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Culture starting time can influence the production of some salad cultivars grown in the field

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Abstract Garden lettuce is grown for the head and leaves, which are mainly consumed as green salads, simple or combined with other green vegetables. It is important in nutrition due to its high content in vitamins and mineral salts. It is cultivated in the field, early spring and autumn, as well as in greenhouses and solariums, to obtain production during winter-spring or autumn-winter period. Being a species with a short period of vegetation is cultivated in the system of successive crops, before or after a basic crop, as well as in associated crops. In temperate climate, salad culture is not practiced during summer because in long day conditions associated with high temperatures, plants emit floral stems in most varieties.
Experience was carried out between 2015 and 2016, in western part of Romania, in Husasau de Tinca in Bihor county, where 14 salad varieties were grown in an ecological system. Growth of salad plants, quantitative and qualitative production, were determined at 14 salad cultivars, cultivated in spring and autumn in open field.

Key words

lettuce, varieties, culture period, production

Garden lettuce is grown for leaves and heads that are used in fresh or prepared form. It is demanded by consumers throughout the year, being cultivated both in open field and protected areas in successive or associated crops (2).
Lettuce leaves and leaves contain 4-8% dry substance, 2-3.5% carbohydrates, 1-1.6% protides, vitamins B1, B2, C (5-20 mg) P and E, carotene (1-3 mg) and mineral salts: potassium-260 mg, iron 1.2-1.7 mg, calcium, phosphorus - 40 mg, magnesium - 24 mg, per 100 g of fresh product. Leaves also contain latex, which prints the slightly bitter taste (5). It is considered a vegetable with a vital impact in healthy nutrition due to rich content of leaves in nutrients, especially vitamin A, vitamin C, vitamin E, folic acid, calcium, iron and dietary fiber (9). Dark green leaf lettuce usually has a higher content of nutrients than than lettuce varieties with light-green leafs. Lettuce is also a good source of catotenoids, in the form of provitamin A, which human body transforms into vitamin A (2). It also has a high vitamin K content, which plays a key role in blood clotting. They also contain flavonoids that determine their color, astringency and bitter taste and which together with anthocyanins give a reddish purple color to the leaves with enhanced antioxidant effect besides decorative effect (9).
Lettuce is easy digestible, has low caloric intake (16-20 calories/100 g), corresponding to a dietary regimen. Lettuce that spends winter in the field has a higher content in vitamins than in forced or spring cultures (1.13). Consumed fresh, lettuce contributes to muscle tissue revitalization, brain and nerves, maintains blood fluidity, is a good diuretic, stimulates appetite, etc. (10). Lettuce consumption reduces the risk of heart disease, cancer and cataracts. It is rich in vegetable fibers, which contributes to the reduction of cholesterol (6).
Because of high nitrate content of lettuce, over 2500 mg NO_3/kg, is included in the group of high nitrate vegetables. This level is influenced by both genetic and technological factors, so measures can be taken to obtain productions with lower nitrate and nitrite content (10, 13).
Lettuce is a long day plant, conditions in which it has a short period of vegetation and forms floral stems before forming the head. Sensitivity to day length, occurs between end of May and first half of June, during which day length is over 14 hours (4, 14). Growth and development of plants can be influenced by various physiological treatments (7). In short day conditions, lettuce forms a rich foliage and large heads, which do not pass into the floral stem stage (3, 8).
Optimal temperature for leaf growth and head formation is around 16^oC, and for the formation of floral stems and flowers, $20\text{-}22^0C$ (11).
Lettuce production is influenced by cultivar used, by culture starting period and by culture system (12). Organic crops use varieties or hybrids whose seed has

been certified ecologically and have genetic resistance to diseases and pests (10). Lettuce cultivars assortment includes ecologically certified genotypes with genetic resistance/tolerance to pathogens and pests with high ecological plasticity. These cultivars are adapted to long days conditions by emitting floral stems much later. They also have superior productive and qualitative potential with good storage capacity.

