

The Utilization Of Co-Product as Organic Mulch to Improve Nutrient Use Efficiency and Growth of Palm Oil Seedlings in The Main Nursery

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ABSTRACT

Replanting is a strategic effort to increase the productivity of oil palm plantations. This effort requires the procurement of quality seedlings, so that maintenance absolutely gets the main attention. This study aims to determine the benefits of co-products to increase nutrient use efficiency (NUE) and the growth of oil palm seedlings in the main nursery. This study used a completely randomized block design with treatments of oil palm co-products (empty bunches, mesocarp fiber, suspended solids applied as mulch on the surface of polybag media, and without co-products) and NPKMg (15:15:6:4) at the rate of 8, 10 and 12 grams/two weekly/seedlings. The treatment applied at transplanting seedlings from PN to MN until the age of 8 months. The results showed that the growth of oil palm seedlings and NUE were influenced by the types of co-products and NPKMg rates. Application of oil palm co-products (empty bunches, mesocarp fibers and suspended solids) as surface mulch and NPKMg fertilizer (15:15:6:4) of 12, 10, and 8 grams/two weekly/seedling can increase the growth of 8-month-old MN oil palm seedlings. The better seedling growth was produced by the application of 8 grams of fertilizer/two weekly/seedling and empty bunches. Application of all co-products can improved NUE in MN nurseries. Improvement of NUE along with the decrease in the dose of NPKMg application (8 > 10 > 12 grams/two weekly/seedling).

Keywords: co-product, mulch, nutrient use efficiency, MN seedlings.

INTRODUCTION

Palm oil plantation reaches 16.8 hectares in area (BDPKS, 2023), run by private big plantations (53%), state-owned big plantations (5%), and public plantations (42%). The productivity achievements are 14-15 tonnes TBA/ha/year for public plantations and 23-24 tonnes TBA/ha/year for large plantations, and thus remain below their productivity potential. This yield gap is caused by

old, unproductive trees resulting from poor maintenance and Ganoderma attacks, leading to tree deaths and reduced tree density. Replanting is the priority in reducing the yield gap and improving productivity. The replanting success begins with quality seedlings, which are a combination of genetic characteristics and maintenance technical culture. Therefore, seedling

preparation must be observed. Ready-to-plant seedlings are 12 months old (3 months of prenursery-PN and 9 months of main nursery-MN). During the maintenance, fertilizer and regular watering are required. The continuous high fertilizer cost leads to the importance of improving fertilizer absorption effectiveness, which is affected by water availability. On the other hand, water availability often becomes an issue in the nursery management during the dry season, where its dry intensity tends to increase due to climate change (global warming).

Palm oil production produces a significant amount of biomass. Each ton of CPO will produce 9 tonnes of biomass, comprising mesocarp fibers, shells, empty bunches, pruned fronds, and palm oil mill liquid waste, which must be observed from the environmental viewpoint (Vakili et al., 2014). Biomass, as a co-product of palm oil plantations and plants, is utilized within and beyond the plantation, mainly as a source nutrient and soil

carbon on non-productive plants (NPP) and productive plants (PP) to reduce inorganic fertilizer use and become soil ameliorant (Yusoff 2006: Singh et al., 2010).

Nutrients, sunlight, temperature, and water are determining factors of plant production. However, fertilizer is a production input that continues to be more expensive, and improper use can harm the environment. Thus, prioritizing fertilizer use efficiency in agriculture (Hawkesford & Baaracclough, 2011). NUE is a sustainable agricultural principle, and applying soil ameliorant can improve NUE (Kumar et al., 2020). NUE relates to differences in absorption, translocation, plant canopy needs, dry matter production, and interaction between plants and the environment (Baligar & Fageria, 2015).

This study aimed to reveal the role of palm oil co-product mulch in enhancing nutrient use efficiency and palm oil seed growth in the main nursery.

