Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.3, No.17, 2013

Management of Root Knot Nematode Affecting Banana Crop by Using Organic Amendment And Biological Products

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Abstract
Plant-parasitic nematodes are a major obstacle to sustainable banana production in Morocco. With rarefaction of efficient nematicide, safe and alternative methods need to be developed. This research aims at evaluating the efficiency of some bioproducts: Biocompost (B), *Ricinus communis* Powder (RP), combined Biocompost with *R. communis* Powder (RP + B) and a bionematicide based on *Paecilomyces lilacinus* commercialised as Nemacont (N) against *Meloidogyne javanica*. All the mentioned treatments not only reduced root knot nematode density and roots gall index significantly, but also improved plant growth. The *R. communis* powder is the most efficient biological product on *M. javanica* population suppression and on banana plant growth enhancing.
Keywords: *Ricinus communis*, Nemacont, *Paecilomyces lilacinus*, Biocompost, *Meloidogyne javanica*, banana.

1. Introduction

Banana is an important popular and widely known crop fruit that provides carbohydrates, proteins, vitamins and minerals to more than 400 million people worldwide (INIBAP, 1987). Yet, beside the constraints of banana market requirements and demands, there are other limiting factors; as banana yields are adversely affected by a number of crop pests (Bridge, 1988; Ganry, 1990) such as nematodes that infest banana roots and cause toppling result in significant yield losses (Bridge, 1988; Quénéhervé, 1993). These phytoparasites reduce bunch weight and plant longevity, and increase the crop cycle duration (Quénéhervé 1991). Globally, banana yield losses due to nematodes average US$178 million annually (Razak, 1994). In Agadir plantations (Araya et al. 1995, 2002) usually only polyspecific communities occur, consisting of a mixture of *Radopholus similis*, *Helicotylenchus multicinctus*, *Meloidogyne incognita*, *M. javanica*, and *Pratylenchus* spp. Soil fumigation with methyl bromide was the frequently method used by growers to manage root knot nematode in Agadir area for many years. This makes Morocco one of the greatest consumers of this harmful product to the environment. The amount of methyl bromide used in this field increased from 333t in 1992 to 2003t in 2003 despite Montreal protocol (UNEP IE, 1998). Actually, because of the phase-out of Methyl Bromide by international treaty and the re-examination of many chemicals nematicides or their remove from the market, biological products remain the alternative and sustainable means for management of plant parasitic nematodes associated to banana crop. For this reason, the aim of this work tends to study the effectiveness of some biological products separately and in combination in the control of root-knot nematodes of banana crop.

2. Results & Discussion

2.1. Effect on nematological parameters

The effect of treatments on root knot nematodes density, gall index and reproduction rate under Banana crops is indicated in Table 1. All the tested products reduced significantly the number of J2 and root damages. The density of *Meloidogyne javanica* juvenile in the treatment was 34,33%; 39,00%; 173,83% and 141,83% respectively in potted plant treated with *R. commuis* Powder (RP), Combined Biocompost with *R. communis* Powder (B+RP), Biocompost (B) and Nemacont (N). The lowest nematode population density was observed in treated plant with *R. communis* products. But no significative difference was recorded when it was applied alone or when in mixture with the biocompost. Treated plant with the Nemacont showed the highest level of nematode population within the biological tested products. Concerning the root damage, all the biological products tested caused similar result with a significant reduction in the gall index compared to the positif control. The greatest nematode reproduction rate was observed in the positive control and treated plants with Nemacont, while in the treated plant with RP and RP + B, this parameter was similar and was significantly lower, compared to the others treatments.

Table 1. Efficiency of treatments, Nemacont, Biocompost, *R. communis* Powder, Combined Biocompost with *R. communis* Powder against root knot nematode, *Meloidogyne javanica*.

Treatment	J2 Number	Gall index	Reproduction rate
Biocompost	141,83b*	2,08a	1,69b
Nemacont	173,83c	2,42a	2,10c
Combined Biocompost with *R. communis*	39,00a	1,92a	0,40a
R. communis Powder	34,33a	1,83a	0,49a
Control	205,50d	3,58b	2,19c

* Within columns, means followed by a common letter do not differ significantly according to Newman and Keuls test at 5%.

2.2. Effect on plant growth

All the biological products enhance the plant growth and length parameters except for root length. Significant difference with positive control was observed among the treatments in case of root weight, circumference, Bouch weight, and plant height (at P<0.05). Maximum root weight was obtained by RP (100,2) followed by RP+P. The plant used as control and the treated ones with the Biocompost and Nemacont showed the lowest root weight. In root length, no significative difference was recorded. But, the tested products enhanced significantly plant height. The higher value was recorded when *R. communis* was applied. Concerning the circumference, the higher measure (17,42cm) was observed in castor treated plant while the lowest circumference occurred in treated plant with Nemcont and Biocompost (Table 2).

In the present study, Nemacont seems to be the less efficient against *Meloidogyne javanica* among the tested products. This lowest effect of Nemacont was probably referred to bad adaptation of *Paecilomyces lilacinus* fungi with ecological conditions in soil.

