

(RESEARCH ARTICLE)



## Effect of NPK fertilizer (16-16-16) concentration on the production and quality of cayenne pepper seeds (*Capsicum frutescens* L.) Bonita and Loblita varieties

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### Abstract

One way to increase the production and quality of cayenne pepper seeds is by proper fertilization. The purpose of this study was to obtain the best concentration of NPK (16-16-16) fertilizer for the production and quality seeds of Bonita and Loblita varieties. This study used a nested design with a basic design of randomized group design consisting of 4 levels of NPK (16-16-16) fertilizer concentrations (0 g/l (control), 5 g/l, 10 g/l, and 20 g/l) and 2 varieties of cayenne pepper (Bonita and Loblita) using 3 replications. The concentration of 5 g/l NPK fertilizer (16-16-16) on the Bonita variety gave the best results on germination (85,33%), seed growth speed (24,73%/ethmal), and seed growth uniformity (84,33%). While in the Loblita variety, the concentration of NPK fertilizer (16-16-16) 10 g/l gives the best results on germination (83%), seed growth speed (11,31%/ethmal), and seed growth uniformity (64,33%).

**Keywords:** Bonita; Cayenne Pepper; Loblita; NPK Fertilizer (16- 16-16); Seed Quality

### 1. Introduction

Cayenne pepper (*Capsicum frutescens* L.) is a horticultural commodity that has a high economic value and is widely cultivated. The decline in production makes the price of cayenne pepper in the market unstable, driven by crop failures experienced by farmers due to erratic rainfall factors, pest and disease attacks, and the use of seed from cayenne pepper varieties. Good seeds are obtained by propagating seeds of high-yielding varieties. A variety is a group of plants within a certain type or species that can be distinguished from other groups based on certain characteristics. Variety selection plays an important role in cultivation, because achieving high production levels is largely determined by its genetic potential [1].

Indonesia has released many varieties of cayenne pepper. Center for Tropical Horticulture Studies has also released Bonita and Loblita varieties of cayenne pepper as national superior varieties. Bonita variety is a non-hybrid red cayenne pepper variety but has the same productivity as hybrids [2]. The Loblita variety is a local variety originating from Blitar Regency with high productivity [3]. Besides being influenced by the use of varieties, seed quality also plays a role in the production of cayenne pepper. Good seeds are seeds that meet the seed quality criteria. Seed quality has four types, namely physical quality, physiological quality, genetic quality, and pathological quality [4]. High seed quality is characterized by high seed purity, free from weed seeds and seedborne diseases, and optimal moisture content [5]. High-quality seeds are obtained from physiologically ripe fruits. Quality cayenne pepper seeds from superior varieties need to be balanced with proper cultivation techniques.

The production and quality of good cayenne pepper seeds need to be supported by adequate nutrition for the growth and development of cayenne pepper plants. The nutrients needed by cayenne pepper plants can be met by applying fertilizer. The application of Pearl NPK fertilizer into the soil in optimal amounts can support the increase in yield and quality in the cultivation of cayenne pepper plants [6]. Fertilizer concentrations that exceed the ability of plants to accept

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the chemical content of fertilizers cause plants to be damaged or even die. Conversely, if the concentration of fertilizer applied is too low, the fertilizer has no effect on the plant. So that using the right concentration of NPK (16-16-16) fertilizer can produce the best seed production and quality in cayenne pepper varieties Bonita and Loblita.

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## 2. Material and methods

### 2.1. Maintenance of cayenne pepper plants

The Bonita and Loblita varieties of cayenne pepper used in the study were grown at SEAMEO BIOTROP (South-East Asian Regional Center for Tropical Biology) Kebun Tajur 2, Center for Tropical Horticulture Studies, Institut Pertanian Bogor (IPB), Bogor, West Java. Before being given the treatment of NPK fertilizer concentration (16-16-16) according to the level, each Bonita and Loblita varieties of cayenne pepper plants were rejuvenated first. The age of the Bonita variety cayenne pepper plant is 9 months rejuvenated by pruning branches, harvesting the cayenne pepper that has appeared and picking the cayenne pepper flowers that appear. While the cayenne pepper plants of the Loblita variety used are 3 months old, they are given treatment in the form of harvesting the cayenne pepper that has appeared and picking the cayenne pepper flowers that appear. Another treatment given so that the cayenne pepper plants are uniform with one another is the application of NPK basic fertilizer (16-16-16) as much as 20 g/l with a flush volume of 250 ml for each plant and spraying pesticides.

