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Vegetative and Productive Behaviors of Cape Gooseberry (*Physalis peruviana* L.), Grown by Direct Sowing Outside Under Conditions of Bulgaria

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Abstract

Cape gooseberry is a new crop for Bulgaria. Therefore, the establishment of appropriate technology is important. The main aim of this study was to evaluate the effect of different date of direct sowing outside under Bulgarian condition on the morphological development and on the productivity of cape gooseberry. The experiments were carried out with two varieties cape gooseberry - first Bulgarian variety Plovdiv and Columbian ecotype Obrazec 1 in region of Plovdiv, Bulgaria. Three dates of direct sowing outside - 1.04, 15.04 and 30.04 were investigated. Phenological observations were carried out. In phases of flower bud, flowering and fruiting the height of the stem; number of branches, weight, number and area of leaves, total vegetative weight were established. The total yield was determined. The content in the fruit of dry matter, sugars, total acids, ascorbic acid and pectin were analyzed. The highest yield for both varieties was obtained by sowing 30.04 - 387 kg/da and 341 kg and kg/da for Plovdiv and Obrazes 1, respectively. In this date of sowing and also in 15.04, the plants developed the highest stem, the biggest number of branches and leaf area. The contents of the above mentioned chemical components were highest in the fruits of Plovdiv when sowing was done on 15.04, while for Obrazes 1 – on 30.04.

Keywords: cape gooseberry, morphology, seedlings, yield, pectin, sugar

Introductıon

The establishment of appropriate terms for direct sowing outside of cape gooseberry, regarding to its development and productivity in Bulgarian conditions is particularly important, because this is a new crop in the country. Through the application of different agrotechnological practices, as a fertilization, crop rotaion and weed control as well as by breeding research has achieved an increase of productivity in some vegetable crops (Antonova, 2004; Antonova, 2010; Haytova, 2012; Dospataliev, 2012; Haytova, 2013; Kostova, 2014).

According to Crawford (2004) high yield and good development of cape gooseberry is obtained by growing mainly by means of direct sowing outside, because the seed germinate relatively easy. In conditions of Argentina for the best plant growth and the highest efficiency of production of cape goosberry, Cerri (2006) recommends the earliest possible sowing in schemes with larger distances. Cape goosberry can be grown as seedlings and by direct sowing outside.

Cherenok (1997) reported that in growing of cape goosberry in the southern regions more often is applied direct sowing outside and in the north - by seedlings. Its cultivation by direct sowing outside can be carried out only in very well prepared, without a strong weeded areas when the soil temperature at a depth of 10 cm is 12^0C. Malla et al. (2008) founded out that by of application of diferent ways of propagation of the plants, depending on the conditions, can be optimized the growth of plants and habit, which affects on the yield of cape goosberry respectively.

The main purpose of this study was to investigate the influence of different terms of a direct sowing outside of cape gooseberry on the morphological development of the plants and on the productivity, in the conditions of Bulgaria.

Materıal and Methods

The experiments were carried out in Experimental fields of the Department of Horticulture and in Central Research Complex at the Agricultural University-Plovdiv, Bulgaria in 2008-10 with two genotype of cape gooseberry -

first Bulgarian variety Plovdiv and Colombian ecotype named Obrazec 1. The direct sowing outside was done in the following terms: 1.04, 15.04 and 30.04 with sowing rate of 15 g.da^{-1} and with 4-5 seeds in one cluster by the scheme 110 + 50 × 50 cm and the plants were thinned in the phase of two true leaves. The experimental plot was 10 m^2 and the experiments carried out in four replications. During vegetation each agro-technological practice that are necessary were applied. At maturity were carried out regularly harvests. Beginning (when it was manifested ion in 10% of plants) and mass (when it was manifested in 75% of plants) of the phenophases: sprouting, flower bud setting, flowering, fruit setting, fruiting were observed. In following stages of development: flower bud setting, flowering and fruiting the length of stem; number of branches; number, weight and area of leaves and total vegetative weight were established. The leaf area was determined by the method developed by Popova et al. (2010). Content of: dry matter (refractometricaly), total sugar (by Hagerdn Yensen), vitamin C (by Mury), total acid (as apple), each of these methods are described by Stambolova et al. (1978) were determinated. The content of pectin was analyzed in University of Food Technologies-Plovdiv by method of Committee of Food Chemicals Codex (2004). The productivity was established. Data of the study were subjected to analysis of variance, and least significant differences between means were calculated by the Fisher test at p = 0.05(described by 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

