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IMPACT OF PALM OIL MILL EFFLUENT (POME) ON THE POPULATIONS OF RHIZOBIUM AND MELOIDOGYNE SPECIES IN AWKA, NIGERIA.

OKOLIE, HENRY, EKWURIBE, CHUKWUEMEKA, OBIDIEBUBE, EUCHARIA, AND OBASI, CHIAMAKA,

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ABSTRACT

The impact of palm oil mill effluent (POME) on the populations of Rhizobium and Meloidogyne species was tested at the Teaching and Research Farm of Nnamdi Azikiwe University Awka, Nigeria. Three cowpea cultivars ,Dan Kano, Borno local and Sokoto local were used as target crops on plots that received 0 l/ha(control),4000l/ha,6000l/ha and 8000l/ha levels of POME applications. The treatments combinations were randomized within each block and replicated three times. Generally, increasing level of POME application increased number of functional root nodules in all the cultivars, but decreased length of roots and number of non- functional nodules. Nematode populations drastically decreased with increase in POME quantities. Both Rhizobium and Meloidogyne species compete for establishment sites on cowpea roots and high POME rates decreased Nematode population which is why all the three cowpea cultivars had their highest yields at 8000l/ha POME application rate. So POME, an organic waste from oil palm processing can be used at up to 8000l/ha to effectively control obnoxious root knot nematode and enrich soil for crop cultivation especially Sokoto local cowpea cultivar.

KEYWORDS: POME (palm oil mill effluent), Rhizobium, Meloidogyne liters/hectare, cowpea cultivars

INTRODUCTION

Cowpea is a grain legume of the family Fabaceae. It is one of the most popular and important crops in the tropics (Langyintuo *et al.*, 2003). It is basically grown in the third world for its cheap source of dietary protein and a supplement for meat. It may be consumed at various stages of its development; green leaves, green pods, green peas, dry grains and the straw are excellent animal feed (Sanginga *et al.*, 2003). Its optimum yields have, however, not been realized due to diseases and other limiting factors. Root-gall nematode disease is one of the diseases that cause significant yield and economic losses on cowpea. Nematodes are spread by anything that moves in soil or infested plant material, including field equipment, water running through fields, and infected transplants((Addo-Quaye *et al.* 2011). These nematodes have wide host ranges, including many vegetable, ornamental, and weed plant species. These nematodes feed on roots, resulting in dysfunctional root systems with reduced water and nutrient absorption (Jones *et al.*, 2013). Poor root function results in above ground symptoms that include plant stunting, wilting, and leaf chlorosis. Affected plants often occur in patches in the field. Root symptoms of root knot nematode include the development of swollen roots areas, called root galls. These galls can be spherical to elongated in shape and vary in size depending on the specific species of Meloidogyne present (Corbett *et al.*, 2011). Symptoms of sting nematode infection include short, stubby roots, and the formation of tight mats of short roots. Once introduced, root knot nematode and sting nematodes are almost impossible to eliminate from the soil. Management is based on an integrated approach involving cultural practices to reduce nematode populations, the use of resistant varieties, and the use of nematicides (Noling, 2012). It is important to lower populations before planting, as there are few effective post planting control options. Amongst the soil bacteria, there is a unique group called rhizobia that have a beneficial effect on the growth of legumes. Rhizobia are remarkable bacteria because they can live either in the soil or within the root nodules of legumes.When legume

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Okolie, Henry, Department of Crop Science and Horticulture, Faculty of Agriculture, Nnamdi Azikiwe University, Awka
Ekwuribe, Chukwuemeka, Department of Crop Science, Michael Okpara University of Agriculture, Umudike
Obidiebube, Eucharia, Department of Crop Science and Horticulture, Faculty of Agriculture, Nnamdi Azikiwe University, Awka
Obasi, Chiamakai, Department of Crop Science and Horticulture, Faculty of Agriculture, Nnamdi Azikiwe University, Awka

