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Interaction of Different Cover Types and Planting Media Combination on Nutrient Uptake, Growth, and Photosynthesis Characteristics of Kepok Bananas (*Musa paradisiaca* L.) During Acclimatization

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Abstract

Tissue culture techniques, in general, have four stages, which include induction, multiplication, root formation, and acclimatization. The acclimatization stage is the most critical stage that plants go through after coming out of the culture bottle, and different climatic conditions exist in the greenhouse and the field. Environmental conditions such as light intensity and planting media greatly affect the growth of kepok banana seedlings during the acclimatization period. This study aims to determine the relationship between the type of canopy and the combination of planting media on the nutrient uptake, growth, and photosynthesis characteristics of kapok banana (*Musa paradisiaca* L.) during the acclimatization period. This research was conducted at the UPTD Balai Induk Hortikultura Gedung Johor Medan from June to August 2024. The research uses a Split Plot Design with two factors. The first factor is the type of cover: 16% UV plastic cover and 75% shade net. The second factor consists of three levels of treatment of the composition of planting media, namely soil + vermicompost (2:1), soil + cocopeat (2:1), and soil + husk charcoal (2:1). 16% UV plastic produces more volume and root length than 75% shade nets. The results showed that the 16% UV plastic produced higher root volume and root lenght than the 75% shade nets type. The chlorophyll a level was higher than that of chlorophyll b in all treatment except in the 16% UV plastic cover treatment and the composition of soil + vermicompost planting media. Nitrogen uptake with 16% UV plastic cover treatment was 46,94% higher than 75% shade net. The implication of this finding is the potential to utilize vermicompost as a planting media mixture at the acclimatization stage of kepok banana.

Keywords: acclimatization; cover; planting media; *Musa paradisiaca* L.

INTRODUCTION

One obstacle to the development of kepok banana cultivation is the provision of good and healthy seeds. Propagation of banana seedlings using conventional methods requires a long time and poor quality. Efforts to provide quality seeds for kepok banana plants can be made through *in vitro* breeding, such as tissue culture techniques. Tissue culture techniques generally have four stages, which include induction, multiplication, root formation, and acclimatization. The acclimatization stage is the stage of adaptation to the conditions of the growing place, from the *in vitro* environment to the field growing place (Dewi *et al*., 2021). The success of tissue culture techniques must be followed by success during the acclimatization process. Acclimatization is the most critical stage in determining propagation success using tissue culture techniques (Singh, 2018). *In vitro* conditions, plantlets are in conditions of nutrient availability that are easily absorbed by plants and are in optimal environmental conditions such as temperature, humidity,

light intensity, and aseptic. However, when transferred to *ex vitro* conditions, plants must adapt to conditions different from *in vitro* conditions (Hamdan *et al.*, 2016).

In acclimatized conditions, plants will receive high light (4000 – 12000 lux), while *in vitro* conditions, plants are at low light intensity (1200 – 3000 lux) with temperatures below 25^{o}C (Teixeira da Silva *et al.*, 2017). Several studies show that nutrient absorption and plant utilization are modified by quality, intensity, and photoperiod of light (Xu *et al*., 2021). Mankotia *et al*. (2024) states that light signals play an important role in regulating N uptake, translocation, and assimilation into organic compounds. Light is also an important plant energy source to regulate growth, flowering, fertilization, and photosynthesis (Roosta *et al.*, 2024). Manipulation of the light environment can adjust the nutrient absorption capacity of plants so that it can further increase yields and economic value in vegetable crops (Xu *et al*., 2021). Light manipulation is commonly used in agriculture using UV plastics and shade nets.

In addition to environmental and climatic conditions, using the appropriate type of planting media will also affect the success of acclimatization (Manju *et al*., 2023). Planting media at the acclimatization stage is expected to make it easier root growth and provide sufficient nutrients for the plantlet (Sari *et al*., 2023). According to Nuzullah & Firgiyanto (2021) a good growing medium to be used in tissue culture acclimatization must meet several requirements, namely: not rotting quickly, not becoming a source of disease, able to bind water and nutrients properly, easy to get in the desired amount and cheap and environmentally friendly. Some planting media that can be easily found around the research location are vermicompost, cocopeat, and burnt husks. This study aims to determine the relationship between the type of canopy and the combination of planting media on the nutrient uptake, growth, and photosynthesis characteristics of kepok banana (*Musa paradisiaca* L.) during the acclimatization period.

