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EVALUATION OF FREQUENTLY GROWN LEAK LANDRACES IN NORTH MACEDONIA

Zvezda Bogevska[1*], Gordana Popsimonova[1], Rukie Agic[1], Margarita Davitkovska[1], Tome Timov[2], Maja Sudimac[3]

[1]Ss. Cyril and Methodius University in Skopje, Faculty of Agricultural Sciences and Food - Skopje, Skopje, Republic of North Macedonia
[2]SOUUD "Dimitar Vlahov", Strumica, Republic of North Macedonia
[3]Tamis Research and Development Institute, Republic of Serbia
[*]e-mail: zvezda@fznh.ukim.edu.mk

ABSTRACT

In North Macedonia, there is a long tradition of growing leek. The most grown are those with long shaft (pseudostem) or kamus type of leeks. The study aimed to evaluate three local landraces of leek with long shafts (pseudostem): Kumanovski, Veleski, and Strumicki. The experiment was set up in the village of Dobrejci near Strumica, during the season of 2019. A single experimental plot was 12 m^2 with a density of 400 plants per plot organized in a complete randomized block design in four replications. During the vegetation period the plant height (cm), the shaft thickness (pseudostem) (mm), leaves number in the shaft (pseudostem), the plant mass (g), length of the shaft (pseudostem) (cm), the shaft mass (pseudostem) (g) and total yield (t ha^{-1}) were measured. According to the results, the thickest shaft (pseudostem) (32.38 mm), the highest number of leaves in the shaft (pseudostem) (11.78), the highest plant mass (460.26g), the highest shaft mass (pseudostem) (285.53 g) and total yield (95.18 t ha^{-1}) were obtained from Kumanovski leek landrace. The highest plants (87.74 cm) had Veleski leek landrace while the longest shaft (pseudostem) (36.35 cm) was observed in the Strumicki leek landrace. It can be concluded that even grown in different climate conditions from its origin, the Kumanovski leek landrace obtained the best results. Further research on these landraces should be taken into consideration.

Key words: pseudostem, leaf number, shaft mass, agronomic value.

INTRODUCTION

In leeks, the development of concentric, ensheathing leaf bases has been selected so that they form long, edible shafts (pseudostems) which vary in length and slenderness (Brewster, 2008). Western and northern Europe is the world's greatest leek-producing and consuming region (De Clercq et al., 1999; Swamy & Veere Gowda, 2006) while leek is the minor allium crop in China (Debin et al., 2005). Leek is one important vegetable that can promote good health and serves as a primary defense mechanism against diseases (Shahrajabian et al., 2021). According to Bernaert et al., 2012, the antioxidant capacity of the leek extracts was influenced by the part (green leaves possess stronger antioxidant properties than the white shaft) and type of cultivar largely, whilst the manner of breeding and seed company had no influence on the antioxidant properties.

Many types of research have been conducted in order to improve the yield and quality of leek. Back in the nineties, Morales-Payan, 1994, suggested that GA3 application at rates of 30-50 ppm during the seven-leaf stage might result in better yield and quality in leeks. The yield to the five leek genotypes in Romania obtained in ecological crop conditions, respectively without chemical fertilizers application and treatments controlled only with ecological products was considered generally, efficient (Rodica et al., 2012). An analysis of the profitability of three leek production systems in a hilly-mountainous region of Croatia showed the highest yields in the conventional system and the best financial results in the integrated production system (Oplanić et al., 2009). A high yield of a good quality leeks crop may be obtained if living mulches would be sown not earlier than 7 weeks after transplanting whereas white clover and perennial ryegrass as less competitive species are being recognized as more suitable than hairy vetch (Kolota & Adamczewska-Sowińska, 2004). Later research on living mulches showed decreased leek height, shaft, weight, and length and consequently leek yielding (Jędrszczyk & Poniedziałek, 2007). In Moscow, greenhouse management resulted in higher yield compared to open field cultivation, due to higher mean pseudo-stem weight, and the cultivar Giraffe gave the best results (Golubkina et al., 2018; Golubkina et al., 2019). Considering the impact of deficit irrigation on yield, water use efficiency, and evapotranspiration of leek, in water-scarce regions, irrigation at 75% ET is recommended for leek to save 5.1% water with only a 4.1% relative yield decrease when compared to control treatment (I_{100}) (Kiremit & Arslan, 2018). Karić et al., 2005 found that the application of 200 kg N ha^{-1} was found to be the best dose of fertilizer and is recommended for the highest yield of leek under the agro-climatic conditions of central Bosnia and Herzegovina. Delay of harvest date is associated with the considerable increment of crop yield caused by the enhancement of dry matter, total and reducing sugars in leek with a lower level of nitrates (Biesiada et al., 2007).

