

## POSSIBILITIES FOR COTTON GROWING UNDER CONDITIONS OF ORGANIC FARMING IN BULGARIA

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### Abstract

*The purpose of this study was to investigate the possibilities for cotton varieties growing under conditions of organic farming. The research was carried out in the certificated field of the Field Crops Institute, Chirpan, Bulgaria in cotton-durum wheat crop-rotation under non-irrigated conditions. The results demonstrated that at organic production the new Bulgarian varieties realized good seed-cotton yield. The average total cotton yield was 1328 kg/ha, ranging from 1279 kg/ha for cultivar Boyana to 1372 kg/ha for Chirpan-539. Varieties Chirpan-539, Boyana and Darmi were identified as a high-yielding and adaptable to biological conditions. As a result of two-fold foliar application with "ALGA 300" in dose of 1l/ha the yield increased with 7.3 to 14.6 % compared to the untreated. Under the influence of field conditions and foliar application the variety Natalia formed most bolls per plant - 3.48, and the boll weight was the highest in cultivar Helius - 4.00 g.*

**Key words:** cotton, organic farming, variety, foliar application, yield, quality.

### 1. INTRODUCTION

According to the National plan for development of organic farming in Bulgaria 2006 - 2013 by 2013 8 % of the arable farming land should be managed by means of organic production methods. The initiation and development of biological farming in Bulgaria is part of the European strategy for ecological integration and sustainable development within the frame of the Common Agricultural Policy whose reforms encourage the market orientation in the production of biological products. Council Regulation (EC) No 834/2007 and Ordinance No 22 Regulation 22 on organic production of plants, plant products and foods of plant origin (SG, issue 68/3 August 2001, amended in SG, issue 13/10 February 2006) determine the conditions for production, labeling and recycling of organic production.

In the last years the biological and ecological production of plant products have been some of the fastest developing branches in Europe. According to data of the International federation of organic agriculture the annual increase in a large number of European countries has been 20-25 %. In Europe, organic agriculture is developing very dynamically due to the increase in the number of farmers willing to produce clean products (Nieberg and Offermann, 2008). The organic farming is an optimal choice for the future development of the farming sector as it preserves the natural resources and the environment, meets the needs of the increasing number of consumers, uses safe methods of production. In organic farming soil is regarded as a living system that evolves, and which plays an active role beneficial to the organisms. It is a source and reserve of nutrients through decomposition of organic waste materials as a medium for antagonists of pests and diseases. The interaction between minerals, water, mold, air and living organisms in the soil is the main basis for sound production system.

The organic products market is sustainable, constantly increasing, efficient and has good prospects. The expansion of the EU creates a large home market in regard with purchasing power, which opens broad range of opportunities before the organic farming.

The conventional farming varieties are not always suitable for organic growing, because they have been bred for high yield and quality at high soil fertility, with high doses of synthetic fertilizers and pesticides. Maintaining the biodiversity is an important principle in organic farming, and steps are to be taken in this direction so that the farmers would be provided with a number of varieties, including adapted for growing at organic farms. Obtaining ecologically clean plant products intended for food for people and animals and preserving the environment are connected to using organic based products.

According to Ordinance No 1452/2003 of the European Union organic farming should not only be supplied with conventional varieties seeds, produced in an organic way, but breeding programs should also be initiated for the creation of varieties better adapted to its conditions. In spite of the efforts in the recent years by non-governmental organizations (Association of Ecological Farming «Ekofarm»; Foundation for Organic Agriculture «Bioselena») and the government of the Republic of Bulgaria for popularization and support of organic farming as a contemporary environmentally friendly farming system, by the moment one of the problems for realization of the National plan for development of organic farming in Bulgaria 2007-2013 is the lack of production of certified biological seeds and initiation of specialized breeding programs. No funding has been provided for the start of such research. Furthermore, even in strategic purpose IV: Practically oriented scientific research, education and consultancy work in the area of organic farming for the National plan for development of organic farming in Bulgaria 2006-2013 accepted in 2007 doesn't provide for funding activities related with seed production of biological varieties and seeds from them.