Plant maintenance stages consist of watering, applying NPK fertilizer treatment (16-16-16) and controlling pests and diseases. Watering is done twice a day every morning and evening using a watering can. The application of NPK fertilizer (16-16-16) according to the concentration level of 0 g/l, 5 g/l, 10 g/l, and 20 g/l was given once a week by sprinkling the soil until the soil surface was evenly exposed to the treatment with a flush volume of 250 ml per plant. Pest and disease control using integrated pest control methods.

### 2.2. Harvest

The Bonita and Loblita varieties of cayenne pepper fruits harvested for seed are physiologically ripe and have a complete structure. Cayenne pepper fruits are harvested by picking and immediately separated out of the field.

### 2.3. Seed extraction

The cayenne pepper fruits selected as seeds are then split using a knife to separate the cayenne pepper fruit from the seeds. Splitting is done slowly to avoid physical damage to the seeds produced. The seeds that have been separated from the cayenne pepper fruit are placed in a container for further drying.

### 2.4. Drying

Seed drying is carried out using a tray covered with newspaper paper and then placed in a room with a temperature of about 25-30 °C not exposed to direct sunlight. Drying is done by drying for 3 days.

### 2.5. Variable observations and measurements

Observations and measurements of variables of the effect of NPK fertilizer concentration (16- 16-16) on the production and quality of cayenne pepper seeds of Bonita and Loblita varieties were carried out in the laboratory of the Center for Tropical Horticulture Studies, Bogor, West Java (including variables of seed yield, weight at 1000-seeds, germination, seed growth speed, and seed growth uniformity) and in the Soil Laboratory, Udayana University, Denpasar, Bali (the variables measured were the leaf nitrogen (N) and phosphor (P) nutrient content. The methods used in the observation and measurement of variables in this study were carried out as follows:

#### 2.5.1. Seed yield (%)

Seed yield observations were made after the seeds were harvested and extracted, calculated by weighing the weight of seeds in 100 grams of cayenne pepper fruit 10 times. The formula used:

$$\text{Seed yield} = \frac{\text{Weight of seeds produced (gram)}}{100 \text{ grams of cayenne pepper}} \times 100\%$$

#### 2.5.2. Weight at 1000-seeds (g)

Counting was done after the seeds were harvested and extracted by weighing the weight per 100 seeds 10 times.

Weight at 1000-seeds = B1+ B2+ Bn + ... + B10

Description:

Bn = Weight 100 seeds at nth weighing.

### 2.5.3. Germination (%)

Observations were made on seeds that had germinated normally at observation I (7 days after sowing) and observation II (14 days after sowing). The method used to test germination is the test between papers. The calculation of germination was done using the ISTA formula [7] as follows:

$$\text{Germination} = \frac{\sum \text{seeds that germinated at 7 days after sowing} + \sum \text{seeds that germinated at 14 days after sowing}}{\sum \text{sowing seeds}} \times 100\%$$

### 2.5.4. Seed growth speed (%/ethmal)

The calculation starts from the first day of germination to the last day of germination. Using the following formula:

$$\text{Seed growth speed} = \frac{N1}{D1} + \frac{N2}{D2} + \frac{N3}{D3} + \frac{Nn}{Dn}$$

Description:

Nn = Number of seeds that germinated on day n

Dn = Length of nth day of germination (ethmal, 24 hours)

### 2.5.5. Seed growth uniformity (%)

Seed growth uniformity was calculated at 10 days after sowing using the formula:

$$\text{Seed growth} = \frac{\sum \text{Seeds that germinated normally at 10 days after sowing}}{\sum \text{Seed sowing}} \times 100\%$$

### 2.5.6. Leaf nitrogen (N) and phosphorus (P) nutrient content (%)

Leaf samples were taken at the flowering and fruiting phases and mixed. Cayenne pepper leaves were baked at 80 °C for 24 hours and pulverized using a mortar until they became flour. Total N content was measured using the Kjeldhall method, while P nutrient content was measured using the spectrophotometer method.

