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Economics of chrysanthemum cultivation at different levels of light interruption under polytunnel condition

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Abstract
An experiment entitled "Economics of chrysanthemum cultivation at different levels of light interruption." was conducted at Nursery No. 10, College of Horticulture, Dapoli, Dist. Ratnagiri during the year 2020-2021. The experiment was laid out in randomized block design with three replications and eight treatments along with control. During the period of research all parameters were significantly influenced by different levels of light interruption/dark exposure in Chrysanthemum cv. Chandrika. Vegetative, flowering and yield parameters like maximum fresh and dry weight for plant, root and shoot, shoot: root ratio (fresh and dry weight), number of flower buds/polytunnel, number of flowers/polytunnel, yield of flowers/polytunnel, yield of flowers/ha and benefit cost ratio (economics) accordingly all these observation parameters mentioned above were found promising in treatment (T_6) i.e., 180 minutes level of light interruption using 90% black shade net in chrysanthemum cv. Chandrika under polytunnel condition while average illuminance of light was recorded at 15 days interval under uniform conditions inside polytunnel which was non-significant.

Keywords: Chrysanthemum, levels of light interruption, vegetative, yield, economics, B:C ratio

Introduction

Chrysanthemum is a popular commercial flower crop of the many countries. It is next only to rose in value of flower trade in the world market. The word Chrysos means "golden" and anthos means "flower". It is commonly known as "Queen of East/ autumn queen/ guldaudi". Chrysanthemum is a national flower of Japan. Chrysanthemum has its origin from northern hemisphere chiefly Europe and Asia. Many authorities claim that it has been originated from China (Bose *et al*. 2002) [3]. Species involved in the development are C. sinense, C. indicum, C. japonicum, C. ornatum, C. maxima. Chrysanthemum is one of the most important commercially grown flowers after rose. In India too, chrysanthemum occupies a place of pride both as a commercial crop and as a popular exhibition flower. It has a wide range of type, size and colour and also "forms". Chrysanthemums are herbaceous perennial plants grown mainly as cut flowers, but also used as potted flowering plants or bedding plants. Modern cultivars are available in a range of colour combinations and petal styles (spider, incurved etc). Their demand is at peak during Christmas, Easter, holidays (Biondo and Noland, 2000; Dole and Wilkins, 2005) [2, 6]. It is a short-day plant.

In chrysanthemum short days are required for flower induction. In this context providing natural light exposure will encourage vegetative growth during short days and use of 90% black shade net will help to manipulate reproductive growth during long days. In this view the research was undertaken during Rabi, 2020 for early induction of flowering and yield improvement, with objective to study economics of chrysanthemum cultivation at different duration of dark exposure using 90% black shade net under poly tunnel condition

Material and Methods

The field trial entitled "Economics of chrysanthemum cultivation at different levels of light interruption" was carried out in variety Chandrika at Nursery number 10, College of Horticulture, Dapoli, Dist. Ratnagiri in October month during 2020-21. The experiment was laid out in Randomized Block Design with nine treatments replicated thrice. The treatments (interruption of light/dark exposure) applied were T_1 (30 minutes), T_2 (60 minutes), T_3 (90 minutes), T_4 (120 minutes), T_5 (150 minutes), T_6 (180 minutes), T_7 (210 minutes), T_8 (240 minutes) was imposed by using 90% black shade n*et al*ong with control-T_9. Experiment was conducted as per the approved outline of research from October, 2020 to February, 2021.

Statistical analysis of the data was collected during the course studies was carried out by standard method of analysis of variance described by Panse and Sukhatme (1995) [9].

Result and Discussion

Vegetative parameters

Fresh weight of plant

Among the different levels of light interruption, plants receiving treatment T_6 (180 minutes) had a greater number of branches and leaves which resulted in highest fresh weight of plants. The plants with T_6 (180 minutes) had highest average fresh weight 379.83 g/plant which was significantly superior over treatment T_5 (150 minutes) 282.67 g/plant. While the lowest average fresh weight 118.01 g/plant was recorded in T_9 (Control).

