ASSESSMENT OF YIELD AND STABILITY OF TWO VARIETIES OF CAPE GOOSEBERRY (PHYSALIS PERUVIANA L.) DEPENDING ON THE NITROGEN RATE

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Abstract

The main goal of the present study was to assess the yield and yield stability in order to established the variety and rate of nitrogen fertilization with high adaptability and flexibility to environmental condition. The experiment carried out with two genotype of cape gooseberry Plovdiv and Obrazec 1, fertilized with five rate of nitrogen – 0, 70, 140, 210 and 280 kg.ha\(^{-1}\). The productivity and the index of stability were determined. The highest yield was established in rates 70 kg.ha\(^{-1}\) and 140 kg.ha\(^{-1}\). With the highest index of yield stability and respectively with good adaptability to environmental condition was assessed the variant N\(_{140}\)P\(_{160}\)K\(_{120}\) in both genotype YS(i)=12+ for Plovdiv and YS(i)=10+ for Obrazec 1.

Introduction

Although that cape gooseberry is a new vegetable crop, under Bulgarian environmental it found excellent and appropriate conditions for very good development and productivity. The perspective of its grown is supplemented even more by increasing of demand and expanding market. Researches in fertilization of vegetable crops is of particular importance, as confirmed by studies conducted by many scientists as Todorova, Todorov, Cholakov (2009), Haytova, Bileva (2011), Haytova (2011), Haytova (2012) and Boteva, Cholakov, Vlahova (2012). In cape gooseberry growing one must pay particular attention to appropriate fertilization with nitrogen (Chernok 1997; Kendall 2008; Christov 2010). According to them in most cases, a high yield is obtained at lower level of nitrogen fertilization. Similar opinion were expressed by McCain (1993) and he noted that although the plants do not require large amounts of fertilizer, the production increases significantly when performing balanced fertilization, and the most appropriate is using N\(_{12}\)P\(_{5}\)K\(_{10}\).

Phenotypic stability of varieties as refers the yield is a reflection of interaction between the genetic characteristics of the individual and the environment in which develops. Several approaches and methods for assessing the phenotypic stability are known (Eberhart, Russel 1966; Shukla 1972), but the most reliable way for simultaneous evaluation of the yield and its stability has proven the method of Kang (Kang 1993) that determines the so-called Yield stability index (Ysi). It gives a summary evaluation for yield and its stability in different environments.

The stability of yield is a complex index about adaptability of given genotype and its ability to develop a higher productivity potential through better use of natural resources and climate conditions. Based on the yield stability index and rank-sum the most stable genotypes with high productivity can be identified (Farshadfar, Mahmodi, Yaghotipoor 2011). Mekbib (2003) reported that stability can be grouped into three groups according to the knowledge generated by stability index. The yield is a sign which is controlled by a complex polygenic system and strong varies depending on the environmental conditions, therefore establishment of phenotypic stability is of paramount importance to their successful implementation. Higher variety phenotypic productive stability, which is result of it genetic peculiarity and also of
environmental condition, applied agri-technology, indicates their better adaptability and steady manifestation of their indexes and less marked genotype-environmental interaction. The changes of technological and environmental factors, during important organogenesis stages and phases of genetics development of plant, caused changes in specters of locus, determining quantitative plant indexes and yield respectively (Rachovska, Dimova, Kolev, Kostov, Ur 2011). In our previous study (Panayotov, Dimova, 2014) we found that through application of the index YS(i) allows for further comprehensive assessment of newly pepper breeding lines as regards the expression of their signs and of its adaptability to environmental conditions, which provides the necessary information about effectiveness of their inclusion in future breeding programs.

The main goal of the present study was to assess the yield and yield stability in order to establish the variety and rate of nitrogen fertilization with high adaptability and flexibility to environmental condition.

Material 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$_2$O$_5$ and 120 kg.ha$^{-1}$ K$_2$O as triple superphosphate and potassium sulphate, respectively were applied. Seeds were sown in a plastic green house in middle of the 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. Through the vegetation periods all agricultural practices were performed. The total yield was established.

The factors of this experiment were: two varieties, five rate of nitrogen fertilization and three years of investigation. The obtained data about the yield by the years, replications and level of fertilization were processed through two-factor ANOVA. Each factorial combination between variety and rate of fertility were perceived as variants for observation and assessment. To determinate the stability index (Ysi) was applied computer program Interactive program for calculating Shukla’s stability index (IPCSSI KYSI), developed by Kang, Magari (1995).

