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Biological Characterstics and Productivity of Cape Gooseberry (*Physalis peruviana* L.) Plants According to Different Term of Seedling Sowing

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Abstract

The main aim of this study was to investigate the effect of different time of sowing of seedlings on the behaviors of morphological development and productivity of cape gooseberry. The experiments were carried out with varieties Plovdiv and Obrazec 1 with 15-day sowing intervals between 01.03, 15.03. and 30.03. Phenological observations were done. Main morphological characteristics of the plants, in stages of flower buds, flowering and fruiting were investigated. Contents of dry matter, total sugar, total acid, vitamin C and pectin were analyzed. The highest productivity was established on 15.03. as the sowing date for both varieties with 40.83% (Plovdiv) and 16.07% (Obrazec 1) above the variant with the lowest yield.

Key words: morphology, yield, phenology, sugar, pectin

Introduction

Crawford (2004) reported that the cape gooseberry plants are propagated mostly by seeds that sprout very easily. However McCain (1993) recommended technology for growing of this crop by seedling. Seedlings are planted in the field, when their length is 15-20 cm. The author considers that the most suitable cultivation would be at larger distances. Shopova et al., 2014 emphasises that the seedling cultivation is a common and very important practice for vegetable crops.

According to Chernok (1997), cape gooseberry can be cultivated with seedling or it could be directly sown outdoors. He established that it would be appropriate to apply direct outdoor sowing in the southern regions, while for northern ones it is preferable to use seedling growing. The cultivation by direct outdoor sowing can be done only on a very well-prepared soil, without strong weeding areas. Both prickle and non-prickle seedlings can be used for the seedling production of this culture.

In growing the cape gooseberry by seedlings, Christov (2010) obtained the best results, with sowing carried out 55-65 days before the last frost for the area. Malla et al. (2008) established that this crop can be grown by both ways, through cuttings and by previously produced seedlings. The application of one or the other technology, to produce plants with better growth behaviour is dependent directly on the environmental conditions on one hand and on the subsoil of the area on another.

The main aim of this study was to investigate the effect of different date of sowing of non-prickle seedlings on the behavior of morphological development and productivity of cape gooseberry (*Physalis peruviana* L.) under Bulgarian conditions.

Material and Methods

The experiments were carried out in 2008-2010 with two cape gooseberry cultivars – Plovdiv and Obrazec 1 in the Experimental field and in the laboratory of Department of Horticulture at the Agricultural University- Plovdiv, Bulgaria. The following terms with a 15-day sowing interval: 01.03; 15.03 and 30.03 were investigated, respectively. The seeds were sown in a plastic non-heating green house by 1.5 g/m^2 and the rate of sowing per hectare was 80 g/ha. On 20 May the seedlings were planted by scheme 70×50 cm (Panayotov & Tcorlianis, 2000) on the experimental plots of 10 m^2, in four replications. Through the vegetation periods all agricultural practices were performed.

Phenological observations of mass occurrence of different stages of plant development: sprouting (in days after sowing), flower buds, flowering, fruit setting, fruiting (in days after sprouting) were observed. The morphological studies were done in three stages of plant development – flower buds (f.b.), flowering (fl.) and fruiting (fr.). Total leaf-stem vegetative weight; weight, height and diameter of stem; number and weight of branches, number, weight and area of leaves (established by the method suggested by Popova et al., 2010 and Panayotov et al., 2014) were measured on 15 plants in the above mentioned phases. Content of dry matter (by drying it in an oven at 105 ^{0}C), vitamin C (by methods of Murry), total sugar (Hagedorn-Yensen method), total acids, were investigated in full maturated fruits. The methods of these analyses are described in details in Stambolova et al. (1978). Content of pectin in the mentioned stage was determined according to the methods of Institute of Medicine (2004), determined in laboratory of University of food technology, Plovdiv. The contents of chemical components were established in four replicates in average samples taken randomly from each four replications in the first harvest. Total yield was established by three harvests in full maturity. Data of the study were subjected to analysis of variance, and the least significant differences between means were calculated by the Fisher test at $p = 0.05$. A method for ANOVA is described in Fowel and Cohen (1992). The presented data are mean values from the three years of the investigation periods, because the trends were similar.

