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INFLUENCE OF THE DIFFERENT RATE OF NITROGEN ON THE POSSIBILITIES FOR POST-HARVEST RIPENING OF THE CAPE GOOSEBERRY (*PHYSALIS PERUVIANA* L.) FRUITS

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Abstract

The main goal of the present study was to establish the influence of the different quantity of nitrogen on the possibilities for post-harvest ripening of fruit of cape gooseberry (Physalis peruviana L.). Some part of the cape gooseberry fruit can not ripen until the end of the growing season. Therefore, it is necessary to be carried out the studies in relation with after harvest ripening. By this way the overall productivity are increased. The experiments were carried out with two genotypes of cape gooseberry – first Bulgarian variety Plovdiv and Columbian ecotype Obrazec 1. The plants were grown with non-pricked out seedling in five level of nitrogen fertilization 0, 70, 140, 210 and 280 N kg.ha^{-1} applied in three times – in pre sowing tillage, in stage of flowering and 20 days later. In the end of vegetation normal development fruits, without damage and injuries, but unripe were placed for after harvest ripening in ambient conditions. In a period of 7 days the quantity of ripening and damaged fruits, the content of dry matter and sugars and weight of the fruits were established. The highest percentage of after harvest ripe fruits for variety Plovdiv was found in variants with 140 N kg.ha-^{1}- 67.0%. For Obrazec 1 these values were the highest in rate of 210 N kg.ha-^{1} - 71.67%. Dry matter and sugar content increased, while the fruit weight decreased. The periods for economic efficiency of after harvest ripening were 14 days to maximum 21 days for both varieties.

Key words*: cape gooseberry, maturity, chemical components, nitrogen, fertilization.*

INTRODUCTION

Several researches conducted studies in different crops to establish the relationship of fertilization and post-harvest behaviors such as additional maturity and storability (Ivanova, 1997; Ivanova and Vasilev, 2003; Cholakov, 2003; Todorova et al., 2009; Cholakov and Boteva, 2012; Haytova, 2013; Haytova et al, 2014). Cape gooseberry is a comparatively new vegetable crop for Bulgaria and for Europe, but with increasing sales and expanding market. Part of the available at the market fruit for fresh consumption are the result of further post-harvest ripening. The flowering, fruit-set formation and maturity of cape gooseberry fruits are directly dependent on the applied agrotechnology and often can be delayed in case of a strong vegetative growth (Prasad, 1979). Chernook (1997) reported that part of fruit of cape gooseberry usually does not ripen on the plant itself and also points out that these green fruit are with very good opportunity for post- harvest ripening. This crop is characterized by very good ability for after harvest ripening and for storage, and these two aspects are the main economic features that often are used in practice. This contributes to increasing the marketed production and the income and consequently to increase also the efficiency of cultivation (Christov, 2010). One of the reasons for immature fruit is a high vegetative growth. In cape gooseberry growing one must pay particular attention to appropriate fertilization with nitrogen (Chernok, 1997; Kendall, 2008; Christov, 2010), because a higher quantities of nitrogen approximately with 50 kg.ha^{-1} N caused much more luxuriant vegetative growth, in which case the setting of flowers and fruits and their maturity greatly reduced (Crawford, 2004; Paksi et al., 2007).

Further ripening causes in green and semi-green fruits of cape goosberry chang of the content of sugars and the total amount of the salts (Sarkar et al., 1993). For a long-term storage is recommended to be picked semi-

green fruits and to be placed for ripening. In the process of ripening the fruit color changes from green to yellow or orange, which is associated with degradation of chlorophyll and an increase of carotenes, primarily of β-carotene. The process of ripening is associated with increase of the content of sugar, total soluble salts, the relationship between soluble salts and acids, and ascorbic acid, while the starch decreases and the ratio of sucrose: glucose: fructose changed. Initially in the ripening the content of acidity increases, but then gradually reduces until the fruit reaches full maturity (Fischer and Lüdders 1997; Fischer et al. 2000; Sarangi et al. 1989; Baumann and Meier, 1993; Majumder and Mazumbar 2001).

The main goal of present study was to determine the influence of different rate of nitrogen fertilizer, applied in cultivation of cape gooseberry on the possibility of after harvest ripening of its fruit.