## 2.6. Data analysis

Data from the results of this study were tabulated and analyzed using analysis of variance (Anova) and continued with the least significant difference (LSD) test at the 5% level (p<0.05)

## 3. Results and discussion

The treatment of cayenne pepper varieties had a significant to very significant effect on the variables of seed yield, weight at 1000-seeds, seed growth speed, and seed growth uniformity, while the variables of germination and leaf N and P nutrient content had no significant effect.

The treatment of NPK fertilizer concentration (16-16-16) for Bonita variety has a real to very real effect on the variables of germination, seed growth uniformity, and seed growth speed. However, on the variables of seed yield, weight at 1000-seeds, N and P nutrient content of leaves, the treatment of NPK fertilizer concentration (16-16-16) had no significant effect. Whereas in the Loblita variety, the treatment of NPK fertilizer concentration (16-16-16) has a very significant effect on the variable of germination and seed growth uniformity, but has no significant effect on the variable of seed yield, weight at 1000-seeds, seed growth speed, and leaf N and P nutrient content.

Seed yield is a variable used as an indicator of successful seed production. The results of the analysis in Table 1 show that the seed yield between Bonita (7,28%) and Loblita (4,83%) varieties is not significantly different, because the varieties used have similar characteristics in producing cayenne pepper [8]. The variety with the highest yield value is

the Bonita variety at the concentration of NPK fertilizer (16-16-16) 10 g/l (9,37%) and the lowest treatment is the concentration of NPK fertilizer (16-16-16) 5 g/l (6,22%). The highest seed yield of Loblita variety was found at the concentration of NPK fertilizer (16-16-16) 20 g/l (5,01%), which was not significantly different from the control treatment (4,67%) as the treatment with the lowest seed yield. The high seed yield indicates that the potential for seed production is better than treatments that have low seed yield values.

**Table 1** Effect of NPK fertilizer concentration (16-16-16) on seed yield and weight at 1000- seeds

Treatment	seed yield (%)	weight at 1000-seeds (g)
<b>Variety</b>		
Bonita	7.28 (15.54) a	4.16 a
Loblita	4.83 (12.64) b	3.85 b
LSD 5%	1.78	0.20
<b>Concentration of NPK fertilizer (16-16-16) on Bonita variety</b>		
0 g/l	6.69 (14.93) a	4.19 a
5 g/l	6.22 (14.43) b	4.09 a
10 g/l	9.37 (17.66) a	4.30 a
20 g/l	6.86 (15.14) a	4.06 a
LSD 5%	2.14	0.31
<b>Concentration of NPK fertilizer (16-16-16) on Loblita variety</b>		
0 g/l	4.67 (12.43) a	3.70 a
5 g/l	4.86 (12.69) a	3.79 a
10 g/l	4.77 (12.61) a	3.93 a
20 g/l	5.01 (12.84) a	3.96 a
LSD 5%	2.14	0.31

Captions:-The numbers outside the brackets are the original data, the numbers inside the brackets are the arcsin transformed data, and the numbers followed by the same letter in the same column are not significantly different in the LSD test 5%; Seed yield variable was transformed because the original data spread abnormally with coefficient of variation 26%.

Good seed production can also be seen from the weight at 1000-seeds. The higher the weight at 1000-seeds, the larger the seed size. Weight at 1000-seeds is significantly different from the varieties used. This explains that the weight at 1000-seeds is determined based on the use of cayenne pepper varieties. The Bonita variety (4,16%) has a higher weight at 1000-seeds and is significantly different from the Loblita variety at 3,85% (Table 1). NPK fertilizer concentration of 10 g/l (4,30%) applied for Bonita variety gave the best response to weight at 1000-seeds and NPK (16-16-16) fertilizer concentration of 20 g/l (4,06%) as the concentration with the lowest weight at 1000-seeds value. However, NPK (16-16-16) fertilizer concentration of 20 g/l (3,96%) for Loblita variety gave the highest result in weight at 1000-seeds and the control treatment (3,70%) gave the lowest weight at 1000-seeds. The various results of weight at 1000-seeds are caused by the ability of plants to absorb the nutrient content in NPK fertilizer (16-16-16) given during the seed filling period. Increased nitrogen in plants will affect the rate of P uptake and result in seed filling, because high N and P nutrients are needed by plants for seed formation. the amount of photosynthate that is translocated to the seeds affects the increase in seed weight [9]. Fruit growth in cayenne pepper plants is influenced by the availability of phosphorus for the photosynthesis process, where the results of photosynthesis are translocated in the form of fruit and seeds [10].

