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The Influence of Combined Pruning and the Use of Root Application of Two Biostimulants and Foliar Nutrition on the Growth and Flowering of Panicle Hydrangea Plants

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Abstract: The experiment assessed the impact of the interaction of two care treatments on the growth and flowering of two varieties of Panicle Hydrangea bushes. The first treatment considered was plant pruning. The second simultaneous treatment was one of the three mentioned, root application of *Trichoderma atroviride* and BlackJak biostimulator and foliar application of a multi-component fertilizer. The strongest impact on improving the length of hydrangea shoots compared to the control (18%) had their simultaneous pruning and inoculation of the plants with *Trichoderma atroviride* mycelium. These two treatments used together also increased the number of flowers (16-47% depending on the variety) and the fresh weight of plants (10-28%) compared to the control. The application of *T. atroviride* alone improved the number of flowers in both varieties (19-24%) and the diameter of inflorescences in the 'Silver Dollar' one (17%). Foliar nutrition in particular increased the mass of plants, depending on the variety and pruning, from 7 to 57%, as well as the diameter and number of inflorescences, but only in one of the varieties considered. Combined with pruning, it intensified the growth of shoots of both varieties (5-10%). The use of the BlackJak biostimulator gave ambiguous results. When pruning plants, the length of shoots improved (15%) for one of the tested varieties and the fresh weight for the other (18%). Without pruning, it increased the number of flowers (16%) and the diameter of inflorescences (9%) in one of the varieties considered, as well as the fresh weight of plants in both varieties (19-21%). Pruning the plants, regardless of the other treatments used, increased the length of the shoots and the fresh mass of the plants. On the other hand, it reduced the number of flowers and their diameter. In most cases, positive effects of the use of biostimulants and foliar fertilization on improving the growth and flowering of plants were obtained. After their use in combination with plant pruning, an improvement in the growth of hydrangea bushes was observed, while the number and diameter of flowers were reduced. The most beneficial care treatments for the growth and flowering of panicle hydrangea were the simultaneous application of *T. atroviride* and pruning of plants during container cultivation in a nursery.

Keywords: Panicle Hydrangea; varieties; container cultivation; nursery; additional care treatments

1. Introduction

Hydrangeas are one of the most popular ornamental plants used for planting in gardens because of their showiness blooms with different sizes and shapes of flowers at the same time [1]. They are easy to care for and have little maintenance problems with pests and diseases, tolerates shade, and they adapt well to both acidic and alkaline soils [2]. The genus Hydrangea is comprised of approximately 80 species [3]. In recent years, Panicle Hydrangea (*Hydrangea paniculata* Siebold) has become one of the most popular species. The interest in its cultivation is due to its characteristic white inflorescences, long flowering period, wide range of growing locations, relatively good frost resistance and low susceptibility to diseases [4]. The attractive appearance and numerous varieties of

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Panicle Hydrangea encourage producers to increase its production in nursery [5]. The problem with the production of shrubs of this species in a nursery is the small number of inflorescences and shoots and their significant elongation, which results in an unattractive appearance. Another difficulty is the lack of customer interest in purchasing this species in the second half of summer due to the lack of flowering. To prevent these shortcomings, at the production stage, young shrubs can be pruned at an early stage of development, which will result in a second flowering later. Plant pruning is a simple procedure widely used in the production of fruits and vegetables. It can promote the formation of branching and additionally stimulate vegetative growth, leading to increased plant yield [6]. The use of this simple care procedure in the cultivation of ornamental plants is not popular because it is not known what the effects will be in the case of a specific species. Current scientific assumptions indicate that pruning may disturb the balance between vegetative and generative growth of plants [7]. As shoots are pruned, more dormant buds are activated, resulting in an increase in leaf area and plant dry weight [8–10]. Below the cutting site, the GA3 content in the buds increases and the IAA and ABA content decreases, which promotes bud development and the formation of flower buds [11]. Evidence confirming these opinions was the experiment on the species Malus 'Profusion' [12]. It was found that unpruned trees bloomed the worst, while heavily pruned trees produced more vigorous and flowering shoots. In another experiment, *Loropetalum chinense* 'Rubrum' was pruned to varying degrees [13]. Pruning made the plants bloom faster and produce more flowers. It was also shown that moderate pruning of jasmine forced the plants to flower and increased the number of flowers [14]. In the case of roses grown as cut flowers, cutting the shoots at the base to a length of 10 cm increased their quality and shortened the flowering time of the plants [15]. Also, pruning the hybrid rose increased the number of flowers on the plant by 68.7% [16].

