Utilization of Oil Palm Fruits Mesocarp Fibres Waste as Growing Media for Banana Tissue Culture Seedling in Malaysia

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Abstract—**Malaysia is one of the largest producer of palm oil and the waste discharged from the mill such as oil palm fruits mesocarp fibres have great potential to be recycled as a valuable agriculture input. These mesocarp fibres were utilized as a growing media for banana tissue culture seedlings to replace the soil in the conventional practices. The mature mesocarp fibres were mixed with compost and chicken manure as growing media for banana tissue culture plantlet. Fibres based media showed to provide vigorous plant growth and sufficient nutrient supplies of phosphorous and magnesium to banana seedling, but required additional nitrogen and potassium through the amendments with compost or chicken manure into the fibre mixture. Fibre based media was proven effective to replace soil media for banana seedling inclusive of other advantages such as free of soil borne pathogens, higher workability and transportation with lighter material as media.**

Index Terms— **palm oil mill waste, mesocarp fibres, growing media, banana seedlings, nutrient uptake**

I. Introduction

Palm oil is one of the most important edible oil in world consumption which contributed about 33% of the total vegetable oils production. Malaysia is among the major world palm oil producers that contributed 39% of total world palm oil production in year 2010/2011. The total oil palm planted area of Malaysia in year 2010 was 4.9 million hectares with the total fresh fruit bunch (FFB) production of 88.3 million tonnes (FFB yield was 18.03 tonnes/hectares) [1]. Plenty of oil palm biomass produced from palm oil mill such as POME (palm oil mill effluent), empty fruit bunches (EFB) and mesocarp fibre (MF) were potentially to be recycled as energy sources and agriculture input. The oil palm biomass has potential to be utilized as renewable energy to produce synthetic bio-fuel, power generation [2] and bio-ethanol production from lignocellulosic waste [3]. The high cellulose (43-65%) and lignin (13-25%) content in EFB fibres is proven a good raw material for biocomposites [4].

EFB have been used as mulching to oil palm tree which able to increase the yield and also improve nitrogen and potassium availability in the soil [5]. EFB was extensively been used to produce organic fertilizer and compost [6]-[10]. Vermicomposting of palm oil mill waste was another practice to recycle the waste to useful plant nutrient and organic fertilizer [11]. Application of *Trichoderma* species was able to accelerate the composting of EFB to produced soil enhancer and biocontrol against phytopathogenic [12]. Besides EFB, the oil palm fruit mesocarp fibre (MF) has great potential to be recycled as agricultural input. MF was produced after the pressed oil palm fruits for oil extraction and separated from palm kernel. It is elongated cellulose about 3-5 cm length. MF compost was a suitable substitute for peat as growing media for potted Chrysanthemum, which showed significant increase of plant dry weight and total flowers production [13]. MF was constituted about 13% of the total FFB production [14], which means about 11.5 million tonnes of MF was available annually from Malaysia palm oil industry. Therefore, a trial was conducted to study the potential of MF to be utilized as growing media for banana tissue culture seedlings.

II. Material and Method

The fresh MF from palm oil mill was stacked about 0.5 m of height on concrete floor under exposed condition to wash out the oil residues by rain water. The fibres were turned three to four rounds to eliminate all the oil residues as possible. After two to three months of exposed under open condition, the colour of the MF will turn from light brown to dark brownish and this indicated that the MF were mature and ready to be used as growing media for banana seedlings. This mature MF was used alone or mixed with compost and composted chicken manure to produce potting mixture as growing media for banana tissue culture plantlet. The soil mixture with compost and composted chicken manure were served as comparison with mature MF mixture and the only soil media was used as standard control. The details of the various growing media derived from mature MF, soil and mixture with compost and composted chicken manure are presented in Table I.

The media were filled in 6” x 9” polybags and each treatment consisted of five polybags as five replications and the experiments were laid out in Complete Randomised Design (CRD). Rooted banana plantlets of about 8 cm in height were used as the planting materials.

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Plant height (the highest leaf) was measured weekly from the time of planting. The leaves of the plant and growing media were sampled at the end of the trial (7 weeks after planting) for nutrient analysis.

TABLE I. VARIOUS MIXTURE OF MATURE MF WITH COMPOST AND CHICKEN MANURE AS GROWING MEDIA.

Code	Mixture
T1	Soil
T2	Soil +20% (v/v) compost
T3	Soil + 20% (v/v) chicken manure
T4	Fibre
T5	Fibre + 20% (v/v) compost
T6	Fibre + 20% (v/v) chicken manure

III. RESULT AND DISCUSSIONS

A. Vegetative Growth

There was no significant difference for plant height in the first three weeks after transplanting into the polybags (Table II). The media effect on the plant growth was observed only from the fifth week after transplanting. Treatments T4 (fibre only) and T6 (fibre + 20% chicken manure) performed significantly better for plant growth when compared to T1 (soil only) and T2 (soil + 20% compost) but not for other media. Final measurement at the seventh week showed that the plantlet planted in media T4 (fibre) and T5 (fibre + 20% compost) performed similarly for growth with T6 (fibre + 20% chicken manure) and T2 (soil + 20% compost) but were more vigorous than T3 (soil + 20% chicken manure). Treatment T1 (soil only) performed poorest for plant growth and was significantly shorter than plants grown in the other media at 5 percent or less probability (Table III). *Treculia africana* planted on rice hull based media with higher organic matter than soil media was able to retained higher volume of water in the media and showed higher dry matter content than soil based media [15]. This study indicated that banana seedling planted in fibre and mixture with compost and chicken manure performed better in plant growth as compared than soil media.

