

COMPARATIVE TESTING OF DIFFERENT LETTUCE CULTIVARS FOR FIELD SPRING PRODUCTION WITH NOVEMBER TRANSPLANTING UNDER NON-WOVEN FABRIC

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Abstract

The aim of this study was to test some cultivars of lettuce for field spring production with November transplanting under non-woven fabric (fleece). The experiment was carried out in the period 2015-2016 in the experimental field on University of Forestry Sofia (42° 7' N, 23° 43' E). There were selected 12 cultivars (10 Batavia and 2 Lollo types) with different requirements for the terms and conditions of cultivation. In the second ten days of November the seedlings were planted in the open field, on the block method with four replications. Immediately after the planting, a low tunnel was placed over the bed, covered with non-woven fabric. During the harvesting of production (April) were made biometric measurements (diameter and average weight per plant). At the end was also reported the percentage of dead plants. Six cultivars from Batavia type were highlighted for winter cultivation under non-woven fabric. Regardless of recommendations given for each cultivar it needs they to be screened for each region, microclimate and growing period.

Key words: Batavia type, *Lactuca sativa*, non-woven fabric, November transplanting.

INTRODUCTION

The lettuce is one of the first fresh vegetables on the market, appearing early in the spring. It is frost-hardy leafy vegetable and grows at a temperature of 5-25 °C. At temperatures below 5 °C the growth of plants stops (Cholakov, 2009), and at a temperature above 25 °C, a flower stem is formed. Young and hardened plants (Phase 7-8 leaf) can withstand temperature down to -5/-6 °C. (Cholakov, 2009; Divina, 2016). The optimal temperature for its growth and development is 16-18 °C (Lorenz and Maynard, 1988; Kartalov et al., 2007).

When growing lettuce for early field production with winter planting, there are used low tunnels with different coatings. The non-woven fabrics, which are used in horticulture, are generally called agro-textiles. In horticulture these materials are used under several forms - as mulch, as covering material etc. They are used with great success concerning early production of vegetables (Buta and Apahidean, 2009).

The microclimate is better under non-woven fabric, temperature is higher and more even, and plants grow faster (Hamamoto, 1996). The covering material had a favorable effect on the environment factors (temperature, air

humidity), less on the light intensity, which registered lower values during the use of Agryl coverings. (Buta and Apahidean, 2009). The temperature under the non-woven fleece can be 2-3 °C higher than plants grown without covers (Hamouz et al., 2006). Earlier growth of lettuce was encouraged by row covers (Rekika et al., 2009).

Vegetables grown under non-woven fleece had greater leaf area, increased number of leaves and increased plant height compared with non-covered plants. Soil temperature is increased under non-woven fleece (Olle and Bender, 2010).

Early-season soil temperature affects leaf appearance and expansion rates. Under higher temperature in the beginning of growing season the leaf area development enhances (Gimenez, 2002). Head weights of lettuce under agrotexile low tunnels were higher than those from the control plots (Jenni et al., 2003). Covering stem lettuce plants with PP non-woven fabric had a positive effect on the acceleration of harvest and on the quantity and quality of the yield (Rekowska, 2011).

Non-woven fabric cover increased early yield, total yield, germination, development and growth speed, plant height, number and area of leaves of plants, protects against low

temperature and frost, and also reduced insect pests damage. (Olle and Bender, 2010).

Factors influencing the quality of salads are the growing season, the weather conditions and the variety (Koudela and Petříková, 2008).

Falovo et al., (2009) have found that salad growing season has a greater impact on yield and quality of production than the composition of the nutrient solution. Significant impact on yield also has the date of planting (Sharma et al. 2009). In the winter production of leafy vegetables and earlier date of planting, the length of the vegetation period until obtaining the finished product is not reduced, however, planting seedlings before the fall of the low winter temperatures and the occurrence of winter frosts leads to the obtaining of larger plants in the spring (Borrelli et al. 2013).

Lebeda et al. (2007) describe seven morphotypes of the species *Lactuca sativa*, which cover seven main groups of varieties (including oil-bearing plants) that differ phenotypically (by Kristkova et al., 2008).

Two of the common types for northern and central Europe, which enter Bulgaria, are the Batavian and Lollo type. Batavia are characterized by open to strong heading; generally medium thick, rather strongly blistered leaves, predominately yellowish or medium green; leaf margin with weak to strong undulation (UPOV, 2017).

It produces moderately dense heads with a crunchy texture and intermediate between iceberg and loose leaf types. Varieties are in red or green colour (Divina 2016). Lebeda et al., 2007 refers Batavia type to Crisphead lettuce (var. *Capitata* L. *nidusjägeri* Helm) together with Eissalat and Iceberg type (Křístková et al. 2008).

