JOURNAL OF NEW RESULTS IN SCIENCE (JNRS)
ISSN: 1304-7981
http://dergipark.gov.tr/jnrs
*Research Article*

**Volume : 6**
**Issue: 2**
**Year: 2017**
**Pages: 32-40**

***Received***: 23.11.2017
***Accepted***: 26.12.2017

*Editors-in-Chief:* ***Ebubekir ALTUNTAS***
*Area Editor*: ***Yusuf YANAR***

# Genotype by Environment Interaction of Potato Breeding Lines Developed for Central-Black Sea Region

**Yasin Bedrettin KARAN**[a,*], **Gungor YILMAZ**[a]

[a] *Department of Crop Science, College of Agriculture, Gaziosmanpasa University, 60250, Tokat.*
yasinb.karan@gop.edu.tr, gungor.yilmaz@gop.edu.tr
**Corresponding author:*

**ABSTRACT:** This study was done as a part of the studies carried out on breeding potato varieties adaptable to central-north intersectional region. This study has been started in 2007, with about 20 thousand hybrid potato seedlings and as a result of clonal selection, 20 clones, performing excellent characteristics in terms of yield and quality characteristics, were subjected to the analysis of stability in terms of genotype x environment interactions. The study was conducted under Tokat-Niksar, Tokat-Kazova (2012-2013) and Tokat-Artova (between 2011-2012 and 2012-2013) conditions as a randomized complete block design with 3 replications in 8 different environments, as the years and locations are accepted as an environment. In the study, four commercial varieties were tested as standards beside White, cream, light yellow and dark yellow clones. The data were subjected regression analysis. Based on the Finlay-Wilkinson regression coefficients, some of the clones (A7-12, T5-4, T11-10, T5-14, A3-15, A3-167, and T10-8) which have better yield and quality characteristics than commercial varieties, showed good adaptation to specific environments while the clones (T6-28 and A3-234) had good adaptation to all the environments (Tokat-Niksar, Tokat-Kazova, and Tokat-Artova). Also in terms of dry matter, A13-1 has been identified as a clone with higher (28.4%) dry matter contents.

***Keywords –*** *Potato, Clone Selection, Solanum tuberosum, Breeding, Stability Analysis*

## 1. Introduction

Successful new varieties must show high performance in respect to yield and other essential agronomic traits. Moreover, their superiority should be reliable over a wide range of environmental conditions. The basic cause of differences between genotypes in their yield stability is the wide occurrence of genotype-environment interactions (GxE-interactions) i.e. the ranking of genotypes depends on the particular environmental conditions where they are grown. These interactions of genotypes with environments can be partly understood as a result of a differential reaction to environmental stress factors like drought or diseases, and consequently resistance breeding is of significance in improving yield stability (Becker and Leon, 1988).

As a matter of fact, studies were carried out by different researchers in different agro ecological regions of the world have resulted in significant differences between genotypes in terms of yield and quality in the conditions of the region and it has been concluded that the most suitable genotypes should be determined for regional conditions [Caesar et al., 1978; Yılmaz and Tugay, 1999].

Potato is an important source of food which contains high levels of carbohydrate, protein, vitamins and minerals. It is also a source of income and employment opportunity in developing countries (FAO, 2016). In addition to high yields, the dry matter content of the tubers is considered an important quality criterion. This property is more important in terms of obtaining economically processed products and nutrient content of the industry.

Potato tubers contain between 18 and 28% dry matter, depending on the variety and environment. The most important part of dry matter is starch. According to cultivars and growing conditions, 70-80% of dry matter is starch. On the other hand, 1.7-2.5% of protein is found in potato tubers and about 8% of dry matter is protein. Potato is the fourth most important plant used as a carbohydrate source in human nutrition. Varieties containing more than 16% starch are evaluated in the starch industry (Er and Uranbey, 1998).

The objective of this research was to test performance, stability of yield, and dry matter content of different flesh color tubers in various environments. A set of 16 promising clones and four commercially available cultivars and one local genotype was tested in field trials at Tokat-Niksar, Tokat-Kazova (2012 - 2013) and Tokat-Artova (between 2010-2011 and 2012-2013) conditions. In order to determine genotypes with stable expression of traits and to examine possible differences in stability, analysis of yield, quality, and GEI was undertaken (Finlay and Wilkinson, 1963).

