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Biological Control Potential of Bridelia wild (*Bridelia ferruginea*) and Wild Sage (*Lantana camara*) against Root-knot Nematode of Tomato (*Solanum lycopersicon* L.)

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ABSTRACT: Assessment of plant *Lantana camara* and *Bridelia ferruginea* based aqueous extracts and powdered form were evaluated on root-knot nematode pest of two tomato varieties at the Screen house of the Department of Crop Protection, Faculty of Agriculture, University of Ilorin, Ilorin, Nigeria. The experimental design was a completely randomized design and was replicated four times. The two varieties of tomato (Roma – VF and UC 82 – B) have been confirmed to be prone to root-knot nematode. Three seeds of tomato were planted in each pot that contained 7kg of sterilized soil and later thinned into one; each pot was inoculated with 4,500 root-knot nematode eggs. The plant materials used as treatments were *L. camara* and *B. ferruginea* aqueous and powdered with an application rate of 50ml and 20g per pot respectively. Untreated pot served as control. Data collected were vegetative parameters and reproductive parameters of tomato, soil and root nematode population as well as the galling rates. The experiment results revealed that *L. camara* and *B. ferruginea* aqueous extracts and powdered significantly increased growth and yield of the two tomato varieties grown in the *Meloidogyne* incognita nematode inoculated soil, while root-knot nematode population in soil and root were significantly reduced. Gall index was also significantly lower in the *L. camara* and *B. ferruginea* treated tomato compared to the un-inoculated control. *Lantana camara* and *Bridellia ferruginea* were effective potential measures for controlling root-knot nematode where the soil is heavily infested.

Key words: *Bridelia ferruginea*, Gall index, *Lantana camara*, Reproductive and Vegetative

Introduction

Tomato (*Solanum lycopersicum* L.) is the second most cultivated vegetable in the world, with China, USA and Turkey being the leading producers (FAOSTAT, 2012). This crop is widely grown around the world because of its value (Adepoju, 2014). Nigeria is ranked as the 16th largest tomato producing nation in the world and has a comparative advantage and potential to lead the world in tomato production and exports (FAO 2010). Among different vegetables cultivated in Nigeria, tomato stands as the most important in production and consumption (Adejobi *et al*. 2011). Tomato is an important component of the daily food need and it is widely grown because of its taste, colour, flavor and nutrient contents, it can be consumed both fresh and in paste form, in salads, as ingredients in many recipes reported by Demlie *et al*.

(2012). According to FAOSTAT., (2015) it has major economic and dietary importance all over the World and the most important cash crop grown by tomato out-growers for fresh market and processing industries. However, tomato production in Nigeria is beset with many problems, such as diseases, insect pests and nematodes, all these resulting in low yield and poor quality fruits. Plant-parasitic nematodes (PPN) attack the majority of economically important crops, causing a global yield loss of up to 12.3% on average (Holbein *et al.*, 2016). There are thousands of genus and species of plant-parasitic nematodes (PPN), which cause damages in quality and quantity of yields in varied crops; moreover, increasing the costs of production (Khalil, 2013). The latest statistics displayed the estimated losses induced by PPN worth US$ 118 billion worldwide (Atkinson et al.2012). Among the plant-parasitic nematodes, root-knot nematode (Meloidogyne spp.) is the topmost economically important obligate plant-parasitic genus with a worldwide distribution (Jones *et al*., 2013). Preventing the introduction of nematodes and lowering the nematode population through the use of nematicides is important. Synthetic Chemical nematicides are effective against plant-parasitic nematodes especially on large scale farming (Atkinson *et al*. 2012),

