The Effect of Urea Fertilizer on the Growth, Production, and Quality of Local Manado Yellow Varieties of Corn (Zea Mays L)

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Abstract- Corn is a fairly important commodity in North Sulawesi. Corn is used as a second food and animal feed. Some people in North Sulawesi prefer local maize to superior corn. High public demand was not balanced with Manado yellow corn production which continued to decline. Therefore, it is necessary to strive to increase the production of corn plants with proper nutritional quality as food and animal feed ingredients. The purpose of this study was to obtain the right dosage of fertilizer N on growth, yield, and quality of local Manado yellow corn plants. For this reason, the effect of urea (N) on growth, production, and local Manado yellow corn yields of Manado yellow was carried out, indicating that maize crops that were not fertilized produced lower growth, production, and quality of corn than plants fed with urea fertilizer (N). In conclusion, the interaction of the treatment of urea fertilizer at a dose of 300 kg ha⁻¹ gave the best results in plant growth with a plant growth rate of 204.70 g.m⁻² ha⁻¹, production of 3.24 t ha⁻¹, and quality of corn seeds namely starch content 47.43 %, total sugar content of 3.91% and carotenoid levels of 1.67 mg/g.

Index Term- Manado yellow local corn, urea, starch, total sugar, carotene.

I. INTRODUCTION

Local corn Manado yellow is a local type of corn that is widely known in the people of North Sulawesi. According to Tamburian (2011), the community likes Manado yellow corn because the rice yield is high and can be stored [1]. But the productivity of Manado yellow maize is low, at farmer level ranging from 1-2 tons per hectare, the relative age is 110-120 days, the plants are high so it is easy to fall down if blown by the wind, many are planted on dry land under coconut trees, or land area with area relatively narrow.

The low level of corn production is due to the level of soil fertility, climate, socio-economic conditions of the community, and inappropriate use of cultivation techniques [1]. The cultivation techniques applied by traditional farmers are still passed down from previous generations. Therefore, improvements are needed through adaptive technology and synergy so that it can increase Manado yellow corn production. The increase in Manado yellow corn production can be done through proper fertilization techniques, types of fertilizers, and dosages and tillage.

Fertilization aims to meet the number of nutrient requirements that are less suitable in the soil, so that production increases. Fertilization efficiency must be done, because the excess or inaccuracy of fertilizer application can adversely affect plants and the environment and is a waste which means increasing input. Fertilization must follow the right six principles, namely: exact number, type, method, place, time, and according to the nature/type of soil. Akil (2011) stated, in general, corn plants absorb 23–34 kg N, 6.5–11 kg P₂O₅, and 14–42 kg K₂O from the ground for each ton of seed produced [2]. In addition to the three macro nutrients, other nutrients were also absorbed, such as 37 kg Mg, 604 g Mn and 519 g Zn / ha.

Fertilizer Nitrogen is an essential nutrient for corn plants. Nitrogen plays a role in the formation of chlorophyll, where chlorophyll plays a role in photosynthesis[3]. Saragih et al. (2013) say that corn plants take N throughout their lives [4]. Nitrogen is absorbed by plants during the growing period until the maturation of seeds, so that this plant requires continuous N availability to all growth stages until seed formation. Proper application of fertilizer during the growth of corn plants can increase corn yield [5].

Formulation of the problem
Based on the above background, the problem can be formulated as follows: What is the effect of N fertilizer dosage on growth, yield and quality of Manado Kuning local maize plants. This study aims to obtain the right
dosage of fertilizer N on growth, yield and quality of Manado Kuning corn plants.

II. RESEARCH METHODS

Experimental design

The study was conducted using an environmental design, randomized block design (RBD) consisting of 3 treatments and repeated three times. The treatment is as follows:

N = control (without fertilizer), N1 = 150 kg ha\(^{-1}\), and N2 = 300 kg ha\(^{-1}\).

Growth observations include:
1. Leaf area (dm\(^{2}\)), measured using leaf area meter (LAM), is by passing all the leaves of the sample plant above LAM.
2. Dry weight (g) per plant, heated at 80\(^{\circ}\)C for 72 hours.
3. Analysis of plant growth consists of leaf area index (ILD), plant growth rate (LTT) and net assimilation rate (LAB) (obtained by the formula Evans, (1972), are:

\[
ILD = \frac{A}{L}
\]

\[
LTT = \frac{1}{L} \times \frac{(W_2 - W_1)}{(t_2 - t_1)} (g \cdot m^{-2} \cdot days^{-1})
\]

\[
LAB = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{(\ln A_2 - \ln A_1)}{(A_2 - A_1)}
\]

The meaning of symbols in the three formulas above is:

- A = leaf area
- L = area of land occupied by plants
- A\(_1\) = plant leaf area at t\(_1\)
- A\(_2\) = plant leaf area at t\(_2\)
- W\(_1\) = total plant dry weight at time t\(_1\)
- W\(_2\) = total dry weight of plants at t\(_2\)
- t = time of observation

Observation of results and components of results

Observation variables for yield and yield components of corn plants are carried out on yields per plot of size 7 m x 4 m which are then converted into area per hectare.