Complying with the principle of maintaining the biodiversity also brings social benefits connected with providing social additional income for the local organic farmers.

Cotton is the main fibrous strategic culture in Bulgaria with strongly reduced areas. Its growing under organic farming, especially in rural areas with available work hands would contribute to stimulating the production for gaining additional income for the population. Due to the high drought-resistance of the culture, big producers are the countries of dry climate.

Growing plants which efficiently use nitrogen is of exceptional importance for the organic farming and environment. The physiological, metabolic, and physicochemical processes in the plants are related with a higher nitrogen use efficiency (NUE) (Cassman et al., 2002; Moll et al., 1982; Shanahan et al., 2008). Varieties of increased NUE are economically and ecologically more valuable. Worldwide the interest of research scientists and producers has grown towards more efficient genotypes of cereal crops (Hirel et al., 2007; Li et al., 2008) and creating strategies for higher efficiency of using the nutrients (Raun et al., 2002; Shanahan et al., 2008; Brancourt-Hulmel et al., 2003).

Organic cotton is attracting a lot of attention at present following some impressive growth in recent years. This situation raises questions and challenges, which the industry must attempt to answer (Organic Exchange 2008). One of the central ones is how to guarantee the sustainability of the system in a time of growth (Ferrigno 2008), which in turn means identifying and analysing the components of a sustainable organic cotton system.

At the Field Crops Institute – Chirpan research has been carried out aiming mainly the ecological production of field crop varieties and testing separate technological elements of organic farming and their impact on soil fertility, productivity and quality of production. Some research made on traditional and economically effective low-cost farming practices has been tested, such as various types of tillage, mineral, organic and mineral-organic fertilization, crop rotation, etc. (Panayotova and Kostadinova, 2003; Saldjiev, 2000; Saldjiev et al., 2005). For the leached vertisols soil type with biological ( $N_0P_0$ ), ecological ( $N_6P_6$ ), moderate ( $N_{12}P_{12}$ ) and intensive ( $N_{18}P_{18}$ ) fertilization it has been established that after a continuous period of non-fertilization pH the humus content practically does not change (Panayotova, 2005b, 2007).

A number of organic and bacterial products have been tested for vegetative nutrition of field crops (Panayotova, 2005a, 2007a; Panayotova and Kostadinova, 2005), for pre-sowing seed treatment (Radevska and Panayotova, 2006), growth regulators (Delchev et al., 2004), using biological sewage sludge from wastewater (Gorbanov et al., 1999; Panayotova et al., 2001). Fertilization may be replaced with vegetation feeding with organic fertilizers, whereat the productivity and production quality do not deteriorate (Panayotova and Valkova, 2006).

Subject of research for different cultures were the humat formulations created in the last years such as extracts of organic sludge, coal, peat, kinds of manure, as well as products from red Californian worm. The results published in the last years show that they have a stimulating effect on the development and productivity of a number of cultures (Delfine et al., 2005; Gramatikov, 2005; Gramatikov and Koteva, 2004; Nankova et al., 2004; Nenov et al., 2004; Sengalevich et al., 2004).

Soil fertility, and particularly nitrogen, may be added by foliar biologically active fertilizers on organic base. Dintcheva et al. (2009) established the influence of bioproducts biohumus and humustim on the productivity of 4 tomato varieties and found that each variety has specific response and an increase of the fruit weigh after treatment with biohumus 150 l/da from 11.5 to 31.4 %, depending on the variety.

So far Bulgaria hasn't got established technologies for organic cotton production, no experiments have been made on testing cotton varieties which is the subject of this innovative and the future scientific research studies.

The purpose of this investigation was to identify the most suitable cotton cultivars for an organic farming system and establish the efficiency of the bioproduct Alga 300 on the development, yield and quality of the Bulgarian cotton cultivars.

