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Assessing the influence of planting time and fertilization on growth, flowering, yield and soil properties of chrysanthemum

Objectives: To identify optimal planting time for maximizing growth and flowering, and assess the impacts of various fertilization techniques on plant growth and soil health in chrysanthemum.

Methods: The investigation was conducted at Dr. Y.S. Parmar University of Horticulture and Forestry in Nauni, Solan, Himachal Pradesh, India from 2022 to 2023.[0] The study aimed to investigate the impact of various planting times and fertilization schedules on the yield, quality, and soil health characteristics of chrysanthemum. Different planting times from 15 June to 30 August under organic and inorganic fertilization regimes were evaluated.[4] Data related to vegetative growth, flowering, soil chemical and biological properties were recorded.

Results:[0] Planting on 15 June along with inorganic fertilization resulted in improved vegetative characters like plant height (74.37 cm) and plant spread (30.56 cm), flowering characters like cut flower stem length (64.07 cm), stem strength (10.40°), flower diameter (11.80 cm) and duration of flowering (22.[0]50 days) and soil chemical properties like available N, P, K (326.53, 40.36 and 359.48 kg/ha, respectively). However, planting on June 15 combined with organic fertilization led to enhancement in soil microbiological properties, including bacterial count (138.33 cfu/g soil), fungal count (31.75 cfu/g soil), actinomycetes count (62.46 cfu/g soil), microbial biomass (52.62 µg/g soil) as well as vase life (19.70 days).

Conclusion: In the present study, it was found that planting time and fertilization significantly impacted chrysanthemum growth, yield and soil properties. The 15 June planting with inorganic fertilization boosted growth, yield and macronutrient content, while organic fertilization on the same date enhanced soil microflora. Flowering was influenced by planting time and organic fertilization showed promise as an alternative to chemical fertilization. Optimizing planting schedules and using organic fertilizers would lead to sustainability and offer economically viable alternatives to conventional crop management.

Keywords:[2] Chrysanthemum, Cut flower, Sustainable farming, Soil health, Yield and Quality

Introduction

Chrysanthemum is one of the most important flower crops in Asteraceae family and holds significant value for its varied forms, vibrant colors and prolonged vase life (Mekapogu et al., 2022). It occupies the second position among the top ten cut flowers after the rose (Darras, 2021). Chrysanthemum holds economic significance in India as it has a major share in the export market along with supporting the local economies of the country.

Chrysanthemum plant, classified as a qualitative short-day plant, has a restricted availability period of around 13 weeks (Van-Der Ploeg and Heuvelink, 2006). Synchronous planting of it can lead to an oversupply in the market, resulting in decreased prices. By implementing planting date scheduling, market volatility can be mitigated through controlled bloom periods, thereby, increasing demand and yielding higher market prices.

Optimal fertilizer application is crucial for plant development, growth and quality (Fageria et al., 2008). Intensive farming and use of agrochemicals cause environmental pollution, impacting human health (Mandal et al., 2020). The shift towards organic agriculture emphasizes ecosystem health and the demand for chemical-free products (Pandey and Singh, 2012). Organic manure provides essential nutrients and enhances the soil physico-chemical and biological properties (Yamada and Xu, 2001).

Jeevamrit, an organic amendment rich in macro and micronutrients and beneficial microorganisms, enhances soil biological activity and nutrient availability, promoting crop growth and environmental sustainability (Rathore et al., 2023). Supporting eco-friendly practices reduces the costs of chemical fertilizers and pesticides and boosts production economics, benefiting small and marginal farmers (Saharan et al., 2023).

This study analyses the impact of planting time and nutrition on chrysanthemum production and quality, hypothesizing that inorganic fertilization boosts growth and yield, while organic fertilization enhances soil microflora. Furthermore, planting time can be manipulated to regulate flowering times. Previous studies have primarily focused on the individual effects of planting time or fertilization types on chrysanthemum cultivation. However, there is a lack of comprehensive research that integrates these factors to provide a holistic understanding of their combined impact. This study addresses this gap by simultaneously examining the effects of planting time and different fertilization methods, thus contributing to a more nuanced understanding of chrysanthemum cultivation.

