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Effect of shading materials on the performance of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.)

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Abstract
The present experiment on the effect of shading materials on the performance of spray chrysanthemum (*Chrysanthemum morifoliu*m Ramat.) cultivars was carried out at the Horticulture Experimental Farm, NU: SASRD, Medziphema Campus, Nagaland during June 2018-January 2019. The experiment was laid out in Split Plot Design with 3 shading materials and open (control) and 4 cultivars of spray chrysanthemum in 3 replications. The findings revealed that maximum number of leaf area (19.17cm^2), number of primary branches (9.91), chlorophyll content (8.81 mg/ml) and maximum size of bloom (5.82 cm) was obtained under open condition. The maximum plant height (96.8 cm) was obtained under black satin cloth cover. Earliness in flowering was also noticed in controlled photoperiod, where thatch cover took the minimum days (128.91, 151.41 and 168.08 days) for bud emergence, bud burst and full bloom respectively. Whereas, the maximum number of cut stems/plant (9.91) and cut stems/hectare (7.93 lakh) was obtained under open condition. While the longest self-life of 76.58 days was obtained under thatch cover. Among the cultivars, the maximum number of leaves (124), primary branches (10.08) and number of cut stems/hectare (7.93 lakh) and minimum days (125.41, 146.91, 166.08 and 185.67) to bud emergence, bud burst, full bloom and peak flowering was obtained in cv. Pusa Aditya. However the tallest plant height (83.88cm), maximum plant spread (27.50 cm) and longest vase life (21.17 days) was recorded in cv. Tata Red. The findings also revealed that cv. Poornima recorded maximum leaf area (19.65 cm^2), chlorophyll content (8.93 mg/ml) and longest self-life (76.83 days). The results revealed that S_0 (open condition) gives highest net return of Rs 261.26 lakh.

Keywords: Chrysanthemum, cultivars, shading materials, vase life

Introduction
Chrysanthemum (*Chrysanthemum morifolium* Ramat.) is a leading commercial flower crops grown for cut and loose flower and also as a potted plant. Chrysanthemum is considered as native to China and Japan and belongs to the family Asteraceae. In International trade, it ranked second as a cut flower and fourth as potted plants. These plants are cultivated as pot plants for beautifying indoors and outdoors, as cut flowers for making bouquets and vase decoration and as a loose flower for making garlands and worshipping purpose.
Chrysanthemum is classified as a short-day plant (Garner and Allard, 1928) which flowers under the condition of the prolonged darkness and cannot normally form flower buds when the day length exceeds 14.5 hours and develop them when it exceeds 13.5 hours. The ability to produce chrysanthemum year round depends on the understanding of the complex interaction between the plant and its environment. Therefore, with the advancement of knowledge and technology, by manipulating the photoperiod and ambient temperature and taking the help of environment control greenhouses, chrysanthemum can be grown throughout the year to get year-round production of flowers (Machin and Scopes, 1978) [10].
For year-round chrysanthemum flower production, when the natural day lengths are too long for flower bud initiation, short day conditions are created artificially by covering the plants with black cloth or polyethylene (Post 1931) [15]. The covering of chrysanthemum cultivars using HDPE (High density polyethylene) resulted best alternative to tarpaulin for offseason flower production of chrysanthemum of both standard and spray cultivars (Sangma *et al.* 2016) [19]. For flower initiation and flower bud development the plants should be provided with night length or short-day conditions for 14 hours or more (Usha 2010) [24].

Materials and Method
The present study was conducted at the experimental farm of Department of Horticulture,

SASRD, Nagaland University during June 2018- January 2019. The experiment involved four (Tata Red, Karnal Pink, Pusa Aditya and Poornima) spray chrysanthemum cultivars and three shading materials (low cost polyethylene, black satin cloth and thatch cover) and open condition as controlled. The experiment was laid out in split plot design; shading materials as main plot and cultivars as sub plot with three replications. The treatment was started by shading the plants for 14 hours (5 p.m. to 7 a.m.) immediately after transplanting the plants till they attained bud emergence stage.

