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Short Communication

Growth and yield response of groundnut [*Arachis hypogaea* (Linn.)] under *Meloidogyne incognita* infection to furfural synthesised from agro-cellulosic materials

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Abstract

Groundnut is widely cultivated for its edible oil. A constraint to production is infestation by plant parasitic nematodes. Synthetic nematicides are employed in suppression of soil nematodes, with effective outcome. However, risk of emergence of resistant nematode strains and health hazards are associated with constant use of nematicides. Hence, there is a need for identifying safer alternatives to synthetic nematicides. Huge quantities of lignocellulosic wastes are generated from harvesting and processing of agricultural products in Nigeria. Colossal amount of resources is wasted through burning and decomposition, which at the same time translates to environmental pollution and public nuisance. These wastes can be utilized positively in the production of furfural. Efficacy of furfural from agricultural biomass waste was investigated as a possible alternative to conventional synthetic nematicides. Agricultural biomass wastes were collected and refluxed with sulphuric acid to produce furfural. Growth response of groundnut plants increased significantly with the highest dose (50 mL) of furfural. Reduction in nematode population in soil and roots of treated plants was observed, with corresponding increase in yield at harvest. Furfural from sorghum husk and corn cob reduced nematode population significantly. Results indicated that furfural could be practically applied in the management of nematode pests of groundnut.

Key words: Agricultural wastes, Carbofuran, Furfural, Groundnut, *Meloidogyne incognita*.

Groundnut *Arachis hypogaea* L, belongs to the family Fabaceae. It goes by several other names such as peanuts, earthnuts and monkey nuts (Beghin et al., 2003). It is native to South America (from Southern Bolivia to Northern Argentina), Mexico and Central America (Putnam et al., 1991). However, it is successfully grown in other parts of the world as well as in Nigeria (Nwokolo, 1996; Madhusudhana, 2013; Osei et al., 2013). Nigeria is one of the major groundnut producing countries of the world, accounting for about 8.2 per cent of world production (Shuren et al., 1995; Zekeri and Tijani, 2013). The major groundnut producing states in Nigeria include Adamawa, Kano, Kwara, Kaduna, Sokoto, Bauchi, Kastina, Nassarawa and Benue. An estimated 1.0 to 2.5 million hectares is devoted to groundnut cultivation in Nigeria and the yield ranges between 500-3000 kg/ha annually (Okolo and Utoh, 1999; Zekeri and Tijani, 2013). Plant parasitic nematodes (PPN) cause a wide range of losses on agricultural crops (Fabiyi and Atolani, 2011; Onkendi et al., 2014), and are a major threat to groundnut production where they cause significant yield loss in all production areas of the world (UNESCO, 2008). Considerable yield losses are caused annually by species of root knot nematodes such as *Meloidogyne arenaria*, *Meloidogyne javanica* and *Meloidogyne incognita*

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on *Arachis hypogaea* (Starr and Morgan, 2002; Fabiyi et al., 2019). The control of plant parasitic nematodes is premised on the use of chemical nematicides, which however has led to environmental degradation, contamination of the biosphere and pesticide residues in treated crops. The negative effects associated with the use of chemical nematicides have spurred research into environmentally safer alternatives. This study examined the effect of furfural (2-furanaldehyde), a colourless oily, viscous liquid produced from different agricultural wastes as a non-toxic and environment friendly substitute to synthetic nematicides.

Agricultural wastes (rice husks, sorghum husks and corn cobs) were collected from the Teaching and Research Farm University of Ilorin, Nigeria. They were air dried in the laboratory for five weeks and then milled with a STEEL MAN diesel engine (model R175A) to increase the surface area of the materials (Fabiyi et al., 2018). The agricultural wastes were hydrolysed at 200^{o}C separately in a 1000 ml round bottom quick fit distillation flask with 600 ml of dilute hydrochloric acid for four hours on a sand bath, in batches of 200, 250 and 300 grams. The procedure converted the pentoses in the agricultural wastes (hemicelluloses) to furfural. The hydrolysate was allowed to cool and then decanted from the residue, transferred into a separating funnel and extracted with a given volume of dichloromethane (DCM). The organic layer was dried over anhydrous magnesium sulphate, while the dichloromethane was distilled off on a water bath and concentrated furfural was collected. This was tested with acidified aniline to confirm the presence of furfural (Fabiyi et al., 2018).