## 2. Material and Methods

This research was carried out in Tokat-Artova (1189 m) during the 2011 and 2012 vegetation periods and Tokat-Niksar (276 m), Tokat-Kazova (571 m) and Tokat-Artova conditions in the 2012 and 2013 vegetation periods. The soil reaction of the trial field is mildly alkaline.

The material used in the experiment is composed of 16 promising clones and 4 standard varieties (Başçiftlik Beyazı, Slaney, Hermes and Agria) with different flesh colors selected as a result of the studies carried out within the scope of TUBITAK project 106 O 626 initiated in 2007 (Table 1). The experiment was laid out in Randomized Complete Block Design, with three replications. The planting was carried out in Niksar in the second half of April in Kazova in early March and in the first half of May in Artova. Potato tubers were planted at spacing of between rows and plants 70cm and 30 cm respectively. The trials were fertilized 12kg/da 15:15:15 (N:P:K) at the time of planting in both years and locations. 8 kg/da N was applied 45 days after planting (Tugay et al., 1995). The plants were irrigated as required to maintain adequate moisture levels by drip irrigation. When cultural and chemical methods are needed to combat diseases and pests, necessary applications have been made.

***Table 1.*** *Flesh colors and pedigrees of clones used in the experiment*

| Number | Clones | Pedigree | Flesh Colour | Number | Clones | Pedigree | Flesh Colour |
|---|---|---|---|---|---|---|---|
| 1 | *T5/4* | *Serrana x DTO-33* | *White* | 9 | *T4/4* | *Granola x TS-2* | *Light yellow* |
| 2 | *A13/1* | *Pentland Crown x TS-2* | | 10 | *T6/28* | *Serrana x LT-7* | |
| 3 | *T5/14* | *Serrana x DTO-33* | Cream | 11 | *A2/11* | *MF-1 x TS-4* | *Dark yellow* |
| 4 | *A7/12* | *Serrana x TS-4* | | 12 | *A3/110* | *Serrana x TS-9* | |
| 5 | *T11/10* | *Granola x Huincul* | | 13 | *A3/15* | *Serrana x TS-9* | |
| 6 | *A3/234* | *Serrana x TS-9* | *Light yellow* | 14 | *A3/142* | *Serrana x TS-9* | |
| 7 | *A3/29* | *Serrana x TS-9* | | 15 | *A3/368* | *Serrana x TS-9* | |
| 8 | *A3/167* | *Serrana x TS-9* | | 16 | *T10/8* | *MF-1 x LT-7* | |

It was determined the regression coefficient by regressing variety mean on the environmental mean, and plotting the obtained genotype regression coefficients against the genotype mean yields (Finlay and Wilkinson, 1963). According to Finlay and Wilkinson (1963), regression coefficients approximating to 1.0 indicate average stability. When the regression coefficients are approximating to 1.0 and are associated with high yield mean, genotypes are adapted to all environments. When associated with low mean yields, genotypes are poorly adapted to all environments.

Regression coefficients above 1.0 indicate genotypes with increasing sensitivity to environmental change, showing below average stability and great specific adaptability to high yielding environments. Regression coefficients decreasing below 1.0 provide a measure of greater resistance to environmental change, having above average stability but showing more specific adapted to low yielding environments. The overall average of the experiment and the regression line (b = 1) confidence limits for; It was found by G.S. = + T. S. formula. Figure 1 is a generalized interpretation of the genotype pattern obtained when genotype regression coefficients are plotted against genotype mean yields (Figure 1.).

