Agric Res J **60** (5) : 712-716, *October* 2023
DOI No. 10.5958/2395-146X.2023.00101.1

EFFECT OF DIFFERENT NITROGEN LEVELS ON GROWTH AND FLOWERING OF CHRYSANTHEMUM (*Chrysanthemum morifolium* Ramat.) CV. 'WHITE STAR'

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ABSTRACT

The investigations were carried out for two consecutive seasons during the year 2018-19 at research Farm, PAU, Ludhiana with the purpose of evaluating the influence of various levels of nitrogen on growth and flowering of chrysanthemum cultivar 'White Star'. Different levels of nitrogen N @ (10, 15 and 20 g m^{-2}) along with 0 (control) were used. The results revealed that the highest plant height and chlorophyll content were recorded in the treatment where nitrogen was applied @ 20 g m^{-2} whereas, the earliness in bud appearance, maximum number of flowers per stem, weight of cut flowers, stem and flower diameter, leaf area and longest vase life were observed in the plants fertilized with nitrogen @ 10 g m^{-2}. The optimum dose of nitrogen for improvement of most of the vegetative and floral characters was 10 g m^{-2} and that can be recommended as economic dose for commercial cut flower production of chrysanthemum.

Keywords: Chrysanthemum, Cut flower, Nitrogen, Optimum dose, White Star

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Ornamental horticulture is gaining popularity in India due to modernization, improved standards of living and increased aesthetic sense. Chrysanthemums are also known as 'mums' and belong to the family 'Asteraceae' and scientifically known as *Chrysanthemum morifolium* Ramat. (Doi *et al*., 2004). Chrysanthemum is very popular throughout the India due to its commercial significance and is famous with many local names like 'Queen of East', 'Autumn Queen', *'Guldaudi'*, 'Glory of East' 'Bijli' etc. in different parts of the country (Meshram *et al.,* 2008). There is lot diversity in terms of its growth habit, flower shape, size, colour and keeping quality which led it to acquire a prime position among the top ten floricultural crops all over the world (Desai, 1962). In India, the cultivated area under chrysanthemum is 28.32 thousand ha with loose flower production of 537.56 thousand MT and 18.52 lakh cut stems production (Anonymous, 2022).

Nitrogen plays a major role in plant growth and development because it is responsible for synthesis of assimilatory system of plants which is directly related to the photosynthetic rate of the plant (Kulkarni, 1998). The composition of photosynthetic pigments and enzyme biosynthesis is responsible for the initiation of process of carbon reduction and chloroplast and also involve the nitrogen for their effective functioning (Lishtenthaler and Wellburn, 1983). Proper application of nitrogenous fertilizers in adequate amount helps to reduce environmental hazards as well as also helps in improving the quality and yield from the plants resulting in more economic returns with reduced cost of production (Hera, 1996). It is required for proper growth and development of the plants as it is an important component of proteins and amino acids (Haque and Jakhro, 2001). During the initial growth period of chrysanthemum plants, there is requirement of sufficient application of nitrogen as there is increased uptake of nutrients (Yoon *et al*., 2000). Nitrogen also shows a strong influence on the post-harvest life of the flowers but this influence depends upon the source as well as dose of the nitrogen applied (Druge, 2000). The cut stems quality can be enhanced using the $N\text{-}NH_4$ + / N_2NO_3 ratio that also affects the after harvest keeping quality of stems (Ramos *et al.,* 2013). The post-harvest behavior of cut flowers is adversely affected due to change in physiological conditions because of salt stress, when nitrogen is provided in excessive amount during crop production. However, with increased nitrogen application, there is a subsequent increase in the photosynthetic activity in a linear proportion unless limited by some other factors (Larchar, 1995).

