*Research article*

# Effect of Stake Storage Methods on Germination, Growth and Yield of Cassava (*Manihot esculenta* Crantz.)

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**Abstract** Quality of stakes is an important factor to determine the germination and plant population, consequently the tuber yield of cassava. Storage of cassava stakes before planting can affect the quality of the cutting. Therefore, the objective of this research was to investigate the effect of different storage stake methods on germination, growth, and yield of cassava. The field experiment arranged in randomized complete block design with 3 replications was conducted in Yasothorn soil series during April-October 2014 in Khon Kaen province, Thailand. The three stake storage methods comprised of storage under tree shade, under sunlight and store under sunlight with gunny sack coverage. Local cultivar of cassava was employed and stakes were stored for 45 days before planting. The results showed that moisture content of the stake, available part and germination percentage at 7 days after planting (DAP) of the stake stored under the sun with gunny sack coverage (69.08%, 73.93% and 85.71%, respectively) was significantly higher than that under shade (57.23% , 47.56% and 28.57%, respectively) and in sun (55.59%, 68.13% and 40.47%, respectively ). However, germination at 14 DAP and survival rate at 30 DAP were not significantly different among storage methods but stakes covered with gunnysack tended to be higher than other methods. Stakes stored by covered with gunnysack gave the highest plant height at 14, 21, 28, 35, 42, 72, and 180 DAP. Moreover, there was no significant difference in leaf, shoot and total aboveground dry weight, tuber yield and starch contents that were found amongst the storage methods. The stakes stored under the sun and covered with gunnysack tended to give the highest values. This study shows the potential method for storing cassava stakes under field conditions before planting.

**Keywords** cutting storage method, germination, survival rate

## INTRODUCTION

Cassava is usually planted by using vegetative part called stem cutting or stake. Normally, farmers use the cassava stems after harvest for the next growing season. These cassava stakes are kept in the field

for a period of time before planting. Thus, exposure of the cutting to the sun can result in lost viability within a short time due to dehydration. These poor stakes cause a poor establishment and finally a low yield. Andrade and Leihner (1980) reported that stake storage conditions were more critical than the duration of the storage. Sinthuprama and Tiraporn (1986) reported that stakes stored upright under shade for 45 days could obtain 80% survival rate but decreased faster when stems were stored in the sun and covered with leaves. However, Boonma et al., (2007) found that stake stored in the sun with the base earthen up resulted in greater stem moisture content and stem length than shade storage with no significant effect on germination and survival percentage. These contradicting opinions, therefore, needed to be proved by alternative method, which could be convenient for field practices by farmers.

## OBJECTIVE

The objective of this study was to investigate the effect of different storage stake methods on germination, growth and yield of cassava.

## METHODOLOGY

**Experimental site and design:** A field experiment was conducted at the Agronomy Field Crop Research Station, Faculty of Agriculture, Khon Kaen University, Thailand (latitude 16° 26´N and longitude 102° 48´E) during April-October 2014. The experiment was conducted in a loamy-sand soil (Yasothorn soil series) with pH 5.14, 0.48 % of organic matter, 28.60 mg/kg of available phosphorus, and 39.55 mg/kg of extractable potassium. The experiment was laid out in Randomized Complete Block Design with 3 replications. The treatments included stakes storage upright under 3 different conditions: under tree shade, in sun, and in sun with gunny sack coverage.

**Materials and cultural practices:** A local cultivar cassava named E-dam which was stored under different methods for 45 days was used in the study. The stakes of 20 cm in length were planted vertically with a 100 x 100 cm spacing in a 5 x 8 m plot. Plots were manually weeded 2 times at 1 and 2 months after planting. Chemical fertilizer grade 15-7-18 (N, $P_2O_5$, $K_2O$) at the rate of 312.5 kg/ha was applied 1 month after planting. Irrigation was applied during the period of 1-2 months after planting to ensure good establishment during April-May 2014 and the field was kept under rain for the rest of the growing period. The total amount of rainfall during the growing period was 946.7 mm and the mean values of daily maximum and minimum temperature were 33.5°C and 24.5°C, respectively.

