



The Effect of NPK Doses and Plant Spacing on Lettuce (*Lactuca sativa* L.) Growth and Production

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Abstract

The aim of this study was to determine the impact of NPK doses and proper plant spacing in lettuce growth and production. The experiment was conducted in Wirimpalenna Village, Tempe Subdistrict, Wajo Regency from January to March 2017. The experiment employed randomized block design with 2 factor factorial namely NPK doses (300 kg/ha, 350 kg/ha, 400 kg/ha and plant spacing (20 x 25 cm, 25 x 25 cm, 25 x 40 cm). The result showed that the interaction between NPK doses and plant spacing were significantly influenced the fresh weight of lettuce. The highest yield of lettuce was 2,16 kg/Ha (12 t/Ha) produced by the combination of NPK dose (350 kg/ha) and plant spacing (25 x 25). The interaction of NPK dose and plant spacing treatments were not significantly influenced others parameters

Keywords: lettuce, fertilization, plant distance

A. Introduction

Soybean The development of the horticultural sub-sector in Indonesia in the future will be pushed towards the agribusiness system. Horticultural commodities (vegetables, fruits and ornamental plants) play important role in its contribution to improving community nutrition, increasing farmers' income, expanding job opportunities, developing agribusiness and agro-industry, increasing exports and reducing imports.

Lettuce is a leaf vegetable that has been cultivated since 2500 years ago. The origin of lettuce is presumed from West Asia, although other sources confirm that the genetic source (germplasm) of lettuce is originated from America. In Indonesia, lettuce has not thrived as a commercial vegetable. Lettuce planted area are still limited in the centers of vegetable producers such as Cipanas and Lembang. In other place like Wajo Regency, South Sulawesi, this plant has never been cultivated. Although lettuce has not been cultivated widely, but its economic prospects are quite promising. Demand for lettuce in the market continuously increase, among others, from supermarkets, restaurants, hotels, and expatriates live in Indonesia. The imbalance between production supplies and domestic demand for lettuce causes Indonesia to import this commodity to fulfill the demand.

Similar to other leaf vegetables, lettuce is commonly eaten raw and consumed as salads or served in various dishes of European and Chinese cuisine. Lettuce is rarely cooked, because the cooking process may change the taste to be unpalatable and make it difficult to digest. Apart from being a vegetable with a distinctive taste, lettuce contains high nutrition, particularly as a source of minerals. The amount and nutritional composition in 100 grams of lettuce include 15,00 calories, 1,20 g protein, 0,20 g fat, 2,90 g carbohydrates, 22,0 mg calcium, 25,00 mg phosphorus, substances iron 0,50 mg, vitamin A 540,00 SI, 0,04 mg vitamin B1, 8,00 mg vitamin C, and 94,80 g water (Rukmana, 1994)

Looking at the large demand for lettuce in the national market, lettuce has great potential to be developed in Indonesia, particularly in Wajo Regency because this area has suitable climatic conditions for lettuce to be grown. In order to popularize and promote this commodity as well as increase its production and quality of lettuce. An effort that can be done to achieve those purposes is by improving cultivation techniques through fertilization and plant spacing as important factors in crop cultivation.

Fertilization is an effort made to add nutrients to the soil to stimulate plants growth and development. Various types of fertilizers contain various ingredients have been widely circulating in the market. NPK Phonska fertilizer is one type fertilizer that has been long circulated in the market, but is not widely used by farmers. This fertilizer contains N, P, K, and S nutrients which needed to stimulate plant growth.

The use of the right dose and concentration needs to be done to achieve efficient fertilization and to get optimum production. The improper and inadequate use of fertilizers such as excessive use may lead to poisoning the plant, on the contrary, insufficient dose of fertilizer will not bring any effect that can be seen visually (no morphology changes).

Meanwhile, the spacing factor will affect the number of plant populations planted in plant unit area. Studies on plant populations has attracted agronomists to find a way to increase yield per unit area, one of effort to achieve this goal is plant spacing. The combination of these two factors (fertilizer and plant spacing) is expected to increase the quality and quantity of lettuce production, thus reducing lettuce commodity imports. Based on the explanation above, it is needed to conduct study regarding the effect of various doses of NPK and plant spacing on lettuce growth and production.

