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Influence of planting dates on growth and flowering of spray *Chrysanthemum* var. Aparajita in the Terai region of West Bengal

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Abstract
The present investigation entitled ‘‘Influence of planting dates on growth and flowering of spray *Chrysanthemum* var. Aparajita in terai regions of West Bengal’’ was carried out at the Instructional Farm, Department of Floriculture, Medicinal and Aromatic Plants, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya during the years 2019-20 and 2020-21. Planting was done at an interval of 30 days starting from 6th July in both the years with planting dates as; 6th July (T_1), 6th August (T_2), 6th September (T_3), 6th October (T_4), 6th November (T_5), and 6th December (T_6). The pooled data of the two subsequent years regarding the height of the plant, (64.62 cm), plant spread {(E-W) (26.08 cm)} & (N-S) (23.37 cm)} and number of branches per plant (12.81) were found better when rooted cuttings planted at 6th July of the both the years. The field life of individual flowers was also found more (13.66 days) when planted at 6th July of the both the years. The spray chrysanthemum mostly used as loose flowers for making of garlands, veni, and bracelets, as well as for religious purposes. The weight of flowers also most important for reducing the transport cost. The maximum weight of ten fresh flowers and minimum weight of ten fresh flowers were observed with the treatment T_1 (7.90 g) and T_6 (6.38 g) respectively was found maximum under 6th July planting (T_1). However, earliest flower bud initiation was recorded under December month (T_6). The overall performance of the spray *Chrysanthemum* var. Aparajita was better when planted in the month of July. Therefore, it may be recommended that for qualitative and quantitative produces of spray chrysanthemum in the terai region of the West Bengal, the rooted cuttings might be planted in the month of July.

Keywords: Spray *Chrysanthemum*, planting date, Terai region, West Bengal

Introduction
Chrysanthemum (*Chrysanthemum morifolium* Ramat.) commonly known as "Queen of the East," "Glory of the East," or "Guldaudi’’. It belongs to Asteraceae family. Chrysanthemum is one of the major commercial flower crops used both as cut and loose flowers due to their colourful, appealing blossoms. *Chrysanthemums* are divided into two categories i.e., Standard (Japanese, single flower), and Spray (Korean, multiple blossoms). The spray *Chrysanthemums* are the smallest and most compact. It maintains a prominent position in the ornamental horticulture. Spray *Chrysanthemums* are suitable- for container culture and are predominantly cultivated as a cut flower, flowering pot plant, and loose flower for making garlands, veni, and bracelets, as well as for religious purposes (Van Der Ploeg and Heuvelink 2006, Bohra and Kumar 2014) [22, 3]. It is commercially cultivated in many different states in Indian, including West Bengal, Karnataka, Andhra Pradesh, Madhya Pradesh, Maharashtra, Assam, Jammu and Kashmir, Telangana and Tamil Nadu (Bhattacharjee and De 2010) [2].
Chrysanthemum is a photosensitive plant with critical day length of 13 ½ h (Post 1931, Furuta 1954) [4, 15]. Based on photoperiod *Chrysanthemums* are classified as qualitative short day plants (Garner and Allard, 1920) [6], which means that they grow their vegetative during long days and their blooms during short days. When there are fewer than 12 hours in a day, the majority of cultivars start to form flower buds. *Chrysanthemums* start to form flower buds if the night exceeds nine hours. Depending on the geographic location of the growing area, the blooming time in traditional culture is brief, lasting only a few weeks or months. Environmental factors such as light, temperature, and relative humidity are the main elements that restrict plant growth and development. Low yields or crop failure may result negative effects from these climate conditions. In an open area, *Chrysanthemums* only bloom from October to December.

Chrysanthemums can be made to bloom at different times of the year by making artificially long and short days inside a protected structure. This helps the flowers bloom all year long. Staggered planting and different planting dates are also important to make sure the strengthening the blooming period for a longer time and capture the market for a longer time of the year. Therefore, for commercial cultivation, the impact of planting date or season on chrysanthemum growth and development is crucial.