In order to improve the growth of ornamental plants, various species of fungi of the Trichoderma genus are used, which are widely recognized as plant growth stimulants [17–20]. These are fungi widely studied as biological control agents [21]. Trichoderma-based preparations are used to protect plants against pathogens [22]. They are known to improve plant resistance to stress such as drought by increasing the branching capacity of the root system, thereby improving nutrient uptake and water acquisition [23–26]. The most common methods of Trichoderma application are soil and foliar applications, with the latter being more effective, especially in preventing soil-borne diseases [27]. However, these authors did not find any improvement in the growth of young olive trees grown in containers after foliar application of the Trianum P biostimulant based on *T. harzianum* fungi. They achieved increased growth of young trees only after using slow-release granular fertilizer Osmocote.

Hydrangeas are generally considered to have high nutrient requirements, especially N, to support their vigorous growth [28,29]. Standard soil application of fertilizers in nursery production can also be supported by the application of appropriate biostimulants. So far, an experiment has been carried out on annual *Hydrangea paniculata* plants treated with water stress, which was attempted to be reduced by the use of biostimulants [30]. Plants treated with biostimulants had the same number of branches and fresh mass as plants not subjected to stress. In the research [31], foliar applications of biostimulant (Asahi) allowed for reducing the dose of Osmocote fertilizer in the cultivation of hydrangea 'Anabelle' shrub.

The BlackJak preparation containing humic acids has also been used so far in the cultivation of the ornamental plant Euphorbia x lomi [32] as well as cherry trees [33] and grape shrubs [34]. Growth and quality results of treated plants in these experiments varied. Despite this, the use of this biostimulator improved the weight of lettuce plants and the chlorophyll content in leaves [35]. Jasim [36] also found that foliar spraying with fertilizer containing humic acid causes an increase in the number and area of leaves, diameter and weight of flower heads in broccoli.

The aim of the experiment was to determine the suitability of introducing two additional care treatments into nursery production and to examine their mutual impact on the growth and flowering of Panicle Hydrangea. The first treatment used in the experiment was pruning the plants. The second one was the root application of *Trichoderma atroviride* mycelium and the BlackJak biostimulator, as well as the foliar application of Universol Green fertilizer.

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2. Materials and methods

2.1. Plant Material and Growth Conditions

The experiment was carried out in 2022-2023 years, in a private nursery as part of research work carried out at the Faculty of Agriculture, Horticulture and Bioengineering, University of Life Science in Poznań. Two-year-old Panicle Hydrangea shrubs in two varieties, 'Silver Dollar' and SKYFALL 'Frenne', were used for the research, the plants of which were obtained from a nursery in the Netherlands. Eight experimental combinations were used separately for both varieties [three treatments of plants and additionally pruning of shoots and no such treatments - as a control]. Forty hydrangea plants were treated with: *Trichoderma atroviride* mycelium, BlackJak biostimulator, Universol Green foliar fertilizer and a control combination. The doses, form of application and content of active ingredients of the tested biostimulants and fertilizer are given in Table 1. In each of the four treatments, 20 plants were pruned and 20 were not pruned in mid-June. The cut was made at the height between the first and second internode under the inflorescence. Plants were arranged in parallel rows to minimize differences in the effects of lighting and irrigation using angle sprinklers [Figure 1]. The plants were grown in a nursery in 5-liter containers. Deacidified peat from Agaris, fraction 0/40 mm, was used for planting plants. The pH of the substrate remained in the range of 5.5-6.0. The substrate was enriched with Osmocote® Exact 3-4mm fertilizer at a dose of $3 g \cdot l^{-1}$ of substrate. The plants were constantly watered using sprinklers with a water dose of $8 l \cdot m^{-2}$ on days without rainfall. For preventive protection against the red spider mite (*Tetranychus urticae*), Koppert's Spical preparation, containing the California red spider mite (*Neoseiulus californicus*), was used. Weeds in containers and near plants were regularly removed manually.