B. Methodology

This experiment used two-factor factorial design in a randomized block design, namely NPK 300 kg per hectare (0,054 kg per plot) (p1), NPK 350 kg per hectare (0,063 kg per plot) (p2), NPK 400 kg per hectare. (0,072 kg per plot) (p3) and plant spacing of 20 x 25 cm (36 plants per plot) (j1), plant spacing of 25 x 25 cm (29 plants per plot) (j2), plant spacing of 25 x 40 cm (18 plants per plot) (j3). Based on these two factors, there were nine treatment combinations that were replicated in three groups, thus made the total number of plant plots was 27.

Planting lettuce seeds in the nursery began with creating a plot (150 cm x 120 cm), followed by cleaning and loosening the soil, then mixed with 1,8 kg chicken manure. Then, made a shade using bamboo pole with height of 100 cm in east side and 60 cm in west side and a roof of woven coconut leaves. The seeding was conducted by soaking lettuce seeds in lukewarm water for 15 minutes then drained the water and left the seeds dry. The nursery beds were watered until moist, then created shallow trench with the depth of 1 cm using index finger with space of 20 cm apart between each trench. Put the seeds in the trench then covered it with soil. Followed by watering the plots. Once the seeds sprouted 3-4 leaves, transferred it to the experimental plot.

The experimental plots were made with a size of 1,5 m x 1,2 m with a space of 0,5 m between plots and a space of 1 m between groups. Weeds and residual roots were removed from experimental plots, followed by loosening the soil. At the same time, chicken manure was given with dose of 10 tons/ha or 1,8 kg per plot.

A month old seedlings (3-5 leaves) were transferred to the experimental plot. Transplanting was carried out in the afternoon and applied plant spacing and NPK dose treatments accordingly. The NPK fertilizer was given a week (7 days) after transplanting.

At the beginning of cultivation, the plants was watered twice a day, in the morning and evening or depend on environmental conditions. To ensure optimum growth, weeding was performed 15 days after planting and been conducted again should needed.

Harvesting was done at 40 days after transplanting. The characteristics of plants suitable to be harvested can be seen from the number of leaves and density of leaves. Plants can be harvested by cutting the base of the plant stem.

Parameters observed included plant height (cm) at 2 and 4 weeks after planting and at harvest time, number of leaves (strands), leaf width (cm), and plant fresh weight per plot (kg) at the end of the experiment.

C. Result and Discussion

The results showed that the interaction between NPK dose and plant spacing was significantly different on fresh weight per plot and not significantly different on plant height, number of leaves and leaf width of lettuce plants.

