Research Concerning the Variability of the Main Characteristics of Lettucefrom V.R.D.S. Buzau Germplasm Collection

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Abstract

Lettuce (*Lactuca sativa* L.) is the most important crop in the group of leafy vegetables. Lately, the nutritionists recommend more often lettuce consumption because of its high content in vitamins, mineral salts, nutrient substances and low content in carbohydrates. Research made at V.R.D.S. Buzau respond to two major problems: biodiversity conservation and creating new vegetable varieties adapted to nowadays climatic conditions. Since 2011 started the collection of biological material at this species from Buzau vegetable area. In this sense, the lettuce collection from V.R.D.S. Buzau contains over 30 accessions. This study presents the main characteristics of 10 accessions cultivated in open field in 2013 – 2014 period. In what it concerns accession 14, in 2013 there were registered the highest values of plant characteristics (height – 26 cm, diameter – 36 cm, weight – 504.33 g) and edible part weight (319.33 g), while in 2014 the values of this accession reached or surpassed the mean value of the experience. All studied accessions, reached heads at the consumption maturity, except accession 18. Most variants had green leafs, while only 3 accessions (8, 15 and 18) had anthocyanin coloration.

Keywords: *breeding, conservation of biodiversity, germplasm collection, Lactuca sativa L., vegetables*.

INTRODUCTION

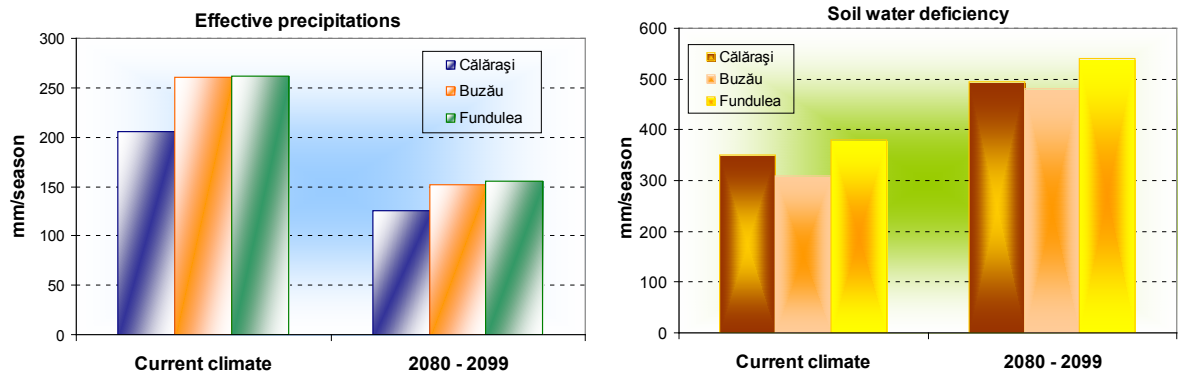
Lettuce is one of the vegetables widely consumed all over the year. Its rather short vegetation period and resistance to low temperatures, permit the extension of consumption period even for extra-season, in protected areas (Lazar *et al*., 2012).

Most modern diets require daily intake of fresh vegetables for supplying the organism with natural vitamins and minerals. Grubben (2014) shows that 100 g dry matter lettuce contains: macronutrients (19 g protein, 4.3 g fat, 41.4 g available carbohydrate, 21.7 g fibre and 13.6 g ash), minerals (Ca 489 mg, Fe 14.1 mg and Zn 5.3mg), energy (236 kcal) and vitamins (20.271 µg β-carotene equivalent, 1.1 mg thiamine, 2.71 mg riboflavin, 1.611 µg folate and 96 mg vit. C).

The ONU conference for environment and development, from Rio de Janeiro (1992), was the international political event in witch the conservation of biodiversity was included in environment problems. The reduction of genetic diversity of crop plants is as high and actual problem as the specific one (Maxim *et al*., 2007).

Brezeanu (2012) shows that in Romania alarming losses were recorded in all plant species, including vegetable.

