

YIELDING AND QUALITY OF LEAF LETTUCE AND ENDIVE IN OPEN FIELD CULTIVATION WITH APPLICATION OF GROWTH BIOSTIMULATORS

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Introduction

Leaf lettuce (*Lactuca sativa* L. var. *crispa* L.) and botanical varieties of endive: curled endive (*Cichorium endivia* L. var. *crispum* Hegi) and escarole (*Cichorium endivia* L. var. *latifolium* Hegi) are vegetables which importance gradually increases in Poland. Their growing demands and vegetation period length is similar to butterhead lettuce, which is very popular in our country. These species, characterized with short growing period and have a tendency toward accumulation of nitrates. There were many studies about influence of nitrogen fertilization on yielding and quality of leafy vegetables (Adamczewska-Sowińska, 2010; Chohura, 2009; Kowalska, 2006). As an alternative to traditional solid fertilizers new research point using liquid fertilizers or foliar feeds, which contain added inorganic and/or biological compounds (for example seaweed extracts). They provide a wide range of beneficial effects such as improved yield, elevated resistance to biotic and abiotic stress and enhanced postharvest shelf-life of products (Edmeades, 2002; Khan, 2009; Matysiak, 2009; Verkleij, 1992). The aim of presented experiments was to assess the effect of biofertilisers on yield and biological value of leaf lettuce and endive. It was compared two biofertilisers available on Polish market: Goëmar Goteo – an organic-mineral fertilizer which contains algae extract (*Ascophyllum nodosum*) with addition of phosphorus (>12% P₂O₅) and potassium (>5% K₂O) and Aminoplant – an organic fertilizer contains aminoacids and short peptide chains.

Materials and methods

A three-factorial field experiment involving biostimulators: Goëmar Goteo and Aminoplant was conducted on cultivars of leaf lettuce: Kitare (green-leaves) and Versai (violet-leaves) and cultivars of endive: Excel (escarole) and Cigal (curled endive) at the Experimental Field of the Department of Vegetables and Medicinal Plants in 2009. The experiments were repeated three times for leaf lettuce: 1- from the beginning of April to the beginning of June, 2- from the beginning of May to the mid-July, 3- from the end of June to the mid-September and two times for endive: 1- from the beginning of April to the end of June, 2 – from the end of June to the end of September. Plantlets were produced in multipots filled with a pit substrate and were planted into the field at 35×35 cm spacing in three replications of 12 plants in each. The following treatments with biostimulators were used: (1) – watering with 0,1% water solution of Goëmar Goteo two week after sowing and one week before planting and (2) – spraying with 0,2% water solution of Aminoplant, one week and three weeks after planting. Water was applied to the soil where group of control (untreated plants) were grown. After harvest, total yield, marketable yield and weight of rosettes were determined. Dry weight was assayed at 104°C, nitrates content was measured using spectrophotometric method, with FIAstar 5000 device (Foss Tecator AB Sweden 1990) and total sugars with Luff-Schoorl method (Charłampowicz, 1996). Statistical analysis was performed with the use of the multivariate analysis of variance. The differences between the source of variance were examined by the Fischer-Snedecor test at $\alpha=0,05$. A determined comparison of the mean values was made by using the Tukey multiple range test.



Acknowledgments

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Results

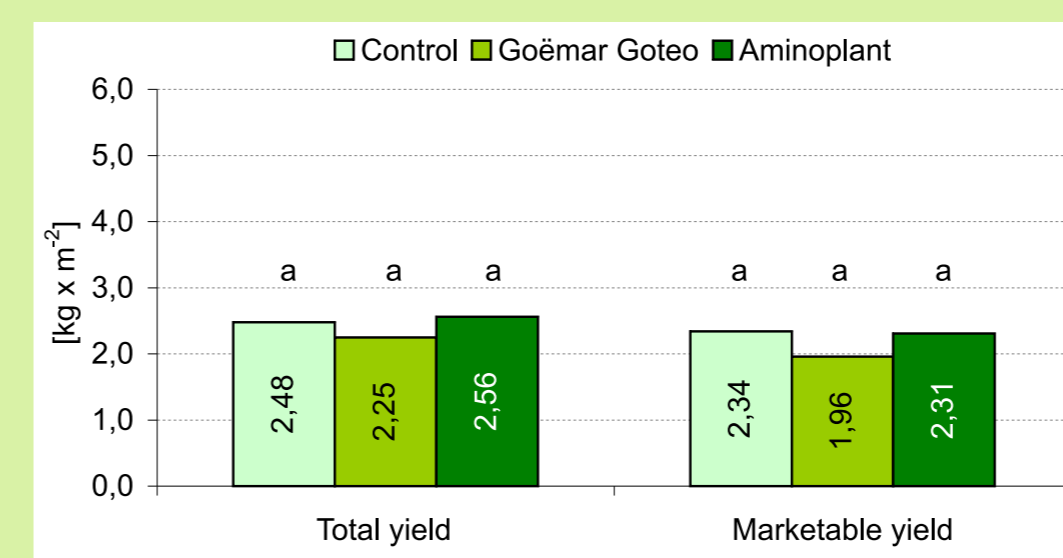


Figure 1. Total and marketable yield of leaf lettuce [kgx m⁻²]

