

[translator's notes are italicised and in brackets]

Assessment of the suitability of Total Hummus product as a stimulator of growth and development of vegetable plants

Product delivered intact, with sample taking report no. 1 dated 13.01.15, by sample-taker Ada Lewandowska (Regional Chemical and Agricultural Station in Gorzów Wlkp.).

Purpose:

The purpose of the experiment was to determine the impact of Total Humus product on the growth, yielding and quality of lettuce

METHODOLOGY:

Site: Experimental Field of the Research Institute of Horticulture in Skierniewice
Cultivation type: soil cultivation in a non-heated tunnel
Plant: crisphead lettuce of Elenas variety
Cultivation period: 25.03-25.05.2015 (62 days)

Soil fertility (without pre-vegetation fertilisation): N-8, P-355, K-141, Mg-74, Ca-953 (mg/dm³) pH-7.3, salinity 0.11 g NaCl/dm³

Pre-vegetation fertilisation (per 1 ha): 330 kg of ammonium nitrate
250 kg of potassium sulphate
160 kg of magnesium sulphate

Experiment design:

Batches: A- dose of Total Humus product a1 - 0.2 %
Total Humus a2- 0.4% Total
Humus a3 - 0.8% Total Humus a4 -
control (no treatment)

B - method of use

b1 - spray application on plants, 3x (R)
b2 spray application of plants and soil
(R+G)

plant spacing 30 x 30 cm, plant density 11 pcs/m², plot size 4.5 m²,
number of repetitions - 4

Agrotechnical schedule

Sowing the seeds (into VP 96 plug trays): **25.02.2015**

Planting **25.03.2015**

treatment

*method b1 spray of the transplant (R) 1st leaf stage -5.03
7 days prior to planting - 19.03 7 days after planting -1.04*

method b2: spray of the transplant, soil and plants (R+a+U)

*spray of the transplant 1st leaf stage 5.03
spray of soil prior to planting - 23.04
spray of plants 7 days after planting 1.04*

harvest

25.05.2015-

Measurements and analyses:

- average weight of the entire plant (gross weight) and inner head - (net weight), structure (percentage of weight fractions in the total number of heads in the batch), inner head diameter (cm), tightness (scale 1-5°), total yield
- nitrogen N-NO₃⁻ and nitrates -NO₃⁻ contents in leaves (mg /kg of fresh weight) and dry weight

Statistical calculations using the analysis of variance at statistical significance NIR $\alpha=0.05$ for a two-factor, dependent system

Skordyle



RESULTS

Crisphead lettuce of Elenas variety was planted in spring, in soil, under a non-heated tunnel. This variety is universal as regards photoperiodic reactions and efficiency. The Elenas variety demonstrated high head curling rate, i.e. just after 3 weeks the leaves start to curl and the head is formed. Within 6 weeks the heads reach the weight of approx. 400 g (the most popular in food chains, such as MacDonald's). Extending the cultivation in optimum weather conditions results in head weight exceeding 800 g.

Early cultivation of crisphead lettuce, both in field and in non-heated tunnels is, however, related to a risk of periodic inhibition of growth in the juvenile period (prior to head curling) and/or blooming in the period of longer days and higher temperatures. This year, the average temperature in April was at the lower limit allowed for lettuce, i.e. 9°C but in the 1st ten days of the month cooler weather occurred with daily average temperature <6 °C. Such temperature pattern, with relatively good sun exposure resulted in slowed growth in size and number of leaves. At average temperature for the 2nd and 3rd decade of the month of approx. 12 °C, normal growth started at the end of April and the heads reached the appearance in line with market requirements for crisphead lettuce.

The conducted experiment showed that in soil cultivation in tunnels, Total Hummus had a favourable impact on the growth, yield and quality parameters of crisphead lettuce. The product was applied both on leaves and in combination, i.e. by being sprayed on the plant and soil.