According to the National Meteorological Administration (N.M.A.) Bucharest (2014) the amount of effective precipitations (Fig.1, a) is nowadays 260 mm precipitation/vegetation period, and in the future this value can be reduced to a half. Corresponding to the same source, soil water deficiency (Fig, 1, b) will increase at over 150 mm precipitation/season.



a) b)

Fig. 1 N.M.A. prognostic concerning effective precipitations (a) and soil water deficiency (b)

Since 2011, at V.R.D.S. Buzau there were started preservation and valorization programs concerning the vegetable patrimony with phenotypic useful expression and high ecological plasticity. In this sense, the lettuce collection from V.R.D.S. Buzău contains over 30 accessions.

Similar actions were made in USAMV Cluj–Napoca (2005) in collaboration with a French research group (Maxim *et al*., 2007).

The purposes of these researches are biodiversity conservation of lettuce and creating new varieties adapted to nowadays pedoclimatic conditions.

MATERIALS AND METHODS

The experiment took pace at V.R.D.S. Buzau during 2013-2014. From the lettuce germplasm collection, there were selected most representative 10 accessions. Therefore, the experimental variants were the following:

V_1 – accession 3;
V_2 – accession 7;
V_3 – accession 8;
V_4 – accession 10;
V_5 – accession 11;
V_6 – accession 14;
V_7 – accession 15;
V_8 – accession 16;
V_9 – accession 18;
V_{10} – accession 19.

The crop was started by seedlings, sowed during the second decade of March and planted in the third decade of April (2013) and in the first decade of April (2014). The planting density was 70,000 plants/ha (70/20 cm).The harvest was made at the beginning of June.

The experiment was organized according to the randomized blocks method with 3 replications. The surface of each experimental plot was aproximatively 20 m^2 and the results obtained were compared with the mean of the experience.In order to analise the results the analysis of variance and multiple comparison method (Duncan`s test) were used.

The biological material was cultivated in open field conditions, according to the technology recommended by the specialty literature (Ciofu *et al*., 2003; Indrea *et al*, 2012).

The determination of plants characteristics was done according to U.P.O.V. guideline (2006) and C.P.V.O. protocol (2011).

There were made biometric mensurements concerning the main plants characteristics (height, diameter, weight and edible weight), main heads characteristics (height, diameter, weight and no of leaves/head) and main characteristics of leaves (length, width, weight and no of leaves/plant).

In what it concerns lettuce, the commercial value is given by the weight of the edible part. Plants weight shows the potential of each variant. The difference between the plants weight and edible parts weight is determined by the culture technology that had been used.

RESULTS AND DISCUSSION

When the first leaf appeared, the seedlings of V_6 variant were dark green (Fig. 2, a). The seedlings of V_9 variant presented a delicate anthocyanin coloration in the first development period (Fig. 2, b). Seedlings growing determined the emphasizing of this characteristic (Fig. 2, c)

a) b) c)

Fig. 2 Seedlings from V_6 (a), V_9 (b) variants and aspect from seedling culture (c)