Table 1. Used treatments in experiment.

Treatment	Concentration Dose per Plant	Application Form	Composition
Trichoderma atroviride	10 ml	root application	spore-forming mycelium of the genus of *Trichoderma atroviride*
BlackJak	$0.5 ml \cdot l^{-1}$ 300 ml per plant	root application	leonardite: min. 28%; organic substances: min. 20 %; humins; ulmic acids; humic acids; fulvic acids
Universol Green	$2 g \cdot l^{-1}$ 40 ml per plant	foliar application	N 23%, K 8.3%, P 2.6%, Fe 0.1%, Cu 0.1%, Zn 0.1%, Mn 0.4%, B 0.01%, Mo 0.01%

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Figure 1. Plants pruned and unpruned (with flowers) of Panicle Hydrangea in experiment.

Plant measurements were taken at the end of October due to persistent flowers and the plant's suspended growth. The sum of the length of shoots [cm] and the diameter of inflorescences [cm] were measured for all plants, the number of inflorescences per plant was counted, and the fresh weight of the plants [g] after shaking them from the substrate was weighed. The results of hydrangea growth and flowering presented in the tables are the averages from two series of experiments.

2.2. Laboratory Analysis of the Presence of the Fungus

In order to confirm the presence of Trichoderma fungi in the rhizosphere of the examined hydrangea plants, root samples were taken for mycological analysis. Healthy roots were surface disinfected for half a minute in 5% sodium hypochlorite and then rinsed with distilled water. After drying, the roots were cut with a sterile lancet into pieces several millimeters long. The prepared plant material was placed on PDA [Potato Dextrose Agar] culture medium in Petri dishes [90 mm]. The incubation process took place at 21°C. After 6 days of cultivation, the presence of Trichoderma spp. colonies, as well as colonies of other filamentous fungi and yeasts was confirmed [Figure 2]. Fungi of the Trichoderma species were identified based on the assessment of macroscopic and microscopic features using mycological keys.

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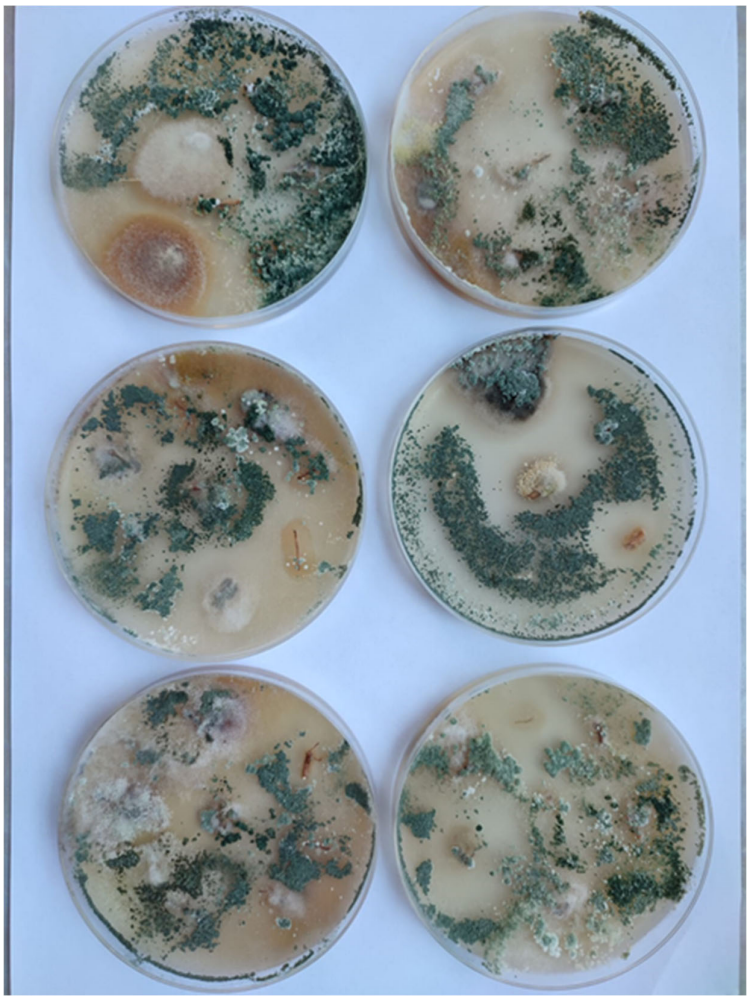