However, the use of plant extract as a soil amendment or agricultural by-product that provides nematode control in the agricultural system as an alternative to synthetic chemical nematicides have increased Worldwide according to Wazel *et al*.(2014).Several compounds of plant origin was evaluated for nematicidal activity and found to be cost-effective and environmentally safe (Aoudia *et al*.2012). Hence, the search for acceptable alternative management strategies using plant materials as organic nematicides is very pertinent. Begum e*t al*. (2015) reported that plants aqueous leaf extract is a rich source of terpenoids, steroids and alkaloids. *Lantana camara* was found to exhibit antimicrobial, insecticidal and nematicidal activities, (Baba *et al.*, 2018). Alowanou *et al*. (2015) had reported that the leaf and bark extracts of Bridellia ferruginea possess antimicrobial activities against some micro-organisms known to inhibit the growth of *Staphyloccus aureus* and *Candida albicous*. In view of the fact that many botanicals which may be cost-effective, environmentally friendly and readily available in Nigeria are yet to be screened for nematicide properties. Therefore, the present study assessed the efficacy of crude leaf extracts of *Lantana camara* and *Bridelia ferruginea* on root-knot nematode (*Meloidogyne incognita*) population as it affects the growth and yield of two improved tomato varieties.

Materials and Methods

Experimental Location

This study was conducted in the screen house at the Crop Protection Department, Faculty of Agriculture, University of Ilorin, and Ilorin Kwara State, Nigeria. Sandy loamy soil was collected from a depth of 20 cm, sieved to remove stones and plant debris. The soil was steam-sterilized at 90°c for 9hrs following the method of Gautam and Goswani (2002), and was allowed to cool for 72hrs, then filled into 10 liter plastic buckets with 7kg sterilized soil.

Experimental Design

The experiment was laid out in a Complete Randomized Design (CRD) in four replicates. Two tomato varieties known to be susceptible to root- knot nematode, ROMA-VF and UC 82-B purchased from Premier seed Sango, Ilorin, Kwara State were used for the study. Three seeds were planted per pot and later thinned to one healthy plant per pot.

Nematode inoculation

The soil was inoculated a week after planting with approximately 4500 root–knot nematode eggs extracted from infected *Celosia argentea* root in the laboratory using the method described by Hussey and Baker (1973).

Preparation and Application of plant extracts

The plant materials used as soil amendments and management of *Meloidogyne incognita* infected plants were fresh leaves of *Lantana camara* and *Bridelia ferruginea* collected at midday and air dried for 14days. Part of dried leaves *were* grounded separately into powdered and the remain part of leaves dried leaves were pulverized using mortar and pestle, and separately soaked (1kg/4liters) for 24hours. The suspension was sieved in both cases and the aqueous extracts were collected in containers. Application of aqueous crude leaf extracts and powdered from wild sage (*Lantana camara*) and Bridelia wild (*Bridelia ferruginea)* as botanical nematicidal were prepared following the method of Izuogu and Abolusoro (2016). The treatments, aqueous and powder form of *L .camara* and *B. ferruginea* (Table 1) were applied at the rate of 50ml and 20g respectively at two weeks after planting, the treatments were repeated at four weeks after the first treatment application (six weeks after planting). The pots without treatments served as the control. Weeding was done by hand picking and watering was done daily.

Data Collection

Data were collected every two weeks on plant height, number of leaves, numbers of fruits and weight of the fruits. , Nematode population was determined at 4 weeks after planting (WAP) and at harvest. In addition, gall index was determined at harvest using Bridge and Page (1980) standard rating scheme 0-10.

Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using SPSS Version 20 and the mean were separated using Duncan's Multiple Range Test at 5% level of Significance.

Table 1: Different treatments application to control *Meloidogyne incognita* nematode infested soil

SN	Treatment code	Treatment name
1	T1a	Aqueous leaf extract of *Lantana camara*
2	T1p	Powdered leaf of *Lantana camara*
3	T2a	Aqueous leaf extract of *Bridellia ferruginea*
4	T2p	Powdered leaf of *Bridellia ferruginea*
5	Control	Inoculated but no treatment