Tab. 1 Main plants characteristics

Variants	Height (cm)		Diameter (cm)		Weight (g)		Edible weight (g)	
	2013	2014	2013	2014	2013	2014	2013	2014
1	17.33 c	15.77 ef	14.67 e	16.40 f	264.33 bcd	162.45 c	217.33 abc	128.94 d
2	13.83 d	17.43 cde	19.33 de	27.57 abcd	234.00 bcd	339.47 ab	186.33 bcd	269.02 ab
3	16.83 cd	20.53 b	24.00 cd	25.97 bcde	252.00 bcd	245.04 abc	199.33 abcd	181.61 bcd
4	17.33 c	17.53 cde	28.67 bc	26.77 abcd	373.00 ab	358.42 a	303.67 ab	277.01 a
5	16.33 cd	15.87 def	21.00 de	23.50 de	124.00 d	241.11 abc	90.67 d	180.80 bcd
6	26.00 a	19.57 bc	36.00 a	25.63 cde	504.33 a	275.37 abc	319.33 a	232.27 abc
7	14.00 d	18.23 bcd	25.00 cd	29.97 ab	270.00 bcd	351.56 a	206.00 abcd	265.62 ab
8	17.33 c	20.37 b	25.00 cd	28.40 abc	199.33 bcd	302.05 ab	142.33 cd	207.17 abcd
9	21.33 b	24.67 a	32.33 ab	30.93 a	187.67 bcd	271.42 abc	139.67 cd	204.08 abcd
10	15.67 cd	14.57 f	24.00 cd	22.30 e	285.00 bc	223.01 bc	202.00 abcd	171.11 cd
Mean	17.60	18.45	25.00	25.74	269.37	276.99	200.67	211.76
Min	13.83	14.57	14.67	16.40	124.00	162.45	90.67	128.94
Max	26.00	24.67	36.00	30.93	504.33	358.42	319.33	277.01
$LSD_{5\%}$	2.81	2.17	6.38	3.85	134.14	112.12	107.54	81.08
$LSD_{1\%}$	3.85	2.98	8.74	5.28	183.96	153.76	147.49	111.19
$LSD_{1\%}$	5.24	4.06	11.90	7.18	250.39	209.28	200.75	151.35

Note: Different letters between variants denote significant differences (Duncan test, $p < 0.05$).

and apparition of anthocyanin coloration at the seedlings of V_7 variant.

At the harvest maturity there were made determinations regarding the main plant characteristics (height, diameter and weight), and also edible weight.

At V_6 variant, in 2013, there were registered the highest values concerning plant characteristics (height – 26 cm, diameter – 36 cm, weight – 504.33 g) and edible weight (319.33 g), while in 2014 the values of this accession reached or surpassed the mean value of the experience (Tab. 1).

Plant diameter registered the lowest values at V_1 for both experimental years. At V_1variant in 2014 there were registered the lowest values concerning plants weight (162.45 g) and edible weight (128.94 g).

In 2014, height (24.67 cm) and plant diameter (30.93 cm) registered maximum values at V_9, and plants weight (358.42 g) and eatable weight (277.01 g) registered maximum values at V_4.

In 2013 weather conditions had negatively influenced V_5 plants; plants weight was 124.00 g and edible weight was 90.67 g. In 2014 the values of the two characteristics doubled. The analysis of variance confirmed the negative influence on V_5 and the positive influence on V_4 and V_6 of 2013 years, concerning the two analysed characteristics.

Plants height varied between 13.93 – 26.00 cm in 2013 and 14.57 – 24.67 cm in 2014. In 2011 in Cluj, Apahidean (2012) observed a plant height within 16.6 and 23 cm. The variation interval concerning this character was larger at Buzau because of the weather conditions of this area.

Studying the 2013 – 2014 evolution it can be observed that 2013 conditions favored V_1, V_4, V_6 and V_{10} variants while 2014 had favorable conditions for V_2, V_5, V_7, V_8 and V_9 variants. At V_3 plants height and diameter were favored by 2013 conditions, while plants weight and edible weight were favored by 2014 conditions.

Concerning the studied parameters (Tab. 1), there was observed that the maximum values of 2013 were higher comparing to the maximum values obtained in 2014. Also, the minimum values of 2013 were lower than the minimum

