THE EFFECT OF PLANT SPACING AND PHOSPHOROUS DOSAGE ON GROWTH AND YIELD OF PEANUT (*Arachis hypogea* L.)

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Abstract

This study aims to find out the effect of plant spacing and phosphorous dosage on growth and yield of peanut (Arachis hypogea L.). The research was carried out at Bleboh, Jiken, Blora from February 19th to May 26th 2022. Using 2 factor of Randomized Complete Block Design (RCBD) and 3 repetition. Plant spacing (J) as factor 1 consisted of 3 levels, namely J1 = plant spacing 40 × 10 cm, J2 = plant spacing 40 × 15 cm, J3 = plant spacing 40 × 25 cm. Phosphorous dosage (D) as factor 2 consisted 4 levels, namely D0 = (Control), D1 = phosphorous dosage at 75 kg/ha, D2 = phosphorous dosage at 150 kg/ha, D3 = phosphorous dosage at 225 kg/ha. The data were analyzed using analysis of variance with a further BNJ test with a level of = 5%. The result showed plant spacing (J) affected to all parameters except number of empty pods per plant, which plant spacing 40 × 10 cm (J1) had the best result in plant height and pods weight per plot, whereas plant spacing 40 × 25 cm (J3) had the best result in number of pods per plant, number of pithy pods per plant, pods weight per plant, seeds weight per plant and 100 seeds weight. Phosphorous dosage (D) affected to all parameters except plant height, with the best dose is 150 kg/ha.

Keywords: phosphorous dosage, plant spacing, peanut.

1. Introduction

Peanuts (*Arachis hypogea* L.) are nuts plant that many seen and cultivated in Indonesia. Peanuts known favorite by people because peanuts is the source of vegetable protein. Peanuts can be processed into some kind of food, for example peanut sauce, cookies and peanut jam. Even peanuts are also used as basic ingredients for the industry, that is cooking oil industries. Various types of the product of peanuts cause the need for peanuts increasing every year. On the other hand, peanut production in Indonesia decreases every year. Data from Badan Pusat Statistik (BPS, 2015) said nasional production of peanuts in 2013-2015 has been decreased of 701.680 tons di 2013, 638.896 tons in 2014 and 605.449 tons in 2015.

One of the efforts to increase peanuts production is to improve the cultivation method through the setting of plant spacing. According to Bolly (2018) inappropriate use of plant spacing can cause competition among plants to the plant growth factors. Therefore, competition between plants to the plant growth factors can be reduced by using the right plant spacing

Apart from setting of plant spacing, other efforts to improve the cultivation method is setting the phosphorous dosage. The appropriate of phosphorous dosage can cause the growth and the outgrowth of peanut plants to be more optimal. Phosphor fertilizer are useful in stimulating the growth of roots, the growth of roots flowers and seeds, increasing the amount of percentage of flower and seed formation, increasing plant immunity over pest attacks and diseases, increasing nutrient content in the soil (Hayati et al., 2012).

The purpose of this research is to find out the effect of plant spacing and phosphorous dosage on growth and yield of peanut (*Arachis hypogea* L.)

2. Literature Review

a. Plant Spacing

Plant spacing will affect plant density and efficiency of light use, competition between plants in the use of water and nutrients so that it will affect crop production. At low densities, plants compete less with other plants, so individual performance is better. Meanwhile, at high density, the level of competition between plants for light, water and nutrients is getting tighter so that plant growth can be stunted (Simanjuntak et al., 2018).

In a research conducted by Hawalid (2019) showed that plant spacing had a significant effect on the yield of the number of pods per plant and had a very significant effect on the yield of pod weight per plant with a spacing of 40 cm x 15 cm giving the best results, this can be seen from the highest average value on the observed variables such as the number of pods planted is 33.33 pods and the weight of pods planted is 57.63 g.

b. Phosphorous Dosage

Phosphorus fertilizer is one of the nutrients that is very helpful in increasing plant production, especially for leguminous plants because it is able to stimulate root growth, especially in the early stages of growth. Phosphorus is a component of every cell in plants and tends to be more abundant in seeds and growing points. Phosphorus also plays a role in the formation of pithy pods and accelerates the process of seed maturation of various plants (Yasinta et al., 2017).

