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Short communication

Evaluation of fertilizing capacity of palm oil sludge on growth and biomass production of oil palm seedlings

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ABSTRACT

Palm oil sludge a good nutrient source, is a waste from oil palm mills. A study was conducted to assess influence of palm oil sludge (POS) on growth and vigour of oil palm seedlings during nursery stage at ICAR-IIOPR, Pedavegi. Village tank silt amended with various doses of palm oil sludge (5, 10, 15 & 20%) was used as growing medium for raising oil palm nursery and tested against conventional practice with chemical fertilizers and the control. Noticeably, all the doses of palm oil sludge exhibited significant improvement in seedling growth and biomass production over the control. However, the best results for key growth parameters like seedling height, leaf and root production, leaf area, collar girth, root volume, root biomass, shoot biomass and total biomass were observed with village tank silt + 10% POS which was significantly higher than conventional practice. Significantly, higher level of organic carbon, Fe, Cu, Mn and Zn in growing medium, N, P, Fe, Cu, Mn, Zn and B in leaf were recorded with 10% palm oil sludge as compared with conventional practice. Hence, results suggest that combination of palm oil sludge@10%with village tank silt can be utilized as a sustainable and cost effective growing medium for oil palm nursery instead of chemical fertilizers.

Key words: Oil palm mills, nutrient status, oil palm nursery.

Growth and productivity of oil palm in commercial plantations mainly depend on the quality of seedlings which are commonly raised in poly bags for 12 months under specific management. Being heavy feeder, oil palm requires lot of nutrients which are applied through chemical fertilizers and organic manures. Production cost of oil palm nursery has been increased exorbitantly by conventional practice due to high cost of chemical fertilizers and organic manures. So, there is a need for alternate source of nutrients which are cost effective, locally available, organic in nature and sustain good seedling growth during the nursery stage of oil palm.

Palm oil sludge (POS) or decanter cake (DC) is a waste material generated at the rate of 3.5%/tonne of fruit bunches used in palm oil mill (Ng *et al*., 4). Palm oil sludge is a good organic manure as it is rich in nutrients especially nitrogen and organic matter (Embrandiri *et al*., 1). Only chemical fertilizers are used in all commercial oil palm nurseries in India. Availability of large quantity of palm oil sludge in palm oil mills prompted the need to use this waste as a substitute for chemical fertilizers to overcome environmental pollution.. Improved growth and biomass were observed in lady's finger plants grown in soil amended with 10% decanter cake (Embrandiri *et al*., 2). In view of above mentioned problems and dearth of literature in oil palm, study was carried out to assess fertilizing capacity of palm oil sludge at different doses on growth and biomass production of oil palm seedlings.

The study was taken up at ICAR-Indian Institute of Oil Palm Research, Pedavegi, West Godavari District, Andhra Pradesh during 2015-16. Experimental site is located at 16^0 43'N and 81^0 09'Ë with a mean sea level of 13.41m. The location Pedavegi experiences hot and humid weather owing to proximity to the sea Bay of Bengal. Average annual temperature ranges from 21.8^0 C to 34.8^0 C and relative humidity is about 69.3 percent. Average rainfall of experimental location is about 1215mm per annum.

Experiment was laid out in completely randomized design (CRD) with 6 treatments and 5 replications with 20 seedlings in each replication.Village tank silt and 4 month old palm oil sludge mixed by w/w were used as a growing medium. Physico-chemical and biological properties of village tank silt and palm oil sludge are presented in Table 1.Treatments of the study were T_1-tank silt+5% palm oil sludge, T_2-tank silt+10% palm oil sludge, T_3-tank silt+15% palm oil sludge, T_4-tank silt+20% palm oil sludge, T_5-tank silt+ recommended dose of chemical fertilizers (30g N, 38g P and 25g K) (conventional practice) andT_6-tank silt only (control). Chemical fertilizers diammonium phosphate (DAP) and complex (17N:17P:17K) were used and their application was commenced from the second month onwards and continued till 11^{th} month at monthly interval. Uniform and healthy seed sprouts of oil palm hybrid (644*Dura*x129*Pisifera*) produced

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Table 1. Nutrient composition of village tank silt and palm oil sludge used for raising oil palm nursery.