Materials and Methods

The experiment was conducted at the Instructional farm, Department of Floriculture, Medicinal and Aromatic Plants, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya during the years 2019-20 and 2020-21. The location is situated at 26^0 19'86" N latitude and 89^0 23'53" E longitude geographically. The site lies in the sub-Himalayan plains at an elevation of 43 meters above mean sea level. The area comes under the Terai-agro climatic zone of West Bengal. The experiment was laid out by following the Completely Randomized Block Design with six planting dates with four replications. The different planting dates were 6th July (T_1), 6th August (T_2), 6th September (T_3), 6th October (T_4), 6th November (T_5), and 6th December (T_6). Planting materials were used for the experimental study was rooted terminal cuttings that were 30 days old. These cuttings were planted in UV-sterilized polythene bag (10 inches) that contained a mixture of media of 2 parts garden soil, 1 part vermicompost and 1 part well-rotten finely sieved Farm Yard Manure (FYM). The uniform sized and healthy terminal cuttings were collected from mother plant block and planted in rooting media (sand) after proper fungicidal treatment and with rooting hormone for proper rooting. After 30 days of planting for rooting, the rooted cuttings finally transplanted in filled up polythene bags. The proper scientific cultivation practices like balanced nutrient management, intercultural operations such as pinching, staking, weeding and application of water had been done as and when necessary. Plant protection measures also had been taken for diseases and insect pest attack. At peak blooming stage, all the vegetative, floral, and yield characteristics were measured in accordance with the treatments. The data of various qualities have been statistically calculated by following Gomez and Gomez (1984) [7] and the biometrical parameters of the data gathered throughout the course of the inquiry have been statistically computed using OPSTAT [8] and WASP 2.0 [9] (Web Based Agricultural Statistics Software Package).

Results and Discussion

Planting dates significantly influenced the vegetative growth and phenological and flowering of spray Chrysanthemum var. Aparajita. The vegetative characteristics, such as plant height, plant spread and number of branches, were taken at peak flowering stage and statistically examined, and are shown in Table- 1.

Plant height (cm)

From the data given in Table- 1 and Fig.- 1, it was clearly evident that plant height which was taken at peak flowering stage showed statistically significant results among the different planting dates in first year, second year as well as in pooled effect also. In the first year of results regarding plant height the longest plant (66.01 cm) was observed from the month of July planting (T_1) which was at par with T_2 (62.01 cm), whereas December month (T_6) planting showed the lowest plant height (36.99 cm). In the second year of the experiment, the same trend was observed i.e., maximum plant height was noticed from July month planting (63.23 cm) and the December month planting had the lowest plant height (34.86 cm). The pooled result of the both the years represented July month planting (T_1) produced maximum plant height (64.62 cm) which was found at par with T_2 (60.82 cm), whereas the lowest plant height was observed from December month (T_6) planting. Increase in plant height might be attributed to the fact, early planting may have been subjected to a bigger number of long days and a higher temperature during the vegetative growth phase, which altered the vegetative features of the plant. This may be because later planting was exposed to a greater number of short days and a lower temperature than earlier planting. This might be because both the daytime and the night time temperatures during this time period were ideal for the growth of plants. It's possible that early planting resulted to more extension growth, which was powered by increased photosynthesis and respiration, in addition to better carbon dioxide fixing. The prevalence of a warmer temperature regime conducive to growth was fulfilled, leading to abundant vegetative growth of the plants. Furthermore, this could have led to an increased quantity of nodes and the elongation of nodes. In addition, Jane *et al.* (2001) [10] have found that early planting on October 5 results in the tallest plants of annual chrysanthemum and the greatest spread. The above findings in are in conformity with Gantait and Pal (2011) [5] in spray chrysanthemum, Kaushal *et al* (2014) [13] in China aster, Singh *et al.* (2004) [20] in Chrysanthemum cv. Flirt, Jyothi *et al* (2018) [12] in Marigold, Thumar *et al* (2020) [21] in Chrysanthemum cv. Ratlam selection.

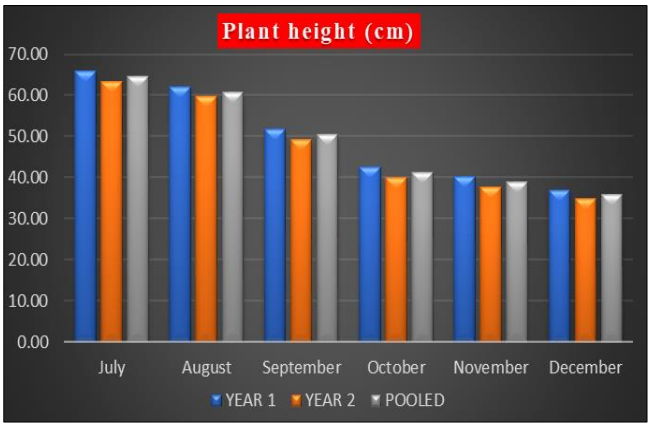

Fig 1: Effect of planting dates on plant height of spray *Chrysanthemum* var. Aparajita in Terai Region of West Bengal

