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RESEARCH ARTICLE

Determining the Yield and Yield Components of Some Local Potato Genotypes Grown in the North Eastern Anatolia Region

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ABSTRACT

This study was carried out in 2018 to examine the yield and yield components of 8 potato genotypes (Kanursu, Aşkar, Çamlı, Akbulut, Yukarıkızı, Incili, Erikdibi, and Nisantası) and 2 potato varieties (Agria and Lady Olympia) procured in the ecological conditions of Bayburt, Turkey. The experimental work was conducted in trial ground at the Experimental Station of the University of Bayburt (Turkey). The research was designed in random blocks with three replications. As a result of the study, the highest number of stems per plant (6.7), tuber yield per hectare (15.19 tons), number of tubers per plant (8.47), and tuber yield per plant (357.01 g) were found to be in the genotype Akbulut; the highest ratio of large tuber (28.27%) in the genotype Konursu; and the highest ratio of medium tuber (85.22%) in the genotype Çamlıkoz. This study; Although the best potato yield was obtained from the Akbulut genotype on a regional basis, these data are a pioneer for other future studies to determine the cultivar candidates needed in the development of domestic potato cultivars.

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Introduction

Potato, one of the most common and important plants in the world, is the main staple food for the majority of the world's population and has various health benefits. It is the fourth most important human food product in the world after rice, corn, and wheat (Karam et al., 2009; Kandil et al., 2011). The high nutritional content, ability to adapt to marginal environments, relative ease of cultivation, low cost and high productivity are the features that make potato one of the most important foods and sources of income for developing countries.

About 500 thousand tons of seed potatoes (Basic-1 and Basic-2) are needed for potato production in Turkey (Öztürk & Polat, 2017). These seed potatoes are procured from the Netherlands, Germany, and the United States, and reproduced, certified, and delivered to the producers in Turkey. While the rate of using certified seed is around 25-30% in Turkey, this rate is 95-100% in other potato producing countries (Yılmaz, 2014). The lack of native potato varieties is one of the reasons that cause Turkey's foreign dependency in terms of potato seed. Although Turkey has the conditions suitable for potato cultivation at all times of the year (in terms of agricultural lands and climate), it lacks the native varieties that can be used commercially. Therefore, many previous studies emphasized the problems of not having a native variety (Öztürk et al., 2008; Çalışkan et al., 2010; Şanlı & Kardoğan, 2012). Selecting the right variety for the right region is a very important parameter, as well as taking many measures to grow a high yielding and

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quality potato. Farming seasons are short in the interior and high parts of Turkey (May-September). This makes it important to identify the early varieties with high adaptation to these regions. In order to grow potatoes with high quality and high tuber yield, it should be determined which native potato variety has good characteristics for which region (Arioglu et al., 2005). In the literature, there are some studies carried out to determine the effects of climate and environmental factors and identify new varieties with high quality and yield characteristics (Akkale et al., 2010; Merga & Dechassa, 2019). In order to produce high yielding potato tubers with high marketing and processing quality, it is very important to identify the best performing varieties on a regional basis (Bilate & Mulualem, 2016; Habtamu et al., 2016; Bekele & Haile, 2019). In their agricultural performance study conducted in Bornova, İzmir on nine local potato genotypes obtained from Eastern Anatolia, Yıldırım and Öztürk (2016) reported that the local genotype Posof yielded the best results (Plant height: 60.5 cm, number of stems: 4.9, number of tubers: 11.2, plant yield: 762.7 g, and plot yield: 3.8 kg). Today, many variety generation studies are being carried out for potato, and these varieties are transferred to different regions to identify the varieties with good adaptability, high quality and yield.

The purpose of the present study was to identify the local potato varieties available in the region, to compare them in terms of yield and quality components, and to make a suggestion about the best variety candidate.

Materials and Methods

Trial Establishment

This study was carried out in the trial area of Department of Organic Agricultural Management, Bayburt University in 2018. Figure 1 shows the average precipitation, temperature, and relative humidity for 2018 and other years.