Results

Estimation of the genotypes phenotypic stability can be searched after establishing of the significant differences between genotypes as well as between rate of fertilization and of interaction between them. The results from dispersion analyses of the investigation variants are shown in Table 1. The data of the conducted dispersion analysis of ten variants (variety x rate of fertilization), during the three years investigation period, indicated that differences are proved between the variances as well as between environmental condition in the separate year. This demonstrates that, depending on the conditions of the years the gradation of the variances has changed accordingly to obtained yield.

In Table 2 are shown the results from carried out analyses for yield stability on the investigated ten variants (two varieties, grown by five level of nitrogen fertilization). The obtained yield as well as the indexes of its stability varied strongly.

Improving the yield of plants is a major objective of any agrotechnological practices. Fertilization with nitrogen greatly affected yield of cape gooseberry. Results over the three
years of study in both varieties are approximately similar. All tested fertilization rates of nitrogen caused increasing of the yield, compared to non fertilized plants. In dependence on nitrogen fertilization the genotypic response regarding to productivity was observed. The highest yield of Plovdiv – 4194.3 kg.ha\(^{-1}\) was obtained by fertilization with N\(_{70}\), followed by N\(_{140P_{160K_{120}}}\) - with 54.41% above the the control.

Higher level of nitrogen provoked decreasing of the yield, but also higher than non fertilized plants. In rate N\(_{210}\) the productivity was with 19% lower than in rate 70 kg.ha\(^{-1}\). In Obrazec 1 the highest productivity was observed in fertilizing with 140 kg.ha\(^{-1}\) nitrogen - 30.54% over the control and second was the next level of N\(_{210}\) - the increase was 26.92%. Throughout the whole period the highest level of N\(_{280}\) caused inhibition and reduction to the control with 29.15%. The lowest productivity was recorded in variant N\(_{280P_{160K_{120}}}\) in variety Obrazec 1. McCain (1993) also found that the most appropriate is to apply low quantity of nitrogen and he emphasized that best rate 120 kg.ha\(^{-1}\) nitrogen. The importance of nitrogen fertilization for the yield formation of cape gooseberry underlined also by Sarkar, Chattopadhyay (1993) and they concluded that the content of nitrogen and potassium in the leaves have a strong influence on the formation of the fruit and the relationship with the quantity of fruit set and with the yield is generally very strong.

The index of stability YS(i) varied in widely limits from -7 to 12+. The last variant mentioned has demonstrated high levels of stability. The established indexes of yield stability proved that with the highest level of yield stability were characterized variant N\(_{140P_{160K_{120}}}\) of variety Plovdiv. The average productivity has been lower than in previous rate, but during the year of the study it was most stable with index YS(i) =12+. In Obrazec 1 the index of stability was also the highest in the same variant YS(i) =10+. This denotes that this variant is with bigger adaptability, it realized potential is comparatively sustainable and that it can develop its
productivity in greater variation of environmental conditions. The variant with the highest yield in Plovdiv N$_{70}$P$_{160}$K$_{120}$ - 4194.3 kg.ha$^{-1}$ characterized with comparatively high index of stability YS(i)=5+, which puts it in third place stability, followed by variant of the same genotype - N$_{210}$P$_{160}$K$_{120}$ with YS(i)=3+. Some of the variants were with negative index of yield stability and they were: the control and in the fertilization with the highest level of nitrogen as well as in rate 70 kg.ha$^{-1}$ nitrogen in Obrazec 1 – YS(i) = -10, -6, -7, -1 and -6, respectively, which indicates that the expression of their yield potential is strongly influenced by the condition of the environment.

Conclusions

Applying of the index YS(i) allows for further comprehensive assessment of better variety of nitrogen fertilization in cape gooseberry as regards the expression of their productivity and of its adaptability to environmental conditions, which provides the necessary information about effectiveness of their growing.

The highest yield as a result of nitrogen fertilization in variety Plovdiv was established in rate 70 kg.ha$^{-1}$ while in Obrazec 1 it was in 140 kg.ha$^{-1}$.

From the studied variants (variety and rate of nitrogen fertilization) with enhanced adaptability by the environmental condition during the years of investigation and the highest stability of the yield is feature variety Plovdiv fertilized with N$_{140}$P$_{160}$K$_{120}$ and YS(i)=12+, followed by the same variant in Obrazec 1 with YS(i)=10+. It may also be pointed and for variants of Plovdiv in N$_{70}$P$_{160}$K$_{120}$ with YS(i)=5+ and in N$_{210}$P$_{160}$K$_{120}$ with YS(i)=3+ and the same variant of Obrazec 1 with YS(i)=1+.

The other variants demonstrate lower adaptive capacity by the yield, influenced significant by the environmental condition in the year.

References

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