Plant spread (cm)

In the first year of experiment (Table-1 and Fig.-2), planting in the month of June significantly produced the maximum plant spread towards East-West (25.69 cm) which was at par with T_2 (23.13 cm). Minimum plant spread was found in the month of December planting (11.86 cm). The effect was also found statistically significant in the second year of experiment in which June month planting (T_1) produced maximum plant spread towards East-West (26.48 cm), whereas minimum plant spread was found in the month of December planting (T_6) (10.89 cm). Similar trend was found in the pooled where

planting in the month of June (26.08 cm) produced maximum plant spread which was found at par with August planting (T_2) (23.68 cm), whereas minimum plant spread was found in the month of December (T_6).

In the first year of the experiment (Table- 1 and Fig.-2), plants that were planted in the month of June spread the most from North to south (25.69 cm), which was the at par with T_2 (22.82 cm). It was found that plant spread was the least (12.15 cm) in December Planting (T_6) The effect was also statistically significant in the second year of the experiment. Plants planted in June month (T_1) produced the highest plant spread in the North to south direction (23.91 cm), while plants planted in December (T_6) produced the least (11.31 cm). In the pooled data the maximum plants spread was recorded when they were planted in the month of June (23.37 cm) at N-S direction, which was statistical at par within August (T_2) (21.35 cm). Plants spread the least (11.73 cm) when they were planted in December (T_6). Increased in plant spread in both the direction (E-W and N-S) may be attributed to the fact that these plants were able to receive adequate time for putting up more vegetative development, which resulted in a greater plant spread. It might be also due to that early planting created a greater number of side stems, which led to higher lateral development and eventually increased plant spread, which might be the cause of the increased plant spread. The same findings were also corroborated with Sharma *et al* (2015) [19] in garland *Chrysanthemum*, Thumar *et al* (2020) [21] in *Chrysanthemum* cv. Ratlam selection, Bajad *et al* (2017) [1] in China Aster and Sharma *et al* (2017) [18] in Candytuft

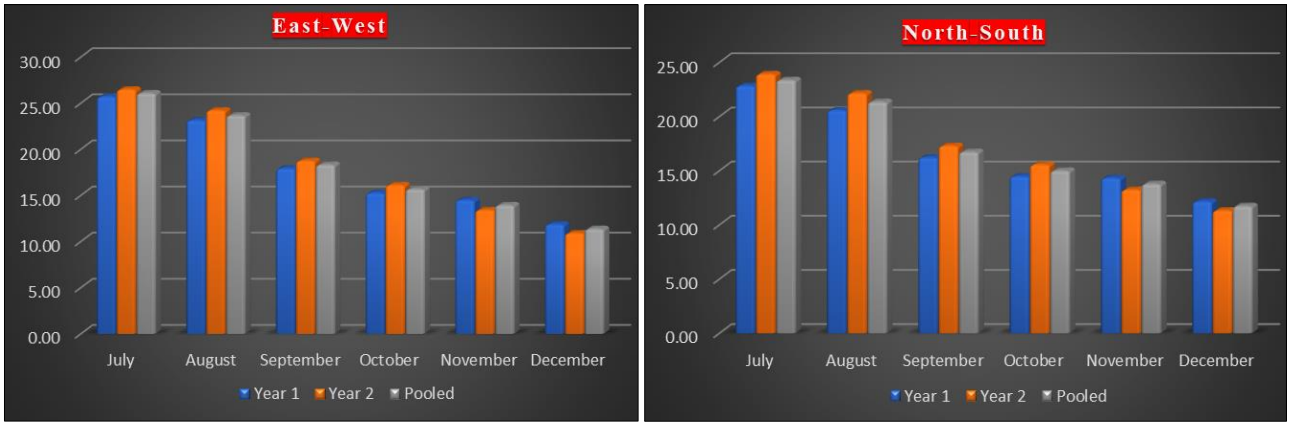

Fig 2: Effect of planting dates on Plant spread (E-W & N-S) of spray *Chrysanthemum* var. Aparajita in Terai Region of West Bengal

