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Can organic Fertilizer be Equivalent to Inorganic Fertilizer for Quality Production of Annual Chrysanthemum and Soil Enrichment?

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ABSTRACT

The investigation was carried out at the experimental farm of Dr YSPUHF Nauni, Solan (HP), India during 2020-22. It aimed to identify the optimal treatments for enhancing the growth, flowering and quality seed production of Glebionis coronaria and enriching the soil health. The experiment encompassed 9 treatments namely T_1 (jeevamrit @ 5%), T_2 (jeevamrit @ 10%), T_3 (jeevamrit @15%), T_4 (jeevamrit @ 20%), T_5 (jeevamrit @ 25%), T_6 (jeevamrit @ 30%) and T_7 (jeevamrit @ 35%) at 15 days intervals, T_8 (RDF) and T_9 (control) were laid out in RBD with three replications. It was observed that better outcomes in terms of vegetative, flowering and seed yield parameters were recorded in T_8 (RDF) but were found to be statistically at par with the results obtained in T_7 (jeevamrit @ 35%) followed by T_6 (jeevamrit @ 30%). Also, the utilization of organic farming products (T_6 and T_7) has played a vital role in flourishing the soil with a vast group of advantageous soil microbiota (bacteria, fungi and actinomycetes) and soil macro-nutrients than inorganic fertilizers (T_8 RDF). Despite the effectiveness of RDF in enhancing growth and yield, its long-term environmental impact and declining soil health raise concerns, necessitating sustainable alternatives like organic amendments. Therefore, with changing climatic conditions and improving agricultural sustainability and soil health this paper provides a step towards the integration of chemical inorganic and organic fertilizers. Thus, not only improving the vegetative and flowering capacity of the plant but improving the soil microbiome and long-term productivity thereby leading to sustainable ecofriendly agriculture.

Keywords: *Glebionis coronaria, Jeevamrit, RDF, PCA, Correlation, Inorganic fertilizer, Annual chrysanthemum, Natural farming, Seed productivity.*

Introduction

Annual chrysanthemum (*Glebionis coronaria* (L.) Spach) also known as 'garland chrysanthemum' and crown daisy is an important winter season annual that belongs to the family Asteraceae, a commercially cultivated flower in South India and native to the Mediterranean region[3]. Annual chrysanthemum is commercially propagated through seeds which are in great demand. Chrysanthemum flowers are rich in phenolic compounds and exhibit strong properties including antioxidants, antimicrobial, anti-inflammatory, anticancer and anti-cholesterol properties[25]. It thrives very well under clement or slightly cold climates but will go hastily into premature flowering if cultivated under warm summer conditions[24]. It has special importance during the festival seasons and is in great demand during various functions and weddings. It is gaining popularity among farmers mainly since it is a short-duration crop with wider adaptability and ease in cultivation, besides less photosensitive. Hence, capable of producing quality blooms around the year.

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The annual chrysanthemum is a robust plant attaining a height of about 100 to 140 cm. The leaves are lanceolated and the flower size varies from 3 to 6 cm depending upon the varieties, species and other edaphic factors. The flower color is usually white or yellow with a cream zone at the center exhibiting single, semi-double to fully double types[21].

The seed yield and quality of annual chrysanthemums are greatly impacted by macro and micronutrients. It is usually cultivated by using inorganic nutrients and plant protection sources of chemical origin that are detrimental to living beings, their surrounding environment as well as the health of the soil. In addition, philandering use of such sources of macro and micronutrients and plant protection chemicals under the laborious system of crop production resulted in the availability of inconsistent amounts of nutrients in the solum leading to severe effects on the growth of plants and their flowering behaviour including yield and quality of seeds too. The significant research of many scientists has proved that extensive sole use of inorganic chemical fertilizers has gradually decreased soil fertility which has led to soil acidification in India and affected agricultural sustainability[2,18].