**Crop measurement:** Before planting, 4 stakes were randomly selected to estimate moisture content by oven dried at 80°C to constant weight. The moisture content was calculated based on the stem fresh weight. Available portion in percentage was measured by dividing the length of vital or usable parts with total stem length and multiplying it by 100. Germination at 7 and 14 days after planting (DAP) was counted and a survival rate at 30 DAP was also recorded. Plant height was continuously measured at 14, 21, 28, 35, 42, 72, and 180 DAP. Biomass measurement was done at 180 DAP by cutting the stem base of three plants at random per plot. Plants were separated into leaves, stems, and tubers and were oven dried at 80°C to constant weight. The fresh tuber root yield (t/ha) were calculated based on the harvested crops. The starch content in the tuber was determined by specific gravity method.

**Statistical analysis:** Analysis of Variance (ANOVA) for all data was done by using Statistix 10.0 software (Analytical Software, Tallahassee, Florida, USA.). The Least Significant Difference (LSD) was used to compare all mean values.

## RESULTS AND DISCUSSION

### Stake Characteristics and Germination

Storage of cassava stems under different conditions had a significant effect on stake moisture content and available plant part usable for planting. Cassava stems stored in the sun with gunny sack coverage had significantly higher stake moisture content (69.08%) and available plant part (73.93%) than other methods (Table 1). However, this study opposed with the report of Boonma et al. (2007) who had found that stakes stored in the sun with base earthen up had greater stem moisture content and stems length usable for planting than that in the shade. They indicated that photosynthesis of the newly sprouts is an important factor in maintaining the stems moisture content compared to the low light intensity perceived by the sprouts of stems stored under the shade. In this experiment, it was found that stems stored in the sun were burnt by sunlight which might result in lower stake moisture content. Stems stored in the sun with gunny sack coverage produced some bud sprouting but with pale and yellow color. Stakes stored under tree shade were destroyed by termite leading to the lowest available part (47.56%).

**Table 1 Effect of stake storage methods on germination and survival percentage of cassava**

| Storage method | Stake moisture content (%) | Available part (%) | Germination (%) at 7DAP | Germination (%) at 14 DAP | Survival (%) at 30 DAP |
|---|---|---|---|---|---|
| Under tree shade | 57.23b | 47.56b | 28.57b | 88.64 | 83.33 |
| In sun | 55.59b | 68.13a | 40.47b | 93.56 | 90.48 |
| In sun with gunny sack coverage | 69.08a | 73.93a | 85.71a | 95.92 | 92.86 |
| F-test | ** | * | ** | ns | ns |
| CV (%) | 9.04 | 17.10 | 14.60 | 3.30 | 14.18 |

*Ns, *, **= not significant, significant different at p<0.05, 0.01, respectively. Means in the same column with different letters are significantly different at p<0.05 and 0.01 by LSD*
*DAP= days after planting*

At 7 DAP, cassava stems kept in the sun with gunny sack coverage germinated significantly faster (85.71%) than stems stored by other methods (28.57-40.47%) (Table 1). This might be contributed by the higher moisture content in the stakes which supported by the study of Leihner (1984) who found that stakes lost its viability when dehydration reduced moisture content less than 60%. The decrease in reserved carbohydrate of the cutting stem by respiration during the storage might also affect the germination rate of stakes (Leihner, 1984). However, no significant difference was found in germination at 14 DAP and survival percentage at 30 DAP among storage methods. But stakes stored in sun with gunny sack coverage tended to have the higher survival rate. Boonma et al., (2007) also found the same results when stems stored in the field and under tree shade. Even no significant difference in germination at 14 days after planting onward, the results from this study indicated that stem with high moisture content had vigorous germination. This would be important for growing cassava at the end of the rainy season, which soil moisture content was quickly loss. The faster germination of crop also indicated the higher leaf area coverage which could be possibly competing with weed.