MATERIALS AND METHODS

The present study was conducted at the Research Farm, Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana, Punjab, India. The experiment site is located at a level of 245 meters above mean sea level and at a latitude of $30^0$54' North and longitude of $75^0$48' East. The climate in this region is considered to be subtropical, the temperature can go as down as 5^0C during winters and up to 45-46^0C during summers. The experiment was carried in sandy loam soil having a pH of nearly 8.1 (slightly alkaline). The experiment was laid out during 2018 to 2019 to study the effect of different levels of nitrogen on growth and

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Date of receipt: 13.10. 2023, Date of acceptance: 31.10. 2023

flowering of chrysanthemum cv. "White Star" for two different flowering seasons. The 'White Star' variety of falls under the decorative group with large white-coloured flowers with flattened shape. The upper florets are generally incurved and the lower florets tend to be reflexed. Under this experiment, the variety was grown as standard cultivar to obtain quality cut stems. The mother stock was raised and maintained during the month of February to June, after which the terminal cuttings of uniform length (5-7 cm) were prepared in the month of July and planted in the plug trays for induction of rooting. The cuttings were treated with rooting hormone IBA @ 400 ppm before planting for fast root induction. The rooted cuttings were transplanted in the field in the month of August. After the flowering during the month of November i.e., the first season, the plants were headed back to the base. The plants resprouted in the month of February-March and again flowered during the May 2019 i.e., second season. The experiment was laid out as randomized block design with four treatments and five replications.

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Experimental layout

The beds of 1x1 m^2 size were prepared and rooted cuttings were planted during the month of August 2018 at a spacing of 10 x 10 cm. The four treatments consisted of application of nitrogen @ 0 (control), 10, 15 and 20 g m^{-2} in the form of Urea (46% available nitrogen content) which was broadcasted in between the rows in three equal split doses. The first dose was applied as basal dose at the time of planting and second and third dose was applied at one-month intervals.

Data recorded

The observations on various vegetative and flowering parameters like, plant height at bud appearance,50% flowers open, stem diameter, leaf area, chlorophyll content, days to bud appearance, colour show stage and 50% flowering, number of flowers per stem, flower diameter, weight of cut stem and vase life. Days were counted from the day of planting till the appearance of first bud, buds start showing colour and till the 50 percent of flowers were open respectively. The diameter of the flower (cm) was recorded by measuring the flower size in East-West and North-South directions using a scale and then calculating its average. The diameter of stem (mm) was measured from the middle of the stem using digital Vernier calipers. Weight of cut stem (g) was measured using weighing balance for freshly harvested individual cut stem. Leaf area was measured using graph method. The method used for chlorophyll estimation of leaves was given by Witham *et al*. (1971) using Dimethyl Sulphoxide (DMSO). The vase life was recorded as the number of days till the flower loses its presentable value from the day of harvest. The data recorded was statistically analyzed by using MS-Excel and SAS (Statistical Analysis System) Software developed by SAS Institute, North Carolina. The means were compared using LSD test and the data was analyzed at 5% level of significance.

RESULTS AND DISCUSSION

The effect of nitrogen on various growth characteristics of chrysanthemum cv. "White Star" was found to be significant in all the treatments as compared to control. It is clear from Table 1 that with increased application of nitrogen, there was delay in bud appearance, colour show stage and days taken for 50% flowering whereas earliness in bud appearance, colour show stage and 50 percent flowering was observed when nitrogen was applied @ 10 g m^{-2}. The earliness in bud appearance, colour show stage and 50 percent flowering can be attributed to the fact that with adequate supply of the nitrogen, the vegetative phase of the plants was completed early and enter into the reproductive phase whereas in control, due to inadequate nitrogen supply the plants took longer time to complete their vegetative growth as well as for bud

Table 1. Effect of different doses of nitrogen on days taken for bud appearance, colour show stage and 50 percent flowering in chrysanthemum cultivar "White Star"

