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STUDY OF DIFFERENCES IN PLANTING TIME ON YIELD OF PEANUT BY INTERCROPPING WITH THE SORGHUM PLANTING MODEL IN DRY LAND

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ABSTRACT

Peanut is one of the potential legumes used in intercropping systems. Peanut cultivation in intercropping is often depressed due to competition with other plants which reduces yield; therefore intercropping of peanuts with sorghum must be carried out properly. One way to minimize competition in the intercropping system is arranging planting time. Aim of this study is to determine growth and yield of peanuts at different planting times in the intercropping with sorghum at many planting models in dry land. The experiment has been carried out at the Pringgabaya Agricultural Technology Research and Assessment Installation (IP2TP) East Lombok, September 2020 – January 2021. Split Plot design was used with three peanut planting times (as the main plot) which are 14 days before sorghum, same planting time with sorghum, and 14 days after sorghum. Sorghum planting model (as subplot): single row (70 cm x 20 cm spacing) 1 plant per clump, double row 20 cm x (50 cm – 100 cm) spacing 1 plant per clump, double row spacing 40 cm x (40 cm – 100 cm) 2 plants per clump. The highest peanut yield 1.69 t/ha, obtained when peanuts planted 14 days before sorghum with a double row sorghum planting model with a spacing of 40 cm x (40 cm – 100 cm) 2 plants per clump (1.69 t/ha). This can be recommended for peanut-sorghum intercropping systems in dry land.

KEY WORDS

Peanut, planting time, intercropping, dry land.

Intercropping is a cropping system with more than one type of plant in an area of land at the same time [1; 2]. Intercropping involves two or more plant species or genotypes that grow side by side for a time [3]. Intercropping is expected to optimize land productivity, especially in dry land. The advantages of the intercropping system include increasing labor efficiency, resource efficiency in the form of land use and absorption of sunlight, increasing yield through increasing population by adjusting plant spacing, obtaining production of more than one commodity in one area, having the opportunity to get yield from one crop when the other crop failure occurs. Combination of several crops can create biological stability in the intercropping that is possible to suppress weed growth, pest and disease attacks and maintain the sustainability of land resources, especially soil fertility [4]. The intercropping cassava on mound on dry land can reduce erosion [5].

Intercropping systems can increase the productivity of dry land if the combined crops form mutually beneficial interactions. Seasonal legumes are often used as combination crops in intercropping because legumes have many benefits in supporting sustainable agriculture [6]. Peanuts are one examples of legume that is used in intercropping system. However, planting peanuts between rows of taller crops in an intercropping often causes peanut experience shade. The height of peanut plants was lower, while the other plants intercropped with peanuts is wider and taller and have a more aggressive growth rate, causing peanuts to be susceptible to shade. Shade can inhibit growth and reduce crop production. Research [7] showed that shading in an intercropping system could reduce the number of pods, 100 pods weight and 100 seed weight. One way to minimize shade is by

arranging the timing of planting. The sorghum planting model relates to the arrangement of plants in optimal spacing. Spacing is the regulation of plant population until it reaches the optimal number of plants that can increase yield per unit area. Proper spacing can increase plant population per unit of maximum land area but affect competition between plants for water and nutrients [8] therefore it will affect yields [9]. Research [10] showed that the spacing of 71 x 107 cm in double rows with a plant population of 123,500/ha plants gave the highest diameter and optimal yield of sweet sorghum.

The arrangement of planting time needs to be done in order to benefit or not to harm the intercropped plants. Timing of planting can minimize shade and increase the efficiency of nutrient utilization on dry land. Differences in planting time between two or more crops in a plot can reduce competition in using nutrients, growing space and water. The delay in planting one crops is intended manage that the maximum growth does not occur at the same time. The timing of planting is basically to minimize competition for light and other growth factors, especially in the critical period of each plant. The critical period for peanuts is about 14-35 days after planting [11]. Research [12] showed that the timing of soybean planting is one of the most important to minimize competition between intercrops and to get high yields. This will help efforts to achieve the yield potential of the two types of intercropping plants [13].