Figure 2. Colonies of the fungus Trichoderma originating from root samples of hydrangea plants treated with this fungus (phot. Świerczyńska I.).

2.3. Data Analysis

The results of the study were analyzed with the STATISTICA 13.1 [Statsoft Polska, Kraków, Poland]. To perform statistical calculations of the obtained results, a two-factor analysis of variance [treatment, pruning] was used for each variety separately. The Duncan test was used, with a significance level of $\alpha = 0.05$.

3. Results

3.1. Analysis of Plant Growth and Flowering

Pruning plants was an important factor intensifying their growth [Tables 2 and 3]. In plants subjected to pruning, the highest value of the sum of the shoot lengths of both examined varieties was found after the application of *Trichoderma atroviride* mycelium. The other two treatments (foliar fertilization and the use of the BlackJak biostimulator) also gave better results than the control. Only the use of the BlackJak biostimulator did not improve the growth of SKYFALL 'Frenne' plants. Unpruned plants did not have different shoot lengths regardless of the other treatments.

Table 2. Total length of shoots of 'Silver Dollar' Panicle Hydrangea (cm).

Treatments	Unpruned	Pruned	Average for treatment

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Trichoderma atroviride	765.0 a	1103.7 e	934.3 c
BlackJak	739.7 a	1036.3 d	888.0 b
Universol Green	762.3 a	950.0 c	856.2 b
Control	741.3 a	901.0 b	821.2 a
Average for treatment	752.1 a	997.8 b	

Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

Table 3. Total length of shoots of SKYFALL 'Frenne' Panicle Hydrangea (cm).

Treatments	**Unpruned**	**Pruned**	**Average for treatment**
Trichoderma atroviride	340.0 a	1325.0 d	832.5 c
BlackJak	367.3 a	1103.7 b	735.5 ab
Universol Green	347.0 a	1188.0 c	767.5 b
Control	304.3 a	1084.3 b	694.3 a
Average for treatment	339.7 a	1175.3 b	

Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

Both with and without pruning, the highest number of flowers of 'Silver Dollar' plants was achieved after inoculation with *Trichoderma atroviride*. The other two treatments did not significantly change the number of flowers. For the second variety SKYFALL 'Frenne', unpruned plants outperformed the control in descending order of values: inoculum treatment, BlackJak biostimulant treatment and foliar fertilization. Compared to the control, pruned plants obtained a larger number of flowers when inoculated with mycelium and treated with Universol Green fertilizer. No improvement with the BlackJak biostimulator. Pruning the plants reduced the number of flowers (Tables 4 and 5).

Table 4. Number of inflorescences of 'Silver Dollar' Panicle Hydrangea.

Treatments	Unpruned	Pruned	Average for treatment
Trichoderma atroviride	17.2 e	9.0 b	13.1 b
BlackJak	13.5 c	4.9 a	9.2 a
Universol Green	15.4 d	5.2 a	10.3 a
Control	13.9 cd	4.8 a	9.4 a
Average for treatment	13.0 b	6.0 a	

Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

Table 5. Number of inflorescences SKYFALL 'Frenne' of Panicle Hydrangea.

