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Effects Of Pelletized Fertilizer Derived from Poultry Manure on the Growth and Development of "Avvatea" Tuber Bulbs

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ABSTRACT

Flowering plants have long been present in human activities and have been used for multiple purposes. Among the ornamental species cultivated in Romania, tuberose is widely appreciated for its decorative qualities and for its applications in the cosmetics, perfume, medical, and food industries. For the experimental study, a tuberose crop belonging to the “Avvatea” variety was established under ecological cultivation conditions. The experiment was conducted in a protected space within the Vegetable Research and Development Station Buzău, Romania. The research examined plant growth, bulb development, and flowering response in tuberose “Avvatea” following the application of a pelletized fertilizer produced from poultry droppings. The analysis of the experimental data indicated that, compared with the unfertilized control variant, the fertilized variants V2 (200 g/m²) and V3 (300 g/m²) recorded higher values for flower production per m², bulb yield, and plant growth and development. The results obtained provide a cultivation approach that can be applied by producers and individuals interested in cultivating flowering plants.

1. Introduction

This study investigates the effects of pelletized fertilizer derived from poultry manure on the growth and development of tuberose (Polianthes tuberosa L.) bulbs of the “Avvatea” variety, under protected cultivation conditions, with the aim of identifying sustainable fertilization practices for improving ornamental plant productivity.

2. Literature review

Floriculture represents a branch of horticultural sciences that focuses on the ornamental value of plant species, their biological characteristics, ecological requirements, propagation methods, as well as the production of planting material and cultivation technologies. The field also addresses the utilization and economic valorisation of ornamental plant species (Draghia, 2014).

Due to their aesthetic qualities, flowers have maintained a constant presence in human life, accompanying numerous social and cultural events and becoming widely used consumer goods

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(Draghia, 2005). Their visual and olfactory attributes have supported their cultivation since the early stages of human civilization (Draghia, 2008).

Ornamental plants cultivated in gardens, parks, indoor environments, or used as cut flowers constitute the main object of floriculture. The discipline is closely connected with landscape architecture, which studies the design and arrangement of vegetative compositions and green spaces with both aesthetic and functional value. Both cultivated ornamental species and those originating from spontaneous flora, together with horticultural design practices, have contributed to the development and structuring of human settlements (Vlăduț & Glăman, 2003).

The relationship between humans and flowers has developed over long historical periods, with flowers being appreciated for their decorative qualities, fragrance, and, in certain cases, medicinal properties. Their presence across various social and cultural contexts has supported their continuous cultivation and use.

The pelletized organic fertilizer used in the experiment was obtained from poultry manure and supplied by the company Toneli (Dragodana, Romania). The fertilizer was incorporated into the soil according to the experimental design and the established application rates. Following distribution, the soil was loosened mechanically to ensure uniform incorporation.

Tuberose is a perennial herbaceous species characterized by an underground elongated bulbous rhizome surrounded by numerous bulbs. A mature bulb capable of flowering typically consists of 15–20 fleshy, light-brown tunics, at the base of which a bud is present at different stages of development. Propagation is achieved vegetatively through bulbs and bulbils formed around the central bulb. Flowering generally occurs in the second or third year of cultivation, when bulb diameter exceeds 3 cm.

Approximately two to three weeks prior to planting, the hardened outer layer at the base of the bulb is partially removed by superficial cutting. This operation must be performed carefully to avoid damaging the basal disc, where reserve substances are stored.

Flowers are harvested when approximately 50% of the florets within the inflorescence have opened. Harvesting at an earlier stage may result in incomplete flower opening in post-harvest conditions.

Bulbs are removed from the soil in late autumn, after the first frost. They are cleaned of soil, leaves and roots are removed and subsequently transferred to protected storage spaces. After partial drying, bulbs are stored on shelves in well-ventilated conditions at temperatures of 20–22°C and relative humidity of approximately 70%.

The experiment was conducted in 2021 in the bio-research greenhouse of the Vegetable Research and Development Station (S.C.D.L.) Buzău and aimed to evaluate the growth and development of tuberose bulbs of the 'Avvatea' variety under the application of pelletized fertilizer derived from poultry manure.

3. Results

Tuberose (Polianthes tuberosa L.) is a perennial herbaceous species characterized by an underground elongated bulbous rhizome, fleshy in structure and surrounded by numerous bulbs. A mature bulb suitable for flowering typically consists of 15–20 fleshy, light-brown tunics, at the base of which a bud is present at different stages of development. The species is propagated vegetatively through bulbs and bulbils formed around the central bulb. Flowering generally occurs in the second or third year of cultivation, when the bulb diameter exceeds 3 cm.