Material and Method

Experience was carried out between 2015 and 2016, in western part of Romania, locality Husasau de Tinca, in Bihor county where a lettuce culture was carried out in an ecological system.
Locality is located in the Miersig Plain, which consists of a higher stretch of flats with a slight slope and terraces located below the Hidişelului (Taşadului) Hills and another lower, in the west, close to Crişurilor Channel.
The northern and southern boundaries are given by Crişul Repede and CrişulNegru Meadow. The south-western boundaries are between the collector channel Culiser and the Crisul Negru channel, where a low-lying area, extending at 90-105 m, which extends to the low plain of Crişul Negru, the approximate limit passing south of Tica- Tulca line.
Biological material consisted of 14 lettuce varieties, recommended for organic farming system, of several types:
- *Roman Lettuce* – represented by the following varieties: Dark Green, Blonde Maraichere, Blonde Lente a Monter;
- *Letuce type Batavia* – represented by the following varieties: Long Stading Batavian, Jester;
- *Leaf lettuce* – was represented by Lola Rosa and Lola Bionda;
- *Head forming lettuce* - Anueme, Gloire de Mantes, Merveille de 4 Saison, Grass Blonde Peresuble, Laituie Silvesta and Laituie Appia;
Dark Green - roman salad that forms a lax head of light green to dark green. Leaves are fleshy with a clear, crisp, and very savory main nervure.
Blond Maraichere - roman salad, which forms a tall, elongated but rather large head. Outside leaves are light green.
Blonde lente a Monter - roman salad that forms a compact head. Leaves have shape of a spatula, long petiolate pale green. It has a good headdress even in the warm summer conditions.
Long Standing Batavian - Batavian salad with a bulky and high head. Leaves are very thick in light green color. It is one of the most resistant batavian salads in the issue of floral stems.
Jester - is a Batavian salad with a very beautiful look. It forms a large rosette of very voluminous leaves. Leaves are large, half-embossed, toothed edges, bright green pigmented with reddish spots. leafs are crisp and tasty.
Anuenue - is a salad that has the ability to grow up in warm soil. Leaves are bright green. It is adapted to high temperatures.
Kwiek - is a vigorous variety with green leaves with a slight reddish tinge. Forms a medium-sized head.
Gloire De Nantes - forms a thick head with slightly light-colored leaves, light green. It resists well at high temperatures.
Merveille of 4 Saisons - is a fast growing and vigorous variety. It forms an elongated colored ruby head to light red. It can be cultivated in all seasons, but it prefers more spring and summer.
Lollo Rossa - is a salad with brown green leaves and the red hot tip. It's very tasty. It resists the heat.
Lollo Bionda - forms a light curly green leaf rosette.
Grosse Blonde Paresseuse - forms a large flattened head. Leaves are light green and the interior leaves are pale green. It resists the heat.
Laituie Sylvesta- is a bright green rustic head salad. Leaves are crisp and very tasty.
Laituie Appia - is a kind of salad of green head, with finely crispy, glossy, very tasty leaves. Resistant to the issue of floral stems.
Culture was established in spring and autumn in the field, as a secondary culture. In spring, culture was set up between 25 and 30 March and for autumn, planting took place on 12-15 September. Culture was established by seedling produced in alveolar trays with 104 cells per tray. The soil mix for sowing was made of muck and peat (with neutral pH).
Planted land was prepared for the basic crop, which was different depending on the crop period. Thus for early salad culture the basic culture was long peppers and pimento peppers, and for autumn culture, potatoes. Prior to lettuce crop establishment, the land was shredded and loose, drip irrigation system and black foil mulch have been installed. Planting was done 35 days after sowing. Planting distances were 30 cm both between the rows and between plants per row. 15 days after planting a nettle macerate treatment was performed.
Harvesting took place between April and May, October to November, depending on variety. Harvesting was done at technological maturity, manually, by cutting the plants under the leaf rosette, then conditioning, removing the yellowish basal leaves and weighing them on variants and rehearsals to determine the yield.
Determination of dry substance concentration in water was performed by gravimetric method. Vitamin C was determined by the chemical method which is based on the reducing property of ascorbic acid (this by oxidation is converted to dehydroascorbic acid).

