Effect of Weed Biomass on Cassava Yield Related to Weeding Times

Abstract
It is well known that poor weeding is cause of difficulty of weed growth reduction and reduce root yield of cassava. This study conducted to confirm quantitatively relationship of weed biomass and cassava root yield under difference weeding frequency. Field experiment was carried out in Agricultural Research Center, National Agriculture and Forestry Research Institute, Lao PDR from May 2014 to March 2015. The experiment was laid out in RCBD with four replications. The treatments consisted of four types of manual weed control; no weeding, 1 time weeding at 2 MAP, 2 times weeding at 1.5 and 3 MAP, and 3 times weeding at 1, 2, 3 MAP. The plot size was 36 m² and plant density was 10, 000 stands ha⁻¹. Chemical fertilizer was applied 100-50-50 kg N-P₂O₅-K₂O ha⁻¹. Soil property was estimated before experimental establishment. Fresh weight of weed of above ground was measured at 6 MAP to determine DM. Cassava root yield was measured fresh weight at 10 MAP. Weed biomass was significant decrease by increasing the weeding time (p≤0.05). The no weeding treatment was covered by a lot of weeds. Cassava root yield was highly contributed (R²=0.811). Extension of weeding to farmers should be based on amount of weed not weeding time. In cassava cultivation, it likely is cause of difficulty of weed growth reduction. We thought extension for farmers to reduce weed should be based on amount of weed not weeding time. In Lao PDR, cassava cultivation area will increase furthermore. It is expected load of weeding will be constraint of cassava production. Weed biomass and cassava root yield is important. This study conducted to confirm of relationship of weed biomass and cassava root yield under different weeding frequency in a research center in Lao PDR using a Thai improved variety KU-50.

Materials and Methods
This experiment was conducted in Agricultural Research Center (18° 08.7’N, 102° 44.3’E), National Agriculture and Forestry Research Institute, Vientiane, Lao PDR from May 2014 to March 2015. At Vientiane Capital, annual mean temperature was 27.8 °C, and average of annual precipitation was 1454 mm [5]. The

Y is cassava root yield (t ha⁻¹), W is weed dry biomass (t ha⁻¹). Once of weeding did not reduce weed biomass and reduce cassava root yield as 4 t ha⁻¹. The weed biomass reduced limited by three times of weeding and sufficiently by four times of it. We think that confirmation of this relationship in Asian country using improved variety is needed.

Keywords: Weed biomass; Cassava yield; Weeding; Weeding time; Relationship of weed; Cassava

Abbreviations

MAP: Months after Planting; Ha: Hectare; M: Meter; Mm: Millimeter; Kg: Kilogram; T: Tone; DM: Dry Matter; RCBD: Randomized Complete Block Design. °C: Degree Celsius

Introduction
Cassava (Manihot esculenta Crantz) is a new important cash crop in Laos. Cassava cultivation area increased since 2011 along with increase of tapioca starch factories. Based on our survey in 2013 - 2015, cassava root yield in farmer fields were varied 12 - 56 t ha⁻¹. Some fields were covered by a lot of weeds. Cassava is cultivated by small holder farmers who do not have enough information on cultivation practices.

It is well known that poor weeding reduces root yield [1]. Reviewed effect of weed control on cassava root yield that full time of weed infestation causes root yield loss of about 46-95% [2,3]. Also reported weedy condition reduced cassava root yield as about 25% and 8% of weed controlled condition. However, study on relationship between cassava root yield and weed biomass is not enough [4] conducted a field experiment to clarify change of cassava root yield by weeding frequency in Sierra Leone in 1972/73 and 1973/74. The relationship of cassava root yield and weed biomass was liner as Y = -1.23W+12.8 (r= -0.95), where.
experiment plots were designed as RCBD with four replications. The plot size was 6 m x 6 m. The treatments consisted of four types of weed control including no weeding, 1 time weeding at 2 months after planting (MAP), 2 times weeding at 1.5 and 3 MAP, and 3 times weeding at 1, 2, 3 MAP.

The experimental field was ploughed and harroned on 2 and 6 May 2014. Cassava variety was KU-50. The stem cut as 20 cm length was planted on 7 May 2014 in vertically position with 1 m x 1 m intervals giving a plant population of 10,000 stands ha\(^{-1}\). Chemical fertilizer was applied 50-50-50 kg N-P\(_2\)O\(_5\)-K\(_2\)O ha\(^{-1}\) as urea, TSP, KCl by side dressing at 20 cm distance from planted stem and covered by soil at the planting time. Additionally, 50 kg N ha\(^{-1}\) as urea was applied with side dressing at 20 cm distance from stand and covered by soil on 5 July 2014.