In organic farming systems, the necessity for nutrients and their derivatives to safeguard crops from attacks by insects, pests and pathogens is typically met through farm-produced substances such as beejamrit, jeevamrit, drekastra and brahamastra[18]. It is well documented that the jeevamrit enriches the solum with macronutrients, vitamins, some amino acids and bio-regulators like gibberellic acid (Ga_3), auxin (IAA) and cytokinins alongside some beneficial micro-organisms which contribute not only for enhancing the growth and flowering but also ensured the production of the quality seeds in various crops, besides improving the soil health and ecology[20]. Now a days consumers go for organic food products similarly it is a need to integrate organic farming in floriculture to produce healthy crops and ensure long-term soil health. There is a huge gap in research pertaining to organic farming for floricultural crops which occupies an essential role in agriculture, especially in industries such as cosmetics, pharmaceuticals, nutraceuticals, poultry, perfumery, etc. The agro-climatic conditions of the western Himalayas of India are highly conducive for cultivating flower seeds of better quality. The sustainable cultivation of annual chrysanthemums in terms of loose and cut flowers as well as excellent quality seed production by employing organic farming seems to be one of the most viable alternatives to replace the farming systems based on chemical fertilizers and pesticides. This approach not only promotes environmental sustainability but also the cost of production[4]. Keeping in view these facts, the present study was planned to assess the impact of jeevamrit applications for enhancing the quality production of annual chrysanthemum (*Glebionis coronaria* (L.) Spach) in mid hills of the western Himalayas of India.

Materials and methods

The experiment was conducted during 2020-21 and 2021-22 for two years on the annual chrysanthemum *Glebionis coronaria* (L.) Spach cv. Open pollinated 'Mix' in the winter seasons at the experimental farm of the Department of Seed Science and Technology, Dr. Yashwant Singh Parmar, University of Horticulture and Forestry, Nauni, Solan, H.P, India. It is situated in hilly areas of the western Himalayas of India at an altitude of 1,060 m above mean sea level having a latitude of 30°51'0" N and a longitude of 77°11'30" E. The climate of the area is typically semi-temperate with average temperature ranging from 9 to 25°C, at 67% humidity and 75 mm rainfall. The field experiment comprising 9 treatments was laid out in Randomized Block Design having three replications. 27 plots of 1 x 1 m^2 size were laid out and 9 plants at a spacing of 30 x 30 cm were planted in them. Healthy, disease-free free and sturdy seedlings of uniform size and vigour at 5-6 leaf stage were selected and transplanted in the beds. The following were the composition of treatments applied in the field:

Treatments	Treatment details
T_1	Drenching with jeevamrit @ 5%
T_2	Drenching with jeevamrit @ 10%
T_3	Drenching with jeevamrit @ 15%
T_4	Drenching with jeevamrit @ 20%
T_5	Drenching with jeevamrit @ 25%
T_6	Drenching with jeevamrit @ 30%
T_7	Drenching with jeevamrit @ 35%
T_8	RDF (40g N/m^2 + 20g P/m^2+ 30 gK/m^2 with 5Kg of FYM/m^2)
T_9	Absolute control

All other intercultural operations of organic farming are common in all treatments viz. achhadan (mulching), beejamrit (organic seed coating), whaapsa (moisture retention), intercrop plantation of sweet pea as well as spraying of Drekastra @ 2.5%, Brahmastra @ 2.5% and sour buttermilk @ 0.3% at 7 days interval.

For preparation of jeevamrit fresh dung (10 kg) and urine (10 L) of (desi) local cow was taken and mixed thoroughly in water (200 L).

Then carefully brown sugar (jaggery) (2 kg), pulse flour (2 kg) and undisturbed soil (handful) were mixed into the solution. After thorough mixing of the various ingredients, continuous stirring was done properly two times a day for 4-5 days. On the fifth day, the solution was filtered using muslin cloth and the filtrate was ready for soil drenching. The applications of jeevamrit commenced after 15 days of post-transplantation as per the treatment protocols and they were withheld when the seed started to mature.

