Vegetable culture vs. climate change
Innovative solutions
Part 2. Research on the influence of shadow with different textile materials of Rubiniu onion plants (*Allium Cepa*)

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ABSTRACT – REZUMAT

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Onion is an important vegetable in Romanian cuisine, implicitly in vegetable growing. The pedoclimatic conditions in our country are favourable for this culture. Onion shading technologies are rare, even in small areas. A Rubiniu red onion culture was established, in the agricultural year 2019. Three types of textile materials were used (2 of them were provided by INCDTP Bucharest), to overshadow the experimental variants and an unshaded witness. The present study aimed to observe the growth of the studied plants, shaded with different types of textile material, in the context of climate change. The analysed results indicate a positive influence of shading on plant growth and development compared to the control variant.

***Keywords**: Allium cepa var. rubra, agrotextiles, shading, development, warp knit*

Culturi legumicole vs. schimbări climatice
Soluții inovative
Partea 2. Cercetări privind influența umbririi cu diferite materiale textile a plantelor de ceapă rubiniu (*Allium Cepa*)

Ceapa este o legumă importantă în bucătăria românească, implicit în legumicultură. Condițiile pedoclimatice din țara noastră sunt favorabile pentru această cultură. Tehnologiile de umbrire a cepei sunt rare, chiar pentru suprafețe mici. O cultură de ceapă roșie Rubiniu a fost înființată, în anul agricol 2019. Au fost utilizate trei tipuri de materiale textile (2 dintre acestea au fost furnizate de INCDTP București), care au umbrit variantele experimentale și un martor neumbrit. Prezentul studiu a vizat creșterea plantelor luate sub observație, umbrite cu diferite tipuri de material textil, în contextul schimbărilor climatice. Rezultatele analizate indică o influență pozitivă a umbririi asupra creșterii și dezvoltării plantelor în comparație cu varianta martor.

***Cuvinte-cheie**: Allium cepa var. rubra, agrotextile, umbrire, dezvoltare de produs, tricot din urzeală*

INTRODUCTION

Onion is among the most important vegetable crops grown around the world mainly for its requirements for daily consumption and its health benefits for human beings [1].

Onion (*Allium cepa*) belonging to the Family *Alliaceae*, is a major bulbous vegetable which ranks second only to tomato in terms of total annual world production [2].

Due to this fact, its production is concentrated in the three world's top producers (China, India, and the USA) for both their daily consumption and/or for export market purposes [1]. Onion is cool-season vegetable crop [3]. Requirements for onion are estimated at 10 kg per person annually, including 7 kg of bulb onion, and 2 kg of onion with leaves [4].

There was increasing consumption of the inhabitant from 15.1 kg up to 15.7 kg which is higher than the average norm of consumption recommended in the country (10 kg) [5].

Besides the export of onion bulb with skin also quite a lot of quantities of the peeled onion for freezing or direct use for meat and fish industries, as well as for gastronomy is exported from Poland.

In some centres of onion production, specialized plants have been established for export only peeled onion [6]. Bulbs cultivar Babtu didieji are suitable for storage (7 months). Bulbs are big and oval. The weight of one marketable bulb reached 95–116 g [7].

To correct high and low temperatures, several shading systems are available in greenhouses: bleaching, mesh, screens and photovoltaic panels. Whitening is the simplest and most economical technique that is used as a shading system. It consists of applying a solution of water and calcium carbonate on the roof of the greenhouse.
The other systems that have been used (mesh and screens) can be used inside or outside the greenhouse and can be permanent (fixed) or mobile (movable) [8].
In addition, they revealed that shading mesh behaves like translucent materials and the colour and solidity of the mesh influence heat transfer.
Later, they confirmed that the temperature and porosity of the mesh are more relevant parameters than texture and colour when radiative transmission and reflection are measured.
That shading methods reduce energy and water consumption and increase fruit productivity and quality [8].
Shading reduces the level of solar radiation, the air temperature, and the rate of evapotranspiration, reducing water consumption – a fundamental aspect for countries where this resource is scarce.
Furthermore, it has been shown that shading combined with evaporative cooling is more effective in arid regions and hot seasons, while shading combined with thermal screens reduces the energy consumption used for heating in cold regions, maintaining the temperature of the internal air at 5°C higher than outside air [9].
On the other hand, fresh onions are usually short-day cultivars, transplanted from late summer to early spring and harvested at different bulb sizes, according to local climatic conditions and consumers' demands [10].
In contrast to pungency variability, the content of total sugars does not show wide differences among the cultivars (8% to 10%), with glucose in the highest amount, followed by fructose and sucrose.
It identified a locus accounting for the major differences in the content of reducing sugars and fructans in onion bulbs between storage varieties with high dry matter content and sweet varieties with low dry matter content [10].
Shallots are onions grown in various climatic zones – from Asia and Africa to northern regions of Europe and America [11].
An additional trend has been the increasing popularity of red onions with 10–15% from sets in 2005 just for the early market, planted in March and harvested mid-August [12].
According to research findings, the Adama red onion variety which has been evaluated under the fiche condition of Ethiopia has responded to different Intra row spacing on different bulb yield parameters [13]. A similar report that three onion varieties, Bombay red, Adama red and Nasika red, responded differently to the intra-row spacing on yield and yield components at Adami Tulu.
Therefore, the identification of this yield-limiting factor due to population density is very important for onions against lower yield trends in the country [1].
This work presents some technically-scientifically aspects regarding the influence of shading on *Allium cepa* crops var. *rubra.* Two warp-knitted fabrics are experimented with as unconventional textile solutions (the organic diatomite was another innovative solution in Part 1 of this research study) for strengthening vegetable culture, by shading, in the context of climate change.