Parameter	Village tank silt	Palm oil sludge
Sand	54.67 %	-
Silt	8.35%	-
Clay	36.98%	-
Texture	Clayey	-
pH	7.12	7.35
EC($mScm^{-1}$)	0.46	3.62
OC	1.25 %	-
N	-	3.21%
P	24.62 mg kg^{-1}	0.35%
K	145.65 mg kg^{-1}	0.79%
Ca	3.34 meq$100g^{-1}$	1.80%
Mg	2.16 meq $100g^{-1}$	0.81%
Bacteria	14 $x10^6$	9 $x10^6$
Fungi	5 $x10^4$	3 $x10^4$
Actinomycetes	3 $x10^3$	1 $x10^3$

from Oil Palm Seed Garden, Pedavegi, Andhra Pradesh were used for the study.

Oil palm seedlings were raised in double stage nursery system*i.e.,*4 months in primary nursery under agro shade net house covered with UV stabilized HDPE 50% shade net and 8 months during secondary nursery in open condition. Seedlings were raised in poly bags of 23 cm × 15 cm during the primary stage and 45 cm × 38 cm in secondary stage. Genetically abnormal seedlings like runts, collants and chimera during primary stage and runts, juvenile seedlings and seedlings with weak stem during secondary nursery stage were culled. All the recommended nursery practices were followed uniformly in all the treatments during the study period.

Observations on growth parameters of oil palm seedlings *i.e*., height, leaf production, 3rd leaf area, collar girth, primary roots, root volume, fresh and dry biomass of seedlings were recorded on 12 month old seedlings by using standard methods. Growing mediumand leaf (3rd leaf from the top) samples from all the treatments were collected and analyzed for pH, EC, OC, N, P, K, Ca, Mg. Fe, Zn, Cu, Mn and B by using standard methods. Analysis of variance (ANOVA) was performed for all parameters by GLM procedure of the statistical software SAS version 9.3. Differences among treatments were analyzed using LSD at $p<0.05$ (Gomez and Gomez, 3).

Results for growth characters demonstrated that growing medium amended with palm oil sludge had highly positive effect on growth and development of oil palm seedlings when compared with (T_5) conventional practice *i.e*., tank silt with chemical fertilizers and (T_6) the control (Table 2). Maximum seedling height was observed in T_2 (192.47 cm) which was found at a par with T_3 (188.77cm) treatment whereas the minimum seedling height was noticed in T_6 (118.60 cm).Among the treatments, seedlings grown under T2possessed the highest number of leaves (19.32) while the lowest number of leaves was recorded with T_6 (15.75). Leaf area measured in T_2 (6758.30 cm^2) was significantly superior to other treatments and the minimum leaf area was recorded with T_6 (2728.92 cm^2).Treatments T_3 (5437.97 cm^2), T_4 (5343.42 cm^2) and T_1 (4776.45 cm^2) were found on par with each other for leaf area. Seedlings with maximum collar girth were observed under T_2 (38.52cm) and it was closely followed by T_3 (36.80cm) while the minimum collar girth was noticed with T_6 (24.70 cm). Of all the treatments, treatment T_2 was significantly superior to T_5 for seedling height, leaf production, leaf area and collar girth.

There was a remarkable growth of seedlings under T_2 and it can be ascribed to better assimilation of nutrients and higher photosynthetic rate. Better leaf area in T_2 may be attributed to production of more number of leaves/seedling. Increased collar girth in T_2 might be accounted for more accumulation

Table 2. Effect of palm oil sludge on morphological Scharacters of oil palm seedlings.

Treatment	Seedling height (cm)	Leaves	3rd leaf area (cm^2)	Collar girth (cm)	Primary roots	Root volume (cc)
T_1	167.40	18.00	4776.45	35.00	28.67	326.67
T_2	192.47	19.32	6758.30	38.52	35.67	413.32
T_3	188.77	18.32	5437.97	36.80	34.32	393.32
T_4	169.42	17.67	5343.42	34.50	27.50	360.00
T_5	143.07	16.32	4275.10	28.27	26.32	203.32
T_6	118.60	15.75	2728.92	24.70	22.67	196.67
$CD_{(0.05)}$	11.03	0.90	917.99	2.38	4.23	66.56

of photosynthates. Growth and vigour of oil palm seedlings got lessened as palm oil sludge dose was increased from 5% (T_1) to 20% (T_4Similarly, enhanced seedling growth was noticed in primary nursery seedlings with palm oil sludge at 15% in oil palm (Vidhana Arachchi and Yahya, 6), 10% in lady's finger (Embrandiri *et al*., 2) and 20% in brinjal nursery (Embrandiri *et al.*, 1). Growth and vigour of oil palm seedlings got lessened as palm oil sludge dose was increased from 5% (T_1) to 20% (T_4). More retarded growth of oil palm seedlings was noticed in T_4. Stunted growth in kailan was observed at higher dose of palm oil sludge which may be due to presence of heavy metals in palm oil sludge (Ramli, 5).

