The increase of corn crop productivity through NPK fertilizer addition in dry land

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Abstract. Corn crop is categorized as C4 plant that may be used as alternative feed substitution of forage grass with high nutritional content. The aim of this study is to identify the effect of NPK fertilizer addition to productivity and nutrient content of corn crop in dry land. This study was performed from March to May 2019 (by the end of rainy season) in Tanete Riaja, Barru. This study employed completely randomized design with 4 treatments namely, A1: No fertilizer addition, A2=100 kg ha⁻¹, A3=200 kg ha⁻¹, A4=300 kg ha⁻¹ and 3 replications. The corn crops used in this study was corn hybrid (Bisi-18) that were harvested at the age of 2 months. The result of this study showed that the use of NPK fertilizer improves the growth and productivity of corn crop, particularly the production and nutritional quality. The highest increase of production and growth occured in A3.

1. Introduction
Corn was categorized as C4 plant that may be utilized as potential alternative food [1] and feed or energy source for ruminants. Corn could be used as forage grass substitution by earlier harvesting at the age of 2 months. At this age, the forage may produce feed with high quality. Generally, corn crop planted in dry land due to the corn’s adaptability to drought stress. There are two efforts of improving corn in dry land including the use of seed with high quality and fertilizer addition. Sutejo [2], Roesmarkam and Yuwono [3] stated that the fertilizer addition here could be defined as the effort to replace the nutrient loss in the media or the soil and to improve both plant’s production and growth. Few studies mentioned that corn productivity may be improved through the use of either chemical or organic fertilizer. However, in this study, the author only focused on productivity increase of corn crop by employing chemical NPK fertilizer. The use of fertilizer in corn is very important since it is able to double the productivity rate.

Low productivity rate in dry land is caused by the low fertility rate, low soil nutritive content, limited water availability. Sirappa and Razak [4] Stated that not all types of corn could absorb nutritive content in soil supplemented with fertilizer. Patrick and Reddy [5] Stated that corn capability in N absorption accounts for 55-60%, Potassium for 50–70%, Phosphorus for 20% and Sulphur for 33%. The plant’s response to fertilizer addition depends on the fertilizer types and soil absorbability.

Approximately 80% of corn cultivation is supplemented with fertilizer at a dose of 85 kg N, 25 kg P₂O₅ and 8 kg K₂O/ha [6]. The balanced combination of N, P, and K fertilizer results in the change of efficient use of N, P, and K soil nutrient in hybrid corn variety. This signifies the effect of interaction in each soil nutrient to its efficiency. According to [7] the soil nutrient need in corn crop is higher
especially for N nutrient that accounts for 150–300 kg N ha⁻¹. The soil nutrients of N, P, and K are considered as necessary macro soil nutrient for corn to produce.

Cooke [8] Stated that in order to produce 1 ton of corn kernels, 27.4 kg nitrogen, 4.8 kg phosphorus, and 18.4 kg potassium are at least required. Marvelia et al. [9] Also explain further that N nutrient contributes to the flowering stage in corn. However, P nutrient plays the major role in the corn flower formation and corncob formation since the corncob is the further development of female flower in corn.

As the fertilizer plays important roles in contributing positively to plant’s growth and production, the availability of fertilizer with good quality is on high demand. However, in order to produce organic fertilizer with good quality, selection for the raw materials, quality test and fertilizer effectiveness should be performed. Therefore, this study aimed to identify the increase in corn crop productivity and growth through NPK fertilizer in dryland.

2. Research methods
This study was performed in Kading Village, Tanete Rilau sub-district, Barru regency from April to June 2019. The experiment was performed on a dry lowland of sandy latosol soil in 1-hectare area. The physical composition and chemical content of experimental land were presented in Table 1. The materials used in this study were inorganic fertilizer (NPK), water, hybrid corn seed (bisi-18).

Fertilizers were added to the corn at the age of +2 weeks after cultivation. Weed control was strictly evaluated to anticipate competition in soil nutrient absorption among the plants. Harvesting was performed after ± 3 months before the corns bear fruits.

