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Article

The Impact of Two New Types of Quince on the Growth and Efficiency of Maiden Pear Trees

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Abstract

The experiment evaluated the growth and productivity of maiden trees from two pear varieties budded onto two standard quince rootstocks, MA and S1, as well as two new selections temporarily designated as P and P1. Growth was assessed based on maiden tree height, trunk diameter, and the number and length of lateral shoots. Fresh and dry leaf weight, as well as tree weight, were also measured. Additionally, an analysis of macronutrient content was conducted on the leaves of a variety deemed incompatible with quince rootstok ('Clapps Favorite'). The productivity of 'Clapps Favorite' maidens showed no significant variation, ranging from 74.3% to 76.6%. For the second variety, 'Conference', the best efficiency was obtained with the quince rootstock S1 (73.2%), and the worst with P1 (64.2%). Considering height and diameter of stem, maidens grown on the quince rootstocks MA and P showed stronger growth than the other two quince types. For the 'Clapps Favorite' variety, the trunk diameter on the S1 quince rootstock was also similar to that on MA and P. The weakest growth was observed in maidens of both varieties on the P1 quince rootstock. The length and number of lateral shoots varied depending on the rootstock used, but similar patterns were not observed for both pear varieties. Pear maidens with the lowest weight and number of roots were found on the P1 quince rootstock. The two tested varieties had the most roots after budding onto the MA rootstock. The fresh and dry leaf weight of the maidens did not differ significantly depending on the rootstock considered. The exception was the fresh weight of the leaves of 'Conference' maidens, which was highest for quince S1 and lowest for P1. The macronutrient content in the leaves of 'Clapps Favorite' maidens varied, with significantly lower levels observed in the P1 quince rootstock. The highest levels of phosphorus and calcium were found in the leaves of plants grown on the MA rootstock, while the highest levels of potassium and magnesium were found on the S1 quince rootstock. However, the content of these elements did not always differ significantly from that of other rootstocks, with the exception of the P1 rootstock. The P1 rootstock should be considered the most growth-inhibiting for pear maidens among the tested quince rootstock types.

Keywords: nursery; fruit trees production; pear; rootstock; macronutrient

1. Introduction

Alongside apple trees, pear trees are the most commonly cultivated fruit trees in various parts of the world [1,2]. Rootstocks are an irreplaceable element in current fruit tree production for many reasons, including their ability to adapt to specific varieties in different soil and climatic conditions. In fruit production, pear trees are grown on vegetative quince rootstocks or generative rootstocks from the genus *Pyrus* [3–5]. The rootstock used has a significant impact on the growth strength of trees, their flowering, and yield [6–8]. In addition, rootstocks affect the varying susceptibility of trees to stress factors such as poor soil quality in the orchard, the presence of diseases and pests, low and high temperatures, and nutritional problems [6,9–11].

In currently established pear orchards, instead of rootstocks propagated from seeds derived from the genus *Pyrus*, quince rootstocks and other vegetatively propagated rootstocks are mainly used [1,12,13]. Pear trees grown on rootstocks derived from *Pyrus* are characterized by strong growth,

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which makes them more difficult to care for than quince rootstocks [14]. The vigorous growth of these trees delays their entry into fruiting [3,15]. Currently, pear trees are mainly grown on quince rootstocks such as Quince A, Quince C, BA 29, Adams, and Sydo. Quince rootstocks reduce the growth of pear trees, which results in a reduction in the distance between trees planted in the orchard [12]. They cause trees to enter the fruiting period earlier, facilitate maintenance, and improve fruit quality [16]. On the other hand, they reduce the resistance of pear trees to low temperatures, are sensitive to soils with high pH, and are not physiologically compatible with all pear varieties, e.g., 'Clapp Favorit', 'Williams' [3,4,11,13,16]. Symptoms of incompatibility between quince and pear varieties may become apparent as early as the nursery production stage or only during the cultivation of trees in the orchard [11,17–19]. Symptoms of physiological incompatibility in the nursery may include lower efficiency of maiden trees, poorer leaf coloration, and differences in the thickness of the rootstock and the budded variety [3,10,18,19]. Incompatibility causes tree losses and reduces tree survival in orchards [20,21]. Pear tree survival varies depending on the rootstocks and varieties used and decreases with the age of the orchard [19,20,22]. Incompatibility affects the resistance of pear trees to changing climatic conditions [23], the susceptibility of trees to diseases and pests [20,24,25], adaptation to poor soil conditions [26]. Due to the incompatibilities that arise between quince and pear varieties, it is important to determine how a particular rootstock is suitable for budding the pear varieties most commonly grown in the soil and climate conditions of a given country. Revealing the possible incompatibility of a variety with a given rootstock [2,19] is very important for both nurserymen and orchardists. According to Mauro et al. [27], an unsuitable combination of rootstock and pear variety leads to limited tree growth after a few years, which is evident in the case of budding pear varieties onto quince.

The rootstock also influences the mineral content of the leaves. Most often, vigorous rootstocks of the genus Pyrus have a higher mineral content than quince rootstocks [28–30]. It has been proven that vigorous rootstocks have a higher N and Mg content than growth-regulating rootstocks [31].

Various rootstocks for pear trees are currently used worldwide, derived from quince, e.g., MA, MC, MH, BA29, Adams, Sydo, and derived from Pyrus, such as Pyrodwarf, OHxF, Farold, Fox. They are the result of breeding programs conducted around the world [2,13,32] Compatibility with pear varieties and tolerance to diseases, especially fire blight, are important factors in the selection of rootstocks for pear trees [33,34].

