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Article

The Influence Of Seed Quantity Per Planting Hole On The Agronomics Of Soybean Variety Dena 1 Under Different Lighting Conditions

Nugraha Ramadhan*, Firsta Ninda Rosadi, Winda Purnama Sari, Obel, Muhsanati, Najeli Rahmatika, Ardiansah

Department of Agronomy, Universitas Andalas, Padang, Indonesia

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*Corresponding Author

nugraharamadhan@agr.unand.ac.id

Abstract

Expansion of soybean cultivation by utilizing land beneath tree canopies and adjusting plant populations can be considered as an alternative to increase national soybean production. The objective of this research is to examine the influence of seed quantity per planting hole on the agronomics of soybean variety Dena 1 under different lighting conditions. This study was conducted from August to November 2023 at the Experimental Garden of the Faculty of Agriculture, Andalas University. The experimental design used was a Completely Randomized Design (CRD) with two factors and three replications. The first factor was lighting conditions, while the second factor was the quantity of seeds per planting hole. Soybean plants under unshaded conditions showed the best influence on plant height, stem diameter, as well as an increase in pod number and percentage of filled pods. The interaction between the treatment of seed quantity per planting hole and different lighting conditions influenced the seed weight per plot, where planting two seeds per planting hole under unshaded conditions yielded the best result at 280.56 g.

INTRODUCTION

Soybean is one of Indonesia's staple foods, containing various essential nutrients for human health. Kancahana et al. [1] and Yudiono [2] mention that soybeans contain omega-6 fatty acids, alpha-linolenic acid, genistein, isoflavones, and daidzein. Additionally, soybeans contain approximately 34% carbohydrates (17% dietary fiber), 34% protein, 5% minerals, 19% oil, and various other components, including vitamins. Despite the high national consumption of soybeans, production levels fluctuate. Indonesia's soybean production was 538.728 tons in 2017, increased to 650.000 tons in 2018, but decreased to 424.189 tons in 2019, and in 2020, soybean production only reached 288.668 tons [3].

The reduction in soybean cultivation area due to land use changes is one of the reasons for the decline in soybean production in Indonesia. The Ministry of Agriculture [3] notes a decrease in soybean cultivation area in 2021 compared to previous years, with 142 thousand hectares in 2021, 189 thousand hectares in 2020, compared to 302 thousand hectares in 2019. Expanding soybean cultivation areas by utilizing land under plantation trees or industrial forest plantation (HTI) as intercropping is expected to be one solution to increase national soybean production [4]. One challenge in soybean cultivation as an intercrop is shading

caused by the main crop. It is hoped that by utilizing shade-tolerant soybean varieties, productivity can be increased.

In addition to expanding cultivation areas, intensification through plant population management can be another alternative to increase productivity. Plant population management includes adjusting the number of seeds per planting hole. Plant population affects competition for sunlight, nutrients, and water absorption. Thus, if not managed properly, it will affect production. Crop yields per unit area depend on the yield per plant and the number of plants per unit area [5]. The aim of this research is to examine the influence of seed quantity per planting hole on the agronomics of soybean variety Dena 1 under different lighting conditions.

EXPERIMENTAL SECTION

This research was conducted from August to November 2023 at the Experimental Garden of the Faculty of Agriculture, Andalas University. Based on data from CHIRPS [6], the minimum rainfall in the research location occurred in August (89 mm) and the maximum rainfall occurred in November (359 mm). The materials used in this study were soybean seeds of Dena 1 variety, manure (20 tons/ha), NPK fertilizer (250 kg/ha), polybags (40 x 40 cm), and 75% shading nets. The tools used included soil tillage equipment, maintenance tools, and several tools for observation. The experimental design used was a Completely Randomized Design (CRD) with two factors and three replications. The first factor was lighting conditions consisting of two levels: without shading and shading (75% shading net). The second factor was the quantity of seeds per planting hole, consisting of three levels: 1 seed/planting hole, 2 seeds/planting hole, and 3 seeds/planting hole. Each treatment consisted of 3 replications, resulting in 18 experimental units. Each experimental unit consisted of 10 polybags, with 4 polybags used for sampling plants. The parameters observed in this study were plant height, leaf number, stem diameter, plant dry weight, pod number, percentage of filled pods, and seed weight per plot. The observation data were statistically analyzed using the F-test at a 5% significance level, and any significant differences were further analyzed using the DNMRT test at a 5% significance level

