively), I_2 - (0.6, 0.8 and 1.0 ER at vegetative, bud and flowering phases, respectively) and I_3- (0.8 ER each at vegetative, bud and flowering phases) and five sub plot treatments (F_1: 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), F_2: 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), F_3: 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), F_4: 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_5: Soil application of recommended dose of fertilizer (100:150:100 Kg NPK/ha) and F_1-F_4: 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 irrigation schedule was calculated by using following formula.

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

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 (cm^2) 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 I_3F_4 and it was on par with I_2F_4 (59.19 cm) and I_2F_3 (59.10 cm) whereas, the minimum (41.10 cm) was recorded in the treatment combination I_2F_2 during the first year. The maximum plant height (65.30 cm), was recorded in I_3F_1 and it was on par with the treatments, I_1F_4 (64.50 cm), I_2F_4 (64.43 cm) and I_3F_4 (63.68 cm) whereas, the minimum (44.60 cm) was recorded in I_1F_2 during the second year. In pooled interaction, the maximum plant height (62.44 cm) was recorded in I_3F_4 and it was on par with the treatment I_2F_4 (61.81 cm) and the minimum (46.91 cm) was recorded in I_1F_2. (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
I_1	51.42	54.48	52.95	9.64	9.96	9.80
I_2	52.32	56.30	54.31	9.74	9.14	9.44
I_3	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
F_1	51.70	57.50	54.60	8.71	9.30	9.00
F_2	44.14	52.40	48.27	9.77	9.50	9.63
F_3	55.33	54.76	55.04	10.13	9.57	9.85
F_4	58.83	64.20	61.52	10.61	10.83	10.72
F_5	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					
	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	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
I_2	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
I_3	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	

	I year SE. d	I year CD (P=0.05)	II year SE. d	II year CD (P=0.05)	Pooled Mean SE. d	Pooled Mean 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		

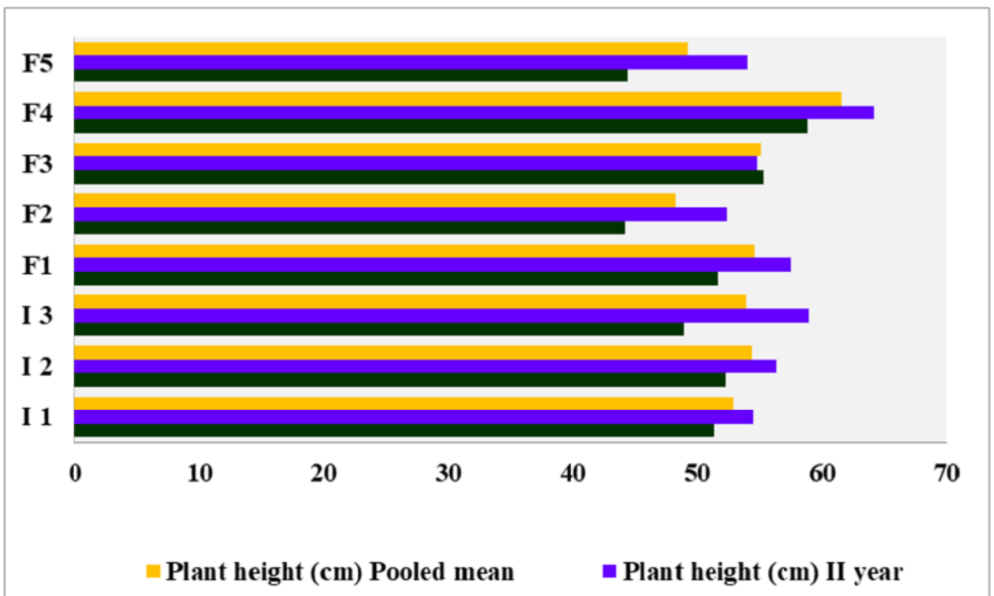

Fig. 1. Influence of phenophase based irrigation and fertigation scheduling on plant height (cm)

The irrigation treatment I_3- (0.8 ER each at vegetative, bud and flowering phases) in combination with F_4 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_3 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 $F_{4,}$ 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 I_1F_4 was on par with I_3F_4 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 I_3F_4 and it was on par with I_1F_4 (41.44) and the minimum (17.75) was recorded in I_1F_5. The treatment I_3F_4 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_1F_4 followed by the treatment I_1F_3 (45.76 cm) and the minimum (31.60 cm) was recorded in the treatment combination of I_1F_5 during the first year. The maximum average plant spread (49.33 cm) was recorded in the treatment combination I_3F_1 followed by I_2F_3 (44.87 cm) and the minimum (30.80 cm) was recorded in the treatment combination I_1F_2 during the second year. In pooled interaction, the maximum average plant spread (47.98 cm) was recorded in the treatment combination I_1F_4 followed by the treatment I_1F_3 (43.61 cm) and the minimum (32.23 cm) was recorded in the treatment combination of I_3F_2 (Table 4 & 6).