Old cultivars and landraces are not only of historical interest, but they may also be of interest for future food supply (De Vahl & Svanberg, 2022). Local landraces have been developed in many European countries from Bulgaria to Ireland and in other parts of the world (e.g., the Middle East) and the early leek cultivars were actually landraces highly variable in agronomic and morphological treats (Bernaert et al., 2012). In addition, the landraces of leeks are well adapted to the climatic and soil types of the areas they are cultivated in, and up till now, the landraces are maintained by farmers without any expert attention (Agic et al., 2015; Jani et al., 2016; Jani et al., 2020). The aim of the study was to evaluate the most frequently grown leek landraces with long shafts (pseudostems) in North Macedonia.

MATERIAL AND METHODS

The research was carried out in 2019 on three long types of leek landraces (Kumanovski, Veleski, and Strumicki) in the village Dobrejci, near Strumica. For the experiment was used seed originated from the places the leek landraces are commonly grown for more than thirty years. The seeds of Kumanovski leek were taken from the village Lopate in the Kumanovo region, the seeds of Veleski leek were taken from the village Karatmanovo in the Veles region and the seeds of Strumicki leek were taken from the village Gradosorci in the Strumica region. These are places where these three landraces of the long leek are usually grown.

The three landraces were grown by the previous production of transplants. The seeds were sown in cold seedbeds on 03.04.2019. The seeds emerged after ten days very even, and transplanting was done on 25.05.2019. The distance between the rows was 20cm and 15cm between the plants in a row. Each experimental plot had 400 plants on a surface of 12 m^2. The plots were organized into a complete randomized block system with 4 replications. Before transplanting, the nitrogen fertilizer of about 200kg/ha was applied as calcium ammonium nitrate (27% N). During the vegetation, custom agricultural practices were applied: loosening the soil, weeding, and furrow irrigation. The plant protection treatments were not applied. The loosening of soil was done on 10.06.2019 when the plants were earth up in order to get longer white shafts.

The weeding was done by hand twice first on 25.06.2019 and the second on 15.07.2019. The first irrigation was done on 10.07.2019 followed by the second on 24.07.2019. In August, the irrigation was done once a week every Saturday (five times). The harvest was on 25.9.2019 and the following measurements were done: plant height (cm), the thickness of the shaft (pseudostem) (mm), the number of leaves in the shaft (pseudostem), the weight of the plant (g), length of the shaft (pseudostem) (cm) and the weight of the shaft (pseudostem) (g). Measurements were done on 25 plants randomly selected per replication or 100 plants per landrace. The plant height and length of the shaft were measured by tape measure. The mass of the plant and shaft was measured by electronic balance with precision to the second decimal, while the diameter of the shaft was measured by caliper (Festa 14001). The total yield expressed in t ha^{-1} was done by multiplying the average plant weight per replication and the number of plants ha^{-1}.

Obtained data were statistically processed by analysis of variance (ANOVA). The Least Significant Difference test at 5 % and 1 % levels of probability was used to test the differences among mean values.

RESULTS AND DISCUSSION

According to the results for the plant height and length of the shaft (pseudostem) the landraces Kumanovski, Strumicki and Velski are long types of leek (Jankulovski et al., 2007). The same authors indicated that the height of plants (cm) was on average 157.0 cm in Kumanovski, 138.0 cm in Strumicki, and 142.0 cm in Veleski. The changes in climate, soil, and used measurement during the vegetation might influence the change in plant height of these three landraces given in Table1a. Agic et al., 2015 stated that having in mind the fact that both (leek and onion) are outbred (cross-pollinated) biennial crops it may very easily come to unlike crossings and loss of authenticity in relation to growth, color, and other characteristics. Morales-Payan, 1994 found that application of GA3, 21 days after transplanting (seven-leaf stage), did not have a significant effect on plant height. Living mulches decreased leek height, especially evident during harvest time (Jędrszczyk & Poniedziałek, 2007). Besides mulching, Kiremit and Arslan, 2018 found that plant height ranged between 84.63 cm (I_{25}) and 130.63 cm (I_{118}), with increases in water deficit levels resulting in decreases in leek plant height. However using bio stimulator Aveikan® (2,5 L/ha) threefold in the seedlings phase, one week after transplanting and 20 days after the second treatment improved the height of the leek cultivar Starozagorski 72 by 7,88 % (Masheva et al., 2012).

