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The Effect of Various Weedy Periods on Growth and Yield of Soybean in Agroforestry System with *Kayu Putih*

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ABSTRACT

This study was aimed to detect the effect of various treatment periods of weedy on the growth and yield of soybean; and to determine the most appropriate time periods of weedy for soybean in agroforestry systems with *kayu putih*. The experiment had been conducted in Menggoran, BDH Playen, KPH Yogyakarta, Gunungkidul Regency, Special Province of Yogyakarta from February 28 to May 9, 2015. Randomized Complete Block Design (RCBD) with three blocks as replications waas applied in this experiment. The treatments were weedy periods on 0, 14, 28, 42, and 56 days after planting (dap) and weed-free period on 0, 14, 28, 42, and 56 dap. The results showed that there were significant differences in the soil moisture content, root surface area, root length, chlorophyll content, root dry weight, shoot dry weight, dry weight of soybean seeds, and weed dry weight. The highest seed weight per hectare was found in weed-free until harvest treatment but it was not significantly different from weedy periods after 56 dap and weed-free after 14 dap. The effective periods of weedy time for soybean in agroforestry systems with kayu putih began at 28 dap - 56 dap.

Keywords: Agroforestry, *Kayu Putih*, Soybean, Weed, Weedy Periods

INTRODUCTION

The soybean production is steadily declining over the last five years (BPS, 2014). The unavailability of land becomes a major factor in crop productivity in order to supply the food demand. Utilisation of available land among forest plants becomes an alternative that can be used for planting annual crops, where the combination can scheme a system, called as agroforestry. This system becomes one of the land management systems to overcome the land productivity.

The land between kayu putih plants in the forest has a potency for annual crops. The approach by location specific system on kayu putih plant which forms alley cropping can be used for optimalising the land productivity. The combination between *kayu putih* plants with annual crop can be seen in the resources sharing, where the kayu putih plant influences the annual plant through resource changes, such as light, nutrition, and water (Scholes and Walker, 1993). The establishment of agroforestry systems can be a basis to increase the value of land; in this case, the proper cultivation techniques need to be included in. Intercropping cultivation system becomes a valuable system in order to improve land productivity and farmers income per unit area in unit time. It also can provide optimum yield in terms of production, because it is composed of several commodities that build a sustainable system (Johu *et al*., 2002).

One way to increase the productivity and economic value of soybean cultivation is by controlling weeds in its field, since weed can reduce the production of cultivated plants. Weeds are a serious constraint to easy harvesting in soybean and can reduce yields and economic returns. Thus, weed control is considered a key factor for successful soybean production. Various weed management systems have been developed for that purpose.

The main competion factor between soybean and weed is solar radiation, water, and nutrients. According to Moenandir (1993), weeding exact timing will be able to reduce the number of weeds which grown and shorten the competition. In plant life cycle, not all growth stages of crop is susceptible to weed competition. Approximately, 25-33% of the first annual plant life cycle is the most critical competition period to weed. There is a false assumption that weeding in any time during plant growth will solve weed competition problem (Zimdahl, 1980). The critical period of weed control (CPWC) indicates the optimum time for applying weed control measure (Cardoso *et al*., 2011). Therefore, information on these periods can be effective to improve the efficiency of weed management practices (Hall *et al*., 1992; Amador-Ramírez, 2002; Bukun, 2004).

For better yield and quality, controlling weeds during the critical period of crop growth is important. Identification of CPWC in major crops is one of the first step in designing a successful integrated weed management (IWM) program (Swanton and Weise, 1991; Knezevic *et al*., 2003) and the use of critical period threshold model will assists in improved farm level decision making (Zimdahl, 1988; Zimdahl, 1993). The CPWC is the length of time that the crop must be kept weed-free to prevent yield loss at a certain level (Weaver and Tan, 1983; Knezevic *et al*., 2003). The CPWC is determined by measuring the time interval between two separately measured crop-weed competition components: (i) the critical duration of weed interference, and (ii) the critical weed-free period (Weaver and Tan, 1983; Knezevic *et al*., 2003).

