AGRITROPICA
Journal of Agricultural Sciences

Content available at:
https://ejournal.unib.ac.id/index.php/jagritropica/index

ISSN (PRINT) 2621-217X ISSN (ONLINE) 2621-699X

Growth Dynamics and Production of Kara Oncet Bean (*Ficia Faba* L.) Through Plant Growth Analysis Approach To Get Optimum Planting Distance

Aditiameri*
Agrotechnology Study Program, Faculty of Agriculture, Borobudur University
Address : Jalan Raya Kalimalang no 1 East Jakarta
* Corresponding author: aditiameri65@yahoo.co.id

ABSTRACT: Setting the spacing with a specific density allows each plant to grow well. Spacing will affect the density and efficiency of light use and competition between plants in the use of water and nutrients to affect crop production. At low densities, plants compete less with other plants so that individual plant performances are better. Conversely, at high densities, the competition between plants for light, water, and nutrients is getting tighter so that plant growth can be stunted. Each kara oncet bean cultivar responds differently to different plant density levels. The experiment was conducted in farmers' rice fields in Lembang with Andosol soil. The altitude is 1500 m above sea level. Cangar and Bromo kara oncet bean cultivars with populations of 83,333 plants per ha, 66,667 plants per ha, and 55,556 per ha were studied using factorial block design with four replications. The response surface methodology and snugness test responses to find the highest population of each kara oncet bean cultivar. From the experimental results, it turns out that different plant populations cause differences in (ILD), (LTT), (LAB), and results. The optimum population to obtain the highest yield of two faba bean cultivars has not yet been determined. The components of plant organs that can be relied upon as a determinant of the yield of kara oncet beans are the number of pods per plant, the number of seeds per plant, and the weight of 25 dry seeds.

Keywords: Cultivar, nutbeans kara oncet, Population, cultivar

This paper should be referenced:
Aditiameri. 2022. Growth Dynamics and Production of Kara Oncet Bean (*Ficia Faba* L.) Through Plant Growth Analysis Approach To Get Optimum Planting Distance. *Agritropica: Journal of Agricultural Science*. 5(1):41-49. Doi: https://doi.org/10.31186/J.agritropica.5.1.41-49.

INTRODUCTION

Peanut kara oncet is a plant of the genus Vicia, a leguminous plant containing 25-28% protein, carbohydrates, minerals, Vitamin A, and Vitamin B (Wikipedia, 2022). Peanuts kara oncet also called pork beans. Peanut kara oncet is an annual plant originating from the tropics and is widely grown by highland people as an intercrop on the edges of mounds. By residents, the leaves of peanut kara oncet are used as vegetables, the seeds for snacks are widely sold in supermarkets, and the leaves for biopesticides and fodder (Ayuning *et al.*, 2013).

Efforts to increase the yield of a plant can be made by extensification and intensification of agriculture. Crop yields are determined by the plant population, while the spacing determines the total plant population per unit area. Setting the spacing with a specific density aims to allow each plant to grow well. Plant spacing will affect the density and efficiency of light use and competition

between plants in the use of water and nutrients to affect plant production (Hamzah Raja, 2019). The same thing was stated by Andi Cakra Yusuf et al. (2017), stated that increasing plant population density per unit area at a specific limit could increase crop yields. However, increasing the number of plants will further reduce yields because there will be competition for nutrients, water, growing space, and sunlight.

The main factor that causes the decline in crop yields is the leaves cover each other. Sunlight is an essential factor in the process of photosynthesis. It determines the plant growth rate so that light intensity, irradiation time, and light quality significantly affect the photosynthesis process. If the leaves cover each other, the light cannot be transmitted to the leaves below it, hurting plant yields. This condition can affect the rate of increase in plant dry weight, which is actualized in increasing or decreasing LTT (plant growth rate, ILD (leaf area index), and LAB (net assimilation rate). The leaf area index (ILD) of plants is closely related to seed yield and plant dry weight. (Chang 1968 in Bilman WS, 2001). He further said that the maximum seed yield was achieved because the ILD was optimum.

