# Optimization rate of urea fertilizer for one-year-old pepper (*Piper nigrum* L.) parent plant

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**Abstract**. Optimum maintenance is required to get a high-quality parent plant. One of the maintenances is fertilization to ensure the optimal growth of the pepper parent plant. This study aimed to obtain the optimum rate of urea fertilizer for a one-year-old of the pepper parent plant. The field experiment used a single factor in a randomized block design (RBD) with five urea rate levels, and each treatment was repeated three times. Treatment levels of urea rate, namely 0 g plant-1 year-1, 100 g plant-1 year-1, 200 g plant-1 year-1, 300 g plant-1 year-1 and 400 g plant-1 year-1. The rate of urea influenced the number of internodes and leaf area of the pepper parent plant. The rate of 315 g plant-1 year-1 urea is the optimum rate for the growth of the number of the branch of a one-year-old pepper parent plant.

## 1. Introduction

Pepper (Piper nigrum L.) is an herb widely used as a flavor enhancer and medicine. Pepper products that are known in the world market are white pepper (Muntok white pepper) and black pepper (Lampung black pepper). It is necessary to increase the national pepper's quality and quantity to compete in the world market. It is recorded that the amount of pepper production in 2015 was 81,501 tons with an area of 167,590 ha. The data shows that pepper production has decreased; previously, in 2014, pepper production was 87,448 tons with an area of 171,920 ha [1]. The causes of decreased pepper productivity in Indonesia include the low population of pepper per hectare, conventional cultivation, attacks by pests and diseases, damaged crops, and not using quality seeds [2].

The garden parent plant was built on the mainland to produce a non-conventional source of seeds. The recommended pepper plant material is derived from Bina seeds that have been released by the Agriculture Minister of Indonesia, namely Natar 1, Natar 2, Petaling 1, Petaling 2, Lampung Daun Kecil, Chunuk, and Bengkayang. Parent plants must have superior characteristics such as fast growth, crown shape, profitable growth, and resistance to pests and plant diseases. The pepper parent plant garden's maintenance is not much different from the production garden, namely watering, weeding, tying orthotropic branches, pruning orthotropic branches, fertilizing, and pests' control.

According to [3], the growth and production of pepper are influenced by quality seeds. Quality seeds are seeds that can grow well and are resistant to unfavorable environments and pests. The fundamental problem is that generally, farmers have not used quality seeds that come from parent plants but plants in production gardens. The provision of seedlings can be made by developing pepper parent plants in the parent garden to produce quality planting material. The recommended planting material for pepper is based on research results by [4], which comes from branches that grow upward (climbing tendrils and hanging tendrils). Optimal maintenance must be carried out to get quality pepper seeds. One of the maintenance activities that must be done is fertilization.

The availability and balance of nutrients play an essential role in supporting plant growth [5]. Fertilizer with the recommended rate is expected to provide beneficial results so that the use of fertilizers can be efficient [6]. Effective nitrogen fertilizer management is essential to increase agricultural productivity while improving air quality and mitigating climate change [7]. The application of nitrogen fertilizer has a function for plants to stimulate overall growth, primarily stems, branches, and leaves, which plays a role in forming green leaves, which are very useful in photosynthesis. Therefore, to get profitable growth in pepper plants, it is necessary to research optimizing urea fertilizer in pepper plants in the main garden. This study aims to obtain the optimum rate of urea fertilizer for a one-year-old pepper parent plant [8].

## 2. Methods

The research was started from April 2020 to September 2020 at the Politeknik Negeri Lampung's Experimental Garden, Lampung Province, Indonesia. The experiment was compiled as a single factor in a randomized block design (RBD) with five urea and three replications rates. Each experimental unit consisted of three pepper parent plants. The level of treatment for urea fertilizer rate, namely 0 g plant-1 year-1 (N0), 100 g plant-1 year-1 (N1), 200 g plant-1 year-1 (N2), 300 g plant-1 year-1 (N3), and 400 g plant-1 year-1 (N4). The research data were analyzed using ANOVA at a significant level of 5% and continued with the Orthogonal Polynomial Test to determine urea's optimum rate.

