# N-fertilization using „Biofert" in Sustainable Maize Production

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***SUMMARY***

*In synthetic fermentation of lysine (amino-acid) a by-product (Biofert) originates which can be characterized by 6% N-content and other ingredients (vitamins, enzymes, micro-elements etc). In small and large plot experiments Biofert was studied in different agroecological (cropyear, soil), biological (genotypes) and agrotechnical (non-irrigated and irrigated; N-splitting etc) conditions in order to obtain information about agronomic efficiency and environmental effects of its applications.*

*Our results proved that Biofert has the same agronomic efficiency as traditional N-fertilizers (applied in equal doses and splitting), but Biofert has economic and environmental advantages (less N-leaching in soils) for maize production. We found a special interaction between N-supply and irrigation. In maize production (irrigation) with the optimum application of nutrient- (N-fertilization, Biofert) and water- supply we could stabilize maize yields at a high level (11.0-14.0 t/ha) fairly independently of agroecological factors. When applying Biofert in autumn, $NO_3$-N leaching was less in 100-200 cm chernozem soil-layers than for applications of traditional N-fertilizer. There were no differences between different maize genotypes concerning the agronomic efficiency of Biofert. In maize production 120-190 kg/ha N (chernozem soil) and 165 kg/ha N (meadow soil) doses of Biofert were the optimum doses in splitting applications (autumn + spring).*

## *INTRODUCTION*

In maize production, fertilization is one of the biggest cost-factors yet most efficient agronomic inputs. Maize has a relatively high nutrient demand and requires not only the nutrients originating from soils. It also efficiently utilizes the different applied fertilizers (artificial, manure etc). Fertilizer usage in Hungary reached a fairly high level (~ 280 kg/ha NPK) in the 1980's. Because of the economic problems of the 1990s, Hungarian fertilizer usage dropped dramatically (the lowest level was only ~ 20 kg/ha NPK, and today ~ 65 kg/ha NPK). In this situation we have to find how to quantitatively and qualitatively improve the efficiency of fertilization. Besides the usage of traditional mineral fertilizers, we could use other cheaper fertilizers which have the same agronomic efficiency. Usage of these new fertilizer materials could reduce the cost of fertilization and improve of maize production, profits.

More than 10 years ago, in the eastern part of Hungary (Kaba), a new fermentation plant was built producing different amino-acids (mainly lysine). Besides the main products (amino-acids) of industrial fermentation, different by-productswere produced, one being Biofert (liquid material), which contains 6% nitrogen and other elements, vitamins and enzymes. Biofert is, on the one hand, a valuable material for fertilization and, on the other hand, environmentally friendly. Biofert has economic advantages compared with traditional N-fertilizers (Although Biofert has transport and spraying costs, it has no price).

In sustainable crop production, it has several important impacts for which we have to ensure three priorities: agronomic-economic efficiency, quality and environmental protection. In the field of environmental protection, nutrient-supply, fertilization and crop protection are the most important elements in all field crops.

In polyfactorial long-term experiments, Gyorffy (1976) stated the effects of different agrotechnical factors on yield of maize: effect of fertilization was 27%, genotype 26%, herbicide usage 24%, plant density 20%, tillage 3%, respectively. Among the main macroelements (NPK), nitrogen plays a decisive role in maize production (Bocz, 1974). According to his experiments, the efficiency of N-fertilization could modify the soil parameters, climatic conditions and other biological factors. Concerning the agronomic, economic and environmental aspects, Sarvari (1993) stated that the optimum N-doses of maize hybrids varied between 60-120 kg/ha on meadow soil. In dry cropyears, the optimum NPK doses of maize were 118-154 kg/ha (including 47-62 kg/ha N), in rainy cropyears and irrigated conditions optimum NPK doses varied between 313-354 kg/ha (including 125-141 kg/ha N) on chernozem soil (Ruzsanyi, 1992).

## *MATERIALS AND METHODS*

Small and large plot experiments using Biofert were carried out in different cropyears (1995-1997), on different soils (chernozem soil: Debrecen; meadow soil: Toviskes) of the eastern part of Hungary in maize production. In our experiments, we studied the effects of maize-genotypes and the effects of different agrotechnical elements (non irrigated and irrigated circumstances) on the agronomic efficiency of Biofert application.