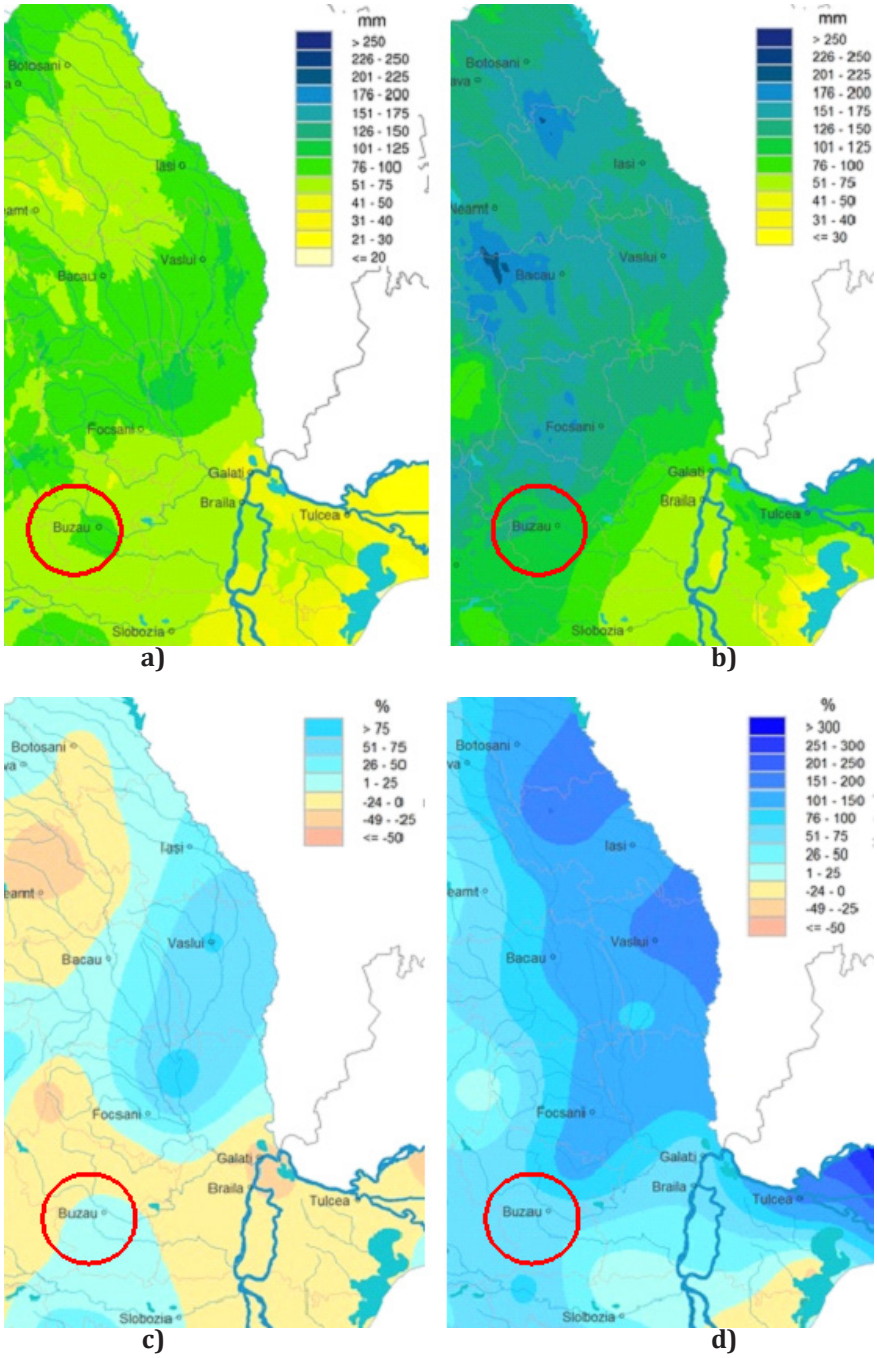


Fig. 3 Precipitation quantity in May 2013 (a), May 2014 (b) and the digression of the precipitation quantity in May 2013 (c) and May 2014 (d) comparing to the multiannual quantities (1961 – 1990) according to NMA. – http://www.meteoromania.ro.

values of 2014. These values were determined by the different weather conditions of the two experimental years.

For Buzău area, concerning the precipitations quantity in May, it was observed that their value surpassed the mean quantity. In 2013, the precipitations quantity was within 76 – 100 mm (Fig. 3, a), with 1 – 25 % more than the mean multiannual quantity (Fig. 3, c).

