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Efficacy of Abamectin for the control of root knot nematodes in tobacco seedling production in Zimbabwe

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The efficacy of different rates of abamectin for the control of root knot nematodes in tobacco soil-based seed beds was evaluated in this study. Different incorporation methods of abamectin in the soil were also evaluated. A combination of 45 ml worked into the soil to a depth of 20 cm using hoes was effective in controlling root knot nematodes. The efficacy was comparable (p = 0.05) to methyl bromide and 1.3 D. The other treatments evaluated did not give control and were comparable to the untreated control. Based on the results, abamectin can be a suitable replacement for methyl bromide for root knot nematode management in the tobacco seedbed.

Key words: Abamectin, root knot, nematodes, tobacco.

INTRODUCTION

To date, tobacco is Zimbabwe's most valuable agricultural commodity, accounting for about 26% agricultural gross domestic product and 61% of agricultural exports (Kachere, 2012; Gono, 2011). Tobacco production is now dominated by small scale famers, which resulted in an increase in number of growers from 8,000 to at least 70,000. The increase in number of tobacco growers has seen tobacco as the largest single source of direct foreign currency to a majority of Zimbabweans (Masuka, 2012). Tobacco production, more particularly tobacco seedlings may however be severely hampered by pests and diseases in the soil or in growing medium. Nematodes, soil or waterborne fungal pathogens and weeds are some of the barriers that stand between the farmer and optimal crop quality and yield (Miller, 2007). Plant parasitic nematodes are widely distributed and cause significant yield losses in wide range of crops (Shaukat et al., 2009). It is difficult to estimate yield suppression caused by plant-pathogenic nematodes because often times, damage is not limited to a single nematode species (Cetintas and Yarba, 2010). Root knot nematodes are however rated the most economically important attacking and infecting a wide range of crops that are produced in wide range of environments (Ploeg, 1999; DeBeer, 2010). Plant species amounting 2000 including almost all cultivated species have been reported susceptible, reducing world production by about 5% and even higher in individual fields (Rehman et al., 2009).

Maximum densities at lower depths are reported for

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Abbreviations: A1, method 1 of incorporating abamectin in the soil; **A2**, method 2 of incorporating abamectin in the soil; **A3**, method 3 of incorporating abamectin in the soil; **transplantable seedlings**, seedlings > 5 cm.

some species and vertical distribution patterns may be further complicated by the occurrence of vertical migration during the season (McSorley and Dickson, 1990). This makes management of these pests difficult because the target of any nematicide often reside at a far distance away from the site of application of the chemical (Chitwood, 2002). A chemical must therefore be volatile to move long distances or be persistent to control nematodes migrating to the root zone at a later point in time.

Most nematicides currently being used have tended to be rather toxic or volatile with poor target specificity and less than perfect human or environmental safety, such as ground water contamination or atmospheric ozone depletion (Chitwood, 2002). Widespread concern about the consequences of conventional pesticide use has resulted in the increased interest in alternative pest control measures (Abuzar and Haseeb, 2009). Methyl bromide and Ethylene Di-Bromide have been the mainstay soil fumigants in tobacco seedbeds in Zimbabwe. Their use however has been withdrawn. There is therefore need to develop naturally occurring nematicides which are less toxic to man and animals but effective against nematodes of various crops as synthetic ones (Adegbite and Adesiyan, 2005).

Bio-products based on pathogenic micro-organisms are a more suitable candidate with regards to integrated pest management. They are advantageous in that they are host specific and environmentally friendly (Rehman et al., 2009). Among the naturally occurring bio nematicides are avermectins. These are a family of 16 membered macrocyclic lactones produced by the soil microorganism, *Streptomyces avermitilis* (Bessi et al., 2010). These compounds are important tools in animal health and crop protection, the major component of the fermentation being avermectin B1 (Abamectin) (Rehman, 2009). A number of success cases in abamectin controlling nematodes have been reported in tomatoes and cotton seed treatments (Becker, 1999; Monfort et al., 2006; Faske and Starr, 2006; Rehman, 2009; Alfonso et al., 2009: Bessi et al., 2010; DeBeer, 2010). Chen et al. (2006) demonstrated the enhancement of a bio agent *Pochonia* in reducing nematode damage in vines with a resultant increase in plant dry weight and height. In the same year, nematode numbers that causes pine wilt of Scot Pine dropped after abamectin application (Randall et al., 2006). Abamectin however has been reported to be inconsistent in controlling nematodes in turf and in shielding cotton roots by Crow (2005) and Faske and Starr (2007), respectively.

This project therefore seeks to evaluate the efficacy of abamectin to root knot nematodes and its application on tobacco seedling production in Zimbabwe. The objectives of the project are: i) To evaluate the rate at which abamectin can be used to control nematodes in the seedbed, ii) To evaluate how best abamectin can be incorporated in the soil.

MATERIALS AND METHODS

The study was carried out at Tobacco Research Board's (TRB) Kutsaga Research Station which is located about 15 km east of the city of Harare (17° 55'S, 31° 08' E, 1,479 m elev). The station lies in Agro-ecological region IIa (Vincent and Thomas, 1960) and experiences a sub-tropical climate with an annual rainfall range of 800 to 1000 mm and average temperature of 18°C in winter and 30°C in summer (FAO, 2003). The soils are in order III of the Zimbabwean soil classification, that is they are Kaolinitic, belonging to group 6 (6G2) which comprises of Paraferrallitic soils with a coarse grained sand fraction, derived from granite (Nyamapfene, 1991). They are on position 2, on the soil catena, which are typically moderately deep to deep well drained soils; they are slightly acidic with a pH of 5.2 which are typical of most tobacco growing soils.