Results

The effectiveness of *Lantana camara* and *Bridellia ferruginea* on the growth of two tomato varieties planted on Meloidogyne incognita nematode infested soil is shown in Table 2. There was a significant difference between the treated and untreated pots. Pots treated with powdered leaves of *Bridellia ferruginea* (T2p) had the highest mean plant height across all the weeks of evaluation. Aqueous leaf extract of L. camara (T1a) had the least effective among the treatments on plant growth with respect to the height of the plant throughout the weeks of evaluation. However, with the exception of the T2p, all the treatments and control had similar growth effects that are statistically different on the tomato varieties. The better performance occurred in the UC 82-B variety as shown in Figure 1. Number of leaf per plant of the two tomato varieties in response to botanical treatments of soil infested with M. incognita was significantly different. At 2 – 4 WAP, leaf formations in the two varieties were similar (Table 3). The treatment T2p had a significant optimum effect on leaf formation, followed by aqueous leaf extract of B. ferruginea. Both treatments of L. camara (T1a and T2p) were less effective but performed better than the control even though the performances were not significantly different. At maturity, 10 (WAP), T2p affect the highest number (167.2) of leaf in the tomato varieties. Meanwhile, in terms of varietal response to the treatments, UC 82-B was better than the ROMA VF (Figure 2). The effectiveness of L. camara and B.

ferruginea aqeous leaf extracts and powder on the reproductive yield of two tomato varieties (ROMA VF and UC 82-B) grown on root-knot nematode infested soil is shown in Table 4.

Table 2: Effect of different botanical treatments on plant height (cm) of two tomato varieties grown on soil infested with *Meloidogyne incognita.*

TRT	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP
T1a	8.62b	14.73a	18.80b	24.96a	31.90a	40.70ab	49.74b	59.40b	70.90b
T1P	8.80b	14.91a	17.70ab	25.25a	32.20a	40.30a	49.90b	60.70b	74.24b
T2a	9.22b	15.50a	20.40ab	27.15a	33.30a	41.40ab	50.40b	59.50b	70.33b
T2P	11.90a	16.80a	20.71a	27.29a	34.30a	44.90a	57.23a	69.10a	83.30a
Control	8.29b	14.50a	18.24ab	21.16b	22.20b	23.40c	30.02c	43.89c	53.32c
S.E.M	0.63	0.50	0.90	1.19	1.41	1.50	1.60	1.92	2.31
*	S	NS	S	S	S	S	S	S	S

- S: significant; NS: Not significant

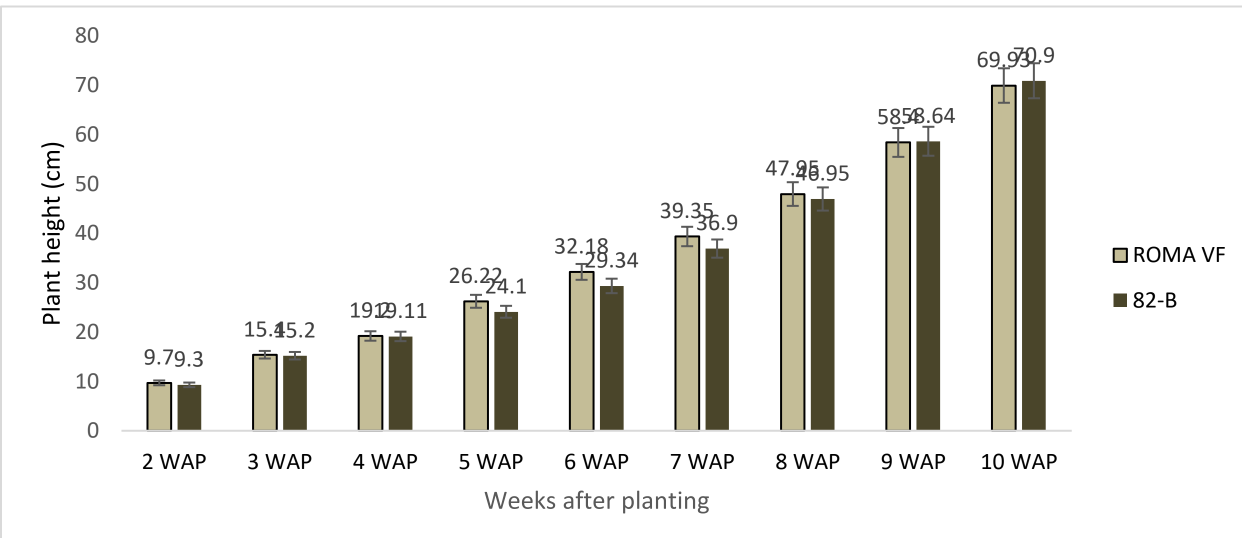

Figure 1: Mean plant height (cm) of two tomato varieties grown on soil infested with *Meloidogyne incognita.*