## 2. MATERIALS AND METHODS

The investigation was carried out during the period from 2011 to 2013 on the the Certificated bio-field of the Field Crops Institute, Chirpan, Bulgaria, situated in a major cotton-growing region of Bulgaria. The cropping pattern was winter durum wheat (*Tr. durum* Desf.) – cotton, double cropping system in a two-year rotation under non-irrigated conditions. Randomized block design with four replications was used. The size of individual trial plots was 25 m<sup>2</sup> (3,0 x 8,33 m), consisting of five rows spaced 0.60 m apart.

The Bulgarian cotton varieties - Natalia, Helius, Boyana and Darmi were grown under organic farming conditions. The results were compared with the variety Chirpan-539 – national standard for earliness and productivity. The tested varieties were created by two different breeding programs:

a) breeding varieties of earliness and high genetic potential for yield. Basic methods in this direction were intraspecies hybridization and experimental mutagenesis. The varieties in this area have short fiber and relatively high yield. Varieties Chirpan-539, Helius and Bojana are from this group.

b) breeding varieties of improved fiber quality. The main method was interspecies hybridization of *G. hirsutum* L. × *G. barbadense* L. Representatives were varieties Natalia and Darmi.

All activities were realized through the use of obligatory methods, rules and principles of organic production with the use of authorized organic supplies.

The varieties were grown without pre-sowing feeding. Organic seaweed fertilizer “ALGA 300” in dosage of 1 l/ha was tested as foliar feeding. The organic fertilizer was applied two-fold at the beginning and end of the bud-formation stage. According to information by the producer Leili Agrochemistry Co, LTD, the ALGA 300 is a completely natural extract, ecologically clean, derived from brown seaweed, quickly and directly included in the metabolism, highly concentrated liquid product. It contains 5 % N, 15 % P<sub>2</sub>O<sub>5</sub>, 4 % K<sub>2</sub>O (5:15:4), seaweed extract ≥ 15 %, amino acid ≥ 1 %, organic matter ≥ 15 %, minerals, plant hormones, complex sugars. ALGA 300 is both nontoxic and environmentally friendly which will increase the marketable value for agricultural products. The product is approved for use in organic production after inspection of Ecocert SA.

Cotton varieties were grown under the adopted cotton technology. Cotton seeds at depth of 4-5 cm were sown within the optimal period - 20-30 April with density of the plant population - 14-16 seeds/m<sup>2</sup>. The pre-sowing soil cultivation included autumn deep ploughing and 2 cultivations, and during the vegetation period were done two machine inter-row and two manual earthing up. Weeds in vegetation period were controlled by hand. Fight against diseases and pests were not necessary.

Observations on the growth and development of plants were performed on 40 plants (10 in replication) for each variety. The total seed-cotton yield in kg/ha was established. Two harvests were made by hand. At maturity the seed-cotton yield from each plot was weighed and ginned on a roller gin. There were determined the number of bolls per plant by accurate count; boll size (g) as seed cotton weight / number of bolls; plant height in maturity (cm). Analysis of variance was used to determine differences and interaction among cultivars, fertilizer rates and years. Mapping of weed species was done. Quantitative method was used to count the different types of weeds.

Soil samples were taken for determination of total humus (%) - by Turin, pH<sub>KCl</sub> (potentiometrically), mineral nitrogen – by Bremner and Keeney, mobile phosphorus and available potassium (mg/100 g soil) - by acetate-lactate method before sowing and after harvest.