The critical duration of weed interference is defined as the maximum length of time early emerging weeds which can interfere with the crop without causing any unacceptable yield loss (Weaver and Tan, 1983; Knezevic *et al*., 2003). The critical weed-free period is defined as the minimum length of required time for the crop to be maintained weed-free before yield loss caused by late emerging weeds is of no practical concern (Weaver and Tan, 1983; Knezevic *et al*., 2003). From a practical standpoint, yield losses caused by weed interference before or after the CPWC will be of limited interest (Knezevic *et al*., 2003). Many studies have been conducted worldwide to determine the CPWC in various crops under a range of environmental conditions (Evans *et al*., 2003; Knezevic *et al*., 2003; Van Acker *et al*., 1993; Arslan *et al*., 2006; Uremis *et al*., 2009; Knezevic *et al*., 2013; Tursun *et al*., 2015; Tursun *et al*., 2016).

Studies conducted in different crops under diversified environmental conditions might not be applicable to all kind of systems due to location differences, including soil and climatic conditions, as well as weed populations (Van Acker *et al*., 1993; Evans *et al*., 2003; Knezevic *et al*., 2003; Bukun, 2004; Tursun *et al*., 2015; Tursun *et al*., 2016). According to Hendrival *et al*. (2014), critical period of soybean crop in the paddy field after rice plantation to weed competition occurred on 2-6 week after planting.

Therefore, this study aims to understand the effect of various treatment periods of weedy on the growth and yield of soybean and to determine the most appropriate time periods of weedy for soybean in agroforestry systems with *kayu putih*.

MATERIALS AND METHODS

This study aimed to understand the effect of various treatment periods of weedy on the growth and yield of soybean and to determine the most appropriate time periods of weedy for soybean in agroforestry systems with *kayu putih*. The experiment had been conducted in Menggoran, BDH Playen, KPH Yogyakarta, Gunungkidul Regency, Special Province of Yogyakarta from February 28 to May 9, 2015. The experiment used a single factor randomized complete block design (RCBD) with three blocks as replications. The treatments were the weedy periods in soybean which consisted of ten levels (Table 1)

The observations were made on the variables of soil moisture content, leaf area, root surface area, root length, chlorophyll content, root dry weight, shoot dry weight, dry weight, dry weight of weeds and soybean seeds. Calculations were performed using PROC GLM ANOVA with SAS for Windows 9.0 software (SAS Institute, 1994). If ANOVA showed that F calculate > F table, it meant that there was a significant difference among treatments, then would be followed by Duncan's Multiple Range Test (DMRT) α 5%. To determine the relationship between weed dry weight and grain yield of soybean, a simple linear regression analysis was done. The simple linear regression analysis was done using SAS PROC REG with SAS for Windows 9.0 (SAS Institute, 1994).

Table 1. Weedy and weed-free periods of treatment

No	Treatment	Remarks
1	W - 0 dap	Weedy until harvest
2	W - 14 dap	Weedy after 14 dap
3	W - 28 dap	Weedy after 28 dap
4	W - 42 dap	Weedy after 42 dap
5	W - 56 dap	Weedy after 56 dap
6	WF - 14 dap	Weed-free after 14 dap
7	WF - 28 dap	Weed-free after 28 dap
8	WF - 42 dap	Weed-free after 42 dap
9	WF - 56 dap	Weed-free after 56 dap
10	WF - 0 dap	Weed-free until harvest