In 2014 the quantity of precipitation in May was about 101 – 125 mm (Fig. 3, b), with 51 – 75% more than the mean multiannual quantity (Fig. 3, d).

The mean temperature in May 2013 was within 18.1 – 20^{0}C (Fig. 4, a). This value is with 2.1 – 3.0 ^{0}C (Fig. 4, c) bigger than the mean multiannual value.

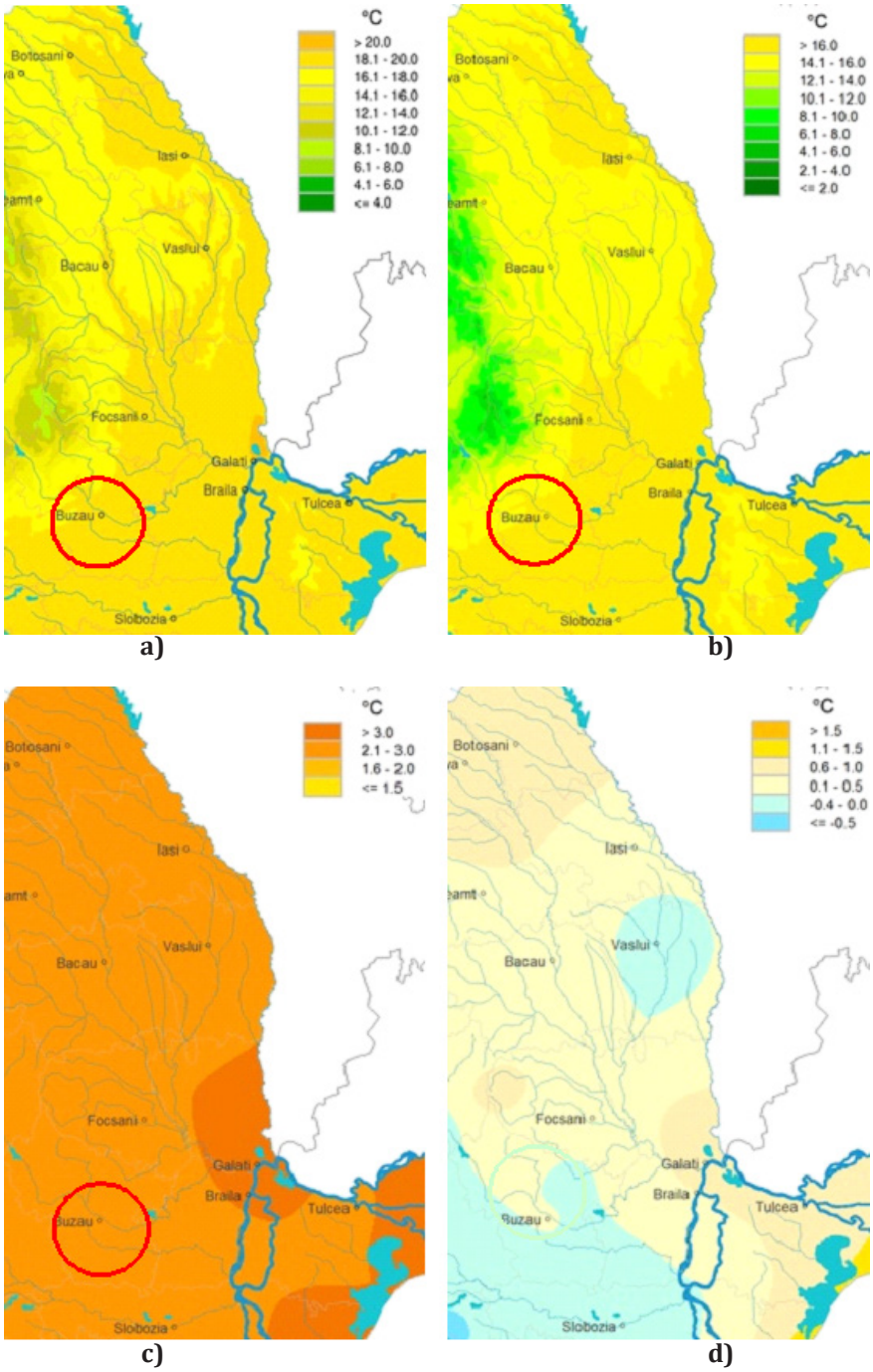


Fig. 4 Mean temperature in May 2013 (a), May 2014 (b) and the digression from the multiannual mean (1961 – 1990) in 2013 (c) and 2014 (d) according to NMA. – http://www.meteoromania.ro.

Tab. 2 Main heads characteristics

Variants	Height (cm)		Diameter (cm)		Weight (g)		No of leaves/head	
	2013	2014	2013	2014	2013	2014	2013	**2014**
1	13.50 bc	11.53 b	9.83 bcd	5.60 c	170.00 a	78.68 bc	26.00 cd	16.67 c
2	13.00 c	13.43 ab	11.33 abc	13.13 a	113.67 abc	180.96 a	33.67 ab	27.67 a
3	15.00 b	11.27 b	13.67 a	12.13 a	113.00 abc	106.68 ab	29.33 bc	20.83 bc
4	13.33 bc	13.37 ab	11.00 abc	13.13 a	161.67 a	188.64 a	38.67 a	23.00 b
5	12.33 c	12.97 ab	8.00 d	11.33 ab	42.00 de	122.06 ab	22.33 de	18.67 c
6	18.00 a	17.10 a	8.67 cd	12.00 a	70.00 bcd	124.97 ab	9.67 g	10.67 d
7	12.33 c	14.80 ab	12.67 ab	13.07 a	128.33 ab	185.15 a	22.67 de	20.00 bc