Results and Discussions

For seedlings planted at the end of March, production ranged between 2.50 kg/m^2 and 3.27 kg/m^2 (Table 1). Average yield achieved by the 14 cultivars was 2.93 kg/m^2, which was exceeded by some varieties by

6.82% to 11.6%. Highest yield of 3.27 kg/m^2 was obtained by Dark Green, with 11.6% more than experience average, with production difference being significant. A significant difference in production was also recorded by the Gloire de Nantes variety. The KwieK, Lollo Rossa and Lollo Bionda varieties produced the lowest yields (85.61-94.19% compared to experience average).

Table 1

Cultivar influence upon lettuce production, cultivated in spring in the field (Husasău de Tinca, 2015-2016)

No.	Variant	Average production		Difference from average (kg/m^2)	Significance of the difference
		kg/m^2	%		
1	Dark Green	3.27	111.60	0.34	*
2	Blonde Maraichère	3.04	103.75	0.11	-
3	Blonde Lente à Monter	2.96	101.02	0.03	-
4	Long Standing Batavian	2.83	96.58	-0.10	-
5	Jester	2.99	102.04	0.06	-
6	Anuenue	2.90	98.97	0.03	-
7	Kwiek	2.50	85.61	-0.43	oo
8	Lollo Rossa	2.76	94.19	-0.23	o
9	Lollo Bionda	2.59	88.39	-0.34	o
10	Gloire de Nantes	3.13	106.82	0.20	*
11	Merveille des 4 Saisons	2.90	98.97	-0.03	-
12	Grosse Blonde Paresseuse	2.85	97.26	-0.08	-
13	Laitue Silvesta	2.92	99.65	-0.01	-
14	Laitue Pomme Appia	2.98	101.73	0.05	-
	Average	2.93	100.00	-	-

LSD P5% 0.18; LSD P1% 0.37; LSD P 0.1% 0.59

Production for the autumn crop at planting epoch 1 was between 2.68 kg/m^2 for Lollo Bionda variety and 3.64 kg/m^2 for Dark Green variety (Table 2). Compared with experience average, varieties Anuenue, Kwiek, Lollo Rossa, Lollo Bionda produced lower yields, with production differences being significantly negative (88.81-92.10% versus average). Dark Green, Blonde Maraichère, Blonde Lente à Monter, and Laitue Pomme Appia have exceeded the average with 8.22-19.73%.

Table 2

Cultivar influence upon lettuce production, cultivated in autumn in the field (Husasău de Tinca, 2015-2016)

No.	Variant	Average production		Difference from average (kg/m^2)	Significance of the difference
		kg/m^2	%		
1	Dark Green	3.64	119.73	0.60	**
2	Blonde Maraichère	3.29	108.22	0.25	*
3	Blonde Lente à Monter	3.46	113.81	0.42	**
4	Long Standing Batavian	3.07	100.98	0.03	-
5	Jester	3.02	99.34	-0.02	-
6	Anuenue	2.77	91.11	-0.27	o
7	Kwiek	2.70	88.81	-0.34	o
8	Lollo Rossa	2.80	92.10	-0.24	o
9	Lollo Bionda	2.68	88.15	-0.36	o
10	Gloire de Nantes	2.86	94.07	-0.18	-
11	Merveille des 4 Saisons	2.93	96.38	-0.11	-
12	Grosse Blonde Paresseuse	3.01	99.01	-0.03	-
13	Laitue Silvesta	3.08	101.31	0.04	-
14	Laitue Pomme Appia	3.34	109.86	0.30	*
	Average	3.04	100.00	-	-

LSD P5% 0.23; LSD P1% 0.45; LSD P 0.1% 0.68

Dark Green variety obtained a production of 3.64 kg/m^2, difference in production compared to control being distinctly significant, and at Blonde Lente à Monter variety, production was 3.46 kg/m^2 with a distinct difference in production (Table 2).

Water content of lettuce varieties cultivated in spring, determined at time of harvest, differed according to cultivated variety, ranging from 93.59% (Blonde Lente à Monter) and 94.23% (Lollo Bionda). Content of lettuce leaves in dry matter was on average higher for

Roman lettuce varieties, 6.22% followed by Batavia lettuce varieties with 5.92% (Table 3). Compared to experience average, leaf lettuce varieties had a dry substance content of 92.01% and head lettuce varieties of 98.61%, while Roman type lettuce varieties exceeded experience average with 7.98 %.