The timing of planting peanuts in intercropping with sweet corn shows that planting peanuts before planting corn will give maximum yield [14]. Research [15] showed the best growth of sweet corn and peanuts when planting peanuts simultaneously or 15 days before planting sweet corn. On the other hand, the research [16] showed that the difference in planting time of peanuts in intercropping between peanuts and corn did not affect the growth and yield components of peanuts. In the cultivation of double row cassava and peanut in an intercropping manner, peanut planting is carried out 20 days earlier than planting cassava [17; 18]. In the research [19] showed that intercropping of sorghum and peanuts causes low growth and yield of peanuts, so it is necessary to study the timing of planting peanuts by intercropping with sorghum in order to increase growth and yield of peanuts.

The yield of peanuts as intercrops in the intercropping system can be maximized by setting the right planting time. The study of the right planting time in the intercropping system is very important as a source of recommendations for the intercropping of peanuts and sorghum in dry land. This study aims to determine the effect of differences in planting time on growth and yield of peanuts intercropped with various models of planting sorghum in dry land with dry climate.

MATERIALS AND METHODS OF RESEARCH

This experiment used a field experiment method that has been carried out at the Agricultural Technology Research and Assessment Installation (IP2TP) Labuhan Lombok, Pringgabaya District, East Lombok Regency in September 2020 - January 2021. The materials used are local sorghum seeds from Bima City (Gando Keta) and North Lombok local peanut seeds.

The experiment was arranged according to the Split Plot Design with 2 treatment factors, that are the planting time of peanuts as the main plot consisting of W1: Peanuts planted 14 days before sorghum, W2: Peanuts planted at the same time with sorghum, W3: Peanuts planted 14 days after sorghum, the model of Plant sorghum as sub-plots consisting of P1: Single row planting model (70 cm x 20 cm spacing) 1 plant per clump, P2: Double row planting model with 20 cm x (50 cm – 100 cm) spacing of 1 plant per clump, P3: Double row planting model with a spacing of 40 cm x (40 cm – 100 cm) 2 plants per clump. Each treatment combination was replicated 4 blocks (replicates).

Land preparation carried out is clearing the soil from weeds followed by minimum tillage. Experimental plots measuring 4.0 m x 3.0 m with a distance between plots of 100 cm which also serves as a drainage channel. Sorghum and peanuts were planted at the time and spacing according to the treatment. The planting of sorghum and peanuts is done by making seed holes, with 2 seeds per hole. Thinning was done at 7-10 days after planting

(DAP) by leaving the number of plants according to the treatment. Seed treatment was carried out before planting using insecticides with metalaxyl active ingredients (Cruiser) to prevent pre-growth pests. Sorghum maintenance carried out included replanting at 7 DAP, fertilizing, weeding and watering. Sorghum fertilization was given equivalent to 350 kg/ha NPK 15:15:15 + 250 kg/ha Urea twice, namely at the age of 7 – 10 DAP with 100% NPK 15:15:15 and 10% Urea, and at the age of 30 – 35 DAP with 90% Urea. Peanut fertilization is done at once at 7-10 DAP with 50 kg / ha Urea. Fertilization is done by applying fertilizer at a distance of 5-7 cm beside the plant stems and a depth of 5 cm. Weeding was done manually every 14 days until the peanut plants started to form gynophores. Irrigation was carried out five times, namely at planting time, 7 DAP, 21 DAP, 40 DAP and 55 DAP. Peanut plant pest control was carried out chemically at the age of 40 days using an Acaricide with the active ingredient Abamectin to control mites and trips. Peanut harvested at 90 DAP when the pods had hardened, fibrous and the inside of the pods was blackish brown.

Peanut growth parameters were observed at 49 DAP and yield parameters at harvest. Peanut growth parameters observed were plant height by measuring from the base of the stem to the highest growing point, the greenness of the leaves using the Chlorophyll meter SPAD-502 Plus and leaf area using the millimeter method. The yield parameters observed were the pod number, pod weight, number of pod bearing seeds, seed number, seed weight, and 100 seed weight. Yield per hectare was calculated by converting the weight of seeds per plant. Data were analyzed by analysis of variance (Anova) and Tukey's HSD test at a confidence level of 95% using Minitab software version 16.

