**Effect of Ferilizer on the Yield of Maize**  
*Zea mays L.*

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**SUMMARY**

The effect of fertilization on the yield of maize was examined on chernozem soil with lime deposits at the experimental station at Látókép of the Center for Agricultural Sciences, University of Debrecen. The yields of maize were evaluated using quadratic regression function, in three years – between 2000 and 2002 – in non-irrigated and irrigated treatments. After calculating the regression equations, by derivation of the functions, we have determined the amount of fertilizers needed for maximum yield.

In the non-irrigated treatments, maximum yield and the active substance amount of fertilizer was as follows: in 2000, yield of 9,133 t/ha with the application of 384 kg/ha mixed active substance, while in 2002 a yield of 6,289 t/ha with the application 236 kg/ha NPK active substance was achieved. In 2001, due to the favourable precipitation, a yield of 9,864 t/ha was achieved with the application of 245 kg/ha fertilizer. In the case of maximum yield, compared to the unfertilized control, the yield increase was 2.5-5 t/ha. The average increase for 1 kg of NPK fertilizer was 13-19 kg.

We also determined the necessary fertilizer dosage for maximum yield in irrigated treatments. In 2000, 10,003 t/ha with a dosage of 423 kg/ha, in 2001, 11,542 t/ha with a dosage of 277 kg/ha and in 2002, 8,596 t/ha of maximum yield could be achieved with a fertilizer treatment of 277 kg/ha in the examined three years. The yield increase, in irrigated treatments, varied between 3.9-5.9 t/ha so it was greater than in the case of non-irrigated experimental plots. The yield increase for 1 kg fertilizer varied between 12-21 kg.

**INTRODUCTION**

We often come across contradictory knowledge regarding the nutrient supply and fertilization of maize. According to Balás (1888): „maize tolerates the greatest possible fertilization and we do not have to be afraid that heavy fertilization will cause any harm”.

Cserháti’s opinion is very similar: „the more manure we apply, the greater the maize yield will be”. In the beginning of maize fertilization experiments in 1955, the basic theory was that maize responds less favourably to greater dosages of fertilizer than other eared plants. According to Gräßner (1965): „if we apply manure under maize plants, then fertilization is unnecessary”.

Györgyffy (1966) stated that maize planted on soil with high cultivation value does not really react to the directly applied manure with extra yield but rather to the nutrient supply level of the soil. Other authors have also stressed that it is more proper to plan fertilization in the framework of the whole crop rotation (Surányi, 1957; Bauer, 1959; Dezső and Martin, 1965).

Between 1956 and 1960, in the fertilizer experiment of Sarkadi and Bánó, carried out on chernozem meadow soil, the first three years did not result in a significant yield difference between the control yields of the fertilized and unfertilized treatments, while the last two years showed just the opposite effect. It also came to light that in drouthy years, fertilization can result in yield depression. However, on soils with poor nutrient supply, a smaller dosage of fertilization resulted in more reliable yields that were less vulnerable to weather.

The long-term fertilizer experiments carried out by Györgyffy (1979) characterise the increase of fertilizer optimum quite well with the progress of time. In the case of hybrids cultivated in the 1960’s, the applied nitrogen was 80-120 kg and in this range the yield curve palled out. In the 1970’s the nitrogen optimum increased to 100-160 kg/ha.

The water supply of a specific area plays an important role in the utilization of fertilizers’ active agent especially in the case of nitrogen (Bocz, 1976). Both Hungarian and foreign authors agree that the effect of fertilizers is greatly influenced by weather. Weather influences the heat and moisture supply and has an indirect effect on clay transformation in soils, plant growth, nutrient uptake, quantity of yield and thus on the utilization of manure. (Hank and Frank, 1951; Szász, 1988; Kovács, 1982; Jolánkai, 1982; Nagy, 1988; 1999; 2000; 2001; Angyán, 1991; Kádár, 1992; Varga-Haszoics and Mikény-Hegedüs, 1993; Hall et al., 1994).