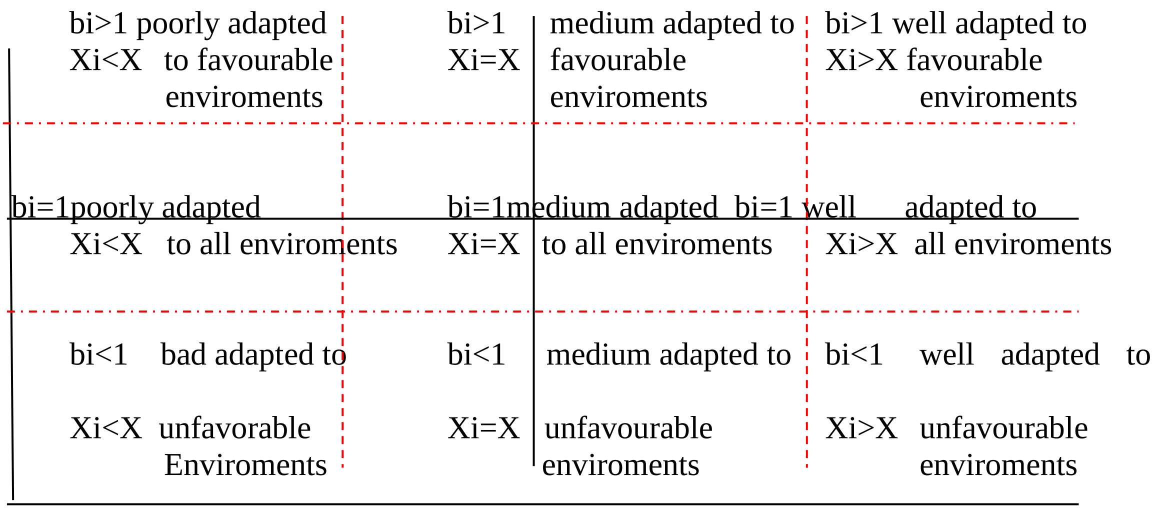


***Figure 1.*** *A generalized interpretation of the genotypic pattern obtained when genotypic regression coefficients are plotted against genotypic mean adapted from Finlay and Wilkinson, 1963.*

## 3. Results and Discussion

### Tuber Yield (kg/da)

The results in Table 2 showed that tuber yield per decare. Since each year and place is regarded as an environment in terms of stability, the study was carried out with 16 advanced generation clones and 4 standard varieties in eight environment. Accordingly, the overall average of the test in terms of tuber yield 5840.8 kg/da., average of standard varieties 4708.4 kg / da., average of advanced clones were 6123.9 kg/da. The tubers yields of the clones are different from each other as well as the differences in the environmental. In this study, the yields of 16 clones ranged from 4976.3-8069.7 kg/da. The highest tuber yield was obtained from A7-12 (flesh color cream). The highest yielding clone in all environmental in white flesh color was A13-1 (6559,3 kg/da), the highest yielding clone in all environmental in light yellow flesh color was T6-28 (7211,5 kg/da), and in dark yellow flesh colors was A3-15 (6339,6 kg/da).

In terms of locations, the highest average tuber yield consisted of respectively Artova, Kazova and Niksar locations. The clones that yield the highest yields in the locations are the light yellow flesh color T6-28 in Niksar and Kazova, and the flesh color A7-12 clones in Artova (Table 2).

Meanwhile, when all the environmental were examined separately, it has been seen that some clones have achieved a yield of over 9 tones, meaning that these clones have high yield potential. These are T6-28 (light yellow), A7-12 (cream), T5-4 (white), T11-10 (cream), T5-14 (cream), A3-15 (dark yellow), A3-167 yellow) and T10-8 (dark yellow). All of these clones were also found to be more efficient than commercial varieties in all environments (Table 2).

High and stable yield levels in potato tubers are always desirable. It is also reported that tuber yield is one of the most important component for the person trying to define an ideal variety (Hoopes and Plaisted, 1987).

