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Assessment of Nitrogen fertigation and plant spacing in Chrysanthemum (Chrysanthemum morifolium Ramat.) cv. Ratlam selection.

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Abstract

The investigations entitled “Studies on plant spacing and fertigation schedule for loose flower production of chrysanthemum (*Chrysanthemum morifolium* Ramat.)” was carried out at Research Farm, Department of Floriculture and Landscaping and Soil and Water Engineering, PAU, Ludhiana during the year 2021-22 with the aim to standardize fertigation level and plant spacing for quality loose flower production. Four different fertigation levels of N@ (60kg/ha, 80kg/ha, 100kg/ha and 120kg/ha) were applied chrysanthemum varietiy namely ‘Ratlam Selection’ through drip irrigation along with three different spacings i.e., 40×30 cm, 40×40 cm and 40×60 cm. The statistical used was Split Plot Design (SPD) and trial was replicated thrice.The data on growth, flowering and yield parameters were recorded and statistically analysed. The data on growth, floral attributes, plant spread (46.70), number of branches (7.80) least days to first flower bud initiation (82.92 days), flower weight (3.22 gm) and highest chlorophyll content (58.57 spad value) was recorded with the application of N@ 120 kg/ha^{-1} with planting distance of 40×60 cm and the maximum flower diameter (7.71 cm) and flowers/plant (138.67) was recorded higher with the application of N@ 100 kg/ha^{-1} with planting distance of 40×60 cm.. Yield attributes such as flowers weight per unit area (m^2), number of flowers per unit area (m^2), were recorded best with treatment N@ 100kg/ha with plant spacing 40×60 cm. Based on the study it can be concluded that fertigation level N@ 100kg/ha was found to be the most suitable for quality production of loose flowers of chrysanthemum with spacing 40×30 cm.

Introduction

Flowers are related to Indian culture and heritage since from the ancient time. Flowers are the most beautiful creation of nature and have ability to attract anyone with delight, love and happiness.. Now a day floriculture industry is flourishing in production as well as trade all over the world. The word ‘Chrysanthemum’ is derived from the two Greek words ‘*Chryos’* meaning gold and ‘*Anthemon’* means ‘flower’ and completely ‘Golden Flower’. It is commonly known as ‘Gul-e-daudi’, ‘Autumn Queen’ and ‘Queen of the East’, belonging to family ‘Asteraceae’ and native of Asia and northern hemisphere especially Europe (Choudhary et al 2021). This flower crop is grown commercially all over the world due to wide diversity with respect to varied colours and hues of flowers, shape and sizes, growing pattern, maturity group and after harvest keeping quality characters. The cultivation of this crop has been reported first time in China and then reached to Japan and other parts of the world for cultivation. Traditionally, yellow and white coloured chrysanthemums are commonly grown for loose flowers and used for garland making and worship purpose. Chrysanthemum flowers can be classified into two categories on the basis of size *viz*., spray and standard type. The spray types are usually grown for loose flower purpose i.e., for social ceremonies, worship purpose, garland making whereas, standards are used for cut flower production, for indoor vase decoration, making bouquet and flower arrangements; pot plant for interior and exterior decoration as well as exhibition purpose. Apart from its exceptional beauty, wide range of colour, size, shape and keeping quality of flowers, easy to propagate have also made it much more popular among the consumers and commercial growers (Bisht et al 2010). These flowers have a

constant demand during the days of festivals, functions and decoration throughout the year. Variety ‘Ratlam Selection’ is a mid to late season variety having spreading type growth habit. Flowers are cream in colour, decorative type and suitable for loose flower production.