When propagating in a nursery, it is important to select a good variety that will ensure successful cultivation and to choose rootstocks that are suitable for the specific growing conditions [35]. The interaction between the variety and rootstock affects the hydration, photosynthesis, growth, and yield of trees in the orchard [29,36].

The experiment evaluated the growth of maiden pear trees of two pear varieties, one considered incompatible with quince 'Clapps Favorite' and one compatible 'Conference' budded onto two known quince rootstocks suitable for MA and S1 cultivation, as well as two new ones selected and provisionally designated as P and P1, which originate from free pollination of S1 quince and several years of selection of seedlings obtained. The study evaluated the growth of the maiden pear trees, their efficiency, and the macronutrient content in the leaves of the incompatible variety 'Clapps Favorite'.

2. Material and Methods

The experiment was conducted in 2023-2024 years at a nursery belonging to the University of Life Sciences in Poznań. Two two-year cycles of production of maiden trees of two pear varieties, 'Clapps Favorite' and 'Conference', were carried out on four rootstocks: quince MA and S1, P and P1 (the first letter of the name of the city of Poznan). The experiment was set up in a randomized block design, with four replicates of 20 rootstocks per plot for each quince type tested. The soil on which the experiment was conducted was of the podzolic type, and the mineral content of the soil was as follows: P- 106, P- 179, Ca-614, Mg- 243 mg·100g of soil, pH 6.2. The amount of rainfall in 2023 was 445 mm, and in 2024-510 mm. The rootstocks were propagated in our own nursery by vertical

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layering. They were planted twice in the nursery in March 2023 and 2024. The rootstocks were budded at the beginning of August using the T-budding method, 10 cm above the ground. In the second year of cultivation, the maiden trees were grown without stakes. Weeds were controlled with herbicides. Nitrogen fertilization was applied in three equal doses, totaling 120 $N \cdot ha^{-1}$ in March, May, and June. During periods of prolonged drought, the nursery was irrigated four times at a dose of 20 $mm \cdot m^{-2}$.

At the beginning of August 2024, 20 fully developed leaves (from 5 maiden trees per plot) were randomly collected from the middle part of the long shoots in order to analyze the content of macroelements in the leaves (% of dry weight). The procedure for determining the content of macroelements in leaves is described in the publication [37]. In mid-October, biometric measurements of the growth of 10 randomly selected plants per plot were performed. The height (cm), stem diameter 10 cm above the budding site, and the length of side shoots were measured, and their number was counted. Before digging up the plants, the fresh weight (g) of leaves picked from five randomly selected maiden trees in each plot was weighed. They were then dried at 60°C for 2 days to determine the dry weight of the leaves. After digging up, the weight of the entire all maiden pear trees (kg) was determined.

The results of the measurements obtained maiden pear trees and the macronutrient content in the leaves were statistically analyzed using one-way analysis of variance for each variety separately. Duncan's test was used at a significance level of α=0.05. The results shown in the figures are averages from two years of research.

3. Results

The percentage of maiden pear trees obtained for the 'Clapps Favorite' variety differed significantly depending on the type of quince used. The best maiden trees efficiency was obtained on quince S1 rootstock (73.2%), which did not differ from MA (69.5%) and was significantly better than P (65.7%) and P1 (64.2%), (Figure 1). In the case of the 'Conference' variety, however, the type of quince did not affect the efficiency of maidens, and the following results were noticed for quince S1 (77.8%), MA (76.6%), P (75.0%), and P1 (74.3%), (Figure 1).

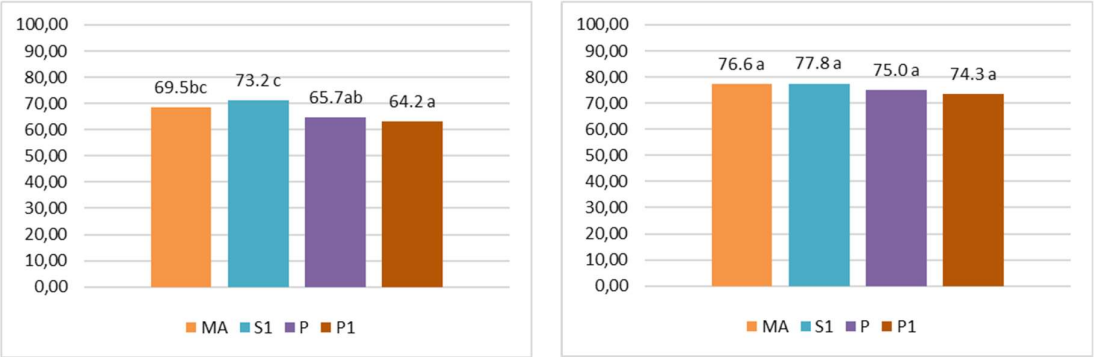

Figure 1. Percentage of the obtained maiden pear trees 'Clapps Favorite' variety (left) 'Conference' variety (right) depending on the type of quince rootstock. The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

Among the four types of quince tested as rootstocks for the 'Clapps Favorite' variety, the maiden pear trees on MA and P quince rootstocks were significantly the tallest, at 119.1 cm and 116.5 cm, respectively. The maidens on the S1 rootstock were shorter, at 107.1 cm. Significantly, the lowest maiden pear trees were found on the P1 rootstock (100.5 cm) (Figure 2). The tallest plants of the 'Conference' variety were obtained when budded onto the P and MA rootstocks, 117.0 cm and 113.5 cm, respectively. The maiden trees on the S1 and P1 rootstocks were significantly lower, with heights of 93.8 cm and 92.8 cm, respectively (Figure 2).