The optimum ILD value indicated that the rate of photosynthesis had reached its maximum. The plant population per hectare also determined the LTT and LAB values because they relate to the interception of light radiation received by plants (Sitompul, 2016). This study aimed to obtain the optimum spacing for two cultivars of kara oncet bean through a growth analysis approach. At the same time, the highest results were studied with the surface technique responses and snugness test responses.

MATERIALS AND METHODS

This research was carried out in the rice fields of the Lembang area at an altitude of 1,500 m above sea level. Andosol soil type. The materials used in this study were kara oncet seeds of the Bromo and Cangar cultivars, NPK fertilizers, and pesticides. While the equipment used is a meter, scales, oven, and leaf area meter.

The method used is factorial block design with four replications. The first factor includes the population of faba bean (P) with 3 levels, namely:

P1 = 83,333 plants ha-1 (planting distance 60 cm x 20 cm)

P2 = 66,667 plants ha-1 (planting distance 60 cm x 25 cm)

P3 = 55,556 plants ha-1 (planting distance 60 cm x 30 cm)

The second factor is the type of oncet bean cultivar (V) with two levels, namely:

V1 = Cangar cultivar

V2 - Bromo cultivar

The land area used is 300 m^2, where each plot has an area of (4.2 x 3) m^2

The variables measured were the average values (LAI), (PGR), and (LAB), while the yield components observed included: (1) number of productive branches per plant; (2) Number of pods per plant; (3) Number of seeds per plant; (4) dry seed weight of 25 and (5) dry seed weight of faba beans.

Data on the yield of kara oncet beans were analyzed univariately with Duncan's test at a 5% level. The response surface technique was used with a linear model to find the optimum population (optimum density) and the highest yield of each cultivar. Snugness test responses tested both curves.

RESULTS AND DISCUSSION

Faba Bean Plant Growth Dynamics

Leaf area index (LAI) shows leaf density per unit area shaded. Increasing LAI is one strategy to increase radiation reception as much as possible to obtain maximum photosynthesis. The amount of LAI is also influenced by the type of cultivar planted. Figures 1 and 2 show the LAI curve, where the initial growth rate of LAI is low, then increases and decreases again when the plant enters the generative phase. The period of fastest leaf growth occurs between 4 to 6 weeks after planting (WAP). There was an increase in the number of leaves and leaf size until it reached the maximum limit and was followed by an increase in total dry matter.

There is also leaf turnover, where new leaves are formed, and older leaves experience aging. LAI reaches its peak when the plants are 8-10 weeks after planting (WAP). Entering the generative phase, the resulting leaves are smaller in size, and leaf production decreases; many leaves turn yellow and fall, resulting in a decrease in the net potential of photosynthesis, resulting in a reduction of the LAI value.

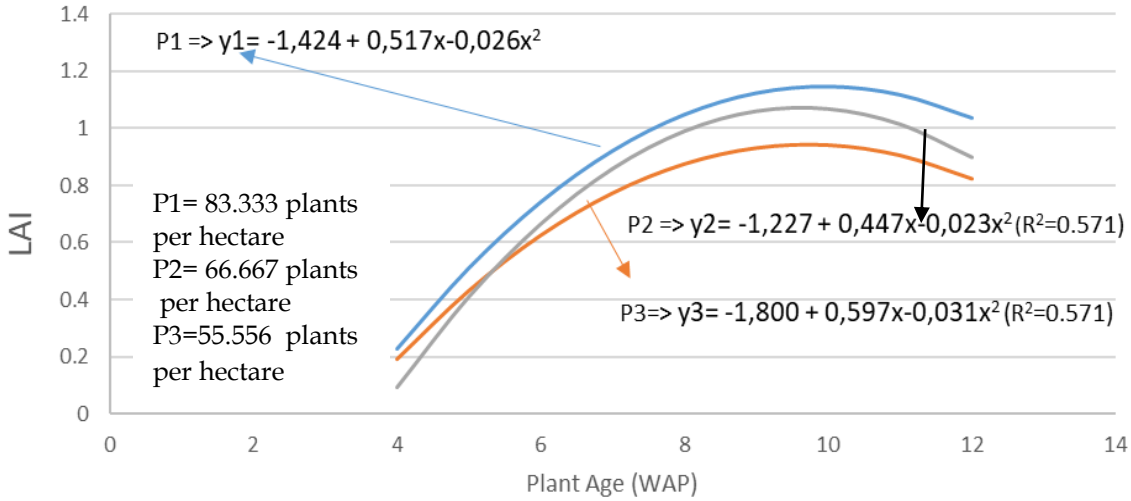


Figure 1. LAI of nutbeans kara oncet cultivar Cangar on various plant Populations