Table 3

Water and dry matter content of some salad varieties cultivated in spring in the field (2015-2016)

No.	Cultivar	Water content (%)	Dry substance	
			%	% compared to average
1.	Dark Green	93.75	6.25	108.50
2.	Blonde Maraichère	94.02	5.98	103.82
3.	Blonde Lente à Monter	93.59	6.41	111.28
4.	*Average of roman type lettuce*	*93.78*	*6.22*	*107.98*
5.	Long Standing Batavian	94.14	5.86	101.73
6.	Jester	94.03	5.97	103.64
7.	*Average of Batavia type headed varieties*	*94.08*	*5.92*	*102.78*
8.	Lollo Rossa	94.55	5.45	94.61
9.	Lollo Bionda	94.23	5.17	89.75
10.	*Average of leaf lettuce variety*	*94.70*	*5.30*	*92.01*
11.	Anuenue	94.41	5.59	97.04
12.	Kwiek	94.37	5.63	97.74
13.	Gloire de Nantes	94.58	5.44	94.45
14.	Merveille des 4 Saisons	94.25	5.75	99.83
15.	Grosse Blonde Paresseuse	93.91	6.09	105.72
16.	Laitue Silvesta	94.37	5.63	97.74
17.	Laitue Pomme Appia	94.57	5.43	94.27
18.	*Average head varieties*	*94.32*	*5.68*	*98.61*
19.	Experience average	94.22	5.76	100.00

From the roman lettuce varieties, Blonde Lente à Monter has a dry substance content of 6.41%, exceeding experience average by 11.28%. Of the Batavia varieties, Jester variety was noted with 5.97% dry substance and from headed varieties, Grosse Blonde Paresseuse cultivar had a content of 6.09% of dry substance.

Table 4

Water and dry matter content of some lettuce varieties cultivated in autumn in the field (2015-2016)

No.	Cultivar	Water content (%)	Dry substance	
			%	% compared to average
1.	Dark Green	94.11	5.89	106.89
2.	Blonde Maraichère	94.32	5.68	103.08
3.	Blonde Lente à Monter	93.87	6.13	111.25
4.	*Average of roman type lettuce*	*94.10*	*5.90*	*107.07*
5.	Long Standing Batavian	94.35	5.65	102.54
6.	Jester	94.22	5.78	104.90
7.	*Average of Batavia type headed varieties*	*94.28*	*5.72*	*103.81*
8.	Lollo Rossa	94.75	5.25	95.28
9.	Lollo Bionda	94.96	5.04	91.47
10.	*Average of leaf lettuce variety*	*94.86*	*5.14*	*93.28*
11.	Anuenue	94.69	5.31	96.37
12.	Kwiek	94.62	5.38	97.64
13.	Gloire de Nantes	94.82	5.18	94.01
14.	Merveille des 4 Saisons	94.58	5.42	98.36
15.	Grosse Blonde Paresseuse	94.22	5.78	104.90
16.	Laitue Silvesta	94.56	5.44	98.72
17.	Laitue Pomme Appia	94.80	5.20	94.37
18.	*Average head varieties*	*94.62*	*5.38*	*97.64*
19.	Experience average	94.49	5.51	100.00

Water content of autumn cultivated lettuce, determined at the time of harvesting, was different depending on cultivated variety, ranging from 93.87% (Blonde Lente à Monter) and 94.96% (Lollo Bionda). Content of the dry substance from lettuce leaves was on average higher for Roman lettuce varieties (5.90%) followed by Batavia salad varieties by 5.72% (Table 4). Compared with experience average, leaf salad varieties had a dry matter content of 93.28% and head lettuce varieties of 97.64%, while the Roman lettuce varieties exceeded the average of the experience by 7.07 %.

