Scientific Papers. Series B, Horticulture. Vol. LXIV, No. 1, 2020
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INVESTIGATION OF THE INFLUENCE OF THE HUMIC ACIDS ON THE CULTIVARS OF LONG-DAY ONION (*ALLIUM CEPA* L.), DRIP IRRIGATED IN THE CONDITION OF SOUTH BULGARIA

Todor BABRIKOV

Agricultural University - Plovdiv, 12 Mendeleev Blvd, 4000, Plovdiv, Bulgaria

Corresponding author email: babrikov@au-plovdiv.bg

Abstract

- During 2014-2015 the varieties of long-day onion (Allium cepa L.), sown in spring were examined at the experimental field of Department of Horticulture in Agricultural University, Plovdiv, Bulgaria. It has been estimated that the foliar treatment with liquid Humustim (23.4% humic acids) during the phase of luxuriant growth of vegetative organs of the onion plants contribute to overcome the negative factors of an environment. The treatments with Humustim gave the higher onion yield of 4% (by varieties Citation and Tamara) to 15.4% (Pueblo and Aspen).

Key words*: long-day onion (Allium cepa L.), humic acids, drip irrigation.*

INTRODUCTION

In the last decades it has been observed global use of increasing in the crop production, including a great number of vegetable crops. The tendency is more clearly expressed by the vegetables, because of the shorter growth period - annual, biennial or triennial. This feature of the intensive vegetable - growing development imposes annually application of the mineral fertilizers in order to achieve maximum biological potential and higher yield. Many times biological value and ecological purity of the crops by reaching the aims are in the background. The application of the chemical fertilizers has increased 10 times compared to 50-ies of the last century, and 17 times in the last ten years. In these cases the increase of the yields was only 3 times. In the most of the cases the excessive application of the mineral fertilizers like base dressing, foliar spray or fertigation leads to disturbance of the plant immunity. This is the cause for decreasing of the crop production and lowering of the vegetables quality. The high requirements very often have posed the questions about quality of the vegetable production, related with valuable nutrient constituents, possibilities for post-harvest handling and storage, good commercial appearance as well as good chemical - technological features of the crop production, intending for processing. The great consumption of the mineral fertilizers has initiated the problems with an application of different bio regulators in the crop production, especially in vegetable production under irrigation in the studies of (Daly and Stewart, 1999; Feibert Erik et al., 2002; Gaur and Adholeya, 2000).

The investigations of the plant bioprocesses activation have particularly attained a great actuality with participation of the soluble humic substances. The humic and fulvous acids from natural origin are the most active biochemical substances to which the plants respond best. Mechanism of the humic acids as bio regulators in the plants have not been enough studied although there are available literature about investigation carried out. This is still incomplete knowledge about the topics on the stimulating effect of humic substances on growth and production.

The investigation of new biological active substances requires detailed research on all the aspects of their action including on their effect on biological habits of plants and soil microflora (Gaur and Adholeya, 2000; Schloter et al., 2003; Hashimoto et al., 1999). Chen and Aviad (1990), Feibert Erik et al. (2002) and David et al. (1994) have reported promoted growth and nutrient uptake of plant due to the addition of humic substances. The plants take more mineral elements due to the better-

developed root systems. In addition, the stimulation of ion uptake in applications with humic materials led many investigators to propose that these materials affect membrane permeability (Zientara, 1983). It is related to the surface activity of humic substances resulting from the presence of both hydrophilic and hydrophobic sites (Chen and Schnitzer, 1978). Therefore, the humic substances may interact with the phospholipids structures of cell membranes and react as carriers of nutrients through them. On the other hand, the application of the very high dose of humic acid is less effective (Lee and Bartlett, 1976). According to several researches, results were changing due to the levels of treatment, growing media and origin of humic substances (Chen and Aviad, 1990; Hashimoto et al., 1999). Feibert Erik et al., 2002, had evaluated products which are nonconventional fertilizers, containing humic acids on the onion yield and quality. Agri-Plus supplied the highest total amount of humic acids (31.4 kg/ha), but this wasn't enough to get higher yield. The granular fertilizer, containing humic acid would be incapable of significantly increasing soil organic matter and consequently improve crop production. The obtained results, Kandil et al. (2013), showed that foliar spraying with humic acid resulted in highest growth characters, total and marketable yields, total culls and bulb weight as well as TSS %, dry matter and total weight loss percentage at storage period compared with the control treatment.

The aim of the present study was to do investigation on the effectiveness of humic acids (trade name Humustim) application on the annual long-day onion, drip irrigated, and estimate the influence on the biological behavior of the plants.

