AGRICULTURE WASTES AND CLONES EFFECTS ON SURVIVAL OF GRAFTED COCOA (*Theobroma cacao* L.) SEEDLINGS IN NURSERY

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ABSTRACT – *A study has been carried out to determine the effects of different sources of agriculture wastes and types of clones on the survival rates of cocoa grafted seedlings in nursery. The treatments listed as: T1: -conventional fertilizer (5 gram / NPK Yellow 12:12:6:4) for cocoa nursery standard, T2: – Chicken manure (CHM), 1.8:1.6:4 (33 gram), T3 – Cocoa pod husk (CPH), 1.7:0.04:3.1 (35 gram), T4 – Cow manure (CM), 1.9:0.9:2.9 (31 gram) and T5 – Empty fruit bunch (EFB), 1.7:0.2:2.2 (35 gram) which applied once a month, with two selected clones; PBC 123 and KKM 22. Design for the trial was Random Complete Block Design (RCBD) in three replicates with two factors studied; Fertilizers and Clones. From the result, it can be concluded that clone KKM 22 has the highest rate of survivability in comparing with clone PBC 123, while all fertilizer treatments have given none effect on the success rate of survivability of the grafted seedlings. Thus, it can be concluded that clone was correlated with success rate of survivability of grafted seedling whereas, fertilizer treatment is merely for growth and development of the cocoa grafted seedlings in nursery.*

Key words: Cocoa, agriculture wastes, clones, survival rate, nursery

INTRODUCTION

Normally cocoa is planted as seedlings in the nursery. Seedlings are easy and cheap to raise, and they develop into trees with a uniform growth. In modern cocoa cultivation, the aim is to maximize early growth, obtain high early yields, and sustain peak yields subsequently. An essential ingredient in most cocoa growing situations is high fertilizer input. However, it is generally known that cocoa seedlings need great care as they are very sensitive to fertilizer toxicity. Therefore, agricultural wastes as fertilizer would be an option.

Agricultural wastes are naturally occurring materials of biological or mineral origin (Allen, 2010). Even though agricultural wastes are low in nutrient content or solubility or both, but the slow release of nutrients makes the nutrient availability for a longer period. There are plenty of waste by-products (biomass and manure) available in plantation and livestock farming that can be used as a source of nutrients. The application of these agricultural wastes is essentially important to supply various kinds of plant nutrients, including micro nutrients, improve soil physical and chemical properties, nutrient holding and buffering capacity, and enhance microbial activities (Suzuki, 1997). Besides that, recent study by Si *et al.* (2016) also stated that agricultural wastes not only improved soil conditions, but also promoted the growth of plant seedlings in the nursery.

Vegetative propagation has an important role where it is necessary or desirable to produce trees true-to-type. Propagation through grafting and stem cutting methods were techniques used in propagating superior commercial clones (Wood and Lass, 1985). However, grafted seedlings always have been used to supply planting materials from selected trees. The success of this method depends on several factors related to the plant and surrounding environmental conditions, include the toxicity of fertilizer that could affect the success rate of grafting seedling. Therefore, the objective of this study was to determine the effects of different sources of agricultural wastes on the rates of survival of grafted cocoa seedlings in the nursery. The result from this study was expected to be positively contributing to the survival rate of grafted seedlings.

MATERIALS AND METHODS

The trial was conducted at the Malaysian Cocoa Board Research and Development Centre nursery in Tawau, Sabah. The design for the trial was Randomized Complete Block Design (RCBD) with two (2) factors; Fertilizers and Clones on survival of grafted cocoa seedlings (*Figure 1*). The treatments were; T1 – Conventional fertilizer (5 gram / NPK Yellow 12:12:6:4), T2 – Chicken manure, 1.8:1.6:4 (33 gram), T3 – Cocoa pod husk, 1.7:0.04:3.1 (35 gram), T4 – Cow manure, 1.9:0.9:2.9 (31 gram) and T5 – Empty fruit bunch, 1.7:0.2:2.2 (35 gram). In this study, all seedlings were treated with composted agricultural wastes and inorganic fertilizer when first leaf had hardened (*Figure 2*). Then the application was postponed one month before grafting, and resumed after bud eye has sprouted, for the next three months of study. This study used 16 of three months old seedlings as rootstock and grafted with selected budwood from two of Class I Clones; PBC 123 (C1) and KKM 22 (C2) in three (3) replicates, with a total of 240 seedlings.