The scientific information about the improved agro-technique for successful cultivation of chrysanthemums is not much available and farmers are not able to get more profit per unit area. As is well-known fact that nutrition and planting density are two major important parameters, which ultimately affect the flower yield. Growers facing problem in scientific cultivation of chrysanthemum due to lack of technical information and improved agro-technique like fertilizer dose (Satar et al 2016). Moreover, the soil health is degrading due to over use of fertilizers, insecticides, pesticides and other factor like repeated plantation of one crop in same field. Improper nutrient management leads to the nutrient imbalance in plants and results in lower down the flower yield (Senapati et al 2020). Nitrogen is considered to be the most critical major element for vegetative growth and flower yield in chrysanthemum (Rajan et al 2019). Nitrogen plays an important role within the plant and ensures the availability of energy to grow when and where the plant needs it to optimize yield. It has been established that there is positive correlation between fertilizer usages and flower productivity. In the current scenario, lower productivity and inferior quality of chrysanthemum is due to inefficient use of fertilizers. Chrysanthemum is a shallow rooted crop and nutrient management as well as maintenance of proper moisture level is essential to compensate the evapo-transpiration losses, economic losses and other losses like leaching of salts. Thus, such type of losses can be reduced by adopting micro-irrigation system and the most successful system is drip irrigation that can be adopted in a large number of crops. Drip irrigation is the most efficient method among the all irrigation methods as water is going down directly to the root zone of a crop and this is one of the most economical methods suitable for the high value crops (Solaimalai et al 2005). It is generally known that fertilisation, which combines irrigation and fertiliser application, is the most efficient and practical way to maintain the ideal fertility level and water supply in accordance with the requirements of crop and soil.. Fertigation through drip irrigation supplies the fertilizers directly to the root zone level of plants and nutrient requirement can be met accurately (Neilsen et al 2004). Plant spacing is another important factor that has effective role in growth and development of plants. Plant population has pronounced effect on the vegetative growth and yield of chrysanthemum flowers at its optimum level, it provides for the scope for efficient utilization of solar nutrients to plants (Sahu et al 2021). Too closer spacing may results in greater competition among the plants for nutrients and other inputs and thus flower yield and quality parameters are affected. Too wider spacing results in less flower yield due to insufficient number of plants per unit area. Appropriate plant spacing and balanced fertilization are essential factors to get better plant spread and flower yield. The optimum plant spacing provides favourable conditions to the plant and gives higher flower yield (Ahirwar et al 2012). Consequently, the appropriate nitrogen level and plant spacing remained unclear.

The objectives of this study were: (1) to standardize the nitrogen requirement through drip irrigation for quality loose flower production in chrysanthemum. (2) to standardize the optimum plant spacing for quality loose flower production.

Materials And Methods

Field site

Field experiments were conducted in 2020-21 at Floriculture and Landscaping Experimental Station of Punjab Agricultural University (latitude of 30.9 ^{0} N and longitude of 75.85^{0}E), Ludhiana. The area was humid sub-tropical and a hot semi-arid type of climate summer, monsoon and winter seasons from the month of April to June and humid from July to September and cool months from December - January occasionally with ground frost. The soil texture is light loam. Prior to the experiment, the 0–20 cm topsoil contained 170.60kg/ha available N, 20.40kg/ha available P, 155.50kg/ha available K and soil pH 7.25.

Experimental Design

A split plot design was employed with four Nitrogen fertigation levels i.e. (60kg/ha (N1), 80kg/ha (N2), 100kg/ha (N3) and 120kg/ha (N4) with three spacing levels i.e. (40×30 cm (S1), 40×40 cm (S2) and 40×60 cm (S3) and replicated thrice. Nitrogen was applied in the form of Urea (46% N). Total 16 nitrogen fertigations were given at 4 day interval and irrigation was applied at 2 day interval. The chrysanthemum variety was “Ratlam Selection”. The seedlings were transplanted into the field in the 1st week of August. The plot size was 8 m^{2} (10×0.8 m).

Results

Vegetative characteristics

The effect of increased nitrogen fertigation leveal and plant spacing on chrysanthemum cultivar ‘Ratlam selection’ showed the significant results on vegetative attributes such as plant height, plant spread, branches/plant and chlorophyll content (spad value). The average maximum height (56.78 cm) was recorded in treatment **T10 (N_4S_1)** followed by **T7 (N_3S_1)** (54.95cm) and maximum plant spread (46.70 cm) was observed in **T12 (N_4S_3)** followed by **T9 (N_3S_3)** (46.04 cm) and the minimum plant spread (34.99 cm) was recorded with treatment **T1 (N_1S_1)**. The maximum number of branches (7.80) recorded in treatment **T12 (N_4S_3)** which was at par with **T11 (N_4S_2)** and minimum number of branches (6.00) was observed in treatment **T1 (N_1S_1)** followed by number of branches (6.13) in treatment **T1 (N_1S_1).** The maximum chlorophyll content (58.57 spad value) was recorded in treatment **T12 (N_4S_3)** and the minimum (45.20 spad value) was observed in treatment **T1 (N_1S_1).**