The soil of the trail area was found to be loamy and slightly alkaline and have a pH value of 7.75, a total salt content of 0.047% (salt-free), an organic matter content of 0.99% (very low), a lime content of 9.3%, a phosphorus content of 11.44 kg $da^{-1,}$ and a potassium content of 80.3 kg da^{-1} (high).

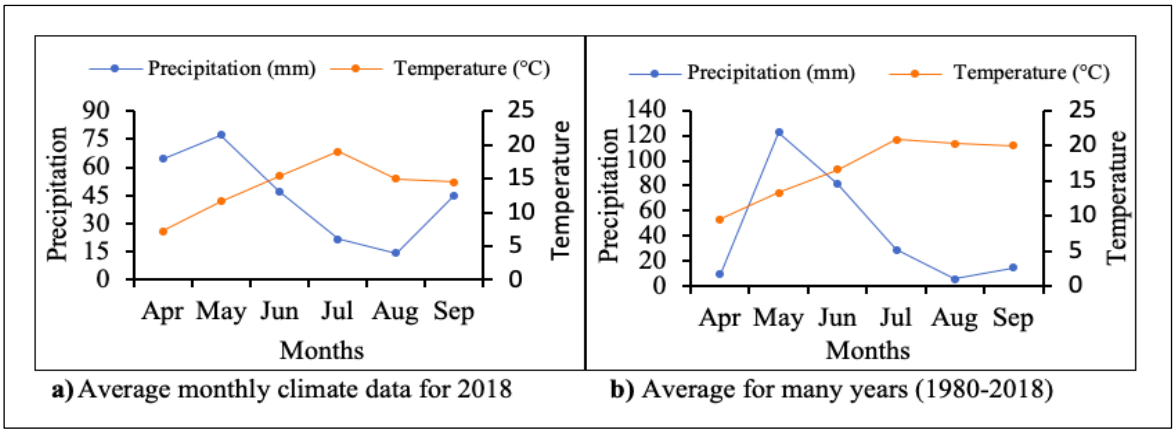

Figure 1. Average monthly temperature, precipitation values at the experimental site in 2018, 2019 and long-term period (1982-2017).

Experimental Layout and Treatments

This study was designed in random blocks with three replications and carried out in 2018 to examine the yield and yield components of 8 potato genotypes (Kanursu, Askar, Çamlı, Akbulut, Yukarıkızı, Incili, Erikdibi, and Nisantaşı) and 2 potato varieties (Agria and Lady Olympia) procured from Bayburt, Turkey (Figure 2). The Agria variety, which is intensively grown in the region, is used as medium late, edible and industrial, while the Lady Olympia variety is used as medium early and industrial.

Seeding and Product Application

Stable manure (30 tons per hectare, 0.9% kg N, 0.5% P_2O_5, and 0.3 kg K_2O) was used as fertilizer. The fertilizer was uniformly applied to the seed bed before planting. The potato plants were planted manually on April 15, 2018, leaving 35 cm between plants and 70 cm between rows.

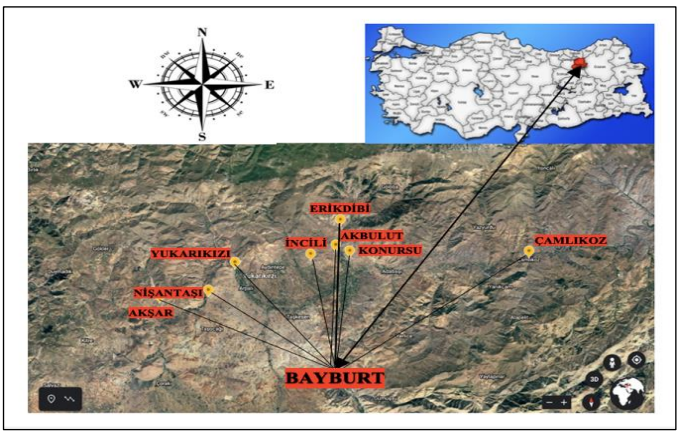

Figure 2. Showing of local potato seed samples obtained from Bayburt region on the map.

Trial Maintenance and Monitoring

Weed control was carried out mechanically during the cultivation period. The experimental area was irrigated regularly and uniformly three times in every 20 days until the end of August as of the end of June against drought stress.