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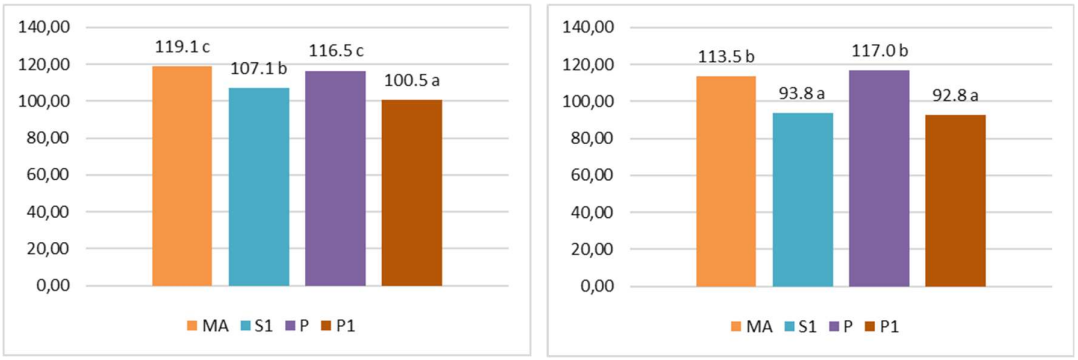

Figure 2. Height (cm) of the maiden pear trees 'Clapps Favorite' variety (left) 'Conference' variety (right) depending on the type of quince rootstock . The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

The largest stem diameter of the 'Clapps Favorite' variety was found in maiden pear trees on the S1 and P quince rootstocks, 15.6 mm and 15.8 mm, respectively. Plants grown on the MA rootstock had a significantly smaller diameter (14.9 mm), and the smallest was P1 (12.4 mm) (Figure 3). Among the maiden trees of the 'Conference' variety, the largest diameter was recorded for the MA and P rootstocks, with values of 14.4 mm and 14.5 mm, respectively. Significantly smaller diameters were obtained for trees grown on the S1 rootstock, which was 12.4 mm. The smallest diameter was observed in maiden trees on the P1 rootstock (11.6 mm) (Figure 3).

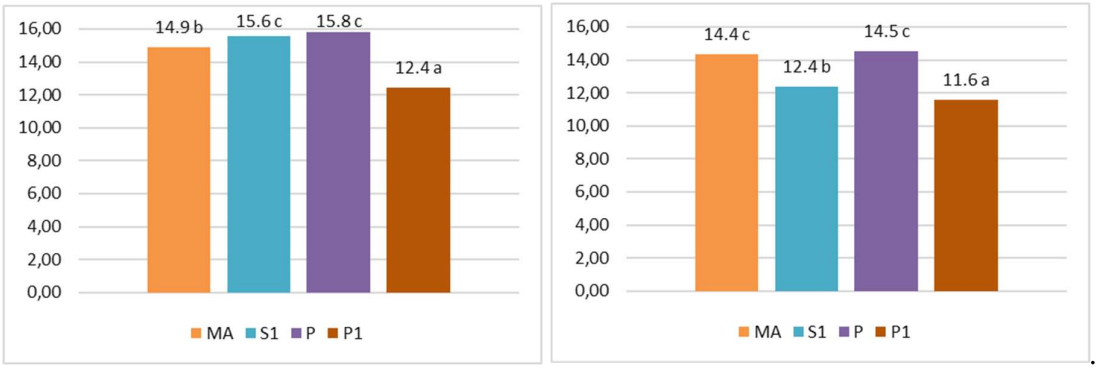

Figure 3. Diameter (mm) of the maiden pear trees 'Clapps Favorite' variety (left) 'Conference' variety (right) depending on the type of quince rootstock. The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

The longest lateral shoots of the 'Clapps Favorite' variety were found in maiden pear trees grown on P and P1 rootstocks, 11.7 cm and 11.6 cm, respectively. Maiden trees on the S1 rootstock had significantly shorter shoots (9.6 cm). The shortest shoots were found on the MA rootstock (1.6 cm), (Figure 4). The longest side shoots of the 'Conference' variety compared to the other rootstocks tested were found on the P1 quince rootstock (21.0 cm). Shoots on MA and S1 rootstocks were shorter, measuring 9.1 cm and 8.4 cm, respectively. The smallest growth of lateral shoots was observed on maiden trees on P rootstock (5.2 cm) (Figure 4).

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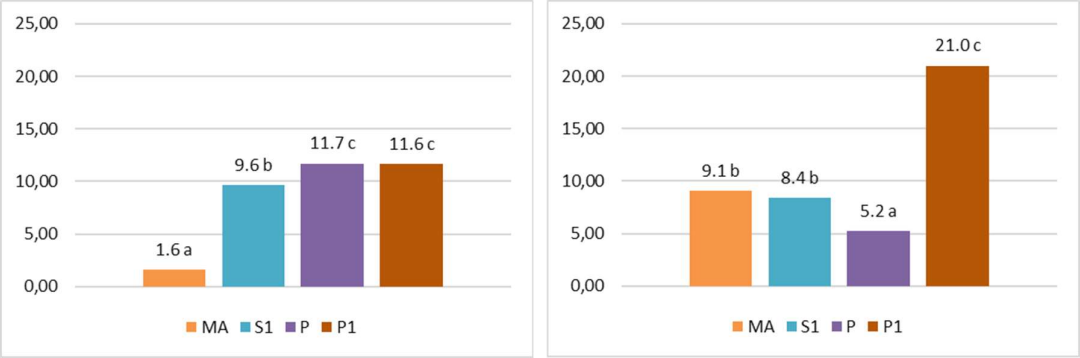

Figure 4. Long of side shots (cm) of the maiden pear trees 'Clapps Favorite variety (left) 'Conference' variety (right) depending on the type of quince rootstock . The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

The number of lateral shoots of 'Clapps Favorite' maiden trees varied significantly depending on the rootstock tested. The highest number of shoots was estimated for the P rootstock, followed by plants grown on the P1, S1, and MA quince rootstocks, respectively (Figure 5). In the case of the 'Conference' variety, the four quince rootstocks considered did not have a significant effect on the examined parameter of maiden trees growth, and the number of shoots ranged from 0.75 to 0.48 (Figure 5).