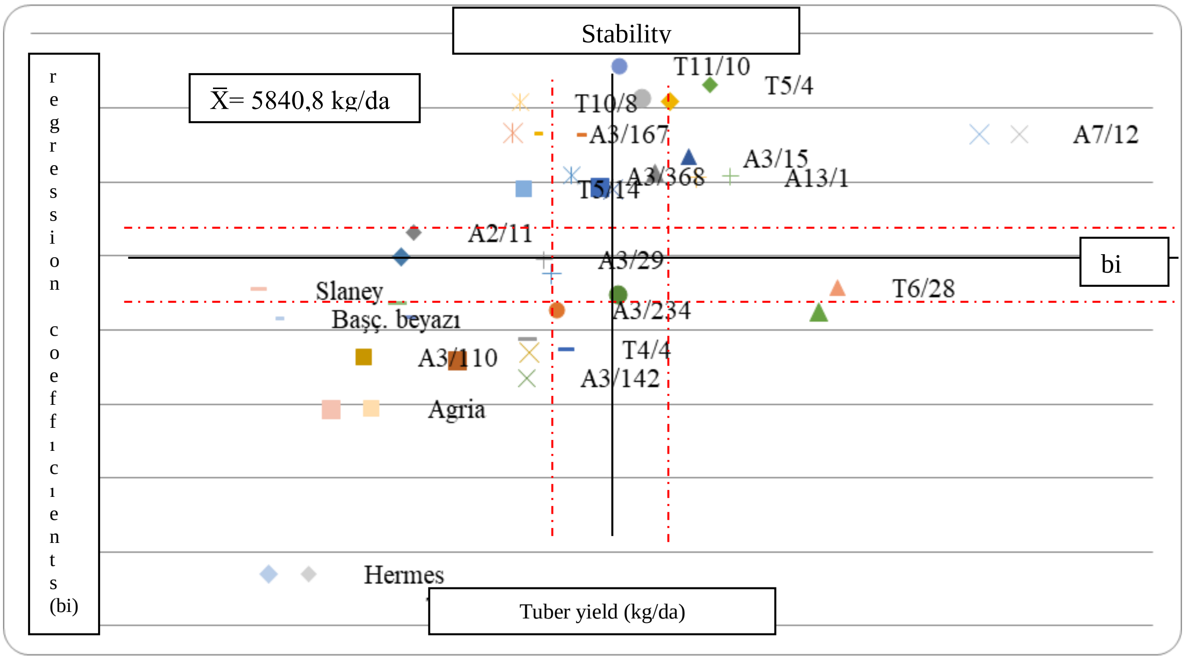


***Figure 2.*** *Adaptation classes of clone and varieties of total tuber yield (kg/da)*

When the findings were examined in terms of genotype x environment interaction and stability, the regression coefficients ranged from bi = 0.72 to 1.43. Accordingly, A3-234 and T6-28 were better suited to grow than other clones in all environmental. The general average and regression coefficients of these clones were closest to bi = 1 in the all environmental (Table 1 and Figure 2).

In environments with different characteristics, the findings of the advanced generation clones have been examined. According to this T11/10, T5/4, A3/15, A13/1 and A7/12 clones showed well adapted in the favorable environmental. T10/8, A3/167, T5/14, A3/368 clones showed medium adapted in the favorable environmental. A3/29 clone showed medium adapted in the all environmental. A2/11 clone and Slaney cultivar showed poorly adapted in the unfavorable environmental. While T4/4 and A3/142 clones showed medium adapted in the unfavorable Başçiftlik Beyazı, Hermes, Agria and A3/110 clone showed poorly adapted in the unfavorable environmental (Figure 2).

**Dry Matter Content (%)**

In this study, the dry matter contents of the tubers were given in Table 3. Accordingly, the overall average of the tubers in terms of the dry matter content % 21,65, average of commercial cultivars were % 21,42 and average of advanced clones were % 22,03. Dry matter clones of the 16 advanced clones and standard varieties differed from each other as well as from each other. In this study, the dry matter content of the clones ranged from 17.2 to 28.4%. The highest dry matter content was obtained from clone A13-1(flesh color white).

According to flesh colors, the highest dry matter content was obtained from A13-1 clone (%28,4) in whites for all colors. Also the highest dry matter was obtained from A3-167 (% 24.50) in light yellows, the highest dry matter content was obtained from A3/368 (% 24.60) in the dark yellows. The dry matter content of the cream colors was lowest (17.2-20.2%) in all clones in this study. As for the locations, when ranking in terms of yield it was determined that Artova (22,86 %), Kazova (21,99 %) and Niksar (20,40%).

The highest dry matter content was determined from A13/1 in all locations and environments. It has been reported that the content of dry matter and starch varies not only with the genetic characteristics of the variety but also under the effect of environmental practices during production. It has been reported that late maturity varieties produce higher dry matter and starch content in cool climatic conditions and high altitude locations. In addition differences in quality of seed tubers affect the content of dry matter and starch (Yılmaz and Karan, 2011).