Harvesting

The potato genotypes and varieties were harvested on September 3rd, 2018 when the following conditions were realized: the green parts turned yellow and dry, the stolons separated from the main plant, and the tubers had a certain size and skin with a normal thickness and could not be peeled. The following parameters were examined within the scope of the study: plant height (cm), number of stems per plant, number of lateral branches, number of tubers per plant, tuber yield per plant (g), single tuber weight (g), tuber yield per hectare (tons ha^{-1}), tuber width (cm) and tuber length (cm), and large tuber ratio (%) (>50 mm), medium tuber ratio (%) (>30 mm, <50 mm), and small tuber ratio (%) (<30 mm).

Statistical Analysis

The data obtained as a result of the research were analysed using SPSS software package. The differences between the means were determined using Duncan Multiple comparison test.

Results and Discussion

Statistically significant differences ($p \leq 0.01$) were found to exist between the eight native genotypes and two varieties of potatoes grown in Bayburt in terms of morphological and agronomic characteristics. Table 1 shows the sources of variance and the levels of statistical significance for these characteristics.

Table 1. The results of analysis of variance for some heavy metal concentrations in potato genotypes in Bayburt, Turkey.

Mean Square/Source of Variation	Genotype	Error	LSD	CV (%)
df	9	18		
Plant Height	8.44**	20.04	7.69	19.64
Stem Number	44.37**	0.11	0.58	30.06
Side Stem Number	32.97**	6.66	4.44	22.56
Hectare Tuber Yield	44.53**	0.71	1.45	36.99
Tuber Number Per Plant	22.42**	0.27	0.89	29.68
Large Tuber Ration	96.87**	1.27	1.94	30.61
Middle Tuber Ration	248.58**	1.58	2.16	16.51
Small Tuber Ration	175.28**	0.86	1.59	54.81
Tuber Width	7.01**	0.09	0.52	12.24
Tuber Length	16.66**	0.18	0.73	16.11
Tuber Yield Per Plant	50.68**	359.68	32.60	36.49
Single Tuber Weight	34.89**	7.86	4.82	23.18

*,** significant at p<0.01; CV: Coefficient of variations.

Morphological and Agronomic Characteristics

The mean values of the morphological and agronomic characteristics of the local potato genotypes and the commercial potato varieties are given in the Figures 3, 4, 5, and 6. According to the results of the study, the genotype İncili was found to have the highest plant height (51.3 cm) and tuber width (4.91 cm); the genotype Akbulut was found to have the highest number of stems per plant (6.7), tuber yield per hectare (15.19 tons), number of tubers per plant (8.47), tuber yield per plant (357.01 g); the genotype Konursu was found to have the highest ratio of large tuber (28.27%) and the highest ratio of small tuber (25.6%); the genotype Çamlıkoz was found to have the highest number of lateral branches (52.4) and the highest ratio of medium tuber (85.22%); and the genotype Erikdibi was found to have the highest tuber length (7.73 cm) and the highest single tuber weight (58.85 g). On the other hand, the variety Agria was found to have the lowest number of lateral branches (29.8) and the lowest number of tubers per plant (3.39); the variety Lady Olympia was found to have the lowest plant height (28.6 cm) and the lowest tuber length (4.94 cm); the genotype Konursu was found to have the lowest tuber yield per hectare (3.42 tons), the lowest ratio of medium tuber (46.14%), the lowest tuber yield per plant (83.86 g); the genotype Akşar was found to have the lowest tuber width (3.39 cm) and the lowest single tuber weight (25.98 g); the genotype Nişantaşı was found to have the lowest number of stems per plant (2.8); and the genotype Yukarıkızı was found to have the lowest ratio of large tuber (6.81%) and the lowest ratio of small tuber (4.78%). It was observed that the potato genotypes of Bayburt region had superior characteristics compared to the varieties, and especially the potato genotype Akbulut had better agricultural characteristics than the other genotypes and varieties.