Material and Methods

Experimental site: [0]The study was carried out at the experimental farm of Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, India in 2022 and 2023. The farm is situated at an elevation of 1,276 meters above mean sea level, at coordinates 30°51'0" N latitude and 77°11'30" E longitude (Fig. 1).

Planting material: Shoot tip cuttings of chrysanthemum cv. ‘Purnima' were prepared from a healthy mother block by following standard practices. Rooted cuttings were used for transplanting.

Experimental conditions:

The experimental field was ploughed up to a depth of 0.30 m. Well-decomposed farmyard manure (FYM) was incorporated @ 5 kg/m². Raised beds, each measuring 1 m² and 6 inches in height, were prepared. Cuttings were planted on different dates with 15 days intervals. For inorganic fertilization, a basal dose of 30 g/m² NPK was applied during bed preparation (half of the dose of N, along with full doses of P and K, was applied). The remaining half dose of N (15 g/m²) was added to the soil 45 days after planting. For organic fertilization, Jeevamrit was applied via drenching @ 30 ml/plant, beginning 30 days after transplanting, using a 1:4 dilution ratio.

[2]The experiment was laid out in a randomized block design (RBD) with 12 treatments, each replicated thrice, in a factorial arrangement (Fig. 2). The factors included planting time (P_1: 15 June, P_2: 30 June, P_3: 15 July, P_4: 30 July, P_5: 15 August, P_6: 30 August) and fertilization regimes (FM_1: Jeevamrit at 30 ml plant^{-1}, FM_2: NPK at 30 g/m²). Planting at 30 cm × 30 cm spacing included 9 plants/m² for June and July plantings, and 49 plants/m² for August plantings. Pinching was done only in plots with 9 plants/m², promoting multi-stemmed branching, while no pinching was done in plots with 49 plants/m².

Vegetative and flowering characteristics

Data were collected on randomly selected five plants from each replication and different vegetative characters (such as plant height and spread, measured with a metre rod) and flowering attributes (days taken to bud formation and stage of harvesting) were observed from the date of planting. The number of cut stems per plot was counted manually, cut flower stem length using a metre rod, flower diameter using vernier calipers; stem strength as deviation angle when placed horizontally, vase life in distilled water under room temperature and duration of flowering at harvesting of 1st cut stem till the harvesting of last cut stem).

Chemical Properties

Soil samples were taken from the study area at a depth of 0 to 15 cm before laying out the experiment. Soil pH and EC were measured using 1:2 soil water suspension and were found 6.85 and 0.34 dS/m, respectively (Jackson, 1993). Soil organic carbon was determined as per Walkley and Black (1934) which was 0.92% (rapid titration method). Available nitrogen was found 292.76 kg/ha (Subbiah and Asija, 1956). Available phosphorus was recorded 27.48 kg/ha (Olsen et al., 1954) and available potassium was recorded 315.84 kg/ha (Merwin and Peech, 1951).

Soil Microbial Attributes

Microbial quantification was performed using the serial dilution standard spread plate technique on three different media: nutrient agar, potato dextrose agar and Kenknight and Munaier's medium, following the protocol outlined by Subbarao (1995). The microbial population was quantified as colony-forming units per gram of soil. Additionally, microbial biomass-C was assessed using the soil fumigation extraction method given by Vance et al. (1987).

$$\text{Microbial biomass – C } (\mu g/g \text{ soil}) = \frac{EC\,(F) - EC\,(UF)}{K}$$

Where, K: 0.25 ± 0.05 (a measure of the effectiveness of microbial biomass carbon extraction), EC (F): Amount of extractable carbon in soil samples post-fumigation, EC (UF): Total extractable carbon in un-fumigated soil samples

The dehydrogenase activity in liquid formulations was calculated using the 2,3,5-triphenyl tetrazolium chloride reduction method (Casida et al., 1964) and phosphatase activity was measured according to the procedure detailed by Tabatabai and Bremner (1969).