On the germination higher influence of the term of direct sowing outside (Table 1) was observed in the last date. In this variant, in comparison with the other two, it is 6 days earlier, it could be due to the higher temperatures up to the end of April, which contributed to accelerated development and faster germination and sprouting of the seeds. The earliest observation of the beginning and of the mass formation of flower buds was esatblished in both genotype in the second date of sowing. The difference in the beginning of this stage throw the earliest term of sowing for Obrazec 1 was 9.77 days, while Pfor lovdiv is 6.34 days, it is similar also for mass appeareance. This trend continued in the next two phenophases. The mass flowering of the plants from date 15.04 is earlier than those from 30.04 with 8.34 days and 11 days, and form mass formation of fruit sets - with 5.66 and 8 days for Plovdiv and Obrazec 1, respectively. The different from the mentioned trend in phenological development was occured in fruiting. The earliest ones comes to Plovdiv for the last date of sowing with 8 and 4 days, compared with the first and second dates of sowing, while mass fruiting is 5 days earlier. In Obrazec 1 the overtaking in fruiting also in the last date of sowing was with 13 and 4.33 days for the begining and with 11.33 and 5.33 days for the mass toward the 1.04, and 15.04 respectively. About the Bulgarian conditions the earliest harvests of cape goosberry cultivated by direct sowing outside can begin 140.00 days and a mass 148-150.67 days after sprouting .

The development of vegetative weight affects the formation and maturation of the fruits of cape goosberry. In this meaning its determination is of a particular importance.

Hristov (2008) poinetd out that very highdeveloped vegetative weight has a significant impact on the yield and in many cases also complicate the harvesting. The development of the vegetative weight (Fig. 1), depends on the term of direct sowing outsied change during the vegetation period. In phase of flower buds was the highest for Plovdiv in sowing date 15.04 - 281 g, and for Obrazec 1 for date 1.04 - 228 g. In the next stage, flowering the latest sowing causes most developing of vegetative weight in plants from Plovdiv and for the other genotype it is in 15.04. In fruiting also with the highest vegetative growth in both genotypes was cape goosberry sowing on 15.04. With higher vegetative weight are characterized the plants from ecotype Obrazec 1. The increase in most of the variants is highest between stage of flowering and stage of fruiting.

For the evaluation of the morphological development and also in relation to the productivity, according Malla et al. (2008) has a great importance and should be paid special attention to the plant height and the number of main branches. The length of the stem (Fig. 2) was changed depending on the term of direct sowing outside. In phase of flower bud the highest stem there were the plants from sowing on 15.04, in flowering – on date 1.04 while for fruiting at the end of the vegetation there was prevest for cape goosberry sown of 30.04. Both genotypes are characterized almost with the same length of stems in different phases. The biggest increase here also recorded between flowering and fruiting stage of varinat 30.04 and for Plovdiv the difference between two consecutive measurements up to 38,67 cm, and for Obrazec 1 - 56,45 cm.

Table 1. Phenological observation (days after sprouting)

Vari-ants	Sprou-ting*	Flower but		Flowering		Fruit setting		Fruiting	
		begin-ing	mass	begin-ing	mass	begin-ing	mass	begin-ing	mass
					Plovdiv				
1.04	18.0	69.67	74.00	72.33	77.67	79.00	85.00	148.33	155.67
15.04	18.0	63.33	67.67	66.33	75.33	75.00	81.67	144.33	155.67
30.04	12.0	67.00	72.67	71.33	83.67	83.33	87.33	140.00	150.67
					Obrazec 1				
1.04	19.33	71.33	74.33	73.33	78.00	80.00	86.33	153.67	160.67
15.04	19.00	61.00	64.00	63.00	67.33	71.33	76.67	145.00	153.33
30.04	13.33	68.00	73.00	72.67	78.33	80.67	84.67	140.67	148.00

*-days after sowing

The productivity of cape goosberry is directly related to the number of branches (Fig. 3). Skvorcova (1997) found that the main morphological feature that defines the potential of the produktivity of this crop is plants branching. According to the author the branching is simpoidial and enhanced formation of branches is due to

greater competition of the top meristem to reproductive organs. Thus, the system of branching on one hand determines the high potential of productivity, but on the other hand retains the maturation of the fruit. Therefore, the researcher believes that perspecrtive are those forms that has a unifromity maturation and determinate growth. The highest number of branches in Plovdiv in flower buds setting was observed at the middle date of sowing and for Obrazec 1 - at 30.04. During flowering, the values of this index were the highest for first variety in sowing at 1.04 – 10,33 number, and for the other genotype the highest number of branches was observed also in variant 30.04 - 10.83 number. On the next stage, of fruiting the number of branches decreased. This could be due on one hand to the circumstance that some of the established in flowering branches has been relatively weak and did not develop to fruiting, and on the other hand to the fact that the plants in this period are in advanced development and setting of new branches is very small or missing. In this final stage the decreaese was the highest in varinat 15.04 for Plovdiv with 2.95 number. However, the highest number for this variety was at sowing of 1.04, and for Obrazec 1 from variant 15.04.