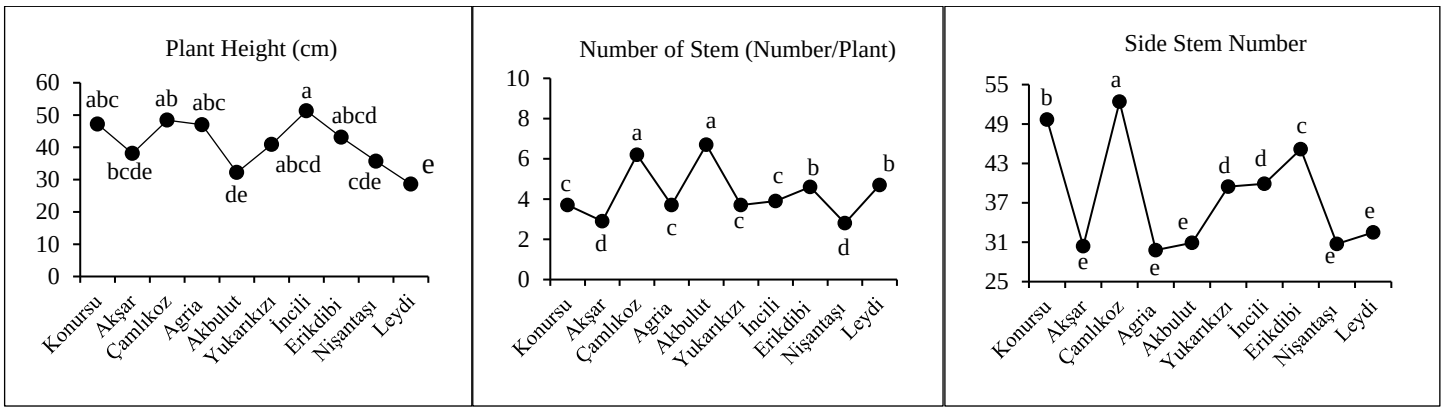

Figure 3. Plant height (left), stem number (middle), and side stem number (right) of potato genotypes.

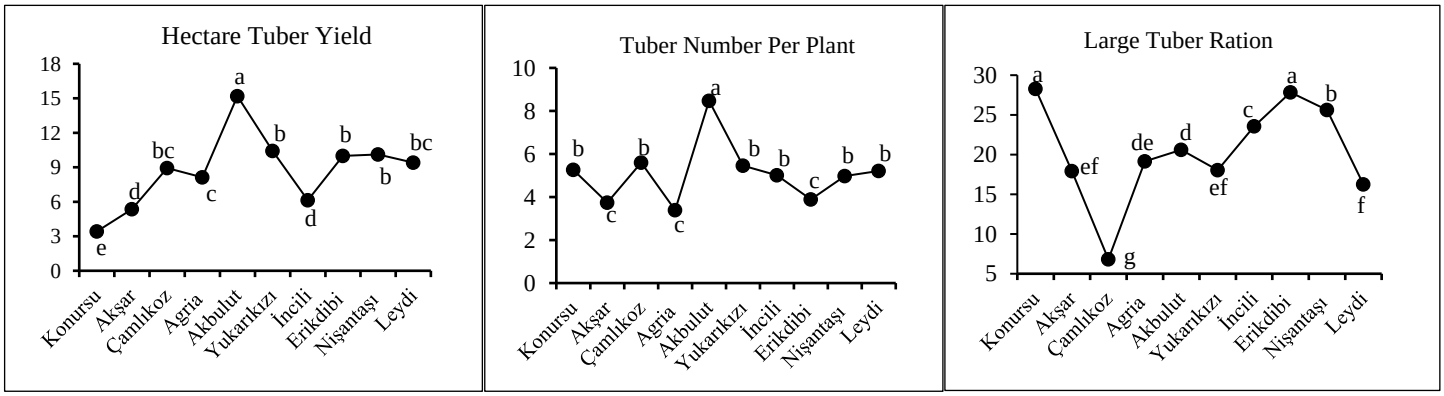

Figure 4. Hectare tuber yield (left), tuber number per plant (middle), and large tuber ration (right) of potato genotypes.