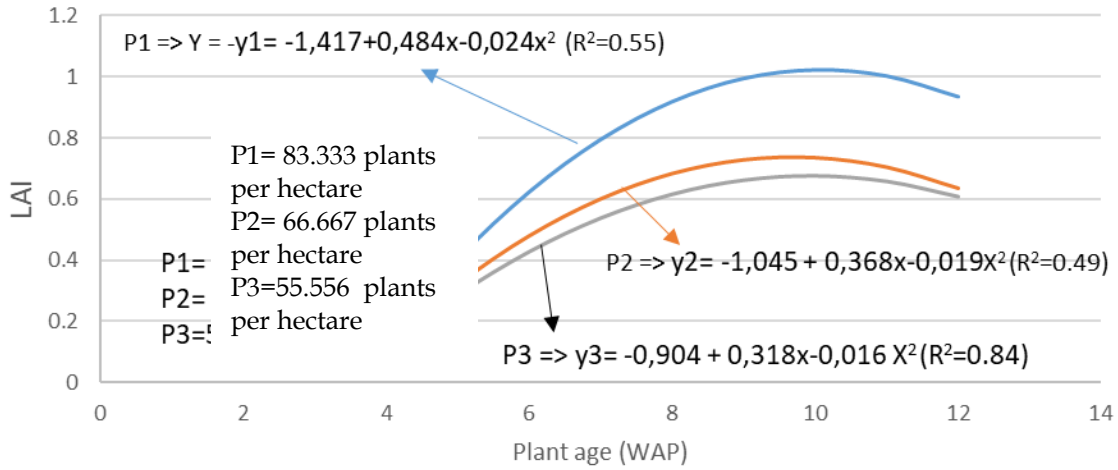


Figure 2. LAI of nutbeans kara oncet cultivar Bromo on various plant populations

The highest LAI value of Cangar cultivars was reached at 8 WAP with a value of 1.15; 1.01, and 1.06 in plant population per hectare 83,333; 66,667, and 55,558. Meanwhile, the highest LAI value of Bromo oncet kara nuts was also achieved at 8 WAP with a value of 1.00; 0.73, and 0.70 in plant population per hectare 83,333; 66,667 and 55,558. The difference in the LAI value between the Cangar cultivar and the Bromo cultivar is presumably because the Bromo cultivar is less able to utilize the environment. This trend was seen from the beginning of growth, indicated by the delay in the germination of seeds (2 WAP) compared to Cangar cultivar seeds (1 WAP).

The plant growth rate (PGR) in kara oncet beans showed almost the same pattern where at the beginning of growth, the PGR value was low, then increased and decreased again at the end of development, as shown in Figures 3 and 4. The decrease in PGR was more and more rapid when the plant was 10 – 12 WAP because the partition of photosynthate to the generative part of the plant is greater than the partition for leaf formation. The PGR value of the Cangar cultivar kara oncet is higher than the Bromo cultivar because it is suspected that the growth of the Bromo cultivar kara oncet plant is not as good as the Cangar kara oncet cultivar