Lollo type Non-heading; thin leaves with strongly undulated leaf margin. The plant as a whole shows mainly the undulating leaf margins. In general strongly blistered leaves, blisters are rather small (UPOV, 2017), forms tender leaves that are delicate and mildly flavoured. Varieties come in green and red and green or purple colour (Divina, 2016). Lolo type refers to Cutting lettuce (var. *Acephala* Alef., Syn var. *Secalina* Alef., Syn var. *Crispa* L.) and this morphotype is extremely heterogeneous (Křístková, et al. 2008).

It is necessary to screen the different varieties to check their adaptation in a given area. This should be done locally in different environments to determine the most stable and well-adapted varieties for a particular growing season and region (Dufault, 2006). The correct selection of varieties makes it possible to avoid crop rotation when higher temperatures occur (Rader and Karlsson, 2006).

The purpose of our study is to test and compare some of the salad varieties offered, in a low tunnel covered with non-woven textile, for winter-spring growing, with November transplantation.

MATERIALS AND METHODS

The field experiment was conducted during 2010–2011 at the experimental field (42°7'N, 23°43'E and 552 m above sea level) of the University of Forestry, Sofia, Bulgaria, on the fluvisol, which is slightly stony and slightly acidic (pH (H₂O) 6.2).

For the aim of the experiment, a total number of 12 types of lettuces have been studied, of two types: Batavia and Lollo (10 are Batavian type, 2 are Lollo type), 4 of which are intended for outdoor cultivation (spring-summer-autumn) and one is only for indoors. The varieties have different origins (8 are Dutch, 2 Swiss, 1 Italian and 1 French), as follows: **1. Cultivar: 'Maritima'**; type Batavia; growing conditions and recommended seasons: outdoor for Spring-Summer-Autumn/indoor for all year round: origin: Netherlands **2. Cultivar: 'Funride'**; type Batavia; growing conditions and recommended seasons: outdoor for Spring-Summer-Autumn (For summer cultivation): origin: Switzerland **3. Cultivar: 'Kriska'**; type Lollo Bionda; growing conditions and recommended seasons: outdoor for Spring-Summer-Autumn/indoor for Autumn-Winter: origin: Italy **4. Cultivar: 'Florine'**; type Batavia; growing conditions and recommended seasons: outdoor for Spring-Summer/indoor for Autumn-Winter: origin: France. **5. Cultivar: 'Funtasia'**; type Batavia; growing conditions and recommended seasons: outdoor for All year round without high and low temp: origin: Switzerland. **6. Cultivar: 'Noisette'**; type Batavia; growing conditions and recommended seasons: outdoor/indoor for all year round:

origin: Netherland. **7. Cultivar: ‘Malice’**; type Batavia; growing conditions and recommended seasons: outdoor for Spring and Autumn/indoor for Autumn-Winter-Spring: origin: Netherland. **8. Cultivar: ‘Fuzila’**; type Batavia; growing conditions and recommended seasons: outdoor for Spring-Summer-Autumn: origin: Netherland. **9. Cultivar: ‘Satine’**; type Lollo Rossa; growing conditions and recommended seasons: indoor for Autumn-Winter-Spring: origin: Netherland. **10. Cultivar: ‘Fanela’**; type Batavia; growing conditions and recommended seasons: outdoor for Spring-Summer-Autumn: origin: Netherland. **11. Cultivar: ‘Sementel’**; type Batavia; growing conditions and recommended seasons: outdoor/indoor for Autumn-Winter-Spring: origin: Netherland. **12. Cultivar: ‘Frisady’**; type Batavia; growing conditions and recommended seasons: outdoor for Spring-Summer-Autumn/indoor for all year round: origin: Netherland.

The seedlings were planted in the second ten days of November (12.11.2015), and this period was the last suitable according to the weather conditions and the medium-term forecast for the month.

The lettuces were planted on a four rows raised bed, with a plant spacing of 25 cm, with pre-produced seedlings. Immediately after the planting, a low tunnel covered with non-woven textile was placed on the bed.

The experiment was performed in a blocking method with four replications, with 12 plants for each replication per cultivar, and all care during growing period were the same for all variants. The harvesting of the produce was carried out in April and during the harvesting were measured the plant diameter and the average weight per plant.

The collected data from these indicators were analysed by ANOVA and were expressed as mean \pm standard deviations. Post hoc analyses were conducted using Fisher’s protected LSD test.

RESULTS AND DISCUSSIONS

For growing lettuces, (early field production with winter transplanting under a low tunnel), are important the selection of the cultivar, date of planting and weather conditions. Overall, the months covering the experimental period

(November '15 – April'16) were warmer compared to the average monthly temperatures over the 30-year period, with the exception of January, which was cold by -0.4°C (Figure 1).