Loamy soils were collected and pasteurized at 60^{o}C for two hours, allowed to cool and later filled in experimental pots of 54 cm diameter and 30 cm depth at 25 kg each. The experimental design was a randomised complete block design (RCBD) with five treatments at three different rates of application and three replicates each. Groundnut seeds (Boro light) were planted in the experimental pots at four seeds per hole, which was thinned down to a single plant stand at two weeks after planting. Pure culture of *Meloidogyne incognita* juveniles were extracted from galled roots of tomato using the Whitehead and Hemming (1965) method. The plants were inoculated with approximately 500 juveniles per pot following the method of Iheukwumere et al. (1995). Extracted furfural was applied at different rates of 50, 40 and 30 ml per pot two weeks after innoculation. The inoculated untreated pots were maintained as the negative control (0), while carbofuran 3G at various rates of 2.0 kg a.i/ha, 1.5 kg a.i/ha and 1.0 kg a.i/ha served as the positive controls. Data on plant height, yield, nematode population in roots and soil were subjected to analysis of variance (ANOVA). Means were separated wherever necessary using the Tukey's honesty significant difference test at p=0.05.

An intense blood red colour confirmed the presence of furfural in all the agricultural waste biomass (corn cob, rice husk and sorghum husk) tested. The influence of furfural on *Arachis hypogea* under *Meloidogyne incognita* infection is depicted in Figures 1 to 5. Significant (p=0.05) differences were observed among the various treatments in the vegetative growth (plant height) of groundnut plants. Corn cob furfural and sorghum husk furfural were significantly more effective than furfural from rice husk, which was not significantly different from carbofuran (Fig. 1). The highest rate of treatment application was obviously more effective than all

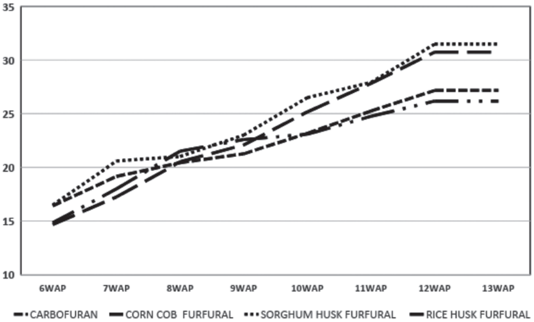

Figure 1. Effect of carbofuran and furfural from agrowastes on plant height of *Arachis hypogea*

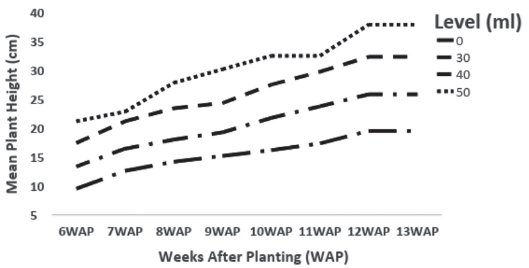

Figure 2. Effect of dosages of carbofuran and furfural on plant height of *Arachis hypogea*

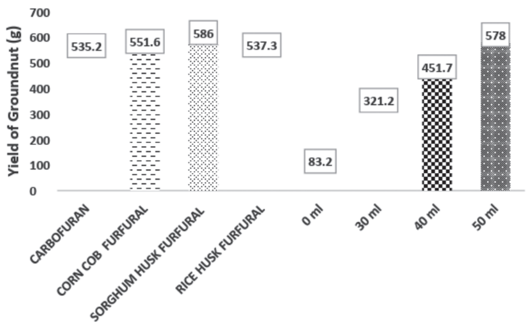

Figure 3. Effect of carbofuran, furfural from agrowastes and dosages on yield of *Arachis hypogea*