Approximately two to three weeks prior to planting, a preparatory operation is carried out on the bulbs. During this stage, the hardened outer layer located at the base of the basal disc is partially removed by a superficial incision. This operation must be performed carefully to avoid damaging the bulb structure and to preserve the integrity of the basal disc, which represents an important storage tissue for reserve substances contributing to the initiation of vegetative growth and subsequent plant development. Tuberose flowers are harvested when approximately 50% of the florets within the inflorescence are open. At this stage, the flowers have reached an optimal level of development that allows them to maintain their decorative qualities after harvesting. When flowers are harvested at an earlier stage, in the closed-bud phase, they do not open properly in water, which reduces their ornamental value and limits their use as cut flowers. The bulbs are removed from the soil in late autumn, after the first frost. They are cleaned of soil, leaves and roots are removed and subsequently transferred to protected storage areas. After partial drying, the bulbs are placed on shelves in well-ventilated storage conditions at temperatures of 20–22°C and a relative humidity of approximately 70%. The experiment was conducted in 2021 in the bio-research greenhouse of the Vegetable Research and Development Station (S.C.D.L.) Buzău and aimed to evaluate the growth and development of tuberose bulbs of the 'Avvatea' variety under the application of pelletized fertilizer derived from poultry manure. The experimental design included five variants: V1 – unfertilized control; V2 – 200 g/m²; V3 – 300 g/m²; V4 – 400 g/m²; and V5 – 500 g/m² of pelletized fertilizer. Prior to planting, the bulbs were stored under optimal conditions at temperatures between 20–22°C. To ensure phytosanitary protection, the planting material was treated with a solution containing Laser insecticide (5 ml/10 L water) and Bordeaux mixture (50 g/10 L water) for several days before planting. Before establishing the crop, the bulbs underwent a preparation stage aimed at reducing the risk of pests and diseases and ensuring uniform plant development. This process included soaking the bulbs in the treatment solution to facilitate the penetration of active substances and improve protection efficiency. This stage is illustrated in Figure 1, which presents the bulb soaking operation.

Figure 1. Bulb soaking operation

Source: Source: Authors' own research

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After the treatment stage, the bulbs were removed from the solution and placed in ventilated trays to allow excess moisture to evaporate (figure 2).

Fig. 2 Appearance of tuberose bulbs during drying

Source: Authors' own research

This drying process ensured proper preparation of the planting material and reduced the risk of fungal infections associated with high humidity. The condition of the bulbs during this stage is illustrated in Figure 2, which presents the drying process prior to planting. This experiment involved a sketch of planting in the protected area of the S.C.D.L. Buzau: total area of the experiment = 42 sqm, width = 70 cm, furrow length = 60 m, area of a variant = 8.4 m²

The experimental design was established to evaluate multiple fertilization variants under uniform cultivation conditions. The plots were arranged according to a structured scheme that ensured the consistent distribution of treatments within the protected cultivation area. The layout included one control variant and four fertilized variants, each replicated according to the experimental design. The arrangement of furrows and treatment allocation facilitated the monitoring of plant growth and the collection of comparable data throughout the vegetation period. The spatial organization of the experimental field is illustrated in Figure 3, which presents the planting scheme used in the protected area of the Vegetable Research and Development Station (S.C.D.L.) Buzău.

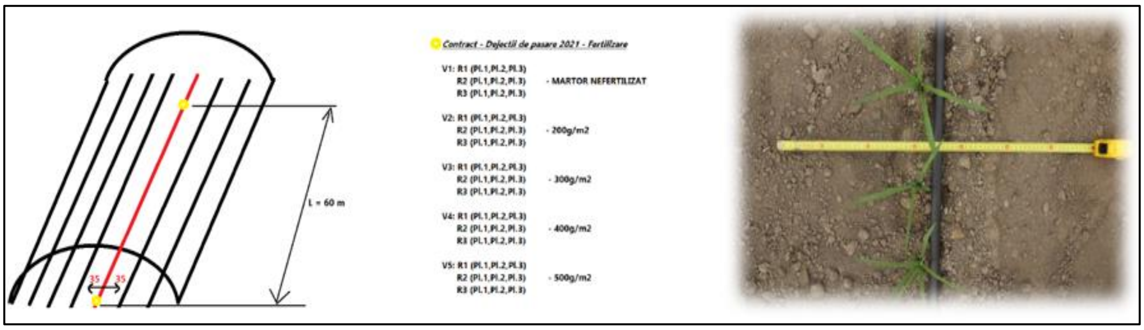

Figure 3. Experimental design and planting scheme for tuberose cultivation in the protected area of S.C.D.L. Buzău

Source: Authors' owns research

The figures 1 and 2 illustrates the arrangement of rows, the dimensions of the experimental area, and the allocation of fertilization variants within the experimental plot. Prior to fertilizer application and bulb planting, soil samples were collected from the experimental area to characterize the initial soil conditions. The analyses included the assessment of the soil microbiological community, represented by fungi and bacteria, as well as the determination of key physico-chemical parameters.