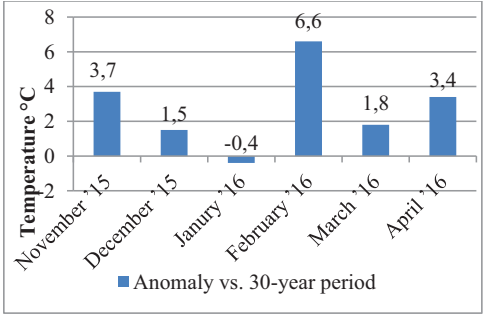


Figure 1 Average monthly temperature anomalies, versus 30-year period

In December, extremely low temperatures were not measured except for 3 days of the month, in two of which the temperature was -6.4°C and -5.2°C , which was around the critical minimum for salads in the early period for their development (-5°C), and a temperature of -11°C was also measured but on the last day of the month (Fig. 2)

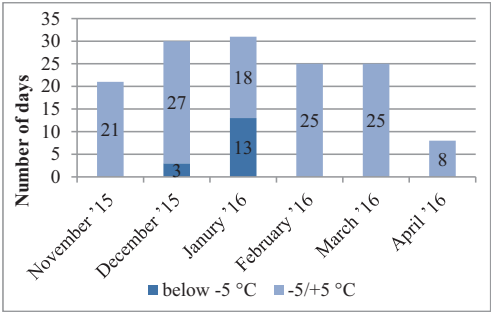


Figure 2 Extremely low temperatures during the experimental period (number of days)

January had a negative monthly average temperature, lower than the 30-year period.

Temperatures during and after the transplantation of the lettuces (second and third ten days of November) were favourable for rooting of seedlings and after the transplanting the raised beds were covered with non-woven textile low tunnels.

In the first ten days of December, temperatures continue to be favourable for plants, but in the second ten days minimal temperatures begin to fall below 0°C (Figure 3).

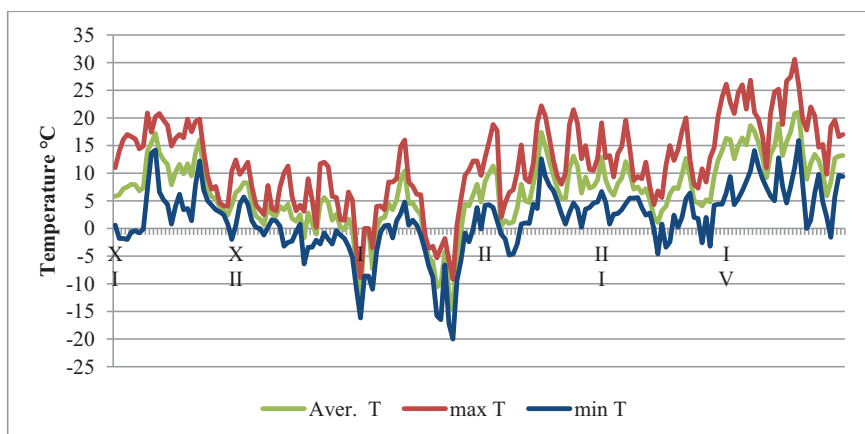


Figure 3 Air temperatures over the experimental period (November 2015 - April 2016)

The low temperatures recorded between the end of December and the end of January is the main limitation for salad growth, as confirmed by Gent, M. P. N., 2002. Raising temperatures from the second ten days of February and March, initiated visible growth of plants.

Together with seedlings planting, were made watering. During the last ten days of November, rainfall of 60.4 l/m², during 7 consecutive days of precipitation (Figure 4), so irrigation was stopped.

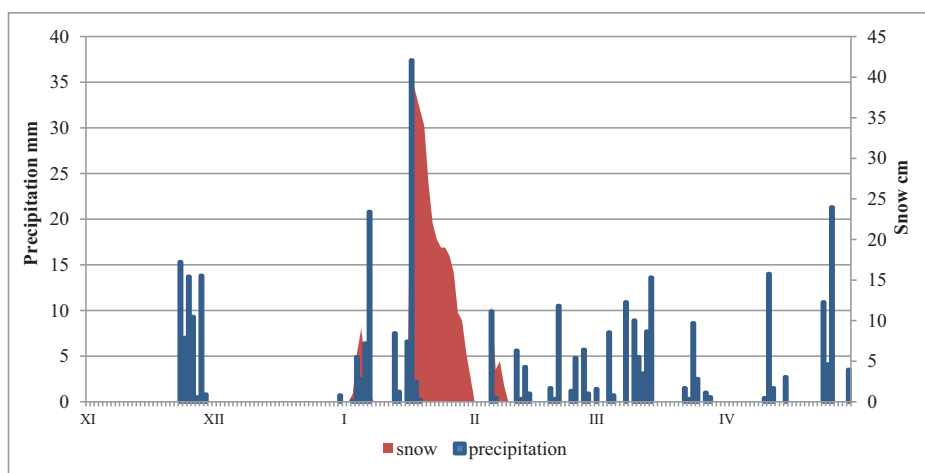


Figure 4 Amount of precipitation (mm) and snow cover (cm) during the salad season (November 15 - April 16)

The fallen rainfall during the months of January, February and the first half of March provided the necessary moisture to the plants, as the non-woven textile releases fallen rainfall, unlike polyethylene coatings (Fig. 4).