The rooted cuttings were transplanted in a polybag filled with garden soil, coarse sand and FYM at the same ratio of 1:1:1. The plants were raised by following routine of intercultural practices like irrigation, weeding, hoeing, staking and control of insect –pest and diseases as per the requirement. The data on various growth and flowering parameters were recorded and subjected to analysis of variance following Split plot design (Gomez and Gomez 1984).

Results and Discussion

Vegetative parameters

In general shading materials had a significant effect on the vegetative growth of the flowers. The data presented in table 1 shows that the tallest plant (85.53cm) was observed under black satin cloth cover followed by open condition (74.08cm). The maximum leaf area (19.17cm^2) was noted in open condition followed by black satin cloth cover (17.95cm^2). The maximum number of primary branches (9.91) was noted in open condition which was at par with plants under thatch cover (9.25) and the least (7.75) was obtained under black satin cloth cover. Maximum chlorophyll content of leaves (8.81mg/ml) was noted in open condition followed by plants under black satin cloth cover (8.62mg/ml). The maximum plant height under satin cloth cover were also reported by Dhiman *et al*. (2018) and Singh *et al*. (2005) [20] who stated that plants grown under satin cloth cover receives more light intensity than other covering materials which help in more vegetative growth of the plants. Plants under control photoperiod had less primary branches as exposure to short days decreased the vegetative growth and advanced the floral bud formation as reported by Lee *et al*. (2001) [9].

Among the cultivars, the maximum number of leaves (124.25) was noted in cv. Pusa Aditya which was followed by cv. Tata Red (102.75). The tallest plant (83.88cm) was recorded in cv. Tata Red followed by cv. Poornima (76.20 cm), the maximum leaf area (19.65 cm^2) was recorded in cv. Poornima followed by cv. Karnal Pink (17.86cm^2) while the minimum leaf area (14.71cm^2) was noted in cv. Pusa Aditya. The maximum number of primary branches (10.08) was noted in cv. Pusa Aditya which was followed by cv. Tata Red (9.16). Cultivar Tata Red exhibit the maximum (27.50cm) plant spread followed by cv. Poornima and cv. Karnal Pink (25.27cm) and (24.70 cm) respectively. The maximum chlorophyll content (8.93mg/ml) in leaves was noted in cv. Poornima. The variation in vegetative characters among the cultivars might be due to their difference in genetic constitution, environmental factors, climatic conditions and the type of covering materials used as reported by Behera *et al*. (2002), Swaroop *et al.* (2008) [21] and Dhiman *et al.* (2018).

Table 1: Influence of shading materials on the growth characters of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.)

Treatment	Number of leaves per plant	Plant height (cm)	Leaf Area (cm^2)	Number primary branches	Plant spread (cm)	Chlorophyll content in leaves (mg/ml)
Shading materials(S)						
S_0-Open condition (control)	107.83	74.08	19.17	9.91	26	8.81
S_1-Low cost polyethylene cover	101.41	69.48	16.16	8.25	24.3	8.15
S_2-Black satin cloth cover	97.25	85.53	16.95	7.75	23.84	8.62
S_3-Thatch cover	104.91	68.35	15.9	9.25	24.70	7.83
S.Em	0.13	1.48	0.48	0.04	0.46	0.17
CD at 5%	NS	6.23	2.04	0.17	NS	0.72
Cultivars (C)						
C_1-Tata Red	102.75	83.88	15.98	9.16	27.50	7.82
C_2-Karnal Pink	98.17	73.25	17.86	8.25	24.04	7.87
C_3-Pusa Aditya	124.25	64.12	14.71	10.08	22.15	8.75
C_4-Poornima	86.25	76.20	19.65	7.67	25.27	8.93
S.Em	1.18	1.18	0.53	0.04	0.46	0.27
CD at 5%	4.016	4.01	1.81	0.16	1.57	0.93
Interaction S×C S. Em	0.08	2.37	1.07	0.09	0.92	0.55
CD at 5%	NS	8.03	3.63	NS	3.14	NS