An indicator of potential viability is germination, while seed growth rate and seed growth uniformity are indicators of seed vigor [11]. Normal sprouts have a complete and healthy structure. Germination was not significantly affected by Bonita and Loblita varieties. The highest percentage of germination is the Bonita variety, which is 80,83%, which is not significantly different from the Loblita variety (67,67%). The treatment of 5 g/l (85,33%) NPK fertilizer (16-16-16) gave the highest germination value compared to the concentration of 20 g/l (74,33%) given to the Bonita variety (Table 2). The Loblita variety with the highest germination was the concentration of 10 g/l (83%) which was significantly different

from the lowest treatment of 20 g/l (56%). The results of this study are different from the research of Yayuk and Nurmauli [12] on soybean seeds, increasing the dose of NPK fertilizer can increase germination at the time before entering the end of period I of seed development. In this study, it was found that the suitability of NPK fertilizer concentration (16-16-16) with the needs of cayenne pepper plants was able to increase germination. Conversely, the concentration of NPK fertilizer (16-16-16) as much as 20 g/l can reduce the germination of seeds. Germination provides information for seed users about the ability of seeds to grow normally and produce optimally in the field [13]. The high germination rate reflects high seed quality [14]. Quality seeds are obtained from superior varieties which are the determinants of agricultural production [15].

**Table 2** Effect of NPK fertilizer concentration (16-16-16) on germination, seed growth speed, and seed growth uniformity

Treatment	Germination (%)	seed growth speed (%/ethmal)	seed growth uniformity (%)
Variety			
Bonita	80.83 a	20.22 a	78.00 a
Loblita	67.67 a	8.51 b	49.50 b
LSD 5%	15.30	5.44	16.89
Concentration of NPK fertilizer (16-16-16) on Bonita variety			
0 g/l	83.67 a	22.31 a	82.67 a
5 g/l	85.33 a	24.73 a	84.33 a
10 g/l	80.00 b	16.93 b	76.00 b
20 g/l	74.33 c	16.90 b	69.00 b
LSD 5%	4.88	2.55	7.58
Concentration of NPK fertilizer (16-16-16) on Loblita variety			
0 g/l	62.67 c	7.20 b	43.00 c
5 g/l	69.00 b	8.75 b	53.33 b
10 g/l	83.00 a	11.31 a	64.33 a
20 g/l	56.00 d	6.77 b	37.33 c
LSD 5%	4.88	2.55	7.58

Captions: Numbers followed by the same letter in the same column are not significantly different in the 5% LSD test

The results showed that the speed of growth had a very significant effect on the variety. The highest growth speed was Bonita variety at 20,22%/ethmal, significantly different from Loblita variety (8,51%/ethmal). The concentration of 5 g/l at 24,73%/ethmal showed the highest results in the Bonita variety, but significantly different from the concentration of 20 g/l (16,90%/ethmal) as the treatment with the lowest growth speed (Table 2). In Loblita variety, the concentration of 10 g/l (11,31%/ethmal) was the highest value of growth speed which was not significantly different from the treatment of 20 g/l (6,77%/ethmal) of NPK fertilizer (16-16-16). These values of growth speed are very weak because the speed of good seed growth is at least 30%/ethmal [16].