Dry weight of plant

After removing all the moisture, the dry weight observations noted were parallel to the fresh weight. The uppermost average dry weight 123.80 g/plant was recorded T_6 (180 minutes) which was significantly superior over treatment T_5 (150 minutes) 97.75 g/plant. While least average dry weight 41 g/plant was recorded in T_9 (Control). The dry weight was linked with fresh weight. Almost all the moisture was removed and the fresh matter was dried to the extinct. The observations were parallel to fresh weight of same plants.

Fresh weight of root

Among the different levels of light interruption, plants receiving treatments with T_6 (180 minutes) had a greater number of branches and leaves which resulted in maximum fresh weight of root. The plants with treatment T_6 (180 minutes) had maximum average fresh weight 16.16 g/ root which was significantly superior over other treatments and followed by treatment T_5 (150 minutes) 13.87 g/ root. While the minimum average fresh weight 6.93 g/ root was recorded in T_9 (Control). The formation of adventitious roots is a critical process in the vegetative propagation of many plants. In different species it has been demonstrated that both light intensity and specific wavelengths can affect adventitious root formation on *in vitro* plants and *in vivo* cuttings (reviewed by Christiaens *et al*. (2016) [5]. The associated increase in auxin biosynthesis in the leaves, might have resulted not only in elongation of the cuttings, but also in an improved rooting as shoot-derived auxin is necessary for rooting (Ahkami *et al*., 2013) [1].

Dry weight of root

After removing all the moisture, the dry weight observations noted were parallel to the fresh weight. The maximum average dry weight 11.30 g/ root was recorded treatment T_6 (180 minutes) was significantly superior over other treatments and followed by treatment T_5 (150 minutes) 9.52 g/ root. While minimum average dry weight 2.76 g/ root was recorded in T_9 (Control). The dry weight of root was linked with fresh weight of root. Almost all the moisture was removed and the fresh matter was dried to the extinct. The observations were parallel to fresh weight of same roots of plants.

Fresh weight of shoot

Among the different levels of light interruption, plants receiving treatments with T_6 (180 minutes) had a greater number of branches and leaves which resulted in uppermost fresh weight of plants. The plants with treatment T_6 (180 minutes) had maximum average fresh weight 363.18 g/ shoot it was significantly superior over treatment T_5 (150 minutes) 268.46 g/ shoot. While the least average fresh weight 110.74 g/ shoot was recorded in T_9 (Control). Light is essential for plant growth and development. As an energy source, it drives photosynthesis to build up biomass, but specific wavelengths can also steer different processes. For instance, light is typically associated with a compact plant growth (Huché-Thélier *et al*., 2016) [7].

Dry weight of shoot

After removing all the moisture, the dry weight observations noted were parallel to the fresh weight. The uppermost average dry weight 112.04 g/ shoot was recorded in treatment T_6 (180 minutes) which was significantly superior over other treatments followed by T_5 (150 minutes) 88.25 g/ shoot. While lowest average dry weight 37.52 g/shoot was recorded in T_9 (Control). The dry weight of shoot was linked with fresh weight of shoot. Almost all the moisture was removed and the fresh matter was dried to the extinct. The observations were parallel to fresh weight of same roots of plants.

Shoot: root ratio (fresh weight)

Among the different levels of light interruption, plants receiving treatments with T_6 (180 minutes) had a superior number of branches and leaves which resulted in topmost fresh weight of plants. The plants with treatment T_6 (180 minutes) had maximum shoot: root ratio (fresh weight) 22.49 g which was at par with T_5 (150 minutes) 21.42 g. While the least shoot: root ratio (fresh weight) of plant 14.04 g was recorded in T_9 (Control).

Shoot: root ratio (dry weight)

The topmost shoot: root ratio (dry weight) 15.96 g was recorded in treatment T_6 (180 minutes) which was significantly superior over all other treatments and was followed by T_5 (150 minutes) 14.19 g. While lowest shoot: root ratio (dry weight) 9.19 g was recorded in T_9 (Control).