METHOD

The research was conducted at the UPTD Benih Induk Hortikultura from June to August 2024. The experiment used a split-plot design with three replicates. The first factor was the type of cover, which consisted of two levels of treatment, namely 16% UV plastic and 75% shade net. The second factor was composition planting media, namely soil + vermicompost (2:1), soil + cocopeat (2:1), and soil + husk charcoal (2:1). Each treatment combination was repeated 9 times. The research used a kepok banana plantlet (*Musa paradisiaca* L.) with a plant height of approximately 4-5 cm. After the plantlet were carefully removed, it were then soaked with a growth stimulant (growtone) mixed with fungicide for 5-10 minutes. The observation parameters were root volume, root length, chlorophyll a, chlorophyll b content, and plant nitrogen uptake. Chlorophyll content was analyzed using the formula:

Chlorophyll a : 13,7 D-665 – 5,76 D-649 / 10 (mg/l)
Chlorophyll b : 25,8 D-649 – 7,60 D-665 / 10 (mg/l)

Nitrogen uptake variables were analyzed using the Kjeldahl method, while plant nitrogen uptake was calculated using the formula plant dry weight (mg/pot) x nutrient content in tissue (%) (Fahmi *et al*., 2022). Volume and length of root, chlorophyll content and nitrogen uptake was analyzed at the age of 4 weeks after planting. Primary data measurements of air humidity and sunlight intensity were performed daily during the study. The data were analyzed using analysis of varience (ANOVA) to determine whether different cover and composition of planting media treatment influence kepok bananas plant yield parameter. If the analysis of variance showed a significant effect, it was further tested with the Duncan test at the 5% level.

RESULT AND DISCUSSION

Based on statistical tests, the type of cover and the composition of the planting medium had a significant effect on root volume, chlorophyll b content, and plant N uptake. Root volume is one of the parameters of plant growth that can determine how large the size of the roots is in a unit of space. At the same time, the length of the roots describes their ability to absorb water and nutrients. Root volume is

measured to determine plant roots' ability to absorb nutrients and metabolism. Table 1 shows the effect of the canopy and planting medium on root volume and length.

Table 1. Effect of different canopy type treatment and planting media composition on the volume and length of roots of kepok bananas during acclimatization

Treatment	Volume root (mm)				Length root (cm)			
	Soil + Vermicompost (M_1)	Soil + Cocopeat (M_2)	Soil + husk charcoal (M_3)	Average	Soil + Vermicompost (M_1)	Soil + Cocopeat (M_2)	Soil + husk charcoal (M_3)	Average
UV Plastic 16% (S_1)	6,03[a]	4,13[b]	3,13[c]	4,43[a]	22,27	11,60	21,03	18,30
Shade nets 75% (S_2)	2,00[d]	0,77[e]	0,30[f]	1,02[b]	13,13	5,90	6,20	8,41
Average	4,02[a]	2,45[b]	1,72[b]		17,70	8,75	13,62	

Note: The numbers followed by different notations on the same line show a significant difference of 5% in the DMRT level.

The use of 16% UV plastic cover has an even root volume and root length that is larger than shade nets. This is because UV plastic produces more humid environmental conditions than shade nets. From the field observations, the plastic cover's humidity level is 44%, while the humidity in the shade nets is 40%. The combination of soil + vermicompost planting medium resulted in a higher average root volume and root length than other planting media composition treatments. This is because vermicompost planting media improves soil structure, increases nutrient availability, encourages beneficial soil microorganisms, and increases soil fertility (Mohite *et al*., 2024). A good soil structure will also allow the roots to develop more widely and absorb nutrients more widely; this is to the statement Mursyid & Anwarver (2023) which states that the better the soil structure, the more it will allow the roots to develop widely. The comparison of growth between the interaction treatment of the cover and the composition of the planting medium can be seen in Figure 1.