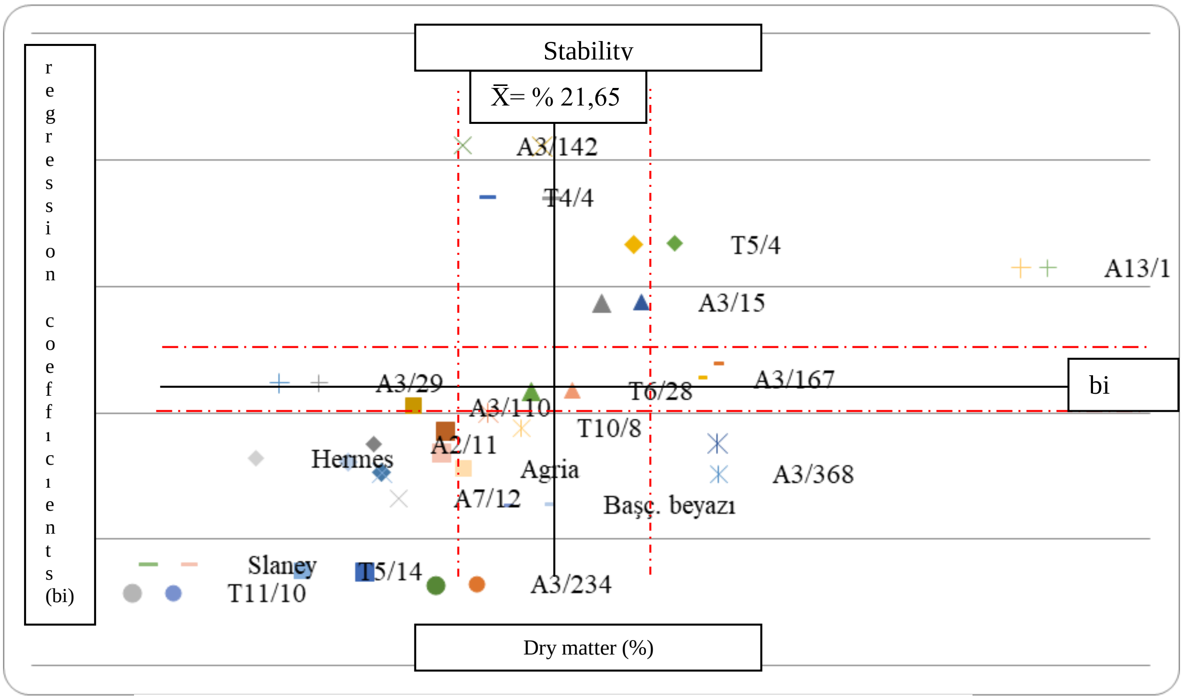


***Figure 3.** Adaptation classes of clones and varieties dry matter content (%)*

Meanwhile, when all the environmental were examined separately, it was seen that some clones could have a dry matter content of over 23%. These clones have the potential to be evaluated as clones with high dry matter content. For example, These are A13-1, A3-368

(24,6%), A3-167 (24,5%), T5-4 (23,5%) and A3-15 (23,1%). All of the clones had higher dry matter content than standard commercial varieties in all environments (Table 3).

When the dry matter contents obtained from this study were examined in terms of genotype x environment interaction and stability, the regression coefficients ranged from bi = 0.29 to 2.06. T6-28 clone had better compatibility than other clones in terms of dry matter content. That is, as it was above the average dry matter content in different environmental conditions, it was the genotype that underwent minimal change. The average dry matter content of this clone (T6-28) in all environmental was above the general average and the regression coefficient was closest to bi = 1 (Table 3 and Figure 3).

When the adaptation in terms of dry matter content was investigated, T5/4, A13/5 and A13/1 had high dry matter content in the favorable condition, A3/142 and T4/4 showed medium adaption in the favorable condition, A3/29 had low dry matter content in the all environmental. A2/11, A3/110, T10/8 and T6/28 were medium adapted in the all environmental. The A3/167 clone was a clone that can be regarded as a stable material, such as T6-28, in terms of dry matter content when confidence limits were taken into consideration. Slaney, Hermes varieties and T5/14 and T11/10 clones were bad adapted to unfavorable environmental. Agria, Basciftlik Beyazi cultivars and A7/12 and A3/234 clones showed medium adapted to unfavorable environmental. The A3/368 clone has been identified as a well clone that is it had high dry matter content even in unfavorable environmental.