Table 1
Effect of different nitrogen levels and plant spacing on vegetative characteristics of chrysanthemum cv. 'Ratlam selection'

Treatments	Plant height (cm)	Plant spread (cm)	Number of branches	Chlorophyll content (Spad value)
T1 (N_1S_1)	47.73	34.99	6.00	45.20
T2 (N_1S_2)	47.73	35.81	6.13	46.67
T3 (N_1S_3)	48.10	35.80	6.53	47.10
T4 (N_2S_1)	49.17	35.88	6.60	48.73
T5 (N_2S_2)	48.54	37.47	6.80	50.00
T6 (N_2S_3)	50.69	38.73	7.13	50.10
T7 (N_3S_1)	54.95	41.99	7.27	55.13
T8 (N_3S_2)	54.26	42.23	7.40	55.47
T9 (N_3S_3)	54.87	46.04	7.73	57.93
T10 (N_4S_1)	56.78	43.03	7.67	56.20
T11 (N_4S_2)	54.74	45.46	7.77	57.83
T12 (N_4S_3)	54.03	46.70	7.80	58.57

Floral Characteristics

The flowering parameters included days to first flower bud initiation, flower diameter, flower weight, number of flowers and total yield, the observations recorded on flowering parameters are given in Table 2.

During the 2020-21 year of experimentation, significantly an early flower bud initiation was noticed in N@ 120kg/ha with plant spacing 40×60 cm (82.92 days) however, highest days to first flower bud initiation from transplanting were recorded in the **T1 (N_1S_1)** i.e. N@ 60kg/ha with plant spacing 40×30 cm. The highest flower diameter (7.71 cm) was observed in treatment **T9** with N@ 100kg/ha and plant spacing 40×60 cm which was at par (7.61 cm) with N@ 120kg/ha with plant spacing 40×60 cm. In contrast the minimum flower diameter (6.71 cm) was recorded in treatment **T1 with N_1S_1**. Nitrogen was found most effective in increasing the flower weight. The maximum flower weight (3.22 gm) was recorded with combination of N@ 120kg/ha with plants spaced at 40×60 cm followed by (3.07 gm) with N@ 120kg/ha with plant spacing 40×30 cm and the minimum flower weight (2.45 gm) was recorded in **T1** with combination of **N_1S_1** i.e. N@ 60kg/ha and plant spacing 40×30 cm. The effect of different levels of

nitrogen and plant spacing and their interaction was found to be significant on number of flowers per plant. Significantly maximum flowers per plant were noticed with higher nitrogen level under wider spacing. The treatment combination N_3S_3 i.e. N@ 100kg/ha with plant spacing 40×30 cm recorded the highest number of flowers per plant (138.67), followed by N_3S_2 (135.52) and the minimum number of flowers per plant (105.82) recorded in T1 with combination of N@ 60kg/ha and plant spacing 40×30 cm.

The N@ 100kg/ha and plant spacing 40×30 cm had recorded significantly maximum flower yield (105.07 q/acre) which was followed by N@ 120kg/ha and plant spacing 40×30 cm (97.67 q/acre). However, significantly minimum flower yield (40.02 q/acre) was recorded with in **T3** i.e. N@60kg/ha with plant spacing 40×60 cm.