MATERIALS AND METHODS

The experiments were carried out during 2008-2010 years in Agricultural University, Plovdiv, with two genotypes – one was the first Bulgarian variety Plovdiv and the other was Obrazec 1. During autumn plowing 160 kg.ha^{-1} P_2O_5 and 120 kg.ha^{-1} K_2O as triple superphosphate and potassium sulphate, respectively were applied. Seeds were sown in a plastic green house in the middle of March at 1.5 g/m^2. On 20 of May the seedlings were planted by scheme 70 × 50 cm on the experimental plots of 10 m^2, in four replications. The soil classified as Molic-Fluvisols, is loamy, with 30 % clay. Five rate of N as an ammonium nitrate fertilizer (34,27 % N) – 0 (control), 70, 140, 210 and 280 N kg.ha^{-1} were applied in three times – ⅓ before planting soil preparation and the remainder was divided into two doses and used in two stages of development - beginning of flowering and twenty days later. During vegetation each agro-technological practice that are necessary were performed. At maturity of the fruit regularly harvests are carried out.

At the end of the growing season, before the first autumn frost, well-formed fruit with normal size, but unripe, undamaged and illnesses were harvested and placed for post-harvest ripening. It carried out in four replications, in ambient conditions in storage house with temperature 20-22^{0}C and 60-65% air humidity. The fruits in quantity of 500 g were placed in plastic, very good disinfected boxes with depth of layer of 7-8 cm. Through periods of 7 days until depletion of healthy fruit, the ripe fruits were taken and their weight was measured, while the rotting and damaged ones were removed. The weight per fruit, content of dry matter (refracto-metrically) and sugar (by the methods of Hagedorn – Yensen, described by Stambolova et al., 1978) were established in four replications on the day of placing for post-harvest maturation and every seventh day of the trial was conducted. 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 DISCUSSIONS

Christov (2010) reported that under Bulgarian condition not all cape gooseberry fruits can mature by the end of the growing season. The proces of maturation according to Sahoo et al. (2002) and Crawford (2004) have a direct relationship with the technology of growth and especill of the applied quantity of nitrogen fertilizer. Different rate of nitrogen affects on the amount of unripe fruits (Table 1). For both varieties they were at least, in the control and their portion augmentation with applying of nitrogen. This could be due eventually to a weak vegetative growth in non-fertilizing plants and the possibility for large-scale ripen of their fruits. The amount of unripe fruits was the highest for Plovdiv in variant with N_{70} – 550.4 kg.ha^{-1} while for Obrazec 1 in N_{140} - 368.7 kg.ha^{-1}. Differences between the two genotypes are almost nonexistent, but the quantity of unriped fruits is more in variety Plovdiv. For ripening, as outlined above, are placed well shaped fruit with normal size. At last variant, with the

highest fertilizer rate, the mentioned quantities of unripe fruits are lower in compared with the previous levels of nitrogen. However it should be borne in mind that these are only fruit that were fit and matching requires for further ripening. It can be assumed that their amount is less because the plants, eventually in results of higher nitrogen fertilization developed stronger vegetative growth. This in turn may have caused for formation of smaller, weaker and underdeveloped fruits, which are not eligible to be placed for post-harvest ripening, which is why the reported quantity is lower, but this applies only for fit for ripening fruit. This assertion confirmed by the next indicator, determining the proportion of immature to all formed fruit. The differences between most of the variants have statistical significance.

The proportion of unripe fruits, to all formed ones increases with increasing of level of fertilization. It was higher for Plovdiv from 9.41 % to 13.31 % and for other variety was between 8.17 % to 15.88 %. These not small amounts suggest that the after harvest ripening of cape gooseberry fruit is a necessary and indispensable practice.

As a result of conducting the after harvest ripening the percentage of riped fruits for variety Plovdiv was the highest in variant N_{140} – 67.0 %, while for Obrazec 1 it was observed for the next level N_{210} – 71.16 %. The values of this index was the least for Obrazec 1 in control and for Plovdiv in N_{280}.

The total quantity of ripe fruits by means of post-harvest ripening increased. The least this increase was in Plovdiv for the control and for the highest amount of nitrogen 4.19 % and 5.68 % and for Obrazec 1 also for the control and for the least quantity of fertilizer – 3.07 % and 4.28 %. The proportion of after harvest ripe fruits was more significant for N_{140} and N_{210} – 8.67 % (Plovdiv) and 6.71 % (Obraze 1), respectively. Therefore more appropriate and economically efficient is the application of his practice in the above mentioned two levels of nitrogen application.

