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RESEARCH ARTICLE

BIOEFFICACY OF SOME BIOPESTICIDE AGENTS AND TREATED *PENNISETUM* BIOFERTILIZER AGAINST ROOT- KNOT NEMATODE (*MELOIDOGYNE INCOGNITA*) ON INDIAN SPINACH (*BASELLA ALBA*) AND SOIL CHEMICAL PROPERTIES

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ABSTRACT

Bioefficacy of some Biopesticide Agents and treated *Pennisetum* Biofertilizer against Root- knot Nematode (*Meloidogyne incognita*) on Indian Spinach (*Basella alba*) and soil Chemical Properties were carried out on the faculty of Agriculture growth chamber of Chukwuemeka Odumegwu Ojukwu University Igbariam. The experiment was laid out in complete randomized design (CRD) with five treatments and three replications. The treatments were as follows: control soil (Ct), Ginger biopesticide (Gb), Pawpaw biopesticide (Pb), Pennisetum biofertilizer (PF), and Ginger biopesticide X Pawpaw biopesticide (Gb X Pb).The two biopesticides and *Pennisetum* Biofertilize rwere found to be very effective in reducing incidence of Root-knot nematode innoculum on biomass production of Indian spinach in the potted experiment but more pronounce effect was observed with combine application of the two biopesticides.The treatments generally increased chemical properties of the soil when compared with the control. The result of the findings revealed that all cases of biopesticide was significantly increased ($p<0.05$).Suggesting that the treatment promoted growth production, germination rates and nematicidal properties that inhibit root-knot nematode damage in the treated soil. These indicate their efficacy in the management of plant parasitic nematode.

INTRODUCTION

Root-knot nematodes, *Meloidogyne* contain more than (70) described species, four species (*M. arenaria, M. hapla, M. incognita and M. javanica*) are responsible for 95% of infestations (Sasser *et al.,* 1983). They are capable of severely damaging a wide range of crops, in particular vegetables, causing dramatic yield losses mainly in tropical and sub-tropical agriculture (Sikora and Fernandez 2005). A number of methods for the management of root- knot nematodes such as chemical control, organic amendments, resistant varieties, soil solarization and biological control have been tried with different levels of successes for the protection of tomato plants (Randhawa *et al.,* 2001; Sakhuja and Jain 2001). The management of nematodes is more difficult than that of other pests because nematodes mostly inhibit the soil and usually attack the underground parts of the plants (Mian, 1998). Use of chemical nematicides has been one of the primary means of controlling plant parasitic nematodes for the past five decades. However, the repeated application of various chemicals under intensive cultivation has not only contaminated the ground and surface water but has also disturbed the harmony existing among the soil, plant and microorganisms (Elyousr *et al*., 2010).

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There has been growing public concern about the negative impact of pesticides on the environment as well as on the safety and quality of food. Due to increasing awareness of pesticidal hazards and contamination of biosphere, biopesticides such as botanicals (plant extracts) and nematopathogenic microorganisms (bacteria and fungi) have created worldwide interest in pest control methods, which offer an environmentally safe and ecologically feasible option for plant protection with great potential for promoting sustainable agriculture (Radhakrishnan, 2010; Pendse *et al*., 2013). The beneficial effects of certain types of plant derived materials and microorganisms in soil have been attributed to a decrease in the population densities of plant parasitic nematodes in different crops worldwide (Chitwood, 2002; Elyousr *et al.*, 2010; Rahanandeh *et al*., 2012; Taye *et al*., 2012; Mamun *et al*., 2014). This investigation aimed to study the positive performance of biological agents and treated *Pennisetum* Biofertilizer against root-knot nematodes, (*M. incognita*) on soil chemical properties and *Basella alba* growth.

MATERIALS AND METHODS

Site location: Potted experiment was conducted at the faculty of Agriculture growth chamber of Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus. The potted experiment was established to investigation the positive performance of biological agents and treated *Pennisetum* Biofertilizer against root-knot nematodes, (*M. incognita*) and on chemical properties and *Basella alba* growth. The study area is located at latitudes $5^0$40' and $6^0$46' north, longitude $6^0$40' and $7^0$20' east. The rainfall distribution is bi-modal with a high period of precipitation. The mean temperature is between 28˚C – 37˚C as maximum relative humidity is 78.2% , the soil of the experimental area falls under the class of sandy clay loam, acidic and low in plant nutrient content (Nweke *et al* ., 2014).

