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THE EFFECT OF DATE AND METHOD OF PLANTING MARSHMALLOW CROPS ON ROOT YIELD AND QUALITY

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Abstract

In 2009. and 2010. factorial trials with marshmallow crops were carried out on three localities in Serbia (Municipalities of Nova Pazova, Petrovac na Mlavi and Pančevo). The effect od planting date (spring and autumn) and method (seedling and direct drilling in the field) on root yield and qualitative traits were examined. Trials were set in accordance with planned design, and experimental results were statistically analyzed. Via adequate analytical methods we determined corresponding values for important root quality parameters (plant fibres and fats, ash, phosphorous, starch, total and natural invert sugar and sucrose). Analysis of variance showed significant impact of date and method of planting marshmallow crops on crop yield. Both planting dates showed reliably higher yield of dried root planted in the field using direct drilling method, compared to seedlings. The average yield was 4.015 kg/ha, while usage of seedlings generated 1.575 kg/ha. Date and method of planting marshmallow crops didn't have significant impact on values of important root quality parameters. Average value was highest for starch (34%), phosphorous content was 11,4%, plant fibres 12,3%, total invert sugar 8,4%, sucrose 6,9%, ash 4,16%, plant fats 2,06%, while natural invert content was the lowest (1,05%). These experimental results should be used in future technology designs for planting marshmallow crops in accordance with principles of sustainable agriculture.

Key words: *marshmallow, methods of planting, planting date, quality, yield.*

Introduction

Nine species within the family *Malvaceae* has been registered in our habitats. Three of those nine are used in traditional and official medicine: high mallow (*Malva silvestris* L.), common hollyhock (*Althaea rosea* L.) and common marshmallow (*Althaea officinalis* L.), (Sarić, 1989). From the economic point of view, the most important species is common marshmallow. It is one of the most wanted and used plants for medicinal purposes, (Dražić, 2010a). Uncontrolled exploitation of the wild common marshmallow led to the disappearance of its habitats, making it one of the endangered species. The advantages of cultivating common marshmallow over its collecting are the following: obtaining large quantities of raw material with uniform, standard quality, possible choice of environmentally acceptable conditions for cultivation and protection of resources from over-exploitation.

The current level of cultivation has an extensive character. Production and environmental conditions and standards also require that new solutions in the technology of cultivating common marshmallow are found. These solutions include flexible agricultural technology which shall combine conventional methods with modern technologies. Defining the cultivation technology on the principles of sustainable agriculture should ensure a stable production, product quality, preservation of natural resources, environmental protection and economic effects. Determining planting periods (spring - autumn) and the method of planting

crops (seedling application - direct sowing) and agroecological conditions of cultivation are the subject of this research.

Material and methods

During 2009. and 2010. we performed experiments with the domestic population of common marshmallow - of Vojvodina. Experiments have been performed on three locations: Nova Pazova, Petrovac na Mlavi and Pančevo. These experiments were conducted in four replications on the primary plot size 5 m^2.

The experiments examined the following factors: periods for planting crops (spring and autumn) and the method of planting crops (seeding application and direct sowing). During the spring and summer 2009. we carried out the production of seedlings in containers. Thus produced seedling had a significantly higher percentage of rooting plants when compared to other methods (cold frames and medium-warm hotbeds), (Andruszczak and Wisniewski, 2006, 2007, Dražić et al., 2010). Replanting was carried out in spring (May) and autumn (October) in 2009. Spacing was 50 x 25 cm (crop density of 80.000 plants/ha).

Direct sowing was also carried out in spring (April) and autumn (October) in 2009. It was carried out with a manual planter in continuous rows with spacing of 50 cm (crop density was around 300.000 plants/ha). The seed is small so the sowing was carried out at the depth of 1 - 2 cm. We used a seed of 95% purity and 53% germination. Recent studies have shown that seed germination can be improved with pelleting (Dražić et al., 2011) and by applying the indigenous strains of *Bacillus* sp.Q3 (Starović et al., 2013).

Removing roots from the spring period in 2009, was carried out in October of the same year, while the removing the roots from the autumn period was carried out in October 2010. Root drying, after primary processing, was carried out in the place for drying with hot air. Regarding the properties, we analyzed the yield of dry root and quality parameters. The results were processed by using the analysis of variance in factorial experiments, while the least significant difference was analyzed with a LSD test. Chemical characterization and analytical methods for testing the composition of roots were defined in the laboratory of the Institute "Tamiš" in Pančevo (Majstorović et al., 2013).

The conditions in which the experiments were carried out. - Nova Pazova is located in the northern part of Serbia (Vojvodina) in the eastern area of Srem district. Experimental plot in municipality of Petrovac na Mlavi was located at the foot of the Homolje mountains, Braničevo district (around 130 m above sea level). Pančevo municipality is located in the Serbian semi-arid climate conditions (southern Banat district in Vojvodina). According to the morphological and genetic characteristic, the soil at the experiment plot in Nova Pazova municipality belongs to chernozem, Petrovac na Mlavi to cambisols, while the one in Pančevo belongs to marsh soil. Average annual temperatures of these locations were approximately 11^oC. Due precipitation in Nova Pazova (620-800 mm) was higher when compared to locations in Petrovac (600-650 mm) and Pančevo (500-550 mm). Based on the analysis of the agroecological conditions, we can state that the conditions in Nova Pazova were the most favourable.