In a research conducted by Rantong et al. (2021) showed that the dose of phosphorus fertilizer had a very significant effect on the growth and yield of peanuts, especially on the variables of plant height, number of branches, flowering age, number of seeds per pod, weight of 100 dry seeds, seed production per plot and seed production per hectare. The dose of SP-36 fertilizer 150 kg/ha had the best effect on the number of branches, flowering age, number of pods per plant, weight of 100 dry seeds, production per plot and production per hectare.

3. Research Method

The research was conducted in Bleboh, Jiken District, Blora Regency from February 19th to May 26th 2022. The type of soil in the research location is Grumusol with the height of location is 95 MASL.

The material used in this research is peanut seed with kancil varieties, SP-36, Urea, KCl, cow manure, dolomite, rhizobium biofertilizer, soil with sand texture, Furadan, labels, measuring stick for plant spacing.

The experimental design used in this research was a Randomized Complete Blok Design (RCBD) with 2 factors. Plant spacing (J) as factor 1 consisted of 3 levels namely J1 : plant spacing 40 × 10 cm, J2 : plant spacing 40 × 15 cm and J3 : plant spacing 40 × 25 cm. Phosphorous dosage (D) as factor 2 consisted 4 levels namely D0 : 0 kg/ha of phosphorous, D1 : 75 kg/ha of phosphorous, D2 : 150 kg/ha of phosphorous and D3 : 225 kg/ha of phosphorous. There are 12 combination treatments and each treatments repeated 3 times.

The data of this research were analyzed by analysis of variance and followed by the BNJ test at a significant level of 5%.

This research through several stages, that are research tillage preparation, phosphorous application, planting, maintenance and harvesting.

4. Result and Discussion

a. Plant Height

Phosphorous Dosage (D)	Plant Spacing (J)		
	J1	J2	J3
D0	36,97 a	32,04 a	29,42 a
D1	38,86 a	33,29 a	29,00 a
D2	39,17 a	33,99 a	29,92 a
D3	38,29 a	36,42 a	31,42 a
Average (J)	**38,32 x**	**33,94 y**	**29,94 z**

Plant spacing had a significant effect on the height of peanut plants, with the highest yield is 38.32 cm (J1) because it was suspected that there were differences in the level of competition between peanut plants in each treatment. If the applied of plant spacing is narrower, it shows the greater the value of plant height because it is suspected that the narrower the plant spacing applied, the canopy of the plants will cover each other then etiolation occurs on the plant and causes the plant stem to rise. According to Muttaqin *et al.* (2016) overlapping the canopy between plants with each other results in the uneven distribution of sunlight on plants so that etiolation occurs because plants do not get enough sunlight which is regulated by the hormone auxin.

b. Number of pods per plant

Phosphorous Dosage (D)	Plant Spacing (J)			Average (D)
	J1	J2	J3	
D0	15,17 a	22,50 a	34,17 a	**23,94 q**
D1	19,67 a	22,83 a	35,83 a	**26,11 pq**
D2	21,44 a	18,17 a	42,50 a	**30,70 p**
D3	15,83 a	24,42 a	32, 83 a	**24,36 q**
Average (J)	**18,03 z**	**24,48 y**	**36,33 x**	

Plant spacing has a significant effect on the number of pods per plant with the highest yield is 36.33 pieces (J3), because it is suspected that plant spacing affects plant competition for plant growth factors such as soil nutrients, water, and sunlight. The loose spacing allows the plant to fall, causing more peanut gynophores that can enter the soil and then resulting in the formation of more peanut pods (Yayang et al., 2014).

Phosphorus dosage setting had a significant effect on the number of pods per plant with the highest yield is 30.70 pieces (D2) because sufficient phosphorus nutrients will be used by plants for their metabolic processes. Elviani et al. (2022) stated that phosphorus in the soil is sufficient for plant absorption to be used in metabolic processes such as plant photosynthesis, especially in the fixation of carbon dioxide to form carbohydrates which are then transported to the formation of pods.

c. Number of pithy pods per plant

Phosphorous Dosage (D)	Plant Spacing (J)			Average (D)
	J1	J2	J3	
D0	13,00 a	20,67 a	32,67 a	**22,11 q**
D1	17,50 a	21,42 a	33,50 a	**24,14 pq**
D2	20,00 a	27,33 a	41,33 a	**29,56 p**
D3	13,94 a	22,83 a	30,67 a	**22,48 q**
Average (J)	**16,11 z**	**23,06 y**	**34,54 x**	

Plant spacing had a significant effect on number of pithy pods per plant with the highest yield is 34.54 pieces (J3) because plant spacing was thought to affect plant competition for plant growth factors such as nutrients, soil, water, and sunlight. According to Yayang et al. (2014) if the plant spacing applied is more tenuous, it causes the sunlight obtained by plants to be used in photosynthesis is getting bigger, which results in greater opportunities for plants to grow well and the production yields of plants that apply a more tenuous spacing will be large.