Table 1. Quantity on non maturity fruits and ratios between maturity and after harvest ripping fruits of cape gooseberry

Varieties	Non maturity fruits ($kg.ha^{-1}$)		Portion of the unripe to all formed fruits (%)		After harvest ripe fruits (%)		Portion of after harvest ripe to whole quantity of maturity fruits(%)	
	Plovdiv	Obrazec 1	Plovdiv	Obrazec 1	Plovdiv	Obrazec 1	Plovdiv	Obrazec 1
$N_0P_{160}K_{120}$	250.5	222.5	9.41	8.17	41.93	38.83	4.19	3.07
$N_{70}P_{160}K_{120}$	550.4	294.0	11.60	9.58	57.33	46.67	6.99	4.28
$N_{140}P_{160}K_{120}$	525.4	368.7	12.41	9.99	67.00	62.67	8.67	5.89
$N_{210}P_{160}K_{120}$	459.5	361.3	11.91	10.04	49.22	71.67	6.23	6.71
$N_{280}P_{160}K_{120}$	385.8	341.3	13.31	15.88	40.83	44.78	5.68	6.64
P=5.0%	54.93	11.52						
GD P=1.o%	75.56	16.69						
P=0.1 %	119.34	25.04						

The dynamic of after harvest ripening is shown on Figure 1. Special differences between the two genotypes were not observed. The most fruits ripe on the seven days and the highest quantity were obtained from variant N_{70} – 41.67 % for Plovdiv and from N_{210} - 37.0 % of Obrazec 1. Secondly for both genotypes were the fruits from N_{140} – 37.56 % and 35.0 % for first and for second variety, respectively. After that day, the percentage of post-harvest ripe fruits began to decrease gradually. After harvest ripening, even in insignificant amount detected until 35 days in Obrazec 1 in N_{140} but in extremely low quantity – 2.0 %, while in Plovdiv it compiled in each variants on 28 day, as the control and N_{280} was even earlier on 21 day. The highest decrease was observed between 7 and 14 days for N_{70} and N_0 with 33.34 % and 26.14 %, respectively in Plovdiv and for Obrazec 1 – in N_{140} and $N1_{70}$ – 23.33 % and 21.0 %. Appropriate period for after harvest ripening was up to 14 days and maximum to 21 day, when for Plovdiv obtained additional ripen fruit within 2.56 % (N_0) to 6.0 % (N_{210}), and for Obrazec 1 between 2.33 % (N_{280}) to 9.33 % (N_{140}).

The weight of the fruit during after harvest ripening decreased relatively slowly from the first to the last day (Figure 2). It could be assumed that this is due to natural processes of transpiration and loss of water from the fruit during post- harvest ripening, which affects on their weight. More sharply this process is observed in Plovdiv on 21 day in variants N_{140} – decrease with 8.29 %, while for the other ones was established on 28 day – with 5.73 % in the same variant. On last day of post-harvest ripening the reduction toward the initial weight was with 3.45 % (N_0 on 21 day) to 10.51 (N_{140} on 28 day) for Plovdiv. In genotype Obrazec 1 this decrease varied between 4.84 % (N_{210} on 21 day) to 12.42 % (N_{140} on 28 day). The initial weight of fruit that were placed for post-harvest ripening was lower for Obrazec 1. The coloring in orange of fruit during post- harvest ripening is an indication for reaching the suitable for consumption maturity and according to Fischer et al. (2000), as it was above mentioned, it is in the result of degradation of chlorophyll and increasing of the carotens.