1. Number of seeds per ear
2. Shell weight per hectare

Variable observation of nutritional quality of seeds.

1. Starch content (%)
2. Sugar content (%)
3. Carotenoid levels (mg g\(^{-1}\))

Analysis of the amount of starch, sugar, and carotenoid content in seeds using a Spectrophotometer.

Data collected was analyzed using diversity analysis. If from the results of the analysis of variance there is a significant effect of differences, further testing is carried out with a 5% BNT test.

III. RESULTS AND DISCUSSION

Leaf area

The results of the variance analysis showed that there was a real interaction with leaf area due to the treatment of urea (N). The average leaf area of corn due to N fertilizer treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>28 HST</th>
<th>42 HST</th>
<th>56 HST</th>
<th>70 HST</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0</td>
<td>12.41 a</td>
<td>26.08 a</td>
<td>55.01 a</td>
<td>65.06 a</td>
</tr>
<tr>
<td>N1</td>
<td>12.92 b</td>
<td>33.94 b</td>
<td>68.35 b</td>
<td>81.92 b</td>
</tr>
<tr>
<td>N2</td>
<td>14.39 c</td>
<td>40.95 c</td>
<td>81.88 c</td>
<td>97.90 c</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>1.84</td>
<td>2.25</td>
<td>3.52</td>
<td>4.23</td>
</tr>
</tbody>
</table>

Description: Numbers accompanied by the same letter show no significant difference in the 5% BNT test.

Based on table 1, it can be seen that corn plants that are not fertilized by urea produce lower leaf area at all plant ages. Increasing the dose of urea fertilizer increases the leaf area of corn plants.

Dry Plant Weight

The results of the analysis showed that the application of urea (N) significantly affected the dry weight of plants. Starting from the age of plants 42 to 70 days, interactions occur due to the treatment of urea fertilizer presented in table II.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>28 HST</th>
<th>42 HST</th>
<th>56 HST</th>
<th>70 HST</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0</td>
<td>5.21 a</td>
<td>60.99 a</td>
<td>266.92 a</td>
<td>502.61 a</td>
</tr>
<tr>
<td>N1</td>
<td>6.75 b</td>
<td>86.99 b</td>
<td>295.69 ab</td>
<td>676.44 b</td>
</tr>
<tr>
<td>N2</td>
<td>7.16 b</td>
<td>90.51 bc</td>
<td>300.91 bc</td>
<td>975.20 c</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>0.44</td>
<td>21.63</td>
<td>35.23</td>
<td>100.77</td>
</tr>
</tbody>
</table>

Description: Numbers in the same column and accompanied by the same letters indicate no significant difference in the 5% BNT test.

Based on table 2 above shows that the provision of urea fertilizer has a significant effect on the dry weight of corn plants. Increasing the dose of urea fertilizer increases the dry weight of corn.
Leaf Area Index (ILD)

The results of the variance analysis showed that there was a real interaction with leaf area index due to the treatment of urea (N). The average leaf area index due to the treatment of N fertilizer at various plant ages is presented in table 3.

Table III
Leaf area index (ILD) of corn plants due to the treatment of urea fertilizer

<table>
<thead>
<tr>
<th>Treatment</th>
<th>28 HST</th>
<th>42 HST</th>
<th>56 HST</th>
<th>70 HST</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0</td>
<td>0.41 a</td>
<td>0.87 a</td>
<td>1.83 a</td>
<td>2.17 a</td>
</tr>
<tr>
<td>N1</td>
<td>0.43 ab</td>
<td>1.23 b</td>
<td>2.28 b</td>
<td>2.73 b</td>
</tr>
<tr>
<td>N2</td>
<td>0.48 b</td>
<td>1.36 c</td>
<td>2.73 c</td>
<td>3.26 c</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>0.06</td>
<td>0.08</td>
<td>0.12</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Description: Numbers accompanied by the same letter show no significant difference in the 5% BNT test.

In table 3 it can be seen that the administration of urea fertilizer shows a real interaction with leaf area index (ILD) at all plant ages. In the treatment of urea (N) by increasing the dosage of N fertilizer, it can significantly increase ILD at all plant ages.

Plant Growth Rate (LTT)

The results of the variance analysis showed that there was a real interaction with the rate of plant growth due to the administration of urea (N) at all planting ages. The average rate of plant growth due to N fertilizer treatment at various plant ages is presented in table 4.

