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Management of rice root-knot nematodes (*Meloidogyne graminicola*) in aerobic rice using botanicals under climatic variability

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ABSTRACT

A field study was conducted to screen out the efficacy of different botanicals against *Meloidogyne graminicola* infected aerobic rice field. The extracts of neem seed kernels, leaf extracts of *Parthenium argentatum, Lantana camara, Jatropha curcus, Moringa* sp. @ 3 % v/v were applied as treatments along with one chemical treatment by Carbofuran @ 1 kg *a.i.* /ha were applied to seven treatments including control. These treatments were given in the plots of anaerobic rice field at KVK Vaishali, Bihar during 2011 and 2012 and compared with control. The results showed that the vegetative growth of plants like shoot length and weight, root length and weight and grain yield was significantly higher than the control. Also reduction in the number of galls, the number of females and number of juveniles were decreased significantly in botanicals treated plants compared to control. Although carbofuran treated plants showed the best results regarding the vegetative and reproductive growth of plants as well as reduction of root-knot nematodes, a treatment where *Parthenium argentatum* was given to the plants, performed better than the other botanicals. Since it is a toxic weed which spreads very fast and causes many deleterious effects on crops, human and animal health as well as on environment as a whole, its use as a biocontrol of *M. graminicola* in aerobic rice may be a great eco-friendly approach for the saving of environment.

Keywords: Aerobic rice, Botanicals, *Meloidogyne graminicola*

INTRODUCTION

Rice is a principal energy source of the human diet in many countries in South Asia including India. Rice is one of the heavy water-demanding crops, hence aerobic rice production technology is a boon for water deficit regions under change climate scenario (Singh *et al*., 2012a). Aerobic rice cultivation saves water and ensures higher grain yield, although it is a new potential technology which ensures water saving and high yield, it has some limitations like weed and pest and disease problems (Kumar *et al*., 2013; Singh *et al*., 2012a and Singh *et al*., 2014). Several factors are responsible for the low productivity of rice. Of these, availability of irrigation water, soil nutrient status and the outbreak of insect pests and diseases are major constraints for higher productivity (Singh *et al*., 2012a and Singh *et al*., 2014). Nematodes are the major constraints responsible for continuous cropping obstacle in upland rice (-). *Meloidogyne graminicola,* the rice root-knot nematode, has become a constraint on Asian rice production due to rice cropping intensification and increasing scarcity of water (Soriano *et al*., 2000).

The root-knot nematodes, *M. graminicola* were the prominent pest problems reducing the yield of aerobic rice and most economic pests associated with rice in upland condition (Bridge *et al*., 2005). The management of these nematodes through nematicides may result in environment pollution and pest resistance although it results in a remarkable reduction in nematode population (Akhtar and Malik, 2000). Also the application of chemicals is beyond the reach of most of the small and marginal farmers. To combat this, biological control is one of the best options for integrated nematode management. As other options, it can be managed through cultural practices like crop rotation, judicious uses of fertiliser for balance nutrition, use of resistant varieties, biological management (Singh *et al*., 2012b). Amongst these, botanical pesticides have much potential to manage these nematodes ecofriendly .The present research has been done to control root-knot nematodes, *M. graminicola* in aerobic rice (var. Rajendra Bhagwati) in collaboration with KVK, Vaishali through selected native bio-pesticides.

MATERIALS AND METHODS

The experiment was conducted in the root-knot infested aerobic rice (Var. Rajendra Bhagwati) fields at KVK, Vaishali during the year 2011 and 2012. The plots were received seven treatments including control in randomized block design with three replications. The treatments were neem seed kernels water extract (NSKWE) @ 3% (V/V), flower extract of *Lantana camara* @ 3% (V/V), leaves of Sahjan (*Moringa sp.*) @3% (V/V), carbofuran 3G @ 1 kg a.i./ha. These were applied to plots as soil drench one week before sowing of rice. *M. graminicola* was assessed before applying the treatments. To obtain NSKWE, seed kernels were processed as described by Khanna and Kumar (2006). After harvesting, the plants were uprooted and observations were recorded on the ten randomly selected plants of each plot as the length and weight of shoot and root and grain yield. Data regarding nematodes were also recorded as number of galls per plant, gall index, no. of females per gram root, no. of J_2 per g root and no. of J_2 per 250

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cc soil. Soil population of *M. graminicola* was estimated by extracting soil samples by Cobb's sieving and decanting method followed by Modified Baermann's Funnel Technique (Southey, 1970). The data of the experiment were subjected to analysis of variance (ANOVA) and standard deviation and critical differences (CD) at 5% were calculated.

RESULTS AND DISCUSSION

Effect of growth and yields

All treatments, NSKWE, *Jatropha curcus, Parthenium argentatum, Lantana camara, Sahjan (Moringa* sp.) and Carbofuran results in significant increase in shoot length shoot weight, root length root weight and grain yield (Table 1). The treatments which received *Jatropha curcus, Lantana camara* and *Moringa* sp. were at par in increasing the shoot and root length and weight respectively and grain yield (Table 1 and Fig. 1).

Among botanicals, the maximum increase in shoot length (34.05%), shoot weight (24.95%), root length (82.29%), root weight (46.98%) and grain yield (76.89%) were recorded in the treatment where NSKWE was given @ 3 % v/v followed by *Parthenium argentatum* @ 3 % v/v. The decreased percentage was very low in shoot length (2.73%) and shoot weight (3.98%) in the *Jatropha curcus* treated plants while the increase percentage in root length (52.19%), root weight (34.69%) and grain yield (43.23%) was considerable. The aqueous neem leaf extracts found effective against root-knot nematode *Meloidogyne incognita* in laboratory and greenhouse condition (Kaur *et al.*, 2012).