## *RESULTS AND DISCUSSION*

After forecrops characterized by a large remaining biomass (plant residues: stem, leaf, root), it is difficult to work the crop rests into soils and it is also important that we accelerate the process of different plant parts from organic materials into humus and inorganic materials in soils. The decomposition of plant residues generally requires N-fertilizers in autumn. From the aspect of environmental pollution, it is necessary to study the conversion and movement of N-fertilizers applied in autumn. From the aspects of crop management the leaching of N-fertilizers used in autumn is important too, because the crops cannot uptake nitrogen from deeper soil-layers, and could, decrease the agronomic efficiency of N-fertilization.

Our experimental data pointed out that bigger N-doses applied in autumn increased the $NO_3$-N content of 0-200 cm soil layers in chernozem soil (*Figure 1*). In the case of doses N=90 kg/ha and N=150 kg/ha used in autumn the $NO_3$-N contents of soil were different depending on N-forms. Application of Biofert the $NO_3$-N contents of 100-200 cm soil layers were less (290 mg/kg and 200 mg/kg $NO_3$-N) than with the use of traditional N-fertilizer (320 mg/kg and 410 mg/kg $NO_3$-N, respectively).

In maize monoculture crop rotation, the decomposition of huge crop residues requires a high level of microbiological activity in soils. The cellulose decomposition bacteria need not only carbohydrate medium but N-sources, too. Without N-sources, the bacterial activity significantly decreases. In our small-plot experiments, we studied the activity of cellulose decomposition soil bacteria during all vegetation periods in chernozem soil. We used two media: pure cellulose (cotton) and crop residues (50%-50% stem-leaf of maize). According to our results, the activity-speed of cellulose decomposition bacteria depended on the doses of nitrogen used in autumn (bigger N-doses higher decomposition) and the cropyear water supply. The decomposition-speed of pure cellulose was significantly less, as compared with the activity-speed in crop residues. In the case of traditional N-fertilizer, the activity of cellulose bacteria was less than in the case of Biofert applied in the same dosage in autumn (*Table 1, Table 2*).

Maize is very sensitive to agroecological factors in the vegetation period and remains sensitive to agrotechnical elements applied in crop management. Maize could indicate deviation from the optimum of ecological and agronomic factors with significant yield decreases. In our experimental projects, the yields from the control treatments could indicate the effects of cropyears and soil (in meadow soil in 1995 3.4 t/ha, in 1996 5.5 t/ha; in chernozem soil in 1995 5.3 t/ha, in 1996 7.5 t/ha, 1997 11.1 t/ha, respectively). Because of better nutrient, water and air husbandry of chernozem soil, the yield-level of the control was higher by about 2.0 t/ha than in meadow soil in the same cropyear. We could demonstrate the effect of different cropyears by using the control yields in chernozem soil: we obtained 5.3 t/ha in an arid cropyear, 7.5 t/ha in an average cropyear, 11.1 t/ha yields in a rainy cropyear, respectively (*Table 3, Table 4*).

The application of nitrogen (N-fertilizer, Biofert) in autumn and spring efficiently could increase the yield of maize both in non irrigated and irrigated crop management. Our experimental data proved that there was no difference between the agronomic efficiency of N-fertilizer and Biofert (*Figure 2*).

The yield-surplus of irrigation was modified by cropyear, soil and N-supply in our maize projects. The effect of cropyear could be demonstrated with the yields obtained in chernozem soil („irrigation-effects” was 1.7 t/ha in an average cropyear [irrigated water 160 mm] and it was 0.4 t/ha in a rainy cropyear [irrigated water 40 mm]). Concerning the „soil-effects” we could state that on meadow soil (characterised by worse nutrient-supply) the irrigation yield-surplus was low without appropriate N-supply (N-fertilizer, Biofert). In our projects, we obtained the largest surplus of irrigation when we used optimum doses and appropriate splitting (autumn + spring) of nitrogen (fertilization x irrigation interactive effects).

Our experimental data pointed out that with an optimum application of nutrient -(N fertilization, Biofert) and water -(irrigation) supply we could stabilize maize yields at a high level (11.0-14.0 t/ha), fairly independently of agroecological factors (*Table 4*).

According to our results, the yield-surpluses of maize were the same in the case of N-fertilizer and Biofert in their application at the same dosage and at the same time (autumn, spring) (*Table 5*). Biofert has the same agronomic efficiency as traditional N-fertilizers, but it has economic -(cheaper) and environmental (less N-leaching in soils) advantages.