8	12.33 c	13.73 ab	7.00 d	11.83 ab	28.33 de	129.42 ab	17.33 ef	17.00 c
9	0.00 e	0.00 c	0.00 e	0.00 d	0.00 e	0.00 c	0.00 h	0.00 e
10	10.33 d	12.97 ab	7.33 d	8.90 b	53.33 cde	83.04 bc	15.33 fg	9.33 d
Mean	**12.02**	**12.12**	**8.95**	**10.11**	**88.03**	**119.96**	**21.50**	**16.38**
Max	18.00	17.10	13.67	13.13	170.00	188.64	38.67	27.67
$LSD_{5\%}$	1.72	4.85	2.77	2.85	62.33	86.34	5.99	3.88
$LSD_{1\%}$	2.36	6.65	3.80	3.91	85.48	118.41	8.22	5.32
$LSD_{0.1\%}$	3.21	9.06	5.17	5.33	116.35	161.17	11.19	7.24

Note: Different letters between variants denote significant differences (Duncan test, $p < 0.05$).

a) b)

Fig. 5 Head shape at V_6 (a) and at V_7 (b) variants

May 2014 had a mean temperature bigger than 16^0C(Fig. 4, b), fact that represents a digression from the mean multiannual value of 0.1 – 0.5^0C (Fig. 4, d).

The high quantity of precipitations in 2014 corroborated with the temperatures close to the lettuce requirements (Ciofu *et al.*, 2003) determined a decrease of the differences registered between the variants comparing to 2013.

All accessions presented reached head at the consumption maturity, except V_9 variant.