MATERIALS AND METHODS

This study is a factorial trial assembled in the Randomized Complete Block Design. The first factor is types of organic mulch from palm oil biomasses, consisting of four levels: empty bunches, mesocarp fiber, suspended solids, and without mulch. The second factor is NPKMg fertilizer doses (15:15:6:4) of three levels: 8, 10, and 12 grams/seed, applied every 2 weeks. There are $4 \times 3 = 12$ treatment combinations. Each treatment combination was repeated 5 times; hence, 60 palm oil seeds were required. Watering

was conducted by sumisansui according to the requirements. Vegetative growth components of MN seeds observed were the height, number of leaves, stem diameter, seed wet weight, root wet weight, petiole width, and thickness measured when MN seeds were 9 months or 5 months old after transplanting from PN to MN. Nutrient use efficiency (Schutz et al., 2018) was measured using agronomic efficiency as the short-term response indicator of the effect of fertilizer application on seedling growth with the following formula:

$$\frac{\text{Fresh weight of treatment seeds (gram)} - \text{Fresh weight of control seeds (gram)}}{\text{Fertilizer quantity applied (gram)}}$$

The control was the MN seed fresh weight with fertilizer dose on each level tested without the application of palm oil co-product.

Variance analysis (F-test) was followed by a significance test using the Duncan test at a 5%

confidence level to infer seed growth component responses on the studied treatment, while nutrient use efficiency was described descriptively.

RESULTS AND DISCUSSION

The study results reveal that several growth components observed showed true responses to the co-product types and NPKMg fertilizer doses (15:15:6:4). General indicators of palm oil seed growth quality include height, number of leaves, and seed stem diameter in PN and MN. The study shows various responses from three growth

components to combinations of co-product types and fertilizer doses. The application of empty bunches as mulch and NPKMg dose of 8g/biweekly/seed resulted in the best height, number of leaves, and stem diameter than other treatment combinations (Table 1).

Table 1. The effect of co-product application and NPKMg doses on the height, number of leaves, and stem diameter of 9-month-old palm oil seedlings in the main nursery

Biomass	NPKMg (g/biweekly/seed)	Height (cm)	Number of leaves (strand)	Stem diameter (cm)
Without	8	57,31 b	16,65 b	7,36 b
	10	46,73 e	13,08 d	4,71 e
	12	58,92 b	14,08 d	4,65 e
Empty bunch	8	63,61 a	17,20 a	9,74 a
	10	57,80 b	14,84 c	6,67 c
	12	53,51 c	15,10 c	5,88 d
Mesocarp fiber	8	54,88 bc	16,65 b	7,97 b
	10	58,51 b	17,54 a	7,56 b
	12	51,27 d	15,80 c	5,52 d
Suspended solid	8	49,44 c	13,67 d	6,61 c
	10	58,91 b	17,53 a	7,34 b
	12	53,41 c	15,16 c	6,45 c

Note: the average with the same alphabet in a column shows insignificant difference between treatment combinations based on the Duncan test with $\alpha = 5\%$

Table 1 also shows that applying NPKMg for 12 grams/biweekly/seed produced better seed growth than the same dose on palm-il co-product. Generally, co-product application with doses of 8 and 10 grams/biweekly/seed resulted in better seed growth than 12 grams/biweekly/seed. Finely chopped empty bunch mulch maintained soil moisture better than mesocarp fibers and suspended solids, hence improving the nutrient provision and absorption processes (Dubos et al., 2019). The C and N content for empty bunches, mesocarp fibers, and suspended solids were 45.00, 0.25, 51.62, and 1.89, respectively (Onoja et al., 2018), and 31.5 and 4.7% (Teh, 2016). These contents indirectly reveal that empty bunch decomposition runs slower than mesocarp fibers and suspended solids. Therefore, empty bunches

have a longer duration as mulch and a better influence on the soil to retain water.

The petiole dimension and fresh weight of palm oil seeds showed significantly different responses to the combined application of co-product and NPKMg fertilizer doses. The application of empty bunches and 8 grams/biweekly/seed NPKMg produced better petiole and fresh weight of palm oil seeds than other studied treatment combinations. The application of all co-products with a dose of 12 grams/biweekly/seed resulted in better petiole dimensions and fresh weight than those with only fertilizer at the same dose (Table 2). Therefore, this treatment combination produced excellent vegetative growth. As mentioned by Corley &

Tinker (2016), the petiole can become a vegetative growth indicator.