2.1. Soil analysis
The soil was categorized as latosol soil containing 41% sand, 41% dust, and 18% clay. The soil nutrient content of the land is presented in table 1.

| Parameter | Soil nutrient content |
|-----------|-----------------------|
| pH        | 6.5                   |
| C         | 1.96%                 |
| N         | 0.21%                 |
| C/N       | 9                     |
| P₂O₅      | 35.14 mg 100 g⁻¹      |
| K₂O       | 15.69 mg 100 g⁻¹      |

Source: Soil Fertility and Chemistry Laboratory, Faculty of Agriculture, Universitas Hasanuddin (2019).

2.2. Observed parameter
The observed parameters were plant height, leaf area, number of leaves, number of chlorophyll, dry matter, crude protein, crude fiber, NDF, ADF, cellulose and hemicellulose content. The measurement was performed after 14 days of cultivation. Dry matter content measurement and corn quality analysis were performed after the harvesting.

2.3. Data analysis
This study employed completely randomized design consisting of 4 NPK fertilizer treatment, namely A1: No fertilizer addition, A2=100 kg ha⁻¹, A3=200 kg ha⁻¹, A4=300 kg ha⁻¹ and 3 replications. Therefore, there were 12 experimental units [10].

The collected data were analyzed using statistical analysis of variance. The treatments with significant effect were further analyzed by using duncan multiple range test (DMRT).
3. Results and discussion

3.1. The growth of corn hybrid variety (bisi-18)

The growth components of hybrid corn variety (bisi-18) observed in this study were plant height, number of leaves, leaf area, and number of chlorophyll was presented in Table 2.

Table 2. The rate of growth components.

| Parameter               | Treatment | A0   | A1   | A2   | A3   |
|-------------------------|-----------|------|------|------|------|
| Plant height (cm)       |           | 168.30<sup>a</sup> | 173.63<sup>b</sup> | 177.52<sup>c</sup> | 182.34<sup>d</sup> |
| Number of leaves        |           | 8.00<sup>a</sup> | 9.00<sup>b</sup> | 11.00<sup>c</sup> | 14.00<sup>d</sup> |
| Leaf area (mm<sup>2</sup>) |       | 443.61<sup>a</sup> | 513.21<sup>b</sup> | 543.42<sup>c</sup> | 615.37<sup>d</sup> |
| Chlorophyll (unit)      |           | 30.70<sup>a</sup> | 36.18<sup>b</sup> | 40.38<sup>c</sup> | 52.40<sup>d</sup> |

Description: the values with different superscript letters in a column are significantly different (p<0.05).

The results of the analysis showed that the growth components of hybrid corn variety (bisi-18) were significantly different (p>0.05) in various fertilizer combination. Based on the four fertilizer combination, A3 appeared as the treatment with the highest value. On the contrary, A0 appeared as the treatment with the lowest value. As can be seen from the parameter of plant height resulted from different NPK fertilizer combination, A3 was higher compared to A0 due to different fertilizer nutrient content. The higher the nutrient content supplemented NPK fertilizer, the faster the plant stimulate. NPK fertilizer supplementation is very necessary to stimulate plant height during the growth or harvest period, the enlargement of stem diameter and root formation that will sustain plant establishment [11].

In a study performed by [12], it was concluded that the extra addition of N fertilizer at a dose of 67.5 kg/ha or Urea at a dose of 150 kg/ha may increase the plant height for 251/08 cm (13.73%). The plant height would be increased as the N fertilizer dose is increased to 134 kg/ha or urea fertilizer dose is increased to 300 kg/ha. As the complementary role in protein synthesizing, Nitrogen is an inseparable part from chlorophyll molecule because sufficient N supplementation in plant will affect the growth such as vigor and fresh green color. Nitrogen also plays an important role in major enzyme production in plants, since enzyme is composed of protein [13].