RESULTS AND DISCUSSION

Difference in planting time of peanuts has a significant effect on vegetative growth and peanut yield parameters. The sorghum cropping model had a significant effect only on the number of pods, weight of pods planted and yield. The interaction of peanut planting time and sorghum planting model had a significant effect on vegetative growth and peanut yield parameters. Therefore, the presentation of data and discussion focused on the effect of interaction.

The height of peanuts in sorghum-peanut intercropping planted 14 days before planting sorghum was lower than the height of peanuts in other treatments (Figure 1). Peanut plant height ranging from 44 to 53 cm is still in the normal category because of the research [20], the height of the local North Lombok peanut plant in Narmada, West Lombok is $\pm$ 50 cm. Peanut intercropping 14 days after planting sorghum with double row sorghum planting model with a spacing of 40 cm x (40 cm – 100 cm) 2 plants per clump had the highest plant size. Research [21] on corn and peanut intercropping showed the highest plant growth response on peanut planting 14 days after corn planting. Timing of planting is related to efforts to keep growth factors such as nutrients, water and sunlight available optimally, especially in critical periods of plants. The delay in planting peanuts by 14 days and the more aggressive growth of sorghum caused the peanut plants to be shaded and lack sunlight. The more shade, the less sunlight received by peanut plants [22]. The low amount of light received causes plants to experience physiological changes, one of which is an increase in plant height [23]. Stem elongation that occurs is a symptom of etiolation. Etiolation causes plant height to be higher due to the accumulation of the hormone auxin in the apical part of the plant which is not degraded by sunlight [24]. Shade increases the content of auxin and gibberellins [25]. Stem elongation is carried out by plants as an effort for plants to find light in order to carry out photosynthesis optimally.

The green leaf level in peanut intercropping planted 14 days after planting sorghum with various models of sorghum planting was lower than the leaf green level of peanut in intercropping planted 14 days before planting sorghum or at the same time with planting sorghum (Figure 2). Leaf green is influenced by nitrogen content in the leaves. There are two factors that determine nitrogen levels in leaves, namely directly by metabolism in plants through photosynthesis and indirectly through the position of the shaded leaves. Shade causes inhibition of nitrogen fixation by Rhizobium. The effect of shade on nitrogen fixation is

related to the direct effect of photosynthesis on the symbiosis of peanut plants and *Rhizobium*. *Rhizobium* requires assimilate as an energy source and reductant in nitrogen fixing activity [26]. The symbiosis of peanuts and *Rhizobium* produces nitrogen which is used in the formation of chlorophyll, protoplasts, proteins and nucleic acids. Plants that grow with sufficient nitrogen content will be green and have the ability to control the photosynthesis process [27-29].

Figure 1 – Average (Mean $\pm$ SE) of peanut plant height in each combination of treatment with peanut planting time and sorghum planting model

Figure 2 – Average (Mean $\pm$ SE) greenish level of peanut leaves in each combination of treatment with peanut planting time and sorghum planting model

Figure 3 – The mean (Mean $\pm$ SE) of peanut leaf area in each treatment combination of peanut planting time and sorghum planting model

Peanut planted 14 days before planting sorghum with various models of sorghum planting had a larger leaf area than other treatment interactions (Figure 3). Research [16] showed that planting peanuts 10 days before planting corn with a double row planting model was able to increase the leaf area of peanut plants. Research [30] showed that the most extensive leaves were obtained on peanut plants planted 15 days before planting corn. Peanut planting time 14 days before planting sorghum and setting the population density of sorghum plants can minimize competition for nutrients, water and sunlight, between peanuts and sorghum, especially in the critical phase of peanut plants. Research [11] showed that the critical phase of competition between peanuts and weeds occurred at 14-35 DAP. The double row planting model increases the intensity of sunlight received by the lower canopy of sorghum and peanut plants. The high intensity of sunlight is used by plants to increase the rate of the photosynthesis process so as to produce a lot of assimilate. In the vegetative phase, assimilate is used by plants, one of which is to form large leaves. Research [31] stated that the resulting assimilate is distributed to the vegetative parts for the formation of new organs including the formation of leaves with a wide surface. Efforts to determine the relationship between vegetative growth and yield, then conducted a correlation analysis.