Phosphorus dosage setting had a significant effect on the number of pithy pods per plant with the highest yield is 29.56 pieces (D2) because it was suspected that phosphorus fertilizer affected the process of pod and seed formation in peanut plants. According to Sirait and Siahaan (2019) for plants, phosphorus nutrients can improve growth in the generative phase, especially the process of forming flowers, fruit and seeds.

d. Number of empty pods per plant

Phosphorous Dosage (D)	Plant Spacing (J)			Average (D)
	J1	J2	J3	
D0	2,17 a	1,83 a	1,50 a	**1,83 p**
D1	2,17 a	1,42 a	2,33 a	**1,97 p**
D2	1,44 a	0,83 a	1,17 a	**1,15 q**
D3	**1,89 a**	**1,58 a**	**2,17 a**	**1,88 p**

Phosphorus dosage setting had a significant effect on the number of empty pods per plant, with the lowest yield is 1.15 pieces (D2), because it is suspected that the addition of phosphorus fertilizer to the soil can increase the amount of phosphorus in the soil which can later be used by peanut plants so that it has an effect on metabolic processes that occur in plants and result in better pod formation. According to Soenyoto (2014) the application of phosphorus fertilizer to the soil with the appropriate dose causes a good start of plant growth and the phosphorus nutrients available to plants will affect the formation of pods to form seeds and cause the peanut pods to be able to mature physiologically.

e. Pods weight per plant

Phosphorous Dosage (D)	Plant Spacing (J)			Average (D)
	J1	J2	J3	
D0	20,19 a	35,48 a	44,53 a	**33,40 q**
D1	25,84 a	32,83 a	49,73 a	**36,13 pq**
D2	28,51 a	37,30 a	53,35 a	**39,72 p**
D3	23,71 a	33,34 a	49,95 a	**35,67 pq**
Average (J)	**24,56 z**	**34,74 y**	**49,39 x**	

Plant spacing had a significant effect on pods weight per plant with the highest yield is 49.39 grams (J3) because it was suspected that the use of loose plant spacing caused an improved root system so that the formation of pods in plants increased and affected the weight of pods per plant. According to Rozak (2020) plants that have a good root system are able to absorb plant growth factors such as water and soil nutrients more optimally, so that photosynthesis occurs optimally and the photosynthate produced will increase. The more photosynthate that is channeled in the process of forming the pods, the more pods formed, so that the weight of the pods increases.

Phosphorus fertilizer dosage setting has a significant effect on pods weight per plant with the highest yield is 39.72 grams (D2) because it is suspected that the application of phosphorus fertilizer in the soil in the right amount causes the initial growth of plants to be better and roots are formed which will subsequently affect the the formation of pods to the formation of seeds and causes the pea pods derived from gynophores to ripen physiologically (Soenyoto, 2014).

f. Pods weight per plot

Phosphorous Dosage (D)	Plant Spacing (J)			Average (D)
	J1	J2	J3	
D0	1283,03 a	1057,80 a	950,67 a	**1097,17 q**
D1	1250,77 a	1093,23 a	976,10 a	**1106,70 q**
D2	1345,40 a	1289,53 a	1113,07 a	**1249,33 p**
D3	1223,43 a	1205,00 a	999,60 a	**1142,68 pq**
Average (J)	**1275,66 x**	**1161,39 y**	**1009,86 z**	

Plant spacing had a significant effect on pods weight per plot with the highest yield is 1275.66 grams (J1) because it was suspected that the spacing used could affect the total population per plot. The narrower plant spacing applied, plant populations per plot and the pods in one plot increased, thus affecting the weight of the pods per plot. In accordance with the statement of Simanjuntak et al. 2018) that the high production of peanuts can be determined by the number of plant populations in a field, while the number of plants per unit area is determined by the size of the plant spacing applied..