The three studied years had different meteorological conditions during the vegetation period (V-X) (Table 1). In terms of weather conditions 2011 and 2012 were defined as unfavourable for the cotton growth and development. The cotton vegetation periods were characterized with long summer drought and high temperatures. In June, July and August the total rainfall for these two years was 113 and 33 mm respectively against 158 mm over perennial sum, and in July the rainfall was only 24 mm and 7 mm, respectively. The temperature amount in 2011 was 11.6 % higher, the hydrothermal coefficient (by Selyaninov) was twice lower than normal - 0.32 against 0.77. The temperature sum for the vegetation period in 2012 was 2305 °C, which was 252 °C under the average values. Harvesting of cotton was carried out in adverse temperature and humidity conditions - nearly double the rainfall compared to the long-term averages. In 2013 the bud-formation -

flowering passed with good provision of moisture which stimulated formation of high number of fruit organs - rainfall in July amounted to 91 mm, with 39 mm above the average of the long period. Most favourable for cotton was 2013 with temperature sum close to the average for the previous year and well provided with rainfall. As a result of the combination of temperature and rainfall 2013 was very favourable for cotton growth and development.

Table 1. Meteorological data during the vegetation cotton period (V-X) recorded at the region of Chirpan, 2011-2013

| Years                 | Months |     |     |     |      |     | Σ     | Σ       | Σ    |
|-----------------------|--------|-----|-----|-----|------|-----|-------|---------|------|
|                       | IV     | V   | VI  | VII | VIII | IX  | IV-IX | VI-VIII | V-IX |
| Temperature sum, Σ °C |        |     |     |     |      |     |       |         |      |
| 1928-2010             | 343    | 519 | 622 | 720 | 711  | 561 | 3476  | 2053    | 3133 |
| 2011                  | 535    | 538 | 645 | 772 | 743  | 558 | 3791  | 2160    | 3256 |
| ±                     | 192    | 19  | 23  | 52  | 32   | -3  | +315  | +107    | +123 |
| 2012                  | 412    | 519 | 688 | 830 | 787  | 623 | 3859  | 2305    | 3447 |
| ±                     | 69     | -   | 66  | 110 | 76   | 62  | +383  | +252    | +314 |
| 2013                  | 416    | 604 | 639 | 710 | 785  | 581 | 3735  | 2134    | 3319 |
|                       | 73     | 85  | 17  | -10 | 74   | 20  | +259  | +81     | +186 |
| Rainfall, mm          |        |     |     |     |      |     |       |         |      |
| 1928 - 10             | 45     | 63  | 65  | 52  | 41   | 34  | 300   | 158     | 255  |
| 2011                  | 46     | 46  | 31  | 24  | 58   | 50  | 255   | 113     | 209  |
| ±                     | +1     | -17 | -34 | -28 | +17  | +16 | -45   | -45     | -46  |
| 2012                  | 14     | 128 | 16  | 7   | 10   | 10  | 185   | 33      | 171  |
| ±                     | -31    | +65 | -49 | -45 | -31  | -24 | -115  | -125    | -84  |
| 2013                  | 41     | 14  | 61  | 91  | 1    | 10  | 218   | 153     | 177  |
| ±                     | -4     | -49 | -4  | +39 | -40  | -24 | -82   | -5      | -78  |

### 3. RESULTS AND DISCUSSION

The soil in the field of organic farming was Pellic Vertisols (FAO). It was clay, with high humidity capacity and small water-permeability, defined by the sand-clay composition. The soil has a high-powered humus horizon (70-100 cm), it has a compact zone of the profile (united horizon). The test field had a bulk weight of the plough soil layer - 1.1-1.2 g/m<sup>3</sup> and specific gravity - 2.4-2.5. The cation exchange capacity was 35-50 mequ/100 g soil.