In the majority of the experiments, medium or good fertilizer effect can be detected in years of high precipitation. In case of severe drought in the first half of the vegetative season, the plant develops well, but in the second half of the vegetative season, due to the great leaf surface index and the increased water demand, a severe water deficiency occurs, which will result in a significant yield depression (Debre cenzi and Debreczeniné, 1983; Rusznányi, 1992; Berzsényi, 1993; Nagy et al., 1999).

The amount of precipitation and the moisture resources of the soil significantly modify fertilizer need and fertilizer effect. In the case of optimum water supply, fertilizer effect increases but when it reaches the level of harmful water surplus, the effect of fertilizers decreases (Harmati, 1987). The influence of soil characteristics depends on the soil fertility, the thickness of the cultivation layer and the water balance (Sarkadi, 1975; Búza, 1987; Németh and Búza, 1991; Rusznányi, 1992). Optimum nitrogen supply contributes significantly to the number of grains per maize cob, less significantly to the increase of kernel weight (Bocz and Nagy, 1981).
In cases of nitrogen deficiency, the accumulation of dry matter and the dynamics of dry matter accumulation are slower (Debreценiné and Szlovák, 1985; Hanway and Russel, 1969; Berzsenyi, 1993). Good nutrient supply promotes the fast, early increase of the leaf surface index of maize and, for this reason, the optimum LAI value can be maintained longer, which is favourable for the endurance of biomass and the flow of assimilates into the grain yield (Anderson et al., 1985; Berzsenyi, 1993). In cases of drought, this favourable characteristic comes with an economic benefit, because maize is deprived of water in the early phase of the reproductive season, which reaches its peak in the case of the highest dielectric moisture. The available VK at 0-100 cm is 157 mm, at 100-200 cm is 150 mm.

Weather characteristics: In the examined period, the precipitation for maize was unfavourable. All three years were dry. In 2001 and 2002, drought occurred in spring of both years. In 2000 a severe drought was experienced.

Data obtained during the experiment was evaluated with correlation and regression analysis (Sváb, 1981; John, 1971; Winer, 1971; Drimba and Ertsy, 2003; Drimba et al., 2000; Ertsy and Drimba, 1995). The applied fertilizer, irrigated treatments and setup were considered during the preparation of the analysis, using the yields in the average of ten maize hybrids.

During the regression analysis, we used a quadratic function. We minimized the square sums of the deviations. In order to determine if the analysis was good, we considered the multiple R value, the result of the F probe and the average amplitude of the square residual MQ (Huzsvai, 1994). The parameters of the function were tested with a t-probe.

The evaluation was done with the help of an IBM compatible computer and the SPSS software.

**RESULTS**

The effect of fertilization on yield was evaluated with the help of regression in irrigated and non-irrigated forms, in the average of three years and annually for the years of the 2000-2002 period, on the basis of dosage experiment setup on the Látókép experimental farm of the University of Debrecen, Center for Agricultural Sciences. During our calculations we applied deviation calculations and characterised natural nutrient utilization on this basis.

We checked whether the function was correct along with multiple R-value with the variance analysis of the regression, with F probe and its accuracy by determining the standard error of the estimate. The correctness of the equation’s parameters was checked with the help of a t-probe, and applied a bilateral symmetrical test to consider significance.

Following the calculations of regression equations, we carried out the derivation of functions and, with this figure, we determined the quantity of fertilizer dosage.

2000 was a dry year. In the growing season, 180 mm less precipitation fell than in the average of 50 years (340 mm), in the winter period however more precipitation fell than in average years. In the case of all fertilizer scales, the yield of the De 377 hybrid – both in the irrigated and unirrigated treatments – was average. The maximum yield was 10,003 t/ha, which was achieved with the application 277 kg NPK mixed active compound.

Precipitation in 2001 was average, or slightly higher than average. This period was more favourable for maize than the previous year; precipitation that fell during the growing season met the average of 50 years. In the precipitation data of
the winter term, significant deviation appeared, about twice as much precipitation fell between the harvest of pre-sowing and sowing than in the same term of the previous year. The maximum yield was 11,542 t/ha, which was achieved with the application of 277 kg of mixed NPK active compound.