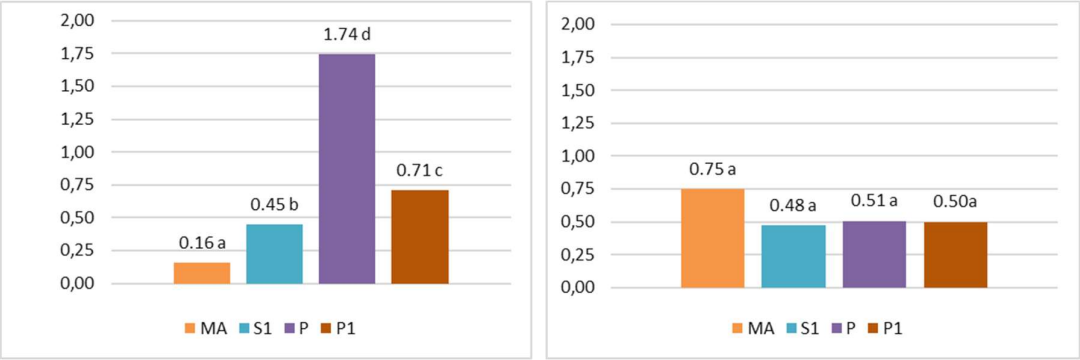

Figure 5. Number of side shots of the maiden pear trees 'Clapps Favorite' variety (left) 'Conference' variety (right) depending on the type of quince rootstock. The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

The fresh weight of the 'Clapps Favorite' maiden trees obtained on the P quince rootstock was significantly the highest (0.50kg), and significantly the lowest on the P1 quince (0.35kg). However, the weight of the 'Conference' maiden trees on the MA and P quince rootstocks (0.39-0.41kg) was higher than on the S1 and P1 quinces (0.32-0.35kg), (Figure 6).

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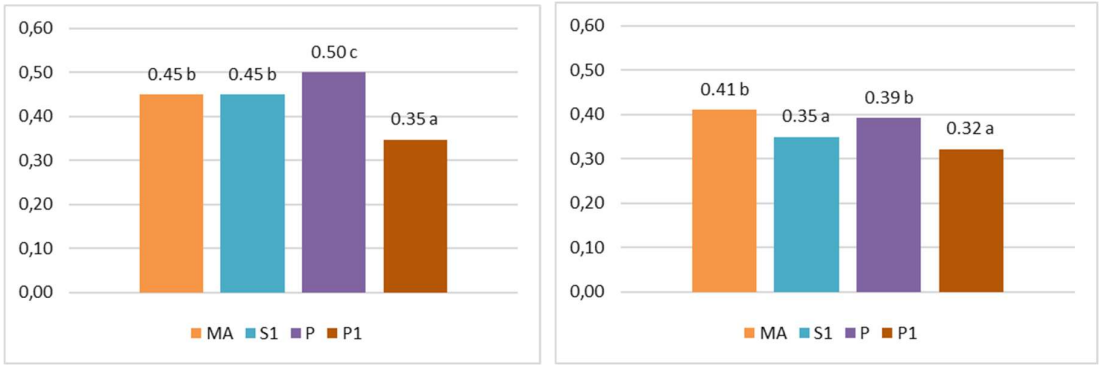

Figure 6. The fresh weight (kg) of the maiden pear trees 'Clapps Favorite' variety (left) 'Conference' variety (right) depending on the type of quince rootstock. The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

The highest number of roots of maiden trees for both varieties was obtained for the MA quince rootstock, with 12.9 for the 'Clapps Favorite' variety and 12.2 for the 'Conference' variety. This was followed by decreasing results for quince S1 (10.7) for both varieties, and for quince P 10.5 and 10.6, respectively. Significantly, the lowest number of roots was found for quince P1, respectively for the 'Clapps Favorite' variety 10.1 and 'Conference' 9.0 (Figure 7).

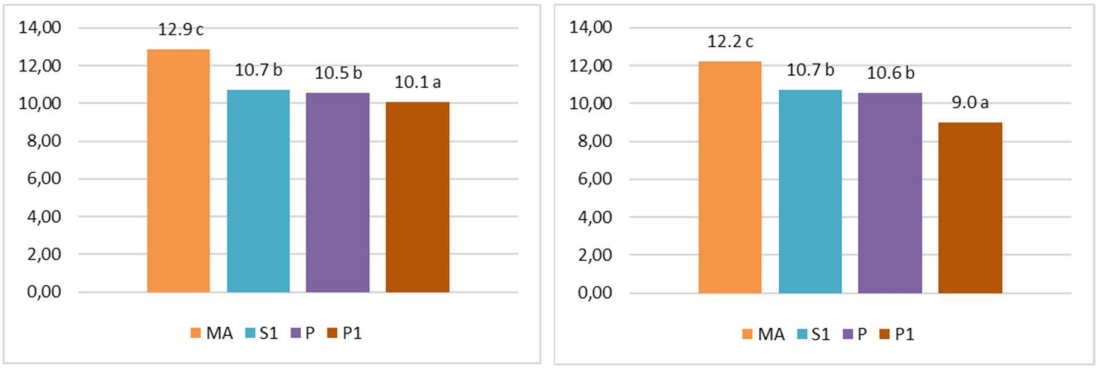

Figure 7. Number of roots of the maiden pear trees 'Clapps Favorite' (left) 'Conference' (right) depending on the type of quince rootstock. The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

The fresh leaf weight (g) for the 'Clapps Favorite' variety for individual quince types did not differ significantly in terms of results and ranged from 77.5 g (S1) to 73.3 g (P1) (Figure 8). In the case of the fresh leaf weight of the 'Conference' variety, differences in the results obtained for individual rootstocks were found. The highest weight was obtained for the S1 quince rootstock (71.2 g). The results for the other quince types were lower and amounted to 68.5 g for MA, 64.7 g for P, and 63.2 g for P1 (Figure 8).