Treatments	**Unpruned**	**Pruned**	**Average for treatment**
Trichoderma atroviride	12.0 e	6.8 b	9.4 c
BlackJak	11.7 d	5.9 a	8.5 b
Universol Green	10.9 d	6.8 b	8.8 b
Control	10.1 c	5.7 a	7.9 a
Average for treatment	11.0 b	6.3 a	

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Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

Pruned plants of the 'Silver Dollar' variety had significantly the largest inflorescence diameter after inoculation. The other two treatments also improved the diameter of inflorescences in pruned plants compared to the control. Unpruned plants achieved better results than the control after inoculation and treatment with foliar fertilizer. Pruned plants of the second variety were characterized by a larger inflorescence diameter only after foliar fertilization. For all treatments, unpruned plants of both varieties had larger inflorescence diameters than the pruned ones [Tables 6 and 7].

Table 6. Diameter of inflorescences of 'Silver Dollar' Panicle Hydrangea (cm).

Treatments	Unpruned	Pruned	Average for treatment
Trichoderma atroviride	11.9 e	6.8 b	9.4 c
BlackJak	11.1 d	5.9 a	8.5 b
Universol Green	10.9 d	6.8 b	8.8 b
Control	10.2 c	5.7 a	7.9 a
Average for treatment	11.0 b	6.3 a	

Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

Table 7. Diameter of inflorescences of SKYFALL 'Frenne' Panicle Hydrangea (cm).

Treatment	Unpruned	Pruned	Average for treatment
Trichoderma atroviride	11.7 c	7.6 a	9.6 a
BlackJak	11.9 c	8.1 a	10.0 a
Universol Green	13.1 d	9.0 b	11.0 b
Control	12.4 cd	7.5 a	10.0 a
Average for treatment	12.3 b	8.0 a	

Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

The highest fresh mass of unpruned plants of the 'Silver Dollar' variety was obtained when using Universol Green fertilizer. The other two treatments also increased the weight of plants compared to the control. For pruned plants, no significant differences were obtained between the four treatments. Pruned plants of the second variety inoculated with mycelium had the highest weight. However, in the absence of pruning, the highest plant weight was recorded when foliar fertilizer was applied. Also, the other two treatments improved the weight of both pruned and unpruned plants of the second variety compared to the control. The weight of pruned plants of both varieties was significantly greater than that of unpruned ones, regardless of the other treatments [Tables 8 and 9].

Table 8. Weight of plants of 'Silver Dollar' Panicle Hydrangea (g).

Treatments	Unpruned	Pruned	Average for Treatment
Trichoderma atroviride	396.0 b	563.0 d	479.5 bc
BlackJak	351.0 b	553.7 d	452.3 b
Universol Green	455.3 c	548.7 d	502.0 c
Control	290.0 a	509.0 d	399.5 a
Average for treatment	373.1 a	543.6 b	

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Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

Table 9. Weight of plants of SKYFALL 'Frenne' Panicle Hydrangea (g).

Treatments	Unpruned	Pruned	Average for treatment
Trichoderma atroviride	376.3	550.0 f	463.2 c
BlackJak	365.0 b	468.7 de	416.8 b
Universol Green	431.0 cd	492.3 e	461.7 c
Control	307.3 a	398.0 bc	352.7 a
Average for treatment	369.9 a	477.3 b	

Mean values marked with the same letters do not differ significantly at the level of significance α= 0.05, using Duncan's test.

3.2. Analysis of the Presence of the Trichoderma Fungus

Trichoderma atroviride colonies originating from root samples of plants treated with this fungus were characterized by a rapid growth rate and abundant sporulation. The color of the fungus colony was usually a shade of green - from pale green to intense green, occasionally with a gray or yellow coating [Figure 2]. The obtained colonies of the tested fungus confirmed the effectiveness of inoculation of plants.