***Table 2.*** *Total tuber yield (kg/da) and regression coefficients (bi) of clones and varieties in all locations.*

| Clone Name | 2011 | 2012 | 2012 | | | 2013 | | | Genotype Avarage | Effect of Genotype ($g_{ii}$) | bi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Artova | Artova | Niksar | Kazova | Artova | Niksar | Kazova | Artova | | | |
| A2-11 | 2095,3 n** | 8095,2 b** | 1959,0 fg** | 4812,0 de** | 6146,7 ghi** | 3020,3 e-h** | 6850,7 c-f** | 6831,0 g-j** | 4976,3 | -864,5 | 1,00 |
| A3-110 | 5880,9 c-f | 6295,2 cd | 2539,0 c-g | 4216,7 e | 6349,7 fgh | 3608,0 c-f | 5900,0 efg | 7469,0 e-i | 5282,3 | -558,5 | 0,72 |
| A3-15 | 6285,7 bcd | 5485,7 d | 2095,0 efg | 7828,7 ab | 9485,3 bcd | 2769,3 e-i | 7336,0 b-e | 9431,0 bcd | 6339,6 | 498,8 | 1,22 |
| A3-142 | 5031,9 e-h | 7990,5 b | 3373,3 bc | 6010,3 b-e | 6444,3 fgh | 3376,0 c-g | 5344,0 fg | 7701,7 d-i | 5659,0 | -181,8 | 0,74 |
| A3-368 | 6031,9 cde | 7345,2 bc | 2300,7 d-g | 6351,7 bcd | 7679,7 c-g | 2271,7 hi | 8300,0 a-d | 8598,7 c-g | 6110,0 | 269,2 | 1,18 |
| A3-234 | 6603,3 bc | 7580,9 bc | 3062,0 cde | 4834,3 de | 8295,7 b-g | 3687,0 b-e | 6925,0 c-f | 8083,7 d-h | 6134,0 | 293,2 | 0,90 |
| A3-29 | 7158,6 b | 7702,4 bc | 2402,0 c-g | 4213,7 e | 7507,0 d-g | 2704,3 f-i | 6899,0 c-f | 7640,7 d-i | 5778,5 | -62,3 | 0,95 |
| A3-167 | 3698,6 jkl | 5095,2 d | 2824,0 c-f | 6052,0 b-e | 10201,7 b | 2650,0 ghi | 5868,3 efg | 10961,3 ab | 5918,9 | 78,1 | 1,33 |
| T4-4 | 2920,5 lmn | 7095,2 bc | 3353,0 bc | 6229,3 bcd | 6559,0 e-h | 4012,0 abc | 8738,7 ab | 6299,0 hij | 5650,8 | -190,0 | 0,77 |
| T5-4 | 4872,9 f-i | 7428,6 bc | 2424,0 c-g | 5131,0 cde | 9929,3 bc | 2913,3 e-h | 8634,7 abc | 10003,0 bc | 6417,1 | 576,3 | 1,42 |
| T5-14 | 3889,0 i-l | 7357,1 bc | 2308,7 d-g | 5410,3 cde | 6627,3 e-h | 3660,7 b-e | 9677,3 a | 9401,3 bcd | 6041,5 | 200,7 | 1,19 |
| T6-28 | 4984,3 e-i | 9676,2 a | 4803,3 a | 8977,3 a | 8451,0 b-g | 4771,7 a | 6863,7 c-f | 9164,7 cde | 7211,5 | 1370,7 | 0,85 |
| A7-12 | 8872,9 a | 6409,5 cd | 4266,7 ab | 5666,7 cde | 12884,7 a | 4529,3 ab | 9722,0 a | 12205,7 a | 8069,7 | 2228,9 | 1,33 |
| T10-8 | 3444,3 klm | 5238,1 d | 1566,3 g | 6789,0 bc | 8599,0 b-f | 2293,0 hi | 7419,0 b-e | 9239,3 b-e | 5573,5 | -267,3 | 1,34 |
| T11-10 | 4079,5 h-k | 7178,6 bc | 2533,3 c-g | 6817,0 bc | 10074,3 b | 2327,7 hi | 6822,7 def | 10254,7 bc | 6261,0 | 420,2 | 1,43 |
| A13-1 | 5412,9 d-g | 8057,1 b | 3038,7 cde | 6236,7 bcd | 8964,7 b-e | 3023,7 e-h | 8817,3 ab | 8923,0 c-f | 6559,3 | 718,5 | 1,21 |
| **Clone Average** | **5078,9** | **7126,9** | **2803,1** | **5973,5** | **8387,5** | **3226,1** | **7507,4** | **8888,0** | **6123,9** | | |
| Başç Beyazı | 2439,5 mn | 7800,0 bc | 2122,3 efg | 6278,3 bcd | 4913,3 hi | 3103,7 d-h | 7307,3 b-e | 6056,3 ij | 5002,6 | -838,2 | 0,83 |
| Slaney | 3687,2 jkl | 5514,3 d | 2949,0 c-f | 5737,3 cde | 6603,3 e-h | 1960,7 i | 5964,7 efg | 7242,0 f-j | 4957,3 | -883,5 | 0,87 |
| Hermes | 4642,8 g-j | 5166,6 d | 3231,3 cd | 4215,7 e | 3858,3 i | 3999,0 a-d | 4990,3 g | 4041,3 k | 4268,2 | -1572,6 | 0,14 |
| Agria | 5287,1 d-g | 5185,7 d | 2097,3 efg | 6078,3 b-e | 4634,7 hi | 2342,0 hi | 5742,7 efg | 5475,7 jk | 4605,4 | -1235,4 | 0,59 |
| **Cultivar Average** | **4014,2** | **5916,7** | **2600,0** | **5577,4** | **5002,4** | **2851,4** | **6001,3** | **5703,8** | **General Average** | | |
| **Environmental Average** | **4866,0** | **6884,9** | **2762,4** | **5894,3** | **7710,5** | **3151,2** | **7206,2** | **8251,2** | **5840,8** | | **1,00** |
| **Effect of Environmenta** | -974,9 | 1044,0 | -3078,4 | 53,5 | 1869,6 | -2689,6 | 1365,4 | 2410,3 | **Confidence Interval** | | |
| **LSD (Genotype)** | **948,72** | **1321,13** | **857,45** | **1624,22** | **2046,41** | **789,00** | **1528,34** | **1545,73** | ±416,00 | | ±0,15 |