Table 2. Soil moisture content on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Soil Moisture Content (%)				
	14 dap	28 dap	42 dap	56 dap	70 dap
W - 0 dap	40.85 cd	43.43 c	44.85 c	41.56 d	35.35 cd
W - 14 dap	41.67 bcd	44.07 bc	45.82 bc	42.14 cd	36.27 bcd
W - 28 dap	40.17 d	42.57 c	44.27 c	40.67 d	34.77 d
W - 42 dap	41.01 cd	44.04 bc	45.59 bc	42.09 cd	35.62 cd
W - 56 dap	43.18 bc	45.97 b	47.16 b	44.09 bc	37.68 bc
WF - 14 dap	44.16 ab	46.20 b	47.21 b	44.55 b	38.64 ab
WF - 28 dap	40.88 cd	43.43 c	45.20 c	41.56 d	35.46 cd
WF - 42 dap	40.80 cd	43.04 c	44.80 c	41.21 d	35.36 cd
WF - 56 dap	40.81 cd	43.25 c	44.90 c	41.27 d	35.37 cd
WF - 0 dap	46.90 a	48.89 a	50.79 a	47.15 a	40.89 a
Average	42.01	44.48	46.06	42.61	36.54
CV (%)	3.64	2.72	2.06	3.04	4.00

Remarks: Number followed by the same letter in the same coloumn indicated that there was no significant difference based on DMRT α 5% test; W: weedy after *n* dap; WF: weed-free after *n* dap.

Table 3. Leaf area on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Leaf Area (cm^2)				
	14 dap	28 dap	42 dap	56 dap	70 dap
W - 0 dap	90.11 b	433.6 a	650.3 a	867.1 a	780.4 a
W - 14 dap	104.81 ab	521.8 a	782.6 a	1043.5 a	939.2 a
W - 28 dap	78.92 b	459.6 a	689.4 a	919.2 a	827.2 a
W - 42 dap	79.37 b	536.2 a	804.4 a	1072.5 a	959.8 a
W - 56 dap	81.74 b	429.3 a	633.4 a	863.8 a	748.6 a
WF - 14 dap	113.69 ab	556.7 a	804.1 a	1096.5 a	950.3 a
WF - 28 dap	80.55 b	533.0 a	769.8 a	1049.8 a	898.2 a
WF - 42 dap	91.85 b	688.8 a	964.4 a	1315.1 a	11251 a
WF - 56 dap	129.12 ab	494.1 a	691.7 a	943.2 a	807.0 a
WF - 0 dap	168.73 a	610.0 a	854.0 a	1164.5 a	996.3 a
Average	101.89	526.30	764.41	1033.51	903.21
CV (%)	39.55	30.98	30.46	30.65	30.32

Remarks: Number followed by the same letter in the same coloumn indicated that there was no significant difference based on DMRT α 5% test; W: weedy after *n* dap; WF: weed-free after *n* dap.

RESULT AND DISCUSSION

Soil conditions at the study site had ustic moisture regime. Ustic moisture regime was a regime which had limited moisture content, but it was available at the time when the environmental conditions was suitable for plant growth (Soil Survey Staff, 2010). Based on the interpretation of soil horizons in each soil profile, it was known that the soil at the site fell under Lithic Haplusterts type. It was a vertisol soil type with a shallow solum and lithic contact within 50 cm of the soil surface (Soil Survey Staff, 2010). Based on the field observation and laboratory test, the soil in the research location was known to be dominated by clay fraction for 75.17 %, which could be classified as clay texture. The bulk density was 1.14 g/cm^3 with a permeability of 0 cm/hour and very slow value due to the high clay content which resulted in a very low porosity. The nutrient content in the research location showed a varied status from very low until very high status with neutral pH.

Soil moisture was very important to the nutrient absorption processes and translocation for plants. The soil moisture condition affected the availability of nutrient in the soil and nutrient absorption by plants (Kramer, 1969).