Table 3: Effect of different botanical treatments on leaf formation of two tomato varieties grown on soil infested with *Meloidogyne incognita.*

TRT	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP
T1a	12.6a	17.4a	29.1bc	40.4ab	60.7a	80.7b	107.0b	136.3b
T1p	13.6a	19.3a	31.3ab	43.0ab	66.5a	84.1b	124.3ab	148.4b
T2a	13.1a	17.9a	31.7ab	41.2ab	68.3a	92.7ab	124.0ab	161.4a
T2p	14.6a	20.3a	35.5a	48.9a	74.5a	102.7a	132.2a	167.2a
Control	14.3a	19.8a	25.1c	34.5c	40.1b	54.1c	70.0c	89.8c
S.E.M	0.8	1.2	1.9	3.0	4.5	5.7	7.3	8.3
	NS	NS	S	S	S	S	S	S

- S: significant; NS: Not significant.

Table 4: Effect of different botanical treatments on fruit characters of two tomato varieties grown on soil infested with *Meloidogyne incognita.*

Treatment	Number of Fruit per plant	Fruit weight (Kg)
T1a	6.70ab	0.21a
T1p	7.30a	0.20ab
T2a	5.50b	0.20ab
T2a	5.30b	0.30a
Control	3.30c	0.11c
S.E.M	0. 12	0.03

The highest number of fruits per plant (7.30) was achieved with T1p, followed by T1a (6.70). About 5 fruits per plant were obtained in plants treated with T2a and T2p which were both significantly higher than the number of fruit per plant obtained from the control plants. Meanwhile, more fruits were generally recorded in UC 82-B than the ROMA VF variety. The average weight of the tomato fruits which ranged from 0.20 -0.30 Kg are not significantly different for the treatments but were significantly higher than the control, where the mean weight of fruit was 0.11 Kg. In general terms, variety UC 82-B showed better agronomic performance than the ROMA VF and all the treatments produced better results than the control plants. The effects of crude leaf extracts and powders of *L. camara* and *B. ferruginea* on the root-knot nematode population of the soil and root of two tomato varieties (Roma VF and UC 82-B) are presented in Table 5. Significant differences were observed between the soil and roots of treated and control plants of the two tomato varieties. Nematode population in soil and roots were significantly lower in the treated plants than the untreated plants. The roots gall revealed that both treatments form were efficient in the control of root-knot nematodes when compared with control plants.

Table 5: Effect of *Lantana camara and Bridelia ferruginea* leaf crude extracts and powders on nematode population in the soil and roots of two varieties of tomato.

Plots	One month S.N.P	Final S.N.P	One month R.N.P	Final R.N.P	Gall index
V1T1a	2104.95^{ab}	648.3^{ab}	159.90^{a}	69.90^{a}	1.00
V1T1p	2031.75^{ab}	604.95^{b}	184.95^{ab}	43.30^{a}	0.00
V1T2a	2184.75^{c}	788.25^{ab}	150.00^{a}	19.95^{a}	2.00
V1T2p	2044.95^{ab}	654.75^{b}	153.30^{a}	30.90^{a}	1.00
V1C	3389.54^{c}	2844.95^{c}	456.60^{a}	845.24^{c}	8.00
V2T1a	1986.6^{ab}	379.95^{a}	159.90^{a}	49.95^{ab}	1.00
V2T1p	2029.95^{ab}	608.40^{b}	165.00^{a}	36.60^{a}	0.00
V2T2a	1894.96_{a}	679.95_{b}	154.95^{a}	$4\ .05^{ab}$	2.00
V2T2p	3061.45^{ab}	711.75^{ab}	184.95^{ab}	38.25^{a}	2.00
V2C	3046.60^{ab}	2986.60^{c}	159.90^{a}	1009.95^{cd}	7.00