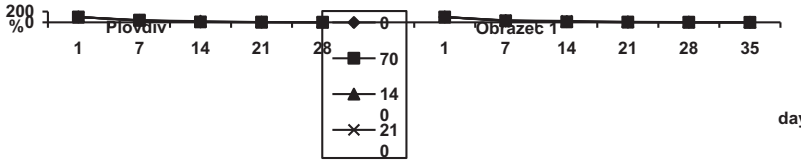

Figure 1. Dynamic of maturation of cape gooseberry fruits during the period of after harvest ripening (0, 70, 140, 210, 280 kg.ha^{-1} N)

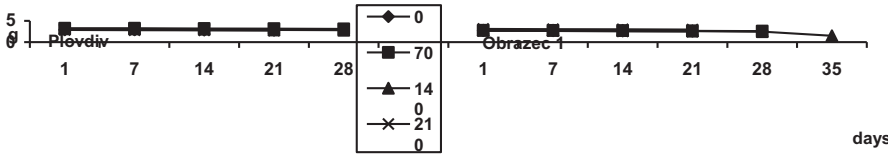

Figure 2. Weight of one fruit during the period of after harvest ripening (0, 70, 140, 210, 280 kg.ha^{-1} N)

The dry matter content increased in the period of after harvest ripening in each variant (Figure 3). The highest increase was observed between 7 and 14 days. For Obrazec 1 the highest increae was observed for level of fertilizer of N_{210} in period 1 - 7 day with 2.12 %. In this genotype sharply decrease was recorded on 35 day for varinat N_{140} with 4.78%. In Plovdiv, the increase up to 28 days. The augmentation for this variety was the highest between 7 and 14 day for N_{140} with 2.19 %. It can be assumed that the reason which was mentioned about weight decrease, i. e. normal water loss is also associated with the increase of dry matter in the fruit.

The processes of post-harvest ripening are associated with convert of nutrients into the fruits. Similar dynamic, such as in the dry mater, has been established also for sugar content (Figure 4). In Obrazec 1 in almost all variants increased without concern for 35 day in N_{140} where the decrease was monitored. Similar trend to increase a sugar was established in Plovdiv in each level of nitrogen application. Sarkar et al. (1993) in an investigation of the chemical composition of the cape gooseberry fruits, with different

stage of maturity, placed for additionall after harvest ripening, also indentified change in quantity of the sugar content as well as in the total quantity of salts.

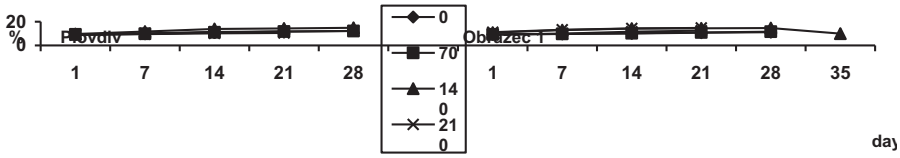

Figure 3. Content of dry mater of cape gooseberry fruits during the period of after harvest ripening (0, 70, 140, 210, 280 kg.ha^{-1} N)

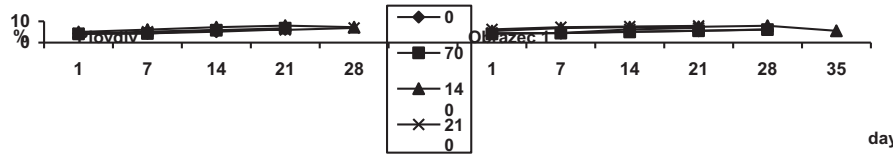

Figure 4. Content of sugar of cape gooseberry fruits during the period of after harvest ripening (0, 70, 140, 210, 280 kg.ha^{-1} N)

CONCLUSIONS

Applied of nitrogen fertilizer in cape gooseberry affects on the amount of unripe fruit during the vegetation season. This quantity was more in fertilization with 70 and 140 kg.ha^{-1}a nitrogen.

The portion of unripe fruits to all formed ones was the highest for the biggest amount of nitrogen. A higher percentage of post-harvest ripe fruits in Plovdiv was observed in variant N_{140} but in Obrazec 1 it was recorded in N_{210}.

Post-harvest ripening is economically efficient when it is done with fruits from plants that are grown by fertilization with quantity of ammonium nitrate in level from 70 to 140 kg.ha^{-1} nitrogen, where unripe fruits were more, and increase of the total amount of ripe fruit as a result of this practice was higher. The dynamics of the after harvest ripening of cape gooseberry fruits indicates that it is appropriate to continue to 14 days.

The weight of the fruit during after harvest ripening decreases the dry mater such as also the sugar content in both genotypes increases.

REFERENCES

Baumann T. W., Meier C. M., 1993. Chemical defense by withanolides during fruit development in *Physalis peruviana* L. Phytochemistry 33:317–321.