seeds germinate in the soil, the root hairs come in contact with rhizobia. If the rhizobia and the legume are compatible, a complex process begins during which the rhizobia enter the plant's root hairs (Antoun and Prevost, 2005). Close to the point of entry, the plant develops a root nodule. Once the relationship between plant and rhizobia is established, the plant supplies the rhizobia with energy from photosynthesis and the rhizobiafixatmospheric nitrogen in the nodule, converting it into a form that the plant can use. Both the plant and the rhizobia benefit from such a relationship called a symbiosis. Nodulation is an ecologically and economically important plant phenomenon, in which the symbiosis between plants from the family Fabaceae and the bacteria Igenerarhizobia results in the development of nitrogen fixing nodules on host plant roots. The rhizobia-plant interaction is initiated by Nod factors, which are produced by species-specific rhizobia; The complex process by which the rhizobia produce nitrogen for the legume is called biological nitrogen fixation. Only rhizobia that are specifically compatible with a particular species of legume can stimulate the formation of root nodules, a process called nodulation. This process has great economic benefit for legume production. As a result, rhizobia linoculantsare produced commercially in many countries. Inoculants contain rhizobia isolated from plant nodules and grown (cultured) artificially in the laboratory. If a root nodule is cut open and the inside is pink/red the nodule is active and fixing lots of nitrogen for the plant. The colour is due to the presence of plenty of leghaemoglobin. The redder the nodule, the more active it is. When nodules are young and not yet fixing nitrogen they are white or grey inside. *Elaeis guineensis*is a tropical forest palm native to West Africa. Grown in plantations it produces 3–8times more oil from a given area than any other tropical or temperate oil crop (Sheil *et al*., 2009).Oil (triacylglycerols) can be extracted from both the fruit and the seed, crude palm oil (CPO) from the outer mesocarp and palm-kernel oil from the endosperm. Most crude palm oil is used in foods. In contrast, most palm-kernel oil is used in various non-edible products, such as detergents, cosmetics, plastics, surfactants, herbicides, as well as a broad range of other industrial and agricultural chemicals (Wu *et al.,* 2009).

Processing oil palm into palm oil produces large amounts ofliquidwaste,around55%to67%ofthetotalfreshfruit bunches processed (Igwe and Onyegbado,2007).This fresh waste is in the form of a colloidalsuspensionconsistingof94-95% water, 0.7-1%oil and 4-5%total solidsincludingfloatingsolidsof2-4%. Raworun processed palm oil mille fluent (POME) has a high BOD value around 25,000mgL^{-1}or more (Wu *et al*.,2009) hence the POME produced by palm oil companies must be processed in order to have no negative impact on human sort he environment. Although, palm oil mill effluent (POME) is not the only waste

Generated during processing of fresh fruit bunch (FFB) (Khairiah and Khairul, 2006). But it is the most expensive and difficult waste to manage by mill operators. This is because large volumes intones are generate data time. The palm oil industry still considers POME treatment a burden rather than as part of the production process. (Okwute and Isu, 2007).For these obvious reasons, raw POME or partially treated POME is still being discharged into nearby rivers or land, as this is the easiest and cheapest method for disposal. However, excessive quantities of untreated POME deplete water body of its oxygen and suffocate aquatic life. Many small and big rivers have been devastated by such discharge as people living downs tream are usually affected (Wu et al., 2009). This work examined a profitable way of disposing this organic waste.

EXPERIMENTAL MATERIALS.

Cowpea cultivars used were: Dan Kano (A1), Borno local (A2) and Sokoto local (A3) .They were sourced from Michael Okpara Federal University of Agriculture, Umudike, Nigeria. The palm oil mill effluent (POME) was sourced from an oil mill in Elele in Ikwere Local Government Area of Rivers State, Nigeria. The four levels of the POME applications were termed factor as followed 4000lit/ha (B1),6000lit/ha(B2),8000LIT/HA(B3) and Control 0lit/ha(B4).The twelve treatments combinations used were A1B1,A1B2,A1B3 and A1B4,A2B1,A2B2,A2B3 and A2B4,A3B1,A3B2,A3B3 and A3B4.The treatment combinations were randomized within each block and replicated three times.

EXPERIMENTAL DESIGN.

A 3×4factorial arrangement that was fitted into randomized complete block design (RCBD) was used for the experiment. Data collected were subjected to analysis of variance and significant means separated by least significant difference (LSD).