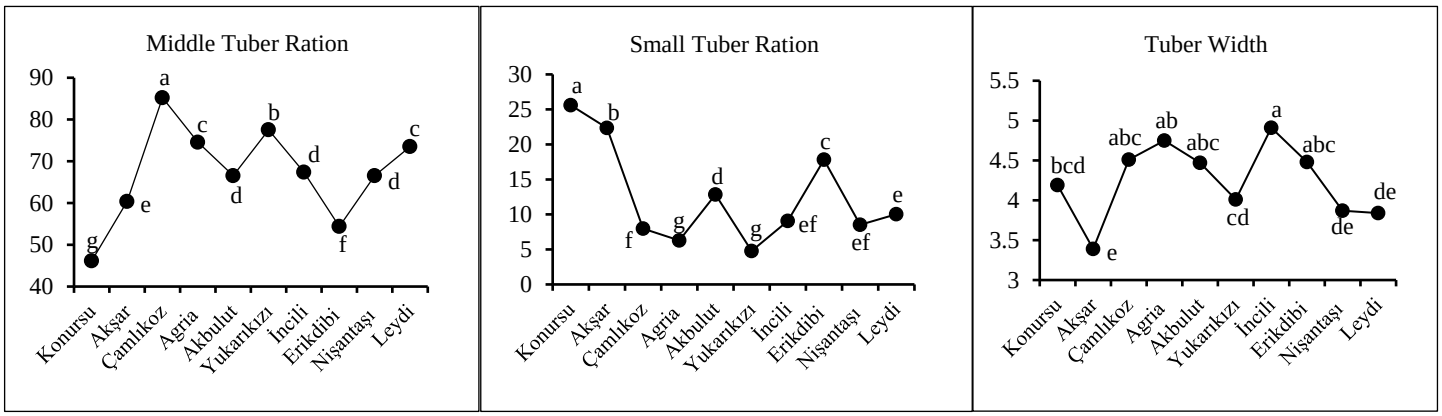

Figure 5. Middle tuber ration (left), small tuber ration (middle), and tuber width (right) of potato genotypes.

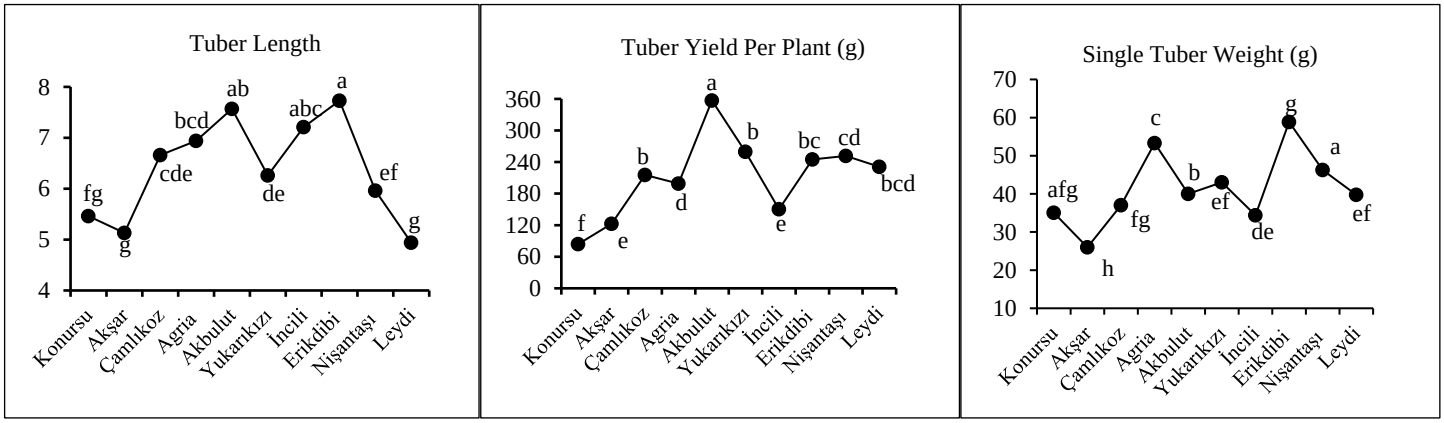

Figure 6. Tuber length (left), tuber yield per plant (middle), and single tuber weight (right) of potato genotypes.