Pseudostem thickness (diameter) is a major component of the quality requirements of leek for marketing (Morales-Payan, 1994) and for the economic outcome (Swamy & Veere Gowda, 2006). The results showed that the thickest shaft (pseudostem) was obtained from the Kumanovski leek landrace (32.38mm), with significance at level 0.01 in comparison to Veleshki and Strumicki that performed very similar no significant results (Table 1b.). Kumanovski and Strumicki differed from the research of Jankulovski et al., 2007 except for Veleski, which gave similar results even growing in different conditions (25.4 mm). The threefold treatment with bio stimulator Aveikan® 2,5 L/ha improved shaft thickness (cm) from 2.48cm in control to 3.28 cm in a cultivar Starozagorski 72 (Masheva et al., 2012).

Table 1. Comparison between leek landraces for the examined traits

Examined traits by leek landraces	Treatments		
	Kumanovski	Veleski	Strumicki
a. Plant height (cm)		LSD 0.05=8.25^{a}	LSD 0.01= 12.50^{A}

Kumanovski	**77.78**	-9.96 [a]	-5.07
Veleski	9.96 [a]	**87.74**	4.89
Strumicki	5.07	-4.89	**82.85**
b. Thickness of shaft (pseudostem) (mm)		LSD 0.05=1.68[a]	LSD 0.01= 2.54[A]
Kumanovski	**32.38**	6.65 [A]	7.13 [A]
Veleski	-6.65 [A]	**25.73**	0.48
Strumicki	-7.13 [A]	-0.48	**25.25**
c. Number of leaves in the shaft (pseudostem)		LSD 0.05=0.56[a]	LSD 0.01= 0.84[A]
Kumanovski	**11.78**	1.24 [A]	1.53 [A]
Veleski	-1.24 [A]	**10.54**	0.29
Strumicki	-1.53 [A]	-0.29	**10.25**
d. Weight of the plant (g)		LSD 0.05=32.31[a]	LSD 0.01= 48.96[A]
Kumanovski	**460.26**	140.86 [A]	171.87 [A]
Veleski	-140.86 [A]	**319.40**	31.01
Strumicki	-171.87 [A]	-31.01	**288.39**
e. Length of the shaft (pseudostem) (cm)		LSD 0.05= 2.56[a]	LSD 0.01= 3.88[A]
Kumanovski	**31.48**	-2.87 [a]	-4.87 [A]
Veleski	2.87 [a]	**34.35**	-2.00
Strumicki	4.87 [A]	2.00	**36.35**
f. Weight of the shaft (pseudostem) (g)		LSD 0.05= 25.97[a]	LSD 0.01= 39.34[A]
Kumanovski	**285.53**	73.85 [A]	91.93 [A]
Veleski	-73.85 [A]	**211.68**	18.08
Strumicki	-91.93 [A]	-18.08	**193.60**

a = significant at 5%. A = highly significant at 1%

Vegetative growth influenced leaves, and pseudo-stem growth, and was significantly improved by 200 kg ha^{-1} nitrogen (Karić et al., 2005). Kumanovski leek landrace gave a significantly higher number of leaves at level 0.01 in comparison to Veleski and Strumicki (Table 1c.). The results are better in comparison to those obtained in Jankulovski et al., 2007 where the number of leaves was on average 9.0 in Kumanovski, 9.1 in Strumicki, and 7.4 in Veleski. In other research, the leaf number (10.08) did not affect significantly by the irrigation levels (Kiremit & Arslan, 2018).

According to Biesiada et al.. 2007 delay in the harvest date resulted in an enhancement of the mean weight of the leek plant from 102.55 to 196.52 g. While the living mulches decreased, the weight of the plant from 264.1g in rye mulch to 411.1 cm in the control treatment (Jędrszczyk, & Poniedziałek, 2007). Bernaert et al., 2012 examined 30 leek cultivars in Belgium and found that the average plant weight was from 358 g (Elefant, old landrace) to 759 g (Poribleu, open-pollinated). The examined landraces showed that the average weight of the plant in Kumanovski (460.26 g) was significantly higher at level 0.01 than in Veleski (319.40 g) and Strumicki (288.39 g) (Table 1d.). The differences in climate conditions and applied measures as well as erosion of some agronomic traits in examined landraces confirm the differences in plant weight in the research of Jankulovski et al.. 2007.