Spray on plants:

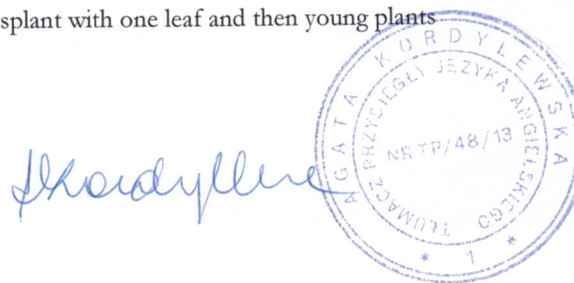
The plants were sprayed twice before planting and once after planting, using Total Humus solutions at 0.2%, 0.4%, 0.8%. After 9 weeks of growing it turned out that Total Humus at 0.4 % and 0.8 % resulted in considerable increase of total plant weight (gross weight) as well as inner head comprising commercial material (table 1). Only in the case of the lowest concentration of 0.2 % the yield did not differ materially from that in the control batch. The best effect was obtained when using solution at 0.4 %. The leaf-only application of Total Humus did not have an impact on the waste volume (leaves removed when preparing the heads for sale). In all batches waste accounted for approx. 10 % (table 1). In the highest yield batches (Total Humus at 0.4% and 0.8%) all inner heads reached the commercial weight, and in over 70% of cases the weight exceeded 400 g. In these batches the heads were also the largest (diameter by 1.3-2.3 cm larger than in other batches) and tighter. This means that the harvest period (earlier harvest) is possible without compromising quality (table 2). In batches where the transplants were treated with Total Humus at 0.4% and 0.8% the highest gross photosynthesis of the crop was recorded, which resulted both from the higher share in dry weight and higher total yield than in other batches. If Total Humus was sprayed on plants only, the gross photosynthetic efficiency was increased from 22% to 64 % (table 3).

The maximum allowed level of nitrates has not been exceeded (2000 [2500] mg NO₃/kg of dry weight). After spraying with solution at 0.4 % and 0.8 % the content of nitrates was lower than in the control batch (table 3).

Taking into account the weight of heads, volume and structure of total yield, the photosynthetic efficiency of crop and nitrates level, the foliar spray with 0.4 % solution of Total Humus was regarded the most efficient (pict. 1-4).

Spray treatment of plant and soil

The second method of application of Total Humus in the cultivation of lettuce consisted in triple treatment in different growth stages. The product was applied on juvenile plant leaves (transplant with one leaf and then young plants



prior to head curling) and in the meantime soil was sprayed to prepare substrate (2 days prior to planting) and to allow root to adjust in soil with highest humus compounds content. After the end of cultivation, it turned out that in all batches treated with Total Humus the plants yielded much better crops than the control batch (table 1). The largest gross (whole plant) and net (head processed for sale) head size was obtained in batches treated with the lowest (0.2%) and the highest (0.8%) concentration of the product (table 1). Despite the fact that the highest total yield was recorded from lettuce treated with Total Humus at 0.8%, due to the increased share of dry weight, the highest gross photosynthesis efficiency of crop was demonstrated after using Total Humus at 0.4% (table 3). Higher gross photosynthetic efficiency of crop means higher crop-yielding potential of plants treated with Total Humus than plants nourished traditionally (table 3). If plants and soil were sprayed, the gross photosynthetic efficiency against control batch was from 44% to 77%. The highest gross photosynthetic efficiency value was recorded when using Total Humus at 0.4 %.

In batches where Total Humus was used for transplant and spraying soil and then soil, heads of weight <300 g were recorded only in batch sprayed with solution at 0.2% and they accounted for only 6.2 %, compared to 56.7 % in the control batch. Both in this batch and when using the highest concentration (0.8%) over 70% heads weighed >400 g. The most uniform structure was demonstrated by yield obtained after application of Total Humus at 0.4 % - share of the "300-400g class" ("food class") and ">400 g class" was similar.

When using Total Humus on soil and plant the allowed nitrate limit has not been exceeded. In each batch treated with Total Humus this level was lower than in the control batch (table 3).