The evaluated parameters comprised pH, total nitrogen (N), total phosphorus (P), total potassium (K), soil moisture (U), dry matter (SU), organic matter (MO, determined by calcination), total sodium (Na), and trace elements such as Cd, Pb, and Cr.

The initial NPK content of the soil was determined before establishing the experimental variants to assess the baseline nutrient status. The results of these analyses are presented in Table 1, which summarizes the main soil chemical characteristics recorded prior to the experiment.

Table 1. Initial soil NPK content determined before the establishment of the tuberose experiment

Physico-chemical composition in NPK of the soil before the establishment of the tuberose culture	Variant	N	P	K
	V1	0.26	0.14	1,22

Source: Authors' own research

At the end of the vegetation period, soil samples were collected again to perform physico-chemical analyses and to assess changes in nutrient content following the application of the experimental treatments. The results indicated an increase in NPK values in variant V2 compared with the unfertilized control (V1).The comparative values for nitrogen (N), phosphorus (P), and potassium (K) are presented in Figure 4. The results show higher concentrations of these nutrients in variant V2 relative to the control, highlighting the positive effect of the applied fertilization on soil nutrient status at the end of the cultivation period.

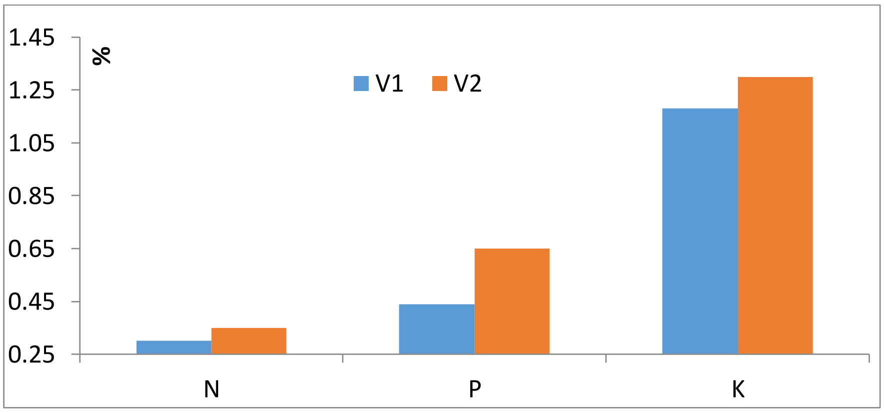

Figure 4. Physico-chemical composition in NPK of the soil at the abolition of the tuberose culture
Source: Authors' own research

The interpretation of soil analysis results indicated the presence of aerobic heterotrophic bacteria, identified through both quantitative and qualitative assessments. The quantitative analysis revealed a density of 7.175×10^6 viable bacterial cells per gram of dry soil.

Qualitative analysis identified several bacterial taxa, including *Bacillus cereus var. mycoides, Bacillus megaterium, Bacillus sphaericus, Pseudomonas acidophila, Pseudomonas sp., Pseudomonas fluorescens, Bacillus circulans, Bacillus subtilis, Bacillus mesentericus, Micrococcus sp., Bacillus cereus, Pseudomonas aurantiaca, Actinomyces sp.,* and *F. sp.*

The organic fertilizer was incorporated into the soil at a depth of 5–10 cm, according to the experimental scheme and established application rates, following soil loosening using a metal tool. This operation was performed on 31 May 2022.

Subsequently, the planting surface was prepared in accordance with the experimental layout. The rows were marked, and the positions of the experimental variants were clearly established to ensure accurate identification throughout the monitoring period.

Tuberose bulbs were planted manually, ensuring uniform distribution along the rows. Planting holes were created at the appropriate depth, allowing proper contact between the bulbs and the surrounding soil, which facilitated optimal plant establishment and subsequent development.

The stages of marking the experimental variants and the manual planting of the bulbs are illustrated in Figure 5, which presents the establishment of the tuberose crop within the protected cultivation area.