Table 2
Effect of different nitrogen levels and plant spacing on floral characteristics of chrysanthemum cv. 'Ratlam selection'

Treatments	Days to bud appearance (days)	Flower diameter (cm)	Flower weight (g)	Number of flowers	Total yield (q/acre)
T1 (N_1S_1)	87.08	6.71	2.45	105.82	70.64
T2 (N_1S_2)	87.17	6.91	2.51	108.31	65.12
T3 (N_1S_3)	86.83	7.12	2.58	110.66	40.02
T4 (N_2S_1)	86.42	7.26	2.59	116.23	81.87
T5 (N_2S_2)	86.33	7.29	2.72	119.02	66.80
T6 (N_2S_3)	85.83	7.34	2.78	123.05	48.04
T7 (N_3S_1)	85.50	7.26	2.97	129.95	105.07
T8 (N_3S_2)	84.42	7.57	2.99	135.52	83.48
T9 (N_3S_3)	84.25	7.71	3.04	138.67	59.13
T10 (N_4S_1)	83.33	7.27	3.07	116.73	97.67
T11 (N_4S_2)	83.33	7.55	3.06	120.93	76.24
T12 (N_4S_3)	82.92	7.61	3.22	122.87	55.54

Discussion

Application of N fertilizer is one of the most important cultivated measures to increase loose flower production in chrysanthemum. Higher level of nitrogen and closer plant spacing increases the plant height. Plants grown with spacing 40×30 cm has maximum plant height, the reason might due to

insufficient space available for plant spread and active competition between the plants for light and aeration under closer spacing treatment resulting into more vertical growth. In the case of calendula, similar outcomes were also observed by (Jadhav *et al* 2014). The maximum height of plants was noted under 100kg nitrogen per hectare followed with use 120kg nitrogen per hectare due to an increased uptake of nutrients. Being nitrogen is a constituent of protein and component of chlorophyll. The similar results were also reported by (Satar et al 2016) an application of 200kg nitrogen per hectare. High amount of nitrogen promotes the vegetative growth of plants and imparts green colour to vegetative phase of plants. Similar findings in chrysanthemum have also been reported by (Rajan et al 2019). Different plant spacing levels showed the significant results with respect to plant spread. The variation in plant spread by the use of different nitrogen levels and plant spacing might be due to the reason that, wider spacing provides the favourable growing conditions for growth of roots and shoots which ultimately help in higher uptake of nutrients. Similar views have also been expressed in chrysanthemum by (Kedar et al 2022). Plants grown with spacing 40×60 cm has maximum number of branches. The reason might be due to sufficient space available for plant spread and sufficient amount of nutrients available for widely spaced plants for vigorous growth of plants with maximum number of branches (Jadahv *et al* 2014) registered with the wider spacing of 30×30 cm in calendula. The possible reason for the increase in number of branches at wider spacing can be due to availability of nutrients at different stages of plant growth through fertigation. The similar results in chrysanthemum were also reported by (Choudhary et al 2021). Chlorophyll content increases with the increase of fertilizers levels. It might be due to the fact that nitrogen is a essential constituent of chlorophyll molecule and participate in amino acid formations and an increased supply of nitrogen accelerate high synthesis of chlorophyll. Similar findings were also reported in chrysanthemum by (Jawaharlal and Ganesh 2020). The least days to bud initiation (82.11 days) was recorded in plants grown application of 120kg/ha. The positive effect of nutrients supplied through drip fertigation on earliest bud appearance might be due to the fact that nitrogen accelerates the reproductive phases, increases the protein synthesis and hence promotes the earlier floral primordial development. Similar views have also been expressed by (Choudhary et al 2021) in chrysanthemum. Use of 100kg nitrogen per hectare followed by 120kg nitrogen per hectare recorded as the optimum nitrogen doses for maximum flower diameter this is in conformity with the work done by (Satar et al 2012), and the variation in flower diameter with different levels of nitrogen might be due to increased photosynthetic activity, better vegetative growth of plant and optimum nitrogen dose might have developed better quality flowers on the plants. The current findings showed that plants with the greatest distance between them had flowers with the largest diameters. This might be because plants with greater distances between them can better absorb the ideal amount of nutrients and receive enough light to improve photosynthesis and the movement of assimilates into storage organs. Other researchers have concurred with these findings in the study of Asiatic lilies (Swetha et al 2018). The flower weight increases with the increasing of nitrogen levels. It might be due to the reason that abundant nitrogen accelerated the photosynthetic activity of plant and thus more assimilates might have been available for flowers to develop and might have resulted in increased cell divison and cell expansion of flower tissue, the ultimate effect of which was resulting in increased flower weight in chrysanthemum. Also in the chrysanthemum, similar findings were reported by (Joshi et al 2013). The reason for variation in number