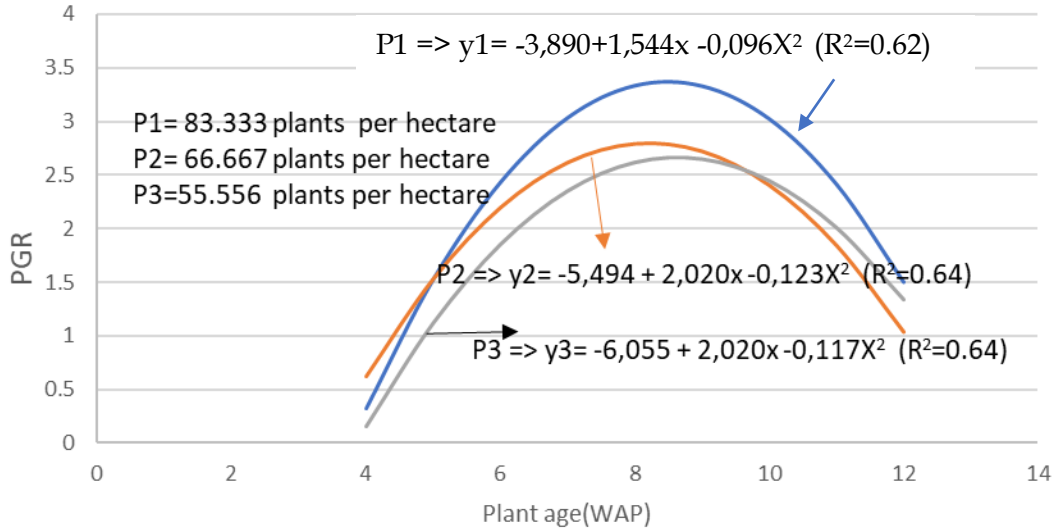


Figure 3. PGR of nutbeans kara oncet cultivar Cangar on various Plant Populations

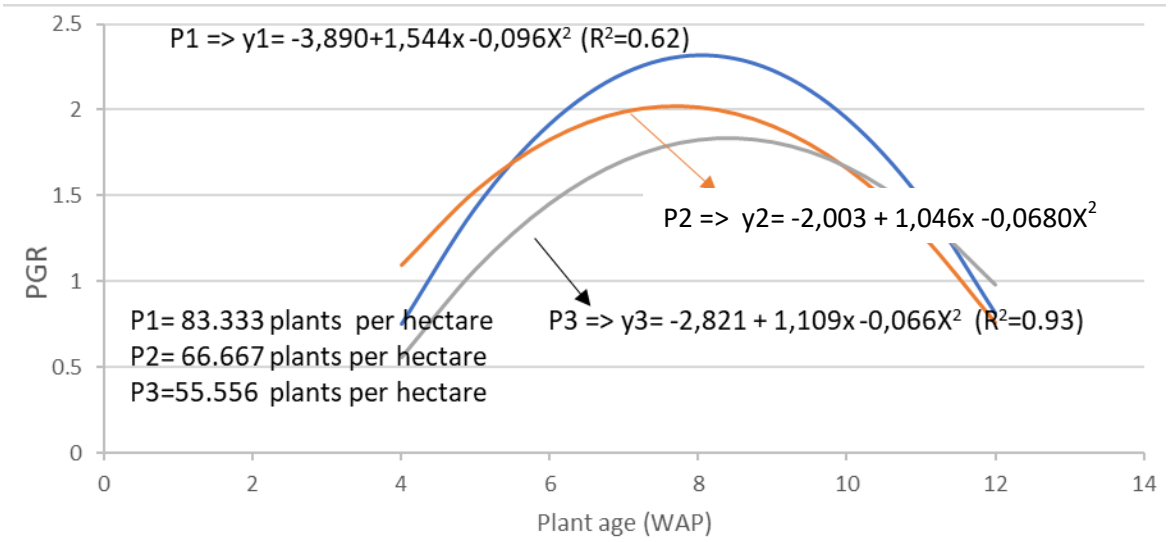


Figure 4. PGR of nutbeans kara oncet cultivar Bromo on various plant populations

The highest net assimilation rate (NAR) was obtained when the leaves could fully intercept light radiation because the highest NAR occurred when the plant was still young. This event was caused at the beginning of growth, the number of leaves was small, and the size of the leaves was not so wide that almost all the leaves could intercept solar radiation. Furthermore, as the age of the plant increases, the number and size also increase so that shading begins to occur among individual plants. As a result, the proportion of light that reaches the lower canopy layer decreases.