Potted experiment preparation/ Experimental design and treatment application

Elephant grass *Pennisetum purpurum* was freshly harvested and chopped into pieces. 8kg of pieces grass weighed out and mixed with 8kg of fresh pig dropping at the ratio of 50:50 on weight basis. The two mixed thoroughly together incubated in an airtight container for 2weeks after which it was aerated for 3-4days. The two biopesticides was prepared using fresh pawpaw leaf and ginger rhizome. 1kg pawpaw leaf and 500g of ginger rhizome was grinded respectively. The filtrate was then mixed thoroughly with 5liter of cow urine incubated in two different airtight container of 10liter capacity for 7days after which it was diluted at the rate 1:3 liter of water.4kg of sieved subsoil was weighed out in 15 plastic pots. The dimension of the pot is 17cm × 19cm. The bottom sides of the pot were uniformly perforated to allow adequate aeration and drainage. 350g of treated *Pennisetum* biofertilizer was added and 500ml of pawpaw leaf extract and ginger rhizome extract was added for biopesticides pot and with 500ml of water for control soil. The potted experiment was laid out in complete randomized design (CRD) with five treatments and three replications. The treatments were as follows: Ct + Bs = control soil + *Basella alba*, G + Bs = ginger biopesticide + *Basella alba*, P + Bs = pawpaw biopesticide + *Basella alba*, F+ Bs = Pennisetum biofertilizer + *Basella alba*, P + Bs x G + Bs = combine effect of pawpaw and ginger biopesticide. Nematode inoculums \was prepared at 1g nematode nodule: 50ml H_20.

The treated soil was added 200ml of nematode inoculum in each pot respectively (Southey, J.F. 1986). 10seeds of *Basella alba* was uniformly planted at initial and later thinned down to 2plant per stand after 10days of planting. The two plants were monitored for 30days before it was finally harvested. The agronomic parameters studied were plant germination percentage and plant biomass production. At the end of the study, soil samples were collected from each pot, air dried and sieved thoroughly with 2mm mesh, after which chemical properties of the soil were determined. Soil pH in water was determined by pH meter using 1:2.5 soil/liquid ratio, CEC was determined by unbuffered Barium chloride ($BaCl_2$) method according to Nikol skill, (1959), electrical conductivity was determined by the method of *Grisso et al*., 2002., buffer capacity by method of Bloom *et al.,* 2000, Exchange acidity by method of Longan *et al*., 2008 and Soluble cation by the method of Corp *et al*., 2006.

Statistical analysis

Data generated from the study were subjected to Analysis of variance using SPSS version 20. The least significant difference (LSD) at the 5% level of probability was determined as described by Obi (2002).

RESULTS

Table1 shows some chemical properties of Igbariam soil at the start of the experiment. The soil was found to be infertile for crop production, acidic, low buffer capacity, low pH and electrical conductivity with low cation exchange capacity and high exchange acidity. Increase in exchange acidity militates against nutrients availability. Due to all these deficiencies the soil of this class needs serious improvement which can be actualized by application of biofertilizer and biopesticides. The result of the study in Table 2 shows that the interactive effect of pawpaw leaf biopesticide, ginger biopesticide and root-knot nematode inoculum on chemical properties of Igbariam subsoil cropped to *Basella*. The table revealed that pH optimal level of 6.7±0.6 compared to the control soil of pH 4.1.The buffer cpawpaw leaf biopesticide, ginger biopesticide and *Pennisetum* biofertilzer increased the capacity at P+Bs and Ct+Bs are low while that of pawpaw leaf biopesticide, ginger biopesticide and biofertilizer is high.

Table 1. Some chemical properties of Igbariam soil at the start of the Experiment

Soil Properties	Values
pH (H_2O)	4.1±1.0
Buffer Capacity (meq/100)	0.2±0.0
Cation Exchage Capacity (meq/100g soil)	8.2±0.0
Soluble Cation (Cmol/kg)	0.3±0.0
Exchangeable Acidity (meq/100g soil)	3.2±0.0
Electrical Conductivity (µs/cm)	10.1±1.0

Table 2. The effects of the evaluated treatments on chemical properties of Igbariam Sandy Loam soil cropped to *Basella alba* plants infected with M. incognita

