COMPETITION STUDY OF COWPEA (*VIGNA UNGUICULATA* L. WALP) AND *BIDENS PILOSA* L. USING REPLACEMENT SERIES APPROACH

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ABSTRACT

Weeds disturb plants through competition or competition that occurs with cultivated plants. Weed competition can reduce crop production by up to 40%, as well as reduce seed quality. The amount of competition between weeds and plants is determined by the density of weeds, the length of time they grow with cultivated plants, and the type of weeds. Thus, it is necessary to increase productivity by considering the presence of weeds that can reduce production. On this basis, it is necessary to conduct research on the competition between cowpea and weeds using the replacement series method. Replacement series is a method used to evaluate competition between species by studying interspecific and intraspecific interactions of plant combinations. This research was carried out in the greenhouse of SEAMEO BIOTROP July – September 2021. This study used a simple randomized block design with a single factor, namely the composition of weeds with 5 treatment levels, namely: P1: 100% weeds. , P2: 75% weeds + 25% cowpeas, P3: 50% weeds + 50% cowpeas, P4: 25% weeds + 75% cowpeas, and P5: 100% cowpeas. The observation parameters are growth parameters represented by plant height variables and yield parameters are represented by dry weight. The results showed that the increasing proportion of weeds was accompanied by a decrease in the dry weight of cowpea. Vice versa. Then, the results of plant height measurements show that the increasing proportion of weeds and plants will be accompanied by a decrease in the height of their competitors. The results of the analysis of RYT values showed that there was competition between weeds and cowpeas at the P3 treatment level: 50% weeds and 50% cowpeas. Meanwhile, in other proportions there is a negative interaction.

INTRODUCTION

Weeds are plants that are easy to grow in different places, ranging from nutrient-poor to nutrient-rich places. It is this property that distinguishes weeds from cultivated plants. In addition, weeds can also form seeds in large quantities, this is what causes weeds to rapidly multiply (Palijama, 2012). Weeds are plants that are not desired by farmers, because they can reduce profits in cultivation businesses. Weeds that grow and are around cultivated plants can inhibit growth as well as suppress the final result. Competition between plants and weeds occurs both above the soil surface in the form of competition in getting sunlight, CO2 and growing space, competition for water and nutrients (Indriyanto, 2010) The cultivation of cowpea nuts does not escape from several inhibiting factors. One of the factors is the presence of weeds. Weeds disrupt plants through competition or competition that occurs with cultivated plants. The existence of weed competition can reduce crop production by up to 40%, as well as reduce seed quality (Cahyanti et al. 2005).

The magnitude of the competition between weeds and plants is determined by the density of weeds, the duration of growing with cultivated plants, as well as the type of weeds. Thus, it is necessary to make efforts to increase productivity by considering the factors of the presence of weeds that can reduce production (Rachmadhani et al. 2014). On this basis, research is needed on the competition between cowpea and weeds using the replacement series method. Replacement series is a method used to evaluate competition between species by studying the interspecific and intraspecific interactions of plant combinations (Park, 2003).

METHODS

Research was conducted at SEAMEO BIOTROP Greenhouse from seeding to harvesting using plastic pots. The planting medium used is a mixture of soil and compost in a ratio (1: 1). The combination of replacement series for *Vigna unguiculata* and *B. pilosa* in proportions of 8:0, 6:2, 4:4, 2:6, 0:8 i.e. 100%, 75%, 50%, 25%, and 0% beans (*Vigna unguiculata* L. Walp). The treatment is completely regulated with 4 tests, so there are 20 experimental units. The parameters observed were the height of plants and weeds from the soil surface to the highest leaf tips as well as the overall dry weight of plants and weeds.

This study used a 1-factor Randomized Group Design (RAK), namely the proportion of cowpea and weeds with 5 levels of treatment repeated 4 times. The level of treatment includes:

P1: 100% Ketul Weed

P2: 75% Ketul Weeds + 25% Cowpea Beans

P3: 50% Ketul Weeds + 50% Cowpea Beans

P4: 25% Ketul Weeds + 75% Cowpea Beans

P5: 100% Cowpea Beans

This experiment consisted of 20 experimental units. The population of each treatment consisted of 8 plants so that the total number of plants in this study was 160 plants.

Observation Parameters

The observation parameters in this study include growth parameters and yield parameters. Growth parameters are represented by plant height variables and yield variables are represented dry weights. Observations made in this study include:

1. Plant height

   Plant height is measured from the base of the stem above ground level to the highest growing point of the plant. Plant height was measured at 7, 14, 21, and 28 day after treatment.

2. Dry Weight

   Measurements of the dry weight of plants and weeds are carried out at the age of 28 day after treatment. Dry weight is measured with the help of ovens and analytical scales.