Nitrogen dose (g m^{-2})	Days taken for bud appearance		Days taken for colour show stage		Days taken for 50% flower opening	
	First Season	Second Season	First Season	Second Season	First Season	Second Season
0	95.67[a]	87.07[a]	103.19[a]	93.20[a]	111.79[a]	101.67[a]
10	88.20[d]	77.00[c]	93.93[d]	82.73[c]	101.13[d]	89.80[d]
15	91.93[c]	82.67[b]	98.40[c]	89.60[b]	106.20[c]	95.84[c]
20	93.47[b]	84.13[b]	100.73[b]	91.07[b]	108.80[b]	97.53[d]
CD @ 5%	1.09	1.50	1.23	1.69	1.24	1.64
SEm±	0.36	0.48	0.40	0.54	0.41	0.53

(If two treatments have same superscript value it shows that the two treatments responses are at par with each other)

Table 2. Effect of different doses of nitrogen on plant height and number of flowers per stem in chrysanthemum cultivar "White Star"

Nitrogen dose (g m^{-2})	Plant height at bud appearance (cm)		Plant height after 50% flower opens (cm)		Number of flowers per plant	
	First Season	Second Season	First Season	Second Season	First Season	Second Season
0	62.66[d]	73.08[d]	70.29[d]	80.33[d]	4.60 [d]	4.87[d]
10	72.71[c]	81.03[c]	81.74[c]	86.47[c]	10.60 [a]	10.27[a]
15	73.19[b]	85.75[b]	83.57[b]	94.33[b]	7.73[b]	8.07[b]
20	74.99[a]	93.34[a]	86.03[a]	99.24[a]	5.87 [c]	6.20[c]
CD @ 5%	0.75	1.39	1.42	1.05	0.785	0.71
SEm±	0.24	0.45	0.46	0.34	0.252	0.23

(If two treatments have same superscript value it shows that the two treatments responses are at par with each other)

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appearance (Sajid and Amin, 2014). The earliness in bud appearance and flowering was observed by Sharma *et al*. (2006) in chrysanthemum, Sehrawat *et al*. (2003) in marigold and Singh *et al.* (2023) in chrysanthemum.

Plant height as presented in (Table 2) was found to be increasing with the increased doses of nitrogen and the minimum plant height was observed under control where no nitrogen was applied. As represented in Table 2, the highest number of flowers per stem was observed when nitrogen was applied @ 10 g m^{-2}. The reason behind increased plant height with increased nitrogen application may be due to the fact that nitrogen is an important part of chlorophyll and nucleic acids which plays a significant role in promoting plant growth particularly above ground plant growth (Dinesh, 2015). This increase in plant height with increased nitrogen application was confirmed in the work of Dorajeerao *et al.* (2012) in garland chrysanthemum and Gani (2007) in dahlia.

From Table 3, it can be concluded that, maximum flower diameter, stem diameter and cut stem weight during both seasons were observed in treatment where nitrogen was applied @ 10 g m^{-2}. On the other hand, minimum stem and flower diameter, minimum weight of cut stem were observed in the plants under control where no nitrogen was applied at all. The maximum number of flowers per stem with nitrogen @ 10 g m^{-2} application can be attributed to the fact that as a result of nitrogen application, there is increased photosynthesis and food accumulation thus directing the metabolites towards the sink and hence more number of flowers per stem were produced (Verma *et al*., 2011).

Increase in flower size can be due to the reason that with optimum amount of nitrogen, there is optimum supply of nutrient solution especially nitrogen which directly or indirectly enhances the growth by balancing the phytohormones in the plants. This increase in stem diameter might be due to the fact that nitrogen being a component of protoplasm and proteins results in cell multiplication, enlargement and differentiation in the stem due to which stem diameter is increased (Satar *et al.,* 2016). The weight of fresh cut flower is increased due to biomass content and turgidity of the flower. The biomass increased due to the increased vegetative growth as a result of nitrogen application therefore the cut stem weight also increases (Sediqy, 2010).