### *2.1. Preparation*

The plants used in this study were 12 months of the pepper parent plant. The parent plants were Natar 1 variety originated from Lampung. Plant spacing is 1 m x 1 m with Gliricidia sepium as a climbing pole. Before treatment, the pepper parent plant's main stem was trimmed 30 cm above the soil surface and trimmed the primary branches leaving three segments to be uniform. The pepper parent plant used was the Natar 1 variety from the Lampung Plantation Service Office. Pruning primary branches is done by leaving three segments, and then fungicide is applied to the pruned branch to prevent fungal attacks. Urea fertilization was done by making a 7-10 cm hole around the plant with about 20 cm from the parent plant. Urea fertilizer is sprinkled according to the treatment rate, while phosphate and potassium are given in the form of SP36 and MoP with a rate of 74.8 g plant-1 year-1 and 40 g plants-1 year-1, respectively. Pepper plant maintenance includes weed control, watering, and pest and disease control. Weed control is done manually using hoes. Watering is done every day or according to weather conditions. If the rainy weather conditions are intense and heavy, watering is only done once every three days. Pest and disease control are carried out on pepper every two weeks with insecticides and fungicides. Pesticide application is carried out under plant conditions.

### *2.2. Observation*

The observed variables were shoot growth rate, orthotropic branch height, number of leaves, number of orthotropic branches, number of internodes, leaf greenness index, and leaf area. The orthotropic branch height is measured monthly on the main branch from the base of the orthotropic branch to the growing point's tip. The number of leaves is counted from all leaves that have opened entirely, indicated by visible leaf bones when observed from above the leaves. The number of orthotropic branches is carried out by counting the number of branches from the primary branches. Observation of the number of segments was carried out by counting the number of orthotropic branches growing from the base to the shoot. The leaf greenness index was observed every month using SPAD-502 Plus on the third leaf from the tip of the orthotropic branch. Every month, leaf area was observed using a CID Bio-Science leaf area meter on the third leaf from the tip of the orthotropic branch.

## 3. 3. Result and Discussion

The experiment results on optimizing the rate of urea fertilizer on the pepper parent plant in the second year showed that until the eighth month after application, the effect of urea fertilizer rate treatment on the growth of the pepper parent plant had not been seen. Based on visual observations in the field, the growth of the pepper parent plant was average. The pepper parent plant, which was given control treatment at 0-8 BSP, showed the same growth as the other treatments. It is suspected that the existence of G. sepium as a climbing pole contributes to the supply of nutrients, especially nitrogen for the pepper parent plant. At 10 BSP, the pepper parent plant showed an objective response to the rate of urea fertilizer given, namely the observation variables for the number of leaves and the number of internodes (Table 1). The preliminary soil analysis results showed that, in general, the soil fertility in the study location was low.

Table 1. Recapitulation of the results of ANOVA on the optimization of urea fertilizer rate of the pepper parent plant.

| Variables observed | Observation time | | | | |
|---|---|---|---|---|---|
| | 2 MAT | 4 MAT | 6 MAT | 8 MAT | 10 MAT |
| Height of branch | ns | ns | ns | ns | ns |
| Number of branch | ns | ns | ns | ns | ns |
| Number of leaves | ns | ns | ns | ns | * |
| Number of internode | ns | ns | ns | ns | * |
| Leaf greenness index | - | ns | ns | ns | ns |
| Leaf area | - | ns | ns | ns | ns |
| Total N in soil | - | - | - | - | ns |
| Leaf N concentration | - | - | - | - | ns |

MAT = month after treatment; ns = non-significant; * = significant at $p<0.05$.

The observation variables for leaf area and leaf greenness index at 2 MAT could not be measured because the pepper plant leaves were still small, so it was impossible to measure them. The leaves of the pepper plant reach average and complete size three months after pruning. The primary role of nitrogen (N) for plants is to stimulate overall growth, primarily stems, branches, and leaves [9]. Also, nitrogen plays an essential role in the formation of green matter, which is very useful in photosynthesis [10]. Nitrogen (N) is one of the soil's primary nutrients, which plays a vital role in stimulating plant vegetative growth and giving leaves a green color [11].

Increasing the rate of urea up to 400 g plant-1 year-1 affects the number of leaves with a linear trend. It is suspected that a climbing pole in the form of G. sepium plants contributes to the supply of nutrients [12], especially N for the pepper parent plant. The pepper parent plant's growth that was not given urea fertilizer showed the same growth as that of the pepper parent plant given urea fertilizer. The pepper parent plant's same growth led to the contradiction that the control plants showed the same profitable growth as the fertilized plants. This happened allegedly due to the existence of the climbing pole plant. It is known that G. sepium plants are classified as legume plants that can fix nitrogen [13].