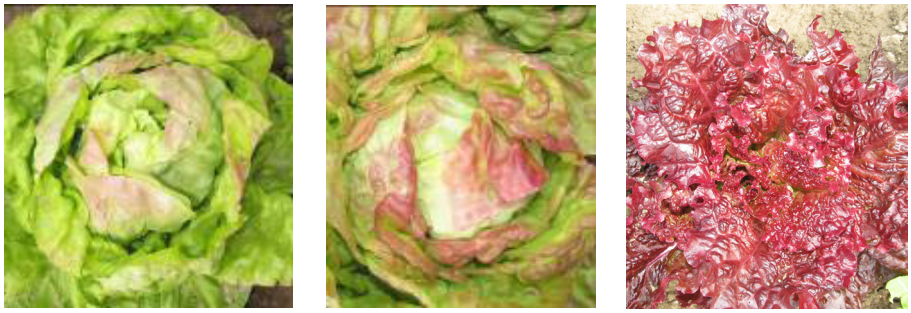
The climatic conditions of 2014 favored the main head characteristics, except the number of leaves/head. Most variants registered bigger values of studied characteristics in 2014 comparing to 2013 (Tab. 2).

Heads weight in V_8 variant increased from 28.33 g in 2013 to 129.42 g in 2014 and in V_5 variant increased from 42 g to 122.06 g.

V_3 and V_1 variants are the only variants in this study where there was observed a decrease of all values in 2014 concerning head characteristics (Tab. 2). This decrease was caused by the *Limax sp.* attack, to which the two variants seem to be sensible.

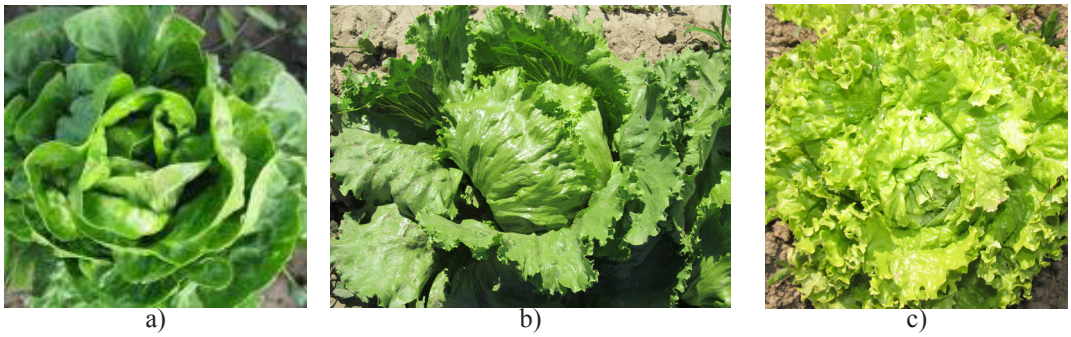
Head height revealed maximum values of 18 cm (2013) and 17.1 cm (2014) in V_6 variant. The minimum values for this characteristic were of 10.33 cm in V_{10} (2013) and 11.27 cm in V_3 variants (2014).

Head shape varied from narrow elliptic at V_6 (Fig. 5, a) to circular at V_7 (Fig. 5, b) variants.



a) b) c)

Fig. 7 Anthocyanin coloration intensity at V_3 (a), V_7 (b) and V_9 (c)



a) b) c)

Fig. 6 Green color intensity at V_1 (a), V_6 (b), V_2 (c) and V_4 (d)

The external head color was green at most variants. Green color intensity was different at the studied varieties from dark green at V_1 (Fig. 6, a) and V_6 (Fig. 6, b) to light green at V_2, V_4 and V_{10} (Fig. 6, c).

Anthocyanin coloration of the external head was observed at V_3 (Fig. 7, a) and V_7 (Fig. 7, b). The most intense anthocyanin coloration was observed at V_9 (Fig. 7, c).

Climatic conditions in 2014 determined smaller values at V_1 and V_3 concerning the leaves characteristics (Tab. 3) comparative to the values registered in 2013.

There were observed very significant differences regarding V_6 during the two experimental years in what it concerns leaves length, width and weight. In 2013 leaf length at this variant was 26 cm, width was 31.67 cm and weight was 48 g. At the same variant there were registered distinct significant (2013) and very significant (2014) differences concerning the number of leaves/plant. The decrease of weight leaf at V_6 variant in 2014 (25.82 g) was caused by the *Limax sp.* attack.