Fresh weight of weed of aboveground in 3 m x 3 m at center in each plot was measured on 3 December 2014. To determine DM ratio of the weeds in each plot, a part of weeds of each plot was collected, was measured fresh weight, was dried in oven with 70 °C for 48 hours, and was measured the dry weight after drying. To determine root yield, cassava root in the area of 4 m x 4 m at center of each plot was collected and was measured fresh weight on 6 March 2015. Soil chemical properties of the experimental field before establishment was pH (H\(_2\)O, 1:2.5) 4.6, Total C 9.0 g kg\(^{-1}\), Total N 0.87 g kg\(^{-1}\), available P (Bray-2) 30 mg P kg\(^{-1}\), exchangeable K 0.19 cmolc kg\(^{-1}\), exchangeable Mg 0.21 cmolc kg\(^{-1}\) and exchangeable Ca 0.9 cmolc kg\(^{-1}\). Statistical analysis was conducted using JMP ver.10 (SAS Institute, 2012).

### Results and Discussion

#### Results

Weed biomass was significantly decreased by increasing the weeding time (Table 1). The plots of the no weeding treatment were covered by a lot of weeds. Weed biomass in the 1 time weeding was varied widely 2.0 - 5.6 t ha\(^{-1}\). Effect of the 1 time weeding to reduce weed growth is uncertain. More than 2 times weeding restricted weeds growth. Cassava root yield was very small in the no weeding treatment and high in the 2 times and 3 times weeding (Table 1). In the 1 time weeding, cassava root yield was varied 11.0 - 26.6 t ha\(^{-1}\). In the no weeding, cassava root yield was very poor as 4 t ha\(^{-1}\) which was 15% compared with it in the 3 times weeding. Relationship between the weed biomass and cassava root yield was shown as Y = -3.78 W + 30.9, where Y is cassava root yield in fresh weight (t ha\(^{-1}\)), W is weed biomass in dry weight (t ha\(^{-1}\)) (Figure 1). Coefficient of determination was 0.81.

Table 1: Effect of weeding time on weed biomass and cassava root yield.

| Weeding Times | Weed Biomass (T Ha\(^{-1}\)) | Cassava Root Yield (T Ha\(^{-1}\)) |
|---------------|-----------------------------|----------------------------------|
|               | Range  | Average | Standard Deviation | Range  | Average | Standard Deviation |
| No weeding    | 6.1 - 7.7 | 6.8 a | 0.8 | 0.5 - 10.9 | 4.4 a | 4.9 |
| 1 time weeding | 2.0 - 5.6 | 3.3 b | 1.6 | 10.6 - 25.8 | 19.3 b | 6.3 |
| 2 times weeding | 0.1 - 1.2 | 0.5 c | 0.5 | 22.7 - 39.4 | 30.3 b | 6.8 |
| 3 times weeding | 0.0 - 0.2 | 0.1 c | 0.1 | 22.7 - 36.6 | 29.4 b | 5.7 |

#### Discussion

Relationship of weed biomass and cassava root yield was linear. It was same as the result in Africa in 1992-94 [4]. Cassava root yield under weed biomass as 0 t ha\(^{-1}\) was 13 t ha\(^{-1}\) in Godfrey-Sam-Aggrey’s study and 31 t ha\(^{-1}\) in this study. This difference is caused by increase of potential yield by improvement of cassava variety. Weed biomass to reach cassava root yield as 0 t ha\(^{-1}\) was 10 t ha\(^{-1}\) in Godfrey-Sam-Aggrey’s study and 8 t ha\(^{-1}\) in this study. The amount of weed was difficult to allow cassava establishment.

The linear relationship of weed biomass and cassava root yield suggest certainly simple competition of water, nutrients, root area, etc. Cassava root yield decreases under drought condition [6-8]. Critical level of cassava growth is so low nutrient content [9]. Weed might absorb water and nutrients up to soil condition to restrict cassava growth even in rainy season and with chemical fertilizer application. But, [10] reported competition of water between cassava and weed was moderate to low. Cassava root yield under intercropping with other crops mostly was same as mono cropping, in some case decreased under cropping with groundnuts, cowpea, and maize [11,12]. And, cassava root might be restricted when it meets weed root.

Ratio of cassava root yield without weeding compared with appropriate weed control was reported 5-75% [1-3]. In this study, it was 15%, which means reduction effect of cassava root yield by poor weeding management was relatively high. Weed
growth might be higher than others due to, for example, a lot of seed bank. Twice weeding, in this study, reduced weed biomass and took good cassava root yield certainly. However, based on our interviews to farmers, the period of 1 - 2 months after planting coincides usually with the sowing period of rice in Lao PDR. Hence, it is difficult to find labor for weeding in the period. As a result, farmer conducted weeding only once. Effective weeding method under low labor input is needed to increase of cassava production in Lao PDR.

**Conclusion**

The once weeding varied weed biomass in this study. In some case, weed biomass reduced so much with the once weeding. Extension of weeding to farmers should be based on weed biomass not the time of weeding for labor saving on cassava cultivation.

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