Figure 5. Marking of experimental variants and manual planting of tuberose bulbs in the protected cultivation area

Source: Authors' own research

The bulbs were planted immediately after the fertilizer was applied and incorporated into the soil on 31 May 2022. The research aimed to develop a cultivation technology for the 'Avvatea' tuberose variety through the application of pelletized fertilizer derived from poultry manure. During the vegetation period, biometric observations and measurements were carried out, including plant height and diameter, number of leaves, dimensions of the flowering stem and inflorescence, number of shoots and lateral buds, leaf length and width, flower colour, number of petals per corolla, chlorophyll content, and additional observations related to plant growth and development. Following planting, the tuberose bulbs entered the initial stages of vegetative development. During this period, the plants gradually emerged from the soil surface and continued their growth through leaf formation and the progressive development of aerial vegetative organs. These early stages are essential for ensuring crop uniformity and supporting the subsequent formation of flowering stems.

The succession of vegetative growth stages, from bulb planting to plant emergence and early development, is illustrated in Figure 6. The figure presents the transition from planting material to the appearance of the first shoots, followed by leaf development and the formation of young plants along the cultivated rows.

Figure 6. Stages of emergence and early vegetative development of tuberose plants after planting
Source: Authors' own research

As the vegetation period progressed, tuberose plants advanced through successive phenological stages, culminating in the formation of the flowering stem and the development of the inflorescence. During this phase, the plants exhibited a well-developed vegetative structure, characterized by elongated leaves and vigorous stems that supported floral bud formation.

The emergence of floral buds marked the transition from the vegetative to the reproductive stage. Subsequently, the buds gradually opened, forming the characteristic inflorescences of tuberose. These stages represent the final phase of plant development, culminating in full flowering.

The sequence of plant development, from the vegetative stage to floral bud formation and complete inflorescence opening, is illustrated in Figure 7.

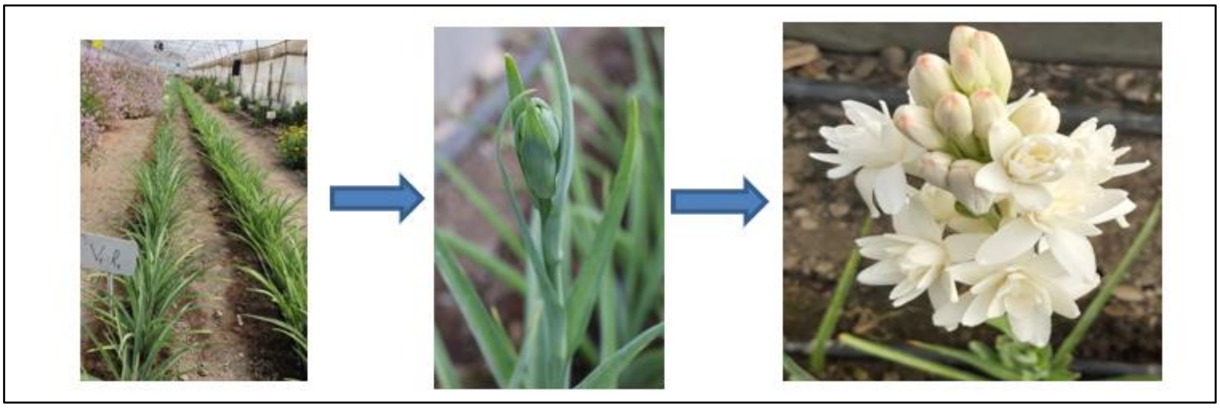

Figure 7. Stages of flowering development in tuberose plants "Avatea" from vegetative growth to full inflorescence
Source: Authors' own research

The analysis of the data presented in Table 1, together with the graphical representation in Figure 8, highlights the variation in tuberose plant height across different observation periods. At the first observation (30 June 2022), variant V2 recorded higher plant height values compared to the other treatments. This trend was maintained on 22 July 2022, indicating a more pronounced growth rate during this stage of vegetation. At later stages, the highest plant height values were observed in variant V3 (16 August 2022), which continued to show superior performance by 30 September 2022, remaining higher than the other fertilization variants.