Treatments	pH (H_2O)	BC (meq/100g soil)	EC (µs/cm^{-1})	EA (meq/100g soil)	C.E.C (meq/100g soil)	SC (meq/100g soil)
Ct+Bs	5.4±0.1	0.6±0.0	68.1±1.6	1.5±0.0	10.3±1.0	0.5±0.0
G+Bs	6.8±0.1	1.8±0.1	119.3±5.3	0.3±0.0	26.7±1.2	1.3±0.0
P+Bs	6.5±0.2	1.1±0.0	112.4±3.5	0.3±0.0	24.4±1.1	1.4±0.0
F+Bs	5.6±0.2	2.7±0.1	171.2±0.4	1.3±0.2	18.3±0.3	0.8±0.0
G+Bs x P+Bs	6.7±0.2	3.6±0.1	246.1±0.9	0.2±0.0	31.8±1.1	1.7±0.0
$LSD_{0.05}$	0.2	0.3	8.6	0.3	2.8	0.3

Key: Ct = Control, Bs = *Basella alba*, Mo = *Moringaoleifera*, G = ginger Biopesticide, P = pawpaw leaf Biopesticide, *F = pennisetum* bioferticide, BC= Buffer Capacity, EC= Electrical Conductivity, EA= Exchange Acidity, CEC= Cation Exchange Capacity, SC= Soluble Cation.

This increase could be as a result of treatment application. Higher buffer capacity indicates stability of soil nutrient. There was remarkable increase in electrical conductivity of soils treated with Pawpaw leaf biopesticide, ginger biopesticide and treated pennisetum biofertilizer which indicates increase in soil fertility status. Biopesticides and biofertilizer treatment gave twice increase in soluble nutrient level when compared to control. The results of above table clearly indicated the relationship that increase in exchange acidity militates against nutrients availability. Ginger biopesticide, pawpaw leaf biopesticide and biofertilizer induce 7.37%, 17.02% and 15.6% reduction in exchange acidity. The values of cation exchange capacity CEC obtained in G+Bs X P+Bs, G+Bs, P+Bs, F+Bs, and Ct+Bs were 31.8±1.1, 26.7±1.2, 24.4±1.1, 18.3±0.3, and 20.3±0.04 Cmol/kg, respectively. The observed CEC in biopesticide treated soil was higher than that of control soil; the increase was as result of biopesticide and biofertilizer application.

Table 3. The effects of the evaluated treatments on Germination Percentage, fresh and dry biomass weight in *Basella alba* plants infected with M. incognita

Treatment/crop	Germination Percentage (%)	Fresh Biomass @ 30 DAP (g)	Dry Biomass @ 30 DAP (g)
Ct + Bs	67.4±1.7	28.9±1.0	1.0±0.0
G + Bs	78.7±2.2	66.6±0.4	4.3±0.2
P +Bs	63.4±1.3	84.7±0.7	5.2±0.1
F +Bs	60.5±0.5	53.1±0.6	2.4±0.3
G+Bs x P+Bs	88.7±1.8	98.2±0.9	9.3±0.1
LSD0.05	3.2	2.8	1.3

Key: Ct = Control, Bs = *Basella alba*, G = ginger Biopesticide, P = pawpaw leaf Biopesticide, *F = pennisetum* bioferticide

Table 3: shows Effect of pawpaw leaf biopesticide, ginger biopesticide, biofertilizer and Root-knot-Nematode Inoculum on the growth of *Basella alba*. The results revealed that soil treated with pawpaw leaf biopesticide, ginger biopesticide and pennisetum biofertilizer gave highest increased in plant biomass and percentage germination when compared to the control soil. Suggesting that the treatment promoted growth production, germination rates and nematicidal properties that inhibit root-knot nematode attack in the treated soil. These indicate their efficacy in the management of plant parasitic nematode.

DISCUSSION

Buffer Capacity: The effects of the treatments on soil buffer capacity for six month are shown in Table 2. The differences observed were statistically significant ($P<0.05$). The buffer capacity at Ct+Bs and F+Bs is low while that of combined treated pennisetum biofertilizer with ginger and pawpaw leaf biopesticide is high. This increase could be as a result of treatment application. Higher buffer capacity indicates stability of soil nutrient. The field trial of Bouajila and Sanaa (2011) showed that application of manure and compost resulted in significant increase of structural stability, with the compost treatment being the most efficient. Their results also indicated that the application of 120 t/ha household wastes and manure improved better the structural stability when compared with control.