RESULT AND DISCUSSION

Growth

There was no interaction observed between the two treatments provided. Different lighting conditions influenced the parameters of soybean plant height and stem diameter at 5 WAP (weeks after planting). However, the treatment of seed quantity per planting hole did not show any effect on plant height, leaf number, or stem diameter (Table 1). Visually, soybean plants under shading conditions exhibited symptoms of etiolation, indicated by their very tall morphology (89.97 cm), yet with a small stem diameter (0.38 cm). Etiolation phenomenon causes the plants under shading conditions to have elongated growth with weak, pale leaves and stems, resulting in disproportionate growth in affected plants [7]. Djoemari [8] also stated that etiolation occurs when plant growth elongates or heightens with weak, pale leaves and stems, resulting in disproportionate growth in affected plants. Several research findings indicate the influence of shading on soybean plant height parameters. For example, Munawaroh *et al*. [9] observed etiolation in soybean variety *Ceneng* under shaded

conditions. Sirait & Karyawati [10] found that using 25% and 50% shading had a significant effect on increasing soybean plant height at 6 WAP. However, in the study by Handriawan *et al*. [11], soybean variety Dena 1 did not exhibit etiolation symptoms when subjected to 25% and 50% shading. This could be because, as described, the Dena 1 variety can tolerate shading up to 50% and has an optimal height of approximately 59 cm.

Table 1. Plant height, leaf count, and stem diameter of soybean variety Dena 1 (5 weeks after planting) with different treatments of seed quantity per planting hole and varying lighting conditions.

	1 seed/planting hole	2 seeds/planting hole	3 seeds/planting hole	Average
Plant Height (cm)				
Shaded	92,42	89,96	87,22	89,87 a
No Shade	49,78	45,42	45,20	46,80 b
Average	71,10	67,69	66,21	
Leaf Count (strands)				
Shaded	13,67	13,83	11,07	12,86
No Shade	20,00	19,72	19,32	19,68
Average	16,83	16,78	15,20	
Stem Diameter (cm)				
Shaded	0,40	0,38	0,37	0,38 b
No Shade	0,60	0,55	0,48	0,54 a
Average	0,50	0,46	0,42	

The numbers followed by letters are not the same in the same column significantly different according to the DNMRT advanced test at the 5% level.

Figure 1 illustrates the significant influence of light on soybean plant growth. Based on the graph, soybeans begin to show symptoms of etiolation at around 2 weeks after planting. There is a significant difference in plant height between the shaded treatment and the treatment receiving optimal light. The height of shaded soybean plants at 1 WAP (week after planting) to 5 WAP respectively are 12.52 cm, 23.54 cm, 49.15 cm, 75.19 cm, and 89.87 cm. Meanwhile, for soybean plants without shading, the heights at 1 WAP to 5 WAP are 6.49 cm, 13.87 cm, 19.11 cm, 23.70 cm, and 46.80 cm. The elongation of plant stems under shading stress is considered as a morphological adaptation by plants to obtain optimal light. Kagawa *et al*. [12] mention that in the effort to achieve optimal conditions for photosynthesis, plants will modulate their shape to optimize the amount of light absorbed throughout their life cycle. Phototropism is a typical example of shape modulation and is easily observed under natural conditions.

The lower average values of leaf number and stem diameter in shaded soybean plants are due to the decreased rate of photosynthesis. Soybeans growing in shaded environments during the generative phase experience a reduction in photosynthesis activity, resulting in

reduced allocation of photosynthates to reproductive organs [9]. Lakitan [13] adds that the products of photosynthesis are transported from leaves to other organs such as the stem through phloem vessels. Transportation occurs through the stem, resulting in continuous stem diameter increase, but the opposite occurs when the rate of photosynthesis is very low.