3. Data Analysis

   The observational data were analyzed by analysis of the variety of F tests at a level of 5%. If there is a real influence (F calculate > F table 5%), it will be continued with the Smallest Real Difference (BNT) test at the level of 5% to see the difference between the treatment levels. The determination of whether competition occurs or not using the Relative Yield Total (RYT) method.

RESULTS AND DISCUSSION

Plant and Weed Height Based on the results of the analysis of the variety of weed height (appendix 2) on the weed height observation variable with the treatment of the proportion of weed and cowpea beans had a marked effect on weed height at an observation age of 28 day after treatment. Meanwhile, based on data from the analysis of the high variety of cowpea beans (appendix 3), the treatment of the proportion of weed ketul and cowpea beans did not give significantly different results to the height of the cowpea bean crop in each week after treatment. The average height of plants and weeds with the treatment of the proportion of weeds and delinquent cowpea bean crops is different presented in table 1.

Table 1. The average height of plants and weeds with the treatment of the proportion of weeds and delinquent cowpea bean.

Treatment	Cowpea and Ketul weed height (cm)			
	7 DAT	14 DAT	21 DAT	28 DAT
Ketul				
P1	6.25	11.46	15.31	22.1 b
P2	6.23	9.73	14.25	18.57 b
P3	5.93	9.97	14.06	18.18 b
P4	6.43	9.00	11.37	8.78 a
LSD 5%	ns	ns	ns	6.47
KK%	17.25	16.37	19.25	23.94
Cowpea				
P2	19.06	29.68	38.62	70.62
P3	15.28	22.59	29.00	46.43
P4	19.39	29.56	35.04	49.55
P5	20.75	31.03	37.78	48.90
LSD 5%	ns	ns	ns	ns
KK%	34.02	28.88	25.47	28.80

Note: Numbers followed by the same letter at the same age and column show no significant difference based on the 5% LSD test: ns = not significant, DAT = Days After Planting: LSD = Least Significant Difference.

Based on the data in Table 2, it can be seen that the treatment of different proportions of weeds and plants does not affect the height of weeds at 7, 14, and 21 DAT or in other words up to 21 DAT the increase in the number of competing plants does not provide a noticeable difference in the height of weeds. This can happen because the resources at the beginning of planting up to 21 HST are still sufficient for the growth of ketul and cowpea. Then, at 28 DAT the resources contained in the planting medium are further reduced because they are used by weeds and cowpea to grow so that at that time there is a negative interaction between weeds and plants that causes height differences. If examined further, in 28 DAT the treatment that gave the lowest average yield was the P4 treatment (25% weeds + 75% cowpea) in other words weeds at a low density at 28 DAT their growth was suppressed by the presence of cowpea in high proportions.

Height of cowpea bean plants based on the data in table 2 did not give markedly different results in each treatment on all week after planting. This can happen because, the resources that can be utilized by the cowpea are still in sufficient quantities up to 28 DAT. In addition, this shows that the increase in the density of ketul weeds does not have a noticeable effect on the height of cowpea. This can happen because the morphological form of the cowpea bean plant is superior to that of the ketul weed.

Dry Weight of Plants and Weeds

Dry Weight of Plants and Weeds Based on the results of the variety analysis there is a noticeable difference in the variable dry weight of weed ketul and cowpea beans. The average dry weight of weed ketul and cowpea is presented in the following Table 2 .

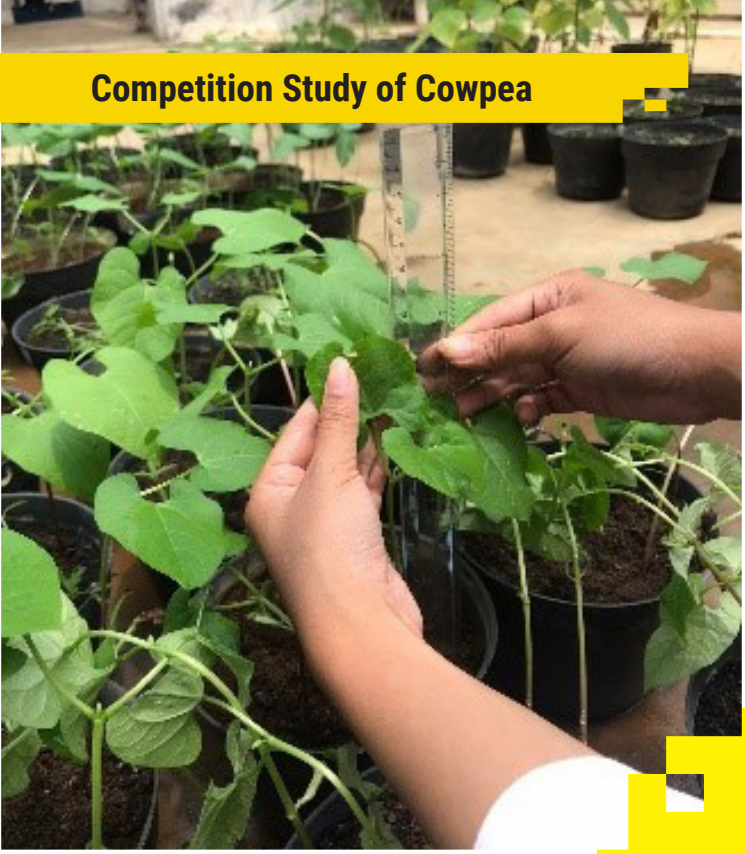
Table 2. Difference dry weight of weed ketul and cowpea beans.