The presence of inefficient leaves in the photosynthesis process is not balanced with the leaf area, causing the dry matter accumulation rate per unit area to decrease. Photosynthesis and relatively large amounts of energy are required for flowering and seed growth in the production phase. At that time, the difference in NAR between the Cangar and Bromo cultivars began to appear in the NAR, which was planted at a population of 83,333 plants per hectare with a population of 55,556 plants per hectare, as shown in Figures 5 and 6. This was due to a population of 55,556 plants per hectare; growth Vegetative growth still occurs when the plant enters the reproductive phase (flowering phase and seed formation), resulting in a rapidly rising NAR (6 - 10 WAP) and then decreasing again after 10 WAP. While the population of 83,333 plants per hectare and 66,667 plants per hectare, NAR decreased linearly with increasing age and did not increase again at 10 WAP. Allegedly, the koro oncit bean plant grows well, so the photosynthate produced is only used for growth and seed formation

The highest net assimilation rate (LAB) was obtained when the leaves could fully intercept light radiation because the highest LAB occurred when the plant was still young. This event was caused at the beginning of growth, the number of leaves was small, and the size of the leaves was not so wide that almost all the leaves could intercept solar radiation. Furthermore, as the age of the plant increases, the number and size also increase so that shading begins to occur among individual plants. As a result, the proportion of light that reaches the lower canopy layer decreases.

The presence of inefficient leaves in the photosynthesis process is not balanced with the leaf area, causing the dry matter

accumulation rate per unit area to decrease. Photosynthesis and relatively large amounts of energy are required for flowering and seed growth in the production phase. At that time, LAB differences began to appear between the Cangar and Bromo cultivars of Koro onset beans planted at 83,333 plants per hectare with a population of 55,556 plants per hectare, as shown in Figures 5 and 6. This was due to a population of 55,556 plants per hectare growth. The vegetative process is still ongoing when the plant enters the reproductive phase (flowering phase and seed formation), resulting in LAB rising rapidly (6-10 WAP) and then decreasing again after 10 WAP. While the population of 83,333 and 66,667 plants per hectare, LAB decreased linearly with increasing age and did not increase again at 10 WAP. Allegedly, the koro oncit bean plant grows well, so the photosynthate produced is only used for growth and seed formation

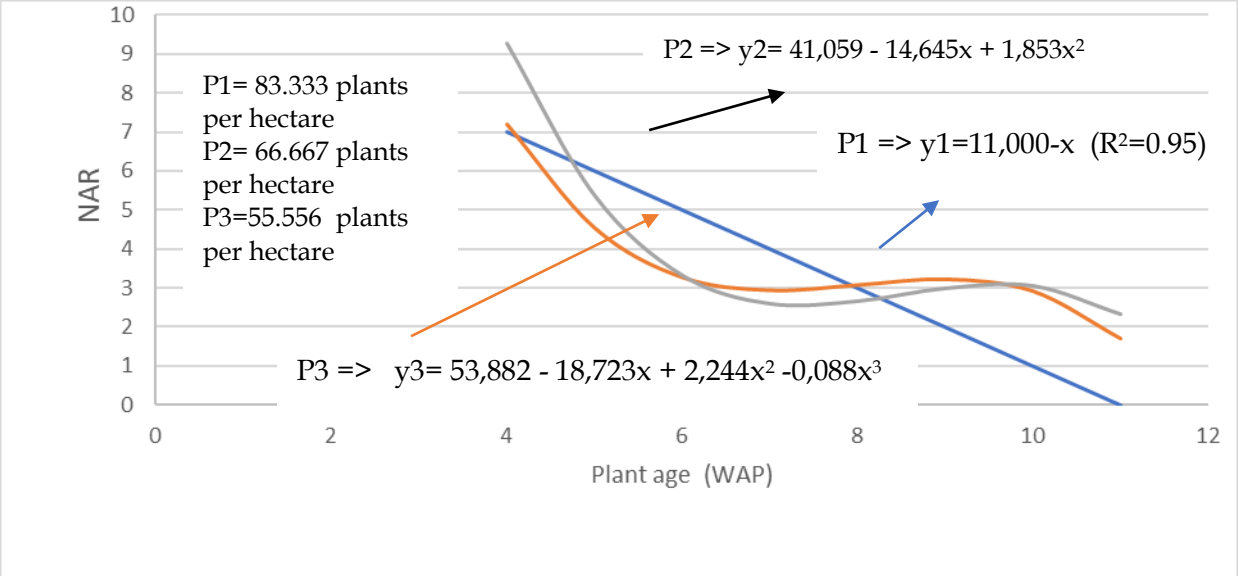


Figure 5. NAR of nutbeans kara oncet cultivar Cangar on various plant populations