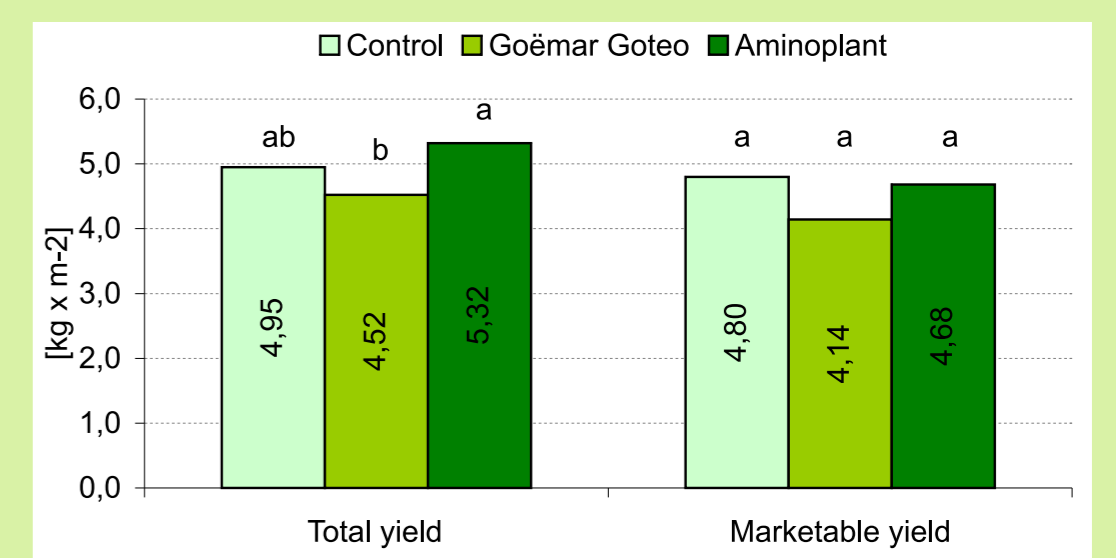


Figure 2. Total and marketable yield of endive [kgx m⁻²]

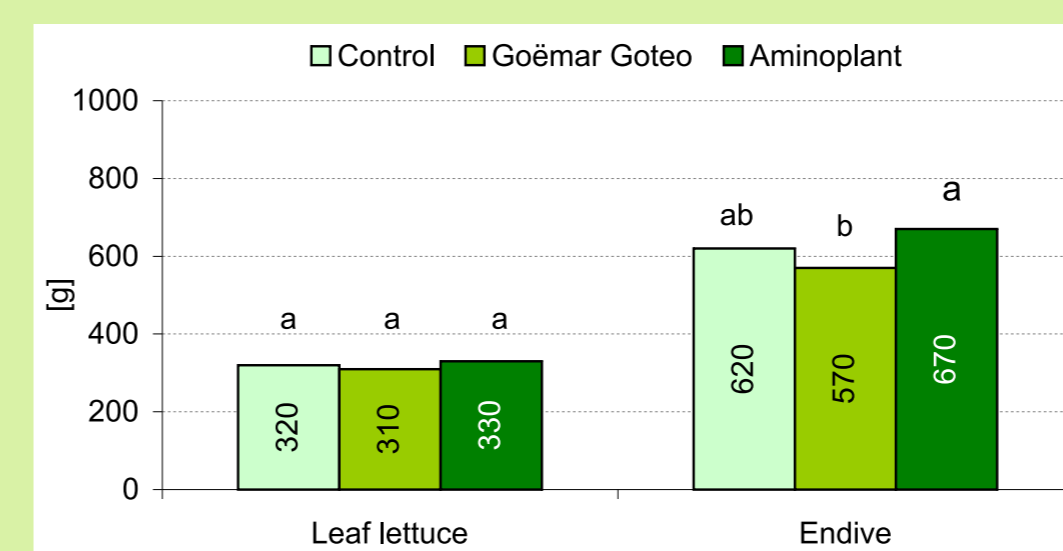


Figure 3. Mean weight of leaf lettuce and endive rosettes [g]