***Table 3.*** *Total tuber yield (kg/da) and regression coefficients (bi) of clones and varieties in all locations.*

| Clone Name | 2011 | 2012 | 2012 | | | 2013 | | | | | bi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Artova | Artova | Niksar | Kazova | Artova | Niksar | Kazova | Artova | Genotype Average | Effect of Genotype ($g_{ii}$) | |
| A2-11 | 19,67 cde** | 21,00 c** | 18,33 hi** | 20,67 ghi** | 20,67 ijk** | 19,33 efg** | 21,33 de** | 22,00 efg** | 20,4 | -1,2 | 0,77 |
| A3-110 | 19,67 cde | 21,33 bc | 19,67 e-h | 20,67 ghi | 23,33 fg | 20,33 def | 21,67 de | 22,67 efg | 21,2 | -0,4 | 0,93 |
| A3-15 | 20,33 bcd | 22,33 bc | 21,00 cde | 23,33 de | 25,00 de | 21,67 cd | 24,67 c | 26,67 bc | 23,1 | 1,5 | 1,43 |
| A3-142 | 20,33 bcd | 23,33 bc | 19,33 fgh | 20,00 g-j | 27,33 b | 21,33 cd | 20,33 ef | 27,00 b | 22,4 | 0,8 | 2,06 |
| A3-368 | 22,33 ab | 23,33 bc | 23,67 b | 25,00 bc | 26,67 bc | 24,00 b | 25,00 bc | 26,67 bc | 24,6 | 3,0 | 0,88 |
| A3-234 | 21,00 bcd | 21,67 bc | 20,33 d-g | 20,67 ghi | 22,00 ghi | 20,68 de | 20,67 ef | 21,33 g | 21,0 | -0,6 | 0,32 |
| A3-29 | 19,33 cde | 22,33 bc | 16,67 j | 17,67 klm | 19,33 k | 17,00 h | 18,67 gh | 21,67 fg | 19,1 | -2,5 | 1,12 |
| A3-167 | 22,67 ab | 24,00 b | 22,00 c | 25,67 b | 26,67 bc | 22,67 bc | 26,33 b | 26,33 bc | 24,5 | 2,9 | 1,20 |
| T4-4 | 20,33 bcd | 22,67 bc | 19,33 fgh | 22,67 def | 25,33 cd | 19,33 efg | 24,33 c | 26,00 bc | 22,5 | 0,9 | 1,85 |
| T5-4 | 22,33 ab | 24,00 b | 21,33 cd | 24,00 cd | 26,33 bcd | 19,33 efg | 24,33 c | 26,67 bc | 23,5 | 1,9 | 1,67 |
| T5-14 | 20,67 bcd | 21,33 bc | 19,33 fgh | 18,67 jkl | 20,33 jk | 20,00 d-g | 19,67 fg | 21,33 g | 20,2 | -1,4 | 0,37 |
| T6-28 | 21,67 bc | 22,33 bc | 20,67 c-f | 21,67 efg | 23,67 ef | 20,33 def | 22,67 d | 25,00 cd | 22,3 | 0,7 | 1,09 |
| A7-12 | 21,33 bcd | 22,33 bc | 18,33 hi | 19,67 hij | 20,33 jk | 18,33 gh | 20,67 ef | 22,00 efg | 20,4 | -1,2 | 0,76 |
| T10-8 | 21,00 bcd | 22,67 bc | 19,00 gh | 21,33 fgh | 23,33 fg | 21,33 cd | 21,33 de | 23,67 de | 21,7 | 0,1 | 1,00 |
| T11-10 | 17,33 ef | 18,00 de | 16,67 j | 16,33 m | 17,33 l | 17,33 h | 16,67 i | 18,33 h | 17,2 | -4,4 | 0,29 |
| A13-1 | 24,33 a | 27,67 a | 26,67 a | 28,67 a | 32,00 a | 27,33 a | 28,67 a | 31,67 a | 28,4 | 6,8 | 1,58 |
| **Clone Average** | **20,90** | **22,52** | **20,15** | **21,67** | **23,73** | **20,65** | **22,31** | **24,31** | **22.03** | | |
| Bb | 21,00 bcd | 22,66 bc | 20,67 c-f | 21,33 fgh | 22,33 fgh | 21,33 cd | 22,67 d | 23,33 def | 21,9 | 0,3 | 0,64 |
| Slaney | 16,67 f | 17,33 e | 17,00 ij | 17,33 lm | 17,67 l | 17,00 h | 18,00 hi | 18,67 h | 17,5 | -4,1 | 0,40 |
| Hermes | 19,00 def | 20,67 cd | 18,67 h | 19,33 ijk | 21,67 hij | 18,67 fgh | 20,67 ef | 21,00 g | 20,0 | -1,6 | 0,81 |
| Agria | 21,33 bcd | 22,67 bc | 19,33 fgh | 21,00 f-i | 22,33 fgh | 19,33 efg | 20,33 ef | 22,67 efg | 21,1 | -0,5 | 0,84 |
| **Cultivar Average** | **19,50** | **20,83** | **18,92** | **19,75** | **21,00** | **19,08** | **20,42** | **21,42** | **General Average** | | |
| **Environmental Average** | **20,6** | **22,2** | **19,9** | **21,3** | **23,2** | **20,3** | **21,9** | **23,7** | **21,65** | | **1,00** |
| **Effect of Environmental** | -1,0 | 0,5 | -1,7 | -0,4 | 1,5 | -1,3 | 0,3 | 2,1 | **Confidence Interval** | | |
| **LSD (Genotype)** | 2,13 | 2,42 | 1,22 | 1,51 | 1,27 | 1,51 | 1,28 | 1,49 | 1,19 | | 0,24 |