Flowering parameters

Number of flower buds/polytunnel (Size of polytunnel-16.51 m × 4.50 m)

Highest number of flower buds per polytunnel 68197.50 was observed in treatment T_6 (180 minutes) which was significantly superior over treatment T_5 (150 minutes) 57257.01 followed by T_4 (120 minutes) 51648.30. The lowest number of flower buds per polytunnel 13196.50 was recorded by the treatment T_9 (Control) where there was no interruption of light. Similar findings were reported for bud to flower development (Yu *et al*., 2002) [10].

Yield parameters

Number of flowers/polytunnel

Maximum number of flower buds per polytunnel 68197.50 was observed in treatment T_6 (180 minutes) which was significantly superior over treatment T_5 (150 minutes) 57257.01. The minimum number of flower buds per polytunnel 13196.50 was recorded by the treatment T_9 (Control).

Cavins *et al*., (2001) [4] reported that 8 hours photoperiod for Zinnia was the most effective to produce optimistic growth and flowering.

Yield of flowers/polytunnel

Among all the levels of light interruption, T_6 - 180 minutes recorded (105.90 kg/ polytunnel) significantly uppermost average flower yield per polytunnel as compared to other treatments and which was at par with T_5 - 150 minutes (95.40 kg/ polytunnel). Lowermost yield per polytunnel (32.55 kg/ polytunnel) was noted in T_9 – Control. The increased flower yield might be attributed to a greater number of leaves resulted in production and accumulation of more photosynthetic material which ultimately resulted in production of a greater number of flowers with large flower size. (Kumar *et al.*, 2017) [8]. As discussed earlier maximum yield per polytunnel in treatment interruption of light level for 180 minutes might be contributed to vegetative vigour, congenial conditions, maximum accumulation of photosynthates, maximum carbon dioxide fixation, manipulation of day length period inducing early reproductive growth ultimately enhancing yield of flowers.

Yield of flowers/hectare (kg/ha)

Among the various treatments of dark exposure maximum yield of chrysanthemum flowers (21136.67 kg/ ha) was recorded in treatment T_6 i.e., interruption of light/dark exposure for 180 minutes which was significantly superior over various treatments while minimum yield (7686.67 kg/ha) was observed in control (T_9). These findings are in line with those reported earlier by Kumar *et al.*, 2017 [8] where flower yield per plant and vegetative vigour is attributed for maximum acreage.

Economics of production of chrysanthemum cv. Chandrika

The economics has been worked out for each treatment. The minimum total input cost (753652.36 Rs/ha) was recorded in the treatment T_9 (Control). Whereas, the higher cost of production in (825021.40 Rs/ha) was observed in treated plots. The maximum net return (2265229.14 Rs/ha) was obtained in treatment T_6 (180 minutes) while minimum net return (399348.14 Rs/ha) was obtained in treatment T_9 (Control). Net returns were maximum in interruption of light for 180 minutes due to maximum yield of flower obtained in similar treatment. The highest benefit-cost ratio, 2.50 was obtained in treatment T_6 (180 minutes). The lowest benefit-cost ratio 0.53 was obtained in the treatment T_9 (Control). The production cost and yield of T_6 treatment is comparatively higher than control i.e., T_9 which reflects with higher B:C ratio.

Table 1: Effect of different duration of dark exposure on vegetative parameters of plant in Chrysanthemum cv. Chandrika