Table 2. The effect of co-product application and NPKMg doses on petiole, fresh weight, and root of 9-month-old palm oil seeds in the main nursery

Biomass	NPKMg (g/ biweekly/seed)	Petiole width (cm)	Petiole thickness (cm)	Fresh weight of seed (gram)	Fresh weight of root (gram)
Without	8	5,52 b	2,34 b	396,3 f	170,0 e
	10	4,33 d	1,68 c	447,3 e	183,9 de
	12	4,69 d	1,67 c	563,2 d	235,7 d
Empty bunch	8	5,73 a	2,93 a	954, 9 a	445,2 a
	10	4,95 c	2,17 c	577,3 c	427,8 a
	12	5,03 c	1,97 d	713,3 b	386,7 bc
Mesocarp fiber	8	5,35 b	2,49 b	575,6 c	340,3 bc
	10	5,84 a	2,39 b	725,1 b	321,1 c
	12	5,27 c	1,94 d	702,3 b	404,1 b
Suspended solid	8	4,56 d	2,15 c	551,3 d	266,5 c
	10	5,84 a	2,33 b	477,3 e	323,1 c
	12	5,05 c	2,82 ab	608,2 c	341,4 c

Note: the average with the same alphabet in a column shows insignificant difference between treatment combinations based on the Duncan test with $\alpha = 5\%$

Table 2 shows that, in general, the growth components are better with smaller fertilizer doses (within the range of 12-8 grams/biweekly/seed) for empty bunches and mesocarp fibers, except for suspended solids. In suspended solids, the lowest growth component occurred at a dose of 8 grams/biweekly/seed than 10 and 12 grams/biweekly/seed. Since it has denser microbe content and experiences faster decomposition, the ability of suspended solids in supporting water holding capacity of seed media is shorter in time

than the other two co-products; thus, having greater potential for moisture stress. According to Foxx & Fort (2019), plants prioritize root growth over shoot growth in the photosynthate partition during a water shortage condition.

Nutrient use efficiency (NUE) based on the NPKMg fertilizer doses applied during seedlings showed differences as a response to the treatment combination effects of co-product and fertilizer doses (Table 3).

Table 3. The effect of co-product application and NPKMg doses on nutrient use efficiency of palm oil seeds in the main nursery

Palm oil biomass	NPKMg Doses (gram/biweekly/seed)			Average
	12	10	8	
Empty bunch	12,51	13,00	69,83	31,78
Mesocarp fiber	11,59	27,78	22,41	20,58
Suspended solid	3,75	3,00	19,38	8,71

Table 3 shows that the highest NUE for palm oil seeds in the MN was achieved by empty bunches, followed by mesocarp fibers and suspended solids. NUE values tended to increase

following the decreasing doses of applied NPKMg (in the range of 12, 10, and 8 grams/biweekly/seed). The results reveal the primary role of organic sources in improving

fertilizing efficiency in palm oil seedlings in the MN. Study findings can become an alternative to enhance absorption effectiveness and reduce fertilizer losses and greenhouse gas emissions (from seedlings) by improving physical and chemical characteristics of the soil (Sham et al., 2016). Increasing NUE in palm oil seedlings can be

carried out through water use efficiency (Sugianto et al., 2016) by providing organic sources as mulch or media mixture. In productive plants, increased NUE did not merely occur in plants given standard fertilizers. Conversely, improvement occurred on fertilizers with N, P, K, Mg, Ca, and Cl content in the leaf network (Tao et al., 2017).

CONCLUSION

The application of palm co-products (empty bunches, mesocarp fibers, and suspended solids) as mulch and NPKMg fertilizers (15:15:6:4) at 12, 10, and 8 grams/biweekly/seed doses can improve 9-month-old palm oil seed growth in the MN. The best seed growth is produced by empty bunches at a dose of 8 grams/biweekly/seed.

Co-product types and NPKMg doses applied affect nutrient use efficiency (NUE) of palm oil seeds in the MN. NUE increases following the decreasing NPKMg applied doses (8 >10>12 grams/biweekly/seed).

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