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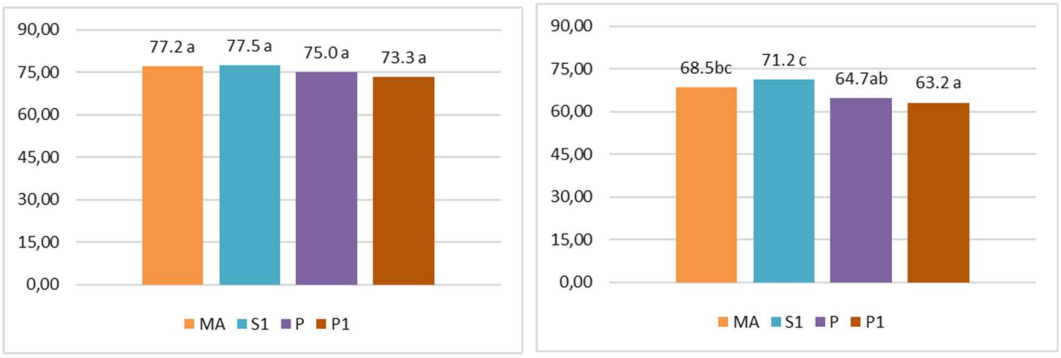

Figure 8. Fresh weight of leaves (g) of the maiden pear trees 'Clapps Favorite' variety (left) and 'Conference' variety (right) depending on the type of quince rootstock. The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

In the case of the dry weight of the leaves of the 'Clapps Favorite' variety, no rootstock significantly differentiated the values obtained, which ranged from 33.8 g for the P quince rootstock to 32.0 g for the MA quince (Figure 9. Similarly, for the second variety tested, 'Conference', the results did not differ significantly and ranged from 31.2 g to 29.5 g (Figure 9).

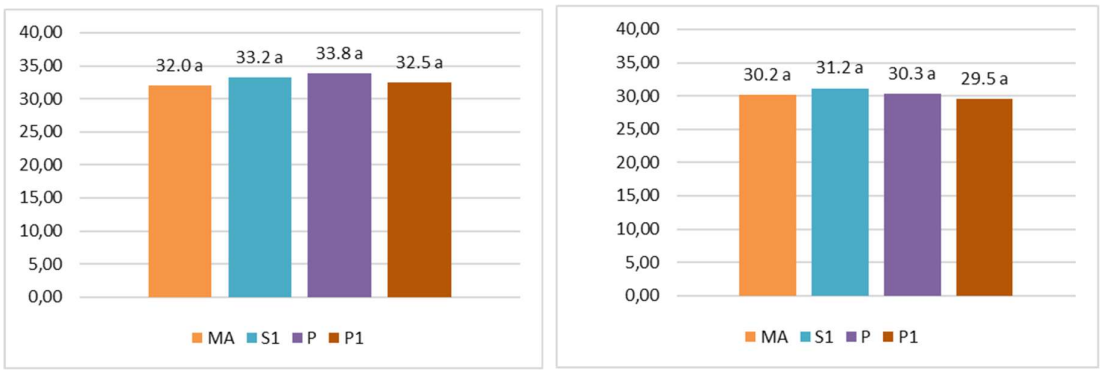

Figure 9. Dry weight of leaves (g) of the maiden pear trees 'Clapps Favorite' variety (left) and 'Conference' variety (right) depending on the type of quince rootstock. The means marked with the same letters within each of the varieties separately do not differ significantly at the level α=0.05, and using Duncan's test.

The P content in the leaves of the 'Clapps Favorite' variety for quince MA (0.55%) and S1 (0.54%) was significantly higher than for the other two quinces, P (0.49%) and P1 (0.47%) (Figure 10. Only quince P1 had a significantly lower K content (2.10) compared to the other quince types (2.13-2.15%) (Figure 10. The Ca level in the leaves of maiden trees grown on quince MA (2.21) was significantly higher than in the other rootstocks (2.12-2.15%) (Figure 11. The highest Mg level was found for quince S1 (0.59%), the lowest for P1 (0.53%), and only the values obtained for the latter rootstock differed significantly from S1 (Figure 11.

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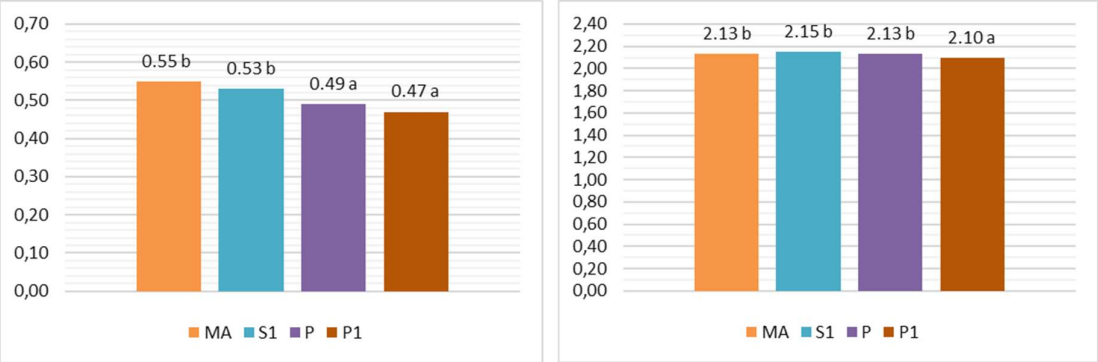

Figure 10. The content of macronutrients in the leaves (% of dry weight) of the maiden pear tree 'Clapps Favorite' variety (P on the left) and (K on the right) depending on the type of quince rootstock. The means marked with the same letters do not differ significantly at the level α=0.05, and using Duncan's test.