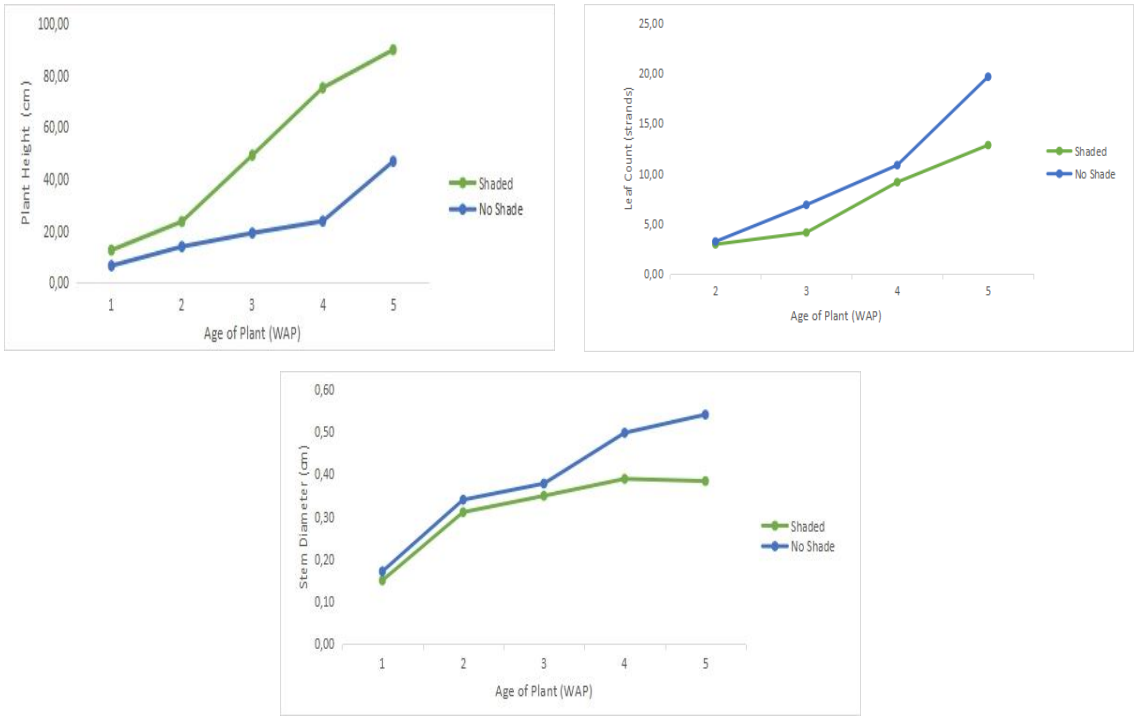

Fig. 1. The graph of plant height, leaf count, and stem diameter of soybean variety Dena 1 (1-5 weeks after planting) under different lighting conditions.

Based on its description, soybean variety Dena 1 can only tolerate shading up to 50%, while in the treatment provided, shading is at 75%. The Shelford tolerance theory states that every organism has a minimum and maximum ecological limit, which are the lower and upper limits of the organism's tolerance range to environmental conditions. If the organism is in an environment approaching the limits of its tolerance range, it will experience stress. Light is an essential factor for plant growth and development because, besides playing a dominant role in photosynthesis, it also acts as a controller, trigger, and modulator of morphogenesis responses, especially in the early stages of plant growth [14].

Dry weight of plants

Table 2 indicates that different lighting conditions have an effect on the dry weight of the plant. However, the quantity of seeds per planting hole does not have an effect on this parameter.

Tabel 2. Dry weight of plant, number of pods, percentage of filled pods, and seed weight per plot of soybean variety Dena 1 with different treatments of seed quantity per planting hole and varying lighting conditions.

	Dry weight of plant (g)			
	1 seed/planting hole	2 seeds/planting hole	3 seeds/planting hole	Average
Shaded	14,43	13,27	13,72	13,81 b
No Shade	27,13	27,12	27,26	27,17 a
Average	20,78	20,20	20,49	

The numbers followed by letters are not the same in the same row and column significantly different according to the DNMRT advanced test at the 5% level.