The growth uniformity variable had a very significant effect on Bonita and Loblita varieties. In line with the speed of growth, the Bonita variety also has a higher growth uniformity of 78% compared to the Loblita variety (49.50%) although not significantly different (Table 2). The highest concentration of growth uniformity of Bonita variety is 5 g/l (84.33%) which is significantly different from the lowest concentration of 20 g/l (69%). The highest uniformity of Loblita variety is the concentration of 10 g/l (64.33%), however, it is not significantly different from the concentration of 20 g/l (37.33%) the lowest result of growth uniformity. The uniformity of growth in this study was in the strong category, but not with a concentration of 20 g/l of Loblita varieties. States that a good vigor index standard is 70%, a growth uniformity value of 40-70% indicates a strong vigor index [16]. Growth uniformity above 70% reflects that the vigor index of the seeds is very strong, but growth uniformity of less than 40% indicates that the vigor index is weak. High seed growth uniformity indicates high absolute vigor because groups of seeds that show uniformity and strength will have high growth strength [17].

The use of NPK (16-16-16) fertilizer aims to meet the plant's need for nutrients in the process of growth and development. Nutrients N and P are included in the macro nutrients needed by plants in large quantities. Based on the results of the study, the N nutrient content of the leaves significantly influenced the variety. Bonita variety (3,81%) has the highest leaf N nutrient value compared to Loblita variety at 3,14% (Table 3). The highest concentration of Bonita variety is the control (4,27%) which is not significantly different from all treatments and the lowest leaf N nutrient content of Bonita variety is in the concentration of 5 g/l NPK fertilizer (16-16-16) at 3,36%. While the Loblita variety with a concentration of 5 g/l (3,36%) gave the highest results and was not significantly different from the control treatment (2,94%) the lowest result of leaf N nutrient content. The control treatment that produces the highest leaf N nutrient content is because N nutrients have not been fully utilized by plants in the growth process.

**Table 3** Effect of NPK fertilizer concentration (16-16-16) on leaf N nutrient content and leaf P nutrient content

Treatment	Leaf N nutrient content (%)	Leaf P nutrient content (%)
Variety		
Bonita	3.81 a	0.36 (0.93) a
Loblita	3.14 b	0.37 (0.93) a
LSD 5%	0.52	0.08
Concentration of NPK fertilizer (16-16-16) on Bonita variety		
0 g/l	4.27 a	0.38 (0.94) a
5 g/l	3.36 a	0.36 (0.93) a
10 g/l	3.69 a	0.35 (0.92) a
20 g/l	3.92 a	0.37 (0.93) a
LSD 5%	1.01	0.09
Concentration of NPK fertilizer (16-16-16) on Loblita variety		
0 g/l	2.94 a	0.46 (0.97) a
5 g/l	3.36 a	0.30 (0.90) a
10 g/l	3.03 a	0.36 (0.93) a
20 g/l	3.24 a	0.34 (0.91) a
LSD 5%	1.01	0.09

Captions: - The numbers outside the brackets are the original data, the numbers inside the brackets are the results of square root transformation, and the numbers followed by the same letter in the same column are not significantly different in the 5% LSD test. - Leaf P nutrient content variables were transformed because the original data were not normally distributed with a coefficient of variation of 29%.

The Loblita cayenne pepper variety has a higher leaf P nutrient content of 0.37% which is not significantly different from the Bonita variety (0,36%). The highest P nutrient content treatment of Bonita variety is the control treatment of 0,38%, which is not significantly different from all treatments given (Table 3). The lowest concentration of NPK fertilizer (16-16-16) for Bonita variety was 10 g/l (0,35%). The treatment of the control Loblita variety (0,46%) gave the highest yield, not significantly different from the 5 g/l treatment. The high content of P nutrients in this study, although it did not give a significant difference, was thought to be due to P nutrients contained in plants that had not been fully utilized in the process of plant development.

#### 4. Conclusion

The concentration of NPK fertilizer (16-16-16) has significant effect on the production and quality of cayenne pepper seeds in both Bonita and Loblita varieties. In cayenne pepper Bonita variety, the concentration of NPK fertilizer (16-16-16) 5 g/l gives the best response to the production and quality of seeds on germination, seed growth speed, and seed growth uniformity. Giving the concentration of NPK fertilizer (16-16-16) 10 g/l on the Loblita variety gives the best response to seed production and quality including variables of germination, seed growth speed and seed growth uniformity.

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

There is no conflict of interest in the research.

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