Results and Discussion

Different terms of sowing of cape goosberry changed the course of the main phenophases (Tab. 1). The fastest the germination began in both varieties was on 30.03, approximately 5 days earlier compared to the first term. The faster growth was also maintained in the following stages. Phases of flower bud, flower and frit set in this variant almost between 12 and 17 days ahead of the mass manifestation. On the later sowing date phenophase passed significantly faster, which is possibly associated with the availability of better temperature conditions in the period of growing of these plants. The largest is the period between the emergence and mass flower bud formation - about 50 to 70 days at separate variants. Around the last date of sowing this interval was shorter.

The accumulation of total vegetative mass (Fig. 1) is associated with genotypic differences. In the flower bud phase in both varieties the highest values were recorded at the last date, which may be due to the shorter period of occurrence of this phase.

Tab. 1. Phenological observations of cape gooseberry plant development (days after sprouting)
Фенолошка запажања раста и развоја биљака физалиса (дана након клијања)

Varieties / Stages *генотипови / фазе*	Plovdiv			Obrazec 1		
	01.03.	15.03.	30.03.	01.03.	15.03.	30.03.
Sprouting* *клијање*	17.67	13.0	12.67	19.67	19.33	14.67
Flower buds *цвјетни пупољци*	88.0	87.0	66.67	85.0	75.33	68.67
Flowering *цвјетање*	91.67	90.0	76.0	88.67	80.0	76.67
Fruit setting *појава плода*	96.68	95.67	79.0	97.33	89.33	81.33
Maturation *зрење*	157.0	156.0	152.67	157.0	156.67	151.0

* days after sowing (*број дана након сјетве*)

At the end of the vegetation (fruiting), however it was the highest for Plovdiv in the sowing variant of 01.03, while Obrazecl 1 was in the variant of 15.03. Its values in flower were the biggest also in the variant of 15.03. The greatest accumulation is between stages of flowering and fruiting. In the initial stages, a larger share in the formation of vegetative mass occupies the weight of leaves, but in the end the weight more strongly influences the branches.

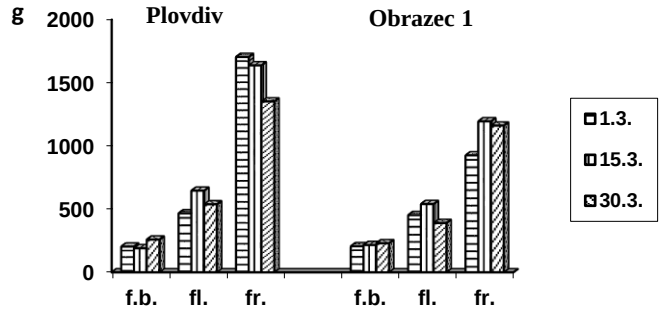

Fig. 1. Total leaf-stem vegetative weight of cape gooseberry
Укупна вегетативна маса листа и стабла физалиса
Stage of (*фаза*): f.b. – flower buds (*пупољака*);
fl. – flowering (*цвјетања*); fr. – fruiting (*зрења*)

The height of the stem (Fig. 2) during the different phases and terms of sowing steadily increased.

The increase was the strongest between the phases of flowering and fruiting. In the final stage it was the highest for Plovdiv when sowing on 01.03 - 123.0 cm, and for the other variety the following date - 114.78 cm. The lowest stem reported for the first genotype was on 30.03, and the second one for the sowing on 01.03, which shows that for this index there is a genotype response to the dates of sowing. McCain (1993) and Sarkar et al. (1993) pointed out that, depending on growing conditions and applied technology, the stem of cape gooseberry can reach up to 2 m of height. The weight of the stem (Fig. 3) followed the same trend as its height - further growth strongest between flowering and fruiting, but in both varieties it was the greatest when sown on 15.03. - 462.94 g of Plovdiv and 309.78 g for Obrazec 1.