The results of the correlation analysis (Table 1) showed that the growth parameters were positively and significantly correlated ($p < 0.05$) with the peanut yield parameters. The correlation value of leaf area ($r = 0.568$) was higher than that of green leaf level ($r = 0.377$) which means that leaf area had a greater effect on production than leaf green level. The broad, flat leaf surface increases light capture per unit volume and minimizes the distance

CO₂ travels from the leaf surface to the chloroplast [32]. In the process of photosynthesis, the light received by the leaves will be converted into chemical energy that produces oxygen and hydrogen [33]. Research [34] shows that the wider the leaf area on a plant, the higher the assimilation value. The green leaf level is related to the chlorophyll content. The formation of chlorophyll in leaves is dominantly influenced by sunlight. Chlorophyll is the main photosynthetic pigment that plays a role in absorbing sunlight which will then be converted into chemical energy [35], so chlorophyll is referred to as the central pigment of the photosynthetic reaction because it can stimulate CO₂ fixation to produce carbohydrates [36] as assimilate.

Table 1 – Correlation between growth parameters and peanut yield

Parameter	Plant height	Leaf Green Level	Leaf Area	Number of Pods	Pods Weight	Weight 100 Seeds
Leaf Green Level	0.065					
<i>P-Value</i>	0.709					
Leaf Area	-0.008	0.436				
<i>P-Value</i>	0.964	0.008				
Number of Pods	-0.317	0.384	0.716			
<i>P-Value</i>	0.060	0.021	0.000			
Pods Weight	-0.278	0.459	0.629	0.952		
<i>P-Value</i>	0.101	0.005	0.000	0.000		
Weight 100 Seeds	-0.075	0.054	0.480	0.524	0.527	
<i>P-Value</i>	0.663	0.755	0.003	0.001	0.001	
Production	-0.245	0.377*	0.568*	0.939	0.939	0.476
<i>P-Value</i>	0.149	0.024	0.000	0.000	0.000	0.003

Figure 4 – Regression relationship between leaf area (a) and green leaf level (b) with peanut yield

The results of the regression analysis of leaf area and green leaf level on yield (Figure 4) showed that each additional unit of leaf area increased peanut yield by 0.0295 t/ha and the addition of one unit of green leaf level increased production of 0.1085 t/ha. Leaf area affects yield by 32.27% and green leaf level affects yield by 14.18% while the rest is influenced by other factors. Leaf area and green leaf level are related to the process of photosynthesis, the higher the rate of photosynthesis, the more the amount of assimilates produced. Assimilate is stored in plant organs and is needed by plants as a source of energy for various metabolic processes and the formation of plant products.

The results of the analysis of variance on the interaction between the planting time of peanuts and the sorghum planting model showed that the intercropping of peanuts planted 14 days before planting sorghum with the double row sorghum planting model with a spacing of 40 cm x (40 cm – 100 cm) 2 plants per clump had the highest value at number of pods planted, weight of pods, weight of 100 seeds and yield. Peanut intercropping planted 14 days before planting sorghum with double row sorghum planting model was more dominant in increasing peanut yields than single row sorghum planting model. The right planting time and arrangement of plant populations in double rows have a positive effect on plant vegetative growth which in turn will have an impact on yield parameters and peanut crop production.

Figure 5 – Average (Mean $\pm$ SE) number of pods per plant in each treatment combination of peanut planting time and sorghum planting model

Figure 6 – Average (Mean $\pm$ SE) weight of pods per plant in each treatment combination of peanut planting time and sorghum planting model

Figure 7 – Average (Mean $\pm$ SE) weight of 100 seeds in each treatment combination of peanut planting time and sorghum planting model

Figure 8 – Average (Mean $\pm$ SE) yield in each treatment combination of peanut planting time and sorghum planting model

Peanut yield components were low in the interaction of peanut intercropping planted at the same time with sorghum and peanut intercropping planted 14 days after planting sorghum with various models of sorghum planting. Sorghum cropping model affects plant population density. The model of planting sorghum in double rows provides a large enough space to allow sunlight radiation to be well received by the peanut leaves. According to research [37] on corn and soybean intercropping showed that double row intercropping increased PAR (Photosynthetically Active Radiation) above soybean canopy compared to single row intercropping. Spacing arrangements affect the efficiency of the use of solar radiation and competition between plants in intercropping systems [38].