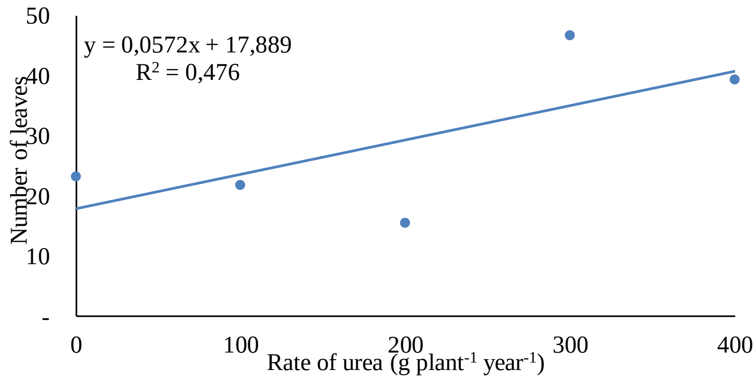


Figure 1. The response of the number of leaves of the pepper parent plant to the increasing rate of urea fertilizer.

Lack of nitrogen in the soil causes disrupted plant growth and development and decreased plant yields because the formation of chlorophyll, which is very important for photosynthetic processes, is disturbed. If N is limited, the upper leaves of the plant will be yellowish-green. Conversely, if N increases, the color of the plant's upper leaves will be green [14,15].

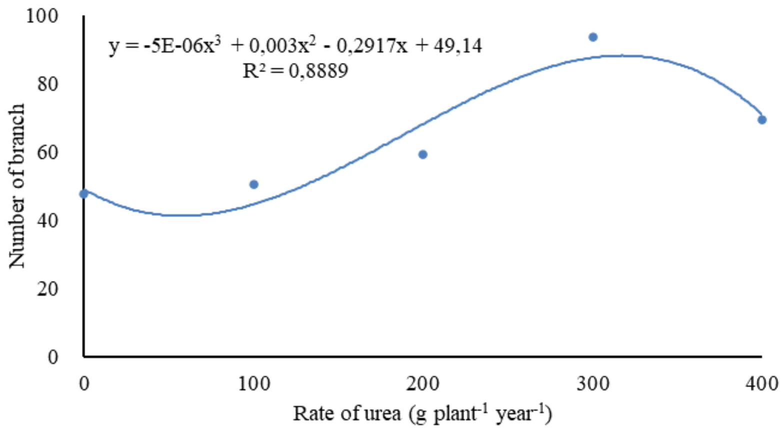


Figure 2. The response of the number of stem plant segments of the pepper parent plant to the increasing rate of urea fertilizer.

The results showed that the response of the number of internodes to the rate of urea was cubic. Based on the equation, the optimum rate of urea fertilizer was achieved at 315 g plant-1 year-1 with the number of internodes that could be achieved at 88.2. These results are under the recommendations issued by the Ministry of Agriculture regarding the recommended rate of fertilizers in the pepper parent plant. Mineral fertilizers play an essential role in increasing plant growth, especially the balance and availability of nutrients to support optimal growth [5]. Soil and environmental conditions specific to a particular location may require exceptional management, including nutrient management, to achieve optimal crop growth and yield. Excessive use of N fertilizers has damaged modern crop production systems. Environmental problems due to the use of excess nitrogen fertilizers continue to increase. Accurate and balanced nitrogen fertilizers are still essential to maintain crop production and environmental sustainability [16].

Table 2. The average effect of urea rate on the leaf greenness index and leaf area of the pepper parent plant.

| Treatment | Observation time | | | |
|---|---|---|---|---|
| | 4 MAT | 6 MAT | 8 MAT | 10 MAT |
| | -------------- Leaf greenness index -------------- | | | |
| 0 g plant$^{-1}$ year$^{-1}$ | 45.99 | 45.84 | 51.21 | 38.07 |
| 100 g plant$^{-1}$ year$^{-1}$ | 43.17 | 44.22 | 48.32 | 33.68 |
| 200 g plant$^{-1}$ year$^{-1}$ | 40.31 | 49.77 | 41.16 | 38.16 |
| 300 g plant$^{-1}$ year$^{-1}$ | 46.35 | 36.88 | 48.84 | 48.84 |
| 400 g plant$^{-1}$ year$^{-1}$ | 43.51 | 51.02 | 47.79 | 43.08 |
| | ------------------ Leaf area (cm$^2$) ------------------ | | | |
| 0 g plant$^{-1}$ year$^{-1}$ | 38.15 | 44.74 | 45.19 | 26.89 |
| 100 g plant$^{-1}$ year$^{-1}$ | 40.61 | 45.46 | 42.50 | 29.11 |
| 200 g plant$^{-1}$ year$^{-1}$ | 33.77 | 42.83 | 46.30 | 29.83 |
| 300 g plant$^{-1}$ year$^{-1}$ | 39.59 | 42.14 | 44.58 | 40.04 |
| 400 g plant$^{-1}$ year$^{-1}$ | 39.61 | 44.99 | 49.91 | 36.18 |