Results and Discussion

Analysis of variance has shown locations and applied variances, which agrees with the previous research (Dražić et al., 2009). Interactions between locations and variances have also been of great significance, Table 1.

Table 1. Factorial analysis of variance (2 x 3) for root yield of marshmallow

Source of Variation	d.f.	MS	
		Spring	Autumn
Treatments	5	2,536**	14,56**
A - locality	2	1,9**	0,186**
B - variants	1	8,07**	72,24**
AB - interaction	2	0,405**	0,095*
Error	18	0,02	0,02

*, **: Significant at 0,05 and 0,01 probability level, respectively

Depending on the length of cultivating the common marshmallow (one-year or two-year crop) yields can vary significantly (4.550 to 9.520 kg/ha), (Andruszczak, 2007). In our conditions, common marshmallow is cultivated as a one-year crop, but the spring crop production lasted shorter (around seven months).

In the spring planting period, there was a total yield of 1.830 kg/ha. It was higher for 510 kg/ha or 28% percent than the autumn planting period (l.320 kg/ha). The highest yield was achieved in Nova Pazova (2.270 kg/ha and 1.370 kg/ha). The differences in the yield height between locations were significant only in the spring period, Table 2.

Direct sowing gave significantly higher yields in both periods when compared to the application of seedlings. In addition, it was observed that the root does not branch (or it branches but a little and rarely) and therefore its processing is easier, which is the most significant advantage of the direct sowing. Differences in the yield height were found when comparing sowing periods. Average yield in the autumn period of 4.790 kg/ha was higher for 1,550 kg/ha i.e. 32%. When compared to the application of seedlings at the same period, the difference is very high and it amounts to 3.470 kg/ha i.e. 72%. Also, the average yields in the spring period of 3.240 kg/ha was increased by 1.410 kg i.e. 44% from the yield accomplished by applying seedlings. There are significant differences for both periods between the locations. The highest yield was accomplished in Nova Pazova. Variations in yield occurred more when applying seedlings, then in direct sowing, Table 2.

Table 2. Average yield of marshmallow

Location	Period			
	Spring		Autumn	
	Usage of seedlings	Direct drilling	Usage of seedlings	Direct drilling
Nova Pazova	2270**	3490**	1370	5080**
Petrovac na Mlavi	1650	3220**	1330	4700
Pančevo	1570	3010	1260	4590
$\overline{X}$	1830**	3240	1320	4790**
CV	14,8	5,3	13,2	4,0

*, **: Significant at 0,05 and 0,01 probability level, respectively

In previous research, the analytics of root ingredients was mainly limited to determining of impurities, number of swelling, loss on drying and total ash. Therefore, the chemical characterization of the common marshmallow root was performed with prior definition of analytical methods that are suitable for testing the root composition. This is important for the purpose of better standardization of plant ingredients in order to define the liquid (necessary) dose for achieving the improvement of optimum physiological effect (Majstorović et al., 2013). Experimentally determined content of tested ingredients showed that periods and method of planting crops did not affect the change in their values, Table 3.

Table 3. Content of the studied components in the root

N^o	Component	Period				Mean	CV
		Spring		Autumn			
		Usage of seedlings	Direct drilling	Usage of seedlings	Direct drilling		
1.	Plant fibres	12,03	12,91	12,06	12,2	12,3	3,0
2.	Plant fast	2,03	2,04	2,13	2,04	2,06	2,0
3.	Ash	4,03	3,64	4,33	4,64	4,16	9,0
4.	Phosphorous	11,09	11,20	12,3	11,01	11,4	4,6
5.	Starch	34,49	36,45	33,9	30,77	34,0	6,0
6.	Total invert sugar	8,32	8,96	7,63	8,69	8,4	6,0
7.	Natural invert	1,17	0,98	1,22	0,83	1,05	14,7
8.	Sucrose	6,79	7,68	6,13	7,0	6,9	8,0

Conclusion

Analysis of variance showed a significant effect that locations, periods and method of planting common marshmallow crops imposed upon the height of achieved root yield. Yield, achieved by planting crops with direct sowing when compared to application of seedlings, was reliably higher on all locations during both planting periods. On average, it was 4.015 kg/ha, while by applying seedlings 1.575 kg/ha was achieved. In the spring planting period, a higher yield (1.830 kg/ha) was achieved when compared to autumn period (1,320 kg/ha). However, when planting with direct sowing, the autumn period was more favourable and therefore the higher yield was achieved (4.790 kg/ha) when compared to spring period (3,240 kg/ha). Agroecological conditions of the location significantly affected the achieved yield. Locations, planting periods and methods of crop planting did not affect the value of analyzed root quality parameters.

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