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# THE EFFECT OF SUMMER SEEDLING PLANTING DATES ON THE DEVELOPMENT OF SEED STALKS IN SHALLOT (*Allium cepa* L. var. *ascalonicum* Backer)

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**Abstract.** Up-to-date production of shallots for commercial purposes was limited due to low supply of the seeding material as well as no breeding cultivars that would produce seeds. Local populations commonly grown in various countries are reproduced mainly in vegetative way, because they usually do not produce generative shoots nor seeds, or they are formed, but in a very reduced number. The aim of this study, conducted in the period 2009–2012, was to evaluate generative growth and seed production in shallot grown from seedlings planted in summer at different dates, without producing mother bulbs. The study included 4 shallot cultivars – 'Toto', 'Ambition $F_1$', 'Bonilla $F_1$', and 'Matador $F_1$'. Seedlings (4 weeks old) were planted in the field on three dates – 3rd decade of July, 1st decade of August, and 3rd decade of August. In the second year of cultivation, after the plants had overwintered in the ground, losses in plants, the percentage of plants producing seed stalks and some traits of these stalks as well as seed yield in the true breeding cultivar 'Toto' were determined. Plants of the other cultivars were not allowed to produce seeds (inflorescence umbels were topped before flower opening), since these were hybrids and undesired cross-breeding could occur. The study showed that overwintering losses in plants were on average 26.3%, but they were the lowest in cv. 'Toto', in particular among plants obtained from the first date of planting seedlings. Irrespective of the cultivar, the largest amount of plants with developed seed stalks and with their highest number per plant were recorded in the treatments where the first planting date was used. A delay in planting seedlings in the first year of cultivation by 2–4 weeks had a significant effect on reducing the percentage of plants developing seed stalks in the second year, while in cv. 'Toto" it resulted in a very high decrease in seed yield.

**Key words**: shallot cultivars, characteristics of seed stalks, seed yield

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## INTRODUCTION

Many years of research on yield and quality of shallot onions of different varieties and populations have allowed the researchers to identify many traits that determine the excellent adaptation of this plant to various climate and soil conditions. As a result of that, this onion is known and appreciated in countries with both hot and cold climates [Brewster 1994, Permadi 1994, Cohat et al. 2001, Tendaj 2005, Răduica and Popescu 2010, Awale et al. 2011, Brink and Basuki 2012].

Existing commercial production of shallot in Poland has been limited due to low supply of seed material and the lack of seed-producing cultivars. Local populations commonly grown in different regions of the country are propagated primarily vegetatively, since mostly they do not produce generative shoots and seeds or they appear in a scarce number. However, long-term vegetative propagation leads to plant degeneration and intensification of diseases of fungal, bacterial, and viral origin [Kotlińska 1995, Tendaj and Piusińska-Siedlecka 1999, McDonald et al. 2004, Tendaj 2005, Tabor et al. 2006].

The essential condition for the spread of shallot cultivation in Poland is the availability of seeds with high parameters of the seeding value. The commercial offer includes seeds of hybrid ($F_1$) of foreign origin which are not reproduced in Poland. The only Polish cultivar 'Toto' is still not very popular in cultivation, but its commercially important traits and generative growth should be evaluated with a view of producing seeds of desired seeding value.

The aim of this study, conducted in the period 2009–2012, was to evaluate the possibility of growing shallot for seed from seedlings planted in summer at different dates. The study was to determine the possibility of overwintering of shallot plants and to show the effect of the seedling planting date on such cultivation. In plants that started growth in spring of the following year, observations were to be made of the growth and development of generative shoots as well as of their traits that might have an effect on seed production.

## MATERIALS AND METHODS

The study carried out during the period 2009–2012 in horticultural farm (51°18'N, 22°45'E) located near Lublin. Experiments included four shallot cultivars – three of them were hybrids ('Ambition $F_1$', 'Bonilla $F_1$', 'Matador $F_1$') (Bejo Zaden) and one was a true-breeding cultivar ('Toto') bred by the company PlantiCo Zielonki.