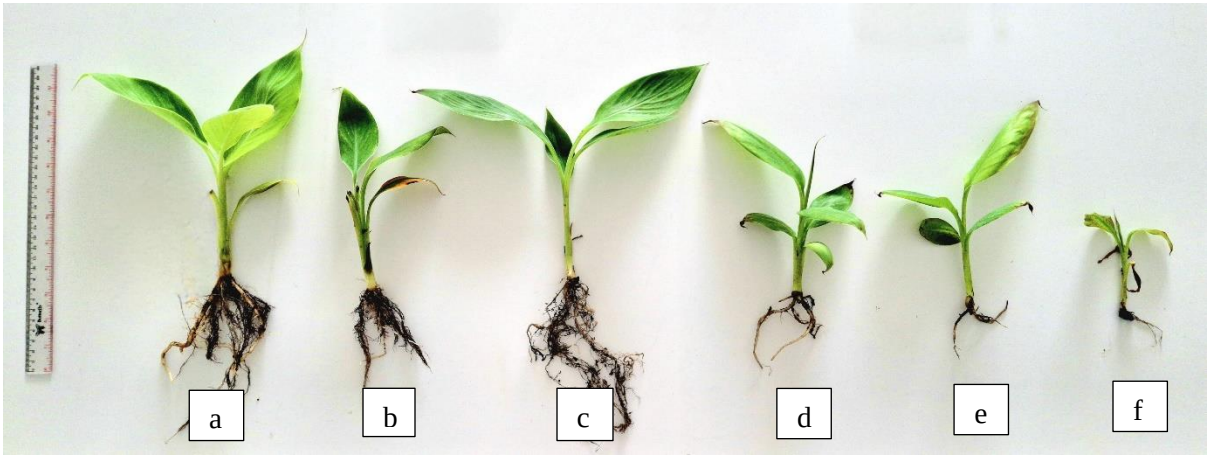

Figure 1. Differences in the growth of kepok banana seedlings during the acclimatization period at the age of 30 HST, (a) 16% UV plastic cover and soil + vermicompost planting medium (2:1) (b) 16% UV plastic cover and soil + cocopeat planting medium (2:1) (c) 16% UV plastic cover and soil + husk charcoal planting medium (2:1) (d) 75% shade nets and soil + vermicompost planting medium (2:1) (e) 75% shade nets and soil + cocopeat planting medium (2:1) (f) 75% shade nets and soil + husk charcoal planting medium (2:1)

The intensity of light received by plants during *in-vitro* conditions and acclimatization periods certainly changes. The light intensity will be higher in acclimatization conditions. Plants must be able to adapt to changes in light intensity, one of which is through regulating chlorophyll content in leaves. Content of chlorophyll a and b of kepok banana plants during the acclimatization period (Table 2).

Table 2. Effect of different cover types and planting media combination on chlorophyll a and b of kepok bananas during acclimatization

Cover	Chlorophyll a (mg/g)			Chlorophyll b (mg/g)		
	Soil + Vermicompost (M_1)	Soil + Cocopeat (M_2)	Soil + husk charcoal (M_3)	Soil + Vermicompost (M_1)	Soil + Cocopeat (M_2)	Soil + husk charcoal (M_3)
UV Plastic 16% (S_1)	1,88	1,81	1,67	1,66^{b}	2,54^{ab}	3,48^{a}
Shade nets 75% (S_2)	1,80	1,83	1,70	2,42^{ab}	2,42^{ab}	1,79^{b}
Average	1,84	1,82	1,69	2,04	2,48	2,63

Note: The numbers followed by different notations on the same line show a significant difference of 5% in the DMRT level.