The three examined leek landraces showed that the significant longest shaft was determined in Strumicki (36.35 cm) (Table 1e.). In comparison to the results by Jankulovski et al., 2007 the length of the shaft was much higher above 50cm in the three landraces (Kumanovski, Strumicki, and Veleski). Alterations in pseudostem length could be attributed to differences in water uptake related to differences in amounts of applied irrigation water and differed from 30.16 cm in the most severe deficit irrigation treatment (I_{25}) to 47.66 cm in the over-irrigation treatment (I_{118}) (Kiremit & Arslan, 2018). The level of nitrogen fertilizer did not significantly influence pseudostem length in the local leek cultivar Karentan, and it was on average 12.3 cm (Karić et al., 2005). Kenton leek cultivar that was grown under biodegradable nonwoven covers showed a significantly higher shaft length (17cm) in comparison to the control (Siwek et al., 2013). The five Romanian cultivars grown in ecological conditions showed the length of the edible part between 31.5 cm (Carentan) and 55.2 cm (Autumn Giant) (Rodica et al., 2012).

The length and weight of the whole shaft, as well as the chemical composition, are also affected by the cultivar (Swamy & Veere Gowda, 2006). In Romania, the average shaft weight of five cultivars varied from 286g (Bulgarian Giant) to 429 g (Autumn Giant) (Rodica et al., 2012). Golubkina et al., 2019 examined nine leek cultivars in the Moscow region and found that with respect to cultivars the mean weight ranged from 132.6 g in Premier to 225.4g in Giraffe cultivar. According to Jankulovski et al., 2007 long leek landraces had better shaft weight altering from 240 g in Strumicki to 280g in Kumanovski. The current study showed similar results (Table 1f.).

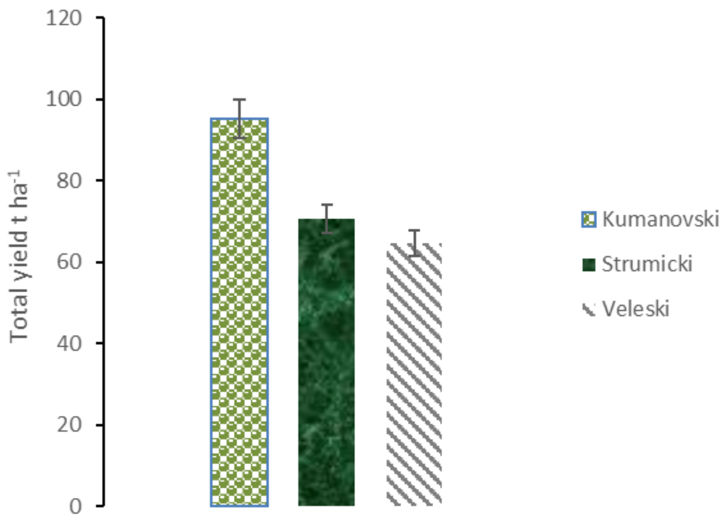

Figure 1. Total yield (t ha^{-1})

The yield in plant production is an essential trait in cultivar selection and widely varies according to genetic and other complex factors (Jankulovski et al., 2007). The current study showed that the Kumanovski landrace (95.18 t ha^{-1}) gave a significantly higher yield at the level of 0.01 in comparison to Strumicki (70.56 t ha^{-1}) and Veleski (64.53 t ha^{-1}) (Figure 1). Previous research on these landraces showed lower yields in Kumanovski and Strumicki landraces while Veleski gave similar results even though grown under different conditions (Jankulovski et al., 2007). In the Moscow region, the cultivar significantly affected the leek yield, which ranged from 23.8 t ha^{-1} (Premier) to 40.2 t ha^{-1} (Giraffe), while the different crop management systems (organic and conventional) did not affect yield significantly (Golubkina et al., 2018). The yield of the five leek genotypes obtained in ecological crop conditions in Romania was between 33.7 t ha^{-1} (Bulgarian Giant) and 48.4 t ha^{-1} (Autumn Giant) (Rodica et al, 2012). The trial of the Belgian landraces showed that they were high yielding, especially in the late season, but also in the early season (harvest in September and November), some Belgian landraces were in the top 10 for yield (De Clercq, 1999). Kumanovski, Strumicki, and Veleski landraces meet UK supermarket specifications as they have pseudostem diameter greater than 20 mm and length greater than 150 mm, including a 50 mm ‘flag’ of the green leaf at the top (Swamy & Veere Gowda, 2006).

CONCLUSIONS

The leek landraces are well adapted to the conditions and well suitable to local production systems. They are therefore potential resources for crop improvement, especially for the development of cultivars that are tolerant to biotic and abiotic stresses and for integrating farmer and market-preferred traits. In the context of these agroecological conditions, the local landrace Kumanovski outperformed in the majority of examined parameters, particularly in terms of yield and yield parameters. Further research in this area is strongly warranted.

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