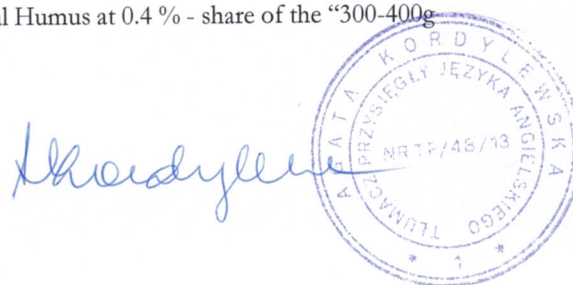
Taking into account the weight of heads, volume and structure of total yield and nitrates level, using Total Humus on plant and soil at 0.8% has been considered to be the most efficient.

The comparison of the two methods of application of Total Humus in the cultivation of lettuce in a non-heated tunnel showed that lettuce responds best to medium concentration of the foliar-applied product, and when spraying soil instead of plant prior to planting, the best effect are gained both at the lowest (0.2%) and highest (0.8%) concentration of the product.

CONCLUSIONS:

1. Except for the foliar application of low concentration solution (0.2%), Total Humus had a favourable impact on plants, regardless of concentration and application method.
2. Foliar application of higher concentration (0.4% and 0.8%) resulted in improved yield and commercial quality of lettuce head, yield structure, as well as increased photosynthetic activity and reduction in foliar nitrates content.
3. When sprayed on plants and soil, Total Humus had a positive impact on all yield parameters and photosynthetic efficiency, regardless of concentration.
4. When sprayed on plants and soil at 0.2% and 0.8%, Total Humus had the best impact on the head weight and size.
5. When sprayed on plants and soil at 0.4 % and 0.8%, Total Humus had the best impact on the yield structure and photosynthetic efficiency of crop.

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DEPARTMENT HEAD

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Kordylewski



Table 1 Impact of concentration and application method of Total Humus on lettuce yielding

concentration /	Average weight (g)				% of head weight wastage			Total yield kg/ha			crop residue weight gross yield - net yield (kg/ha)	
	of whole plant (gross)		of inner head (net)		R	R+g+U	R	R+g+U	R	R+g+U	R	R+g+U
	R	R+g+U	R	R+g+U								
Method of application												
Total Humus 0.2%	422 c	519 a	378 c	466 a	10.4	10.2	4642	5709	484	583		
Total Humus 0.4 %	588 a	487 b	535 a	425 b	10.0	12.7	6468	5357	583	682		
Total Humus 0.8 %	535 b	548 a	476 b	500 a	11.0	8.8	5885	6028	649	528		
Control	415 c	415 c	362 c	362 c	12.6	12.6	4550	4550	580	580		
NIR a = 0.05	for A x B 94,24				for A x B 79,20							

Table 2 Impact of concentration and application method of Total Humus on lettuce yield structure

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concentration	Method of application	sick		non-marketable		marketable		marketable head diameter (cm)			tightness of marketable head (scale 1-5) ¹		
		R	R+g+U	R	R+g+U	R	R+g+U	R	R+g+U	R	R+g+U		
Total Humus 0.2%		0	0	12.5	6.2	66.7	20.8	20.8	73.0	15.7	16.0	4.2	4.8
Total Humus 0.4 %		0	0	0	0	12.5	56.2	87.5	43.8	17.0	17.0	5.0	5.0
Total Humus 0.8 %		0	0	8.3	0	20.8	20.8	70.9	79.2	17.0	16.5	5.0	4.8
Control		0	0	56.2	56.2	6.3	6.3	37.5	37.5	14.7	14.7	4.1	4.1

1/ Tightness scale (palpation method): 1 - rosette, 2 - elevated, thick rosette, 3- half-open head, 4- closed head, soft, 5 closed head (5+ closed head, very tight)