For the preparation of drekastra, the fresh cow dung (1 kg) and urine, (5 L) of the local cow was added in tub containing water (100L). Manually the drek leaves (*Melia azedarach*) (5 kg) were crushed and added to the above mixture. Thorough stirring of the solution was done thrice a day in a clockwise direction with a wooden stick. The solution was kept for 48 hrs. to ferment. After the completion of fermentation, the solution was filtered using muslin cloth and used as per the treatment module. For preparation of Brahmastra crushed leaves of neem (*Azadirachta indica*) (5 kg), custard apple (*Annona reticulata*) (2 kg), papaya (*Carica papaya*) (2 kg), pomegranate (*Punica granatum*) (2 kg) and guava (*Psidium guajava*) (2 kg) was mixed in tub containing cow urine (10L). The ingredients were mixed thoroughly and boiled 4 times until it was reduced to half of the previous quantity. The solution was allowed to settle for 48 hrs and then filtered using a muslin cloth. Drekastra and Brahmastra were each administered at a concentration of @ 2.5 % along with sour buttermilk @ 0.3 % at 7 days intervals as per the treatments for controlling the insectpests harboring the crop. Sour Buttermilk "Lactic acid bacteria" (LAB) refers to a large group of bacteria, rather than a single species or strain, that produce lactic acid as a by-product of digesting their food source (usually carbohydrates). Take the fresh buttermilk and let it for fermentation for 6 days in an earthen pot. Add 6 litre of fermented buttermilk in 100 litre of water. In addition, 250 g ginger (*Zingiber officinale*) and 250 g green chili (*Capsicum annum*) paste can also added to increase the efficiency[12].All the plant material was locally sourced from the university and annual chrysanthemum seeds were provided from the Department of Floriculture and Landscape Architecture, of Dr. YSP, UHF, Nauni, India.

For the inorganic fertilization module, following the preparation of beds, the basal dose of chemical fertilizer was incorporated. Half of the nitrogen (N) dosage, the entire phosphorus (P) and potassium (K) dosage were applied at the initiation of bed preparation as the basal dose. The remaining half of the nitrogen was incorporated into the soil 45 days after transplanting. Urea, muriate of potash (MOP), and single super phosphate (SSP) served as nutrient sources. Standard cultural operations were meticulously followed to cultivate a healthy crop throughout the experiment. Pinching was performed at the 5–6 leaf stage, 30 days post-transplanting, to induce lateral branching. Irrigation was conducted twice weekly during the winter and on alternate days during the summer (up to 8 cm depth). At the conclusion of each year's experiment, plants were uprooted, and fresh planting was undertaken for the subsequent year's experiment using seeds collected from the previous year.

Vegetative, flowering, and seed yield parameters

For every replication and treatment, five plants were randomly selected and all the vegetative parameters (plant height and spread) and flowering parameters (days taken to flowering, duration of flowering, the diameter of flower heads (cm), number of flower heads per plant) were noted at the proper stage of data collection. Plant spread was recorded at the time of peak flowering as the average distance between the outermost side shoot in east to west direction and the distance between the outermost side shoot in north to south direction[18]. A digital vernier caliper was used for parameters such as flower diameter. Data collection on seed yield parameters (number of seeds per head per plant and seed yield per plant per plot (g) done after harvesting. Seed counting was done by IndoSaw seed counter and seed yield (g) was measured by weighing balance.

Soil sampling

After laying out the experiment, random soil samples were collected by auger from the different plots of the experimental field from a depth of 0-15 cm to judge the fertility status of the soil. Then, the composite sample was prepared and analyzed for various soil characteristics in order to obtain information about the physico-chemical status of the soil. The methods employed for available nitrogen[23], available phosphorus[17] and available potassium was measured using the method outlined[16].