Chernok L. G., 1997. Tomato, pepper, eggplant, cape gooseberry. Series-Vitality 12, 280- 288. (Ru)

Cholakov T., 2003. Factors and quality in vegetable and fruit species. University of Food Technology- Plovdiv, Scientific works, L (1): 160-165.

Cholakov T**.,** Boteva Hr., 2012. Influence of biological fertilizers on productivity of early potatoes. Journal of International Scienctific

Publications ; Ecology&Safety, vol. 6 (3): 137 - 143.

Christov Chr., 2010. Cape gooseberry - Physalis peruviana L. In: Seeds of small and unknown fruits and vegetables. www.hobi-semena.com (accessed March, 2010) (Bg)

Crawford M., 2004. West Australian Nut and Tree Crops Associacian. Yearbook Australian University 27, 42-51.

Fischer G., Lüdders P., 1997. Developmental changes of carbohydrates in cape gooseberry (*Physalis peruviana* L.) fruits in relation to the calyx and the leaves. Agronomia Colombiana 14:95–107.

Fischer G., Ebert G., Lüdders P., 2000. Provitamin A carotenoids, organic acids and ascorbic acid content of cape gooseberry (*Ph. peruviana* L.) ecotypes grown at two tropical altitudes. Acta Horticulturae 531, 263–267.

Fowel J., Cohen L., 1992. Practicle statistics for field biology. John Wiley & Sons, New York, 223.

Haytova D., 2013. Influence of foliar fertilization on the morphological characteristics and short-term storage of fruits of zucchini squash, Ecology and future – Journal of agricultural Science and forest science, vol.XII, No.1, Sofia, pp. 33-39. (Bg)

Kostova D**.,** Haytova D., Mechandjiev D. 2014, Effect of type and method of fertilization on marrows (*Cucurbita pepo* L.) yield and fruit quality, American Journal of Experimental agriculture American Journal of Experimental agriculture 4(4):376-383

Ivanova V., 1997. Effects of Nitrogen Rates and Mode of Plant Formatting on the Growth, Flowering Responses and, Vase Lite of Chrysanthemum Indicum L. - Dahlia Greidinger International Symposium on Fertilization and the Environment, Technion - II T, Haifa, Israel, 24-27.03.1997, p. 457-466.

Ivanova V., Vassilev A., 2003. Biometric and physiological characteristics of chrysanthemum (Chrysanthemum indicum L.) plants grown at diferent rates of nitrogen fertilization.
Journal of Central EuropeanAgriculture v. 4, 1.

Kendall H., 2008. Cape gooseberry. In: Kendall farm. http://www.kendallfarms.com. (accessed October, 2008)

Majumder K., Mazumdar B. C., 2001. Effects of auxin and gibberellin on pectic substances and their degrading enzymes in developing fruits of cape-gooseberry (*Physalis peruviana* L.). Journal of Horticultural Science and Biotechnology 76:276–279.

Paksi A. M., Kassai T., Lugasi A., Ombodi A., Dimeny J., 2007. *Physalis peruviana* L. an alternative crop for small scale farms. Cereal Research Communications 35 (2), 877-880.

Prasad I. D., 1979. Effect of nitrogen, phosphorus and potash on growth, yield and quality of cape-gooseberry (*Physalis peruviana* L.). Master of Science Thesis, Rajasthan Agricultural University, Bihar, Pusa, India.

Sahoo D., Mahapatra P., Das A. K., Sahoo N. R., 2002. Effect of nitrogen and potassium on growth and yield of tomato (*Lycopersicon esculentum* Mill.) var. Kumari. Haryana Journal of Horticultural Science 31, 264-266.

Sarangi D., Sarkar T. K., Roy A. K., Jana S. C., Chattopadhyay T. K., 1989. Physicochemical changes during growth of cape gooseberry fruit (*Physalis peruviana* L.). *Progressive Horticulture* 21:225–228.

SarkarT. K., Pradhan U., Chattopadhyay T. K., 1993. Storability and quality changes of cape gooseberry fruit as influenced by packaging and stage of maturity.

Stambolova M., Chopaneva T., Argirova T., 1978. Handbook for biochemistry practice. Zemizdat, Sofia. (Bg)

Todorova V., Todorov Y., Cholakov T., 2009. Association between cultivar performance for economic and morphologic traits and agrometeorological factors in Bulgarian pepper. Revista Científica Agrícola 9, 776-882.