Table 2 shows that the interaction of UV plastic and soil + vermicompost planting media shows a higher level of chlorophyll a (1,88 mg/g) than the level of chlorophyll b (1,66 mg/g). Other treatments showed higher chlorophyll b than chlorophyll a. This shows that plantlets planted in a 16% UV plastic canopy and soil + vermicompost planting medium have better photosynthetic ability than other treatments. This is by the statement Dash *et al*. (2022) which states that species that are tolerant of low light show a higher proportion of chlorophyll b compared to chlorophyll a, which leads to a lower chlorophyll a/b ratio, chlorophyll b, whose synthesis is greatly influenced by chlorophyll a, chlorophyll b is highly influential in the photosynthesis process. In addition to this Frungillo *et al*. (2016) also added that a low chlorophyll a/b ratio leads to an efficient photosynthesis process. The efficiency of plant photosynthesis changes significantly with variations in light intensity, which leads to dynamic changes in the accumulation of sugars in plants. Exogenous sugar supplementation can substantially increase nitrate absorption.

Nitrogen is an essential element for organic compounds such as proteins, chlorophyll, and nucleic acids and has an important role in improving crop yield and quality (Piñero *et al.*, 2018). The results showed that the treatment of the type of cover and planting medium as well as the interaction the type of cover and the planting medium had a significantly effected on the plant nitrogen uptake.

Table 3. Effect of different cover type treatment and planting media composition on nitrogen uptake of kepok banana root crops during the acclimatization period

Treatment	Nitrogen Uptake (g/plant)			Average
	Soil + Vermicompost (M_1)	Soil + Cocopeat (M_2)	Soil + husk charcoal (M_3)	
UV Plastic 16% (S1)	19,29^{a}	16,60^{a}	19,69^{a}	18,53^{a}
Shade nets 75% (S2)	18,25^{a}	14,06^{a}	5,54^{b}	12,61^{a}
Average	18,77^{a}	15,33^{a}	12,61^{b}	

Note: The numbers followed by different notations on the same line show a significant difference of 5% in the DMRT level.

Table 3 shows that UV plastic treatment has the highest average nitrogen absorption compared to the use of shade nets. Light intensity and N concentration have been shown to play important roles in nitrogen absorption and the Nitrogen content of plant leaves. Increased light intensity has also been shown to increase enzyme activity in N metabolism (Esmaeili *et al*., 2022). There is a high correlation between light intensity and plant nitrogen levels in terms of plant growth and development (Li *et al.*, 2020). The increase in light intensity is in line with the increase in photosynthesis and nitrogen absorption rate. In addition, light is very closely related to plant nitrogen metabolism (Lemaire, 2019). The combined treatment of soil + vermicompost planting media resulted in a higher average nitrogen uptake than other treatments. he combined treatment of soil + vermicompost planting media resulted in a higher average nitrogen uptake than other treatments. This is because vermicompost contains a percentage of macro and micronutrients almost twice as high. So that the nitrogen level absorbed by the plant will also be higher. This is by the statement (Mohite *et al.*, 2024), which states that macronutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) in higher concentrations can provide essential elements for plant growth and development. In addition, vermicompost contains more micronutrients such as iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), and boron (B), which are essential for various physiological processes in plants. Vermicompost contain 3,50% nitrogen (Geremu *et al*., 2020). The high nutrient content in vermicompost planting media also allows for higher nutrient accumulation. This is supported by the statement (Chaulagain *et al.*, 2017), which states that there is a significant accumulation of N, P, K, Ca, and Mg in the root system and shoots with the application of humic acid derived from vermicompost, which correlates with nutrient uptake by plants. In addition, the application of vermicompost and inorganic fertilizers showed an increase in the nutrient content of plants.

CONCLUSION

Based on research results, the intensity of sunlight and the combination of planting media affect root volume, root length, chlorophyll b levels, and nitrogen uptake. The use of 16% UV plastic produces more volume and root length than 75% shade nets. Chlorophyll a was higher than chlorophyll b in all treatment interactions except the 16% UV plastic cover treatment and the combination of soil + vermicompost planting media. Nitrogen absorption with the 16% UV plastic cover treatment was 46,94% higher than with 75% shade nets. The results showed that the best planting medium for the acclimatization of kepok bananas was vermicompost, while the best cover for the acclimatization of kepok bananas was UV plastic. The combination of plastic canopy treatment and soil and vermicompost planting media is the best combination for the acclimatization of kepok bananas. The implication of this finding is the potential to utilize vermicompost as a planting media mixture at the acclimatization stage of kepok bananas. This research is beneficial for the nation because this research can be used as a reference in cultivating plants.

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