Microbiological properties of soil

The data on quantification of viable microbial count (cfu/g) of soil samples was recorded after completion of the experiment by adopting the serial dilution standard spread plate technique[22] on nutrient agar (NA) medium for bacteria, potato dextrose agar (PDA) medium for fungi and Kenknight & Munaier's medium for actinomycetes. The population was expressed in terms of colony-forming units (cfu) per gram of soil.

Statistical Analysis

The statistical analysis for Randomized Block Design (RBD) was done as per the design of the experiment as recommended by Gomez and Gomez[10]. MS Excel was used to analyze the data collected. Principal component analysis was performed as proposed by Jeffers[13]. A bi-plot display of the first two components was used for grouping genotypes illustrating the relationship between genotypes and indices[26]. The parameters studied were subjected to DMRT (Duncan Multiple Range Test)[8] at 5% level of significance and Pearson correlation coefficient analysis was subjected using the statistical software General R-based Analysis Platform Empowered by Statistics 1.0.0.[11]

Results and discussion

Vegetative parameters

From the study (Table 1.) it is clearly depicted that the various treatments based on the application of jeevamrit and RDF have an applicable impact on growth, flowering and seed parameters of (*Glebionis coronaria*). The maximum plant height (94.65 cm) as well as plant spread (41.13 cm) is measured in T_7 (Jeevamrit @ 35%) which is statistically at par with T_8 (RDF) (95.92; 42.68 cm), T_6 (Jeevamrit @ 30%) (93.47; 40.36 cm) and minimum in T_9 i.e. (absolute control) (74.91; 29.76 cm), respectively.

Flowering and seed yield parameters

The minimum days taken to flowering (85.63 days) and duration of flowering (35.75 days) was observed in T_9 (absolute control) which was at par with T_1 (Jeevamrit @ 5%). The maximum days taken to flowering was observed in T_8 (RDF) (97.85 days) and T_7 (jeevamrit @ 35%) (96.75 days).

The T_7 (jeevamrit @ 35%) treatment obtained the uppermost values for duration of flowering (50.99 days), diameter of flower heads (4.47 cm), followed by T_8 (RDF). The T_8 (RDF) showed the maximum number of flower heads per plant (262.38), number of seeds per head (240.02), seed yield per plant per plot (9.88; 88.92 g) which was found statistically at par with T_7 (jeevamrit @ 35%) followed by T_6 (Jeevamrit @ 30%).

The differences observed due to fertilization can be explained by the quick availability of essential nutrients, especially nitrogen, phosphorus and potassium, provided by inorganic fertilizers, which facilitates faster uptake and utilization by plants[15]. Thus, the combination of applied NPK through RDF exhibits improved growth and yield parameters. The findings are proven in inchrysanthemum[1] and marigold[6]. It is a well-established fact that jeevamrit contains all the macronutrients *viz*., N (0.16%), P (0.02%) and K (0.12%), micronutrients, majority of vitamins and amino acids including some phytohormones namely GA_3, cytokinins and IAA[4]. However, the organic fertilization method using Jeevamrit, despite being nutrient-rich, may release nutrients more slowly and exhibit variability in nutrient composition compared to inorganic sources. Still the higher doses of jeevamrit increased the nutrients in the soil due to the significant bio mechanisms of beneficial microorganisms (bacteria, fungi and actinomycetes) leading to solubilization of nutrients and their conversion from non-available form to easily available forms. Subsequently, the plants grew better which was significantly comparable to inorganic fertilizers as observed in chrysanthemum[18] and China aster[19]. However, T_9 i.e. absolute control exhibited significantly poor results in terms of growth, flowering and seed parameters. The earliest flowering in T_9 could be due to the lesser growth of plants which could produce a minimum number of branches and they developed few reproductive buds that took minimum time for opening[19].