It was recorded that irrigation regime I_1- (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_1F_4 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
I_1	29.18	30.65	29.91	42.32	39.67	41.00	221.93	136.89	179.40
I_2	32.42	27.27	29.85	36.71	41.04	38.88	220.26	141.43	180.82
I_3	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
F_1	30.06	34.06	32.06	37.13	43.87	40.50	224.07	159.64	191.86
F_2	26.32	23.44	24.88	38.26	35.26	36.76	220.74	136.21	178.47
F_3	31.50	27.30	29.40	40.54	40.92	40.73	214.97	143.18	178.57
F_4	42.12	39.86	40.99	42.98	41.81	42.39	225.88	154.83	190.36
F_5	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

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	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
I_2	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
I_3	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

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	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
I_2	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
I_3	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_1F_1 (229.61) and the minimum number of leaves per plant (205.01) were recorded in I_1F_5 during the first year. The maximum number of leaves per plant (215.50) was recorded in the treatment combination I_3F_1 and it was on par with I_2F_2 (192.21), I_1F_3 (171.61) and I_3F_4 (175.90) whereas, the minimum (89.61) was recorded in I_1F_2 during the second year. In pooled interaction the maximum number of leaves per plant (217.76) were recorded in the treatment combination I_3F_1 and it was on par with I_2F_2 (208.41), I_1F_3 (195.96), I_1F_4 (197.22) and I_3F_4 (198.75) whereas, the minimum (154.61) was recorded in I_1F_2 (Table 4 & 7).

The treatment I_3F_4 registered maximum number of leaves per plant and maximum leaf area (2404.74 cm^2) was recorded in I_1F_4 and it was on par with I_3F_4 (2352.18 cm^2) and the lowest (1308.31 cm^2) was recorded in I_3F_1 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

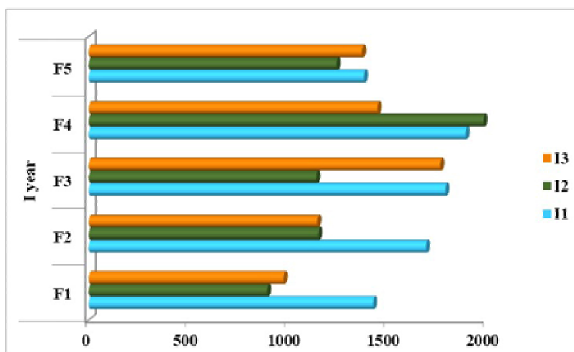

Fig. 2.a. Influence of phenophase based irrigation and fertigation scheduling on leaf area (cm²) at vegetative phase during first year

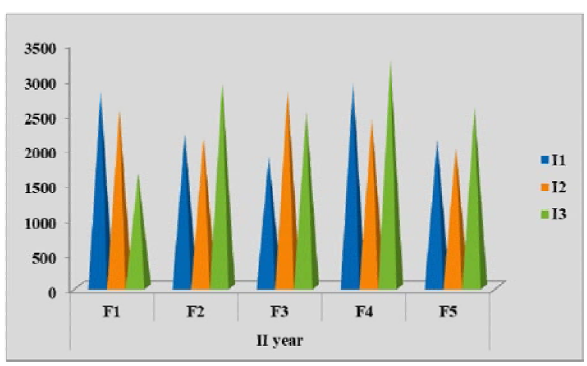

Fig. 2.b. Influence of phenophase based irrigation and fertigation scheduling on leaf area (cm²) at vegetative phase during second year

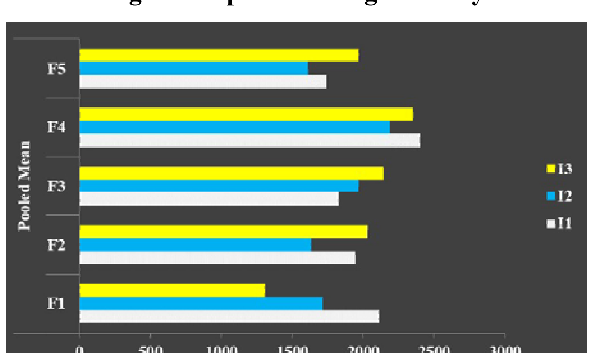

Fig. 2.c. Pooled influence of phenophase based irrigation and fertigation scheduling on leaf area (cm²) at vegetative phase

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

Leaf area (cm²) at vegetative phase

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	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
I_2	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
I_3	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
I_1	1640.80	2373.74	2007.27
I_2	1286.42	2362.97	1824.68
I_3	1345.88	2575.28	1960.58
SE. d	8.89	45.52	5.30
CD (P=0.05)	24.68	101.36	10.50
F_1	1102.67	2319.68	1711.18
F_2	1334.65	2408.43	1871.54
F_3	1569.73	2388.75	1979.24
F_4	1778.79	2851.51	2315.15
F_5	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 (cm^2) at vegetative phase 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	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
I_2	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
I_3	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_3-(0.8 ER each at vegetative, bud and flowering phases) in combination with fertigation treatment F_4 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_3F_4 was registered as the best treatment to improve the vegetative growth of chrysanthemum var. Marigold.

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