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SADRŽAJ:

The effect of two different fertilisers on the quality of *Viola x wittrockiana* Gams. seedlings

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Abstract

This research was carried out to analyse the effect of diverse types of fertilisers on the morphological features of pansy seedlings (*Viola x wittrockiana* Gams.), as well as to decide on the most appropriate concentration of fertiliser in order to obtain the highest seedlings quality. Two different types of liquid fertilisers were used in this experiment - Magnicvet and Magnihortal with six treatments. Each treatment comprised 30 plants or a total of 180 plants in the experiment were used. 30 plants per treatment were measured, 50 days after planting into plastic containers. The following biometric parameters were analysed: plant height (mm), stem thickness (mm), number of branches and number of flower buds. Measurements of biometric parameters showed that the liquid mineral fertiliser Magnihortal with NPK 10-5-5 + micro elements is more appropriate as compared with the liquid mineral fertiliser Magnicvet with NPK 7-1-5 + micro elements concerning the reinforced nutrition and eventually the enhanced quality of *Viola x wittrockiana* Gams. seedlings. Treatment V (Magnihortal 0.3 %) showed the highest average height of seedlings, average stem thickness and average number of branches, while the treatment VI (Magnihortal 0.4 %) showed the highest average number of flower buds.

Key words: *Viola x wittrockiana* Gams., seedlings, fertiliser concentration, biometric parameters.

Introduction

Viola x wittrockiana Gams. belongs to the Violaceae family. There are approximately 500 species in the *Viola* genus (Hadži Pecova, 2017). They are native to temperate areas around the world. Numerous species of the genus *Viola* are interesting for ornamental horticulture. They are used for planting in

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rockeries, flower beds, borders, decorative pots and balcony boxes (Dorbić et al., 2018). *Viola wittrockiana* Gams. is a commercially important cool season garden crop for landscape, and one of the five best-selling bedding plants in both developed and undeveloped countries (Gandolfo et al., 2016). *Viola* × *wittrockiana* Gams. (*syn. Viola tricolor* hort., non L.) is a hybrid obtained by crossing the species *Viola altaica* Ker-Gawl, *Viola lutea* Huds. and *Viola tricolor* L. (Kaur and Dhatt, 2020; Dorbić et al., 2018). This is a perennial plant, but in Republic of Macedonia it is grown as a biennial. *Viola* × *wittrockiana* Gams. (garden pansy) is a common bedding plant worldwide, exhibiting a wide range of flower colours, cold tolerance, long flowering and compatibility to broad climatic conditions as well as other charming characteristics, such as odour and taste (Fernandes et al., 2017). The height of the plant is 15 to 25 cm. Its leaves are oval, heart-shaped, shallowly incised, glossy, medium to dark green, 3.5 cm long or longer (Dorbić et al., 2018). The flower has a diameter of 5 to 6 cm and appears in the axils of the leaves singly or rarely in pairs. It is monochromatic, bicolor or tricolor, in a wide range of colors: blue, white, yellow, orange, pink, red and purple. It blooms profusely in spring, but with the onset of high temperatures, the flower becomes small and the flowering stops (Hadži Pecova, 2017). Propagation is by seed or in rare cases by cuttings (Hadži Pecova, 2017). Sowing is carried out in the period June - August. Resistance to winter conditions is closely dependent on the stage of development of the species (Hadži Pecova, 2017). Plants that begin to bloom in October - November are more sensitive to low temperatures. To avoid this and direct flowering in the spring, sowing is done during the summer in August (Dorbić et al., 2018). The substrate should be sterilized, well drained, with a pH of 5.4 to 5.8 with a moderate amount of nutrients and a lower concentration of phosphorus to prevent elongation. Seeds should be covered with vermiculite and temperatures above 21 °C should be avoided (as this results in unnecessary elongation). The first phase (root appearance) lasts 3-4 days. The second phase (developing roots and appearance of cotyledons) lasts 10 days at a temperature of 18 to 21 °C during the day and 15 °C at night. The third phase (appearance of the first true leaves) lasts 14 days at a temperature of 18 °C during the day and 15 °C at night. The fourth phase (the seedlings are almost ready for transplanting) lasts 7 days at a temperature of 15 °C during the day and 13 °C at night (Dorbić et al., 2018). Under glasshouse conditions, flower size (mm^2) decreased linearly with increasing temperature between 9 and 31 °C ($r^2 = 0.72$) (Pearson et al., 1995). Flowering, flower size and shoot weight increase simultaneously with decreasing temperatures (Adams et al., 1997). The quality of irrigation water used for greenhouse crop production can strongly influence plant growth (Kuehny and Morales, 1998). However, the effect on plant growth is probably a combination of water quality and the type of growing media used (Kuehny and Morales, 1998). Choosing the most appropriate fertilizer for nourishment of flowers in protected environment represents one of the most significant activities in the process of production. Nutrient absorption by pansy in different stages of development is influenced by temperatures and the choice of N form in fertilization. Adjusting fertility programs according to peak demand periods and production temperatures will help prevent periodic nutrient disorders during the life cycle, and may reduce