of flowers with different level of nitrogen and planting distance may be due to the excessive vegetative growth that may transform into reproductive growth and high nitrogen appears to favours to the flower development. Higher level of nitrogen produced the highest yield of flowers was also reported by (Satar et al 2016) in chrysanthemum and (Kumar et al 2018) in marigold.. The wider spacing resulted into the production of more flowers per plant might be attributed to more vegetative growth of plants due to the availability of maximum nutrients to plants, sunlight and soil moisture in widely spaced plants. (Jadhav *et al* 2014) also recorded the similar findings with wider spacing 30×30 cm in calendula. These findings also get support from other scientists such as in chrysanthemum (Sahu et al 2021). Higher yield of flowers in chrysanthemum was recorded to the treatment receiving the higher dose of nitrogen i.e. 100kg N/ha. A similar increase in flower yield due to higher dose of nitrogen (150 kg N ha-1) was also recorded by Sehrawat et al (2003) and by Baboo *et a.* (2005) in African Marigold.

Conclusion

The interaction effect of nitrogen levels and plant spacing also found significant. The data on growth, floral attributes, plant spread (46.70), number of branches (7.80) least days to first flower bud initiation (82.92 days), flower weight (3.22 gm) and highest chlorophyll content (58.57 spad value) was recorded with the application of N@ 120 kg/ha^{-1} with planting distance of 40×60 cm and the maximum flower diameter (7.71 cm) and flowers/plant (138.67) was recorded higher with the application of N@ 100 kg/ha^{-1} with planting distance of 40×60 cm.. Yield attributes such as flowers weight per unit area (m^2), number of flowers per unit area (m^2), were recorded best with treatment N@ 100kg/ha with plant spacing 40×60 cm. Based on the study it can be concluded that fertigation level N@ 100kg/ha was found to be the most suitable for quality production of loose flowers of chrysanthemum with spacing 40×30 cm.

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Figures

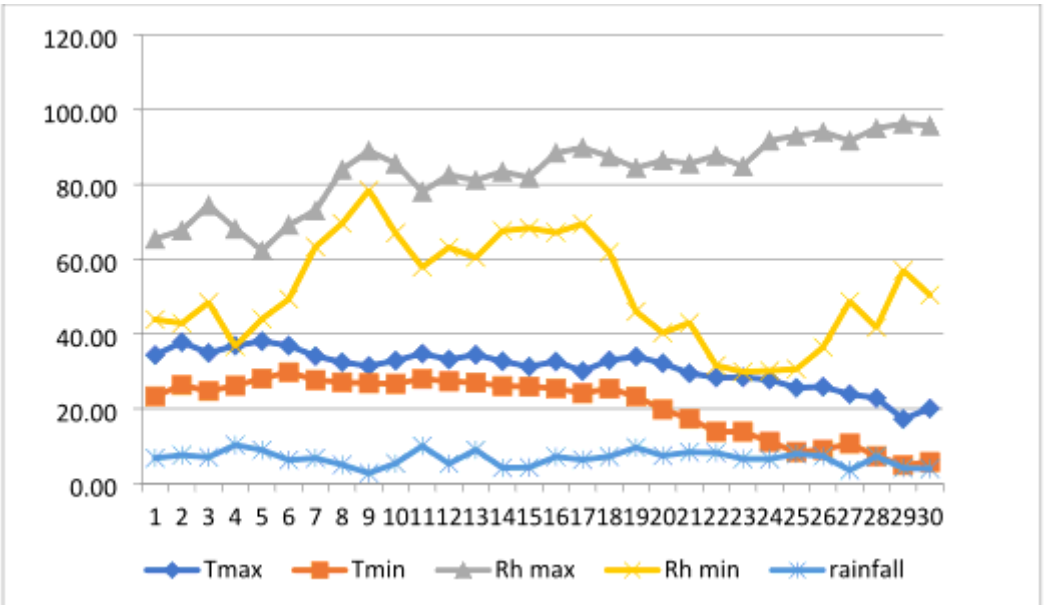


Figure 1

Rainfall, relative humidity, max temperature and mini temperature during the growing season of chrysanthemum cv. 'Ratlam selection'