Experimental design

The experiment was carried out in a soil based seedbed. Abamectin rates were established from greenhouse preliminary trials. Each plot measured 1 m^2 and plots were replicated in four complete randomized blocks. Prior to experimental set up, sunflower was planted to the area and maintained for three months to boost nematode populations. Ploughing followed by discing was later done. Beds were prepared by raising them 5 cm above ground and were watered for three weeks. Sampling to a depth of 20 cm using a 20 mm diameter auger followed. Nematodes were extracted from 200 g samples and 1 kg soil was used to set up bioassays with four weeks old tomato seedlings in the greenhouse and initial populations were determined. Methyl-bromide, 1.3 Dichloropropene (1.3 D) and three abamectin rates 15, 30 and 45 ml/m^2 were applied as treatments and untreated control was included.

Three different methods of incorporating abamectin in the soil were evaluated. The first method (A1), an injector gun was used to place the required amount of abamectin to a 20 cm depth. Five injections were done in each plot. 4 L of water was applied before and 4 L after injecting abamectin. In the second method (A2), five holes with a diameter of 4 cm and a depth of 20 cm were drilled. Abamectin was then drenched in 4 L of water. After all the water had soaked in, a setting in irrigation with 4 L of water was applied. After 24 h, a fine tilth was done and tobacco seed was sown. The third method (A3), soil was loosened and abamectin was drenched in 4 L of water. After all the water had soaked in, a setting in irrigation with 4 L of water was applied. After 24 h, digging and mixing of soil to a depth of 20 cm was done using a hoe and a fine tilth was made and seed was sown. Tobacco seed was sawn after 24 h after all the abamectin treatments. All the plots except the Methyl bromide ones were treated with clomazone two weeks before sowing to control weeds and cultural practices were done until seedlings were ready for transplanting.

Measurements

Experimental measurements included germination and survival counts 28 and 42 days after sowing, stem length from stem base to apical meristem, total number of transplantable seedlings (seedlings > 5 cm), % transplantable seedlings (transplantable seedlings/total number of seedlings × 100), and dry weight and final root gall rating on tobacco.

RESULTS

Germination and survival were not significantly different

Table 1. Total transplantable, % transplantable and final gall rating.

Treatment	Tobacco seedlings		Final gall rating	Seedling drymass (g/m^2)
	Total transplantable	% transplantable		
1. Untreated control	81.25^{a}	56.64^{ab}	1.37^{bc}	135.00^{a}
2. Methyl bromide	180.00^{abc}	55.03^{ab}	0.04^{a}	478.75^{a}
3.1.3 D	253.75^{c}	72.86^{b}	0.1^{a}	731.25^{bc}
4.15 mlA1	138.33^{abc}	45.61^{ab}	1.07^{b}	958.33^{c}
5. 30 mlA1	223.75^{c}	64.61^{ab}	1.68^{bc}	622.50^{bc}
6. 45 mlA1	240.00^{c}	64.89^{ab}	2.05^{c}	532.50^{a}
7.15 mlA2	250.00^{c}	71.93^{b}	1.45^{bc}	377.50^{ab}
8. 30 mlA2	101.25^{ab}	37.22^{a}	1.29^{bc}	453.75^{ab}
9. 45 mlA2	140.00^{abc}	43.28^{ab}	1.13^{bc}	480.00^{ab}
10. 15 mlA3	235.00^{c}	59.21^{ab}	1.15^{bc}	640.00^{bc}
11. 30 mlA3	193.75^{abc}	51.32^{ab}	0.76^{ab}	422.50^{ab}
12. 45 mlA3	151.67^{abc}	60.24^{ab}	0.05^{a}	388.33^{ab}
F-Probability	0.060	0.407	0.001	0.154
SED	59.50	15.12	0.47	232.00
LSD	121.10	30.75	0.96	472.00
CV %	46.10	37.60	66.30	63.30

in all the plots (p = 0.87 and 0.21) respectively. This shows that Abamectin does not have phototoxic effects that disturbs and tobacco seedling germination and growth at all the rates tested. The treatments also did not have a significant effect on seedling dry mass (p = 0.15). From Table 1, at pulling, the total transplantable seedlings and % transplantable were also not significantly different (p = 0.06 and 0.41), respectively at p < 0.05. This means that the product being evaluated does not have a negative effect of reducing seedling growth. Final gall rating of tobacco was however significant (p= 0.001). Abamectin 30 mlA3 and 45 mlA3 had the best nematicidal effects. The treatments were comparable to the standard nematicides, Methyl bromide and 1.3 D. All the other abamectin treatments were not significantly different from the untreated control.

DISCUSSION

A number of success cases have been demonstrated on seed treatment for the control of rootknot nematodes in a number of crops by abamectin (Monfort et al., 2006; Barham et al., 2005). In most of the success cases, the protection was durable for 14 DAP. In a study by Faske and Starr (2007), they noted and found out that abamectin protected roots from galling by rootknot nematodes 5 cm along the growing root, further beyond, abamectin did not protect the growing root. They deduced that much of the active product remained on the seed coat. Lopez-Perez et al. (2011) found abamectin to be inconsistent in controlling rootknot nematodes. They attributed this to the strong adsorption of abamectin to soil particles.

In this study, the eight abamectin treatments that were evaluated were not significantly different from the untreated control. This might also be attributed to the immobility of abamectin in soil. In another treatment 45 mlA3, abamectin significantly protected the roots from damage. The protection compared to that posed by Methyl bromide and 1.3 D. This shows that if abamectin is incorporated into the soil, it gives good control. Rehman (2009) also observed that abamectin gave better control after thoroughly incorporating it in potted soil.

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