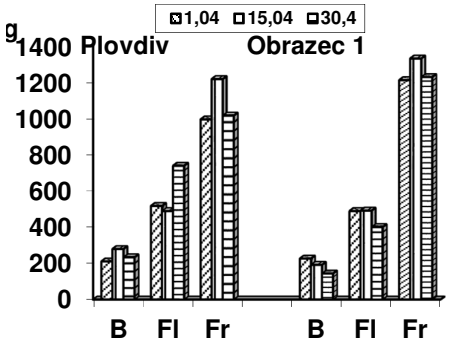

Figure 1. Total vegetative weight
B-flower bud setting, Fl- flowering, Fr-fruting

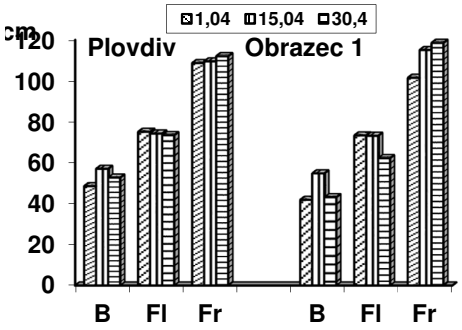

Figure 2. Length of stem
B, Fl, Fr- like as fig.1

The number of leaves (Fig. 4) increased throughout the growing season. In phase of bud flowering ranged from 103.0 to 165.39 for Plovdiv and from 91.17 to 131.61 numbers for Obrazec 1 for sowing of 30.04 and of 15.04, respectively. In the time of flowering most leaves were developed by the plants sown on 15.04. Some differences were observed on the final stage, where the leaves of Obrazec 1 are most at 1.04., while for Plovdiv it was from 15.04. In this phase, with least leaves are characterized the cape goosberry plants sown of 30.04 - 625.7 number of Plovdiv and 489.28 number for Obrazec 1. The highest number of leaves were developed between flowering and fruiting phenophases, the highest difference for

Plovdiv was for variant 15.04 - 390.89 number and for Obrazec 1 was on date 30.04 - 254.22 number.

The weight of the leaves (Fig. 5) followed approximately similar trend. In most phenophases, in except for flowering in Plovdiv, the highest weight of leaves caused the sowing on 15.04. and the least - on 30.04. The values of this feature in Plovdiv in the above menitoned stage, of flowering, in direct sowing outside of 30.04 reached to 455.33 g, and in Obrazec 1- to 407.72 g. The leaves weight increased most after the phase of flowering.

There were some genotype differences for the leaf area (Figure 6). In all phases of accounting, it was the least for Plovdiv in variant 1.04 of, and for Obrazec 1 - from 30.04. The leaves have formed the largest area in the next date of sowing 15.04, except for the flowering phase of Plovdiv, where it was ocurred in the last term of sowing. Leaf area increased most strongly in most variants between flowering and fruiting.

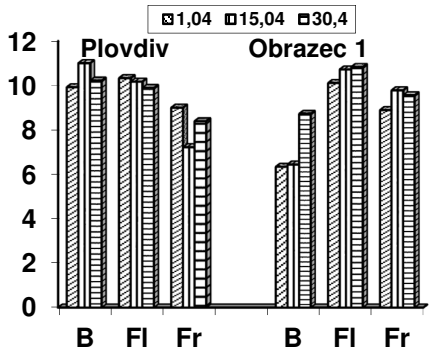

Figure 3. Number of brunches
B, Fl, Fr- like as fig.1

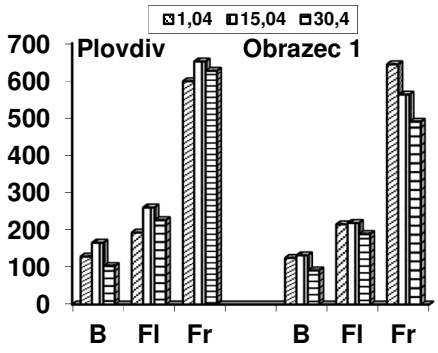

Figure 4. Number of leaves
B, Fl, Fr- like as fig.1

The productivity is the most important indicator for the assement of the effects of given agrotechnological practice. With the highest fruitfulness of the three year duration of the experience was 2010 (Table 2). The lowest yield was recorded from Plovdiv in 2009 when in sowing of 15.04 it was 200 kg.da^{-1}, and from Obrazec 1 in the date but in the previous year - 187 kg.da^{-1}. Productivity for both genotypes was the highest in average for the three years at 30.04 sowing – 387 kg.da^{-1} and 341 kg.da^{-1}. It can be assumed that this is due to the favorable climatic conditions, with not high temperatures and suitable air humidity, in which had been set and the formed the fruit as a result of the later sowing. In this variant the total vegetative weight was also relatively lower, which may have helped to better formation and ripening of the fruits. Most of the differences between the variants are statistically significant.