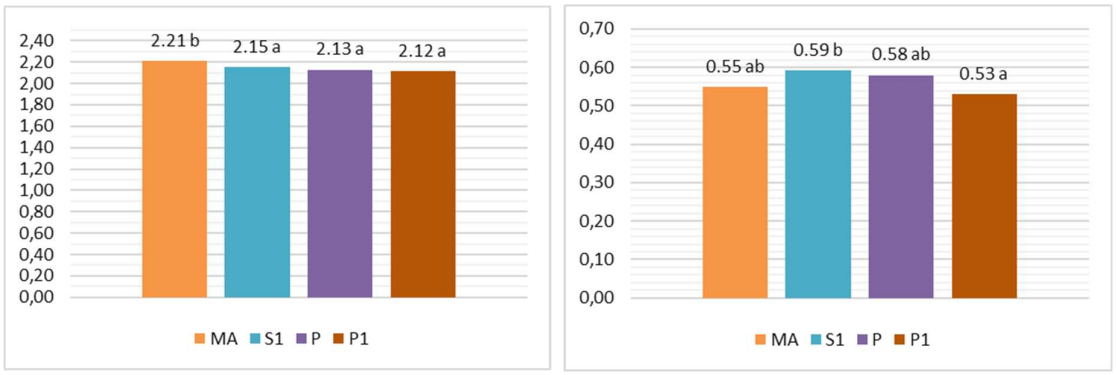

Figure 11. The content of macronutrients in the leaves (% of dry weight) of the maiden pear tree 'Clapps Favorite' variety (Ca on the left) and (Mg on the right) depending on the type of quince rootstock. The means marked with the same letters do not differ significantly at the level α=0.05, and using Duncan's test.

4. Discussion

In line with the results of researches by other authors [19,22,38,39] rootstocks have an impact on the number of maiden pear trees obtained. The experiment showed that the different types of quince used had a significant impact on the number of pear maidens obtained from the 'Clapps Favorite' variety. Significantly lower maiden trees efficiency were noticed for the new quince types P and P1 compared to quince S1, which had the best results. However, for the 'Conference' variety, no differences in maiden trees efficiency were found. In research by Nečas and Lébl [40], a very high efficiency of 'Conference' plants grown on two types of quince, MA and S1, was found, amounting to 98-100%. Ozturk [22] also obtained an average of 91% bud acceptance on MA quince for several pear varieties tested. Serttas and Ozturk [39] reported bud acceptance ranging from 86.7 to 100.0% for various vegetative rootstocks. Rathore et al. [41] also obtained high bud acceptance rates for several pear varieties budded onto MC and BA29 quince rootstocks, ranging from 90.00% to 96.67%. On the other hand, Rahman et al. [19] found lower bud take (84.5%) for six pear varieties tested on an unknown type of quince. In our own experiment for 'Conference' maiden trees, an average efficiency of 75.9% was obtained for four types of quince. A lower efficiency was found for the 'Clapps Favorite' variety, with an average of 68.2%. An even lower percentage of bud acceptance was obtained by Irisarri et al. [42] for the 'Conference' variety on BA29 quince rootstock (65.1%). However, in the opinion of these authors, pear varieties differ in their compatibility with quince, hence the varying success rates of budded buds. According to some researchers, air temperature and humidity also have a significant impact on the acceptance of budded buds [10,11,43]. In particular, temperatures between 12 and 32°C during the first two weeks after budding promote good bud

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acceptance [10]. This causes callus formation and the bud to fuse with the rootstock. From a botanical point of view, the closer the relationship between the rootstock and the variety budded onto it, the higher the success rate of the budding procedure [10,44]. However, ultimately, many factors can influence this, including ecological, physiological, morphological, and genetic factors. In addition, the growth phase of the rootstock, the time of budsticks collection, the budding technique, and the skill of the person performing the budding procedure are also important. A low percentage of buds acceptance under appropriate care conditions and climatic conditions, or a slow growth rate of buds, may be due to physiological incompatibility between the rootstock and the variety [10,44]. Variable survival rates of maiden trees may be the result of varying levels of compatibility between the variety and the rootstock [45]. In the experiment under consideration, the 'Clapps Favorite' variety yielded a lower average percentage of maiden trees, which may indicate a lower affinity of this variety with the rootstocks tested. On the other hand, maiden trees survival is not synonymous with potential tree losses in the orchard, as incompatibility sometimes only becomes apparent after several years of tree growth in the orchard [18,43,46]. Kurt et al. [21] obtained a survival rate of 'Williams' pear trees on MC-50 quince rootstocks of % and MA-63 of % after three years of cultivation in the orchard. In another experiment, Hudina et al. [20] found that the compatibility of four-year-old pear trees on MA quince was 100% and on BA quince 92%. Physiological incompatibility eliminates the use of a given rootstock and requires the use of an interstem [32,47]. It should be noted that the number of maiden trees obtained (own research) is always lower than the number of buds accepted (research by other authors mentioned above), as during the annual cultivation of plants, there are losses in plant density due to random factors (wind, drought, mechanical damage). The survival rate of maiden pear trees in the nursery in the experiment under consideration was lower than that reported by Ozturk [22], who obtained an average of 88.0% for a dozen or so pear varieties grown on quince, and lower than that reported by Kobelus [48] – 85% on several types of quince. On the other hand, Rahman et al. [19] found a significantly lower survival rate of maiden trees in a nursery grown on quince, which was 55.9% for several varieties studied. The varieties considered by these authors also had varying survival rates ranging from 44.6% to 73.1%, which was confirmed in the consider experiment. According to some authors [41,49–51], the rootstock has a more significant impact than the variety on the acceptance of buds and, as a result, on the efficiency of maiden pear trees. This relationship was found in our own experiment only in the case of the 'Clapps Favorite' variety, where quince types varied in efficiency.