Soil macro-nutrient content

An inquisition of data in Fig. 1 expresses that the application of different treatments exhibited significant influence on available macro-nutrient content in the soil. The maximum values for available nitrogen (N), phosphorus (P), and potassium (K) (370.85 kg/ha, 85.35 kg/ha, and 424.85 kg/ha, respectively) were found in T_8 (RDF) and were statistically comparable with the treatments T_7 (364.54 kg/ha, 75.73 kg/ha and 413.13 kg/ha NPK). However, the lowest availability of N, P, and K content (291.93 kg/ha, 53.56 kg/ha & 306.90 kg/ha, respectively) was recorded in T_9 (absolute control). Inorganic fertilizers typically contain readily available nitrogen, phosphorous, and potassium that readily dissolve in soil thereby improving the soil macronutrient content. Additionally, this inorganic fertilizer may have additives that improve the uptake of the macronutrients in soil[7]. These cow-based products are known to possess abundant numbers of beneficial microorganisms which easily degrades complex organic compounds into soluble minerals thereby increasing the fertility of soil[21].

Soil microbiome

The effect of all the treatments (T_1 to T_9) in enriching the soil with the population of beneficial microbes revealed that count of viable beneficial bacteria (114.41 × 10^5cfu/g soil) and fungi (16.59 × 10^3cfu/g soil) was reported to be significantly maximum in T_7 (drenching of jeevamrit @ 35%) (Fig. 2) followed by T_6 (Jeevamrit @ 30%). However, the minimum count of beneficial living bacteria (90.28 × 10^5cfu/g soil) and fungi (14.28 × 10^3cfu/g soil) as well as a load of actinomycetes (11.43 × 10^2cfu/g soil) was tested in the plots incorporated with

T_8 (RDF). The application of jeevamrit contains high carbon (dung and jaggery) and nitrogen (urine, gram flour, and milk) as ingredients in the organic inputs facilitates the growth of beneficial bacteria, fungi and actinomycetes present in the microflora improving the rhizosphere of the plant[5].

Correlation analysis

Correlation analysis is a statistical technique used to measure the mutual relationship or association between different plant characters. The correlation analysis helps to identify traits that strongly positively correlate with yield[14] which in this case are the number of flowers per plant and the number of seeds per plant. Pearson correlation coefficient analysis was measured to find the effect of growth, flowering, and seed yield attributes with soil macronutrients and microbiome (Fig. 3.). The analysis revealed a significant positive coefficient of correlation (r) between all the growth and flowering parameters on seed yield. The vegetative parameters (plant height, plant spread), flowering parameters (days and duration of flowering, flower diameter, number of flower heads per plant) and seed yield parameters (number of seeds per head per plant, seed yield per plant) positively correlate with macronutrient content of soil and soil microbiome. The actinomycetes count in soil positively correlates only with flower diameter (0.43). The flower yield i.e. number of flowers per plant positively correlated with the available soil macronutrient content and soil microbiota further improving the seed yield. This shows improving all the studied parameters increases the seed yield of crops hence increasing the production of crops and getting more returns.

Principal component analysis (PCA)