MATERIALS AND METHODS

During 2014-2015 the trials were conducted at the Experiment Station of the Department of Horticulture, Agricultural University - Plovdiv, Bulgaria to test the varieties of long-day onion (*Allium cepa* L.), sown in spring. The soil was light alluvial - meadow solonetz, silt loam with field capacity FC of 30%, and bulk density of 1.2 g/cm^3. A soil sample taken from the top foot showed a pH of 7.88, 1.56% organic matter, 43.38 mg N per 100 g, and 96.33 mg K per 100 g. The experimental plots were replicated four times and onion plants were irrigated by drip installation, maintaining optimal moisture of 70% to 100% of field capacity. The beds were 1m wide with experimental block area of 5 m^2 with two drip laterals. The soil samples were taken at the rooting depth. The object of investigation were the following cultivars of long-day onions and treatments: 1. Aspen (Enza Zaden); 2. Aspen + Humustim; 3. Tamara (Enza Zaden); 4.Tamara + Humustim; 5. Citation (Enza Zaden); 6. Citation + Humustim; 7. Twist (Enza Zaden); 8.Twist + Humustim; 9. Pueblo (Enza Zaden); 10. Pueblo + Humustim; 11. BGS 217 (Enza Zaden); 12. BGS 217 + Humustim; 13. BGS 196 (Enza Zaden); 14. BGS 196 + Humustim.

The sowing was done during February, 15th and March, 20th with precise sowing machine in the scheme of 70+30+30+30/3 cm at sowing rate of 1 g/m^2. Drip irrigation system with emitters spaced 10 cm for vegetative irrigation applications was used. The single treatment with liquid humic acids Humustim (23.4% humic acids) during the luxuriant growth of vegetative organs of the onion was done with a solution of 0.25% in a dose of 4 l/ha, according the producer. The controls were untreated variants with Humustim. For the investigation of vegetative behavior and onion production were estimated following indices:

1. Dynamics of the plant growth - height (cm), fresh matter (g); 2. Beginning of the bulb formation; 3. Crop production - total yield (kg/ha); 4. Dry matter and sugar content (%). The results were calculated using Fisher's method for the probability of differences.

RESULTS AND DISCUSSIONS

The most important meteorological components for the tested plants in Plovdiv are graphically present in Figures 1 and 2 for experimental period 2014-2015. The favorable climate condition in the spring of 2014 permitted to be the sowing in the second part of February, 20th. The optimal positive air temperatures (from +12^{0}C to +24^{0}C) continued to the end of May, and together with uniform rainfall distribution in April and May allowed the fast development of the investigated cultivars (Figure1). The soil moisture of the top

layer flucktuated continously in accordance to rainfall and irrigation application during 2014. Significant differences among the onion cultivars, sowed at the same date by treatment with Humustim were observed.

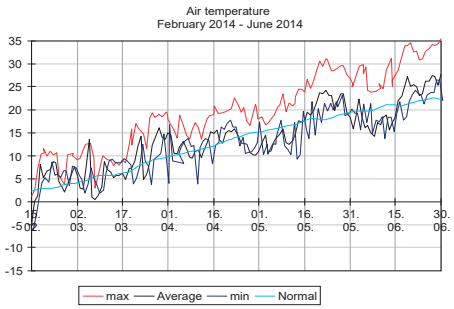

Figure 1. Air temperature in the period of February-June, 2014

The winter of 2015 (Figure2) prolonged to the end of March, when the sowing was on 19th. The rate of development of the onion plants retarded in spite of the a sudden change in the air temperature above +30°C in May and heavy rainfall in the end of April.

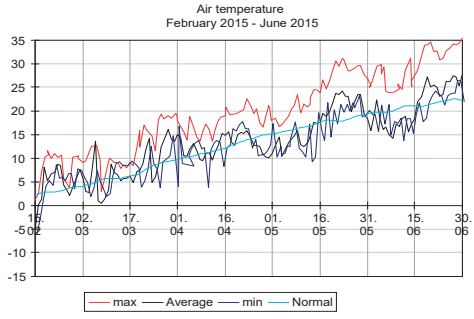

Figure 2. Air temperature in the period of February-June, 2015

In Table 1 it can be seen the dynamics in fresh matter increase for different varieties onions per plant in g during 2014.

The faster growing rate was of the cv. Citation. The onion plants of cv. Citation accumulated the greatest fresh matter of 239 g, while the treatment with Humustim increased the accumulated fresh matter to 250 g. Comparatively high fresh matter was accumulated by cv. Tamara and cv. BGS-196 (Table 1).