In the consider experiment, the height of maiden pear trees varied depending on the type of quince used, ranging from 107 cm to 119 cm for the 'Clapps Favorite' variety and from 93 cm to 117 cm for the 'Conference' variety. Other authors have also noted the influence of rootstocks on the variable growth of maiden pear trees [22,41,52]. Similar to the experiment in question, Milošević and Milošević [53] found the height of maiden trees of the 'Conference' variety on MA quince (118.5 cm). Rathore et al. [41] also reported a similar height of plants of four pear varieties for MC and BA29 quince, which ranged from 99.3 cm to 111.4 cm. Nečas and Lébl [40] obtained a lower height of maiden pear trees of the 'Conference' variety on MA and S1 quince rootstocks, at 100 cm. Ozturk [22] found an even lower height of maiden pear trees for several varieties budded onto MC rootstock, with an average of 82.6 cm. However, it should be emphasized that MC quince is considered the slowest growing of the known quince types. On the other hand, according to this author, the same varieties obtained on MA quince had a height of 145.9 cm, which is significantly higher than that obtained in the experiment under consideration. Jacyna [54] also obtained an average height of 149 cm for the 'Clapps Favorite' variety grown in a nursery on MA quince rootstock. In our own experiment, we found a significantly lower height of 'Clapps Favorite' maiden trees on MA quince (113.5 cm). Kobelus [48] obtained a much lower height for 'Conference' maiden pear trees budded onto several types of quince, only 84 cm. An even lower height was obtained by Rahman et al. [19], who found the height of several maiden pear varieties on quince rootstock to be only 73.7 cm. The differences in the height of the maiden trees in the various experiments compared may have resulted

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from genetic differences between the varieties and rootstocks observed, and in particular from the level of maiden trees care and soil and climatic conditions [55].

The results of maiden pear trees stem diameter obtained in the experiment varied, and both the rootstock and variety used had an impact on this parameter. Depending on the rootstock, maiden trees of the 'Clapps Favorite' variety had a diameter ranging from 15.8 mm to 12.4 mm, and those of the 'Conference' variety from 14.5 mm to 11.6 mm. Nečas and Lébl [40] found stem diameters above 16 mm for the 'Conference' variety on MA and S1 quince rootstocks. In contrast, Lewko et al. [56] obtained an average stem diameter of 13.7 mm for two pear varieties budded onto three types of quince rootstocks (MA, S1, and BA29), which was similar to the value obtained in the experiment discussed here. Nečas and Lébl [40] observed a larger diameter on the S1 rootstock than on the MA rootstock, while Lewko et al. [56] found the opposite relationship between diameter and these two rootstocks. In the experiment discussed, the budded varieties had different diameters depending on the rootstock used. For the 'Clapps Favorite' variety, trees on S1 quince had a larger diameter, and 'Conference' trees on MA quince had a larger diameter. This did not confirm the constant growth ratio obtained by the pear varieties budded onto the same types of quince. In another experiment, Jacyna [54] obtained a diameter of 13.1 mm for the 'Conference' variety budded onto MA quince, which was worse than his own result (14.9 mm). Milošević and Milošević [53] found the stem diameter of the 'Conference' variety on MA quince rootstock to be only 10 mm. In contrast, Ozturk [22] obtained an average diameter of 21.2 mm for several pear varieties cultivated onto MA quince rootstock and 15.2 mm for MC quince rootstock, which were significantly better results than in the experiment under consideration. However, this author studied completely different varieties and under different soil and climatic conditions. Other authors obtained maiden pear trees stem diameters ranging from 9.8 to 13.2 mm for different pear varieties on a single quince rootstock [19]. Some researchers found no difference in the effect of rootstock and variety on the diameter of the budded trees [57]. As stated by many authors, the diameter of maiden pear tree stems is the result of several factors, including the genetic conditions of the variety and the care measures carried out in the nursery [19,38,57], hence the difficulty in comparing the results of researches by different authors.

The length of lateral shoots obtained in the experiment varied depending on the rootstock, ranging from 9.6 cm to 11.7 cm for the 'Clapps Favorite' variety and from 5.2 cm to 21.0 cm for the 'Conference' variety. The number of lateral shoots observed was small and only for the 'Clapps Favorite' variety was it significantly dependent on the rootstock. The best value for quince P and the 'Clapps Favorite' variety was 1.74, and for the second variety, 'Conference', for quince MA, it was 0.75. An equally small number of shoots of the 'Clapps Favorite' variety (0.35) on the MA quince rootstock was found by Jacyna [54]. In contrast, Milošević and Milošević [53] obtained an average of 2 lateral shoots for the 'Conference' variety on MA rootstock. Other authors, under different soil and climatic conditions, found a greater number of lateral shoots, but they observed other pear varieties. For example, Rahman et al. [19] found 2 to 4.5 shoots for maiden trees of different varieties grown on quince rootstock. Ozturk (2021) obtained an average of 3.5 lateral shoots for MC quince rootstock and 5.4 shoots for MA quince rootstock for several pear varieties. Rathore [41] found that four pear varieties on BA29 quince rootstock had between 1.88 and 3.44 shoots, while those on MC quince rootstock had between 2.11 and 3.44 shoots. In general, variations in the number of lateral shoots were found in maiden pear trees depending on the rootstock [9,19,42,57–59]. In the experiment conducted, no significant variation was found between the varieties studied. Thus, the observations of other authors [58,60,61] that rootstocks influence the branching of maiden trees because they differentiate the growth of the budded variety. However, the opinions of other researches [62–64] that in the first year of growth it is difficult to obtain branched maiden apple and pear trees on dwarf rootstocks.