In 2002, the growing season was dry. A 100 mm less precipitation fell, than the average of 50 years. This mainly affected the first half of the growing season, and accordingly it had great effect on the yields. The precipitation of the winter term was average, this influenced the great precipitation deficiency favourably. The maximum yield was 8,596 t/ha, which was achieved with the application of 287 kg of fertilizer active compound (Table 1).

### Table 1

The effect of fertilization on the yield of maize

<table>
<thead>
<tr>
<th>Active compound of fertilizer kg/ha</th>
<th>Unirrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Control</td>
<td>4,16</td>
</tr>
<tr>
<td>1</td>
<td>5,99</td>
</tr>
<tr>
<td>2</td>
<td>7,56</td>
</tr>
<tr>
<td>3</td>
<td>8,20</td>
</tr>
<tr>
<td>4</td>
<td>9,13</td>
</tr>
<tr>
<td>5</td>
<td>9,08</td>
</tr>
<tr>
<td>Average</td>
<td>8,37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Irrigated</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6,01</td>
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<tr>
<td>1</td>
<td>7,79</td>
</tr>
<tr>
<td>2</td>
<td>9,12</td>
</tr>
<tr>
<td>3</td>
<td>9,64</td>
</tr>
<tr>
<td>4</td>
<td>10,19</td>
</tr>
<tr>
<td>5</td>
<td>10,73</td>
</tr>
<tr>
<td>Average</td>
<td>8,91</td>
</tr>
</tbody>
</table>

1=30 kg N+22,5 kg P₂O₅+27,5 K₂O; 2=60 kg N+45 kg P₂O₅+53 K₂O; 3=90 kg N+67,5 kg P₂O₅+70,5 K₂O; 4=120 kg N+90 kg P₂O₅+98 K₂O; 5=150 kg N+112,5 kg P₂O₅+125,5 K₂O

### Table 2

The statistical result of the De 377 maize hybrid, unirrigated, Debrecen, 2000

<table>
<thead>
<tr>
<th>The source of variance</th>
<th>SQ</th>
<th>FG</th>
<th>MQ</th>
<th>F-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Residue</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Regression coefficient</th>
<th>Error of the coefficient</th>
<th>Standardized regression coefficient</th>
<th>t-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>0,025861</td>
<td>0,004316</td>
<td>1,811921</td>
<td>5,3992</td>
<td>0,0000</td>
</tr>
<tr>
<td>Fertilizer2</td>
<td>-0,0003364</td>
<td>-0,00001046</td>
<td>-0,972288</td>
<td>-3,215</td>
<td>0,0042</td>
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</table>

During the three years, the average error of the estimate was between 600-900 kg/ha. We have carried out in all three years, the series correlation of residual values. Their values fluctuated between 0,07-0,17. We determined that the accuracy of our estimate did not depend on the magnitude of the yield average.

On the basis of the collective evaluation of the three years, we got the highest yield, 9,864 t/ha with the application of 245 kg of NPK mixed active compound.
Table 3

The statistical result of the De 377 maize hybrid, unirrigated, Debrecen, 2001

<table>
<thead>
<tr>
<th>The source of variance</th>
<th>SQ</th>
<th>FG</th>
<th>MQ</th>
<th>F-value</th>
<th>Significance level</th>
</tr>
</thead>
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<tr>
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<td>Residue</td>
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<td>0,678257</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Regression coefficient</th>
<th>Error of the coefficient</th>
<th>Standardized regression coefficient</th>
<th>t-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0,004423</td>
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</tr>
<tr>
<td>Fertilizer2</td>
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<td>0,000010723</td>
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<td>0,373806</td>
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Table 4

The statistical result of the De 377 maize hybrid, unirrigated, Debrecen, 2002

<table>
<thead>
<tr>
<th>The source of variance</th>
<th>SQ</th>
<th>FG</th>
<th>MQ</th>
<th>F-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>44,384815</td>
<td>2</td>
<td>22,192408</td>
<td>30,47543</td>
<td>0,0000</td>
</tr>
<tr>
<td>Residue</td>
<td>15,292337</td>
<td>21</td>
<td>0,728207</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Regression coefficient</th>
<th>Error of the coefficient</th>
<th>Standardized regression coefficient</th>
<th>t-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>0,027223</td>
<td>0,004582</td>
<td>2,330085</td>
<td>5,942</td>
<td>0,0000</td>
</tr>
<tr>
<td>Fertilizer2</td>
<td>-0,000047483</td>
<td>0,00001109</td>
<td>-1,676289</td>
<td>-4,274</td>
<td>0,0003</td>
</tr>
<tr>
<td>Constant</td>
<td>4,694414</td>
<td>0,387248</td>
<td>12,122</td>
<td></td>
<td>0,0000</td>
</tr>
</tbody>
</table>