As the focus is on organic soil, it is very important to maintain and increase soil fertility. The analysis results before the experiments in the 0-60 cm soil layer indicated slightly acid to neutral soil reaction (Table 2). The values of pH<sub>(KCl)</sub> were within the favourable scope for cotton growing. In the 0-20 cm layer the soil had slightly acid reaction, and in the deeper soil layers (20-60 cm) the acidity decreased and the values ranged within 5.8-6.5. According to the total humus content (1.54-2.40 %) the soil had from low to middle supply of organic matter. The content of mineral nitrogen as a sum of NH<sub>4</sub>-N + NO<sub>3</sub>-N varied significantly, it changed dynamically under the influence of the meteorological conditions and the grown crops had low values, reaching a maximum of 25 mg/kg soil. As for the available phosphates supply, it was established that in the 0-60 cm soil layer the phosphates supply was low - 0.3-3.2 mg/100 g soil. The phosphates regime was unfavourable for cotton development. The Pellic Vertisols in the field was well provided with available potassium. Its content ranged within 15-38.0 mg/100 g soil with its highest values being for the plough layer.

No significant deviations were established in the agrochemical soil property in the end of the vegetation periods under the influence of the applied foliar fertilization which would effect the cotton development and productivity as well as the fibre quality. The soil kept its neutral reaction at high nitrogen rate with no negative effect on the culture. The established amount of total humus within boundaries of 1.84-2.58 % for the plough layer and 2.24-2.47 % for the under plough layer was an index for a very good potential soil fertility. In cotton growing with no fertilization the content of available forms of nitrogen insignificantly decreased. The mineral nitrogen varied in accordance with the nitrogen rate.

The combination of temperature and rainfall was the main regulatory factor for the phenological development of the cotton plants (Table 3). During the period of research an insignificant delay was observed in the culture flowering and development. Overall the cotton plants were well developed and matured in the period from 25 to 30 September.

Table 2. Agrochemical characterization of the organic farming field, 0-60 cm

| Depth, cm | pH <sub>(KCl)</sub> | Humus, %    | Mineral N (NH <sub>4</sub> +NO <sub>3</sub> ),<br>mg/kg soil | Available forms, mg/100 g     |                  |
|-----------|---------------------|-------------|--------------------------------------------------------------|-------------------------------|------------------|
|           |                     |             |                                                              | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O |
| 0 -10     | 5.5 - 5.8           | 2.05 - 2.20 | 15 - 18                                                      | 0.3 - 0.5                     | 32-38            |
| 10-20     | 5.5 - 5.8           | 2.10 - 2.40 | 20 - 25                                                      | 0.5 - 1.4                     | 25-35            |
| 20-40     | 5.8 - 6.5           | 1.95 - 2.25 | 23 - 25                                                      | 2.5 - 3.0                     | 19-28            |
| 40-60     | 6.0 - 6.5           | 1.54 - 1.70 | 20 - 22                                                      | 2.0 - 3.2                     | 15-26            |
| Average   | 5.5 - 6.5           | 1.54 - 2.40 | 15 - 25                                                      | 0.5 - 3.2                     | 15-38            |

Table 3. Phenological stages in cotton development, 2011-2013

| Stage       | Beginning | Mass  |
|-------------|-----------|-------|
| Germination | 07.05     | 10.05 |
| Bud forming | 25.06     | 01.07 |
| Flowering   | 20.07     | 25.07 |
| Maturity    | 10.09     | 25.09 |

Cotton yield, its structural elements and quality of production were significantly influenced by the year weather conditions, cultivar and foliar feeding. The weather conditions in the uncontrolled year had the biggest share of the total influence, most explicit in the September and total cotton yield (97.0 % and 92.7 %, respectively) and fibre yield (90.8 %).

The results showed that in organic production the new Bulgarian varieties realized very good seed-cotton yield. Without foliar treatment the total yield reached an average of 1328 kg/ha, ranging from 1279 for Boyana to 1372 kg/ha for variety Chirpan-539 (Table 4). With additional foliar feeding the total yield reached an average of 1456 kg/ha, from 1414 kg/ha for cultivar Natalia to 1503 kg/ha for Chirpan-539. As a result of the two-fold foliar feeding the yield increased with 7.3 to 14.6 % compared to the untreated, with highest value displayed by the variety Boyana.