Table1. Dynamics in the fresh matter increase per onion plant in g at sowing date February, 2014

Variety	15.04	30.04	15.05	15.06	30.06	15.07
Aspen	10	22	35	90	122	131
Aspen +H	10	22	37	102	140	155
Tamara	11	27	70	184	226	228
Tamara+H	11	27	87	212	232	238
Citation	11	30	85	206	233	239
Citation+H	11	30	108	229	246	250
Twist	11	24	38	144	174	181
Twist+H	11	24	52	161	194	202
Pueblo	11	24	37	106	138	148
Pueblo+H	11	24	44	129	162	175
BGS217	12	25	68	170	203	204
BGS217+H	12	25	68	181	213	216
BGS196	10	27	59	176	216	216
BGS196+H	10	27	76	193	224	228

The treatment with Humustim increased the fresh matter of these cultivars with 4.2% and 5.3%, respectively. Cv. Twist showed slow vegetative growth, compared with other investigated cultivars in 2014. Aspen and Pueblo had the smallest yield of fresh matter. By harvesting in the end of July, 2014 these cultivars had the lowest yield of bulbs in comparison with others. The treatment with Humustim gave the highest yield of bulbs for Citation and Tamara (Table 2).

Table 2. Yield kg/ha from different varieties of long-day onion at sowing date February, 2014

Variety	Mean bulb weight g	Bulb height cm	Bulb diam. cm	Number of dry layers	Dry matter %	Sugars %	Total yield kg/ha
Aspen	107	4.6	6.6	3-4	12.5	15.8	18 270
Aspen +Humustim	114	4.7	6.6	3-4	12.5	15.8	21 000
Tamara	198	6.9	7.8	3-4	6.6	5.82	47 910
Tamara +Humustim	204	6.9	7.8	3-4	6.6	5.82	50 430
Citation	232	7.7	8.8	3	6.3	5.41	56 180
Citation +Humustim	238	7.7	8.8	3	6.3	5.41	59 140
Twist	143	6.1	7.2	3-4	8.4	7.41	26 710
Twist +Humustim	145	6.1	7.2	3-4	8.4	7.41	29 680
Pueblo	135	5.7	7.1	3-4	11.8	15.4	19 780
Pueblo +Humustim	138	6.0	7.1	3-4	11.8	15.4	23 000
BGS217	160	6.5	7.3	3-4	7.2	6.22	34 410
BGS217 +Humustim	165	6.5	7.3	3-4	7.2	6.22	37 000
BGS196	189	8.0	7.5	3-4	7.4	6.46	40 250
BGS196 +Humustim	194	8.0	7.5	3-4	7.4	6.46	42 820

In Table 2 were shown the yield of cultivars in 2014, as following: 59 140 kg/ha for Citation + Humustim, 50 430 kg/ha for Tamara + Humustim, and 42 820 kg/ha for BGS 196. The lower content of dry matter and sugar – 6.3% and 6.6% of the onion bulbs had Citation and Tamara, respectively. Cultivars Pueblo and Aspen are with white colored onion bulbs, suitable for processing, but they could not accumulate high content of dry matter and sugar during the first year, characterized with heavy rainfall. The yields of Pueblo and Aspen were 23 000 kg/ha and 21 000 kg/ha, respectively. The treatment with Humustim for these variants increased the yield of 14.9% and 15.4%, than with untreated.

Table 3. Dynamics in the fresh matter increase per onion plant in g at sowing date March, 2015

Variety	15.04	30.04	15.05	15.06	30.06	15.07
Aspen	6	14	35	90	122	127
Aspen+H	6	14	37	107	140	145
Tamara	9	15	68	176	208	210
Tamara+H	9	15	68	183	211	217
Citation	9	15	76	190	218	221
Citation+H	9	15	86	197	223	227
Twist	9	15	38	124	153	162
Twist+H	9	15	47	145	175	182
Pueblo	7	15	37	97	129	139
Pueblo+H	7	15	41	125	155	163
BGS217	9	15	54	148	181	189
BGS217+H	9	15	54	158	189	196
BGS196	9	15	59	162	194	200
BGS196+H	9	15	59	171	200	206

During the next 2015 the beginning of the intensive grow of the over ground parts started in the middle of May, when was the treatment with Humustim. The extreme high air temperature > + 33°C in the end of May and lower relative air humidity in June (Figure 2) impeded the growth of the investigated onion cultivars during the second year.

The bigger fresh matter had cv. Citation, treated with Humustim, shown in Table 3 (227 g per plant), than the untreated of 221 g. Treated cv. Tamara and BGS 196 had influence on yield too.

In Table 4 are shown the yield of all investigated cultivars of long-day onion during 2015. The best cultivar was Citation of 49 470 kg/ha. The treatment with Humustim increased the yield of 3% to 51 000 kg/ha. The next good cultivars of high yield were Tamara - 42 270 kg/ha and BGS 196 - 32 000 kg/ha. Aspen turned out more sensitive to the factors of the environment.