Treatments (Interruption of light)		Fresh weight of plant (g)	Dry weight of plant (g)	Fresh weight of root (g)	Dry weight of root (g)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Shoot: Root ratio (Fresh Weight)	Shoot: Root ratio (Dry Weight)
T_1	30 minutes	125.25	43.33	7.23	2.81	116.22	39.91	16.07	9.94
T_2	60 minutes	127.93	56.82	8.31	4.00	120.09	52.34	16.24	11.08
T_3	90 minutes	163.62	73.53	8.54	4.97	154.46	56.59	18.19	12.84
T_4	120 minutes	223.09	95.91	10.68	7.09	212.65	87.82	20.63	13.25
T_5	150 minutes	282.67	97.75	13.87	9.52	268.46	88.25	21.42	14.19
T_6	180 minutes	379.83	123.80	16.16	11.30	363.18	112.04	22.49	15.96
T_7	210 minutes	221.61	87.60	9.40	5.75	208.20	68.03	18.88	12.93
T_8	240 minutes	139.86	57.70	8.45	4.14	134.36	53.19	16.59	11.33
T_9	Control	118.01	41.00	6.93	2.76	110.74	37.52	14.04	9.19
Range		118.01-379.83	41.00-123.80	6.93-16.16	2.76-11.30	110.74-363.18	37.52-112.04	14.04-22.49	9.19-15.960
Mean		197.98	75.263	9.95	7.03	187.97	66.14	18.32	12.30
S. Em. ±		9.70	3.70	0.15	0.11	9.59	3.72	1.02	0.57
C.D. at 5%		29.08	11.11	0.46	0.34	28.75	11.15	3.06	1.71

Table 2: Effect of different duration of dark exposure on flowering and yield parameters in Chrysanthemum cv. Chandrika

Treatments (Interruption of light)		Flowering parameter	Yield parameter		
		Number of flower buds per polytunnel	Number of flowers per polytunnel	Yield per polytunnel (kg)	Yield (kg/ha)
T_1	30 minutes	26907.30	32030.46	41.51	8443.33
T_2	60 minutes	34292.25	33184.90	62.38	12403.33
T_3	90 minutes	39098.43	34825.18	75.01	14196.67
T_4	120 minutes	51648.30	36565.80	84.89	17950.00
T_5	150 minutes	57257.01	37916.51	95.40	19426.67
T_6	180 minutes	68197.50	38919.97	105.90	21136.67
T_7	210 minutes	48619.35	36132.34	83.70	16540.00
T_8	240 minutes	41883.75	32711.76	48.61	10640.00
T_9	Control	13196.50	25371.74	32.55	7686.67
Range		13196.50-68197.50	25371.74-38919.97	32.55-105.90	21136.67-7686.67
Mean		42344.48	34184.29	69.99	14269.26
S. Em. ±		1737.81	568.90	3.52	562.94
C. D. at 5%		5209.94	1705.57	10.56	1687.69

Table 3: Economics of chrysanthemum cultivation under the influence of different levels of interruption of light using black shade net 90% (Rs/ha)

Treatments		Yield (kg/ha)	Total input cost (Rs/ha)	Gross Returns (Rs/ha)	Net Profit (Rs/ha)	B:C Ratio
T_1	30 minutes	8443.33	825021.4	1266499.5	441478.14	**0.54**
T_2	60 minutes	12403.33	825021.4	1860499.5	955228.14	**1.06**
T_3	90 minutes	14196.67	825021.4	2129500.5	1224229.14	**1.35**
T_4	120 minutes	17950.00	825021.4	2692500	1787228.64	**1.97**
T_5	150 minutes	19426.67	825021.4	2914000.5	2008729.14	**2.22**
T_6	180 minutes	21136.67	825021.4	3170500.5	2265229.14	**2.50**
T_7	210 minutes	16540.00	825021.4	2481000	1575728.64	**1.74**
T_8	240 minutes	10640.00	825021.4	1596000	690728.64	**0.76**
T_9	Control	7686.67	753652.36	1153000.5	399348.14	**0.53**

Selling rate of flowers: 150Rs/kg.

Conclusion

From the present studies it can be concluded that from the experiment the use of levels of light interruption influenced the growth, flowering, yield and quality of chrysanthemum cv. Chandrika. It was observed that Vegetative, flowering and yield parameters like maximum fresh and dry weight for plant, root and shoot, shoot: root ratio (fresh and dry weight), number of flower buds/polytunnel, number of flowers/polytunnel, yield of flowers/polytunnel, yield of flowers/ha and benefit cost ratio (economics) was promising in plants treated with interruption of light for 180 minutes (T_6).

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