There were significant results among the treatments for root production (Table 3). Among the treatments, T_2 recorded the highest number of primary roots (35.67) and maximum root volume (413.32 cc) and this was significantly superior to rest of the treatments except T3. Results were not significant among the treatments T_5 (26.32), T_4 (27.50) and T_1 (28.67) for number of primary roots. Higher root production and root volume must be due to better partitioning of photosynthates towards roots. There was a significant reduction in root growth of seedlings grown in control. Palm oil sludge being organic in nature improved physico-chemical and biological properties of soil which in turn might have created favourable environment for better root growth in oil palm seedlings (Vidhana Arachchi and Yahya, 6).

The treatment T_2 produced maximum root (89.75 g), shoot (790.08 g) and total biomass (879.83 g) of seedlings which were markedly superior to other treatments barring T_3 and the minimum biomass production was observed under T_6 (49.08 g, 282.74 g & 331.82 g), respectively (Table 4). Treatments T_4 (683.32 g) and T_1 (643.92 g) were at par with each other in respect of total dry biomass. Significant increase in total dry biomass production was observed in all the treatments wherein palm oil sludge was used as growing medium when compared with T_5 and T_6. Improved dry biomass production under T_2 must be ascribed to better photosynthetic rate which in turn might have ensured greater synthesis, translocation and accumulation of carbohydrates. Also, better assimilation of nutrients might be responsible for enhanced biomass production in T_2. Present results are in agreement with the findings of Vidhana Arachchi and Yahya (6) in oil palm primary nursery.

Table 3. Effect of palm oil sludge on physiological characters of oil palm seedlings.

Treatment	Root dry biomass (g)	Shoot dry biomass (g)	Total dry biomass (g)
T_1	62.30	581.62	643.92
T_2	89.75	790.08	879.83
T_3	80.86	726.86	807.72
T_4	73.63	609.69	683.32
T_5	70.90	402.78	473.68
T_6	49.08	282.74	331.82
$CD_{(0.05)}$	11.81	133.25	132.35

Among the treatments (Table 4), more pH was noticed in growing medium under T_1 (7.87) and T_2 (7.72) whereas less pH was observed in T_5 (7.24), T_4 (7.28) and T_3 (7.29). Results reveal that pH of the growing medium in all the treatments was above neutral and presence of slightly less pH in T_3 and T_4 might be due to higher dose of palm oil sludge in growing medium. EC of growing medium recorded in T_4 (1.39 $mScm^{-1}$) and T_5 (0.82 $mScm^{-1}$) was found as the maximum and minimum, respectively. More organic carbon in growing medium was estimated with T_4 (2.39%) while it was the minimum in T_6 (0.66%) and T_5 (0.69%). The treatment T_4 recorded the maximum level (44.87 ppm) of phosphorous in growing medium and the minimum quantity of phosphorous was observed in T_6 (28.76 ppm). The treatment T_4 (73.70 ppm) was significantly superior to other treatments in respect of availability of potassium in growing medium. Potassium content was the lowest in T_6 (34.22 ppm) which was found on par

Table 4. Effect of palm oil sludge on nutrient status in growing medium.

Treatment	pH	EC (mS cm^{-1})	OC (%)	P (ppm)	K (ppm)	Ca (meq/100g)
T_1	7.87	1.06	1.25	30.18	39.42	6.03
T_2	7.72	1.33	1.92	36.27	49.45	6.46
T_3	7.29	1.28	2.20	39.36	65.33	6.48
T_4	7.28	1.39	2.39	44.87	73.70	6.57
T_5	7.24	0.82	0.69	30.64	41.88	6.08
T_6	7.66	1.10	0.66	28.76	34.22	5.27
$CD_{(0.05)}$	0.41	0.24	0.24	6.87	10.15	0.68

with T_1 (39.42 ppm) and T_5 (41.88 ppm). Similarly, higher level of Ca in growing medium was noticed in T_4 (6.57meq100g^{-1}) while the minimum was in T_6 (5.27meq100g^{-1}). Maximum level of Fe (10.22 ppm), Mn (5.42 ppm) and Zn (1.59 ppm) whereas minimum levels of same in growing medium were observed in T_4 and T_6, respectively. The treatment T_3 recorded the highest Cu content (1.75 ppm) and followed by T_4 (1.65 ppm) and the lowest Cu content was in T_6 (0.43 ppm) (Table 5). Macro and micro nutrients were high in growing medium mixed with palm oil sludge when compared with T_6 (control) and T_5 (tank silt mixed with chemical fertilizers). Availability of OC, P, K, Ca, Fe, Mn and Zn was increased as the palm oil sludge dose was enhanced from 5% (T_1) to 20% (T_4) except Cu. Increased nutrient availability in growing medium amended with palm oil sludge can be correlated with improved microbial activity. Similarly, Vidhana Arachchi and Yahya (6) reported enhanced physical and nutritional aspects of soil mixed with15% palm oil sludge used for oil palm nursery.