Shallot was grown from seedlings planted in summer. Seedlings were produced in a greenhouse by sowing seeds in highmoor peat substrate. Three seedling planting dates were used in the experiment and seedling production lasted about 4 weeks. Before planting, plants reached the 2–3 leaf stage and a height of ca.12 cm.

Depending on the seedling planting date used in the experiment (I, II, III), the planting dates in the successive years of cultivation were as follows:

– 28 July 2009 (1st date), 10 August 2009 (2nd date), 31 August 2009 (3rd date);
– 23 July 2010 (1st date), 6 August (2nd date), 27 August (3rd date);
– 22 July 2011 (1st date), 8 August (2nd date), 23 August 2011 (3rd date).

In the tables, these dates are designated as the 3rd decade of July, 1st decade of August, and 3rd decade of August.

Before planting seedlings, the soil was loosened with a rototiller to a depth of about 15 cm, at the same time mixing with the soil a compound fertilizer, Azofoska, at a rate of 10 kg·100 $m^{-2}$. Azofoska is distinguished by the proportion of N : P : K nutrients (1 : 0.5 : 1.4) that is beneficial to onions and, additionally, it contains micronutrients such as: B, Cu, Fe, Mn, Mo, and Zn. Each year in the spring, in the first or second 10-day period of April, top dressing was applied using the same fertilizer at a rate of 5 kg·100 $m^{-2}$. The field was prepared in accordance with the general recommendations for the cultivation of common onion grown from seedling [Brewster 1994].

The experimental plots had an area of 3 $m^2$ (1.5 × 2 m) and 100 plants were planted in them at a spacing of 30 × 10 cm. The number of experimental replications was 3.

Each year in autumn, in the second decade of November, the number of plants in the plots was recorded and this operation was repeated in spring of the following year (the third decade of March in 2010 and the first decade of April in 2011 and 2012). This allowed determining the percentage of plants that resumed growth after overwintering as well as their losses.

Observations of the growth and development of plants were carried out during the growing season until the complete formation of inflorescence umbels. Before the opening of flowers in umbels of plants of the hybrid cultivars, all inflorescences were removed to prevent their pollination. Only generative shoots of the true-breeding cultivar 'Toto' were left to produce seeds. The proportion of plants that produced generative shoots as well as their number per plant and height were determined during plant growth. In the cultivar 'Toto', the weight of seed umbels after drying and seed yield were determined depending on the seedling planting date.

## RESULTS AND DICUSSSION

Shallot plants grown from seedlings planted in summer overwintered well in the following two autumn and winter seasons – 2009/2010 and 2011/2012. Plant losses found in the spring were on average 12.6% in 2010 and 2.0% in 2012 (tab. 2). Very high plant losses were recorded in the spring 2011. They were caused by exceptionally adverse weather conditions after seedlings were planted in the summer 2010. Total rainfall from July to September, i.e. during the period when plants should become well rooted after planting, exceeded the long-term mean for this area by almost 100% (tab. 1). In addition, the plants, which had rooted poorly in the autumn 2010, were subjected to rather low temperatures in the period between December 2010 and March 2011. The thinner snow cover, compared to the other years, also promoted the death of plants. Such weather conditions caused high plant losses and, as a consequence, this resulted in lower seed yield per unit area compared to the yield obtained in 2010 and 2012 (tab. 6).

Similarly as in common onion, in shallot bolting, which leads to seed production, is a result of undergoing vernalization. According to the study of Tabor et al. [2005], shallot plants cv. 'Matador $F_1$' (long-day variety) as well as 'Tropix' and 'Roxy $F_1$' (short-day varieties) produced seed stalks after vernalization at the 6–12 leaf stage, i.e. after

90–120 days from planting seedlings. The study showed that plants vernalized at an older age were characterized by an earlier formation of inflorescences and a larger number of them. This is also confirmed by the study of Krontal et al. [1998] which