The PCA analysis provides a comprehensive understanding of how different organic and inorganic fertilizers impact the growth, flower, and seed yield of annual chrysanthemum and soil enrichment. The scree plot (Fig. 4) shows a steep drop after the first component (72.9 %) and another drop after the second component (17.1 %), forming an "elbow." This indicates that the first two components are sufficient enough to explain most of the variance. The principal component biplot analysis (Fig.5) indicates how much each original variable contributes to the principal components (PC). PC1 has high loadings (72.9 %) for most variables, suggesting it is a general factor (growth and yield characteristics) capturing overall variability. A high variance explained by PC1 suggests that the type of fertilizer (organic or inorganic) used has a significant impact on plant growth and seed yield. PC2 captures the microbial environment of the soil (17.1 %) which indicates that fertilizers also significantly affect soil microbial activity and composition. The application of jeevamrit fertilizer typically enhances soil microbial activity by providing organic matter that serves as food for soil microorganisms. Thereby showing higher loadings on PC2 due to increased bacterial, fungal, and actinomycetes counts and having a positive impact on PC1 variables (plant spread, days to flowering, seed yield) due to improved soil health, leading to better nutrient availability and plant growth. Whereas inorganic fertilizers provide immediate nutrient availability, often leading to rapid plant growth and may show higher loadings on PC1 due to the direct impact on plant growth metrics. The inorganic fertilizers potentially lower the impact on PC2 if they do not contribute significantly to soil microbial activity or may even reduce it due to lack of organic matter. The PCA analysis highlights the significant impact of the combination of jeevamrit and recommended dose of fertilizer as the best strategy to maximize both immediate plant growth (PC1) and long-term soil health (PC2). This approach can provide a balance between rapid nutrient availability and sustainable soil enrichment. This study provides insight for future research to develop fertilization plans combining both organic and limited use of inorganic fertilizers tailored to specific goals—whether the primary goal is immediate high yield or long-term soil health.

CONCLUSION

From the present study, it is concluded that, better results in terms of plant growth and flowering behaviour including seed yield and their quality were obtained in T_7 (jeevamrit @ 35%) and T_6 (jeevamrit @30%) but found to be statistically matchable with the results of T_8 (RDF). Furthermore, the applications of T_6 and T_7 in addition to increasing of plant growth, flowering, and production of quality seeds have also contributed significantly in enriching the soil with a huge load of beneficial bacteria, fungi and actinomycetes. Therefore, it is recommended to go for an integrated approach i.e. application of the recommended dose of fertilizer during the initial growth phase facilitating vegetative growth and increasing flower yield. While simultaneously application of jeevamrit (T_7) in the annual chrysanthemum (*Glebionis coronaria)* will maintain balance between soil microbiota and plant growth promoting long-term good soil health and high productivity.

Statements and Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

Data is provided within the manuscript. Any other information on datasets used in this study is available from the corresponding author upon request.

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Conflict of interest

The authors declare no conflict of interest.

Author contribution

All authors contributed to this research. Material and method preparation and layout of work were planned by Dr. BS Dilta. Data collection and analysis was done by Mr. Sahil Lohia. The first draft of the manuscript was written by Mr. Sahil Lohia. All authors commented on previous versions of the manuscript. The corrections in the manuscript for the journal were done by Ms. Arushi Garg. Final approval was made by all the authors after proofreading.

Table 1. Effect of different doses of organic and inorganic fertilizers on growth, flowering and seed yield parameters of Glebionis coronaria

Treatment details		Plant height (cm)	Plant spread (cm)	Days taken to first flowering	Duration of flowering (days)	Diameter of flower heads (cm)	Number of flower heads per plant	Number of seeds per head	Seed yield per plant (g)	Seed yield per plot (g)
T_1	Jeevamrit @ 5%	83.48^{d}	34.31^{d}	86.71^{c}	38.82^{e}	3.50^{b}	247.36^{e}	228.26^{f}	8.8^{d}	79.23^{f}
T_2	Jeevamrit @ 10%	84.31^{d}	36.85^{c}	87.26^{c}	41.63^{d}	3.89^{ab}	249.26^{e}	232.01^{de}	8.92^{d}	80.31^{ef}
T_3	Jeevamrit @ 15%	85.03^{cd}	37.13^{c}	87.89^{c}	43.31^{cd}	3.69^{b}	252.95^{d}	232.94^{cd}	9.07^{cd}	81.66^{de}
T_4	Jeevamrit @ 20%	86.91^{c}	37.24^{c}	88.19^{c}	44.06^{c}	4.08^{a}	255.64^{cd}	234.06^{cd}	9.17^{c}	82.56^{cd}
T_5	Jeevamrit @ 25%	89.63^{b}	38.78^{bc}	90.5^{b}	45.36^{c}	4.17^{a}	256.75^{bc}	235.7^{bc}	9.27^{bc}	83.4^{bc}
T_6	Jeevamrit @ 30%	93.47^{a}	40.36^{ab}	95.52^{a}	47.99^{b}	4.36^{a}	259.51^{ab}	238.38^{ab}	9.41^{b}	84.72^{b}
T_7	Jeevamrit @ 35%	94.65^{a}	41.13^{ab}	96.75^{a}	50.99^{a}	4.47^{a}	261.76^{a}	238.27^{ab}	9.74^{a}	87.63^{a}
T_8	RDF	95.92^{a}	42.68^{a}	97.85^{a}	49.85^{a}	4.11^{a}	262.38^{a}	240.02^{a}	9.88^{a}	88.92^{a}
T_9	Absolute control	74.91^{e}	29.76^{e}	85.63^{c}	35.75^{f}	3.34^{b}	208.98^{f}	221.28^{g}	8.37^{e}	75.33^{g}
Mean		**87.59**	**37.58**	**90.70**	**44.25**	**3.96**	**250.30**	**233.42**	**9.27**	**83.84**