Soybean plants under optimal lighting conditions have the highest average dry weight of 27.17 g. According to Sitompul & Guritno [15], the number and size of plant canopies will affect the weight of plant biomass, so the taller the plant and the greater the number of leaves, the greater the fresh biomass weight. Although Table 1 shows that shaded soybean plants have the highest average plant height, their stem diameter is the smallest, which will significantly affect the plant weight. Gardner *et al*. [16] add that plant dry weight is related to the accumulation of photosynthesis products in plant organs. The decrease in dry weight in shaded plants is also evident from the study by Handriawan *et al*. [11], where soybeans subjected to 50% shading had a lower dry weight of approximately 61% compared to those without shading.

Plants in shaded environments or with very low light intensity will undergo various agromorphophysiological and anatomical changes. According to Salsabila *et al*. [17], shading stress significantly affects parameters such as plant dry weight, plant height, leaf area, leaf number, nitrogen, chlorophyll, as well as soybean yield components and production.

Production

Table 3 shows that different lighting conditions have an effect on the number of pods and the percentage of filled pods. However, the quantity of seeds per planting hole does not have an effect on these parameters. The interaction between the quantity of seeds per planting hole and different lighting conditions is only observed in the parameter of seed weight per plot. The number of seeds and the percentage of filled pods in shaded plants are much lower compared to those without shading. In shaded soybean plants, the number of pods is only 6.30 pcs, and the percentage of filled pods is 2.42%. Meanwhile, in soybean plants without shading, the number of pods reaches 64.26 pcs, and the percentage of filled pods is 81.89%. Plants experiencing suboptimal light intensity during growth and development will produce low levels of assimilates, resulting in decreased production. Shading during the early

flowering stage will alter the availability of assimilates in developing reproductive structures and reduce flower and pod formation [18]. Baharsyah [19] adds that shading stress on plants leads to decreased plant metabolism, affecting growth and yield.

Tabel 3. Number of pods, percentage of filled pods, and seed weight per plot of soybean variety Dena 1 with different treatments of seed quantity per planting hole and varying lighting conditions.

	1 seed/planting hole	2 seeds/planting hole	3 seeds/planting hole	
		Number of pods (pcs)		
Shaded	7,00	6,56	5,33	6,30 b
No Shade	62,56	70,22	60,00	64,26 a
Average	34,78	38,39	32,67	
		Percentage of filled pods (%)		
Shaded	2,56	2,38	2,33	2,42 b
No Shade	83,60	83,53	78,55	81,89 a
Average	43,08	42,95	40,44	
		Seed weight per plot (g)		
Shaded	13,94 c	11,09 c	10,89 c	11,97
No Shade	205,38 b	280,56 a	258,77 a	248,24
Average	109,66	145,82	134,83	

The numbers followed by letters are not the same in the same row and column significantly different according to the DNMRT advanced test at the 5% level.

The quantity of seeds per planting hole and lighting conditions significantly influence the weight of soybean seeds. Planting two seeds per planting hole under unshaded conditions shows the best treatment for seed weight, with a value of 280.56 g. Meanwhile, the lowest seed weight is observed in all treatments with varying seed quantities per planting hole under shaded conditions. This is influenced by the low yield components in those shaded treatments, such as the low yield component and percentage of filled pods (Table 3). This finding is consistent with the statement by Susanto & Sundari [20], which suggests that as shading intensity increases, it can enhance soybean plant height and specific leaf area. However, the rates of light absorption, photosynthesis, chlorophyll content, leaf number, percentage of filled pods, and soybean seed weight will decrease.

CONCLUSION

Soybean plants under unshaded conditions show the best influence on plant height, stem diameter, and an increase in pod number and percentage of filled pods. The interaction between the quantity of seeds per planting hole and different lighting conditions affects the seed weight per plot. Planting two seeds per planting hole under unshaded conditions yields the best result, with a seed weight of 280.56 g.

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