In 2011 and 2012, under the unfavourable humidity conditions during the vegetation period, the varieties had a total seed-cotton yield without foliar feeding of 956 kg/ha for variety Natalia up to 1249 kg/ha for variety Darmi. The average total yield from the unfertilized area was 1011 kg/ha in 2011 up to 1803 kg/ha in 2013. Variety Chirpan-539 and Darmi manifested as more adaptable under organic conditions, but the differences between the tested varieties have not been proven. According to ANOVA cultivars have 28.95 % influence on yield, and foliar feeding - 22.23 %.

Table 4. Total yield of cotton varieties in organic production, average for 2011-2013

| Variety                    | 2011  | 2012  | 2013  | Average |                     |                        |
|----------------------------|-------|-------|-------|---------|---------------------|------------------------|
|                            |       |       |       | kg/ha   | % to<br>Chirpan-539 | % / without<br>feeding |
| 1. Without feeding         |       |       |       |         |                     |                        |
| Chirpan-539                | 1134  | 1096  | 1886  | 1372    | 100.0               | -                      |
| Natalia                    | 956   | 1230  | 1767  | 1318    | 96.1                | -                      |
| Helius                     | 992   | 1149  | 1864  | 1335    | 97.3                | -                      |
| Boyana                     | 965   | 1131  | 1740  | 1279    | 93.2                | -                      |
| Darmi                      | 1009  | 1249  | 1759  | 1339    | 97.6                | -                      |
| Average                    | 1011  | 1171  | 1803  | 1328    | -                   | -                      |
| 2. Two-fold foliar feeding |       |       |       |         |                     |                        |
| Chirpan-539                | 1420  | 1148  | 1941  | 1503    | 100.0               | 109.5                  |
| Natalia                    | 1059  | 1327  | 1855  | 1414    | 94.1                | 107.3                  |
| Helius                     | 1165  | 1213  | 1946  | 1441    | 95.9                | 107.9                  |
| Boyana                     | 1350  | 1194  | 1854  | 1466    | 97.5                | 114.6                  |
| Darmi                      | 1248  | 1258  | 1866  | 1457    | 96.9                | 108.8                  |
| Average                    | 1248  | 1228  | 1892  | 1456    | -                   |                        |
| Average 1+2                | 1130  | 1200  | 1848  | 1423    | -                   |                        |
| GD 5 %                     | 218.7 | 227.7 | 373.6 | 238     | 17.35               |                        |
| GD 1 %                     | 295.4 | 285.8 | 398.9 | 324     | 23.62               |                        |
| GD 0.1%                    | 363.3 | 378.4 | 436.7 | 383     | 27.92               |                        |

September seed-cotton yield best characterizes the variety earliness. The tested Bulgarian varieties are by rule with early ripening, but as a result of the higher temperatures in August, they had mass ripening at the beginning of September. Average for the three-year period early ripening was very good – the share of the September part of harvested cotton out of the total amount ranged from 76.1 % (Chirpan-539) to 89.53 % for Natalia.

Under the experiment conditions the cotton yield was not reduced by low productivity of the varieties and field poorly supplied in nutrients, rather than by the reduced number of plants per area unit in the inter-row earthing up, especially during the early development stages (2-3 leaf to bud formation). The weeds had unfavourable influence on growth and development of cotton plants.

The increase of cotton yield resulted from the higher number of bolls formed on one plant – 3.24 without feeding and 3.33 at two-fold foliar feeding and from the bigger boll weight – 3.77 g without feeding and 3.84 g at foliar fertilization. The structural analysis of the yield shows that the foliar feeding additionally stimulated the formation and growth of the cotton bolls. Under the specific field and foliar feeding conditions Natalia formed most bolls per plant – 3.48, and boll weight was biggest for Helius – 4.00 g (Table 5).

Under organic production plant height in maturity without feeding averaged 55.50 cm, from 50.82 cm in cultivar Chirpan-539 to 58.2 cm in Darmi, while at foliar fertilization growth was 7.4 % over untreated, the height of the plants was in the limits 56.3-61.2 cm. The application of ALGA 300 stimulated additionally the cotton growth processes (Table 6).