All seedlings were grafted according to the Malaysian Cocoa Board (2013) method where the top of rootstock was cut at the middle stem, placed the scion and wrapped firmly the entire union and scion with parafilm or biodegradable plastic. This method is also known as whole-wrapped top grafting. Once the bud eye has sprouted and developed at the fourth week (*Figure 3*), observation on survival of the grafted seedling was recorded. At the end of study, observation data obtained from all treatments were analysed statistically using computer software package SPSS to determine the survival rate of the grafted seedling and its interaction effect.

Figure 1: Polythene bag arranged per design

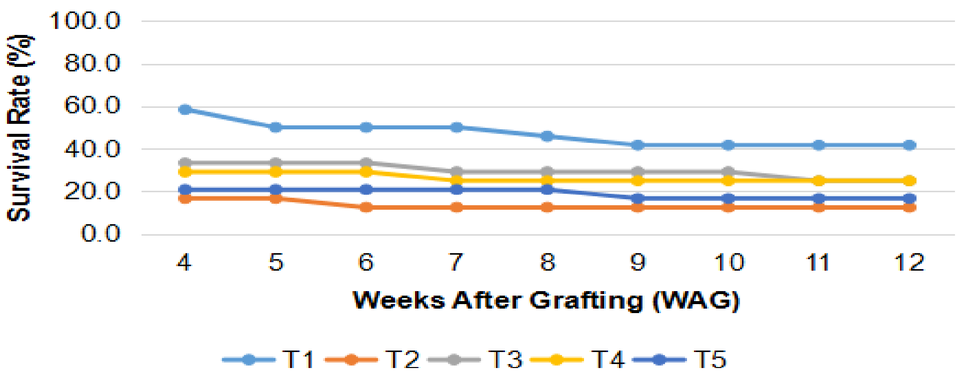
Figure 2: Application of treatment

Figure 3: Emergence and development of sprouted bud eye

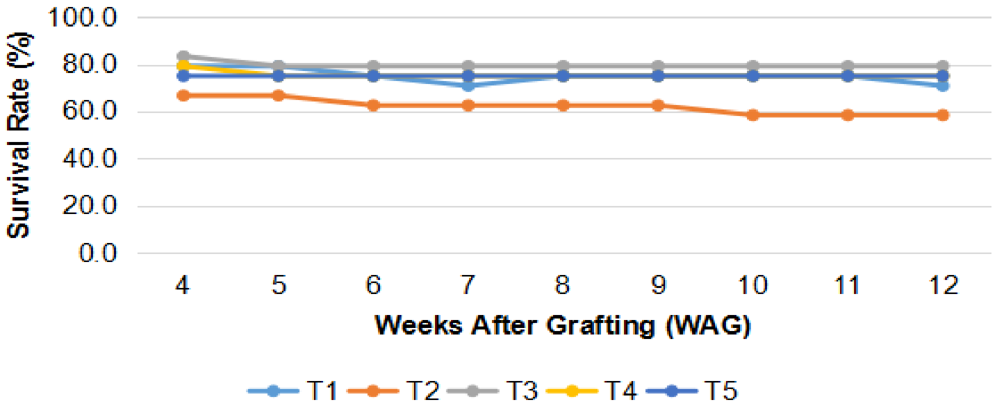
RESULTS AND DISCUSSIONS

Effect of Treatments and Clones on Survival Rate of Grafted Seedlings

Observation completed at the twelfth (12) weeks after grafted (WAG) had indicated that all treatments has a similar downward trend of survival rate on both clones. For clone PBC 123, the percentage of survival rate had decreased since the fourth (4) WAG (*Figure 4 (a)*), while for clone KKM 22 the percentage of survival were more consistent until the end week of study (*Figure 4 (b)*). The result for the percentage of survival for each treatment on both clones also suggested that there were no significant differences ($p>0.05$) between the treatments (*Figure 5*). The figure indicated that the percentage of survival rate of grafted seedlings for clone KKM 22 was higher compared to clone PBC 123 at the final week of observation, whereas the figure also shown that there were no significant differences between treatments on both clones.