Table 1. Average daily temperature and total monthly rainfall during the study period relative to the long-term mean

| Weather factor | Year | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Temperature (°C) | 2009 | -2.7 | -1.2 | 1.4 | 11.4 | 13.6 | 16.4 | 19.9 | 19.0 | 15.3 | 6.9 | 5.5 | -1.7 |
| | 2010 | -8.2 | -2.3 | 3.4 | 9.4 | 14.5 | 18.0 | 21.6 | 20.2 | 12.5 | 5.6 | 6.4 | -4.7 |
| | 2011 | -0.9 | -4.5 | 2.4 | 10.2 | 14.3 | 18.6 | 18.4 | 18.8 | 15.2 | 8.0 | 2.4 | 1.9 |
| | 2012 | -1.9 | -7.4 | 4.4 | 9.5 | 15.0 | 17.3 | 21.4 | 19.2 | 15.0 | 8.0 | 5.5 | -3.7 |
| Mean 1951–2005 | | -3.5 | 2.7 | 1.1 | 7.4 | 13.0 | 16.2 | 17.8 | 17.1 | 12.6 | 7.8 | 2.5 | -1.4 |
| Rainfall (mm) | 2009 | 20.2 | 36.9 | 69.6 | 2.9 | 71.1 | 125.5 | 57.1 | 54.7 | 21.0 | 103.6 | 43.1 | 37.1 |
| | 2010 | 35.6 | 34.6 | 18.6 | 24.5 | 156.7 | 65.6 | 101.0 | 132.8 | 119.0 | 11.2 | 46.8 | 32.4 |
| | 2011 | 24.8 | 25.2 | 8.1 | 29.9 | 42.2 | 67.8 | 189.0 | 65.3 | 5.4 | 28.5 | 1.0 | 34.5 |
| | 2012 | 33.6 | 22.1 | 28.6 | 34.0 | 56.3 | 62.8 | 52.3 | 37.6 | 35.5 | 88.0 | 29.8 | 28.8 |
| Mean 1951–2005 | | 22.7 | 25.6 | 26.3 | 40.2 | 57.7 | 65.7 | 83.5 | 68.6 | 51.6 | 40.1 | 38.1 | 31.5 |

Table 2. Effect of summer seedling planting dates on the percentage loss in the number of shallot plants recorded in early spring in the second year of cultivation

| Seedling planting date | Cultivar | 2010 | 2011 | 2012 | Mean |
|---|---|---|---|---|---|
| I (3rd decade of July) | Toto | 4.0 | 58.8 | 2.0 | 21.6 |
| | Ambition $F_1$ | 4.7 | 60.0 | 1.2 | 21.9 |
| | Bonilla $F_1$ | 10.1 | 67.5 | 1.7 | 24.4 |
| | Matador $F_1$ | 6.8 | 60.4 | 3.1 | 23.4 |
| | mean | 6.4 | 60.1 | 2.0 | 22.8 |
| II (1st decade of August) | Toto | 9.0 | 66.4 | 3.8 | 26.4 |
| | Ambition $F_1$ | 10.0 | 66.0 | 0.0 | 25.3 |
| | Bonilla $F_1$ | 13.5 | 68.8 | 1.7 | 28.0 |
| | Matador $F_1$ | 17.8 | 71.1 | 0.0 | 29.6 |
| | mean | 12.5 | 68.0 | 1.3 | 27.2 |
| III (3rd decade of August) | Toto | 13.7 | 60.4 | 3.5 | 25.8 |
| | Ambition $F_1$ | 17.0 | 59.4 | 2.6 | 26.3 |
| | Bonilla $F_1$ | 23.0 | 73.0 | 4.0 | 33.3 |
| | Matador' $F_1$ | 21.7 | 66.7 | 1.7 | 30.0 |
| | mean | 18.8 | 64.8 | 2.9 | 28.8 |
| Mean | Toto | 8.9 | 61.8 | 3.1 | 24.6 |
| | Ambition $F_1$ | 10.5 | 61.8 | 1.2 | 24.5 |
| | Bonilla $F_1$ | 15.5 | 67.7 | 2.4 | 28.5 |
| | Matador $F_1$ | 15.4 | 66.0 | 1.6 | 27.6 |
| | mean | 12.6 | 64.3 | 2.0 | 26.3 |

demonstrated that short-day shallot plants with a longer growing period in the field, before vernalizing temperatures occurred during the winter period, bolted earlier and had more generative shoots than plants with a short growing period before vernalization.