The quality of the root system, determined in the experiment by the number of roots, favored MA and P quince rootstocks, which was reflected in the growth of maiden trees, especially of the 'Clapps Favorite' variety. It has already been proven that the amount of nutrients taken up by the root system from the soil, which is determined by the type of rootstock root system, plays a key role

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in their availability to the plant [65,66]. The uptake of larger amounts of nutrients, in turn, intensifies the growth of maiden trees. This relationship was confirmed in the consider experiment.

Leaves are the most important tool for transpiration and photosynthesis in plants, which vary in their distribution, size, and anatomy in different environments [67]. According to Warrington et al. [68], stronger rootstocks have a larger leaf area than dwarf rootstocks. It has been proven that both the budded variety and the rootstock affect the number of maiden tree leaves [68,69] and their area [41]. In the experiment conducted for maiden trees of the 'Clappps Favorite' variety, differences in fresh and dry leaf weight were obtained. The two quince rootstocks MA and S1 had a higher leaf weight than quince P and P1. However, this was not always associated with stronger growth of maiden trees of this variety, as maiden pear trees on quince P grew as strongly as on MA. In contrast, for the 'Conference' variety, the leaf weight results were not significantly different, while the growth of maiden trees was significantly different. A similar result was obtained by Coban and Ozturk [70], who found significant differences in the leaf area of maiden trees depending on the quince rootstock for the 'Williams' variety, but not for the 'Deveci' variety. It has been proven that in the case of maiden pear trees, differences in vegetative development under the same environmental conditions depend on the different genetic structure of the varieties [71].

The point of connection between the rootstock and the scion can sometimes act as a region of selective transport of macronutrients from the root to the shoot of the cultivated variety. Sometimes this also hinders the movement of organic compounds produced in the scion to the rootstock [16]. This can manifest as thickening at the junction of these two parts of the fruit tree. However, according to some authors [16,41], slight overgrowth is not always a sign of incompatibility. Changes in mineral content can be confirmed by chemical analysis of leaves, which was performed in the experiment in question for a variety potentially incompatible with quince ('Clapps Favorite'). The results did not confirm a large variation in the macronutrients content in the leaves of maiden pear trees of the 'Clapps Favorite' variety depending on the rootstock used. It was observed that for all macronutrients, the lowest content was recorded for maiden trees grown on quince P1, which was due to their weaker growth, which differed significantly from the other three types of quince. The only exception was the length of side shoots, which was greatest for quince P. It should be noted that the macronutrients content of P, K, Ca, and Mg in the leaves obtained in the experiment was above the high level, which, according to the recommendations of Leece [72] and Bright [73], is P> 0.30, K> 2.0, Ca >2.5, Mg >0.50, respectively. This indicates a comfortable supply of essential macronutrients to the maiden trees. In the experiment under consideration, the macronutrient content was twice as high as in the studies by Lewko et al. [74], who obtained 0.22 and 0.21% P, 1.70 and 1.63% K, 1.23 and 1.13 Ca, and 0.27 and 0.24 Mg, respectively. The authors of the above study found only a difference in the Ca content in the leaves of maiden pear trees depending on the type of quince. The slower-growing MC quince type had a lower content of this element than the faster-growing S1 quince. Ikinici et al. [75] also found no differences in P and K content and differences in Ca and Mg content among three types of quince (MA, MC, and BA29). The slower-growing MC type had significantly lower content of these elements than the BA29 quince type. The macronutrient contents obtained by these authors were also slightly lower than in the experiment under consideration and amounted to P-0.14-0.18%, K-1.27-1.44, Ca-1.38-1.67, Mg-0.36-0.45%. However, the results obtained came from five-year-old pear trees of the 'Santa Maria' variety. All this confirms the influence of rootstock and environmental conditions on the mineral content in maiden pear tree leaves [75,76]. In addition, it has been proven that rootstocks that reduce the growth of maiden pear trees have a lower K and Mg content compared to stronger growing rootstocks [75,77]. The reduction in the content of these elements in the leaves of maiden trees growing on the P1 quince rootstock confirmed its weaker growth observed in maiden trees based on the height, trunk diameter, and weight of the maiden trees obtained.

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5. Conclusions

Based on the results obtained for the growth of maiden pear trees on the tested types of quince, it can be concluded that they differed in their growth strength. The use of MA and P quince rootstocks resulted in stronger growth of maiden pear trees than those grown on S1 and P1 quince rootstocks. The efficiency of 'Conference' maiden trees did not vary, which confirmed its physiological compatibility with the quince rootstocks considered at the nursery production stage. However, the compatibility of the 'Clapps Favorite' variety, especially with new types of quince, requires further research, also at the stage of pear tree growth and yield in the orchard. The two new quince types tested are promising, especially type P1, which reduced the growth of maiden pear trees compared to the control types MA and S1. However, further research on new types with other pear varieties is needed to confirm or refute the observed relationships.

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