The different maize genotypes characterized by good fertilizer (mainly N) responses could similarly utilize the N-content of Biofert. In our projects, the different maize genotypes gave similar yield-surpluses as when using Biofert (we obtained in Furio SC 2.0-5.3 t/ha, in Colomba SC 1.4-5.8 t/ha yield-increase of Biofert x irrigation interactive treatments compared to the control), so there was no hybrid-specific effect in Biofert-application.

On the basis of a three-year project, we could determine the optimum N-doses of Biofert-application in different soils, cropyears and input-level crop models:

| Soil types | N-doses (kg/ha) | | |
|---|---|---|---|
| **Crop-models** | **autumn + spring** | | **total** |
| Chernozem soil | | | |
| non-irrigated | 60 | 60 | 120 |
| irrigated | 60-90 | 60-100 | 120-190 |
| Meadow soil | | | |
| non-irrigated | 90 | 75 | 165 |
| irrigated | 90 | 75 | 165 |

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*Table 1:* **Effects of N-supply on the activity of cellulose-decomposition bacteria in soil**
(chernozem soil)
(pure cellulose decomposition g/10g)

| Autumn treatments (N kg/ha) | Spring treatments | |
|---|---|---|
| | **Average** | **Interval** |
| **Biofert** | | |
| 0 | 0,32 | 0,02-0,52 |
| 60 | 0,37 | 0,08-0,72 |
| 90 | 0,40 | 0,09-0,71 |
| 150 | 0,39 | 0,17-0,70 |
| **N-fertilizer** | | |
| 0 | 0,29 | 0,10-0,60 |
| 60 | 0,32 | 0,10-0,52 |
| 90 | 0,37 | 0,08-0,71 |
| 150 | 0,37 | 0,08-0,70 |

*Table 2:* **Effects of N-supply on the activity of cellulose-decomposition bacteria in soil**
(chernozem soil)
(crop residiues decomposition g/10 g)

| Autumn treatments (N kg/ha) | Spring treatments | |
|---|---|---|
| | **Average** | **Interval** |
| **Biofert** | | |
| 0 | 2,96 | 2,05-3,71 |
| 60 | 2,63 | 1,77-3,76 |
| 90 | 3,69 | 2,45-4,70 |
| 150 | 3,66 | 3,10-4,66 |
| **N-fertilizer** | | |
| 0 | 2,90 | 2,02-3,58 |
| 60 | 2,59 | 1,96-3,10 |
| 90 | 3,50 | 2,05-4,47 |
| 150 | 3,30 | 2,60-4,61 |

*Table 3:* **Effects of biofert and irrigation on yield-level of maize in different cropyears**
(Toviskes, 1995-1996, meadow soil)

| Treatment | 1995 | 1996 |
|---|---|---|
| | **Yield-level (t/ha)** | |
| Control – non irrigated | 3,40 | 5,50 |
| Control – irrigated | 4,10 | 4,70 |
| Biofert – non irrigated | 3,80 | 6,30-10,10 |
| Biofert – irrigated | 4,90-5,70 | 6,70-9,50 |

*Table 4:* **Effects of biofert and irrigation on yield-level of maize in different cropyears**
(Debrecen, 1995-1996-1997, chernozem soil)

| Treatment | 1995 | 1996 | 1997 |
|---|---|---|---|
| | **Yield-level (t/ha)** | | |
| Control – non irrigated | 4,90-5,60 | 7,50 | 11,10 |
| Control – irrigated | - | 9,20 | 11,50 |
| Biofert – non irrigated | - | - | 11,10-14,50 |
| Biofert – irrigated | 6,90-11,40 | 10,10-13,50 | 11,90-13,90 |
| **$LSD_{0,05}$** | **0,44** | **0,63** | **0,41** |