The morphological and agronomic characteristics we found were similar to those reported by some researchers (Kimoone et al., 2005; Ekin, 2009; Cerit & Kaynak, 2010; Kara, 2016; Boydak & Kayantaş, 2017), but lower than those reported by some others (Ekin, 2009; Şanlı & Karadoğan, 2012; Yalçın & Tunçtürk, 2018; Çöl & Akınerdem, 2017; Merga & Dechassa, 2019). This difference might be due to the differences between ours and the previous studies in terms of soil properties, environmental and climatic factors. As a matter of fact, many studies asserted that the low yield was due to the reasons such as soil poor in organic matter, heavy textured soil, genetic characteristics of the varieties, environmental and climatic factors (Karaca Öner & Aytaç, 2016; Boydak & Kayantaş, 2017; Yalçın & Tunçtürk, 2018; Arslan, 2019). It is very important for farmers to use the potatoes they have grown as seeds in determining the potato varieties adapted to a region. Potato is very sensitive to biotic (such as diseases and pests) and abiotic (such as climate and environmental factors) conditions of the region where it is grown (Simakov et al., 2008; Hirsch et al., 2013). Moreover, not only the tuber yield, which is a key parameter in potato, but also the parameters such as number of tubers, tuber size, and plant height vary depending on the climate and environmental factors of the region where the plant is grown (Graveland, 2014). Yılmaz and Tugay (1999) asserted that better quality seeds should be used rather than the physiologically damaged tubers being used in the region for a long time, and that potato tubers grown in high altitudes had higher yields.

Correlation Coefficients

When the Pearson correlation results for the parameters were examined, it was found that there was a high positive correlation between the plant height and the number of stems ($r=0.71^{**}$), the number of stems and the number of lateral branches ($r=0.73^{**}$), the tuber yield per hectare and the tuber yield per plant ($r=0.99^{**}$); a moderate positive correlation between the plant height and the number of lateral branches ($r=0.50^{**}$) and the tuber width ($r=0.51^{**}$), the tuber yield per hectare and the number of tubers per plant ($r=0.58^{**}$), the number of tubers per plant and the tuber yield per plant ($r=0.56^{**}$), the tuber width and the tuber length ($r=0.66^{**}$), the tuber length and the single tuber weight ($r=0.50^{**}$); a high negative correlation between the ratio of medium tuber and the ratio of large tuber ($r=-0.83^{**}$), the ratio of medium tuber and the ratio of small tuber ($r=-0.86^{**}$); a moderate negative correlation between the ratio of small tuber and the tuber yield per plant ($r=-0.507^{**}$); a weak negative correlation between the plant height and the tuber yield per hectare ($r=-0.48^{**}$) and the tuber yield per plant ($r=-0.47^{**}$), the tuber yield per hectare and the ratio of small tuber ($r=-0.48^{**}$) with a significance of $p\leq0.01$ (Table 2). Moreover, there was a weak positive correlation between the number of stems and the tuber width ($r=0.43^{*}$); the tuber yield per hectare and the ratio of medium tuber ($r=0.39^{*}$), the tuber length ($r=0.45^{*}$), and the single tuber weight ($r=0.41^{*}$); the ratio of small tuber and the ratio of large tuber ($r=0.44^{*}$); the ratio of medium tuber and the tuber yield per plant ($r=0.40^{*}$); the tuber width and the single tuber weight ($r=0.36^{*}$); the tuber length and the tuber yield per plant ($r=0.44^{*}$); the tuber yield per plant and single tuber weight ($r=0.45^{*}$) with a significance of $p\leq0.05$ (Table 2).

Table 2. Correlation coefficients between observed characteristics.