**In a column, means followed by same letters do not differ significantly at the 5% level by Duncan's Multiple Range Test*

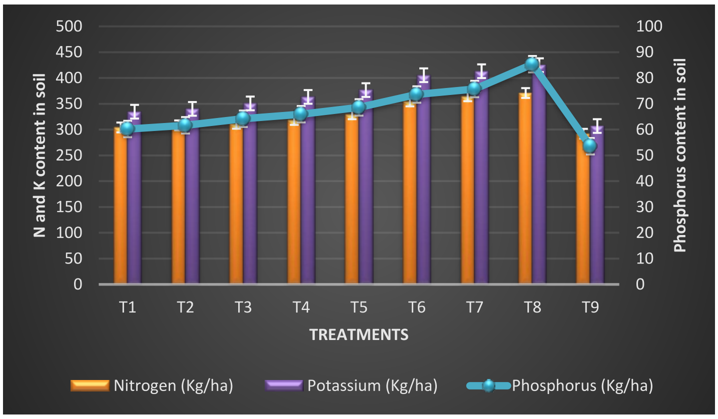

Fig. 1. Effect of different doses of fertilizer on macro-nutrient content of the soil

T_1: Drenching with jeevamrit @ 5%, T_2: Drenching with jeevamrit @ 10%, T_3: Drenching with jeevamrit @ 15%, T_4: Drenching with jeevamrit @ 20%, T_5: Drenching with jeevamrit @ 25%, T_6: Drenching with jeevamrit @ 30%, T_7: Drenching with jeevamrit @ 35%, T_8: RDF, T_9: Absolute control.

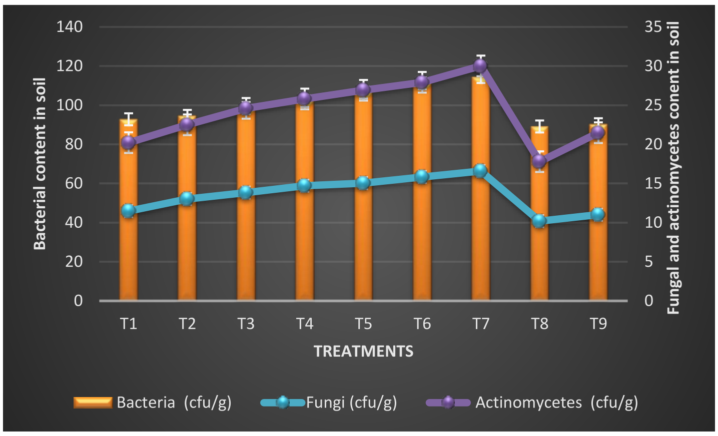

Fig. 2. Effect of different doses of fertilizer on microbiological properties of the soil

T_1: Drenching with jeevamrit @ 5%, T_2: Drenching with jeevamrit @ 10%, T_3: Drenching with jeevamrit @ 15%, T_4: Drenching with jeevamrit @ 20%, T_5: Drenching with jeevamrit @ 25%, T_6: Drenching with jeevamrit @ 30%, T_7: Drenching with jeevamrit @ 35%, T_8: RDF, T_9: Absolute control.