In April, the lettuces reached the harvesting phase. The varieties tested showed good results when grown in a small-sized tunnel covered with non-woven textile.

Of the 12 tested cultivars, only the “Funtasia” showed a strong sensitivity to the growing conditions, where much of the plants did not survive (75% dead plants) and the remaining ones did not develop well, compared to the other tested cultivars.

Of the remaining 11 varieties in four more were reported dead plants, with two of the varieties below 5% (‘Kriska’ – 4% and ‘Malice’ – 3%) and the other two - just over 5% (‘Fuzila’ – 8%

and 'Fanela' – 6%). There were no losses in seven varieties.

From the collected and analysed biometric data (diameter and average weight) of plants of different varieties (Table 1), it was found that there were significant differences in the diameter of the plants $F(11, 125)=10.57$ $MSE = 2.75$ $p < .0001$ at the .05 alpha level, as well as in the average mass of a plant $F(11, 22)=3.60$ $MSE = 3193.18$ $p = .005$ at the .05 alpha level.

Three of the cultivars formed a diameter around and over 26 cm: 'Funride' > 'Maritima' > 'Florine' (arranged in descending order from the largest diameter to the smaller one), and four of them had a diameter between 23.50 and 24 cm: 'Fuzila' > 'Fanela' > 'Noisette' = 'Satine', also in descending order.

The average weight per head for most cultivars varies between 300 and 367 g.

By this indicator, in descending order, the salads are arranged as follows: 'Funride' = 'Frisday' > 'Malice' > 'Fuzila' = 'Noisette' > 'Maritima' > 'Florine' > 'Fanela' (Tab. 1).

The red variety 'Satine' (type 'Lollo Rosa'), with outdoor cultivation under low tunnel covered with non-woven fabric, forms salads that have a relatively good average weight and diameter and competed with some of the green lettuce cultivars.

Table 1. Mean value (M) and standard deviation (SD) of plant diameter and weight per plant.

№	Cultivar	Plant diameter (cm)		Plant weight (g/per plant)	
		M± SD	LSD	M± SD	LSD
1	'Maritima'	26.33±1.61	a	307±61	AB
2	'Funride'	26.58±2.19	a	367±75	A
3	Kriska	22.33±1.15	cd	203±29	CD
4	'Florine'	25.92±1.88	a	303±25	AB
5	'Funtasia'	22.60±2.51	bcd	90±0	D
6	'Noisette'	23.50±1.57	bc	313±68	AB
7	'Malice'	23.08±0.79	bcd	323±64	AB
8	'Fuzila'	23.92±1.68	b	313±81	AB
9	Satine	23.50±1.00	bc	233±23	BC
10	Fanela	23.58±2.35	bc	300±80	AB
11	Sumetie	21.92±1.78	d	230±26	BC
12	'Frisday'	22.75±1.06	bcd	367±38	A

Means within a column followed by the same letter do not differ significantly based on Fisher's protected LSD at $P<.05$.

Combining both indicators, can be made the following ordering of the varieties: 'Funride' > 'Frisday' > 'Malice' > 'Maritima' > 'Fuzila' >

'Noisette' > 'Florine'. If the information about the dead plants is also taken into account in the ordered cultivars, then the order is changed, with two of the cultivars passing to the end of the line: 'Funride' (0%) > 'Frisday' (0%) > 'Maritima' (0%) > 'Noisette' (0%) > 'Florine' (0%) > 'Malice' (3%) > 'Fuzila' (8%).

CONCLUSIONS

All tested cultivars, except for the 'Funtasia', developed well in early-field cultivation with non-woven fabric. Only the 'Funtasia' cultivar, which is highly sensitive to low temperatures, could not be growing under non-woven fabric.

It can be summed up that 6 of the 12 cultivars stand out and are suitable for early spring field production with winter plantation under non-woven fabric covered low tunnel, namely 'Funride' (0%) > 'Frisday' (0%) > 'Maritima' (0%) > 'Noisette' (0%) > 'Florine' (0%) > 'Malice' (3%) > 'Fuzila' (8%). Of these four are intended for indoor year-round cultivation and one is for the autumn-winter-spring indoor season (excluding the summer season). Interesting is the cultivar 'Funride', which, although intended for growing during the spring-summer-autumn outdoor season, showed very good resistance and quality in winter-grown methods.

The red variety 'Satine' (type Lollo Rosa), with outdoor non-woven fabric protection, formed a product part with a relatively good average weight and diameter and competed with some of the green lettuces without loss.

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