An increase in chlorophyll content was found with increased levels of nitrogen during both flowering

Table 3. Effect of different doses of nitrogen on flower diameter, stem diameter and weight of cut stem in chrysanthemum cultivar "White Star"

Nitrogen dose (g m^{-2})	Flower Diameter (cm)		Stem Diameter (mm)		Cut Stem Weight (g)	
	First Season	Second Season	First Season	Second Season	First Season	Second Season
0	8.75[d]	3.90[d]	2.58[d]	8.74[d]	17.19 [d]	26.77[d]
10	13.01[a]	10.10[a]	7.24[a]	13.01[a]	30.21[a]	44.53[a]
15	11.91[b]	7.61[b]	5.46[b]	11.91[b]	28.20[b]	41.51[b]
20	10.87[c]	6.18[c]	4.34[c]	10.87[c]	24.76 [c]	36.77[c]
CD @ 5%	0.40	0.47	0.30	0.41	1.42	1.42
SEm±	0.13	0.15	0.09	0.13	0.46	0.46

(If two treatments have same superscript value it shows that the two treatments responses are at par with each other)

Table 4. Effect of different doses of nitrogen on leaf area, chlorophyll content and vase life of chrysanthemum cultivar "White Star"

Nitrogen dose (g m^{-2})	Leaf Area (m^2/plant)		Chlorophyll Content (mg/gm tissue)		Vase Life in distilled water (days)	
	First Season	Second Season	First Season	Second Season	First Season	Second Season
0	1017.40[d]	1528.73[c]	0.85[d]	0.85[d]	14.07[d]	6.67[d]
10	1579.78[a]	2019.77[a]	1.48[c]	1.48[c]	20.07[a]	12.07[a]
15	1392.67[b]	1710.51[b]	1.62[b]	1.62[b]	18.13[b]	9.67[b]
20	1135.24[c]	1712.69[b]	1.83[a]	1.83[a]	16.20[c]	7.53[c]
CD @ 5%	105.84	145.84	0.08	0.08	0.79	0.71
SEm±	34.35	46.81	0.02	0.02	0.26	0.23

(If two treatments have same superscript value it shows that the two treatments responses are at par with each other)

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seasons (Table 4). Maximum chlorophyll content was found in the plants which were applied with nitrogen @ 20 g m^{-2}. In contrast to chlorophyll content, vase life was found to be decreasing with increased levels of nitrogen. The longest vase life was found in the cut stems harvested from the plot fertilised with 10 g m^{-2} nitrogen whereas the least vase life of 6.67 days was found in the control treatment.

The increase in chlorophyll content with the increased nitrogen may be attributed to the fact that nitrogen is an essential part of chlorophyll and nucleic acid, which might have played major role in promoting plant growth**.** Nitrogen is considered to have the ability to increase the number as well as the size of the cells in the leaves which results in overall more leaf production (Meyer *et al.,* 1973; Sigedar *et al.,* 1991) and it was also observed that after an optimum amount of nitrogen uptake, the increase in leaf area was not significant because with the increased application of nitrogen, the uptake and metabolism of the nutrient decrease. The increased vase life at lower doses of nitrogen might be due to the fact that optimum level of nitrogen helps to maintain the sturdiness in the cut stems and therefore less succulence in the cut stem help it to bear the weight of the flower. Moreover, the optimum nitrogen also helps in more accumulation of photosynthates in the stem tissues (Thaneshwari, 2014).

From the above investigation, it can be concluded that the optimum dose of nitrogen for improvement in various vegetative and floral characters was 10 g m^{-2} during both flowering seasons. The plants fertilized with nitrogen @ 10 g m^{-2} were found to have early bud appearance, maximum number of flowers per stem, improved flower and stem diameter and improved vase life of the flowers.

Authors' contribution

Conceptualization and designing of the research work (MB, PS); Execution of field/lab experiments and data collection (NS, MB, PS); Analysis of data and interpretation (NS, MB, PS); Preparation of manuscript (NS, MB).

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