## References

Becker, H.C., J. Leon, 1988. Stability Analysis in Plant Breeding. Plant Breeding, 101,123

Caesar, K., K.B.A. Bodlaender, C. Hunicken, L. Roer, M. Umaerus, 1978. Physiological Changes of the Potato by Planting Under Different Ecological Conditions. 7th Triennial Conference of the European Association for Potato Research, 26 June-1 July, Warsaw, Poland, s. 51-54.

Yılmaz. G., Tuğay. M.E., 1999. Patatesde Çeşit X Çevre Etkileşimleri. II. Çevresel Faktörler Yönünden İrdeleme. Turkish Journal Of Agriculture And Forestry, 23:107-118.

FAO,2016. Food and Agriculture Organizition of the United Nations. http://faostat.fao.org/

Er, C., Uranbey, S., 1998. Nişasta Ve  Şeker Bitkileri. Ankara Üniv. Ziraat Fak. Yayın No:1504, Ders Kitabı:458, Ankara. Esendal, 1984.

Finlay, K.W. and G.N.Wilkinson, 1963. The Analysis of Adaption in a Plant Breeding Progromme, Aust. Jour. Agric. Res. 14: 742-754.

Tugay, M.E., Çıtır, A., Yılmaz, G., Çağatay, K., Kara, K., 1995. Tokat Yöresi Ova ve Yayla Koşullarında Tohumluk Patates Üretimi Üzerine Araştırmalar. Tübitak Tovag-950 Nolu Projenin Kesin Sonuç Raporu. Gaziosmanpaşa Üni. Ziraat Fak. Tarla Bitkileri Bölümü, Tokat.

Hoopes, R. W. ve Plaisted, R. L., 1987. Potato (Chapter Eleven). Princeples Of Cultivar Development, Volume : 2 (Editor : Walter R. Fehr).

Yılmaz, G. Karan, Y.B., 2011. Farklı Alanlarda Üretilen Patates (*Solanum tuberosum* L) Tohumluklarının Tokat-Artova Şartlarındaki Performansları. Uluslar arası Katılımlı I. Ali Numan Kıraç Tarım Kongresi 27-30 Nisan 2011.