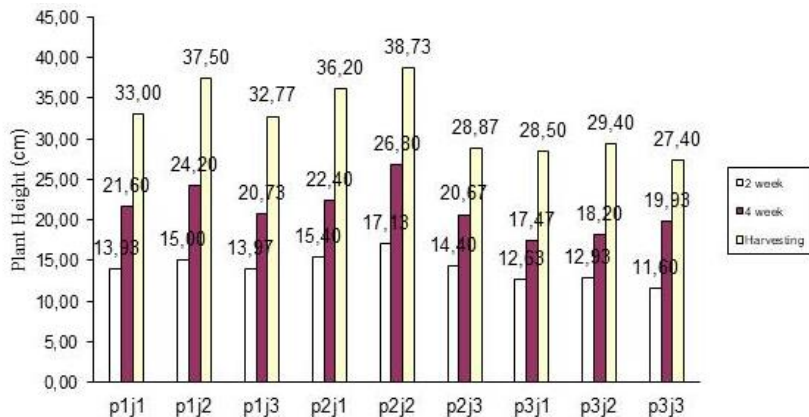


Figure 1. Diagram of average height of lettuce plants

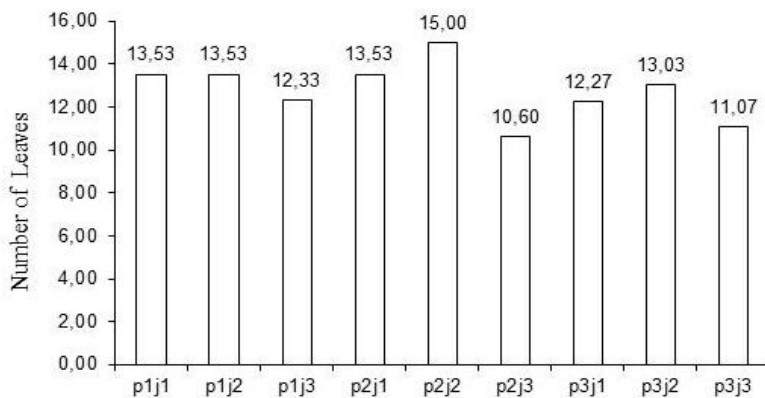


Figure 2. Diagram of number of leaves of lettuce plants

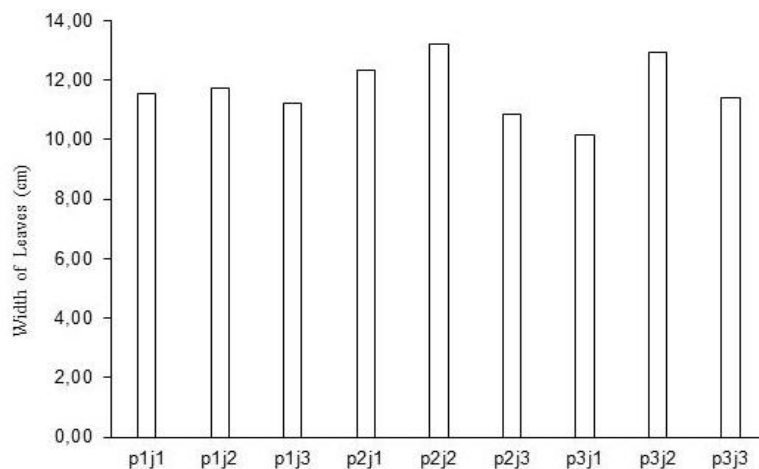


Figure 3. Diagram of leaf width of lettuce plants

Figure 1,2,3 shows that the treatment combination of NPK 350 kg/ha and plant spacing of 25 x 25 cm (p2j2) produced better results on plant height, number of leaves and leaf width compared to other treatments.

Table 1. Average Fresh Weight of Lettuce Plants

NPK dose	Plant Spacing			
	J1	J2	J2	J3
P1	1.38b	1.97a	1.97a	1.65a
P2	1.88a	2.16a	2.16a	1.80a
P3	1.67a	1.88a	1.88a	1.60a

Tukey HSD $\alpha = 0,05$ (Interaction = 0.65)

Note: The numbers followed by the same letter are not significantly different at Tukey HSD test level $\alpha = 0.05$

The results of the Tukey HSD test (0.05) in Table 1 show that the highest fresh weight (highest yields production) was produced by the combination of NPK dose 350 kg/ha and plant spacing of 25 x 25 cm (p2j2) which was significantly different from the combination of NPK dose 300 kg per hectare (0.054 kg per plot) and plant spacing of 20 x 25 cm (36 plants per plot) (p1j1), but not significantly different from other treatments.

The application of NPK 350 kg/ha resulted in the best growth and largest yields production out of all observed parameters. This is assumed that these dose is the suitable (right) amount needed by plants to stimulate maximum growth and production. NPK fertilizer can provide sufficient and balanced nutrients for plants growth, thus it also shows the function of nitrogen, phosphorus, and potassium nutrients as important nutrients in plant metabolism. Nitrogen, phosphorus and potassium are nutrients needed in large quantities and can move (translocate) from one part to another part of plants (mobile nutrients). According to Sarief (1993) and Cyberextension (2019), nitrogen and potassium play important role in protein formation and are essential factors in photosynthesis. Nitrogen is essential for chlorophyll (the green pigments in plants) that helps plants to create food through photosynthesis. Nitrogen is one of the main components of amino acids needed in protein formation, as well as functions to stimulate vegetative growth, and increases leaf production. Phosphorus stimulates the grow of root branch which will help plants absorb nutrients more optimally, strengthens stems, stimulates the formation of flowers and fruit. Meanwhile, potassium as an enzyme activator, increases plant resistance and stimulates carbohydrate translocation