Of the Roman lettuce varieties, Blonde Lente à Monter has a dry substance content of 6.13%, exceeding experience average by 11.25%. Of the Batavia varieties, Jester variety was noted with 5.78% dry substance content and among head lettuce varieties Grosse Blonde Paresseuse had a content of 5.78% dry substance.

Table 5

Vitamin C content of some salad cultivars grown in the field (Husasău de Tinca 2015-2016)

No.	Cultivar	Vitamin C (mg/100 g.p.p.)/ Culture period		
		Spring	Autumn	Difference
1.	Dark Green	5.16	4.78	0.38
2.	Blonde Maraichère	5.83	5.26	0.57
3.	Blonde Lente à Monter	6.25	5.83	0.42
4.	*Average of roman type lettuce*	*5.75*	*5.29*	*0.46*
5.	Long Standing Batavian	6.74	6.12	0.62
6.	Jester	7.22	6.87	0.35
7.	*Average of Batavia type headed varieties*	*6.98*	*6.49*	*0.49*
8.	Lollo Rossa	6.70	6.15	0.55
9.	Lollo Bionda	7.84	7.20	0.64
10.	*Average of leaf lettuce variety*	*7.27*	*6.68*	*0.59*
11.	Anuenue	5.50	5.03	0.47
12.	Kwiek	5.82	5.16	0.66
13.	Gloire de Nantes	5.75	5.23	0.52
14.	Merveille des 4 Saisons	6.84	6.22	0.62
15.	Grosse Blonde Paresseuse	7.06	6.77	0.29
16.	Laitue Silvesta	7.12	6.58	0.54
17.	Laitue Pomme Appia	5.97	5.44	0.53
18.	*Average head varieties*	*6.29*	*5.77*	*0.52*
19.	Experience average	6.41	5.90	0.51

On average, contents of lettuce varieties grown in spring in the field in vitamin C was 6.41 mg/100 g of fresh produce and in the case of autumn culture, the vitamin C content was 5.90 mg/100 g of fresh produce. (Table 5). Leaf lettuce varieties accumulated on average 7.27 mg/100 g of fresh produce in spring crops and 6.68 mg/100 g of fresh produce in autumn culture. Batavia varieties have accumulated 6.98 mg/100 g of fresh produce in spring and 6.49 mg/100 g of fresh produce in autumn and Roman lettuce varieties had a content of 5.75 mg/100 g of fresh produce. in spring and 5.29 mg/100 g of fresh produce. in autumn culture. Leafy lettuce varieties have accumulated on average 6.29 mg/100 g.p.p. in spring culture and 5.90 mg/100 g of fresh produce in autumn. From data presented in table 5 it can be observed that during autumn, due to less favorable light conditions, the amount of vitamin C accumulated in the leaves was lower by 0.29-0.66 mg/100 g of fresh produce compared to spring period.

Conclusions

On the basis of obtained results from the research on open field salad culture, under specific conditions in the western part of Romania, the following conclusions were drawn:

- average production achieved by the 14 varieties cultivated in spring was 2.93 kg/m^2, which was exceeded by some varieties by 6.82% to 11.6%. The highest production, of 3.27 kg/m^2, was obtained by Dark Green variety, 11.6% more than experience average.
- autumn crops yield was between 2.68 kg/m^2 and 3.64 kg/m^2. Dark Green variety obtained a production of 3.64 kg/m^2, the difference in production compared to experience average being significantly significant, and at Blonde Lente à Monter variety the production was 3.46 kg/m^2 with a distinct difference in production.
- for spring crops, lettuce content in dry substance was on average higher for Roman lettuce type, with 6,22%, followed by Batavia type lettuce with 5,92% compared to experience average.

- in autumn culture, lettuce content regarding dry substance was on average higher for the Roman lettuce varieties, with 5.90% followed by Batavia lettuce varieties with 5.72% compared to experience average.
- on average, the content of lettuce varieties, grown in spring in the field, in vitamin C was 6.41 mg/100 g of fresh produce and in the case of autumn culture, vitamin C content was 5.90 mg/100 g of fresh produce.
- in autumn, due to less favorable light conditions, the amount of vitamin C accumulated in the leaves was lower by 0.29-0.66 mg/100 g of fresh produce compared to spring period.

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