Table IV
The rate of growth of corn plants (g.m⁻².h⁻¹) due to the treatment of urea fertilizer at various plant ages

<table>
<thead>
<tr>
<th>Treatment</th>
<th>28 – 42 HST</th>
<th>42 – 56 HST</th>
<th>56 – 70 HST</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>13.37 a</td>
<td>47.60 a</td>
<td>57.55 a</td>
</tr>
<tr>
<td>N1</td>
<td>19.19 bc</td>
<td>49.69 ab</td>
<td>90.59 b</td>
</tr>
<tr>
<td>N2</td>
<td>19.98 bc</td>
<td>50.10 ab</td>
<td>204.70 c</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>5.14</td>
<td>6.10</td>
<td>21.06</td>
</tr>
</tbody>
</table>

Description: Numbers accompanied by the same letter show no significant difference in the 5% BNT test.

In table 4 it can be seen that the application of urea and KCl shows a real interaction with the rate of plant growth (LTT) at all plant ages. In the treatment of urea (N) by increasing the dose of N fertilizer, it can significantly increase LTT at all plant ages. The treatment of N2 at all plant ages produces the highest growth rate of plants.

Net Assimilation Rate (LAB)

The results of variance analysis showed that there was a real interaction with the rate of net assimilation of plants due to the treatment of urea (N) in all plant ages. The average rate of net assimilation due to the treatment of N fertilizer at all plant ages is presented in table 5.

Table V
The rate of growth of corn plants (g.m⁻².h⁻¹) due to the treatment of urea fertilizer at various plant ages

<table>
<thead>
<tr>
<th>Treatment</th>
<th>28 – 42 HST</th>
<th>42 – 56 HST</th>
<th>56 – 70 HST</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>20.09 a</td>
<td>24.11 a</td>
<td>25.46 a</td>
</tr>
<tr>
<td>N1</td>
<td>23.67 bc</td>
<td>25.44 a</td>
<td>36.31 b</td>
</tr>
<tr>
<td>N2</td>
<td>25.28 cd</td>
<td>30.34 b</td>
<td>53.71 c</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>2.46</td>
<td>2.71</td>
<td>7.85</td>
</tr>
</tbody>
</table>

Description: Numbers accompanied by the same letter show no significant difference in the 5% BNT test.

Table 5 can be seen that urea fertilizer shows a real interaction with the net assimilation rate (LAB) at all plant ages. By increasing the dose of N fertilizer, it can significantly increase LAB at all plant ages. The treatment of N2 at all plant age results in the highest net assimilation rate.

Results and Components of Results
Dry Piped Weight per Cob

The results of the variance analysis showed that there was a real interaction between the treatments of urea fertilizer (N) on dry shelled weight per ear. The average dry piping weight per cob due to urea (N) is presented in table 6.

Table VI
Dry shell weight per cob (g) due to the treatment of urea fertilizer

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dry shelled weight of seeds/cob</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>23.94 a</td>
</tr>
<tr>
<td>N1</td>
<td>45.75 b</td>
</tr>
<tr>
<td>N2</td>
<td>48.64 b</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>2.18</td>
</tr>
</tbody>
</table>

Description: Numbers accompanied by the same letter show no significant difference in the 5% BNT test.

Table VI shows that maize plants that are not fertilized with N (urea) fertilizers produce the lowest squat dry shell weight compared to those given N. Fertilizer The supply of 150
kg/ha and 300 kg/ha fertilizer is not significantly different from dry shell weight per cob.

**Dry Piping Weight per Hectare**

The results of the variance analysis showed that there was a real interaction with dry shelled weight per hectare due to the treatment of urea (N) fertilizer. Giving a higher dose of urea fertilizer has a significant effect on dry shelled weight per hectare. The average dry shelled weight per hectare due to the treatment of urea fertilizer (N) was presented in table 7.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dry shelled weight of seeds/cob</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₀</td>
<td>1.60 a</td>
</tr>
<tr>
<td>N₁</td>
<td>3.05 b</td>
</tr>
<tr>
<td>N₂</td>
<td>3.24 c</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Table VII
Dry shell weight per hectare (t ha⁻¹) due to the treatment of urea and KCl fertilizer

Description: Numbers accompanied by the same letter show no significant difference in the 5% BNT test.

In table 7, it can be seen that maize which is not fertilized with urea fertilizer produces the lowest dry shelled weight per hectare (N₀), compared to corn plants fertilized by urea. The increase in the dose of urea to 300 kg ha⁻¹ (N₂) resulted in the highest dry weight per hectare of 3.24 tons 1.