MATERIAL AND METHODS

The experiments were placed in the research field of the S.C.D.L. Buzau, field 32, plot A447 (45009`32,7``N and 26049`40,8``E), coordinates which gives together with soil composition, particularities of the vegetables from Buzau region, generally.
In 2019, 3 types of textile materials provided by the INCDTP Bucharest, were tested, and also with an unshaded control variant.
The variants of shading textile materials are warp knitted fabrics, and net type, which differ from each other by the surface of the net eye. The warp knitted fabrics are made of synthetic filament yarn of high tenacity, and low density, and with additional textured synthetic (micro) filament yarn.
Through the adopted structures (variants), the final aspect of the neat mesh is given and generates rectangular meso-surfaces, which have a uniform, well-defined distribution, "chessboard" type, with a variable coverage factor.
Thus, the entire fabric system formed has double functionality, of shading without overheating the microclimate, which must be shaded or dissipated in the air currents, by breaking off the aggressive air currents on the sides of the separation medium, represented by the developed knitted fabric variants [14].
These materials studied were mounted in the Rubiniu onion culture.
The onion variety (*Allium cepa*) Rubiniu, created by S.C.D.L. Buzau, is a semi-late variety of water red onion (150–160 days), with good tolerance to diseases and pests, and needs preventive treatments.
The production potential is 60–70 to/ha.
The edible part, the bulb, has the following characteristics:
– average weight 250.5 g;
– length 9.2 cm;
– shape cone trunk;
– package diameter 1.2 cm;
– median diameter 8 cm;
– disc diameter 1.6 cm;
– the number of fleshy tunics 10;
– the number of parchment tunics 3;
– the colour is red-purple.
It is recommended for fresh consumption [15].
The experiments located in onion culture had 4 variants with 4 repetitions (according to figure 1).
The pictures show the three experimental variants shaded with textile materials:

- V1 – warp knitted fabric, with 30% yarns cover factor, code P3 (figure 1, *b*);
- V2 – warp knitted fabric, with 50% yarns cover factor, code P15 (figure 1, *c*);
- V4 – woven fabric, with low technological threads density, from the specific market, used for shading property, Code PU (figure 1, *a*).

The shaded area was 0.8 m^2. The height at which the nets were installed was 1.10 m.

For the onion culture, the cultivation technologies specific to this species were used, adapted to the climatic conditions of 2019. The onion crop was established by direct sowing in the field, in the place established for the experiment, on 09.04.2019 and emerged on 29.04.2019. The nets were mounted on 04.07.2019.