Flowering parameters

Shading materials also had significant effect on the flowering characters of chrysanthemum. The experiment revealed that the least number of days (128.91,151.41 and 167.25) for bud emergence, bud burst and full bloom respectively was recorded under thatch cover while the plants under open condition took a greater number of days (139.58, 165.91 and 177.91) to bud emergence, bud burst and full bloom respectively. The present findings were in conformity with the results of Velmurugal and Vadivel (2003) [25]. This may be due to the fact that increase in short day exposure decreased the final leaf number and advanced the floral stage suggesting a facultative response to photoperiodic cycles Lee *et al.* (2001) [9]. The maximum size of the bloom (5.82cm) was recorded in open condition while the minimum size of blooms (4.85cm) was recorded under thatch cover. Plants under open condition produced bigger bloom which may be due to the fact that the plants were exposed to a greater number of long days which might have favoured good bloom size Sangma *et al*. (2016) [19]. The longest self-life (76.58 days) was recorded under thatch cover and shortest self-life (68.67 days) was recorded under open condition. Prevailing temperature under the respective shading materials also might have attributed in prolonging the self-life of chrysanthemum cultivars Dhiman *et al*. (2018).

Among the cultivars the least number of days (125.41, 146.91

and 166.08) for bud emergence, bud burst and full bloom respectively was exhibited by cv. Pusa Aditya. The maximum (211.67 days) taken for peak flowering was recorded in cv. Poornima which is at par with cv. Tata Red (209.08 days). The maximum flower size (5.82 cm) was recorded in cv. Poornima. The longest self-life (76.83 days) was recorded in cv. Poornima followed by cv. Tata Red (75.50days). The reason of significant variation among cultivars is due to the to their difference in genetic constitution, environmental factors, climatic conditions and the type of covering materials used as reported by Pattanaik *et al*. (2010) [14] and Dhiman *et al.* (2018).

Table 2: Influence of shading materials on the flowering attributes of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.)

Treatment	Days to bud emergence	Days to bud burst	Days to full bloom	Size of blooms (cm)	Days to peak flowering	Self-life (days)
Shading materials (S)						
S_0-Open condition (control)	139.58	165.91	177.91	5.82	206	68.67
S_1(Low cost blue polyethylene)	134.11	157.00	172.41	5.26	201.25	75.16
S_2(Black satin cloth)	135.83	162	176.5	5.31	199.08	74.08
S_3(Thatch grass)	128.91	151.41	168.08	4.85	195.84	76.58
S.Em	0.04	0.04	0.03	0.09	0.08	0.03
CD at 5%	0.17	0.19	0.16	0.39	NS	0.15
Cultivars (C)						
C_1(Tata Red)	141.67	167.08	177.91	5.48	209.08	75.5
C_2(Karnal Pink)	128.87	154.34	171.75	4.84	195.75	74.57
C_3(Pusa Aditya)	125.41	146.91	166.08	5.10	185.67	70.34
C_4(Poornima)	142.5	168	179.17	5.82	211.67	76.83
S.Em	0.04	0.05	0.06	0.07	0.06	0.07
CD at 5%	0.13	0.19	0.21	0.24	0.23	0.23
Interaction S×C S. Em	0.08	0.11	0.12	0.14	0.13	0.01
CD at 5%	0.27	0.40	NS	0.49	NS	0.47

Yield and yield attributes

The maximum number of flowers/branch, flowers/plant and flowers/hectare (12.67, 107.58 and 87.41lakh) respectively was obtained in open condition. The increased in number of flowers/branch, flowers/ plant and flowers/hectare was due to more number of branches and vigorous growth in open condition which ultimately results to more number of flowers. The present results were in conformity with the findings of Sangma *et al*. (2016) [19] and Sultanpuri (2014) in chrysanthemum.