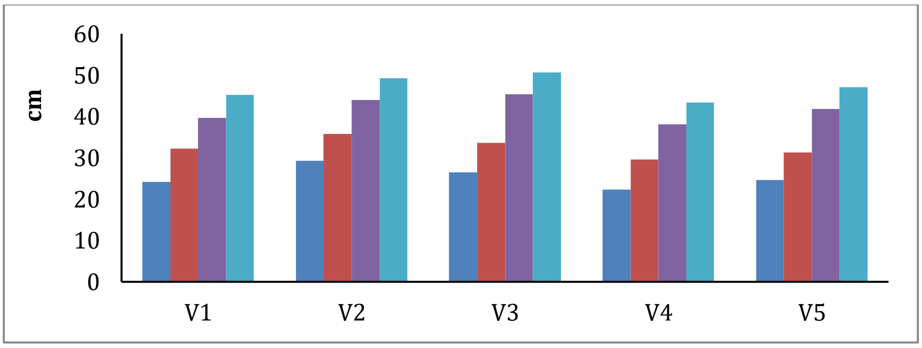

Figure 8. Dynamics of tuberose plant height by phenophases (cm),

Source: Authors' own research

Figure 8 illustrates the variation in the number of flowering plants across the experimental variants during the observation period, highlighting differences associated with the applied fertilization treatments.

The results indicate that variant V2R3 recorded the highest flowering intensity, corresponding to the application of pelletized fertilizer at a dose of 200 g/m². This treatment appears to have stimulated a higher number of flowering plants compared to the other variants.

In contrast, variants V1R3, V2R2, and V3R1 showed lower flowering values, although a gradual increase was observed between the two measurement stages. Overall, the findings suggest that fertilization influenced the flowering dynamics of tuberose plants, with the most pronounced response observed in variant V2R3.

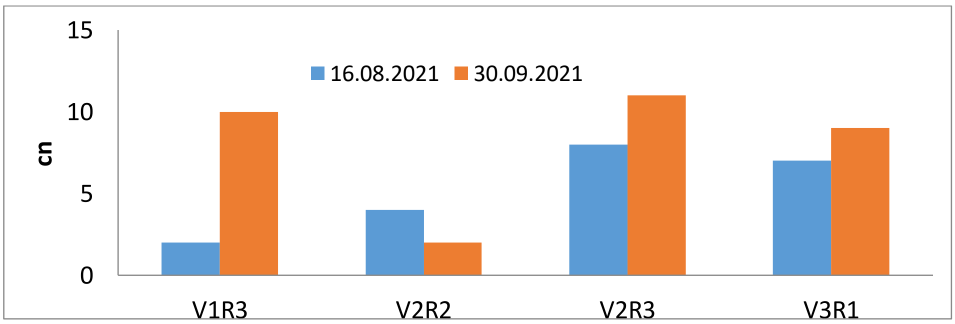

Figure 9 Dynamics of tuberose flowering in relation to the applied fertilization variants

Source: Authors' own research

The results of biometric measurements and flowering observations indicate distinct differences in plant response among the applied fertilization variants. Variations were observed in both plant height during the vegetation period and flowering intensity across the treatments. The findings suggest that fertilization doses influenced both vegetative growth and reproductive development of tuberose plants. Variants treated with pelletized fertilizer derived from poultry manure exhibited higher values for key growth parameters and flowering indicators compared to the unfertilized control.

These results provide relevant insights into the response of the 'Avvatea' tuberose variety to fertilization under protected cultivation conditions.

5. Conclusions

The results of this study highlight the positive effects of pelletized fertilizer derived from poultry manure on the cultivation of the 'Avvatea' tuberose variety under protected conditions. The application of the fertilizer significantly improved both vegetative growth and flowering performance compared to the unfertilized control.

The fertilizer was incorporated into the soil at a depth of 5–10 cm, according to the experimental design, ensuring direct contact with the root development zone. Among the tested treatments, variants V2 (200 g/m²) and V3 (300 g/m²) recorded the highest productivity, demonstrating superior performance in terms of flower yield per unit area and overall plant growth dynamics.

The highest flowering intensity was observed in variant V2R3, corresponding to the application of 200 g/m² of pelletized poultry manure at planting, indicating that this dose represents an optimal balance between nutrient availability and plant response. The results also suggest that staged fertilization may enhance nutrient use efficiency, as indicated by the observed differences in plant diameter and photosynthetically active leaf area. In this context, a combined fertilization strategy—consisting of partial application in autumn followed by pre-planting fertilization—could further improve crop performance. Future research will focus on testing this approach by applying additional fertilization doses during the vegetation period. Beyond its direct nutritional contribution, pelletized organic fertilizer improves soil structure and enhances water and nutrient retention capacity. Its use also reduces the risk of toxic accumulation associated with excessive application of chemical fertilizers, while promoting the recycling of organic resources, thus representing an environmentally sustainable fertilization option.

Overall, the findings provide valuable insights into the response of the 'Avvatea' tuberose variety to organic fertilization and support the use of pelletized poultry manure as an effective strategy for improving crop productivity in protected cultivation systems. These results may serve as a basis for optimizing fertilization practices and developing sustainable cultivation technologies for ornamental plants.

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