fertilization costs (Hamlin and Mills, 2001). Overall, pansies absorbed more total N, NH_4 +, NO_3 −, calcium (Ca), potassium (K), magnesium (Mg), phosphorus (P), zinc (Zn), and less iron (Fe) and manganese (Mn) at 12°C than at 22°C (Hamlin et al., 1999). In addition, absorption of NO_3^- by pansy was negligible if any NH_4^+ was present in solutions at 22 °C (Hamlin R. L. et al., 1999). Fertilization begins in the development phase of the first true leaves and is applied twice a week with 50 ppm N in the complex fertilizer 14-0-14, i.e. 20-10-20 (Dorbić et al., 2018). Then, after one week, the N concentration increases to 100 ppm. Multipot plates or cultivation pots with a diameter of 9 cm are used for further cultivation. The most common pests that occur in production are aphids, thrips, moths, whiteflies, and from diseases *Botrytis cinerea* Pers., *Sclerotinia sclerotiorum* (Lib.) de Bary, *Peronospora violae* de Bary (Dorbić et al., 2018). According to research by Pieta and Kiecana (1991), fungi most frequently isolated from *Viola wittrockiana* seeds are *Alternaria alternata* and *Botrytis cinerea*.

This research was carried out to analyse the effect of diverse types of fertilisers on the morphological features of pansy seedlings, as well as to decide what is the most appropriate concentration of fertiliser for highest seedlings quality of *Viola x wittrockiana* Gams.

Materials and methods

The experiment was conducted in the greenhouse of the farm "Flower-Garden" in the village Vladevci, Strumica, Republic of North Macedonia. The experiment was conducted on *Viola x wittrockiana* "Power Yellow with Blotch". Substrate used for seedlings production of *Viola x wittrockiana* Gams. is known as "Poinsetia". The structure of the substrate "Poinsetia" is as follows: 65 % white peat, 30 % black peat and 5 % perlite. This substrate is universal for production of flower seedlings. The most common organic substrate used for plant growth is peat moss and most of the crop technology available has been calibrated according with it (Gandolfo et al., 2016). Two different types of liquid fertilizers – Magnicvet with NPK 7-1-5 + micro elements and Magnihortal with NPK 10-5-5 + micro elements, with three different concentrations were used in the experiment. The company which produce this fertilizers is Alkaloid AD Skopje. Seedlings of *Viola x wittrockiana* Gams. were produced from seeds. The seeds were sown in containers and grown in containers up to germination and formation of the first two to three leaves. The seedlings were manually transplanted in plastic pots with 9,5 cm diameter. The experiment contained six treatments. Every treatment was consisted of 30 plants or a total of 180 plants in experiment. Fertilization was started when the seedlings developed 3 to 4 leaves. 80 ml of the fertilizer solution was applied manually on each plant, i.e. one seedling fertilized once a week, i. e. during the experiment 6 fertilizations were conducted. Types of fertilizers, their concentrations and solution are shown in the following Table 1.

Table 1. Types of fertilizers, their concentrations, solution and number of plants

Treatment	Type of fertilizer	Concentration	Solution	Number of plants
Treatment I	Magnicvet	0,2 %	3 ml / 1,5 l	30
Treatment II	Magnicvet	0,3 %	4,5 ml / 1,5 l	30
Treatment III	Magnicvet	0,4 %	6 ml / 1,5 l	30
Treatment IV	Magnihortal	0,2 %	3 ml / 1,5 l	30
Treatment V	Magnihortal	0,3 %	4,5 ml / 1,5 l	30
Treatment VI	Magnihortal	0,4 %	6 ml / 1,5 l	30

When plants were transplanted from the containers to plastic pots, irrigation was immediately carried out. After that, irrigation was conducted twice a week. Every plant was irrigated manually with 80 ml of water. 30 plants of every treatments were measured, after 50 days of transplanting in the plastic pots. Following biometric parameters were analysed: plant height (mm), stem thickness (mm), number of branches and number of flower buds. Measurements of biometric parameters were conducted in the laboratory of Department of vegetable and flower crop production, at the Faculty of Agricultural Sciences and Food in Skopje, University "Sv. Cyril and Methodius" in Skopje. The received results were statistically processed according to ANOVA.