Among the cultivars the maximum number of flowers/branch, flowers/plant and flowers/hectare (13.67, 112.08 and 90.08) was recorded in cv. Pusa Aditya while the minimum yield of flowers/branch, flowers/plant and flowers/hectare (10.24,89.5and 77.55) respectively was recorded in cv. Poornima. The reason of significant variation among cultivars is due to the difference in the genetic makeup of the cultivar, environmental condition, climatic conditions and the type of covering materials Puneetha *et al.* (2011) [16].

Vase life

The effect of shading materials on the vase life of the flowers was found to be non- significant. However, there is a significant variation on the vase life of the flowers as influenced by shading materials. The longest vase life ((21.17 days) were noted in cv. Tata Red while the shortest vase life (13.91days) was observed in cv. Pusa Aditya. Singh *et al.* (2017) opined that the variations in vase life of flowers might be due to the difference in the senescence behaviour of the varieties by producing higher amount of ethylene forming enzymes. Similar results were also reported by Mepfu-o (2018) in chrysanthemum.

Table 3: Influence of shading materials on yield and yield attributes of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.)

Treatment	Number of flower/branches	Number of flower /plants	Number of flower /hectare (lakhs)
Shading materials (S)			
S_0-Open condition(control)	12.67	107.58	87.91
S1(Low cost blue polyethylene)	11.91	95.75	82.91
S_2 (Black satin cloth)	11.58	93	79.41
S_3(Thatch grass)	12.34	101.41	86.34
S.Em	0.03	0.14	0.08
CD at 5%	0.12	0.62	0.34
Cultivars (C)			
C_1(Tata Red)	13	103.5	86
C_2(Karnal Pink)	11.58	92.67	81.5
C(Pusa Aditya)	13.67	112.08	91.08
C_4(Poornima)	10.25	89.5	77.5
S.Em	0.04	0.15	0.07
CD at 5%	0.14	0.51	0.25
Interaction (S×C) S.Em	0.08	0.30	0.15
CD at 5%	NS	NS	NS

Table 4: Influence of shading materials on the vase life of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.)

Treatment	Vase life
Shading materials (S)	
S_0-Open condition (control)	16.08
S_1- Low cost blue polyethylene	16.75
S_2-Black Satin cloth	18.75
S_3- Thatch grass	17.67
S.Em	0.08
CD at 5%	NS
Cultivars (C)	
C_1-Tata Red	21.17
C_2-Karnal Pink	15.34
C_3-Pusa Aditya	13.91
C_4-Poornima	18.84
S.Em	0.04
CD at 5%	0.16
Interaction (S×C) S.Em	0.09
CD at 5%	NS

Table 5: Influence of shading materials on the economics of cultivation of spray chrysanthemum (*Chrysanthemum morifolium* Ramat.)

Treatments	Cost of production			Yield of cut stalks (lakh/ha)	Gross return (lakh/ha)	Net return (lakh/ha)	Benefit: Cost Ratio
	Fixed cost (lakh/ha)	Treatment cost (lakh/ha)	Total cost (lakh/ha)				
S_0 (Open condition)	16.29	0	16.29	7.93	277.55	261.26	16.03
S_1(Low cost polyethylene cover)	39.50	7.20	46.7	6.60	231.00	184.30	3.95
S_2(Black satin cloth cover)	39.50	7.20	46.7	6.20	217.00	170.30	3.64
S_3 (Thatch cover)	39.50	18.7	58.20	7.40	259.00	201.33	3.45

Conclusion

The present investigation reveals that for production of cut flowers, the plants should be grown under black satin cover to get desirable stalk length. Thatch cover shading materials was found suitable for production of potted chrysanthemum. Among the cultivars, Pusa Aditya was found to be early in flowering with higher yield as compared to others cultivars. Cultivar Tata Red proved to superior in plant height, plant spread and exhibit longer vase life which is found suitable as cut flowers. The results revealed that S_0 (open condition) gives highest net return of Rs 261.26 lakh.

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