The setting of Phosphorus dosages had a significant effect on pods weight per plot with the highest yield is 1249.33 grams (D2) because if the peanut plants were given adequate amounts of phosphorus fertilizer, the seed formation process would take place optimally so that the weight of the peanut production increased (Gusmiatun et al., 2019).

g. Seeds weight per plant

Phosphorous Dosage (D)	Plant Spacing (J)			Average (D)
	J1	J2	J3	
D0	13,42 a	23,63 a	29,92 a	**22,32 q**
D1	16,80 a	22,59 a	30,65 a	**23,35 pq**
D2	17,56 a	26,20 a	35,88 a	**26,55 p**
D3	16,04 a	22,21 a	30,88 a	**23,05 q**
Average (J)	**15,95 z**	**23,66 y**	**32,83 x**	

Plant spacing has a significant effect on seeds weight per plant with the highest yield is 32.83 grams (J3). It is suspected that the wider the spacing used, the better the plant root system. The better the plant root system, the better the plant's root system in absorbing nutrients and metabolism in plants so that it will cause a large number of metabolic products to be stockpiled in the seeds which affects the higher seed weight per plant (Rozak, 2020).

Phosphorus dosage setting had a significant effect on seeds weight per plant with the highest yield is 26.55 grams (D2) because the application of phosphorus fertilizer was thought to increase the phosphorus nutrient content for plant absorption. In accordance with the statement of Sirait and Siahaan (2019) that plant metabolism will increase along with the increase in the supply of phosphorus nutrients to plants, which in turn can increase seed filling activity, resulting in an increase of seed weight.

h. 100 seeds weight

Phosphorous Dosage (D)	Plant Spacing (J)			Average (D)
	J1	J2	J3	
D0	48,20 a	42,70 a	52,93 a	**47,94 q**
D1	46,67 a	53,17 a	54,80 a	**51,54 pq**
D2	51,50 a	56,20 a	57,77 a	**55,16 p**
D3	53,37 a	53,43 a	55,70 a	**54,17 p**
Average (J)	**49,93 y**	**51,38 y**	**55,30 x**	

Plant spacing had a significant effect on 100 seeds weight with the highest yield is 55.30 grams (J3) because it is suspected that the use of loose spacing causes sunlight reception and photosynthesis that occurs in peanut plants can take place optimally so that it affects the filling of peanut seeds. In accordance with the statement of Kurnia et al. (2019) that the higher seed weight is due to the amount of light from the sun that the plants receive and the optimal photosynthesis process results in maximum seed growth.

Phosphorus dosage setting had a significant effect on 100 seeds weight with the highest yield is 55.16 grams (D2) because the application of phosphorus fertilizer was thought to increase the phosphorus nutrient content for plant absorption. In accordance with the statement of Sirait and Siahaan (2019) that plant metabolism will increase along with the increase in the supply of phosphorus nutrients to plants, which in turn can increase seed filling activity, resulting in an increase in seed weight.

5. Conclusions

Conclusions from this research are :

a. Plant spacing treatment (J) has a significant effect on the entire observation parameters except number of empty pods. Along with the increasing of plant spacing width followed by an increase in the number of pods per plant with the highest average is 36,33 nuts; number of pithy pods per plant 34,54 nuts, pods weight per plant with the highest average is 49,39 grams, seeds weight per plant with the highest average is 32,83 grams and 100 seeds weight with the highest average is 55,30 grams. While, more narrower plant spacing is followed by an increase of plant

height with the highest average is 38,32 cm and pods weight per plot with the highest average is 1275,66 grams.

b. Phosphorous dosage (D) has significant effect on increasing the number of pods per plant with the highest average is 30,70 nuts; number of pithy pods per plant with the highest average is 29,56 nuts; pods weight per plant with the highest average is 39,72 grams; pods weight per plot with the highest average is 1249,33 grams; seeds weight per plant with the highest average is 26,55 grams; 100 seeds weight with the highest average is 55,16 grams and reduced the number of empty with the lowest average is 1,15 nuts.
c. The interaction between plant spacing (J) and phosphorous dosage (D) does not have a significant effet on the entire observation parameters.

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