4. Discussion

4.1. Plant Growth and Flowering after Applying the Pruning

Pruning had the strongest impact on the growth of hydrangea plants. The sum of the shoot lengths of the 'Silver Dollar' variety was significantly greater in all treatments of pruned plants compared to unpruned ones. In the case of the SKYFALL 'Frenne' variety, this parameter was almost three times higher in the case of pruned plants inoculated with mycelium compared to unpruned ones. Pruning the shoots also had a positive effect on the fresh mass of the plants. Hence the conclusion that pruning hydrangea plants stimulates them to further growth and more intensive development of the vegetative mass. Observations in the nursery also showed that the root system of pruned plants was more developed. On the other hand, pruning the plants resulted in a reduction in the number of flowers in both varieties, with 'Silver Dollar' having more flowers compared to SKYFALL 'Frenne'. The diameter of the inflorescences was smaller in pruned plants and larger in the case of the SKYFALL 'Frenne' variety. Compared to the results of other experiment [5], the diameter of inflorescences of unpruned plants was similar. Other researchers have found similar positive effects of pruning on the growth of ornamental plants. In the experiment by Zhang et al. [13] *Loropetalum chinense* 'Rubrum' plants were subjected to different pruning, and then the relationship between the pruning intensity and the number of flowers obtained was compared. The results confirmed that pruning the plants increased the number of flowers. Also another experiment [16] with pruning roses of different strengths (light, medium and heavy), where with light pruning the number of flowers increased by 68.7% compared to unpruned plants. Additionally, the length of the flower stem increased from 18.0 to 50.7 cm. The above studies show that pruning increases the number of flowers and the length of shoots, which does not fully correspond to the research results obtained for hydrangeas. Because pruning reduced the number of flowers, intensifying plant growth.

4.2. Growth and flowering of plants after application of Trichoderma atroviride

The results of the experiment confirmed that inoculation of plants with *Trichoderma atroviride* had a positive effect on their growth and flowering. In the case of both varieties, pruned plants treated with mycelium obtained the highest total shoot length. A similar relationship was found by Yahya et al. [37] when cultivating *Lantana camara* plants. Plants treated with *T. harzianum* and pruned most

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severely had the greatest height and trunk diameter compared to those pruned less heavily and not inoculated. In the experiment, the number of hydrangea flowers was the highest for inoculated plants, whether they were pruned or not. However, the fresh mass of inoculated plants obtained the highest value in both groups of plants, but only in one of the varieties considered. In turn, research conducted by Di Vaio et al. [27] did not confirm an improvement in the growth of young olive trees grown in containers after foliar application of the fungus *Trichoderma harzianum*. However, better growth of these plants occurred only after using Osmocote slow-release fertilizer. Similarly, Cruz et al. [38] did not show that Trichoderma spp. had an impact on the length of shoots and the quality of flowering of gladiolus. It can therefore be concluded that plant inoculation will not replace soil fertilization in nursery production and that the best results are achieved by combining two treatments [pruning and inoculation].