Results and discussion

Height of the plants

The highest average plant height (55,23 mm) was recorded in Treatment V (Table 2), followed by Treatment III with plant height of (55,03 mm) and Treatment I with plant height of (53,1 mm). Treatment II with average plant height of (52,80 mm) and Treatment VI with height of (52,13 mm) are approximately the same, where the shortest average plant height is recorded in Treatment IV with height of (48,77 mm).

Table 2. Height of plants (mm) *Viola x wittrockiana* Gams. in six different treatments

Treatment	Treatment I	Treatment II	Treatment III	Treatment IV	Treatment V	Treatment VI
Arith. mean	53,1±12,86	52,80±12,43	55,03±8,44	48,77±8,99	55,23±9,33	52,13±9,73
Coeff. of variation	24,23	23,55	15,33	18,43	16,89	18,66
Interval of variation (min-max)	38-100	37-80	39-72	35-73	40-73	39-72

Stem thickness

As shown in Table 3, the highest stem thickness (4,18 mm) was recorded in Treatment V, followed by Treatment IV with average stem thickness of (4,17 mm), Treatment VI with average stem thickness of (4.15 mm) and Treatment III with stem thickness of (4,01 mm). Treatment I with average stem thickness of (3,89 mm) and Treatment II with stem thickness (3,81 mm) are treatments with the lowest average stem thickness.

Table 3. Stem thickness (mm) of *Viola x wittrockiana* Gams. in six different treatments

Treatment	Treatment I	Treatment II	Treatment III	Treatment IV	Treatment V	Treatment VI
Arith. mean	3,89±1,10	3,81±0,76	4,01±0,72	4,17±0,72	4,18±0,75	4,15±0,68
Coeff. of variation	28,29	20,02	17,92	17,28	17,98	16,47
Interval of variation (min-max)	2,3-7,0	2,4-5,1	3,0-5,5	3,0-5,1	3,0-5,3	3,0-5,3

Number of branches

The highest number of branches (3,57) was recorded in Treatment V, followed by Treatment VI with average number of branches of (3,43) and Treatment II with number of branches (3,37). In Treatment III average number of branches was (3,33), in Treatment I average number of branches was (3,3), while the lowest average number of branches (2,53) was recorded in Treatment IV, Table 4.

Table 4. Number of branches of of *Viola x wittrockiana* Gams. in six different treatments

Treatment	Treatment I	Treatment II	Treatment III	Treatment IV	Treatment V	Treatment VI
Arith. mean	3,3±1,09	3,37±1,45	3,33±1,21	2,53±1,46	3,57±1,17	3,43±1,19
Coeff. of variation	32,96	43,07	36,39	57,47	32,67	34,79
Interval of variation (min-max)	1-6	1-6	1-5	0-5	1-5	1-5

Number of flower buds

As shown in Table 5, in Treatment VI, the highest average number of flower buds was recorded (1,73), followed by Treatment V with average number of flower buds of (1,70), Treatment II with number of flower buds of (1,47), Treatment IV with number of flower buds of (1,37) and Treatment III with number of flower buds of (1,23). The lowest average number of flower buds was recorded in the Treatment I of (1,1) flower buds per plants.

Table 5. Number of flower buds of *Viola x wittrockiana* Gams. in six different treatments

Treatment	**Treatment I**	**Treatment II**	**Treatment III**	**Treatment IV**	**Treatment V**	**Treatment VI**
Arith. mean	1,1±0,55	1,47±0,57	1,23±0,50	1,37±0,49	1,70±0,75	1,73±0,74
Coeff. of variation	49,79	38,96	40,87	35,86	44,10	42,67
Interval of variation (min-max)	0-2	0-2	1-3	1-2	1-3	1-3

Conclusion

Viola x wittrockiana Gams. is biennial floral breed that is mostly used for flower-beds, window containers and hanging flower baskets. It is popular due to its beautiful flowers which are available in a wide range of colours. Based on the analyzes of the statistic data acquired by measuring the morphological characteristics, the seedlings fertilized with liquid mineral fertilizer Magnihortal were of better quality. The results also showed that fertilizer that contains larger amounts of nitrogen and phosphorus was better for fertilization of *Viola x wittrockiana* Gams. seedlings. Analyzing the treatments individually, it was showed that in Treatment V the highest average seedling height, stem thickness and number of branches were recorded, while in Treatment VI the highest average number of flower buds was recorded. For better quality of pansy seedlings the liquid mineral fertilizer Magnihortal with NPK 10-5-5 + micro elements is recommended.

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