Effect of AGRO BIOSOL® on the Long-term Nitrogen Supply and Health of Lettuce

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By order of: Sandoz GmbH, A-6250 Kundl, Austria
Dipl.-Ing Michael Ammann
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1. Introduction

Fertilization in organic vegetable growing is fairly demanding. In particular nitrogen has to be made available to the culture at the right time with the relatively expensive organic commercial fertilizers (as compared to conventional cultivation) to achieve economic yield and, more important, a marketable quality.

Trials carried out by FiBL (Research Institute of Organic Agriculture) together with Sandoz GmbH with the organic fertilizer Agro Biosol have shown that Agro Biosol has a slower mineralization after incorporation into the soil than other fertilizers (report ’AGRO BIOSOL 2003-2004’, FiBL 2004). It is also assumed that treatment with Agro Biosol has a disease-reducing effect on the crops.

This leads to the following questions:

- Does Agro Biosol have a longer lasting nitrogen effect than other organic fertilizers (based on horn meal and feather meal)?
- Does Agro Biosol have an inhibiting effect on the spreading of diseases, such as downy mildew (Bremia lactucae) and lettuce rot (rhizoctonia, sclerotinia and botrytis)?

To answer these questions, a fertilization trial has been designed with two consecutive lettuce crops.
2. Materials and Methods

2.1 Cultivation and Experimental Design

The trial was carried out on a plot in Steinmaur ZH, Switzerland, that has been organically farmed for several years. Agro Biosol and a reference fertilizer were spread with half of the desired quantity of nitrogen and the total quantity according to “Handbuch Gemüse” (Swiss vegetable manual, Tab. 1) and then incorporated with a rotavator. Then the first batch of butterhead lettuce was planted. After harvesting and assessment of the first batch, the soil was ploughed, and the second batch (crisphead lettuce) was planted in mid-August. The experiments were designed with four repeat tests, block randomized. The plot size was selected in such a way that the displacement of soil caused by ploughing could be taken into consideration for the second sampling. N\textsubscript{min} analyses were carried out at three different times: when starting the trial, when harvesting the first batch and when harvesting the second batch. Specifications regarding cultivation are summarized in Table 2. Figure 1 lists the crop sequence and sampling.

Tab 1. Fertilizing procedure

<table>
<thead>
<tr>
<th>Fertilizing variant</th>
<th>N content</th>
<th>Nitrogen quantity per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) unfertilized</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2) reference, half amount; Biorga nitrogen fertilizer</td>
<td>11 %</td>
<td>60 kg N</td>
</tr>
<tr>
<td>3) reference, total amount; Biorga nitrogen fertilizer</td>
<td>11 %</td>
<td>120 kg N</td>
</tr>
<tr>
<td>4) Agro Biosol, half amount</td>
<td>6 %</td>
<td>60 kg N</td>
</tr>
<tr>
<td>5) Agro Biosol, total amount</td>
<td>6 %</td>
<td>120 kg N</td>
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</tbody>
</table>

Tab 2. Conditions of cultivation

<table>
<thead>
<tr>
<th>Crop</th>
<th>lettuce</th>
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<tbody>
<tr>
<td>first batch</td>
<td>butterhead lettuce, variety Ponchito, Jiskia</td>
</tr>
<tr>
<td>second batch</td>
<td>crisphead lettuce, variety Platinas; spring onions</td>
</tr>
<tr>
<td>Site</td>
<td>Steinmaur (ZH), Switzerland</td>
</tr>
<tr>
<td>Farm</td>
<td>BioLand Agrarprodukte AG</td>
</tr>
<tr>
<td>Soil</td>
<td>clayey loam, pH 7.7; humus 3 %; nutrient content classes: P\textsubscript{2}O\textsubscript{5}; E-enriched; K\textsubscript{2}O: D-supply</td>
</tr>
<tr>
<td>Treatment</td>
<td>see Tab. 2</td>
</tr>
<tr>
<td>Preceding crop</td>
<td>lucerne-grass meadow (basal dressing)</td>
</tr>
<tr>
<td>Experimental design</td>
<td>4 repeat tests, block randomized</td>
</tr>
<tr>
<td>Plot size</td>
<td>3.6 m * 8 m (28.8 m\textsuperscript{2})</td>
</tr>
<tr>
<td>Planting</td>
<td>first batch of butterhead lettuce, planting: 15.6. (week 25)</td>
</tr>
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<td></td>
<td>second batch of crisphead lettuce (beds 5-8), planting: about 16.8. (week 33)</td>
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<tr>
<td></td>
<td>second batch of spring onions (beds 1-4), planting: about 16.8. (week 33)</td>
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<tr>
<td>Harvest</td>
<td>first batch: 21.07.04 (planting of week 25)</td>
</tr>
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<td></td>
<td>second batch: 29.10.04 (planting of week 33)</td>
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### Sampling