The NPK 300 kg/ha produced lower growth and lower yields production than NPK 350 kg/ha but higher than the NPK 400 kg/ha. It can be due to this dose is insufficient amount of nutrients needed by plants to stimulate its growth and production. If the availability of macro nutrients is less than needed, the plant metabolism will be disturbed results in morphology changes causes by macronutrient deficiency.

The same result occurred in NPK fertilizer treatment of 400 kg/ha which showed the lowest results on all the observed parameters. It can be due to the dose given exceeding amount needed by the plants. Either excessive or insufficient fertilization have negative impacts on plants growth. The slowness of plant growth as a result of insufficient nutrient will also affect crop production. According to Himatan (2019), excessive fertilizers can harm soil microorganisms because it can increase soil acidity, makes soil texture tougher thus disturb the activity of soil microorganisms and causes poisoning to the plants.

Results of plant spacing indicated that the plant spacing of 25 x 25 cm showed the highest results for all the parameters observed. This is thought to be due to the number of population of the plots that are in accordance with the environment, thus the plants do not shade each other, thus eliminates competition between plants to absorb nutrients, water and sunlight.

According to yArdhani, Sunyoto, Kamal & Hidayat, (2015), determining the plant density in a cropping area is one way to achieve maximum crop yields. By regulating plant density to a certain extent, plants can use the growing environment efficiently. Population density is closely related to the amount of solar radiation that plants can absorb. In addition, plant density also affects competition among plants in using nutrients. Furthermore, Wahyu, Baskara & Guritno, (2016) stated that each type of plant has an optimum plant population density to obtain maximum production. If the level of soil fertility and water amount is sufficient, then the optimum plant population density is determined by competition above the soil rather than in the soil or vice versa.

Plant spacing in the field will affect crop production due to competition for nutrients, water and light. This affects the plant's ability to produce a higher number of leaves that support photosynthetic activity. If the spacing exceeds the minimum plant density limit, then the yield of harvested tubers will not increase profitably. The right spacing will ensure the photosynthesis process run smoothly, thus it can produce larger assimilates. The amount of assimilates

transported and stored as food reserves determines the tuber weight. A small amount of assimilates will produce a smaller tuber weight and vice versa, the larger amount will increase the tuber weight (Fatchullah, 2017)

Plant spacing of 20 x 25 cm shows lower yields than spacing of 25 x 25 cm. It can be due to the high population of plants led to fierce competition for nutrients and sunlight. The crowded density made the leaves shade each other, thus photosynthesis was disturbed and ineffective. This is in accordance with the theory that an increase in plant density causes the plant canopy to be shaded from one another, therefore respiration decreases along with decreased photosynthesis (Gardner, Pearce, & Mitchell, 1991). Furthermore, it is said that the shaded plants will turn yellow and thin (Setyati, 1991).

Meanwhile, the plant spacing of 25 x 40 cm produced the lowest yields compared to other plant spacing treatments, it was assumed because the plant population was the less crowded, thus the production tended to be less. This means the plant spacing of 25 x 40 cm is not effective or efficient in utilizing the space or the environment.

The interaction between the NPK dose 350 kg/ha and plant spacing of 25 x 25 cm in lettuce production produced the best growth and largest yields. This result indicates that fertilization with the right dose and right plant spacing will accelerate plant growth and production.

D. Conclusion

Based on the results obtained, it can be concluded that the NPK dose 350 kg/ha and plant spacing of 25 x 25 cm had the best effect on plant height, number of leaves, leaf width, and plant fresh weight. The interaction between NPK dose and plant spacing of lettuce influenced fresh weight of lettuce. Future study on lettuce plants with a lower NPK dose and a narrowed spacing is needed.

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