CULTURAL PRACTICES.

Land clearing for dry season planting was done on November26th, 2017 while that for 2018 rainy season was done on April 6th.POME was applied seven days before planting in the different seasons to allow percolation before planting. Planting was done manually at 25cm × 30cm.

DATA COLLECTION.

Soil samples were collected from 0 to 15 cm depth in all the 12 subplots and composited for analysis before POME application. The Baermann-funnel techniques was used to determine the population of the nematodes based on motality test. The soil PH was determined electrometrically using EL model 720 PH meter. Other soil parameters were determined using convectional techniques. Composite soil samples were also collected and analyzed towards the end of the experiment. Lengths of roots was determined by carefully digging out and washing the roots with water and measurement with flexible meter tape .Root nodules were manually counted at 4,6 and 8 weeks after planting .Pink colour indicates a functional nodule while dark colour indicates a non –functional nodule. After the final harvest, drying, threashing and winnowing the final grain yield at 14% moisture content was determined for each plot.

RESULTS:

(1) Impact of POME rate on root length (cm).

During the first 4WAP, the control plot was significantly higher than other treatments despite cultivar or POME application rate. The trend was also the same during 6-8WAP with the longest root from the Dan Kano (26.60cm) on control plot in 6 WAP rainy season.

Generally, there was decrease in root length with increase in POME rate.

Table: 1 Impact of POME on Length of roots (cm)

WAP	Wet Season				Dry Season		
	POMELevei	Dan Kano	Borno local	Sokoto local	Dan Kano	Borno local	Sokoto local
4WAP	Control	18.5	18.00	20.23	17.17	11	22.23
	4000l/ha	17.17	12.67	19.33	16.83	12.50	17.00
	6000l/ha	13.83	11.83	19.33	15.50	11.17	16.67
	8000l/ha	10.83	10.43	15.33	9.43	9.33	13.43
6WAP	Control	26.60	24.67	21.37	26.23	18.17	18.17
	4000l/ha	25.93	21.67	19.50	17.73	15.00	15.67
	6000l/ha	24.77	20.67	18.77	15.00	14.67	12.33
	8000l/ha	23.17	18.67	15.87	11.93	11.93	12.07
8WAP	Control	20.43	19.00	22.87	19.23	19.07	22.50
	4000l/ha	18.33	18.33	19.00	17.20	17.87	20.00
	6000l/ha	17.83	16.83	18.17	15.25	14.83	16.57
	8000l/ha	17.07	16.83	18.17	14.83	14.90	16.77
LSD			0.56			0.51	

(2) Impact of POME rate on number of functional root nodules.

At 4WAP Bornu local had the highest functional nodules (38) on 8000l/ha plot in the dry season. During 6 -8 WAP, there was significant difference on the effects of different POME rates. Sokoto local had the highest number of functional nodules (50) in dry season of plots with 8000i/ha POME rate.

Generally, there was increase in the number of functional nodules with increase in POME rates.

Table: 2 Impact of POME on Number of Functional Nodules

	Wet Season				Dry Season		
	POMELevei	Dan Kano	Borno local	Sokoto local	Dan Kano	Borno local	Sokoto local
4WAP	Control	10	8	16	8	11	15
4WAP	4000l/ha	9	9	12	6	9	16
4WAP	6000l/ha	16	12	30	16	28	30
4WAP	8000l/ha	21	20	26	24	38	34
6WAP	Control	12	11	18	9	14	18
6WAP	4000l/ha	10	11	13	7	11	17
6WAP	6000l/ha	18	18	26	25	27	31
6WAP	8000l/ha	29	21	31	39	34	50
8WAP	Control	10	12	22	11	12	12
8WAP	4000l/ha	12	10	16	11	13	24
8WAP	6000l/ha	21	10	31	29	24	35
8WAP	8000l/ha	35	22	36	37	28	39s
LSD			0.69			0.75	

(3) Impact of POME rate on the number of non – functional nodules.

During the first 4WAP, all the cultivars despite season recorded the highest number of non-functional nodules in control plots. The same trend followed in 6-8 WAP with the highest number (15) in Sokoto local on 4000l/ha plots 8 WAP dry season. Comparatively, increasing POME level decreased number of non-functional nodules significantly.