Values in the same column followed by the same letters have no significant differences at $p<0.05$ according to Duncan Multiple Range Test (DMRT). V1T1a =ROMA VF *Lantana camara* aqueous, V1T1P = ROMA VF *Lantana camara* powdered, V1T2a = ROMA VF *Bridelia ferruginea* aqueous, V1T2p = ROMA VF *Bridelia ferruginea* powdered, V1C = ROMA VF Control, V2T1a = UC82-B *Lantana camara* aqueous, V2T1p= UC 82-B *Lantana camara* powdered V2T2a= UC82-B *Bridelia ferruginea* aqueous, V2T2p= UC82-B *Bridelia ferruginea* powdered, V2C =82-B Control. O.M.S.N.P =One month soil nematode population; F.S.N.P = Final Soil Nematode Population; O.M.R.N.P = One month root nematode population; F.R.N.P = Final Root nematode population.

Discussion

The effectiveness of *Lantana camara* and *Bridellia ferruginea* crude leaf aqueous and powered in controlling root-knot nematode in tomato cultivation has been established in this study. The treatments were effective in reducing root galling, nematode population in the soil and root of tomatoes. Application of L. camara and B. ferruginea as a soil amendment, bio–nematicides and anthelmintic activity against parasitic nematodes was demonstrated by many workers (Alowanou *et al*.2015; Baba *et al*. 2018).

Findings in this present study indicated that aqueous crude leaf extracts and powdered of *L. camara* and *B. ferruginea* can be used to improve the growth and yield of tomato grown on nematode infested soil, these results conforms with the work of Izuogu *et al.* (2016), Ganesh *et al.* (2015) had earlier reported that various concentrations of *L. camara* leaf extract affected root-knot nematode. The result of this study also showed that aqueous and powdered leaves of *L. camara* and *B. ferruginea* can be used as natural amendment to reduce the use of synthetic chemical nematicides. Neeraj *et al*. (2017) observed the effect of aqueous extracts of different medicinal plants against root-knot nematode. The bioactive ingredients (saponins, alkaloids, flavonoids and steroids) present in *L. camara* and *B. ferruginea* could be responsible for the suppression and reduction of the population size of the root-knot nematodes infesting the tomato varieties (Baba *et al.*, 2018) The botanicals used in managing the effect of root-knot nematodes on the two tomato varieties with plant treated with *Lantana camara* showing signs of smaller numbers of galls when compared to plant treated with *Bridelia ferruginea*, the control plant has the highest number of galling. The roots assessment provides a rapid visual indication to nematode infection and a relative indication of crop resistance. The roots of the control plants were heavily galled rated as 7 and 8 of the root galled, roots of plants treated with the aqueous and powdered form of *Bridelia ferruginea* was rated as 2 of the root system galled while plants root treated with both forms of *Lantana camara* were rated as 0 and 1 of the root system galled, these are rated according to the method of Bridge and Page (1980) standard rating scheme of Nematode. The two tomato varieties also displayed some level of tolerance to the parasitic nematode in this study and this could be due to release of chemical compounds from root of tomatoes, Bais *et al*.(2006) reported that the root exudates from both resistant and susceptible tomato rootstock increased significantly the mortality of second-stage juvenile of Meloidogyne incognita.

Conclusion

In conclusion, *Lantana camara* and *Bridellia ferruginea* were effective potential measure for controlling root-knot nematode on tomato. L. camara crude leaf powdered extract is the most effective of all treatments on infected tomato plants. It can therefore be recommended to the tomato growers in areas where root-knot nematodes are a menace. The findings of the present study are not conclusive. Further studies should be conducted in greenhouse and field conditions to assess the nematicidal properties.

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