The result of variance (Table 2) showed that there were

Table 4. Chlorophyll content on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Chlorophyll Content		
	a chlorophyll	b chlorophyll	Total chlorophyll
W - 0 dap	0.43 d	0.30 e	0.73 e
W - 14 dap	0.49 bc	0.33 d	0.82 d
W - 28 dap	0.49 bc	0.33 d	0.83 d
W - 42 dap	0.50 abc	0.40 c	0.90 bc
W - 56 dap	0.52 ab	0.42 bc	0.94 bc
WF - 14 dap	0.52 ab	0.45 b	0.97 ab
WF - 28 dap	0.49 bc	0.43 b	0.92 bc
WF - 42 dap	0.47 c	0.42 bc	0.89 c
WF - 56 dap	0.46 cd	0.44 b	0.91 bc
WF - 0 dap	0.54 a	0.49 a	1.03 a
Average	0.49	0.40	0.90
CV (%)	4.41	4.36	4.26

Remarks: Number followed by the same letter in the same coloumn indicated that there was no significant difference based on DMRT α 5% test; W: weedy after *n* dap; WF: weed-free after *n* dap.

Table 5. Root surface area on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Root Surface Area (cm^2)				
	14 dap	28 dap	42 dap	56 dap	70 dap
W - 0 dap	38.58 e	142.43 e	231.51 e	234.98 e	237.33 e
W - 14 dap	80.35 cd	187.17 d	362.93 cd	374.41 cd	379.47 cd
W - 28 dap	81.76 cd	228.81 cd	369.42 cd	381.31 cd	386.59 cd
W - 42 dap	90.78 bc	246.15 bc	412.69 bc	428.18 bc	435.57 bc
W - 56 dap	96.76 bc	257.60 bc	483.80 ab	495.90 ab	505.81 ab
WF - 14 dap	108.09 b	278.89 b	493.64 ab	515.16 ab	525.62 ab
WF - 28 dap	78.27 cd	222.14 cd	355.58 cd	366.81 cd	371.69 cd
WF - 42 dap	68.28 d	203.01 d	313.17 de	321.69 de	324.94 de
WF - 56 dap	78.20 cd	261.93 bc	312.80 de	325.32 de	333.45 cde
WF - 0 dap	138.95 a	334.22 a	555.78 a	583.57 a	601.08 a
Average	86.00	236.23	389.13	402.73	410.15
CV (%)	13.21	9.57	12.91	13.31	13.54

Remarks: Number followed by the same letter in the same coloumn indicated that there was no significant difference based on DMRT α 5% test; W: weedy after *n* dap; WF: weed-free after *n* dap.

significant differences in soil moisture content on the 14 dap to 70 dap. The weed-free treatment from the beginning of the research until the harvest time showed the highest value compared with other treatments.

It was assumed that the soil moisture was only utilised by soybean, so the moisture content in the soil was relatively higher. In a weedy until harvest treatment, the soil moisture content was used by soybean and weeds, causing a relatively lower moisture content compared with other weedy treatments. The degree of crop yield reduction due to weeds interference depended on various factors, such as type of weeds, their density and distribution, time of emergence of weeds relative to crop, as well as soil characteristics such as type, soil moisture status, pH, and fertility level (Papamichail *et al*., 2002; Bukun, 2004).

Leaf played a very important role. As a photosynthetic organ, it highly determined the growth and development of the plant. Leaf was not only able to produce photosynthate, but also other compounds such as growth hormone (Gardner *et al*., 1991).

Based on the results of analysis of variance (Table 3), weedy treatment period had a significant effect on soybean leaf area at 14 dap, where the weed-free after 0 dap treatment had the highest leaf area compared with the weed-free after 14 dap, 28 dap, 42 dap, and 56 dap treatments. It was also significantly

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Table 6. Root lenght on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Root Length (m)				
	14 dap	28 dap	42 dap	56 dap	70 dap
W - 0 dap	1.00 e	1.94 e	3.97 d	5.28 c	5.47 c
W - 14 dap	2.81 bcd	4.47 d	9.58 bc	12.83 ab	13.02 ab
W - 28 dap	2.98 cb	5.87 b	9.96 abc	12.95 ab	13.02 ab
W - 42 dap	3.09 bc	6.11 ab	10.44 ab	13.86 ab	14.10 a
W - 56 dap	3.13 bc	6.13 ab	10.34 ab	13.58 ab	13.76 ab
WF - 14 dap	3.38 ab	6.28 ab	10.61 ab	14.07 a	14.36 a
WF - 28 dap	2.72 cd	5.56 bc	9.15 bc	12.01 ab	12.27 ab
WF - 42 dap	2.38 d	5.00 cd	7.89 c	10.66 b	10.79 b
WF - 56 dap	2.78 cd	6.32 ab	8.05 c	11.79 ab	12.12 ab
WF - 0 dap	3.75 a	6.81 a	11.78 a	14.85 a	15.46 a
Average	2.80	5.45	9.18	12.19	12.44
CV (%)	10.85	7.95	12.35	14.33	13.72