Leaf area in the A3 treatment was significantly higher compared to A2, A1 and A0. This was due to the differences in fertilizer dose. Consequently, leaf area of corn crop differed. Generally, the length and width of leaf are correlated in which the longer the leaf formed, the wider the leaf formed that contributes to leaf area. According to [14] soil nutrient and soil acidity were able to affect leaf area because it may serve as light energy absorber in the photosynthesis. To acquire high amount of harvest production, the plants should generate sufficient leaf area index for major absorption of light that can be utilized by the plants in achieving dry weight production and optimizing photosynthesis for plant’s growth improvement [15].

In terms of chlorophyll concentration, the results of SPAD meter measurement indicated that treatment A3 was highest treatment of all treatments of A2, A1 and A0. This implied that N different content in the fertilizer could improve the green substances in leaves. According to [16] the critical scale of chlorophyll unit based on the SPAD meter observation is 35 units. According to [17] the efficiency of nitrogen supplementation can be observed from the synchronization of N fertilizer addition with N nutrient needs in plants. The synchronization results of N fertilizer supplementation to fulfill appropriate dose of N needed by plants could be observed from SPAD meter.

The highest chlorophyll content in corn crop (A3) was generated by optimal light absorption that improved the photosynthesis rate. This was in accordance with [18] stated that the chlorophyll mechanism in improving the quality and plant production is initiated in the process of CO<sub>2</sub> and H<sub>2</sub>O
conversion to carbohydrate (C_{6}H_{12}O_{6}) and oxygen (O_{2}) as well as energy (ATP). The higher the chlorophyll content in photosynthesis rate the more quality and production will increase.

3.2. Chemical quality of corn hybrid variety (bisi-18)
The content of corn hybrid variety (bisi-18) observed in this study consisted of crude protein, NDF, and ADF. The quality rate of the corn crop is presented in table 3.

Table 3. Dry matter, crude protein, NDF, ADF rate of hybrid corn variety (bisi-18).

| Parameter       | Treatment |   A0  |   A1  |   A2  |   A3  |
|-----------------|-----------|-------|-------|-------|-------|
| Dry Matter (%)  |           | 75.82a| 77.37b| 85.52c| 88.65d|
| Crude Protein (%)|          | 6.87a | 7.13b | 9.10c | 11.04d|
| NDF (%)         |           | 50.79a| 55.04b| 56.03c| 68.08d|
| ADF (%)         |           | 36.97a| 40.39b| 45.59c| 48.19d|
| ADL (%)         |           | 8.61a | 7.20b | 6.80c | 5.48d |
| Cellulose       |           | 28.36a| 33.19b| 38.79b| 42.71c|
| Hemicellulose   |           | 13.82a| 14.65a| 10.44b| 19.89c|

Description: the values with different superscript letters in a column are significantly different (p<0.05).

As can be seen from table 3, the dry matter, crude protein, NDF, ADF content in corn hybrid variety (bisi-18) appeared in treatment A3. This indicated that fertilizer system affects the quality of corn crop. NPK fertilizer supplementation at different dose resulted in different soil nutrient content in each treatment. NPK fertilizer is easily absorbed to boost corn crop growth. NPK fertilizer contains more than two types nutrients with 15% N nutrient content, in the form of NH_{3}, 15% P nutrient content in the form of P_{2}O_{5} and 15% K in the form of (K_{2}O). The phosphorus content that plays important role in energy transfer of plant cell, boosts the root and fruit formulation, strengthens the stem, and improves N absorption during the early growth period. Potassium (K) content also plays important role in the plant growth such as to enhance carbohydrate translocation from the leaf to other vegetative organs [19].

4. Conclusion
Based on the results and discussion, it can be concluded that there were significant differences among the corn hybrid variety (bisi-18) supplemented with NPK fertilizer at different dose. Fertilizer addition at dose of 300kg ha^{-1} is recommendable for corn hybrid variety (bisi-18) in critical dry land.

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