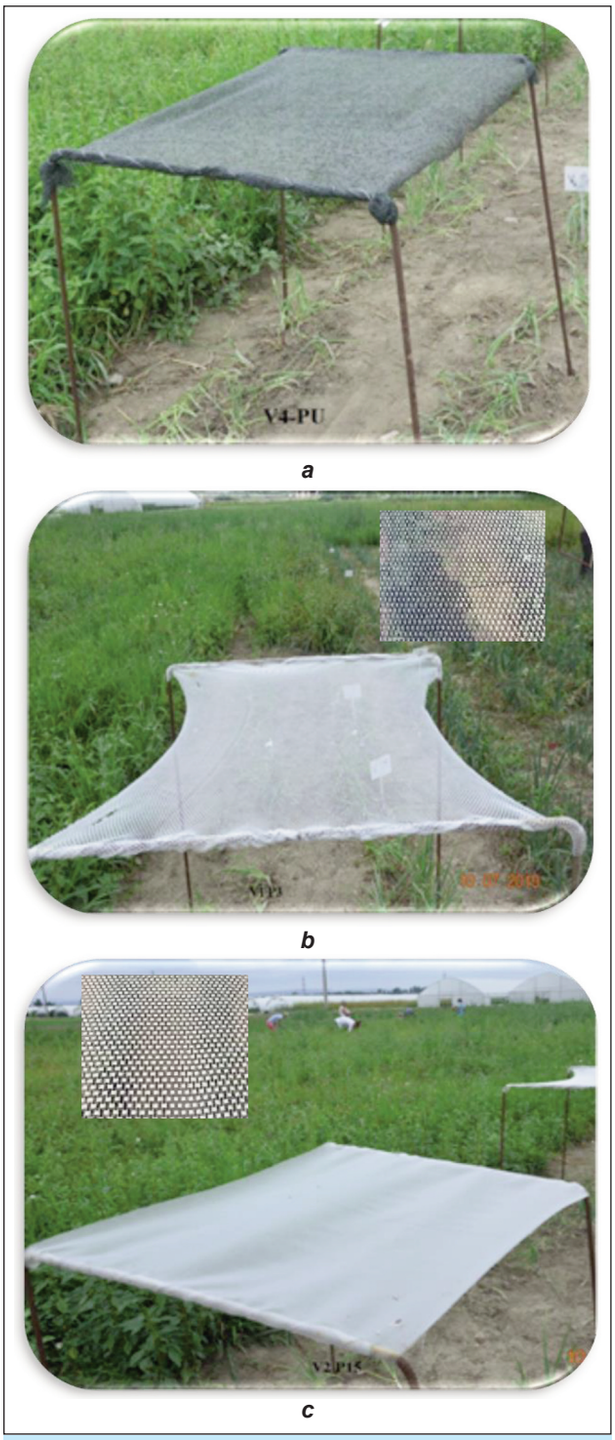

Fig. 1. Shading nets in the culture of red onion Rubiniu variety: *a* – shading net PU; *b* – shading net P3; *c* – shading net P15

Climate

During the vegetation period of the red onion, minimum temperatures were registered in April, at 5°C, and the maximum temperature was 33°C (figure 2).

The amount of precipitation in a total of 297–322 mm was distributed according to the graph from figure 3 for the vegetation period. In general, in the plain area, the amount of precipitation is 400–500 l/m^2 [16] for a vegetation season.

For September, an amount of precipitation is estimated at 50 and 75 l/m^2 in the Subcarpathian area [17].

The soil

From a geomorphological point of view, the land on which the unit is located is in the form of an alluvial plain, anthropically shaped by levelling, within a dam, the former major riverbed of the Buzau River. The altitude of the land is 94.0 m, with a natural slope of NNV – SSE.

As a type of soil, we appreciate that it is alluvial, and depending on the humus content, groundwater intake, skeleton content and physical clay content, the soil is part of the group of soft soils, slightly salinized (table 1).

Table 1

AGROCHEMICAL CHARACTERIZATION OF THE SOIL [18]

Specification	Values recorded on mapping	Interpretation of values
pH (water)	8.20	weakly alkaline
Humus (%)	2.57	supplied environment
$CaCO_3$% carbonates	4.50	weakly carbonated
C: N	11	normal
N total%	0.151	good
P total%	0.183	very good
P mobile ppm	> 144	very good
K mobile ppm	> 268	very good

The bedrock consists of medium and heavy clays, carbonates and alluvial clays. The soil texture is loamy-sandy, and the groundwater depth is located at 2.0–3.0 m [18].

In culture, determinations were made regarding the following parameters: average plant height, the average number of leaves/plants, average leaf length, average leaf width [19–21], and area foliar calculation [22].

The production data were not recorded because during the intense growth of the bulb there were abundant precipitations that determined a strong rooting of the plants, and they maintained their green foliage to the detriment of bulb formation [23].