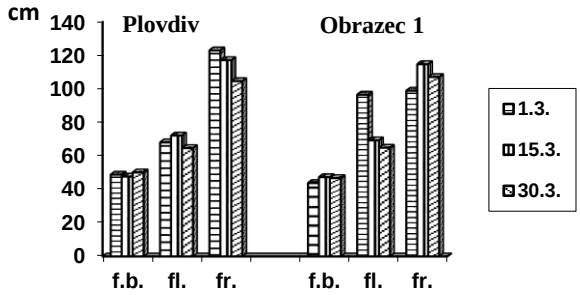

Fig. 2. Stem height of cape gooseberry
Висина стабла физалиса

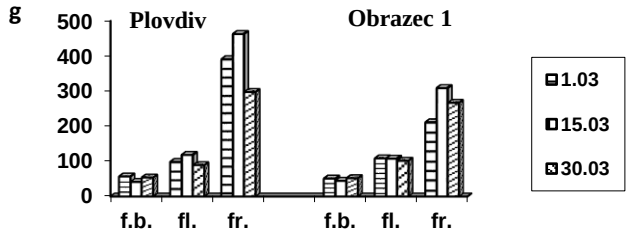

Fig. 3. Stem weight of cape gooseberry
Маса стабла физалиса

Main morphological characteristic of cape gooseberry, closely related to the potential productivity, is branching of the plants (Skvorcova, 1997). Data of the number of branches are shown in Fig. 4.

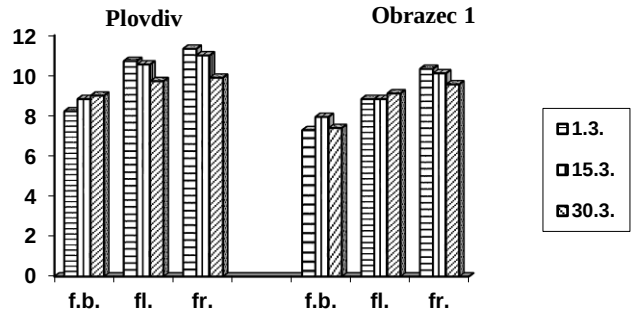

Fig. 4. Number of branches of cape gooseberry
Број грана по биљци физалиса

The development of this morphological characteristic between the different phases of measurement is more even. Its values are also the highest in fruiting for variant 01.03. – 11.33 numbers of Plovdiv and 10.33 numbers for Obrazec 1. The number was the lowest on the last date 9.89 and 9.56, respectively of Plovdiv and Obrazec 1. The development of the weight of the branches (Fig. 5) is similar to that of their number. The greatest was in the phase of fruiting, for Plovdiv - 821.0 g, when sowing on 01.03 and for Obrazec 1 - 524.22 g on 30.03. Also increasing is the most significant after flowering to fruiting.

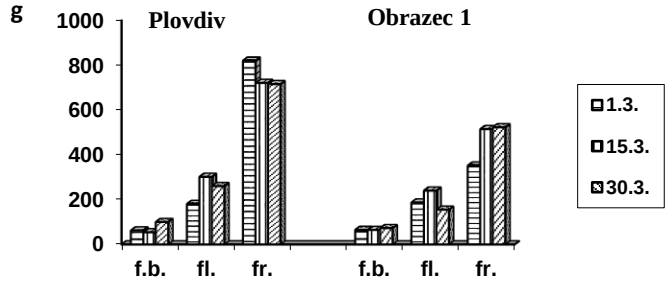

Fig. 5. Weight of branches of cape gooseberry
Маса грана по биљци физалиса

Slightly lower results were reported for the first variety the last date, and the second one on the first term. The development of leaves is a very important parameter in cape gooseberry. Chernok (1997) and Christov (2010) emphasized that many great leaf masses make the harvest difficult and its excessive increase is not desirable.

The sowing on 1.3. of Plovdiv affected the setting in the phase of fruiting of the largest number of leaves (Fig. 6), with the highest weight (Fig. 7) and leaf area (Fig. 8) - 635.89 pcs., 493.55 g and 16923.8 cm^2.