The results of this study showed that bolting in long-day shallots – 'Toto', 'Ambition $F_1$', 'Bonilla $F_1$', and 'Matador $F_1$' – was significantly dependent on the seedling planting date, thus on plant age before the winter period started during which vernalization can take place (tab. 3).

Table 3. Percentage of shallot plants that bolted in the second year of cultivation

| Seedling planting date | Cultivar | 2010 | 2011 | 2012 | Mean |
|---|---|---|---|---|---|
| I (3rd decade of July) | Toto | 100.0 | 28.6 | 29.5 | 52.7 |
| | Ambition $F_1$ | 100.0 | 55.5 | 29.7 | 61.7 |
| | Bonilla $F_1$ | 100.0 | 49.2 | 29.2 | 59.4 |
| | Matador $F_1$ | 100.0 | 62.1 | 44.1 | 68.7 |
| | mean | 100.0 | 48.8 | 33.1 | 60.6 |
| II (1st decade of August) | Toto | 90.0 | 18.0 | 14.4 | 40.8 |
| | Ambition $F_1$ | 93.8 | 28.0 | 32.0 | 51.2 |
| | Bonilla $F_1$ | 96.0 | 20.0 | 33.5 | 49.8 |
| | Matador $F_1$ | 96.5 | 30.0 | 58.3 | 61.6 |
| | mean | 94.0 | 24.0 | 34.5 | 50.8 |
| III (3rd decade of August) | Toto | 4.4 | 12.0 | 10.9 | 9.1 |
| | Ambition $F_1$ | 3.5 | 19.5 | 17.8 | 13.6 |
| | Bonilla $F_1$ | 10.0 | 18.6 | 21.7 | 16.7 |
| | Matador $F_1$ | 5.0 | 25.0 | 25.5 | 18.5 |
| | mean | 5.7 | 18.7 | 18.9 | 14.4 |
| Mean | Toto | 64.8 | 19.5 | 18.2 | 34.1 |
| | Ambition $F_1$ | 65.7 | 34.3 | 26.5 | 42.1 |
| | Bonilla $F_1$ | 68.6 | 29.2 | 28.1 | 41.9 |
| | Matador $F_1$ | 67.1 | 39.0 | 42.6 | 49.5 |
| | mean | 66.5 | 30.5 | 28.8 | 41.9 |

The highest number of plants with generative shoots was recorded in the second year of cultivation in plants obtained from the first seedling planting date (3rd decade of July). The later seedlings were planted, the fewer plants produced seed stalks (tab. 3). A delay in planting seedlings by 1 month (the 3rd decade of July to the 3rd decade of August) resulted in a reduction in the percentage of plants producing seed stalks by 46.2% (on average from 60.6% to 14.4%). At the same time, cultivar-specific differences were noticeable.

Depending on the cultivar, the percentage of plants that produced seed stalks varied for each seedling planting date. By far the highest number of plants that bolted was recorded in cv. 'Matador $F_1$', while the lowest one in cv. 'Toto' which was not a hybrid cultivar (tab. 3).

Plants of this cultivar, compared to the other ones (except for 'Ambition $F_1$'), handled better wintering conditions, as on average only 24.6% of plants did not start growth in the second year of cultivation (tab. 2).

The study of Tabor et al. [2005, 2006] showed that in shallot bolting was possible when plants were propagated from seed. However, the percentage of bolting in plants grown from onions was significantly higher (it was 97%, while in plants raised from seeds 88%). It was also shown that shallot plants grown from seedlings, at an age of 60 days or younger, do not receive sufficient vernalization which induces bolting.

Shallot, as a plant belonging to the Aggregatum Group when propagated from bulbs, can produce clusters with a large number of daughter bulbs, whereas when it is grown from seeds or seedlings clusters contain on average 1–3 onions or plants produce only a single onion [Brewster 1994, Sumanaratne et al. 2002, Tendaj 2005, Tendaj and Mysiak 2012].