treatment	dry weight (gram)	
	Ketul weed	Cowpea Bean
P1	0.09 a	
P2	0.21 b	1.19 b
P3	0.17 b	0.59 a
P4	0.03 a	0.67 a
P5		0.66 a
LSD 5%	0.1	0.41
KK (%)	52.93	38.67

Note: Numbers followed by the same letter in the same column show no significant difference based on the 5% LSD test. Based on the data in table 2, it can be seen that the proportion of weeds and plants affects the dry weight of ketul weeds and cowpea beans.

The observation also showed that there was a marked difference in the dry weight of weeds in the P2 and P3 treatments against the weed control treatment (P1), while the P4 treatment did not differ markedly from the control treatment. The dry weight of cowpea beans in the P2 treatment differed markedly from the control treatment, while the P2 and P3 treatments did not give markedly different results than the plant control (P5). Then, if it is connected, it can be known that an increase in the proportion of weeds does not decrease the dry weight of the cowpea bean crop. Meanwhile, an increase in the proportion of plants is followed by a decrease in the dry weight of weeds. This is supported by Madkar's (2011) statement which states that the severity of yield loss from weeds varies and depends on a number of different characteristics of weeds, plants and the environment in which they grow.

Association Form Analysis with Relative Yield Total (RYT) There are a variety of terms used to describe the way plants interact. The most commonly used terms are interference



and competition, although they are not always used consistently and are sometimes used interchangeably. Interference describes how plants respond to the presence of neighboring plants. Competition refers to the relative ability of various plants in the community to exploit resources, which will be influenced by how effectively plants acquire resources and how efficiently they use resources for growth and produce seeds. The competitive ability of a species or plant variety describes how well it can limit yield loss from weeds and/or suppress weed growth. Determination of the form of association between weed ketul and cowpea beans in the replacement series method can be done by determining the RYT value. A RYT value equal to 1 indicates that there is competition between two competing species, a RYT<1 value indicates that the two species establish an antagonistic mutual relationship or whose interspecies competition is greater than the intraspecies competition. Then, the RYT value of > 1 indicates that the two species avoid competition for their survival or even work together to form a mutualism relationship. The results of the calculation of RY and RYT values are presented in Table 3.

Table 3. observation of Relative Yield Total (RYT) from Ketul weed and Cowpea.

	Treatment				
	P1	P2	P3	P4	P5
RY Ketul weed	1	2.29	1.86	0.32	0
RY Cowpea (crop)	0	1.79	0.90	1.01	1
RYT	1	4.08	2.76	1.35	1

Based on table 3, it can be seen that in the P2, P3 and P4 treatments have a RYT value of > 1 which means that in all three treatments both species avoid the occurrence of competition, or both form different niches so that competition does not occur. However, based on the RY value, it can be seen that in the P4 treatment there was a very large decrease in the RY value of weeds compared to other treatments, while the RY value of cowpea beans is getting bigger along with the decrease in proportion.

Competition between compea bean and ketul weeds

There are several types of weed and plant interactions, including positive interactions such as associations and negative interactions such as competition and interference. Parameters that can be observed to assess the influence of the proportion of one species on another can be morphological, physiological, or growth and yield parameters. However, further the yield value can be used to determine whether competition occurs or not. At 28 HST there was a noticeable difference in the height of the ketul weed. If examined further, in 28 HST the treatment that gave the lowest average yield was the P4 treatment (25% weeds + 75% cowpea) in other words weeds at a low density at 28 HST their growth was suppressed by the presence of cowpea in high proportions. This is supported by the statement of Gultom (2017) which states that the density of weeds affects their ability to compete, the higher the density, the higher the ability to compete. Conversely, the lower the density value, the lower the competition ability. Then, in another sense, it can be stated that in general, replacement series experiments show that plants are more competitive than weeds because the effect of weeds on plants is due to their density in plants instead of individual competitive capacities (Bianchi et al. 2006).