Remarks: Number followed by the same letter in the same coloumn indicated that there was no significant difference based on DMRT α 5% test; W: weedy after *n* dap; WF: weed-free after *n* dap.

Table 7. Root dry weight content on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Root Dry Weight (grams)				
	14 dap	28 dap	42 dap	56 dap	70 dap
W - 0 dap	0.39 abc	0.58 d	1.09 d	1.36 d	1.51 d
W - 14 dap	0.30 bc	0.68 cd	1.54 bc	2.01 bc	2.23 bc
W - 28 dap	0.30 bc	0.67 cd	1.56 bc	2.04 bc	2.25 bc
W - 42 dap	0.37 abc	0.73 bc	1.66 bc	2.19 bc	2.39 bc
W - 56 dap	0.35 abc	0.81 b	1.85 ab	2.41 ab	2.60 ab
WF - 14 dap	0.51 abc	0.82 b	1.86 ab	2.44 ab	2.61 ab
WF - 28 dap	0.58 ab	0.67 cd	1.51 bc	1.97 bc	2.19 bc
WF - 42 dap	0.28 c	0.64 cd	1.38 cd	1.78 cd	2.00 c
WF - 56 dap	0.38 abc	0.64 cd	1.36 cd	1.74 cd	1.94 cd
WF - 0 dap	0.61 a	0.94 a	2.13 a	2.72 a	2.90 a
Average	0.41	0.72	1.59	2.06	2.26
CV (%)	36.62	9.24	12.04	12.35	11.51

Remarks: Number followed by the same letter in the same coloumn indicated that there was no significant difference based on DMRT α 5% test; W: weedy after *n* dap; WF: weed-free after *n* dap.

different from the weed after 0 dap, 14 dap, 28 dap, 42 dap, and 56 dap treatments. However, at the age of 28, 42, 56, and 70 dap, each treatment had no significant effect on leaf area of soybean.

Chlorophyll was a determinant element on the plant's photosynthesis ability which was mostly found in leaves. The content of chlorophyll in the leaves was closely related to the leave's greenness. The higher the chlorophyll content, the higher the photosynthesis ability. According to Taiz and Zieger (2002) concerning photosynthesis process, chlorophyll was a complex molecule which played a role in capturing solar energy and transfering energy and electron.

The results of analysis of variance (Table 4) showed that the weedy period treatment had a significant effect on the contents of chlorophyll a, chlorophyll b, and total chlorophyll of soybean. The contents of chlorophyll a, chlorophyll b, and total chlorophyll in weed-free until the harvest treatment were higher than any other weedy treatment.

This was presumably due to the competition for nutrients, one of which was nitrogen that influence the chlorophyll content in soybean. The availability of essential nutrients was one of the many site-specific factors which directly influence the outcome of crop-weed interference of a particular site (DiTomaso, 1995; Evans *et al*., 2003; Leskovsek *et al*., 2012). Nitrogen (N) was the major nutrient applied to increase crop