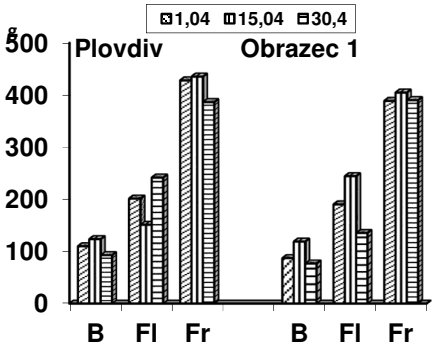

Figure 5. Weight of leaves
B, Fl, Fr- like as fig.1

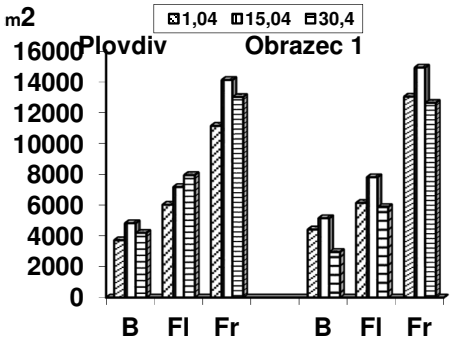

Figure 6. Leaf area
B, Fl, Fr- like as fig.1

The data of the content of the main chemical components of cape goosberry are presented in Table 3. The dry matter was the highest when sowing has been done on 1.04 - 17.43%, and 18.18% for Plovdiv and Obracec 1, respectively and the lowest was in variant 30.04 . The situation

for vitamin C was similar. A contrariwise trend was established for total sugars, at the least was content in the fruits in varinats 1.04 and it was the highest of 30.04. In Plovdiv total acids were lower on the second date of sowing, and were the highest at the later date. A contrariwise situation was observed in the above mentioned data for Obrazec 1. The pectin is one of the important ingredients of cape gooseberry. The highest levels were established in fruits from Plovdiv. The highest values of 1.16% were detected about direct sowing outside at15.04.

Table 2. Yield of cape gooseberry

Variants	Plovdiv				Obrazec 1			
	2008	2009	2010	average	2008	2009	2010	average
1.04	374	218	411	335	195	225	495	305
15.04	380	200	442	341	187	217	584	329
30.04	262	307	590	387	337	210	476	341
LSD p=0.05	12.80	10.47	13.15		15.53	10.74	12.16	

Table 3. Content of chemical components in cape gooseberry fruits

Variants	Plovdiv					Obrazec 1				
	Dray matter (%)	Vitamin C (mg%)	Sugar (%)	Acid (%)	Pectin (%)	Dray matter (%)	Vitamin C (mg%)	Sugar (%)	Acid (%)	Pectin (%)
1.04	17.43	35.09	8.85	0.93	1.14	18.18	36.43	9.32	1.03	0.98
15.04	16.87	31.52	9.10	0.87	1.16	16.36	34.71	9.39	0.94	1.01
30.04	16.01	27.16	9.39	1.09	1.06	16.14	35.46	9.85	0.90	1.07

Conclusıon

The terms of sowing influence the overall development of the cape goosberry plants. The germination and passing of the vegetation period were most accelerated at a later sowing of 30.04.

Vegetative development was most intensive between phenophase of flowering and of fruiting. The length of the stem in the initial phases was the highest in sowing of 15.04, while in the last phase fruiting it was the highest in sowing date 30.04. The number of branches were most in flowering and decreased in fruiting phenophase.

The number of leaves and their weght were the biggest when sowing was carried out on 15.04. and relatively lower values were established in date 30.04. The highest values of leaf area were observed of 15.04 while the lowest for Plovdiv in sowing of 1.04 and for Obrazec 1 it was observed on 30.04.

The productivity of cape gooseberry was the highest at a later sowing on 30.04., but the earliest date caused the lowest yield.

The content of dry matter and of vitamin C were the highest in sowing of cape goosberry on 1.04, and the sugar was the highest on 30.04. The fruits from variety Plovdiv characterized by a higher amount of pectin.

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