In 2011 without feeding were formed low cotton bushes – mean height in maturity was 43.4 cm, from 35.2 cm to 55.7 cm, and at foliar fertilization plant height was in the range 48.2-57.8 cm. In 2013 the height of plants in maturity without feeding was considerably larger - average 69.4 cm, and at foliar application was 71.4 cm, with a maximum value of 76.5 cm in Natalia. There was a tendency for the impact of foliar application on the cotton height.

The average height of first fruiting branch of Bulgarian tested varieties was 15.7 cm without fertilization, and at foliar treatment it increased to an average of 16.5 cm, with 5.1% more. Height of first fruiting branch below 13 cm are considered critical for mechanized cotton harvesting with combine. In harvest years there was no significant differences between varieties in terms of this indicator.

Table 5. Structural elements of seed-cotton yield at organic production, average for 2011-2013

| Variety                           | Ripe bolls per plant |                  |                     | Boll weight |                  |                     |
|-----------------------------------|----------------------|------------------|---------------------|-------------|------------------|---------------------|
|                                   | number               | % to Chirpan-539 | % / without feeding | g           | % to Chirpan-539 | % / without feeding |
| <b>1. Without feeding</b>         |                      |                  |                     |             |                  |                     |
| Chirpan-539                       | 3.22                 | 100.0            | -                   | 3.81        | 100.0            | -                   |
| Natalia                           | 3.43                 | 106.5            | -                   | 3.67        | 96.3             | -                   |
| Helius                            | 3.22                 | 100.0            | -                   | 3.87        | 101.6            | -                   |
| Boyana                            | 3.21                 | 99.7             | -                   | 3.74        | 98.2             | -                   |
| Darmi                             | 3.14                 | 97.5             | -                   | 3.75        | 98.4             | -                   |
| <b>Average</b>                    | <b>3.24</b>          | -                | -                   | <b>3.77</b> | -                | -                   |
| <b>2. Two-fold foliar feeding</b> |                      |                  |                     |             |                  |                     |
| Chirpan-539                       | 3.23                 | 100.0            | 100.3               | 3.98        | 100.0            | 104.5               |
| Natalia                           | 3.48                 | 107.7            | 101.5               | 3.82        | 96.0             | 104.1               |
| Helius                            | 3.42                 | 105.9            | 106.2               | 4.00        | 100.5            | 103.4               |
| Boyana                            | 3.25                 | 100.6            | 103.5               | 3.84        | 96.5             | 102.7               |
| Darmi                             | 3.27                 | 101.2            | 100.9               | 3.91        | 98.2             | 104.3               |
| <b>Average</b>                    | <b>3.33</b>          | -                | -                   | <b>3.91</b> | -                | -                   |
| <b>Average 1+2</b>                | <b>3.28</b>          | -                | -                   | <b>3.84</b> | -                | -                   |
| GD 5%                             | 0.11                 | 2.44             |                     | 0.09        | 2.14             |                     |
| GD 1%                             | 0.16                 | 3.55             |                     | 0.14        | 3.33             |                     |
| GD 0.1%                           | 0.23                 | 5.11             |                     | 0.17        | 4.05             |                     |

The weather conditions exerted a stronger influence on the lint percentage, fibre length and weight of 1000 seeds, than the fertilization. “ALGA 300” does not have a constant effect on the technological fibre properties. Under organic farming varieties realized fiber length from 23.5 mm at Boyana to 25.8 mm at Darmi. There was a tendency to increase the length of the fiber under the influence of foliar application. In the three-year period the 1000 seeds weight was in the range 99-108 g, but significant differences between the varieties and the influence of foliar fertilizer were not established. These properties are mainly genetically set and vary to a greater extent under the influence of the year conditions.