Table: 3 Impact of POME on Number of Non-Functional Nodules

	Wet Season				Dry Season		
	POMELevei	Dan Kano	Borno local	Sokoto local	Dan Kano	Borno local	Sokoto local
4WAP	Control	6	4	6	7	6	7
	4000l/ha	4	5	3	7	7	5
	6000l/ha	4	4	3	5	5	4
	8000l/ha	3	3	2	4	3	1
6WAP	Control	5	4	10	7	7	13
	4000l/ha	7	3	6	5	5	8
	6000l/ha	4	2	4	4	5	7
	8000l/ha	4	2	4	4	4	5
8WAP	Control	6	6	11	5	9	9
	4000l/ha	10	5	11	4	8	15
	6000l/ha	6	4	6	3	6	8
	8000l/ha	6	2	3	3	4	7
LSD			0.82			2.14	

(4) Impact of POME on Nematode population.

Control plots had the highest number of Nematode (*Meloidogyneinconita*) (8,553).The least Nematode population was recorded 8000l/ha plots. Higher POME levels negatively affected nematode population and favoured nitrogen fixing Rhizobium population.

Table: 4 Impact of POME on Nematode populations.

		Wet Season		Dry Season
POME Level	Before Application	After Application	Before Application	After Application
Control	8553	8554	6695	6697
4000lit/ha	8553	8554	6695	6149
6000lit/ha	8553	2632	6695	2001
8000lit/ha	8553	3005	6695	1660

(5) Impact of POME on dry seed matter yield(t/ha)

Generally, as the rate of POME application increased, the seed yield increased. The least yield was recorded in control plots. Sokoto local had higher yields irrespective of season. It had the highest yield (0.3t/ha) in wet season on 8000l/ha POME plot.

Table: 5 Dry matter yield (t/ha)

		WET SEASON			**DRY SEASON**	
POME LEVELS	Dan Kano	Borno local	Sokoto local	Dan Kano	Borno local	Sokoto local
Control 0lit/ha	0.17	o.26	0.24	0.14	0.15	0.15
4000lit/ha	0.15	0.24	0.24	0.18	0.18	0.18
6000lit/ha	0.23	0.27	0.26	0.24	0.22	0.23
8000lit/ha	0.25	0.25	0.30	0.16	0.25	0.24
LSD	0.15			0.12		

DISCUSSION

During the course of the work the control plots had longer roots than POME applied plots. This showed that POME when newly applied negatively affected cowpea roots growth and development (Osaigbovo and Orhue, 2011).The raw or partially treated POME has an extremely high content of degradable organic matter, which is due in part to the presence of unrecovered palm Oil(Ahmad *et al*.,2008).Oil generally reduces penetration of sunlight there by reducing soil temperation. It also reduces soil aeration by blocking the soil pore spaces, reduces solubility of soluble minerals and root hairs absorption ability (Osaigbovi and Orhue, 2011).Most of cowpea roots are found near the soil surface ,therefore they were highly affected by POME application especially during the first 4WAP.In most of the cultivars and rates of POME rates ,functional root nodules were more in dry season, this might be due to the soothing effect of POME(McGill,1980).This was also why higher POME levels reduced number of non functional root nodules. The control plots had the highest population of root knot nematode (*Meloidogyneincongnita*) while the 8000l/ha had the least. Higher POME rates negatively affected nematode population to the advantage of nitrogen fixing bacteria population. This could be attributed to the ability of Rhizobium bacteria to decompose and make use of the POME useful nutrients(Nwoko and Ogunyemi, 2010).Since there is always an increased atmospheric Nitrogen fixation during oil decomposition phase by soil bacteria (McGill,1980) there was high yields of cowpea in 8000l/ha plots. This high yields was also attributed the release of useful POME nutrients like phosphorus(Iwara *et al*., 2011) and calcium by soil bacteria (Qgboi *et a*l.,2010).This work showed that POME, an organic waste can be effectively be applied on farm land at up to 8000l/ha for cowpea cultivation, especially Sokoto local.

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