Table 8. Shoots dry weight content on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Shoots Dry Weight (grams)				
	14 dap	28 dap	42 dap	56 dap	70 dap
W - 0 dap	0.89 abc	2.66 c	3.16 c	3.47 c	7.61 d
W - 14 dap	0.43 d	3.63 bc	4.85 bc	4.92 bc	13.10 bcd
W - 28 dap	0.80 a-d	3.68 bc	4.94 bc	5.00 bc	13.37 bcd
W - 42 dap	0.54 cd	4.03 bc	5.54 bc	5.53 bc	15.09 bc
W - 56 dap	0.53 cd	4.83 b	6.98 b	6.91 b	18.80 b
WF - 14 dap	0.60 bcd	4.86 b	7.04 b	6.94 b	19.00 b
WF - 28 dap	1.00 a	3.57 bc	4.74 bc	4.83 bc	12.74 bcd
WF - 42 dap	1.01 a	3.23 c	4.13 c	4.31 c	10.90 cd
WF - 56 dap	0.65 a-d	3.21 c	4.11 c	4.29 c	10.74 cd
WF - 0 dap	0.96 ab	6.42 a	9.83 a	9.97 a	25.65 a
Average	0.74	4.01	5.53	5.62	14.70
CV (%)	26.54	18.07	23.37	23.32	22.99

Remarks: Number followed by the same letter in the same coloumn indicated that there was no significant difference based on DMRT α 5% test; W: weedy after *n* dap; WF: weed-free after *n* dap.

Table 9. Delta of seeds dry weight per hectare decreased on various weedy periods of soybean in agroforestry system with *kayu putih*

Treatment	Weeds Dry Weight per Hectar (ton/ha)	Seeds Dry Weight per Hectar (ton/ha)	Δ Decrease of Yield a result by Weeds (%)
WF 0 dap	0.00 e	2.00 a	0.00
WF 14 dap	5.13 ab	1.53 ab	23.50
WF 28 dap	2.00 cd	1.03 bcd	48.50*
WF 42 dap	3.50 bc	0.86 cd	57.00*
WF 56 dap	5.13 ab	0.84 cd	58.00*
W 0 dap	6.86 a	0.56 d	72.00*
W 14 dap	1.84 cd	1.08 bcd	46.00*
W 28 dap	1.42 cde	1.10 bc	45.00*
W 42 dap	1.01 de	1.25 bc	37.50*
W 56 dap	0.18 e	1.53 ab	23.50

Remarks: Number followed by same letter in same coloumn indicates no significantly different based on DMRT α 5% test; W: weedy after *n* dap ; WF: weed-free after *n* dap; (*): Significan different with control (WF after 0 dap).

yield. However, weed demographic processes and crop-weed competitive interactions were affected by changing N levels in soil (Camara *et al*., 2003; Blackshaw *et al*., 2004).

Root was the main vegetative organ which supplied water, minerals, and materials which were essential to the growth and development of the plants. A strong root growth was necessary for the strength and growth of shoots. The roots might be damaged due to the disruption of biological, physical, or mechanical and less work, then growth will be reduced (Gardner *et al*., 1991).

Based on the analysis of variance (Table 5), the weedy period treatment had a significant effect on the root's surface area at the age of 14 to 70 dap. The weed-free until the harvest time treatment had the highest root's surface area compared with 9 weedy period treatments at all observation periods. Meanwhile, the weedy until the harvest time treatment had the lowest roots surface area at all observation periods. This was caused by the soybean plants grown on a weedy land, there would be a competition for nutrients, water, and place to growth with weeds growing around.

This resulted in the obstruction in plant growth, indicated by roots which were unable to absorb nutrients and water optimally. However, when the soybean plants grew on a weed-free land until the harvest, the plants could optimally absorb the nutrients contained in the soil without any competitors so that the growth