Table 6. Height of cotton plant in maturity at organic farming (cm), average for 2011-2013

| Variety                    | 2011 | 2012 | 2013 | Average |                     |                        |
|----------------------------|------|------|------|---------|---------------------|------------------------|
|                            |      |      |      | cm      | % to<br>Chirpan-539 | % / without<br>feeding |
| 1. Without feeding         |      |      |      |         |                     |                        |
| Chirpan-539                | 35.2 | 52.2 | 65.1 | 50.8    | 100.0               | -                      |
| Natalia                    | 38.3 | 53.2 | 75.2 | 55.6    | 109.4               | -                      |
| Helius                     | 41.6 | 55.4 | 67.9 | 55.0    | 108.1               | -                      |
| Boyana                     | 46.2 | 53.6 | 70.2 | 56.6    | 111.3               | -                      |
| Darmi                      | 55.7 | 54.2 | 64.8 | 58.2    | 114.6               | -                      |
| Average                    | 43.4 | 53.7 | 69.4 | 55.5    | -                   | -                      |
| 2. Two-fold foliar feeding |      |      |      |         |                     |                        |
| Chirpan-539                | 48.2 | 52.4 | 68.2 | 56.3    | 100.0               | 110.8                  |
| Natalia                    | 52.2 | 54.8 | 76.5 | 61.2    | 108.7               | 110.1                  |
| Helius                     | 54.5 | 56.1 | 70.2 | 60.3    | 107.1               | 109.7                  |
| Boyana                     | 51.4 | 54.8 | 72.4 | 59.5    | 105.7               | 105.1                  |
| Darmi                      | 57.8 | 55.0 | 69.8 | 60.9    | 108.2               | 104.6                  |
| Average                    | 52.8 | 54.6 | 71.4 | 59.6    | -                   | 107.4                  |
| Average 1+2                | 48.1 | 54.2 | 70.4 | 57.6    | -                   |                        |

In the bio-field with cotton was established 28 species of weeds. They can be conditionally divided into three groups: annual broadleaf, annual grasses and perennial weeds. Annual broadleaf weeds were the most common group as number and species composition. They were represented by the 17 species from which the highest density occur *Amaranthus retroflexus*, *Amaranthus blitoides*, *Amaranthus albus*, *Solanum nigrum*, *Polygonum aviculare*, *Xanthium strumarium*, *Chenopodium album*, *Portulaca oleracea*, *Hibiscus trionom*. In lower density were found *Datura stramonium*, *Abutilon theophrasti*, *Persicaria lapatifolia*, *Lactuca serriola*, *Chenopodium polyspermum*, *Galinsoga parviflora*, *Tribulus terrestris*, *Xanthium spinosum*. Annual grasses were represented by 6 species, mainly *Setaria viridis*, *Setaria glauca* and *Setaria verticillata*, and individual plants of *Echinochloa crus-galli*, *Echinochloa coarctata* and *Digitaria sanguinalis*. Perennial weeds were represented mainly by deciduous species *Cirsium arvense* and *Convolvulus arvensis*, and of cereal species were established patches of *Cynodon dactylon*, and single shoots from *Sorghum helepense* and *Elytrigia repens*. The larger number of weeds in cotton depends on the habitus and technology of cultivation. No significant differences in the degree of weed infestation between options.

#### 4. CONCLUSIONS

In organic farming the new Bulgarian varieties realized very good seed-cotton yield – average 1328 kg/ha. Varieties Chirpan-539, Boyana and Darmi were identified as a high-yielding and adaptable to biological conditions. At foliar feeding the total yield reached 1456 kg/ha, from 1414 kg/ha for cultivar Natalia to 1503 kg/ha for Chirpan-539.

The results from the application of liquid biologically active product “ALGA 300” showed that it exerts a favourable influence on the cotton growth and productivity. “ALGA 300” may be successfully applied to cotton as a two-fold foliar application in dose of 1l/ha. No negative effects were seen as a result of applying the foliar fertilizer in the appointed doses on the cotton plants.

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