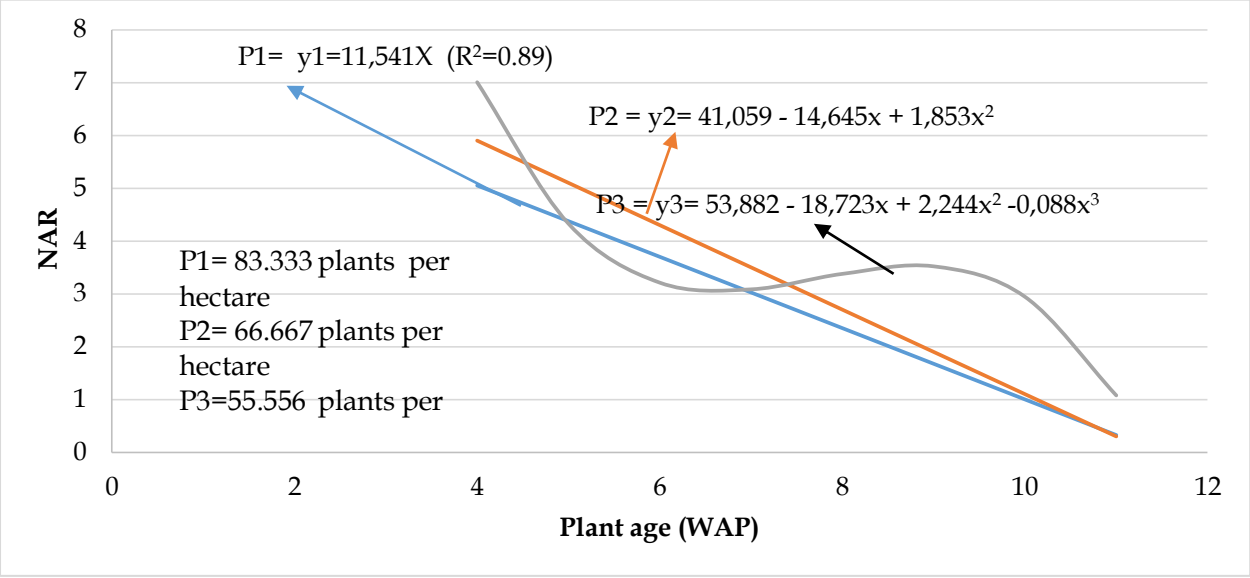


Figure 6. NAR of nutbeans kara oncet cultivar Bromo on various plant populations

Crop Yield Components

The data analysis found that yield components in the form of a number of branches per plant, number of pods per plant, number of seeds per plant, and weight of 25 koro oncet seeds in various populations did not differ simultaneously. However, there were differences between the yield components of the two kara oncet bean cultivars, especially in the number of branches per plant, number of pods per plant, number of seeds per plant, and dry seed yield (Table 5). The difference in the components of the plant yield is thought to be due to each cultivar having different abilities in adapting to the new environment of the Lembang area. This affects the process of photosynthesis, and the resulting photosynthate is then translocated to the formation of seeds.

Table 1. Number of productive branches per plant, number of pods per plant, number of seeds per plant, the weight of 25 dry seeds, dry seed yield tons per hectare

Cultivar	Number of productive branches per plant	Number of pods per plant	number of seeds per plant	weight of 25 dry seeds	dry seed yield tons per hectare
Cangar	3.42 b	12.95 b	14.23 b	0.08 b	0.41 b
Bromo	2.92 a	2.88 a	6.32 a	0.02 a	0.25 a

Note: the average value followed by the same letter in each column does not differ based on the simultaneous confidence interval test at the 5% level

Estimation of nutbean kara oncet yield was calculated by multiple linear regression between yield components and crop yields. The equation is as follows:

Y - - 0.0430 + 0.0009 X1 + 0.0013 X2 + 0.0019 X3 + 8.3814 X4

(R^2 = 0.97)

Where:

Y = yield of nut bean koro oncet (tons per hectare)
X1 = Number of branches per plant
X2 = Number of pods per plant
X3 = Number of seeds per plant
X4 = weight of 25 dry seeds