Single shallot plants obtained from the summer dates of planting seedlings produced very few seed stalks in spring and summer of the following year (on average 2). However, their number significantly depended on the seedling planting date and quite varied depending on the cultivar (tab. 4). Plants obtained from the earliest date of planting

Table 4. Number of generative shoots per plant in shallots obtained from summer seedling planting dates

| Seedling planting date | Cultivar | 2010 | 2011 | 2012 | Mean |
|---|---|---|---|---|---|
| I (3rd decade of July) | Toto | 3.6 | 1.8 | 2.5 | 2.6 |
| | Ambition $F_1$ | 2.7 | 2.0 | 2.7 | 2.4 |
| | Bonilla $F_1$ | 2.6 | 2.6 | 4.1 | 3.1 |
| | Matador $F_1$ | 4.6 | 2.7 | 4.2 | 3.8 |
| | mean | 3.3 | 2.2 | 3.3 | 2.9 |
| II (1st decade of August) | Toto | 2.0 | 1.6 | 1.4 | 1.6 |
| | Ambition $F_1$ | 2.0 | 1.0 | 2.7 | 1.9 |
| | Bonilla $F_1$ | 3.8 | 1.3 | 2.4 | 2.5 |
| | Matador $F_1$ | 1.6 | 1.8 | 3.2 | 2.2 |
| | mean | 2.3 | 1.4 | 2.4 | 2.0 |
| III (3rd decade of August) | Toto | 1.6 | 1.0 | 1.0 | 1.2 |
| | Ambition $F_1$ | 1.3 | 1.0 | 1.7 | 1.3 |
| | Bonilla $F_1$ | 1.5 | 1.0 | 1.3 | 1.2 |
| | Matador $F_1$ | 1.0 | 1.0 | 1.4 | 1.1 |
| | mean | 1.3 | 1.0 | 1.3 | 1.2 |
| Mean | Toto | 2.4 | 1.4 | 1.6 | 1.8 |
| | Ambition $F_1$ | 2.0 | 1.3 | 2.3 | 1.8 |
| | Bonilla $F_1$ | 2.6 | 1.6 | 2.6 | 2.2 |
| | Matador $F_1$ | 2.4 | 1.8 | 2.9 | 2.3 |
| | mean | 2.3 | 1.5 | 2.3 | 2.0 |
| $LSD_{0.05}$ | | | | | |
| Planting date (A) | | | | | 0.73 |
| Cultivar (B) | | | | | n.s. |
| Interaction (A × B) | | | | | n.s. |

seedlings, i.e. the third decade of July, produced the highest number of seed stalks (on average 2.9 pieces). The later the seedlings were planted, the significantly fewer generative shoots were recorded in the plants that had bolted. Among the tested cultivars, plants cv. 'Matador $F_1$' produced the highest number of seed stalks (on average 2.3). In this cultivar, seed stalks also reached the highest height (on average 93.5 cm), which was comparable with stalk height in cv. 'Ambition $F_1$' (tab. 5).

Table 5. Height of generative shoots in shallots obtained from summer seedling planting dates (cm)