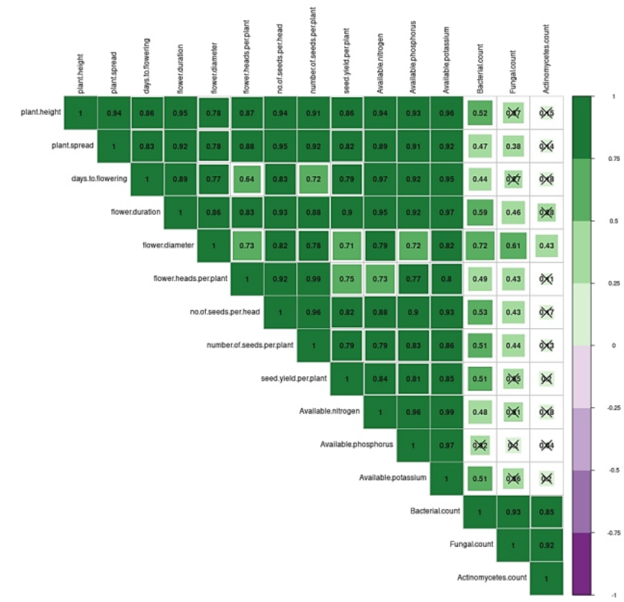

Fig. 3. Correlation analysis on growth, flowering and seed yield parameters of annual chrysanthemum

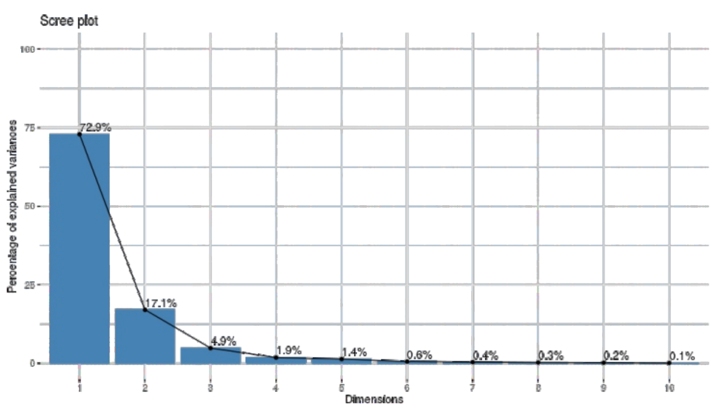

Fig. 4. Scree plot analysis of the studied parameters showcasing the variance in the data

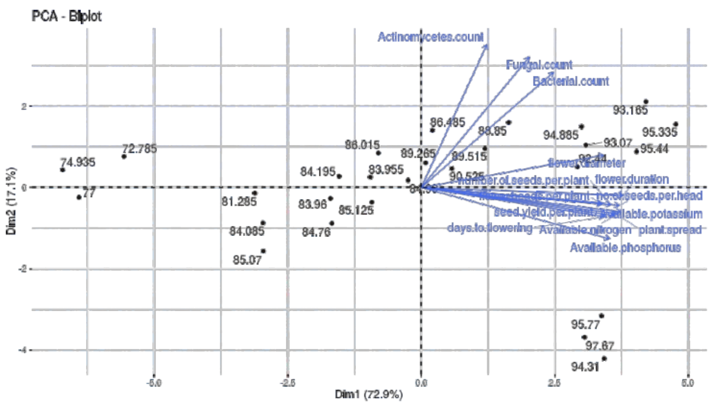

Fig. 5. Biplot analysis for first two principal component (PC1 and Pc2)

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