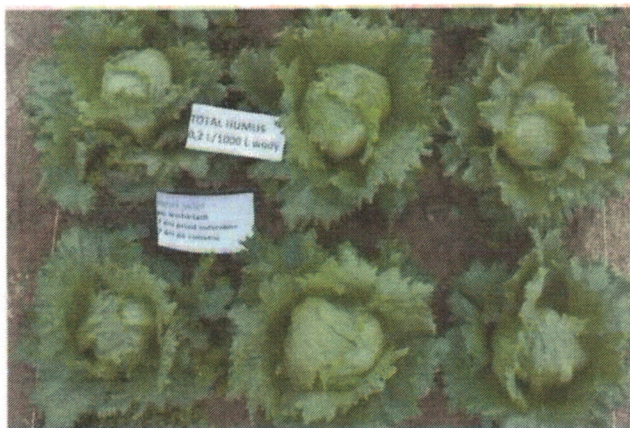


Table 3 Impact of concentration and method of application of Total Humus on the accumulation of nitrates in heads and gross photosynthetic production in the cultivation period

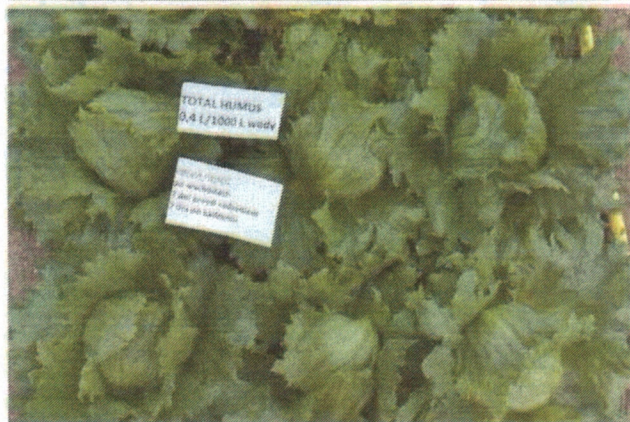
concentration	Method of application	Nitrate content		Dry weight		Gross photosynthetic production		Nitrogen deposit from crop residue	
		mg NO ₃ '/kg of fresh weight		%		kg of dry weight/ha		kg N-NO ₃ '/ha	
		R	R+g+U	R	R+g+U	R	R+g+U	R	R+g+U
Total Humus 0.2%		1634	1144	4.27	3.98	198	227	0.19	0.15
Total Humus 0.4 %		948	1200	4.13	5.34	267	286	0.13	0.20
Total Humus 0.8 %		1146	925	4.49	4.29	264	259	0.17	0.11
Control		1215	1215	3.57	3.57	162	162	0.16	0.16



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Pict. 1 Total Humus 0.2% - method 1 (on plant)



Pict. 2 Total Humus 0.4% - method 1 (on plant)



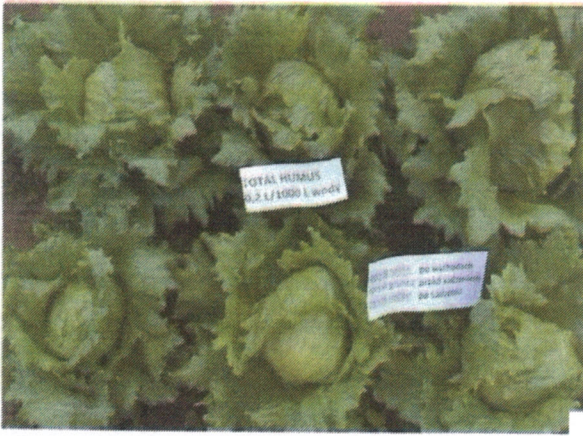
Pict. 3 Total Humus 0.8% method 1 (on plant)



Pict. 4 Control batch

Agata Kordylewska





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I, Agata Kordylewska, certified translator of the English language entered in the register of certified translators kept by the Minister of Justice under entry number TP/48/13, do hereby certify the above to be a true and faithful translation of the document presented to me in the Polish language.

Translation no. 131/2017

Poznań, 19 December 2017

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