<table>
<thead>
<tr>
<th>Yield:</th>
<th>4 x 6 head weights per plot</th>
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<tbody>
<tr>
<td>Nmin:</td>
<td>mixed sample per experiment</td>
</tr>
<tr>
<td>Disease assessment:</td>
<td>assessment of infestation with <em>Bremia lactucae</em>, evaluation of infestation with lettuce rot.</td>
</tr>
<tr>
<td>Range from 1 (total infestation) to 9 (no infestation), determined during harvesting</td>
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### Comments

#### Fig. 1: Summary of the crop sequence of the year 2004 (basal dressing GD = lucerne-grass mixture)

<table>
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<tbody>
<tr>
<td></td>
<td>GD</td>
<td></td>
<td></td>
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<td></td>
<td>Kopfsalat</td>
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<td></td>
<td>Bundzwiebeln</td>
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<tr>
<td></td>
<td>Kopfsalat</td>
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</tr>
<tr>
<td></td>
<td>Eissalat</td>
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</tbody>
</table>

Legend:
- Mai, Juni ... May, June, July, August, September, October
- Beet: bed
- GD: basal dressing
- Kopfsalat: butterhead lettuce
- Bundzwiebeln: spring onions
- Eissalat: crisphead lettuce
- Düngung: fertilization
- Ernte: harvest

### 2.2 Evaluation

The fertilizing procedures were examined with regard to significant differences by means of a two-factor analysis of variance (factors fertilizer and repeat block design). If significant differences were found, the mean values were tested by means of the Tukey-Kramer test. The residual data were examined with regard to normal distribution.

### 3. Results

After a fairly dry summer, there was frequent rainfall in autumn. Whereas temperatures were rather low in summer, autumn was relatively warm. The potential infestation, in particular with downy mildew of lettuce, was high during the entire year, also during dry weather periods.

Due to a misunderstanding, four of eight beds were planted with spring onions that are harvested as late as spring 2005.
3.1 $N_{\text{min}}$ Analyses

$N_{\text{min}}$ analyses were carried out at three different times: when starting the trial, when harvesting the first batch and when harvesting the second batch. When starting the trial (June 15), the topsoil (0 – 30 cm) contained 53 kg of N/hectare and the subsoil (30-60 cm) 15 kg of N/ha. A mixed sample of all repeat tests was prepared for $N_{\text{min}}$ sampling after the first harvest (Fig. 2). The two variants with 120 kg of N fertilizer had the highest nitrogen quantities, the values of Agro Biosol being higher by 70 % than those of the reference fertilizer. There is no difference between the two fertilizers when using half the nitrogen amount. All fertilizer variants show clearly increased values as compared to the untreated variant.

After the second harvest at the end of October (Fig. 2 and Fig. 3), no differences were found in the top layer (0-30 cm). The highest N amounts were found in the subsoil under crisphead lettuce treated with Agro Biosol, whereas the highest N amounts were found under spring onions in plots treated with reference fertilizer.

![Graph showing $N_{\text{min}}$ at the time of the first harvest](image)

**Fig. 2: $N_{\text{min}}$ at the time of the first harvest (July 21, 2004)**

Legend:
- Referenz: reference
- ungedüngt: untreated
**Fig. 3:** $N_{\text{min}}$ at the end of October (Oct. 29, 2004) under spring onions (beds 1-4)

**Fig. 4:** $N_{\text{min}}$ at the end of October (Oct. 29, 2004, harvest of second batch) under crisphead lettuce (beds 5 - 8)
3.2 Crop Yield

In the first lettuce batch, the average weight of the heads was higher by 46 g in the fertilized variants (Fig. 5). No difference was detectable between half the amount and the total amount of fertilizer used. 60 kg of N per hectare was sufficient fertilizer for this batch of butterhead lettuce. A trend towards smaller lettuce heads was observed in the variant with the total amount of Agro Biosol.

![Bar chart showing head weight of butterhead lettuce depending on treatment in the first batch (harvested July 21). Fertilizer variants without the same letters differ significantly (analysis of variance p < 0.001; Tukey α = 0.05; n=96). Legend: ungedüngt untreated, Referenz reference, Kopfgewicht head weight.]