R. communis powder alone was found to be an effective nematicide. No improvement of its nematicidal potential was recorded when it is combined with Biocompost. However, the efficiency of that product could be increased if it is mixed with synthetic nematicide as reported by Jothi (Jothi, 2004).

The efficiency of soil amendment with *R. communis* powder in reducing *Meloidogyne javanica* infestation in banana plants was shown. The results support earlier reports of decreased infestations of root knot nematode following *Ricinus communis* products application in diffrents crops (Zaki F. et al., 1999; Ferji et al., 2004a, 2004b; Laghdaf & Ferji, 2005, Mayad et al., 2006a, Mayad, 2011) and direct effect of chemical compounds of *R. communis* on J2 larvae of *Meloidogyne* spp. (Mayad et al., 2006b).

Table 2. Efficiency of treatments, Nemacont (N), Biocompost (B), *R. communis* Powder (RP), Combined Biocompost with *R. communis* Powder (RP + B), Negative Control (C-) and Positive control (C+) on growth parameters of banana crops.

Treatment	Root		Aerial part		
	Root Weight (g)	Lenght (cm)	Circumference (cm)	Bounch Weight (g)	Height (cm)
B	42,25c*	38,42a	13,00c	61,75b	39,50c
N	32,08c	44,83a	11,33c	36,58c	32,00d
RP + B	77,58b	44,00a	15,50b	101,08a	48,08b
RP	100,20a	46,75a	17,42a	110,83a	56,42a
C-	37,08c	52,33a	12,92c	39,92c	26,75e
C+	26,42c	37,92a	9,75d	30,33c	25,50e

*Within columns, means followed by a common letter do not differ significantly (P<0.05).

R. communis derivatives have been shown to be effective against nematodes attacking other crops and against several species of parasitic nematodes (Jothi, 2004; Panvinder, 1989; Pandey, 1994; Nandal & bhatti, 1990). The bioactive molecules in *R. communis* are lectins named Ricin (Ameenah, 2006). These compounds of *R. communis* also have been reported to inhibit the penetration, hatchability and development of nematodes (Adegbite, 2005, Rich et *al.*, 1989).

Improvement of banana plants growth by the application of these biological products appear to undergo physiological changes that render them unsuitable for nematode penetration and development, thus inducing a certain degree of resistance in plants against nematode infestation soil (Alam, 1993). The beneficial effects of organic amendments for improving the physical, chemical and biological properties of soil are well recognized

(Abawi and Thurston, 1994, Mayad et *al.*, 2013). It has been suggested that the depressive effect of some amendments on fungi and nematodes may be due to highly specific fungistatic and nematicidal substances released during their decomposition or due to nitrogen starvation resulting from greater capacity of saprophytes to multiply or greater sensitiveness of parasitic fungi to liberation of CO2 during decomposition. Use of organic amendments also leads to the increase of natural enemies' level in soil (Chavarria-Carvajal & Rodriguez-Kabana, 1998). The volatile fatty acids like formic, acetic, propionic and butyric acids, ammonia, formaldehyde, hydrogen sulphide, phenols and amino acids that are released during the decomposition of amendment, have been reported to be toxic to nematodes (Reddy et al., 1975; Alam et al., 1979). The suppression of root knot nematodes by organic amendments used in this study is probably based on a complex mode of action involving multiple mechanisms. Changes in soil enzyme activities cause a shift in specific groups of microorganisms after the application of organic amendments.
In conclusion, *Ricinus communis* powder is the most effective among the tested treatment. This finding could have practical applications in the integrated management of banana nematodes.

3. Material & Methods

Experiments were conducted at experimental research greenhouse in agronomic and veterinary medicine institute of Agadir. One-month-old, banana vitroplants var. "Grande Naine", were planted in 11 litres capacity pots, containing *Meloidogyne javanica*-infested soil mixed with turf (1/3:2/3).
All the treatments were applied by manuring one week before transplantation. Those treatments are Nemacont (*Paecilomyces lilacinus* as actif agent) at 10mg/plant (N), Biocompost at 100g/plant (B), Powder of *R. communis* aerial part (RP) applied twice at 100g/plant with 45 days of interval, Combined biocompost at 100g and Powder of *R. communis* aerial part at 100g/ plant (B+RP). Plants not treated with any product, served as the positif control (C+). The plants potted in a sterilised soil were considered as negative control (C-). Potted plants were placed in a completely randomized design. Each treatment was replicated four times and each tow potted plant constituted a replicate. The experiment was terminated 90 days after planting. The plants were uprooted and growth was observed in terms of plant height, dry weight, circumference, root weight, root length of plant, and extent of galling. Nematodes were extracted from soil using modified Baermann's funnel method and the population density of *Meloidogyne javanica* in 100g of soil and multiplication rate was also assessed. The root gall index was estimated according to the scale proposed by Murray et al. (1986). Data obtained were subjected to the analysis of variance and mean separation using the Newman and Keuls Test ($P<0.05$).

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