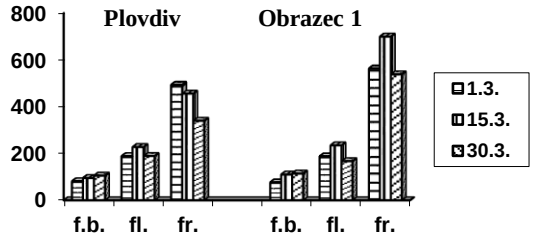

Fig. 6. Number of leaves of cape gooseberry
Број листова по биљци физалиса

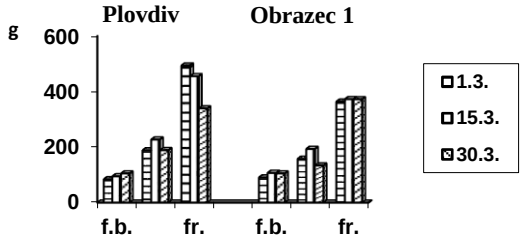

Fig.7. Weight of leaves of cape gooseberry
Маса листова по биљци физалиса

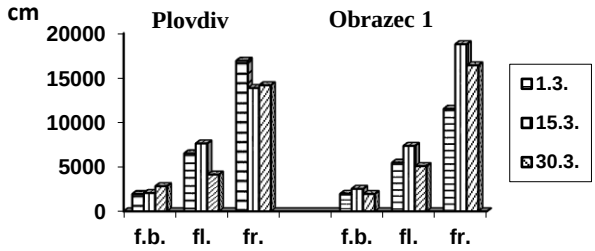

Fig. 8. Leaf area of cape gooseberry
Површина листа по биљци физалиса

While in Obrazec 1, this trend of the same stage was reported on 15.03. - 699.56 number, 372.67 g and 18777.57 cm^2, respectively, in earlier stages of development – of flowering, the values of these signs for both varieties were the highest for sowing on 15.03. The quality of cape gooseberry fruit is best determined by basic food ingredients contained in them.

Abak et al. (1994) reported that in the fruit of this species, the average contents of vitamin C were 21.37 mg/100ml, total soluble solid content - 12.65%, and titratable acidity was 1.68 mg/100 ml. In fruits of Plovdiv the highest contents of dry matter (Table 2), total acids, and pectin were established for variant 15.03, while for vitamin C and total sugar for sowing on 30.03. As to the other variety, the dry matter, vitamin C and pectin were most in fruits obtained from date 01.03, the total sugars - from 15.03, but total acids - from 30.03. The effectiveness of the agrotechnological practices are best assessed through plant productivity (Table 3).

Tab. 2. Chemical components of cape gooseberry fruits
Хемијски састав плодова физалиса

Component / *Елемент* Date / *Датум*	DW* (%)	Vit. C* (mg %)	S* (%)	A* (%)	P* (%)
	Plovdiv				
01.03.	18.08	36.48	9.57	0.96	1.11
15.03.	24.67	36.18	10.18	1.16	1.16
30.03.	17.95	37.99	10.22	0.88	1.15
	Obrazec 1				
01.03.	16.99	41.70	8.50	0.88	1.07
15.03.	16.47	39.51	9.73	0.99	1.04
30.03.	15.70	36.62	9.20	1.00	1.03

*Variants (*varijanta*); DW - dry weight (*suva materija*); Vit. C - vitamin C (*vitamin C*); S - total sugar (*ukupni šećeri*); A - total acid (*ukupne kiseline*); P - pectine (*pektin*)

Tab. 3. Productivity of cape gooseberry (kg/ha)
Prinos fizalisa (kg/ha)

Year / *Година* Date / *Датум*	2008	2009	2010	average *просјек*
	Plovdiv			
01.03.	3768.2	3451.8	3624.2	3614.7
15.03.	3894.3	3698.2	4031.1	3874.5
30.03.	2296.5	2111.3	3845.6	2751.1
LSD p = 0.1%	128.5	202.3	111.2	968.0
	Obrazec 1			
01.03.	2631.7	2424.6	3617.8	2891.3
15.03.	3305.5	3056.0	3636.7	3332.7
30.03.	2723.2	2500.5	3390.0	2871.2
LSD p = 0.1%	108.2	73.8	96.2	347.1

It can be noted that the highest productivity features were observed in 2010. Higher fruiting in all variants and years indicated Plovdiv. Average three-year values displayed that the yield was the highest for both varieties in sowing of the seeds to produce the seedlings on 15.03. - 3874.5 kg/ha for Plovdiv and 3332.7 kg/ha for Obrazec 1.

The increase compared to the variant with the least fruiting is with 40.83% of Plovdiv and with 16.07% for Obrazec 1.

The lowest productivity was registered for sowing on 30.03. and the first date 01.03. occupied an intermediate position.

In all the years and dates of sowing, higher yields were obtained in 2010 in Plovdiv for sowing on 15.03. – 4 031.1 kg/ha. Statistical significances of the differences between the variants are established.