At V_7 variant there was observed a high anthocyanin coloration on the entire leaf surface during the first development period (Fig. 8, a). Subsequently, leaf base was green and the anthocyanin coloration could have been seen only on the superior half of the leaf (Fig. 8, b) and on the external closed head (Fig. 7, b). Anthocyanin coloration was observed on the superior half of the leaf at V_9 variant (Fig. 7, c).

Leaves shape was round at V_4 (Fig. 9, a), obovate at V_3 (Fig. 9, b), broad obtrullate at V_6 and V_{10} (Fig. 9, c and d), and narrow elliptic at V_9 (Fig. 8, c).

The foliar limb margin was entire at most variants and fimbriat at V_6, V_9 and V_{10}. The foliar limb surface was smooth at most variants, but at V_7 and V_9 was very embossed.

CONCLUSION

The high level of precipitations in 2014 corroborated with the temperatures close to the lettuce requirements determined a decrease of the differences registered between variants comparing to those registered in 2013, regarding the studied characteristics. The climatic conditions of 2013 year favored the variants V_1, V_4, V_6 and V_{10}, while those of 2014 year were favorable to V_2, V_5, V_7, V_8 and V_9 variants. In V_1 and V_3 variants a decrease of the main head characteristics in 2014 comparing to 2013 was registered. V_1 and

Tab. 3 Main leaves characteristics

Variants	Length (cm)		Width (cm)		Weight (g)		No of leaves/plant	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
1	13.50 f	14.23 f	11.50 d	10.17 f	14.33 bc	7.34 c	34.33 cd	30.67 de
2	16.33 cde	19.60 cd	15.00 bc	16.70 bcd	9.67 cde	11.65 c	46.67 b	41.33 ab
3	18.67 bc	22.57 ab	15.83 bc	17.97 b	15.33 bc	8.66 c	41.67 bc	39.33 ab
4	18.00 c	18.63 de	17.33 b	16.97 bc	12.67 bcd	12.36 c	61.67 a	43.00 a
5	14.50 def	16.67 ef	13.50 cd	14.63 cde	5.67 e	7.75 c	36.67 bcd	36.00 bcd
6	26.00 a	25.00 a	31.67 a	21.87 a	48.00 a	25.82 a	23.00 e	22.67 f
7	15.00 def	18.90 cde	15.33 bc	19.83 ab	16.33 b	18.66 b	34.67 cd	33.00 cd
8	16.67 cd	21.60 bc	12.83 cd	16.90 bc	7.33 de	9.56 c	36.00 cd	37.00 abc
9	20.67 b	24.57 a	16.13 bc	13.67 de	13.67 bc	12.03 c	31.33 cde	38.33 ab
10	13.83 ef	14.07 f	17.33 b	12.97 ef	17.33 b	11.71 c	30.00 de	26.67 ef
Mean	17.32	19.58	16.65	16.17	16.03	12.55	37.60	34.80
Max	26.00	25.00	31.67	21.87	48.00	25.82	61.67	43.00
Min	13.50	14.07	11.50	10.17	5.67	7.34	23.00	22.67
$LSD_{5\%}$	2.49	2.67	3.17	2.98	6.15	5.65	9.71	5.49
$LSD_{1\%}$	3.42	3.66	4.34	4.09	8.43	7.74	13.31	7.52
$LSD_{0.1\%}$	4.65	4.98	5.91	5.56	11.48	10.54	18.12	10.24

Note: Different letters between variants denote significant differences (Duncan test, $p < 0.05$).

a) b) c)

Fig. 8 Leaf anthocyanin coloration intensity at V_7 (a and b) and V_9 (c)

a) b) c) d)

Fig. 9 Leaf shape at V_4 (a), V_3 (b), V_6 (c) and V_{10} (d)

V_3 variants presented sensibility to the *Limax* sp. attack in 2014 climatic conditions.The highest value regarding head height was registered at V_6 variant in both experimental years. Leaves length, width and weight registered maximum values in V6 variant in both experimental years.

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