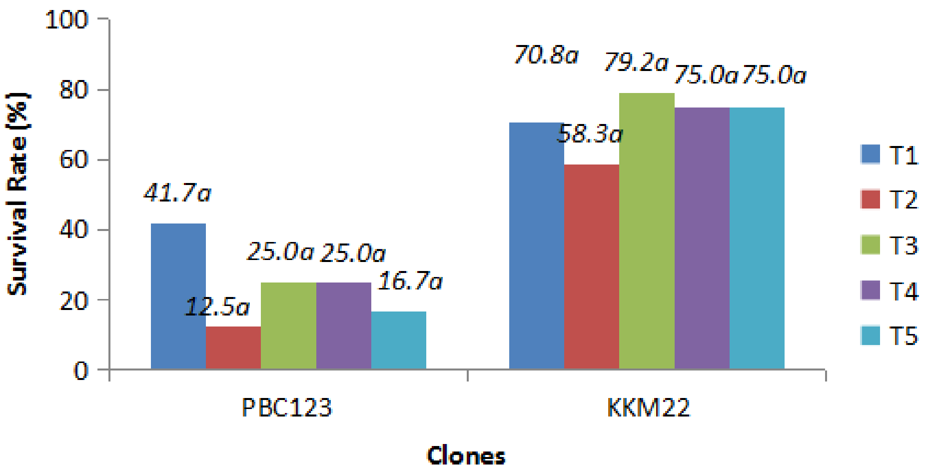
(a)



(b)

Note: T1 – NPK Yellow, T2 - Chicken Manure, T3 – Cocoa pod husk, T4 – Cow manure & T5 – Empty fruit bunch (EFB) (± S.D)

Figure 4: The survival rate of grafted seedlings on (a) clone PBC 123 and (b) clone KKM 22 for twelve (12) WAG for all treatments



Note: T1 – NPK Yellow, T2 - Chicken Manure, T3 – Cocoa pod husk, T4 – Cow manure & T5 – Empty fruit bunch (EFB) (± S.D)

Figure 5: The survival rate of grafted seedlings of different clones at twelve (12) WAG for all treatments

Fertilizer particularly derived from agricultural wastes had been known to promote growth and development of plant seedlings (Murmu *et al*., 2013), but for this study result had shown that all treatment fertilizers did not effect the survival rate in each grafted seedlings clones. Despite that, there was a significant difference ($p<0.05$) between the clones that had been determined through a two-way ANOVA statistical analysis.

Table 1: Main and interaction effects of survival rate of grafted seedlings

	Source	***df***	***F***	***Sig.***	***Partial Eta Squared***
Survival rate (%)	A. Clone	1	42.195	.001*	.678
	B. Treatment	4	.942	.460 ns	.158
	A*B	4	.474	.754 ns	.087
	Error	20			

ns – not significant
* mean difference is significant at the .05 level

A two-way between-groups analysis of variance had been conducted to explore the impact of clone and treatment on survival rate of grafted seedlings (Table 1). The survival rate results indicated that there were significant difference ($p<0.05$) in the effect of clone [$F(1,20)=42.19$, $p=.001$] on grafted seedlings, as the effect size had also been large (partial eta squared =.678) meaning that clone affected the survival rate of grafted seedlings by 67.8%. Nevertheless, there was no significant difference ($p>0.05$) indicated in the main effect for treatments [$F(4,20)=.94$, $p=.46$] and the interaction effect [$F(4,20)=.47$, $p=.75$) on the survival rate. Again, results on the grafted seedlings showed that the application of all treatments had not affected the survival rate of grafted seedlings, but has affected on the survival rate by the clones. This agreed with Effendy *et al.* (2013) study stated that every clones need specific type of grafting to exhibited high grafting success. Therefore, instead of top grafting, clone PBC 123 can be grafted with side grafting or patch budding as an option to increase its success.

Table 2: The Pearson Correlation between survival rate of grafted seedlings, fertilizers treatments and clones

	Survival rate	**Treatment**	**Clone**
Survival rate			
Treatment	-0.029		
Clone	0.789**	0.00	

** Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis of survival rate, fertilizer treatments and clones indicated that Clone has large correlation coefficient (0.789) to Survival Rate as stated in Table 2. It is significant at the 1% level of probability. However, there was no significant difference in the correlation between Survival Rate and Treatment (-0.029). Therefore, this study had clearly identified that treatments applied include agriculture wastes and inorganic fertilizer had given no effect on the survival rate of cocoa seedlings, while clone such as KKM 22 exhibited high grafting success and survival rate.

CONCLUSIONS

As for conclusion, clone KKM 22 has shown the highest rate of survival in comparing with clone PBC 123, while fertilizer treatment has given none effect on the success rate of survival of the grafted seedlings. Clone also was correlated with success rate of survival of grafted seedling, whereas fertilizer treatment is merely on the growth and development of the grafted seedlings in the nursery.

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