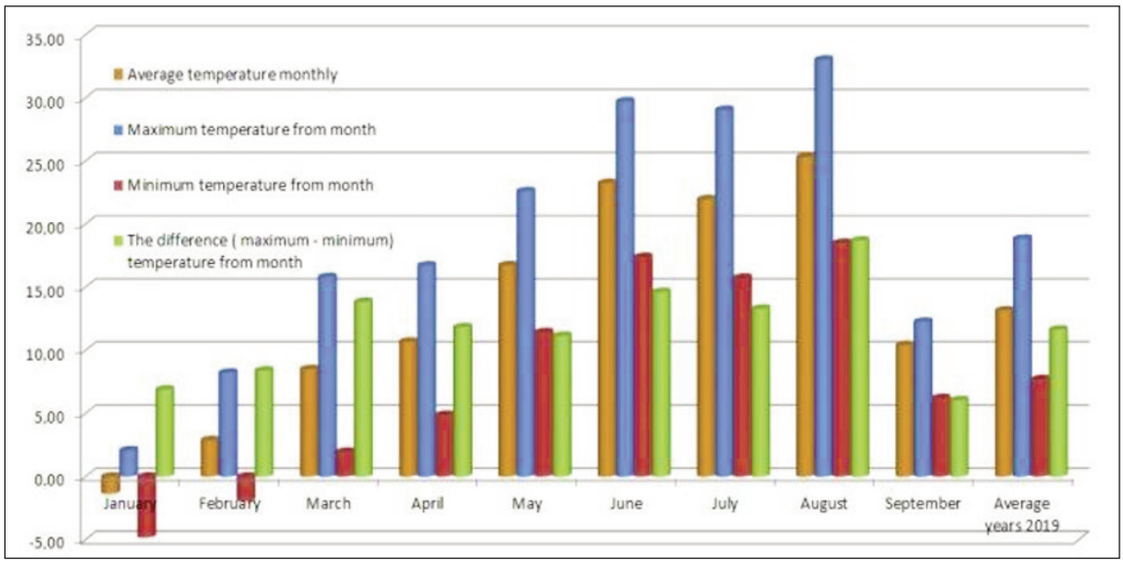

Fig. 2. Graph of monthly temperatures in 2019

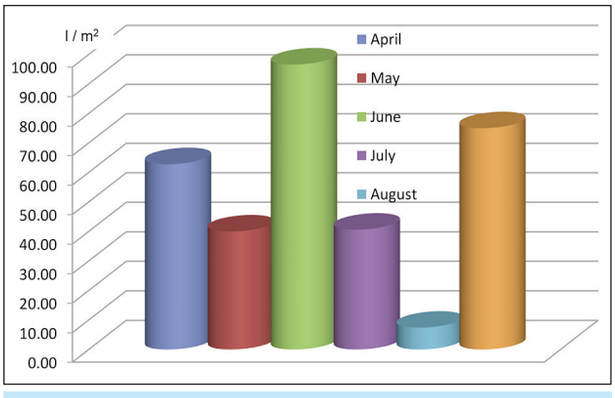

Fig. 3. The amount of precipitation, l/m^2, for each month, from April to August

In September was estimated an amount of precipitation of at least 50 l/m^2 [17].

RESULTS AND DISCUSSION

The analysis of the results regarding the evolution of the plant height is presented in figure 4.

The first determinations were made on 05.07.2019 (meaning 24 days of shading) and a maximum value of plant height was found in variant V2 with mesh P15 and a minimum value in variant V4 with shading mesh PU 30%.

At the last determination on 19.08.2019 (50 days of shading), the highest value of the height of a plant, in centimetres, was registered at variant V1 (the shading net-type P3), and the lowest at the control V3.

The evolution of the number of leaves per plant (figure no. 5) shows a higher number of leaves in all shaded variants (7.5–8 leaves on the average per plant).

The variant with the lowest average number of leaves per plant was V3 Control (4.5–5), the highest average value being variant V2 textile material type P15 (figure 5).

The surface of an onion leaf (mm^2), in the conditions of shading with textile materials as seen in figure 6, shows an increasing trend, with higher values for shaded variants (V1 – textile material type P3, V2 – textile material type P15, V4 – PU 30%) compared to the unshaded control starting from the 24th day of shading, until the last determination in the 50th day of shading.