With the help of the function’s derivatives, we determined the quantity of NPK fertilizer active compound which, in 2000 with a dosage of 384 kg/ha fertilizer active compound resulted in 9,133 t/ha, in 2001 with a dosage of 245 kg/ha NPK dosage resulted in 9,864 t/ha, and in 2002 with a dosage of 236 kg/ha resulting in 6,289 t/ha maximum yield.

The evaluation of fertilization effect in irrigated treatments

The results of statistical evaluation in irrigated treatments are shown in Table 5-7. The multiple R values were between 0.86-0.95 during the three years. According to the F-probe, fertilization and the yield of maize show a strong correlation under the level of 0.1% significance in all three years. The approximation with a quadratic function varied between 0.8-1.2 t/ha. The t-probes proved the significance of linear and squared members at less than 0.1%. The differences between the estimated and observed yield averages are independent, they do not depend on the quantity of the yield.

With the help of the function’s derivatives, we determined the quantity of NPK fertilizer active compound which, in 2000, with a dosage of 423 kg/ha fertilizer active compound, resulted in 10,003 t/ha, in 2001 with a dosage 277 kg/ha NPK dosage resulted in 11,542 t/ha, and in 2002 with a dosage of 287 kg/ha resulted in 8,596 t/ha maximum yield.

Examining the slope of the quadratic function, we can determine that we get a great yield at relatively low nutrient levels. It follows that, the slope is moderate and around the yield maximum a longer constant section can be observed. In this section the quantity of yield barely changed. The slope of the quadratic function is so small in this function that with the decrease of fertilizer belonging to maximum yield, the quantity of the yield decreases only on a small scale. This means that even with lower levels of fertilization, we get almost maximum yield and this is a very important result from a practical point of view.

Table 5

The statistical result of the De 377 maize hybrid, irrigated, Debrecen, 2000

<table>
<thead>
<tr>
<th>The source of variance</th>
<th>SQ</th>
<th>FG</th>
<th>MQ</th>
<th>F-value</th>
<th>Significance level</th>
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<tbody>
<tr>
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<td>35,058093</td>
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</tr>
<tr>
<td>Residue</td>
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<td>0,343518</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Regression coefficient</th>
<th>Error of the coefficient</th>
<th>Standardized regression coefficient</th>
<th>t-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>0,023026</td>
<td>0,003147</td>
<td>1,731315</td>
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<td>0,0018</td>
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<tr>
<td>Constant</td>
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<td>0,265973</td>
<td>19,283</td>
<td></td>
<td>0,0000</td>
</tr>
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</table>
The statistical result of the De 377 maize hybrid, irrigated, Debrecen, 2001

<table>
<thead>
<tr>
<th>The source of variance</th>
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<th>MQ</th>
<th>F-value</th>
<th>Significance level</th>
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<tbody>
<tr>
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</tbody>
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<tr>
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</thead>
<tbody>
<tr>
<td>Fertilizer</td>
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<td>2,590354</td>
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The statistical result of the De 377 maize hybrid, irrigated, Debrecen, 2002

<table>
<thead>
<tr>
<th>The source of variance</th>
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<td>0,387248</td>
<td></td>
<td>12,122</td>
<td>0,0000</td>
</tr>
</tbody>
</table>

During the examined three years, the maximum total yield was achieved with the application of 277 kg/ha NPK mixed active substance. This fertilizer dosage can be recommended, because in this case the marginal efficiency of fertilization is 21 kg/kg, so it can be considered favourable. In the case of the maximum yield, yield increase compared to the unfertilized treatment varied between 2,6 and 5 t/ha, the average increase for 1 kg fertilizer was 13-19 kg (Table 8).