*Table 5:* **Effiency of biofert and n-fertilizer in maize production**
(chernozem soil)
(Debrecen, 1996)

| N-doses (kg/ha) in vegetation period | N-doses (kg/ha) in autumn | | | |
|---|---|---|---|---|
| | **0** | **60** | **90** | **150** |
| **Biofert** | | | | |
| 0 | 9165 | 10580 | 11579 | 11423 |
| 50 | 10246 | 11982 | 12755 | 12898 |
| 100 | 11970 | 11970 | 12455 | 12956 |
| 150 | 11982 | 12640 | 12052 | 12636 |
| **Average** | **10841** | **11793** | **12210** | **12478** |
| **N-fertilizer** | | | | |
| 0 | 9165 | 10580 | 11579 | 11423 |
| 50 | 10059 | 11061 | 12303 | 12845 |
| 100 | 10828 | 11870 | 12107 | 12336 |
| 150 | 11768 | 12105 | 12516 | 12713 |
| **Average** | **10455** | **11404** | **12126** | **12329** |
| **$LSD_{0,05}$** | **632** | | | |

*Figure 1:* **Effect of biofert and N-fertilizer on $NO_3$-N content of chernozem soil**

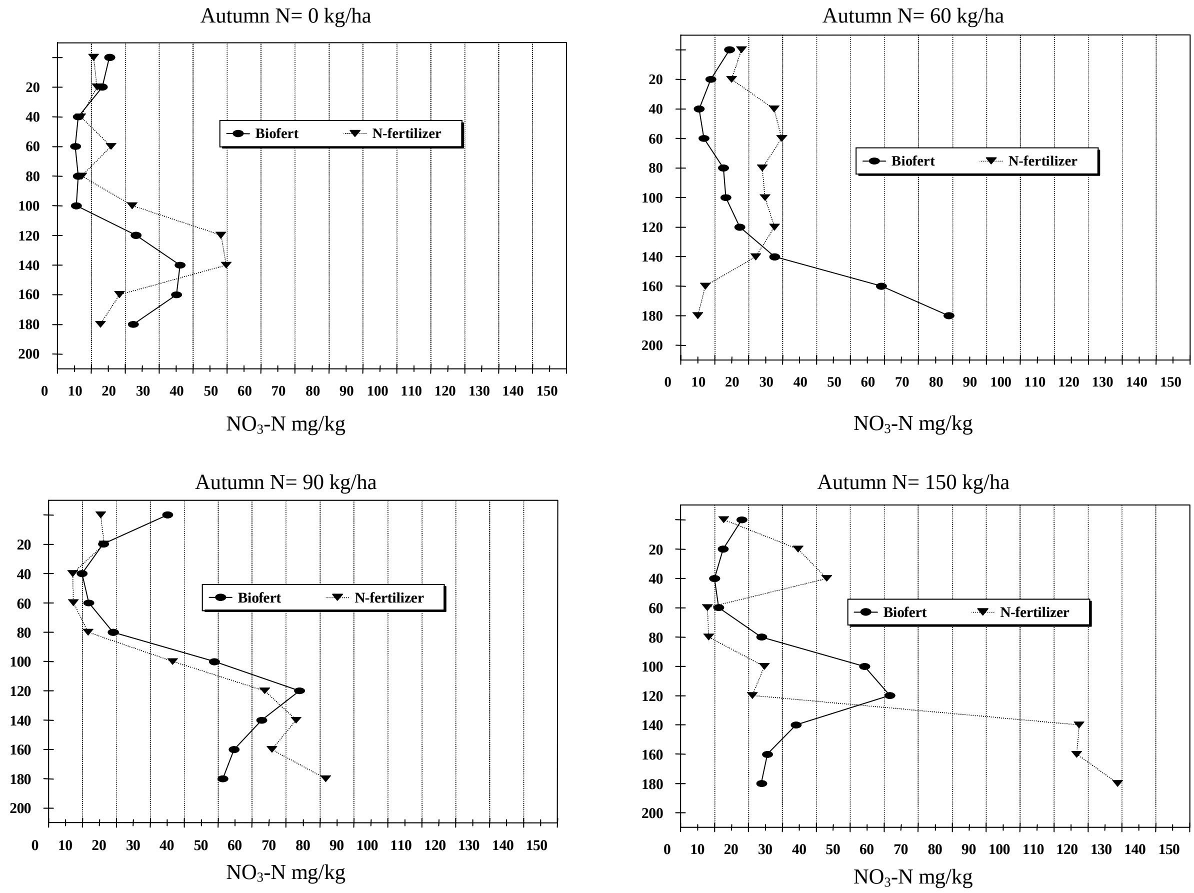


*Figure 2:* **Efficiency of biofert and N-fertilizer in maize production**
(chernozem soil)