TABLE II. PLANT HEIGHT OF BANANA SEEDLING AT WEEK 0-WEEK 3 AFTER PLANTING ON VARIOUS GROWING MEDIA.

Code	Treatment	Plant Height (cm)			
		Week 0	Week 1	Week 2	Week 3
T1	Soil	12.60 a	13.18 a	14.40 a	14.70 a
T2	Soil + compost	12.80 a	12.96 a	14.54 a	15.60 a
T3	Soil + chicken manure	10.80 a	12.30 a	15.50 a	16.30 a
T4	Fibre	12.00 a	13.44 a	17.30 a	18.90 a
T5	Fibre + compost	13.10 a	13.62 a	14.70 a	17.20 a
T6	Fibre + chicken manure	11.00 a	12.42 a	15.30 a	16.90 a

Values in column with the same letter are not significantly different at HSD 5%.

B. Nutrient Uptake

Leaf nutrient analysis results showed that the leaf nitrogen (N) level of the seedlings planted in fibre only media (T4) was slightly low as compared to soil only (T1) media. The microbial decomposition activities in fibre may occur and caused depletion of N for plant uptake [16]. Therefore, mixture of chicken manure into the fibre (T6) was able to compensate the N depletion and significantly improved the leaf N in the seedlings (Table IV). Leaf potassium (K) was higher in the seedling that planted in soil based media as compared to fibre based media, mixture of compost (T5) and chicken manure (T6) into fibre were significantly improved the leaf K as compared to fibre only (T4) media (Table IV). Mixture of compost and chicken manure into the fibre was very important to improve the leaf N and K level. The compost types use in growing media was also the key factor that affected the N and K uptake in the plant [17].

TABLE III. PLANT HEIGHT OF BANANA SEEDLING AT WEEK 5-WEEK 7 AFTER PLANTING ON VARIOUS GROWING MEDIA.

Code	Treatment	Plant Height (cm)		
		Week 5	Week 6	Week 7
T1	Soil	17.30 c	21.32 b	26.54 c
T2	Soil + compost	18.80 bc	28.80 ab	37.10 ab
T3	Soil + chicken manure	20.40 abc	29.14 ab	36.50 b
T4	Fibre	24.76 a	35.24 a	44.78 a
T5	Fibre + compost	23.00 abc	37.70 a	44.68 a
T6	Fibre + chicken manure	26.10 a	34.74 a	40.78 ab

Values in column with the same letter are not significantly different at HSD 5%.

The leaf phosphorous (P) level was obviously higher in all the fibre based media as compared to soil based media except for treatment T2 with the mixture of soil and compost (Table 3). Organic based growing media such as rice hull was demonstrated higher leaf P in *Treculia Africana* as compared to those planted in soil based media [15]. Leaf magnesium (Mg) level showed distinct high in all seedlings planted in fibre based media as compared to soil based media, compost was able to improve the leaf Mg when mixed with soil media (Table IV). Generally, fibre based media was able to improve the leaf P and Mg level in the banana seedlings.

TABLE IV. FOLIAR NUTRIENT ANALYSIS OF BANANA SEEDLING AFTER 7 WEEKS OF TRANSPLANTING.

Code	Treatment	(% dry weight)			
		N	P	K	Mg
T1	Soil	3.89 a	0.17 b	5.42 b	0.10 d
T2	Soil + compost	2.73 c	0.35 a	6.55 a	0.32 c
T3	Soil + chicken manure	3.02 bc	0.18 b	5.47 b	0.21 cd
T4	Fibre	2.86 c	0.37 a	3.21 d	0.94 a
T5	Fibre + compost	2.98 bc	0.42 a	5.43 b	0.62 b
T6	Fibre + chicken manure	3.30 b	0.36 a	4.40 c	0.82 a

Values in column with the same letter are not significantly different at HSD 5%.

C. Leaf Nutrient Level in Relation to Total Media Nutrient

The studies showed that the leaf N level and total N content in the media increased in through amendment with compost and chicken manure in the fibre and soil media. Therefore, compost and chicken manure are effective as N sources to improve the N uptake by banana seedlings planted in both soil and fibre based media (Fig. 1). Soil based media showed much higher total K content and leaf K level in banana seedlings when compared to fibre based media (Fig. 2). High K content in soil based media enabled the seedlings to maintain high K leaf levels, whereas in the fibre based media with low K content amendment with compost and chicken manure to the media is required to improve the K uptake.