### Plant Height

Different storage methods significantly affected plant height at 14, 28, 35, and 42 DAP. Stakes stored in the sun with gunny sack coverage had significant higher plant height than other methods at 14, 28, 35, and 42 days after planting and tended to have higher plant height than other methods at 21, 72, and

180 days after planting (Table 2). This might be due to the ability of early germination of seedlings grown from this method, which indicating the strong vigor of the stored materials.

**Table 2 Effect of stake storage methods on height (cm) of cassava at 14-180 days after planting**

| Storage method | 14 DAP | 21 DAP | 28 DAP | 35DAP | 42DAP | 72DAP | 180DAP |
|---|---|---|---|---|---|---|---|
| Under tree shade | 12.15b | 14.00 | 14.85b | 20.67b | 27.15b | 77.49 | 238.78 |
| In sun | 13.31b | 14.58 | 15.41b | 22.79b | 29.84ab | 86.14 | 246.66 |
| In sun with gunny sack coverage | 15.96a | 18.30 | 19.61a | 27.31a | 35.52a | 86.91 | 250.78 |
| F-test | ** | ns | * | * | * | ns | ns |
| CV (%) | 3.28 | 10.74 | 8.17 | 6.50 | 8.67 | 12.75 | 7.00 |

*Ns, *, **= not significant, significant different at p<0.05, 0.01, respectively. Means in the same column with different letters are significantly different at p<0.05 and 0.01 by LSD*
*DAP= days after planting*

**Table 3 Effect of stake storage methods on cassava population, growth and yield at 180 days after planting**

| Storage method | Plant population/ha | Leaf dry weight (kg/ha) | Stem dry weight (kg/ha) | Aboveground dry weight (kg/ha) | Tuber dry weight (kg/ha) | Tuber fresh weight (t/ha) | Starch content (%) |
|---|---|---|---|---|---|---|---|
| Under tree shade | 8333 | 1752.9 | 5558.1 | 7311.0 | 11556 | 32.6 | 20.90 |
| In sun | 9048 | 1776.1 | 5412.4 | 7188.5 | 10516 | 30.8 | 21.95 |
| In sun with gunny sack coverage | 9286 | 2549.1 | 7092.9 | 9642.0 | 12365 | 36.1 | 22.60 |
| F-test | ns | ns | ns | ns | ns | ns | ns |
| CV (%) | 14.18 | 18.15 | 12.58 | 12.92 | 15.84 | 13.31 | 7.56 |

*Ns = not significant*

### Plant Population, Crop Biomass and Yield

Due to the higher survival percentage, population per ha of cassava grown from stems stored in sun with gunny sack coverage was higher than the other methods (Table 3). Different stem storage methods had no significant effect on crop biomass, root fresh yield, and starch content in the tuber (Table 3). However, due to the higher population, cassava planted from stems stored in sun with gunny sack coverage tended to have higher leaf, stem, aboveground, tuber dry weight per ha, and tuber fresh yield per ha than other methods. Storage methods did not have significant effect on root starch content. Boonma et al., (2007) also reported no significant difference between stakes stored in the field with the base earthen up and under tree shading in terms of fresh and dry root yield and root starch content. This study is consistent with the findings of Andrade and Leihner (1980) who indicated that final stand percentage or population of crops were not the factors responsible for yield variation of cassava if stem cuttings were kept under appropriate conditions.

## CONCLUSION

Storage of cassava stake under field conditions before planting is critical for better germination and survival of the seedlings. The results show that stems stored in the sun with gunny sack coverage had the highest germination and survival percentage, which resulted in higher population and higher crop biomass and tuber yield per area. However, under the three studied storage conditions, other factors affecting shoot and root growth, rather than population, may determine cassava yield. Therefore, stakes can be stored by any of the three methods from this study.

However, in order to get the higher root yield and higher starch content, stem cutting stored in the field with gunny sack coverage should be recommended.

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