By using variable selection according to the step-by-step procedure in the response surface methodology, the yield components that can reliably determine the dry seed yield are the number of seeds per plant and the weight of 25 dry seeds with multiple linear regression equations as follows:

$Y = 0{,}040 + 0{,}001\ X_2 + 8{,}390\ X_4$ (R^2 = 0.96)

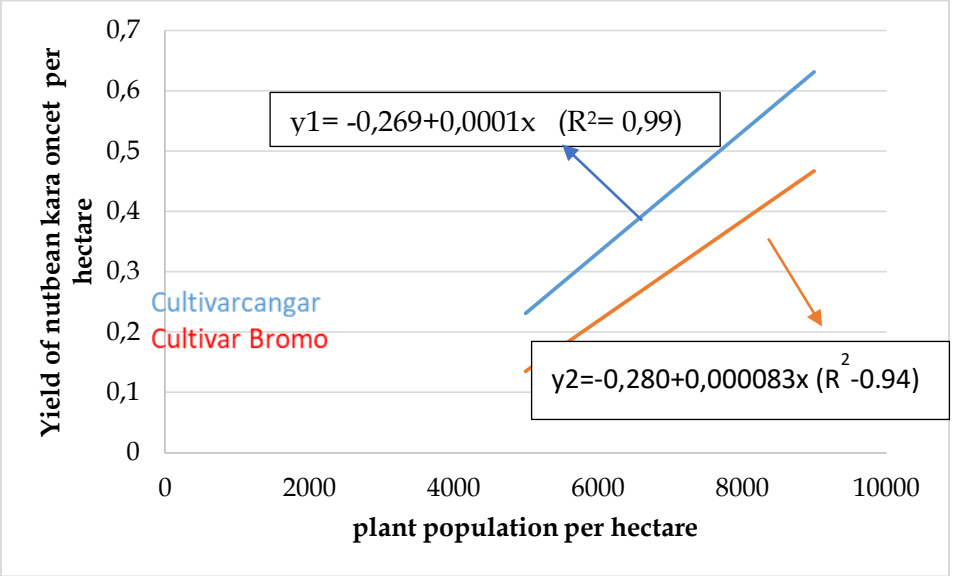
The yield of peanut kara oncet in different populations is shown in Table 2.

Table 2. yield of dry beans (tons per hectare) from each cultivar with different population

Cultivar	Plant Population Per Hectare			Average
Cangar	83.333	66.667	55.556	
	0.5771	0.4011	0.2532	0.4104 b
Bromo	0.3852	0.1983	0.1818	0.2551 a
	0.4812 B	0.2997 AB	0.2175 A	

Note: the average value followed by the same letter in each column does not differ based on the Duncan test level 5%

Based on snugness test responses., the highest yields for the two nutbeans kara oncet cultivars were obtained in a population of 83,333 plants per hectare, followed by 66,667 plants per hectare and 55,556 plants per hectare. However, from the experimental results, the optimum population for the two cultivars has not been obtained based on the response surface methodology with a quadratic model.



Note: the two curves are parallel and do not coincide based on the F with a level of 0.05

Figure 7. The response curve of the plant population to the yield of nutbean kara oncit on two cultivars

CONCLUSION

LAI and PGR as growth dynamics increase rapidly in line with plant growth and development, then decrease again when plants enter the reproductive phase (8 to 10 WAP). NAR of peanut kara oncet Cangar and Bromo cultivars at a population of 83,333 plants per hectare decreased linearly with increasing plant age. While the NAR at a population of 55,556 plants per hectare initially decreased and then increased again when the plant entered the reproductive phase (age 6 to 10 WAP). After that, it again reduced before the plant ended its growth period.

Yield components that can be reliably determined the yield of dry bean seeds are the number of pods per plant, the number of seeds per plant, and the weight of 25 dry seeds.

The optimum population in this study has not been obtained for both Cangar and Bromo cultivars. However, the highest yield was obtained at 83,333 plants per hectare, followed by a population of 66,667 plants per hectare and 55,556 plants per hectare.

The Cangar cultivar kara oncet yielded higher yields in various plant populations than the Bromo cultivar.

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