The number of pods and pod weight were higher in the interaction of peanut intercropping planted 14 days before planting sorghum with a double row planting model with a spacing of 40 cm x (40 cm – 100 cm) 2 plants per clump with a spacing of 40 cm x 20 cm for peanuts (two rows between rows of sorghum) is in line with the research of [39] showed that planting soybeans 2 weeks before planting sugarcane by intercropping resulted in higher pod weight and seed weight. The interaction of peanut planting time 14 days earlier and the model of planting sorghum in double rows were able to minimize the competition for absorption of nutrients, water and sunlight between plants, especially in the critical phase and create a microclimate around the plant that supports flowering. Air temperature and humidity affect the number of flowers formed; the number of flowers that develop into gynophores and pods is positively correlated with pod yield. The pods are formed from flowers and gynophores which are formed in the early period and are located not too high so that the pod filling period becomes longer [40]. Pod filling is closely related to the ability of plants to produce assimilate. The formation of leaf area and green leaf level takes place

optimally to support the rate of photosynthesis to produce assimilate. Pod weight is related to the plant's ability to carry out photosynthesis and produce assimilate in the form of carbohydrates. Carbohydrates produced in photosynthesis are converted into proteins, fatty acids, nucleic acids and other organic molecules, during the generative phase of the plant assimilate will be stored in generative organs such as pods and seeds. The more assimilate, the greater the number and weight of the pods/seeds produced, which in turn will increase crop production.

The lowest weight of 100 peanut seeds (19.75 g) was obtained at interaction of peanut planted 14 days after planting sorghum with single row sorghum planting model. The weight of 100 seeds is influenced by the genetic characteristics of the plant and the environment. The genetic nature of plants is related to the size of the seeds, while environmental influences are related to the availability of nutrients, water and sunlight that play a role in the photosynthesis process, the higher the rate of photosynthesis, the more assimilate produced. In the generative phase, assimilate is distributed and stored in production organs such as pods and seeds. The large size of the seeds and the large number of assimilates will result in a high weight of 100 seeds. The difference in planting time for peanuts and sorghum planting models is an environmental regulation in an intercropping system that is carried out to minimize competition between plants in obtaining nutrients, water and sunlight so that they remain optimally available. Research [41] showed that wide spacing resulted in a higher weight of 100 soybean seeds than narrower spacing. Planting time of peanut 14 days after planting sorghum with single row sorghum planting model, causes more aggressive growth of sorghum plants and the close distance between plants causes competition, especially sunlight. Peanuts are shaded and the intensity of sunlight received is low, causing the rate of photosynthesis to be low. So that the amount of assimilate produced and stored in the seeds is reduced and the weight of 100 seeds is low.

Optimal vegetative growth of peanuts in peanut planted 14 days before planting sorghum with double row sorghum planting model with a spacing of 40 cm x (40 cm – 100 cm) 2 plants per clump caused the plant yield to be high compared to other treatments. Research [42] show that the closer the spacing, the higher the population, the less sunlight received by plants, so that the photosynthesis process is hampered and causes production to decrease. Plant needs for nutrients, water and sunlight are optimally met due to low competition between plants during vegetative growth through the timing of planting peanut and sorghum planting models. Peanut planting time and sorghum planting model are able to produce optimal plant height so that they can receive the maximum intensity of sunlight, the intensity of light received by the leaves will increase the chlorophyll content of the leaves. The high content of chloroplasts and the large number of stomata in plant leaves will stimulate the entry and exit of water and CO₂ thereby increasing the rate of photosynthesis and producing assimilate. In the generative phase, plant assimilates are distributed to generative organs such as flowers, pods and seeds. The greater the amount of assimilate that is distributed and received by the generative organs, the more pods are formed, and the heavier the weight of the pods and seeds so that plant production is higher.

CONCLUSION

Peanut planting time with sorghum row arrangement in intercropping affects the growth and yield of peanut plants. The highest yield of peanuts was obtained at the time of planting peanuts 14 days before planting sorghum with a double row sorghum planting model with a spacing of 40 cm x (40 cm – 100 cm) 2 plants per clump of 1.69 t/ha.

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