Table 4. Yield kg/ha from different varieties of long-day onion at sowing date March, 2015

Variety	Mean Bulb weight g	Bulb height cm	Bulb diameter cm	Number of dry layers	Dry matter %	Sugars %	Yield kg/ha
Aspen	96	6.3	6.7	3-4	18.5	23.6	14 790
Aspen +Humustim	97	6.3	6.7	3-4	18.5	23.6	17 000
Tamara	158	6.9	7.3	3-4	7.4	6.46	40 580
Tamara +Humustim	160	6.9	7.3	3-4	7.4	6.46	42 270
Citation	192	7.7	7.5	3	7.2	6.22	49 470
Citation +Humustim	198	7.7	7.5	3	7.2	6.22	51 000
Twist	122	6.1	6.6	3-4	8.4	7.41	20 160
Twist +Humustim	125	6.1	6.6	3-4	8.4	7.41	22 400
Pueblo	107	5.2	5.0	3-4	17.8	16.4	16 340
Pueblo +Humustim	110	5.2	5.0	3-4	17.8	16.4	19 000
BGS217	140	6.5	7.1	3-4	8.4	7.41	29 100
BGS217 +Humustim	144	6.5	7.1	3-4	8.4	7.41	30 000
BGS196	150	8.0	7.2	3-4	8.4	7.41	31 040
BGS196 +Humustim	152	8.0	7.2	3-4	8.4	7.41	32 000

CONCLUSIONS

The treatment with humic acids - Humustim on varieties of long-day onion (*Allium cepa* L.) in the phase of development of the vegetative parts contributed to overcome more quickly the negative factors of the environment (extremely high air temperatures and low relative humidity of air, typically for this region). The onion yield of treated variants with Humustim was bigger of 4% (cv. Citation and cv. Tamara) to 15.4% (cv. Pueblo and cv. Aspen). Citation and Tamara, treated with Humustim had yield of 59 140 kg/ha and 50 430 kg/ha during 2014, which was the highest of all investigated long-day onions. These cultivars are with lowest contents of dry matter. That is confirmation of the studies of Kandil et al. (2013), who estimated relationship between increasing the yield with 1tonne and decreasing of onion dry matter to 1% using humic acid.

The treatment with humic acid by foliar application on varieties of long-day onion (*Allium cepa* L.) didn't influence on the content of sugar, but increase the yield under condition of South Bulgaria.

REFERENCES

Chen, Y. and Schnitzer, M. (1978). The Surface Tension of Aqueous Solutions of Soil Humicsubstances. *Soil Sci*., 125, 7-15.

Chen, Y. and Aviad, T. (1990). Effect of Humic Substances on Plant Growth. In: Humic Substances in Soil and Crop Sciences: Selected Reading, MacCarthy, P., C.E. Clapp, R.L. Malcolm and P.R. Bloom (Eds). Soil Science Society America, Madison, WI., pp: 161-187.

Daly, M. J. & Stewart, D.P.C. (1999). Influence of Effective Microorganism (EM) on Vegetable Production and Carbon Mineralization – a Preliminary Investigation, J. Sust. Agricult, vol.14: 2-3, 15-25.

David, P.P., Nelson, P.V. and Sanders, D.C. (1994). A Humic Acid Improves Growth of Tomato Seedling in Solution Culture. J. Plant Nutr., 17: 173-184.

Feibert Erik B.G., Shock, Clint C. and Saunders, Lamont D. (2002). Evaluation of Humic Acid and Nonconventional Fertilizer Additives for Onion Production, Annual Reports Oregon State University, Special Report 1029, 41-51.

Gaur, A, Adholeya, A. (2000). Response of Tree Vegetable Crops to VAM Fungal Inoculation in Nutrient Deficient Soils Amended with Organic Matter, Symbiosis, vol. 29: 19-31.

Hashimoto, Y., Tahashi,T., Tsuchiya, K., Yokoyama, K. (1999). Effect of Application of Urea-condensation Polymer on Rhizosphere Microbial Flora in Fields with Continuous Cropping of Welsh Onion, Soil Microorg., vol. 53: 3-11.

Kandil A. A., Sharief, A. E., Fatalla, F. H. (2013).Onion Yield as Affected by Foliar Application with Amino and Humic Acids under Nitrogen Fertilizer Levels, E. Scie. J. Crop Prod.vol. 2, no. 2, 62-72.

Lee Y.S. and Bartlett, R. J. (1976). Stimulation by Humic Substances, Soil Science Society of America Journal, 40, 876-879.

Schloter, M., Dilly, O., Munch, J. C. (2003). Indicators for Evaluating the Soil Quality, Agriculture, Ecosystems and Environment, vol. 98: 255-262.

Zientara, M. (1983). Effect of Sodium Humate on Membrane Potential in Internodal Cells of Nitellopsis obtuse. Acta Societatis Botanicorum Poloniae, 52: 271-277.