Number of branches

Number of branches (Table- 1 and Fig.- 3) which also significantly influenced among the different planting dates. In June month (T_1) planting significantly recorded the maximum number of branches per plant during first year and second year (12.64 and12.97) which was found statistically at par with T_2 (12.49 and 12.58) Lowest (8.70 and 7.63 respectively) number of branches per plant during both the years was recorded in December month (T_6). Similar trend was observed in pooled effect too i.e., maximum branches (12.81) were produced in June month Planting, it was found at par with T_2 (12.54), whereas the lowest branches were found in December month Planting. More branches per plant could be due to early planting which created the optimum and more prevailing conditions to put lush vegetative growth and delay in planting could be another reason for reduced number of branches in which plants enter to reproductive phase so sufficient vegetive growth can't attained. Increase in plant spread might directly influenced the increase in a greater number of branches per plant which ultimately produced the more number of flowers per plant. Above findings are close conformity with Sharma *et al* (2015) [19] in garland *Chrysanthemum*, Thumar *et al* (2020) [21] in *Chrysanthemum* cv. Ratlam selection

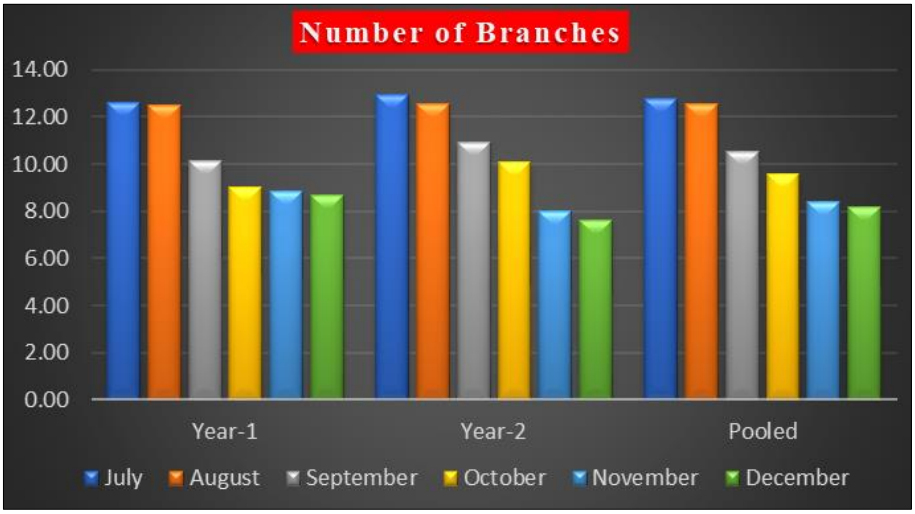

Fig 3: Effect of planting dates on Number of branches of spray *Chrysanthemum* var. Aparajita in Terai Region of West Bengal

Days taken for first flower bud Initiation (days)

On the perusal of data presented in Table- 2 and Fig.- 4 represents that different planting dates exerted significant results on first flower bud initiation in which days were counted from transplanting of rooted cuttings. During the first year of the experiment, the earliest initiation of bud (64.52 days after transplanting of rooted cuttings) was noticed in the December planted cuttings (T_6) and maximum days (102.79 days after transplanting of rooted cuttings) was noticed from the month of July month (T_1) planting. In the second year of study December planted cuttings(T_6) took the shortest days (64.88 days after transplanting of terminal cuttings) for flower bud initiation. July planted cuttings (T_1) took maximum time for the initiation of flower bud (101.50 days after transplanting of rooted cuttings). The combined findings from the two years also showed statistically significant results in this respect where December planted cuttings (T_6) recorded the shortest duration (65.14 days after transplanting of rooted cuttings) for first flower bud initiation. The maximum days for flower bud initiation were noticed when rooted cuttings were planted in July month (T_1). The reason for this might be due to early planting which led to accelerated extension growth, which was induced by higher photosynthesis and respiration in conjunction with increased carbon dioxide fixation. Delay in flower bud initiation might be due to the interference with carbohydrate and florigen movement to the receptive site, production of transmissible inhibitor, and production of a substance that acts antagonistically to the flowering hormone at the apex under long day condition may have contributed to the delayed flowering that occurred as a result of exposure to photoperiod (Vince-Prue, 1975) [23]. This may have been the case because of the production of transmissible inhibitor. Above results are in conformity with Palai *et al.*, (2018) [14] in *Chrysanthemum*, Jindal *et al* (2018) [11] in *Chrysanthemum* Cv. Ratlam selection, Gantait and Pal (2011) [5] in spray *Chrysanthemum*.