Table 8

<table>
<thead>
<tr>
<th>Years</th>
<th>NPKmax.</th>
<th>Yield t/ha</th>
<th>Increase t/ha</th>
<th>Average fertilizer efficiency kg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Non-irrigated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>384</td>
<td>9,133</td>
<td>4,969</td>
<td>13</td>
</tr>
<tr>
<td>2001</td>
<td>245</td>
<td>9,864</td>
<td>4,743</td>
<td>19</td>
</tr>
<tr>
<td>2002</td>
<td>238</td>
<td>6,289</td>
<td>2,574</td>
<td>11</td>
</tr>
<tr>
<td>Average</td>
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<td>8,43</td>
<td>4,1</td>
<td>14,33</td>
</tr>
<tr>
<td></td>
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<td>Irrigated</td>
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<td></td>
</tr>
<tr>
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<td>423</td>
<td>10,003</td>
<td>4,874</td>
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<tr>
<td>2001</td>
<td>277</td>
<td>11,542</td>
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<td>2002</td>
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<td>8,596</td>
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<td>329</td>
<td>10,047</td>
<td>4,88</td>
<td>15,67</td>
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</tbody>
</table>

In the case of the irrigated treatments, the yield increasing effect of fertilization was greater than in unirrigated treatments. Greater yield, however, does not always mean greater fertilizer dosages. About the marginal efficiency of fertilization, we can say that usually – excluding the year 2000 – the marginal efficiency of the irrigated treatments is higher than that of the unirrigated treatments (Table 9).

The quantity of the economic fertilizer dosage always depends on the economic environment. In order to determine the quantity of the economical fertilizer dosage – by using the data of the experiment – we determined the fertilizer active compound quantities belonging to 15 kg grain yield, so these values can be benchmarked to different economic conditions quite well. We carried out the evaluation for both unirrigated and irrigated parcels. In the case of irrigated treatments, the marginal efficiency of fertilization was 10 kg/kg in 2001, so in this case the value of boundary productivity is -5, so it is worth increasing the quantity of fertilization, while in the irrigated treatment this unfavourable situation arose in 2000.
The average efficiency of fertilization

<table>
<thead>
<tr>
<th>Years</th>
<th>Marginal efficiency 15 kg/kg fertilizer</th>
<th>Yield t/ha</th>
<th>Increase t/ha</th>
<th>Average fertilizer efficiency kg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-irrigated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>161</td>
<td>7,461</td>
<td>3,297</td>
<td>20</td>
</tr>
<tr>
<td>2001</td>
<td>150</td>
<td>9,153</td>
<td>4,032</td>
<td>27</td>
</tr>
<tr>
<td>2002</td>
<td>74</td>
<td>5,073</td>
<td>1,358</td>
<td>18</td>
</tr>
<tr>
<td>Average</td>
<td>128.33</td>
<td>7,229</td>
<td>2,896</td>
<td>21.67</td>
</tr>
<tr>
<td></td>
<td>Irrigated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>148</td>
<td>7,934</td>
<td>2,805</td>
<td>19</td>
</tr>
<tr>
<td>2001</td>
<td>179</td>
<td>10,81</td>
<td>5,142</td>
<td>29</td>
</tr>
<tr>
<td>2002</td>
<td>129</td>
<td>7,412</td>
<td>2,717</td>
<td>21</td>
</tr>
<tr>
<td>Average</td>
<td>152</td>
<td>8,72</td>
<td>3,56</td>
<td>23</td>
</tr>
</tbody>
</table>

In conclusion on sites similar to the experimental location, 236-384 kg/ha mixed active compound without irrigation can be recommended while in irrigated treatments, an application of 277-423 kg/ha NPK active compound may be used, in the case of the De 377 hybrid.

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REFERENCES

Balás, Á. (1888): Általános és különleges mezőgazdasági növénytermelés, Czéh s., Magyar-Óvár
Hank, O.-Frank, M. (1951): Összefüggés a talaj tánypenyagellátás és a vízfogyasztás között egyes gazdasági növényeknél. ÖKI Évkönyv, Szarvas