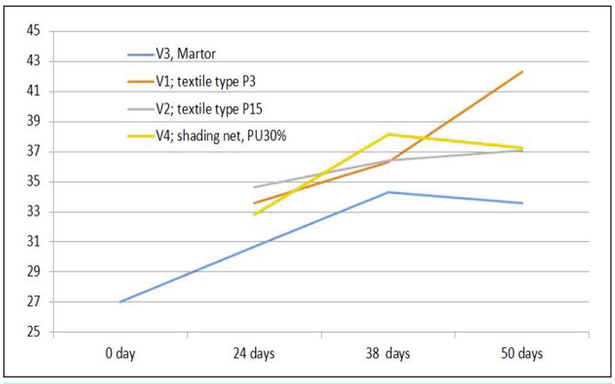

Fig. 4. Evolution, in days, of plant height in cm – Rubiniu red onion variety, different variants

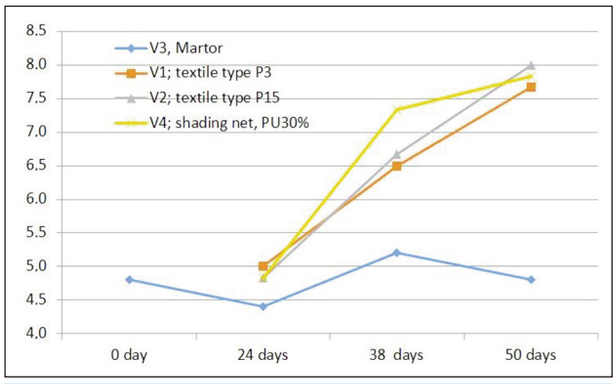

Fig. 5. The evolution, in days, of the number of leaves – the Rubiniu red onion variety, different variants

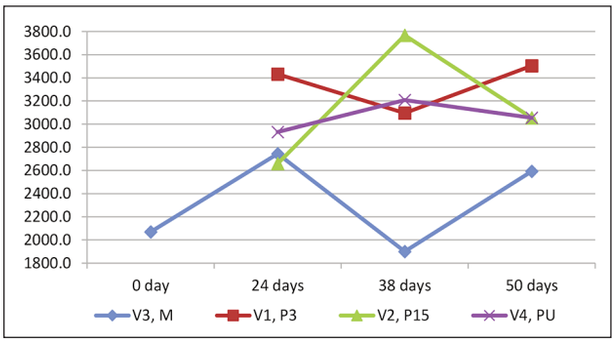

Fig. 6. Evolution, in days, of the surface of an onion leaf (mm^2), in the conditions of shading with textile materials (variants were: V1 – textile material type P3, V2 – textile material type P15, V3 – unshaded control, V4 – PU 30%)

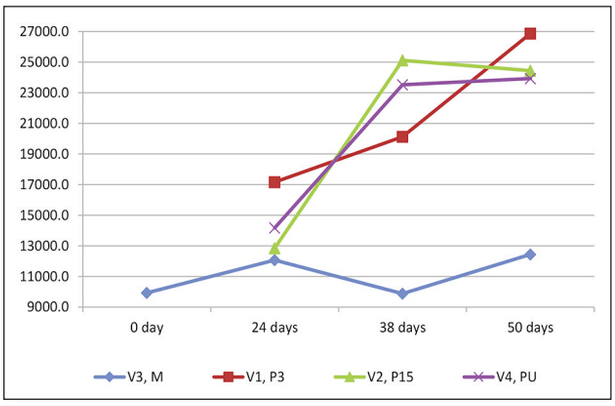

Fig. 7. The evolution, in days, of the total surface of onion leaves, in mm^2, in the conditions of shading with textile materials (V1 – textile material type P3, V2 – textile material type P15, V3 – unshaded control, V4 – PU 30%)

The smallest surface of a leaf is calculated in mm^2, it is found in the unshaded control variant, at 50 days of shading (2592.3 mm^2).

At the opposite pole there can be found the largest surface of a leaf at 38 days of shading variant V2 net P15 3767.2 mm^2 and 50 days of shading V1 net P3 3504.1 mm^2 (figure 6).

The shaded plants had a much larger leaf area per plant in the shaded variants than in the case of the non-shaded variants (figure 7).

The lowest value of the leaf area per plant at 50 days of shading is 12443.1 mm^2, representing approximately half of the value of shaded variants (figure 7).

The highest value is 26864.7 mm^2 at 50 days of shading in variant V1 with mesh P15 (figure 7).

CONCLUSIONS

After experimentation it was found that onion plants shaded with the material textile P15, have increased their leaf area; the number of leaves was higher under the mesh model P3 and the black shade.

Also, all the shaded variants had an almost double-leaf area compared to the unshaded control, which shows the positive influence of shading.

The use of textile fabrics in vegetable crops can contribute to a significant increase in plant height, having an important role in the faster growth and development of plants, as well as in protecting from the action of unfavourable climatic factors and sudden changes in the weather (frost, strong wind, high/low atmospheric heat, heavy rains, etc.).

The textile structures in agriculture were and still have an active, positive role. A circular economy, strengthens the complementarity of textiles in agriculture, in future.

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