Conclusion

The most accelerated plants from cape gooseberry grow when sown on 30.03. The highest vegetative weight was observed in sowing on 01.03. (of Plovdiv) and 15.03. (Obrazec 1). Its increase was most significant between phases of flowering and fruiting. Better development of stems was recorded on the sowing term of 15.03. The number of branches was the highest for earlier sowing of 01.03. Genotype differences were observed regarding the development of leaves. The highest values at the end of the vegetation of the number, weight and leaf area for the plants of Plovdiv were established on the sowing terms of 01.03, but for Obrazec 1 - on 15.03. The variety Plovdiv was characterized by a higher productivity. In both examined varieties the highest yield was obtained by sowing the seeds for seedling grown on 15.03. – 3 874.5 kg/ha of Plovdiv and 3 332.7 kg/ha for Obrazec 1.

References

Abak K., Güler, H., Sari N. and Paksoy, M. (1994). Earliness and yield of physalis (*P.ixocarpa* and *P.peruviana*) in greenhouse, low tunnel and open field. *Acta Hort.*, *366*, 301-306.

Chernok, L.G. (1997). Tomato, pepper, eggplant, physalis. *Ser.-Vitality*, (12), 280- 288.

Crawford, M. (2004). Australian Tree Crops. *Yearbook Australian University*, *27*, 42-51.

Christov, Chr. (2010). Cape gooseberry - *Physalis peruviana* L. In *Seeds of small and unknown fruits and vegetables*. Retreived in January 2016 from: www.hobi-semena.com

Fowel, J. and Cohen, L. (1992). *Practical Statistics for Field Biology* (pp. 100-223). NY: John Willey and Sons.

Institute of Medicine of National Academes. Food Nutrition Board, Committee on Food Chemical Codex. (2004). *Food Chemical Codex, Fifth Edition* (pp. 321-323). Washington D.C.: Pectin, National Academies Press.

Malla A., Sharma, R.M., Singh, A.K. and Masoodi, F.A. (2008). Propagation and pinching studies in cape gooseberry (*Ph. peruviana*). *Journal of Research, SKUAST, 7*, 112-118.

McCain, R. (1993). Goldenberry, passion fruit: Potential fruits for cool subtropical areas. In Janick, J. and Simon, J.E (Eds.), *New Crops* (pp. 479–486). New York: John and Sons.

Panayotov, N. and Tcorlianis, St. (2000). The effect of type of seedlings and of the planting scheme on productivity and quality of *Ph. peruviana* L. grown under Bulgarian condition. *Acta Hort., 579*, 373 - 376 .

Pnayotov, N., Ivanova, I. and Popova, A. (2014). Determination of leaf area of whole plants of cape goosberry (*Physalis peruviana* L.). *Agricultural Science*, *6*(16), 131-135.

Popova, A. Panayotov, N. and Ivanova, I. (2010). Express method for establishing of leaf area of cape gooseberry (*Physalis peruviana* L.). *Crop Science*, *6*, 580-583.

Sarkar, T.K. and Chattopadhyay, T.K. (1993). Correlation studies on cape gooseberry (*Physalis peruviana* L.). *Annals of Agricultural Research, 14*, 211–214.

Shopova, N., Cholakov, D. and Haytova, D. (2014). Productivity of the plants for late field tomato production depending on the age and planting area of the seedling. *Agriculture and Food*, *2*, 179-191.

Skvorcova, R. V. (1997). *Breeding vegetable crops from Solanaceae for open air field*. (PhD Thesis). Moskow Agricultural Academy K. A. Timirazev, Moscow.

Stambolova, M., Chopaneva, T. and Argirova, T. (1978). *Handbook for biochemistry practice*. (pp 82-124). Sofia: Zemizdat.

Биолошке особине и продуктивност биљака инка бобице (физалис) (*Physalis peruviana* L.) у зависности од различитих периода сјетве сијанаца

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Сажетак

Главни циљ овог истраживања је био да се утврди утицај различитих термина сјетве сијанаца на морфолошки развој и продуктивност физалиса. Експерименти су извршени на генотиповима Plovdiv и Obrazec 1 и то у интервалима сјетве од 15 дана: 01.03, 15.03. и 30.03. Извршена су одређена фенолошка запажања. Анализиране су основне морфолошке карактеристике биљака у фази формирања пупољака, цвјетања до зрења. Такође, анализиран је садржај суве материје, витамина Ц, укупних шећера, укупних киселина и пектина. Највећа продуктивност за оба генотипа установљена је за термин сјетве 15.03. и то до 40.83% (Plovdiv) и 16.07% (Obrazec 1) више од варијанте са најнижим приносом.

Кључне ријечи: морфологија, принос, фенологија, шећери, пектин

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