Taking into account the independent use of the fungus Trichoderma spp., some studies were carried out on various species, e.g. Begonia × tuberhybrida [39] and Kalanchoe sp. [40] confirmed the positive effect of this treatment on the number of flowers. Additionally, Sisodia et al. [41] found longer flowering of selected Gladiolus varieties. Moreover, during the propagation of the GiSelA 6 rootstock, the use of the fungus *Trichoderma harzainum* improved the growth of the root system and the above-ground part of the plants [42]. In the case of annual cucumber plants [43] and lettuce [44] more intensive growth of shoots and roots was confirmed. In turn, Lorito et al. [45] found that the mechanisms supporting the beneficial effects of Trichoderma spp. and stimulation of plant growth were not fully elucidated and were based on the suggestion that this stimulation is related to increased nutrient availability. Some researchers claim that plant growth after applying Trichoderma sp. depends on the plant species and even the variety. For example, Fiorentino et al. [46] showed that the use of two strains of Trichoderma spp. significantly improved the growth parameters of lettuce, without improving the growth of rocket. Moreover, Tucci et al. [47] showed that inoculation of cultivated and wild tomato varieties with *T. atroviride* and *T. harzianum* improved plant yield, but it also depended on the variety tested. Also, the experimental results depended on the species of Trichoderma sp. fungus used, which was observed in relation to mutual associations with Trichoderma spp. on soybean [48]. Additionally, as concluded by Di Marco and Osti [49], the beneficial effects of Trichoderma spp application may be related to the choice of the nursery stage production and the way of application. Their study showed that reducing the dose did not lead to a reduction in the activity of Trichoderma spp. Overall, all types of Trichoderma applications resulted in the growth of the grape root system. Also, research in container cultivation of young poplar trees confirmed the effectiveness of the use of *Trichoderma asperellum* by root application on their height, trunk diameter and dry weight of roots and above-ground parts [50]. Similar results were obtained in the experiment under consideration after root application of *T. atroviride* to Panicle Hydrangea plants. This method of application is much more effective than foliar application used by Di Vaio et al. [27]. Without achieving increased growth of young olive trees in container cultivation in a nursery. On the other hand, Rakibuzzaman et al. [51] in a tomato experiment achieved an increase in post-inoculation tomato dry weight, which they attributed to the combined effect of increased leaf area index, nutrient uptake and photosynthetic intensity.

4.3. Growth and flowering of plants after foliar spraying with fertilizer

Foliar fertilization alone used in the experiment had a clearly positive effect on the fresh weight of plants and the diameter of inflorescences. Additionally, in combination with pruning, it increased the growth of shoots. In another study [52] they showed that foliar application of fertilizers significantly improved the growth of maiden apple trees in nursery. On the other hand, in an experiment with half the dose of soil fertilizer combined with foliar nutrition [53], the content of macroelements in the leaves of maiden apple trees did not significantly change. However, a positive effect of foliar application of biostimulants and fertilizers on the gas exchange parameters of maiden sweet cherry trees was found [54]. From the results obtained regarding foliar fertilization of hydrangeas, it can be concluded that even with the optimal dose of fertilizer applied to the soil, it is worth using it in nursery production, and preferably combined with pruning the plants.

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4.4. Growth and flowering of plants after root application of BlackJak preparation

The use of a preparation based on leonardite (BlackJak) in the experiment had the least effect on the growth and flowering of plants compared to the two above-mentioned treatments. However, it resulted in significantly better results in some growth parameters compared to the control. The activity of humic acids on the growth and development of plants is known [55–57]. Additionally, Demiren [33] found an improvement in the nutritional status of cherry fruits after their use. Hajizadeh et al. [58] achieved an improvement in sugar beet yield by 7% compared to the control. On the other hand, no improvement in fruit size and grape yield was achieved by Olego et al. [34]. In the experiment under consideration BlackJak biostimulator and pruning ambiguously improved the shoot length and fresh mass of plant only of one of the two varieties considered. Its use without pruning the plants also increased the number and diameter of inflorescences only for one of the variety. However, the fresh weight of plants of both varieties improved. The introduction of soil application of humic acids into nursery practice using the example of the BlackJak biostimulator requires further research due to the ambiguity of the results obtained [positive only for one variety].

5. Conclusions

The most beneficial effect of combining two treatments of root application of *Trichoderma atroviride* and plant pruning on improving the growth and flowering of the two tested hydrangea varieties in container cultivation in a nursery was demonstrated. Foliar fertilization with Universol Green fertilizer most effectively influenced the growth of plants, especially their fresh mass and, to a lesser extent, flowering. The use of the BlackJak biostimulator caused the smallest changes in flowering and plant growth compared to the other two treatments, but improved most of the tested parameters compared to the control. Plant pruning resulted in increased shoot growth and fresh mass of the obtained plants, but on the other hand it had a negative impact on the number of flowers and their diameter. The variety with a larger number of flowers was 'Silver Dollar' and the diameter of the inflorescences was SKYFALL 'Frenne'.

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