**Quality of Corn Seeds**

*Content of starch, total sugar, and corn carotene*

The results of the variance analysis showed that there was a real interaction between the treatment of urea (N) dosage on seed starch content, total sugar content and carotene content of corn. The average starch, total sugar and carotene content of corn kernels due to urea fertilizer (N) are presented in table 8.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Starch (g 100g⁻¹)</th>
<th>Content of total sugar (%)</th>
<th>Caroten (mg g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₀</td>
<td>3.35 a</td>
<td>2.44 a</td>
<td>0.43 a</td>
</tr>
<tr>
<td>N₁</td>
<td>4.16 b</td>
<td>3.88 b</td>
<td>1.45 c</td>
</tr>
<tr>
<td>N₂</td>
<td>4.74 c</td>
<td>3.91 b</td>
<td>1.67 d</td>
</tr>
<tr>
<td>BNT 5%</td>
<td>3.11</td>
<td>0.55</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Table VIII
Content of starch, total sugar (%), and carotene (mg g⁻¹) due to fertilizer treatment of urea (N) doses.

Description: Numbers accompanied by the same letter show no significant difference in the 5% BNT test.

Table 8 can be seen that the dose of urea fertilizer shows a real interaction with the content of starch, total sugar, and carotene at all plant ages. Increasing the dosage of N fertilizer can significantly increase the content of starch, total sugar, and carotene in all plant ages. The treatment of N₂ at all plant ages produces the highest content of starch, total sugar, and carotene.

**DISCUSSION**

Corn Manado yellow is a local corn that is preferred for consumption by the people of North Sulawesi. So far Manado yellow corn production is still low, so efforts to improve cultivation techniques are needed to improve yield growth and quality. One of the growth enhancements depends on fertilization. Corn plants need N elements throughout their lives. The land where the research location has low N content in the soil. Therefore an additional amount of N fertilizer is needed to increase the growth of the yellow Manado corn plant. The results showed that the application of 300 kg ha⁻¹ (N₂) of Urea fertilizer resulted in growth of Manado yellow corn plants better than Urea doses of 150 kg ha⁻¹ (N₁). N nutrients absorbed by plants through roots are used to carry out vegetative growth, including to form leaves. The application of Urea fertilizer of 300 kg ha⁻¹ (N₂) results in a higher leaf area than the dose of 150 kg ha⁻¹ (N₁) or without fertilizer (N₀). A wide leaf surface will increase the catch of sunlight by the leaves, thereby increasing the photosynthetic rate of plants and increasing photosynthesize accumulation to dry matter. The application of urea fertilizer affected leaf area, dry weight, leaf area index, plant growth rate, and net assimilation rate. The highest plant growth at 56 - 70 HST. Plant growth rate is influenced by the leaf area formed. Leaves are places where plants carry out photosynthesis so that the yield of dry weight formed is determined by the leaf area of the plant. The effectiveness of photosynthesis is known from the higher rate of net plant assimilation, higher dry matter formation and the highest growth rate resulting in higher yield/production and quality of corn plants.

According to Hokmalipur and Darbandi (2011) the effectiveness of photosynthesis depends on leaf area and chlorophyll content in the leaves [3]. The more effective the photosynthesis process, the higher the number and weight of the seeds so that it produces higher shell weight per ear and per hectare. These results are in accordance with the results of the study by Sithaphanit et al. (2010) which showed that the administration of 300 kg of ha⁻¹ of N fertilizer produced higher yield per hectare compared to 150 kg ha⁻¹ fertilizer [6].
Corn as a food must have enough nutrient content to be consumed. Corn as food contains starch ranging from 72-73%, sugar content 1-3%, and corn protein ranges from 8-11%. Yellow corn also contains carotene ranging from 1.5 to 2.6 mg/g [7].

Content of starch, sugar, and carotene can increase if during the time of growth the plant gets a sufficient amount of nutrient supply. This is because the end result of photosynthesis will be partially directed to the seed section. The fulfillment of nutrients during growth will further improve the quality of corn kernels. The results showed that the application of 300 kg ha\(^{-1}\) urea fertilizer produced the highest starch, sugar and carotene content, the efficiency of nutrient uptake could be increased. The results of these studies are in accordance with the results of the study of Ul Hassan et al. (2010) which showed that the application of N fertilizer dosage 140 kg N ha\(^{-1}\) which resulted in the growth of corn plants was better than other treatments. Better growth will increase photosynthate directed to seeds, so that the content of starch, sugar and carotene seeds increases.

IV. CONCLUSION

Based on the results of the study it can be concluded that the interaction of the treatment of urea fertilizer with a dose of 300 kg ha\(^{-1}\) gave the best results on plant growth with a plant growth rate of 204.70 gm\(^{-2}\) ha\(^{-1}\), production of 3.24 t ha\(^{-1}\), and corn seed quality content starch 47.43%, total sugar 3.91%, and carotenoids 1.67 mg g\(^{-1}\).

REFERENCES