MAT = month after treatment

Leaf greenness index and leaf area of the pepper parent plant were not affected by an increase in urea fertilizer rate. However, there is a tendency for an increase in leaf greenness index and leaf area growth due to an increase in urea fertilizer rate. Leaf greenness index reflects the nutrient content of nitrogen contained in the leaves.

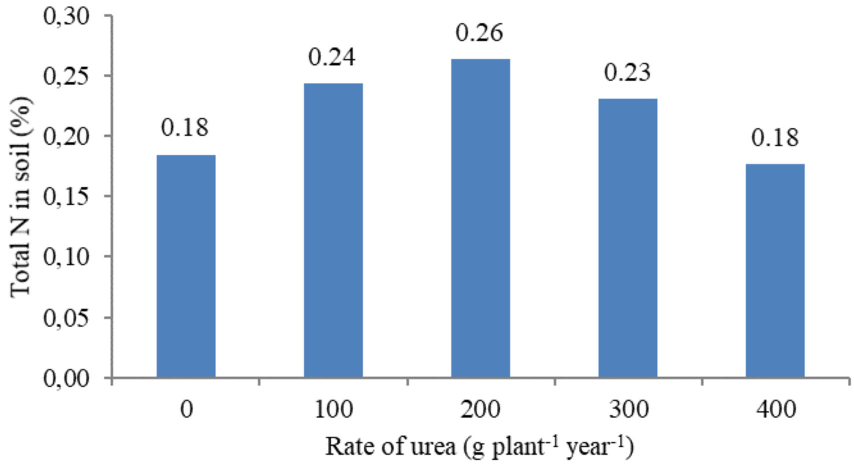


Figure 3. Total N content in the soil.

The application of urea fertilizer with increasing rates through the soil did not significantly affect nitrogen content or levels both in soil and in leaves (Figure 3 and Figure 4). These results indicate consistency and imply that urea fertilizer has not been absorbed optimally by the pepper parent plant. It is recognized that plants can absorb not all of the fertilizers applied through the soil. Some parts of the fertilizer can be absorbed by weeds, washed off, or lost through evaporation. Urea fertilizer has the characteristic of being easily lost through evaporation and leaching.

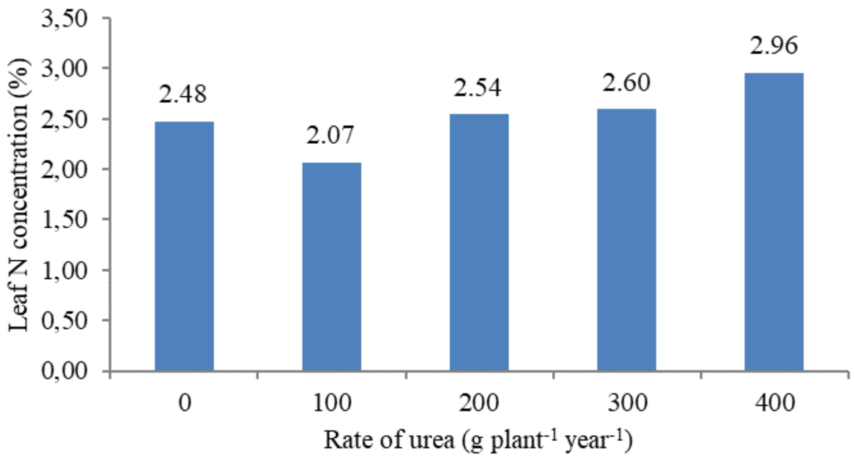


Figure 4. N content in the leaves of the pepper parent plant.

## 4. Conclusion

Based on the description of the results and discussion, it can be concluded that the rate of 315 g plant-1 year-1 urea is the optimum rate for the growth of the number of the branch of a one-year-old pepper parent plant.

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