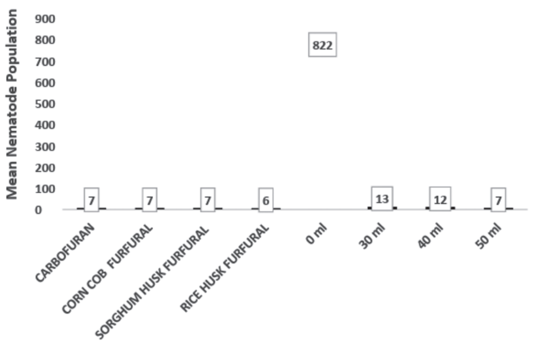

Figure 4. Effect of carbofuran, furfural from agrowastes and dosages on nematode population in soil

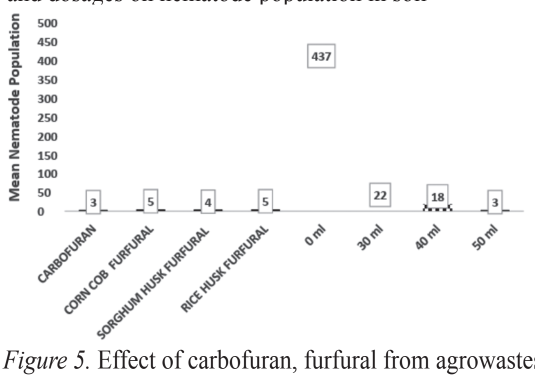

Figure 5. Effect of carbofuran, furfural from agrowastes and dosages on nematode population in root

the other lower rates of application, while the untreated control (0) plants had significantly lower heights (Fig. 2). Significantly higher yields were observed in groundnut plants treated with sorghum husk furfural and corn cob furfural as opposed to rice husk furfural. Similarly, the highest concentration of furfural application produced higher yields of groundnut (Fig. 3). There was no significant difference between the treatments on their effect on nematode population in soil (Fig. 4), while there were significant differences in the final population in the root at harvest. The highest concentration (50 mL) was significantly more effective in reducing nematode population in the soil and root (Fig. 4 &5). Aldehydes have been indicated to contain fungitoxic and nematostatic properties (El-Mougy et al., 2008; El- Mougy et al., 2012). The above results are an indication that furfural, an aldehyde, is an effective nematicidal substance. The toxicity of aldehydes to *Meloidogyne* species has been widely reported. Benzaldehyde, furfural (2-furanaldehyde), menthol (5-methyl-2-(1-methylethyl) cyclohexanol and á-terpineol (á, á,4-trimethyl-3-cyclohexene-1-methanol) was tested at 0.18 to 2.14 ml/kg soil by Bauske et al. (1994), and they observed a reduction in the population of *Meloidogyne incognita* juveniles in cotton root and soil, with the number of galls/gram root tissue reduced. In the same vein, Bauske et al. (1997), reported the potential of furfural in the control of phytonematodes, while Canullo et al. (1992) and Stephan et al. (2001) established furfural as a natural fungicide and nematicide. They reported a 75.43 per cent and 65 per cent reduction (respectively) in disease complex involving root-knot nematode and fungi on tomato plants. A reduction in percentage incidence of root diseases was observed in vegetables treated with 50 ml/L of furfural (Abdel-Kader et al., 2012). Similarly, Abdel-Kader et al. (2015), in their research on *Meloidogyne incognita* infecting cucumber using 10 ml/L of furfural, recorded a significant reduction in juvenile population in 200 g soil, number of galls on 5 g root and egg masses of *Meloidogyne incognita* which translated into an increase yield in kg/row of cucumber. The findings of Oka (2001) also corroborated this. In pot experiments, furfural at 100 mg/kg reduced the root galling of tomato, with reduced gall index and increased shoot weight of tomato plants.

The results in this study indicate that furfural has significant nematicidal effect on *Meloidogyne incognita* infecting groundnuts. This will thus reduce the use and over reliance on the toxic synthetic nematicide and hence a healthier environment. Further studies are needed to purify the extracted furfural from agricultural wastes. The significant differences observed in the effect of furfural from the various agricultural biomass wastes could be due to impurities present.

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