Higher concentration of nitrogen (2.55%), phosphorous (0.18%), potassium (1.87%), Ca (1.21%) and Mg (0.64%) in leaf was observed in T_4 which was markedly superior to the control. Of all the treatments, T_2 had significantly higher concentration of micronutrients *i.e*., Fe (34.06 ppm), Cu (10.18 ppm), Mn (89.93 PPM), Zn (8.56 PPM) and B (10.21 PPM) In leaves when compared with control (Table 6). Foliar analysis of seedlings grown in T_4 had shown maximum uptake of major nutrients. Better availability of nutrients in growing medium might have promoted absorption of more nutrients by seedlings in T_4. However, growth and development of oil palm seedlings was weaker in T4 than seedlings grown under T_2. Higher levels of nutrients in T_4 indicated the luxury consumption which was not reflected in growth and development of seedlings. Hence, results revealed that N, P, K, Ca and Mg levels in seedlings in T_2 must be optimum for better growth of oil palm seedlings.

Increasing cost of oil palm nursery is the main issue of nursery growers in India. There was a variation among the treatments for cost of production, gross returns, net returns and benefit cost ratio calculated for 1000 seedlings (Table 7). Differences noticed in respect of cost of production among the treatments were attributed to cost of chemical fertilizers and palm oil sludge. Comparatively, less cost of production in T_1, T_2, T_3 and T_4 was on account of low cost of palm oil sludge. Among the treatments, higher net return and benefit cost ratio were noticed under T_1, T_2, T_3 and T_4 as compared to T_5 where in relatively lesser net returns (Rs.14422) and benefit cost ratio (1.25) were observed. It is clear from the study that use of chemical fertilizers can be replaced by palm oil sludge.

Table 5. Effect of palm oil sludge on status of micronutrients in growing medium.

Treatment	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
T_1	2.78	0.90	3.70	0.59
T_2	6.08	1.38	4.32	1.18
T_3	7.64	1.75	4.74	1.55
T_4	10.22	1.65	5.42	1.59
T_5	2.45	0.52	3.91	0.58
T_6	6.04	0.43	4.07	0.66
$CD_{(0.05)}$	0.96	0.13	0.37	0.25

Table 7. Economics of oil palm nursery (1000 seedlings) influenced by palm oil sludge and chemical fertilizers.

Treatment	Cost of production (Rs)	Gross returns (Rs)	Net returns (Rs)	Benefit cost ratio
T_1	55587	73000	17413	1.31
T_2	55790	73000	17210	1.31
T_3	56081	73000	16919	1.30
T_4	56374	73000	16626	1.29
T_5	58578	73000	14422	1.25

Table 6. Nutrient status in leaves of oil palm seedlings under influence of palm oil sludge.

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)	B (ppm)
T_1	2.25	0.16	1.32	0.88	0.46	25.27	8.72	76.10	7.77	5.18
T_2	2.51	0.18	1.56	1.08	0.52	34.06	10.18	89.93	8.56	10.21
T_3	2.52	0.12	1.78	1.11	0.59	27.70	8.89	80.39	8.28	8.40
T_4	2.55	0.18	1.87	1.21	0.64	25.53	9.19	80.23	7.70	5.12
T_5	2.31	0.13	1.84	1.15	0.52	12.03	8.52	32.80	7.11	3.46
T_6	2.06	0.09	1.23	0.85	0.39	9.84	5.42	28.02	5.55	2.35
$CD_{(0.05)}$	0.17	0.03	0.12	0.09	0.06	3.30	1.09	13.52	1.34	1.43

The results of the study clearly indicated that palm oil sludge based growing medium had significantly influenced the growth and biomass production of oil palm seedlings. Being rich in nutrients, the palm oil sludge/decanter cake has a great potential to replace chemical fertilizers as it is cost effective, eco-friendly and excellent growing medium. It is therefore recommended that palm oil sludge @10% mixed with village tank silt can be used commercially in oil palm nurseries in India.

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