Statistical Techniques and Analysis

The data collected during the two years of experimentation in 2022 and 2023 were pooled and analyzed using SPSS statistics.[1] Analysis of variance (ANOVA) was performed on the pooled data employing randomized block design (RBD) and the treatments were compared using the critical difference at 5% level of significance.

Results:

Vegetative and flowering characteristics:[1]

Planting time and fertilization regimes had a significant effect on vegetative characteristics of chrysanthemum (Table 1). Among different planting times, highest plant height (71.06 cm) and spread (29.[1]06 cm) were observed in P_1 as compared to other planting dates. FM_2 recorded the higher plant height (53.93 cm) and spread (20.57 cm) over FM_1 which recorded plant height of 47.79 cm and plant spread of 18.46 cm. Under the interaction effect, highest plant height (74.37 cm) and spread (30.56 cm) were recorded under P_1xFM_2.

Data embodied in Table 1 show that the earliest bud formation (32.45 days) and time to reach the harvesting stage (79.58 days) were recorded in P_6. Maximum cut stems/plot (49.00) were recorded under P_5 and P_6. Maximum stem length of cut flower (61.00 cm), flower diameter (11.03 cm), stem strength (10.83^{o}), flowering duration (21.50 days) and vase life (18.92 days) were observed under P_1.

Earlier bud formation (61.85 days), lesser period taken to reach the harvesting stage (110.20 days) and more cut stems/plot (41.18), stem length of cut flower (46.09 cm), flower diameter (9.95 cm), stem strength (13.53^{o}) and flowering duration (19.58 days) were observed in FM_2. FM_1 recorded higher vase life (17.97 days).

The interaction effect of dates of planting and fertilization regimes revealed that the earliest bud formation (31.[2]87 days) was observed in P_6xFM_2. Maximum flower diameter (11.80 cm) was recorded in P_1xFM_2 and vase life (19.70 days) in P_1xFM_1.

Soil chemical properties:

[0]Maximum available N, P and K (318.81, 38.08 and 352.47 kg/ha, respectively) was observed in P_1 in comparison to all other planting times (Fig. 3). FM_2 resulted in maximum available N, P and

K (321.71, 38.48 and 353.29 kg/ha, respectively) (Fig. 4). The interaction was found non-significant (Fig. 5).

During both study years, fertilizer regimes and planting days had non-significant effects on soil pH and EC (Fig.6-8). Among different planting time, maximum OC (1.14%) was observed in P_1 planting compared with all other planting time (Fig. 6). Organic fertilization recorded maximum OC (1.13%) (Fig. 7). The interaction effect on OC was found to be non-significant (Fig. 8).

Soil microbiological properties:

[6] Data presented in Table 2 show that planting time had a non-significant effect on all the soil microbiological properties. Among different planting times, maximum dehydrogenase enzyme was recorded in P_1 (3.69 mg TPF/h/g/soil, respectively). Maximum phosphatase enzyme (24.20 mmole PNP/h/g/soil, respectively) was recorded under P_1.

Fertilization had a significant effect on soil microbial properties and data reveal that more bacterial, actinomycetes and fungal counts (133.09, 61.58 and 31.26 cfu/g soil, respectively), microbial biomass (51.85 µg/g soil) and, dehydrogenase and phosphatase enzymes (3.81 mgTPF/h/g soil, 22.52 mmole PNP/h/g soil, respectively) were recorded in FM_1. [0] The interaction effect had no significant effect on all the soil microbiological properties

Discussion:

Vegetative and flowering characteristics:

Delayed planting in chrysanthemums shortened the bud formation and flowering period, whereas, early planting extended the juvenile phase, delaying flower initiation. Early-planted crop benefited from prolonged optimal long-day conditions, enhancing vegetative growth, compared to those planted later. A study on chrysanthemum cv. Aparajita found that early plantings enhanced vegetative growth (Kishore et al., 2023).