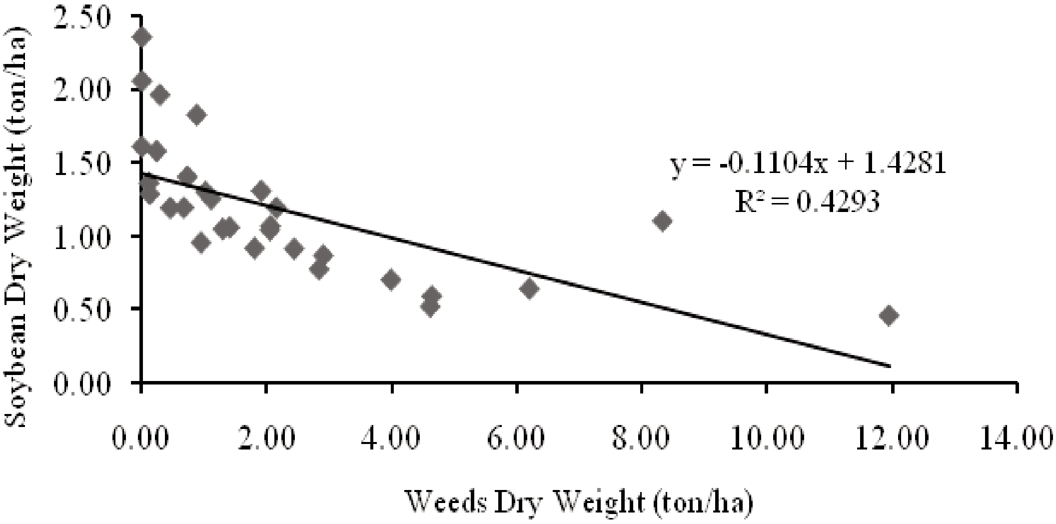

Figure 1. Regression analysis between weeds dry weight with soybean dry weight

was better than nine other treatments.

Analysis of variance (Table 6) showed that the weedy period treatment had a significant effect on roots length of soybean. Weedy period had an effect when plants were at the ages of 14. 28. 42. 56. and 70 dap. where the weed-free until harvest treatment had the longest roots at the age of 14 to 70 dap compared with nine other treatments. In addition. the weedy until the harvest treatment had the shortest roots at all ages. It was presumably due to the competition of growing space which resulted in weedy soybean's inability to develop its roots optimally and thus affected root length.

Analysis of variance result (Table 7) showed that the weedy period treatment had a significant effect on the dry weight of soybean roots at all observed ages. The weed-free until the harvest treatment generated the highest roots dry weight compared with other weedy treatments. When the soybean could grow normally without any weeds growing around, it would affect the root growth. The roots of soybean could grow well and were able to absorb nutrients and water optimally when there was no competitor. the weeds. Therefore. the dry weight of roots was also higher than the roots of soybean with weedy treatment. It was proved that the soybean in the weedy until the harvest treatment had the smallest roots dry weight at the age of 28 to 70 dap.

This was caused when plants were in their vegetative phase. The weeds put pressure on soybean to produce carbohydrates from photosynthesis which were mostly used for cell division. cell elongation. and the growth of roots. stems. and leaves.

The results of this research showed that longer weedy period resulted in higher diversity of weed species compared with shorter weedy period. The weeds which grew before harvest time led to a lower diversity of weed species to appear. The longer the weeds grew in soybean plantation. the greater the competition that resulted in more obstruction of growth and lower product components. The weed competition in the early growth period would reduce the product's quantity. while the competition near harvest time affected the product's quality.

The results of this research showed that the critical period of soybean began at 40-70% of its age. It was different from the research conducted by Hendrival *et al*. (2014). Zimdahl (2004). and Mercado (1979). Hendrival *et al*. (2014) stated that the critical period of soybean against weed competition occured in 14-42 dap. Meanwhile Zimdahl (2004) stated that the critical period occured in the 25% - 33% of plant's first life cycle. Mercado (1979) stated that the critical period ranged from 33% - 50% of the plant's age. It was possibly due to the interaction between genetic and environmental factors.

CONCLUSION

There was a significant difference in moisture of soil, root surface area, root length, chlorophyll content, root dry weight, shoot dry weight, dry weight of soybean seeds, and weed dry weight. The highest seed weight per hectare was shown in weed-free until harvest treatment, but it was not significantly different from the weeded plants after 56 days after planting and weed free after 14 days after planting. The appropriate period of weeding time for soybean in agroforestry systems with kayu putih began at 28 – 56 days after planting.

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