| Seedling planting date | Cultivar | 2010 | 2011 | 2012 | Mean |
|---|---|---|---|---|---|
| I (3rd decade of July) | Toto | 102.2 | 74.9 | 91.6 | 89.5 |
| | Ambition $F_1$ | 105.1 | 88.0 | 97.0 | 96.7 |
| | Bonilla $F_1$ | 101.0 | 82.6 | 78.3 | 87.3 |
| | Matador $F_1$ | 93.6 | 86.0 | 91.6 | 90.4 |
| | mean | 100.4 | 82.8 | 89.6 | 90.9 |
| II (1st decade of August) | Toto | 89.0 | 72.0 | 80.3 | 80.4 |
| | Ambition $F_1$ | 104.5 | 81.3 | 94.3 | 93.3 |
| | Bonilla $F_1$ | 84.2 | 74.1 | 88.6 | 82.3 |
| | Matador $F_1$ | 111.0 | 76.0 | 103.6 | 96.8 |
| | mean | 97.1 | 75.8 | 91.7 | 88.2 |
| III (3rd decade of August) | Toto | 91.2 | 73.0 | 101.0 | 88.4 |
| | Ambition $F_1$ | 95.0 | 89.8 | 90.0 | 91.6 |
| | Bonilla $F_1$ | 84.0 | 84.0 | 95.6 | 87.8 |
| | Matador $F_1$ | 96.3 | 90.7 | 93.6 | 93.5 |
| | mean | 91.6 | 84.3 | 95.0 | 90.3 |
| Mean | Toto | 94.1 | 73.3 | 90.9 | 86.1 |
| | Ambition $F_1$ | 101.5 | 86.3 | 93.7 | 93.8 |
| | Bonilla $F_1$ | 89.7 | 80.2 | 87.5 | 85.8 |
| | Matador $F_1$ | 100.3 | 84.2 | 96.2 | 93.5 |
| | mean | 96.4 | 80.9 | 92.0 | 89.8 |
| $LSD_{0.05}$ | | | | | |
| Planting date (A) | | | | | n.s. |
| Cultivar (B) | | | | | n.s. |
| Interaction (A × B) | | | | | n.s. |

The study of Tabor et al. [2005] and Anisuzzaman et al. [2009] proved that in plants of the cultivars 'Matador $F_1$' as well as 'Tropix' and 'Rox $F_1$' full bolting was attained after reaching the 6–17 leaf stage, before the effect of vernalizing temperature occurred. A high percentage of bolting was achieved when the age of plants increased before vernalization. The older the plants were before the beginning of vernalization, the higher the percentage of bolting was. Such a correlation was found in the present study, as shallot plants obtained from the earliest planting of seedlings produced the largest number of seed stalks and had the highest height (tabs 4, 5). These were the oldest plants before temperature inducing vernalization occurred and they had already finished the juvenile stage.

Table 6. Number and weight of seed umbels (after drying) and seed yield in shallot cv. Toto from summer seedling planting dates

| Seedling planting date | Number of seed umbels (pcs.·100 $m^{-2}$) | | | | Weight of seed umbels (g ·100 $m^{-2}$) | | | | Seed yield (g ·100 $m^{-2}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | mean | 2010 | 2011 | 2012 | mean | 2010 | 2011 | 2012 | mean |
| I (3rd decade of July) | 1866.5 | 124.9 | 2458.3 | 1483.2 | 7337.4 | 3412.9 | 5208.3 | 5319.5 | 521.3 | 438.5 | 807.2 | 589.0 |
| II (1st decade of August) | 1199.8 | 85.7 | 333.3 | 539.6 | 2994.1 | 163.9 | 416.6 | 1191.5 | 109.2 | 59.9 | 48.8 | 72.6 |
| III (3rd decade of August) | 99.9 | 30.3 | 66.6 | 65.6 | 766.6 | 558.0 | 208.3 | 510.9 | 0.0 | 91.9 | 22.3 | 38.0 |
| Mean | 1055.4 | 80.3 | 952.7 | 696.1 | 3699.3 | 1378.2 | 1944.4 | 2340.6 | 210.1 | 196.7 | 292.7 | 233.2 |
| $LSD_{0.05}$ Planting date | | | | 496.2 | | | | 3657.5 | | | | 292.0 |

Umbels with developed seeds were collected only in cv. 'Toto', which was the only true-breeding cultivar. In the other ones, which were hybrid cultivars, umbels were cut off after their formation, before flowering. The number and weight of seed umbels in cv. 'Toto' significantly varied depending on the seedling planting date in the first year of cultivation (tab. 6). Umbels obtained from the first date of planting seedlings (3rd decade of July) had a significantly higher weight. The weight of umbels from the second planting date (1st decade of August) was more than 4 times lower, while in the case of those obtained from the third date (3rd decade of August) it was more than 10 times lower (tab. 6). For this reason, seed yield was significantly the highest in shallot plants obtained from the first planting date (8 times higher compared to the second date and 15.5 times higher compared to the third one). It can be concluded that seed yield obtained from the earliest date of planting seedlings was not high yield (it averaged 589 g·100 $m^{-2}$). On a per hectare basis, it was on average 58.9 kg. In the study of Morozowska and Hołubowicz [2009], the average seed yield per seed stalk in common onion was 3.3–4.3 g (depending on the size of onions used for planting). In the research of Tomar [2004] seed yield of hybrids onion was usually lower then the variety. In the shallot cultivar 'Toto' grown for seed from seedlings, seed yield per seed head was much lower. This is justified by poorer seed production in shallot, in spite of its abundant flowering. This is also shown in the studies of Sumami and Soetiarso [1998] as well as of Tabor [2004].