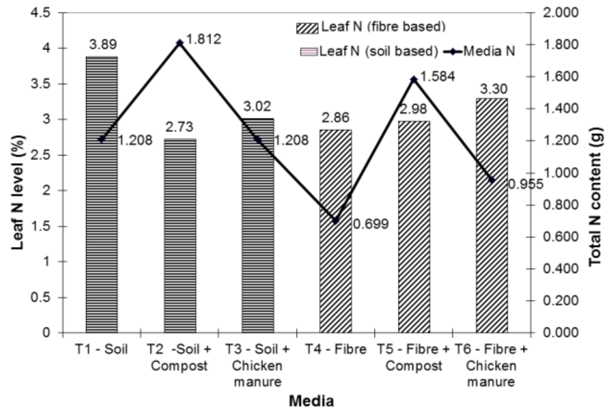

Figure 1. Leaf N level and total N content in the media.

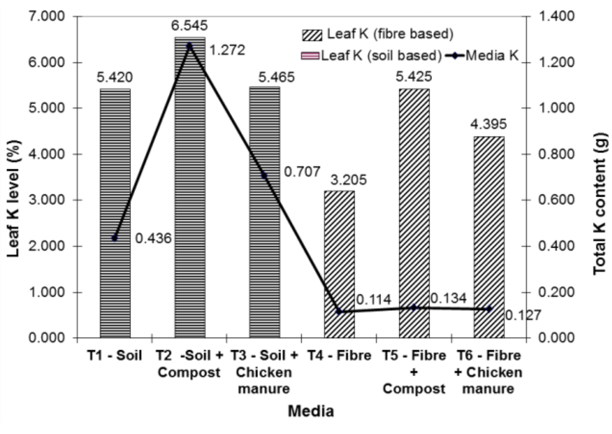

Figure 2. Leaf K level and total K content in the media.

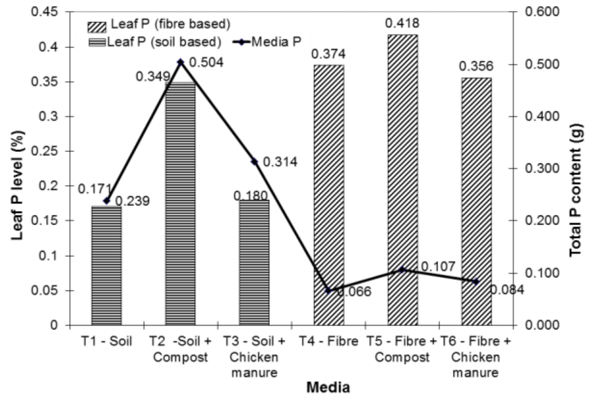

Figure 3. Leaf P level and total P content in the media.

A similar trend was observed between leaf P and leaf Mg level with regard to total P and Mg content in the media. Both P (Fig. 3) and Mg (Fig. 4) recorded higher total content in soil based media but were low for leaf nutrient status and vice-versa for fibre based media. It is clearly shown that the P and Mg were mostly fixed in the soil with low availability when compared to fibre based media which were more accessible for plant uptake. Improving on P and Mg uptake by the seedlings grown in soil based media is seen to be more effective by amendment of compost. An increase of Mg level in the floriculture plant tissues was detectable as compost usage was increased in the growing media [18].

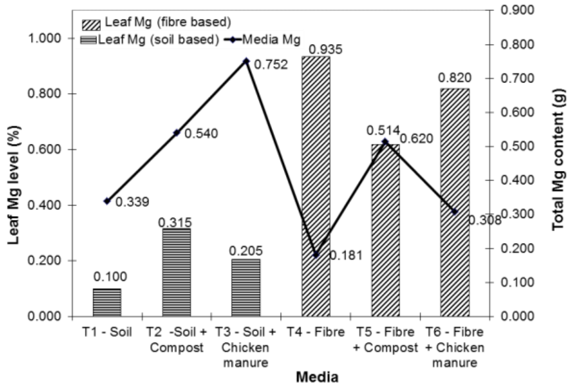

Figure 4. Leaf Mg level and total Mg content in the media.

D. Other Advantages of Mesocarp Fibre Media

The above study clearly showed that MF or amendments with compost or chicken manure was effective as growing media for banana seedling in promoting vigorous plant growth and providing essential plant nutrients. The other beneficial characteristics of MF based media as compared to soil based media were included: i) free of soil borne pathogens such as *Fusarium* sp., nematodes thereby reducing the risk of diseases transmitted from soil media to a new area; ii) higher workability and transportation by having low media weight in MF based media which is about 6 times lighter than soil based media; iii) less weed problems on MF media resulting in cost savings in weeding; iv) easier media handling and bag-filling can be mechanised to increase productivity.

IV. Conclusion

All the fibre based media provided vigorous plant growth and sufficient nutrient supplies of P and Mg, but required additional N and K nutrients. The additional N and K could be introduced through amendments with compost or chicken manure into the mixture. Fibre based media was superior for plant growth and could be further exploited. Therefore, oil palm mesocarp fibre was able to be utilized as a growing media for banana tissue cultures seedlings.

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