	PH	SN	SSN	HTY	TNPP	LTR	MTR	STR	TW	TL	TYPP	STW
PH	1											
SN	0.71^{**}	1										
SSN	0.50^{**}	0.73^{**}	1									
HTY	-0.48^{**}	-0.30^{ns}	-0.32^{ns}	1								
TNPP	-0.33^{ns}	0.05^{ns}	0.01^{ns}	0.58^{**}	1							
LTR	0.04^{ns}	0.21^{ns}	-0.08^{ns}	-0.17^{ns}	-0.12^{ns}	1						
MTR	-0.04^{ns}	-0.25^{ns}	-0.10^{ns}	0.39^{*}	0.13^{ns}	-0.83^{**}	1					
STR	0.03^{ns}	0.20^{ns}	0.21^{ns}	-0.48^{**}	-0.11^{ns}	0.44^{*}	-0.86^{**}	1				
TW	0.51^{**}	0.43^{*}	0.25^{ns}	0.12^{ns}	0.07^{ns}	0.09^{ns}	0.12^{ns}	-0.29^{ns}	1			
TL	0.32^{ns}	0.27^{ns}	0.13^{ns}	0.45^{*}	0.24^{ns}	0.14^{ns}	0.07^{ns}	-0.26^{ns}	0.66^{**}	1		
TYPP	-0.47^{**}	-0.31^{ns}	-0.32^{ns}	0.99^{**}	0.56^{**}	-0.16^{ns}	0.40^{*}	-0.507^{**}	0.12	0.44^{*}	1	
STW	0.08^{ns}	0.02^{ns}	-0.02^{ns}	0.41^{*}	-0.22^{ns}	0.28^{ns}	0.03^{ns}	-0.31^{ns}	0.36^{*}	0.50^{**}	0.45^{*}	1

* and ** significant at 0.05 and 0.01 probability levels by t test, respectively. ns: Not significant, PH: Plant height, SN: Stem number, SSN: Side stem number, HTY: Hectare tuber yield, TNPP: Tuber number per plant, LTR: Large tuber ration, MTR: Middle tuber ration, STR: Small tuber ration, TW: Tuber width, TL: Tuber length, TYPP: Tuber yield per plant, STW: Single tuber weight.

In their study, examining the response of potato to an environment in subtropical agricultural ecology, Molahlehi et al. (2013) reported that there was a high positive correlation between the tuber yield and agricultural applications. Sattar et

al. (2007) carried out a correlation analysis to examine the effect of genetic variation on yield and yield parameters in 28 potato genotypes and reported that there was a significant positive correlation between the tuber yield per plant and the number of tubers per plant and the mean tuber yield. This result is similar to our results. Correlation analysis helps to identify the superior characteristics of plants and improve their genetic characteristics in yield, especially when potato genotypes are evaluated genetically (Leilah & Al-Khateeb, 2005; Bello et al., 2006; Haydar et al., 2009; Gedamu et al., 2010). Similarly, based on the Pearson correlation results, it can be asserted that there were significant correlations between the tubers of all the potato genotypes depending on genetic characteristics.

It was observed that there were significant differences between the local potato genotypes grown under the conditions of Bayburt region and two commercial potato varieties in terms of yield and yield parameters. When the Pearson correlation results for the parameters that show the quality of genotypes and varieties were examined, it was found that the tuber yield per hectare, one of the important parameters, was highly positively correlated with the tuber yield per plant ($r=0.99^{**}$) and moderately positively correlated with the number of tubers per plant ($r=0.58^{**}$) with a significance of $p\leq0.01$. Based on the yield and quality parameters, it was observed that the local potato genotypes were adapted to the conditions of the region better than the commercial potato varieties.

Conclusion

The highest number of stems per plant (6.7), tuber yield per hectare (15.19 tons), number of tubers per plant (8.47), and tuber yield per plant (357.01 g) were found to be in the genotype Akbulut; the highest ratio of large tuber (28.27%) in the genotype Konursu; and the highest ratio of medium tuber (85.22%) in the genotype Çamlıkoz. In conclusion, we are of the opinion that the high-altitude regions of Northeastern Anatolia, where the study was carried out, are suitable for potato cultivation. This study will contribute to the future studies designed to identify the local genotypes and varieties suitable for the region and help the farmers who grow potato in the region in their efforts for achieving better yield and quality.

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Conflict of Interest

The authors have no conflicts of interest.

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