## CONCLUSIONS

1. Growing shallot for seed by the seed-to-seed method proved to be possible when using summer planting seedling dates. Plant losses after overwintering can be low (on average 26%), which may correspond to losses in mother bulbs during their storage for planting in spring.

2. Only planting seedlings in early summer, at an age of about 4 weeks, ensured the best effects in the formation of seed stalks. Under local conditions, this was in the 3rd decade of July. A delay in planting seedlings in the first year of cultivation by 2–4 weeks had a significant effect on reducing the percentage of plants producing seed stalks and their number per plant.

3. The cultivar 'Toto' (true-breeding) produced slightly fewer seed stalks compared to the hybrids. They were also lower, irrespective of the seedling planting date.

4. Seed yield obtained was not high compared to yield attained in common onion, which justifies their higher price in trading.

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## WPŁYW LETNICH TERMINÓW SADZENIA ROZSADY NA ROZWÓJ PĘDÓW NASIENNYCH SZALOTKI (*Allium cepa* L. var. *ascalonicum* Backer)

**Streszczenie**. Dotychczasowa produkcja szalotki na skalę towarową była ograniczona z powodu małej podaży materiału siewnego i braku odmian hodowlanych wytwarzających nasiona. Miejscowe populacje uprawiane powszechnie w różnych krajach rozmnażane są przede wszystkim wegetatywnie, gdyż przeważnie nie wytwarzają pędów generatywnych i nasion lub pojawiają się one w znikomej liczbie. Badania przeprowadzone w latach 2009–2012 miały na celu ocenę rozwoju generatywnego i wytwarzania nasion u szalotki uprawianej z letnich terminów sadzenia rozsady z pominięciem produkcji cebul wysadkowych. W badaniach uwzględniono 4 odmiany szalotki: 'Toto', 'Ambition $F_1$', 'Bonilla $F_1$', 'Matador $F_1$'. Rozsadę (wiek 4 tygodnie) sadzono w polu w trzech terminach: 3. dekadzie lipca, 1. dekadzie sierpnia i 3. dekadzie sierpnia. W drugim roku uprawy, po przezimowaniu roślin, określono ich straty oraz udział roślin wytwarzających pędy nasienne i niektóre cechy tych pędów, a także plon nasion u ustalonej odmiany 'Toto'. Do wytworzenia nasion nie dopuszczono roślin pozostałych odmian (ogławiano baldachy kwiatostanowe przed otwarciem kwiatów), gdyż były to mieszańce i mogło dojść do niepożądanego przekrzyżowania. Wykazano, że straty po przezimowaniu roślin wynosiły średnio 26,3%, lecz najmniejsze były u odmiany 'Toto', zwłaszcza wśród roślin z pierwszego terminu sadzenia rozsady. Niezależnie od odmiany, najwięcej roślin z wytworzonymi pędami nasiennymi i o największej ich liczbie u jednej rośliny zarejestrowano w obiektach pierwszego terminu sadzenia rozsady. Opóźnienie sadzenia rozsady latem w pierwszym roku uprawy o 2–4 tygodnie istotnie wpływało na zmniejszenie udziału roślin wytwarzających pędy nasienne w drugim roku, a u odmiany 'Toto' na bardzo dużą obniżkę plonu nasion.

**Słowa kluczowe**: odmiany szalotki, charakterystyka pędów nasiennych, plon nasion

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