Meanwhile, an increase in the proportion of weeds does not affect the height of the cowpea bean crop on all MSTs. This can happen because cowpea have better morphological characteristics than ketul weeds in their quest to obtain growing conditions or available resources. This is in accordance with the statement of Madkar (2011), that the morphological form of plants can affect the ability of plants to compete with weeds. Delinquent bean plants belong to the type of legumes or legumes. Legume has a high ability to compete with weeds. The ability of legumes to compete with weeds is related to the ability of plants to control the nutrient cycle in plant ecosystems, especially nitrogen elements. Legume plants can symbiotic with rhizobium bacteria, these bacteria will infect the roots and form root nodules in them. Rhizobium is able to provide nutrients for plants by fixing nitrogen in the atmosphere so that nitrogen is available for plant growth and development (Sari and Prayudaningsih, 2015).

Based on dry weight data, it can be known that an increase in the proportion of weed ketul does not make the dry weight of peanuts in cowpea decrease, on the contrary. An increase in the proportion of delinquent beans leads to a decrease in the dry weight of the ketul weed. This can occur because weeds are suppressed in growth due to the presence of delinquent bean plants in high density. Meanwhile, the increase in weed density did not result in a decrease in the weight of the cowpea beans due to

the superior morphological factors of the beans. This is supported by Sujana's (2017) statement which states that competition between species is also influenced by morphological and physiological factors of both species. Delinquent beans that have a wider leaf canopy, a wider root system, and a high growth speed after germination lead to a higher ability to compete than weeds. This leads to a higher accumulation of dry matter from photosynthesis results. However, if studied further, an increase in the proportion of cowpea tends to decrease the dry weight of cowpea, this can occur due to intraspecific competition among individuals of cowpea beans that have grown. This is supported by the statement of Sarifin (2017), which states that plants associated with weeds will compete for the resources needed if the amount of resources available is very limited for both. If the amount of resources is limited, it will result in competition between the weeds and the plant.

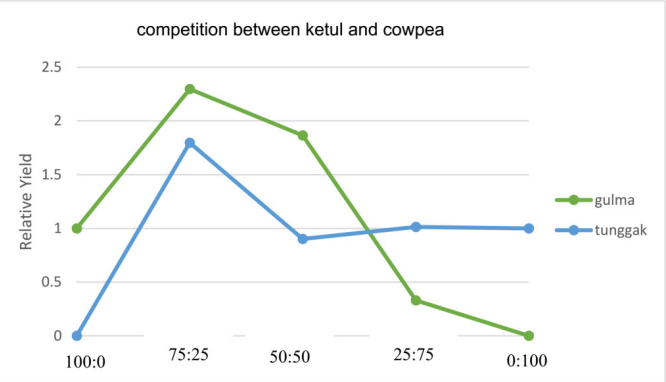


Figure 1. Relative yield total to see the competition between compea bean and ketul weeds

Competition between species will be even greater if the species has growing environmental requirements that are increasingly similar to the species involved. In addition, at too high a density individual plants will compete with other plants that have similar needs in limited resources. The determination of the occurrence of competition can be analyzed using the RYT value. The RYT value describes the effect of the interaction of two or more species on the outcome. The RYT>1 value of positive interactions, RYT=1 of competition, and RYT<1 of mutually antagonistic negative interactions or interspecific competitions of a species is higher than its intraspecific competition. RYT graph the weed of ketul and cowpea beans is presented in Figure 1 above. Based on the graph, it can be seen that in the treatment of P2, P3, and P4 have RYT>1 values, it can be concluded that weed ketul and cowpea beans do not interact negatively or do not compete and form positive interactions. There are several assumptions that can be put forward based on the graph above, one of which is that there is no interspecific competition because the two plants need different resources or the available resources are still sufficient to meet the growth needs of both species. However, if you look at the chart pattern formed, it can be seen that the competition has not yet occurred

but the indicator that there will be competition has been seen where in P4 the RY value of each species decreases compared to other treatments. So, if the planting time is continued until the next MST, competition will soon occur in that proportion.

CONCLUSION

The main results obtained were research data on the competition test between arrears beans and ketul weeds. Includes plant height comparison data and dry weight comparison data. The replacement series approach between cowpea and ketul weeds gives an idea that weed populations play a role in niche competition that exists in the environment of cultivated plants. Competition between weeds and cultivated plants can provide information about the exact timing of the planting to control weeds, so as not to pass the critical period of cultivated plants.

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