The second lettuce batch was highly affected by downy mildew. The required head weight of 250 g was rarely reached. Significant differences were only found between the plot treated with reference fertilizer (total amount) and the untreated plot and/or the plot treated with Agro Biosol (total amount).
3.3 Disease Assessment

The evaluation of lettuce diseases revealed a significantly lower infestation of the first batch with downy mildew on the variant treated with Agro Biosol, total amount, as compared to the unfertilized variant or the variant Agro Biosol, half the amount (Fig. 7). No differences with regard to mildew infestation were found in the second batch. There is no significant difference in the two batches with regard to lettuce rot (Tab. 3). When evaluating the second batch, absolute infestation values per head were estimated in addition to giving assessment marks. All assessment procedures used produced the same results.
**Fig. 7:** Assessment mark (1 = without infestation to 9 = total infestation) of infestation with downy mildew of lettuce (*Bremia lactucae*) depending on the fertilization at the time of harvesting of the first batch (July 21; analysis of variance p < 0.05; Tukey α = 0.05; n=16).

**Legend:**
- **ungedüngt** untreated
- **Referenz** reference
- **Befall mit ...** infestation with downy mildew (assessment mark)

**Tab 3. Infestation, depending on the fertilizer variant, with lettuce rot in the first and second batches and downy mildew in the second batch.** Mean value and standard deviation of the assessment mark and/or infestation in percent at the respective harvest date.

<table>
<thead>
<tr>
<th>Fertilizer variant</th>
<th>Lettuce rot, first batch mark 1 = without infestation mark 9 = total infestation</th>
<th>Lettuce rot, second batch, infest. in %</th>
<th>Downy mildew, second batch, infest. in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agroisol 1/1</td>
<td>3.19 ± 0.43</td>
<td>41.6 ± 23.5</td>
<td>31.9 ± 5.3</td>
</tr>
<tr>
<td>Agroisol 1/2</td>
<td>3.19 ± 0.13</td>
<td>45.9 ± 17.4</td>
<td>28.8 ± 6.4</td>
</tr>
<tr>
<td>Reference 1/1</td>
<td>3.38 ± 0.14</td>
<td>27.1 ± 21.6</td>
<td>26.9 ± 3.7</td>
</tr>
<tr>
<td>Reference 1/2</td>
<td>3.13 ± 0.48</td>
<td>35.4 ± 20.8</td>
<td>30.0 ± 7.1</td>
</tr>
<tr>
<td>Untreated</td>
<td>3.00 ± 0.41</td>
<td>33.1 ± 15.4</td>
<td>26.3 ± 5.2</td>
</tr>
</tbody>
</table>
4. Discussion and Conclusion

The effect of Agro Biosol was not longer lasting than that of a reference fertilizer (feather meal, horn meal and malt). In a batch following butterhead lettuce, where there was no difference in fertilizer variants, the head weight of crisphead lettuce was even significantly lower than that of the reference fertilizer.

However, in the first batch of butterhead lettuce, a significantly lower infestation with downy mildew was detected on the variant treated with the total amount of Agro Biosol. There was no difference between the variant treated with half the amount of fertilizer and the control. It was not possible to determine during this on-farm trial, whether the slightly lower head weight of the variant treated with the total amount of Agro Biosol can be attributed to the additional performance required by the plant to build up an induced resistance.

There were comparatively few cases of lettuce rot in the trial plot. It was therefore not possible to observe any effect of Agro Biosol on rhizocotonia, the most important pathogen.

The relatively small fertilizing effects in the following batch may also be explained by ploughing between two cultures which is customary on this farm. Greater effects could be expected if the soil were worked only superficially.

The effect of Agro Biosol on downy mildew is an interesting observation. This disease cannot be controlled in organic farming except with resistant varieties (where the effect continues only for 1 – 2 years). Organic gardeners are therefore greatly interested in any measures able to delay the infestation. This effect would have to be confirmed in follow-up trials.

The lower head weights in the Agro Biosol variant may be attributed to the fact that a considerable amount of nitrogen was leached into the subsoil in this variant planted with crisphead lettuce (however, not with spring onions) (see Fig. 4).

5. Literature, References and Thanks


We would like to thank Stephan and Daniel Müller and Stephan Hämmerli from BioLand Agrarprodukte for letting us have the plot for the trial and for their excellent cooperation, as well as Roy Ganz for helping with the trial performance.