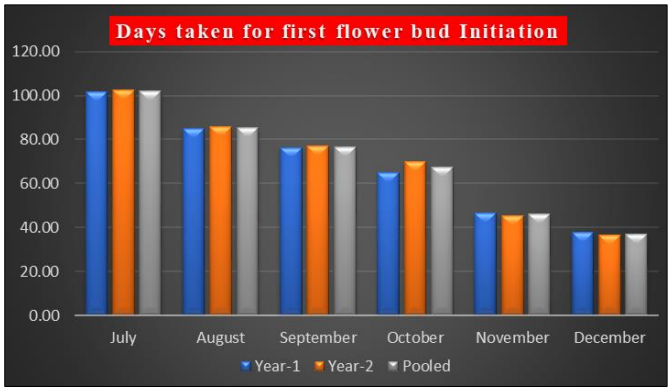

Fig 4: Effect of planting dates on days taken to first flower bud initiation of spray *Chrysanthemum* var. Aparajita in Terai Region of West Bengal

Days taken to First flower Wilting (days)

On the perusal of data presented in Table- 2 and Fig.-5 revealed that different planting dates exerted a significant result on days for first flower wilting. The maximum days (14.00 days from first flower full opening) taken for first flower wilting were recorded in the first year with the treatments T_1 (July planting). In December month planting (T_6), the minimum days (8.38 days from first bloom complete opening) were noticed. In the second year, maximum days (13.32 days from first flower full opening) were observed with the treatment T_2 (August month planting) which was at par (13.32 days from first flower full opening) with July month plants (T_2). The minimum days (9.00 days from first flower full opening) were reported from the treatment T_6 (December month plants). Parallel tendency was recorded in polled effect too in which July month planting had the maximum days for first flower wilting, whereas the minimum days (8.69 days) were noticed from planting in the month of December (T_6). It may be happened due to continuous supply of nutrients (carbohydrates) to the flowers in the process of photosynthesis as well as favourable environmental conditions.

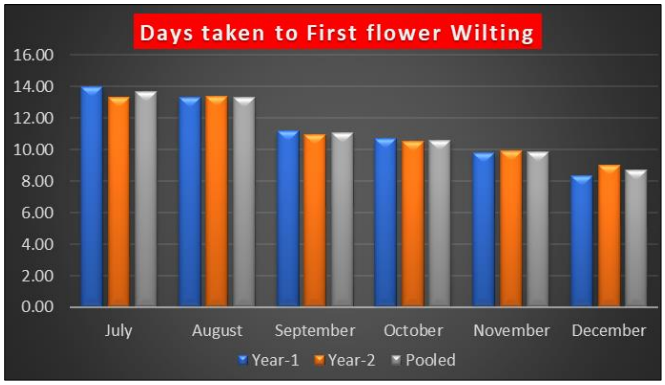

Fig 5: Effect of planting dates on days taken to first flower wilting of spray *Chrysanthemum* var. Aparajita in Terai Region of West Bengal

Weight of ten fresh flowers (g)

Weight of ten fresh flowers (Table- 2 and Fig.-6) during the first year of experiment study, it was revealed that the maximum weight of ten fresh flowers (7.85 g) was recorded with the treatment T_1 (July month plants) which was at par with T_2 and T_3 (7.79 g and 7.74 g respectively), whereas the least weight (6.16 g) was noticed from the plants which were planted in December month (T_6). In the second year of study the maximum weight of ten fresh flowers (70.96) was found from the July month planting and it was at par with T_2 with a value of 7.83g, T_3 with a value of 7.76 g and T_4 with a value of 7.68 g. Similar trend was noticed in case of pooled data too in which the maximum weight of 10 fresh flowers (7.90 g.) was recorded from the plants which were planted in July month (T_1) which was at par with the treatments T_2 (7.81 g.), T_3 (7.75 g.) and T_4 (7.58 g.). Increase in weight of individual flower weight could be attributed to the existence of congenial climatic conditions during the crop growth period, which enabled them to produce an increased amount of photosynthates and intern resulted in more dry matter accumulation. It was observed that, unfavourable climatic conditions exist for optimum vegetative growth and better flowering, during the July to September planted crops. These results are in close conformity with Pratibha *et al* (2018) [16] French marigold, Gantait and Pal (2011) [5] in spray *Chrysanthemum* and Sahu *et al* (2021) [17] in African marigold.