Cation Exchange Capacity, Electrical Conductivity and Soluble Cation: The effect of treated pennisetum biofertilizer, ginger and pawpaw leaf biopesticide on cation exchange capacity, electrical conductivity and soluble cation was significant ($P<0.05$). The values of cation exchange capacity CEC obtained in G+Bs X P+Bs, G+Bs, P+Bs, F+Bs, and Ct+Bs were 31.8±1.1, 26.7±1.2, 24.4±1.1, 18.3±0.3, and 20.3±0.04 Cmol/kg, respectively which help nutrient retention and thus it prevents cations from leaching into the groundwater. Agegnehu *et al.,* (2014); Mohammad *et al.,* (2004) proved that compost amendment resulted in an increase of CEC due to input of stabilized OM being rich in functional groups into soil. In Mohammad *et al.,* (2004) study, following the first harvest from dry season the same plots were used for re- planting during the wet season. Data obtained from the second trail indicated that as the compost application rates were increased from 0 tons per acre to 120 tons per acre the soil CEC as one of the major soil quality indexes were also increased (Table 2) indicating a considerable improvement in nutrient exchange capacity of the soils treated with organic matter amendments. According to Amlinger *et al.,* (2007), soil organic matter contributes about 20 – 70% to the CEC of many soils. In absolute terms, CEC of organic matter varies from 300 to 1,400 $cmol/kg^{-1}$ being much higher than CEC of any inorganic material. There was remarkable increase in electrical conductivity of soils treated with Pawpaw leaf biopesticide, ginger biopesticide and pennisetum biofertilizer which indicates increase in soil fertility status. Biopesticides treatment gave twice increase in soluble nutrient level when compared to control.

pH, Exchange acidity and Base saturation: pH, Exchange acidity and Base saturation of the soil under different treatment presented in Table2. There was significant treatment effect ($P > 0.05$). Treated pennisetum biofertilizer, ginger and pawpaw leaf biopesticide induced 6.51% and 13.25% reduction when compared with the control that gave 100% increased in soil exchange acidity. The favorable pH level of the treated soil reflect resourcefulness of the biofertilizer and biopesticides to address the problem of undesirable acidification of the soil particularly the problem of erratic changes in soil pH which can cripple crop growth in soil of low pH as observed in the control soil. Table2 revealed that soil pH was significantly increased following the application of treatments to an optimal level of 6.7±0.6 when compare with the control soil of pH 4.1.Compost application has a liming effect due to its richness in alkaline cations such as Ca, Mg and K, which were liberated from OM due to mineralization (Agegnehu *et al*., 2014 and Daniel and Bruno, 2012).

Germination Percentage and Plant Biomass: Table2 shows Effect of pawpaw leaf biopesticide, ginger biopesticide and treated pennisetum biofertilizer on the growth of *Basella alba.* The results that the plant biomass in the soils amended with the two biopesticidesand pennisetum biofertilizer were significantly higher than that obtained in the non-amended soil (Table2), because of their ability to stimulate plant hot defense and other physiological processes that make treated crops more resistant to nematode infestation but greater plant biomass was observed in soil treated with combine effect of ginger rhizome extract and pawpaw biopesticide when compared that was obtain in individual effect (Table2). Therefore, the use of ginger rhizome and pawpaw leaf biopesticides demonstrated their nematicidal potential against nematode which frequently attack vegetable crops like Indian spinach in the study area during their early stage of seedlings growth (Elyouser *et al*., 2010, Pascual *et al*., 2002).Besides controlling nematode infestation in indian spinach and improving their growth, these two biopesticide also promote the microbiological quality of soil. They activate electrical conductivity, cation exchange capacity, soluble cation and buffer capacity (Table2), This indicates beneficial effects of certain types of plant derived materials and microorganisms in soil have been attributed to different crops worldwide (Chitwood, 2002, Elyouser *et al*., 2010, Rahanandeh *et a*l., 2012, Taye *et al*., 2012, Manun *et al*., 2010).

Conclusion

Although the use of pesticides has been proven beneficial for crops but decrease the overall fertility of the soil, and has also polluted the environment (Arora *et al*., 2010). In turn, biopesticides like ginger rhizome extract, pawpaw leaf extract and *Pennisetum* have not only found to be increasing the fertility of soil, plant biomass and control of nematode but also are eco-friendly, non-hazardous and beneficial for crops. As from the above study, we have concluded that biopesticide treatment showed higher plant biomass, in the soil as compared to the control treatment, hence promises to have a superior role and can be recommended for use in agriculture by farmers for control of nematode. Thus the investigations suggest that the two biopesticides also influence plant germination percentage. Finally, it could be concluded that the results from this study indicated that using of both biofertilizer and biopesticides achieved a highly activity against the root-knot nematode, in addition gave higher increased in plant growth. Therefore, the results imply that it should focus on using biological agents as a safety method for human and environment to management of root-knot nematode in Nigeria.

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