Table 1. Dry weight [%], nitrates [mg×100g⁻¹ f.w.] and total sugars content [g×100g⁻¹ f.w.] in leaves of leaf lettuce

| Term | Cultivar | Dry weight [%] | | | Mean for cultivar | NO ₃ ⁻ [mg×100g ⁻¹ f.w.] | | | Mean for cultivar | Total sugars [g×100g ⁻¹ f.w.] | | | Mean for cultivar | |
|-------------------------------------|----------|----------------|--------------|------------|-------------------|---|--------------|------------|-------------------|--|--------------|------------|-------------------|------|
| | | Control | Goëmar Goteo | Aminoplant | | Control | Goëmar Goteo | Aminoplant | | Control | Goëmar Goteo | Aminoplant | | |
| 1 | Kitare | 6,14 | 8,17 | 6,32 | | 74,24 | 115,52 | 99,93 | | 0,77 | 0,52 | 0,82 | | |
| | Versai | 5,71 | 6,22 | 6,65 | | 161,74 | 138,34 | 122,48 | | 0,38 | 0,52 | 0,47 | | |
| Mean for term | | 6,53a | | | | 118,71a | | | | 0,58c | | | | |
| 2 | Kitare | 4,95 | 5,69 | 5,03 | | 11,07 | 12,90 | 6,35 | | 0,96 | 0,61 | 0,65 | | |
| | Versai | 5,81 | 6,03 | 5,32 | | 44,77 | 22,43 | 20,62 | | 0,57 | 0,76 | 0,62 | | |
| Mean for term | | 5,47b | | | | 19,69c | | | | 0,69b | | | | |
| 3 | Kitare | 4,77 | 4,87 | 4,69 | 5,63a | 32,54 | 66,31 | 50,27 | 52,13b | 0,89 | 0,67 | 0,99 | 0,76a | |
| | Versai | 4,75 | 4,40 | 4,71 | 5,40a | 99,37 | 82,26 | 49,88 | 82,43a | 0,67 | 0,87 | 0,84 | 0,63b | |
| Mean for term | | 4,70c | | | | 63,44b | | | | 0,82a | | | | |
| Mean for combination | | 5,35b | 5,90a | 5,45ab | | 70,62ab | 72,96a | 58,26b | | 0,71a | 0,66a | 0,73a | | |
| LSD _{0.05} (A) term | | | | | 0,47 | | | | | 13,45 | | | | 0,11 |
| LSD _{0.05} (B) combination | | | | | 0,47 | | | | | 13,45 | | | | n.s. |
| LSD _{0.05} (C) cultivar | | | | | n.s. | | | | | 9,09 | | | | 0,07 |

Table 2. Dry weight [%], nitrates [mg×100g⁻¹ f.w.] and total sugars content [g×100g⁻¹ f.w.] in leaves of endive

| Term | Cultivar | Dry weight [%] | | | Mean for cultivar | NO ₃ ⁻ [mg×100g ⁻¹ f.w.] | | | Mean for cultivar | Total sugars [g×100g ⁻¹ f.w.] | | | Mean for cultivar | |
|-------------------------------------|----------|----------------|--------------|------------|-------------------|---|--------------|------------|-------------------|--|--------------|------------|-------------------|------|
| | | Control | Goëmar Goteo | Aminoplant | | Control | Goëmar Goteo | Aminoplant | | Control | Goëmar Goteo | Aminoplant | | |
| 1 | Excel | 5,45 | 6,33 | 5,69 | | 14,50 | 10,81 | 21,00 | | 0,95 | 1,22 | 1,17 | | |
| | Cigal | 5,82 | 6,04 | 5,68 | | 12,06 | 9,32 | 16,78 | | 1,25 | 1,20 | 1,23 | | |
| Mean for term | | 5,83b | | | | 14,08b | | | | 1,17b | | | | |
| 2 | Excel | 7,41 | 5,85 | 7,02 | 6,29 a | 58,27 | 49,92 | 18,17 | 28,78 a | 1,26 | 1,45 | 1,85 | 1,32a | |
| | Cigal | 5,80 | 5,46 | 5,99 | 5,80 b | 35,67 | 22,98 | 17,19 | 19,00 b | 1,43 | 0,69 | 1,90 | 1,28a | |
| Mean for term | | 6,25a | | | | 33,70a | | | | 1,43a | | | | |
| Mean for combination | | 6,12a | 5,92a | 6,10a | | 30,13a | 23,26b | 18,29b | | 1,22b | 1,14b | 1,54a | | |
| LSD _{0.05} (A) term | | | | | 0,17 | | | | | 4,06 | | | | 0,06 |
| LSD _{0.05} (B) combination | | | | | n.s. | | | | | 6,01 | | | | 0,08 |
| LSD _{0.05} (C) cultivar | | | | | 0,17 | | | | | 4,06 | | | | n.s. |

Conclusions

- Goëmar Goteo and Aminoplant application gave different results in leaf lettuce and endive growing under the field conditions.
- Biofertilisers application did not affected significantly increasing yield and weight of rosettes of leaf lettuce. Dry matter content in leaf lettuce increased significantly after treatments of Goëmar Goteo and Aminoplant, whereas total sugars content did not changed significantly.
- Aminoplant spraying caused rise of total yield, weight of rosettes and total sugars content of endive but did not affected marketable yield. There were no significant differences in dry matter of endive content among control combination and with using biofertilizers.
- The higher nitrate contents were found in control plants of both cultivars of endive and one (the red) of leaf lettuce than treated with Goëmar Goteo and Aminoplant.