Fig 6: Effect of planting dates on days taken to first flower bud initiation of spray *Chrysanthemum* var. Aparajita in Terai Region of West Bengal

Table 1: Effect of planting dates on plant height, plant spread (E-W and N-S) and number of branches per plant of spray *Chrysanthemum* var. Aparajita in the Terai region of West Bengal

Treatment Details		Plant height (cm)			Plant spread (cm) E-W			Plant spread (cm) N-S			Number of branches per plant		
		Year- 1	Year-2	Pooled	Year- 1	Year-2	Pooled	Year- 1	Year-2	Pooled	Year- 1	Year-2	Pooled
T_1	6th July	66.01 a	63.23 a	64.62 a	25.69 a	26.48 a	26.08 a	22.82 a	23.91 a	23.37 a	12.64 a	12.97 a	12.81 a
T_2	6th August	62.01 a	59.63 a	60.82 a	23.13 a	24.22 b	23.68 b	20.55 a	22.14 a	21.35 a	12.49 a	12.58 a	12.54 a
T_3	6th September	51.70 b	49.19 b	50.45 b	17.92 b	18.75 c	18.33 c	16.19 b	17.28 b	16.73 b	10.15 b	10.95 b	10.55 b
T_4	6th October	42.67 c	39.95 c	41.31 c	15.26 bc	16.13 d	15.69 d	14.46 bc	15.55 b	15.00 bc	9.04 c	10.11 b	9.58 b
T_5	6th November	40.36 c	37.69 c	39.03 c	14.49 bc	13.41 e	13.95 d	14.31 bc	13.23 c	13.77 cd	8.83 c	8.01 c	8.42 c
T_6	6th December	36.99 c	34.86 c	35.93 c	11.86 c	10.89 f	11.38 e	12.15 c	11.31 c	11.73 d	8.70 c	7.63 c	8.17 c
SE(m) ±		2.61	2.88	2.67	1.16	0.62	0.80	0.99	0.70	0.80	0.28	0.53	0.34
CD at 0.05		7.81	8.63	7.98	3.46	1.85	2.41	2.95	2.10	2.38	0.83	1.58	1.02

Table 2: Effect of planting dates on DFFFBI, DFFW and Weight of ten harvested fresh flowers (g) of spray *Chrysanthemum* var. Aparajita in the Terai region of West Bengal

Treatment Details		DFFFBI (Days)			DFFW (Days)			Weight of ten fresh flowers (g)		
		Year- 1	Year-2	Pooled	Year- 1	Year-2	Pooled	Year- 1	Year-2	Pooled
T_1	6th July	102.79 a	101.50 a	102.14 a	14.00 a	13.3s2 a	13.66 a	7.85 a	7.96 a	7.90 a
T_2	6th August	85.35 b	84.81 b	85.08 b	13.31 a	13.38 a	13.35 a	7.79 a	7.83 a	7.81 a
T_3	6th September	76.85 c	76.31 c	76.58 c	11.19 b	10.94 b	11.07 b	7.74 ab	7.76 a	7.75 a
T_4	6th October	73.73 d	73.19 d	73.46 d	10.69 bc	10.50 b	10.60 bc	7.49 b	7.68 a	7.58 a
T_5	6th November	71.42 e	70.88 d	71.14 e	9.78 c	9.94 bc	9.86 c	6.54 c	6.81 b	6.67 b
T_6	6th December	65.42 f	64.88 e	65.14 f	8.38 d	9.00 c	8.69 d	6.16 d	6.61 b	6.38 b
SE(m) ±		0.63	0.99	0.72	1.24	1.08	0.82	0.10	0.18	0.13
CD at 0.05		1.88	2.97	2.16	0.41	0.36	0.28	0.30	0.55	0.39

* DFFFBI- Days taken to first flower bud initiation (Days), DFFW-Days taken to first flower wilting,

Conclusion

From the above experiment, it can be concluded that spray *Chrysanthemum* var. Aparajita when planted in the month of July resulted the best vegetative growth and floral development. It may be recommended that in the Terai region of West Bengal, the suitable- planting dates of the spray *Chrysanthemum* may be in the month of July.

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