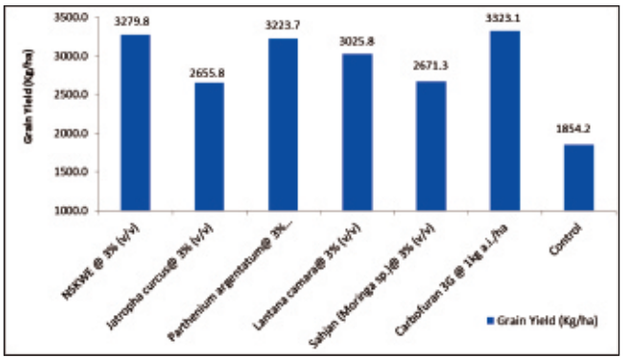

Fig. 1: Effect of the botanical pesticides on the yield of aerobic rice (Pooled data of two years)

Table 1: Effect of the botanical pesticides on growth parameters and yield of aerobic rice (Pooled data of two years

Treatment	Shoot Length (cm)	Shoot Weight (gm)	Root Length (cm)	Root Weight (gm)	Grain Yield (kg/ha)
NSKWE @ 3% (V/V)	81.33 (34.05)	31.4 (24.95)	16.17 (82.29)	18.77 (46.98)	3279.83 (76.8 9)
Jatropha curcus @ 3% (V/V)	62.33 (2.73)	26.13 (3.98)	13.5 (52.19)	17.20 (34.69)	2655.75 (43.2 3)
*Parthenium argentatum*_@ 3% (V/V)	68.43 (12.79)	29.17 (16.07)	15.13 (70.57)	19.73 (54.5 0)	3223.67 (73.8 6)
Lantana camara @ 3% (V/V)	63.07 (3.95)	26.43 (5 .17)	14.47 (63.13)	17.77 (39.1 5)	3025.75 (63.18
Sahjan (*Moringa*sp.) @ 3% (V/V)	62.07 (2.30)	26.57 (5 .73)	13.5 (52.19)	16 .8 (31.5 6)	2671.33 (44.0 7)
Carbofuran 3G @ 1kg a.i./ha	83.37 (37.41)	33.10 (31.71)	17.57 (98.08)	19.83 (57.2 8)	3323.08 (79.2 2)
Control	60.67	25.13	8.87	12.77	1854.17
SEm ±	0.54	0.31	0.15	0.23	8.39
CD (P=0.05)	1.67	0.96	0.47	0.72	26.13

Note: The figures in parentheses represent the percentage increase in control

It was reported that extracts from Neem (*Azadirachta indica*), Bael (*Aegle marmelos*), Jatropha (*Jatropha curcas*), Eucalyptus (*Eucalyptus globus*), Sahjan (*Moringa oleifera*), Ber (*Ziziphus mauritiana*), Sarifa (*Annona reticulate*) and Congress grass (*Parthenium argentatum*) were found to be most effective in reducing the population of rice root-knot nematode, *Meloidogyne graminicola* in rice. These extracts significantly increased the growth of the plants (Dongre and Simon, 2013).

Effect on M. graminicola

The treatments, NSKWE, *Jatropha curcus, Parthenium argentatum, Lantana camara,* Sahjan (*Moringa* sp.) and Carbofuran significantly decreased the number of galls per plant, no. of females / g root, no. of J_2 per 250 cc soil (Table 2). Using plant extracts in controlling plant parasitic nematodes has shown by several authors (Satyal *et al.*, 2012).

The plants which received carbofuran 3G @ 1kg *a.i.*/ha had produced least number of galls and recorded the least number of females, also the number of juveniles per gm root and per 250cc soil recorded was least when compared to treatment which received no treatment. Among botanicals, NSKWE was recorded significantly higher than the other treatments followed by *Parthenium argentatum* (Table 2). Importance of organic horticultural production, which avoids synthetic pesticides applications, increased the research on botanical pesticides with potential use for nematode management (Rao *et al.*, 1998).The maximum decrease in number of galls (88.9 %)

Table 2: Effect of the botanical pesticides on *Meloidogyne graminicola* in aerobic rice (Pooled data of two years)

Treatment	No. of galls/ plant	No. of females/plant	No of J2 per. gram root	No. of J2/ 250cc Soil
NSKWE @ 3% (v/v)	14.33	33.0	161.0	209.33
	(88.1)	(81.6)	(79.5)	(64.2)
*Jatropha Curcus*_@ 3% (v/v)	21.67	53.67	247.67	363.00
	(82.0)	(70.0)	(68.5)	(37.9)
*Parthenium argentatum*_@ 3%	17.67	35.0	159.33	225.67
(v/v)	(85.4)	(80.5)	(79.7)	(61.4)
*Lantana camara*_@ 3% (v/v)	18.67	37.67	177.33	234.67
	(84.5)	(79.0)	(77.4)	(59.8)
Sahjan (*Moringa*s p.)_ @ 3%	22.67	53.67	238.33	358.33
(v/v)	(81.3)	(70.0)	(69.6)	(38.7)
Carbofuran 3G @ 1kg a.i./ha	13.33	24.67	160.67	174.00
	(88.9)	(86.2)	(79.5)	(70.2)
Control	121.0	179.33	785.0	584.67
SEm±	1.09	1.38	2.53	4.77
CD (P=0.05)	3.39	4.29	7.88	14.87

Note: The figures in parentheses represent the percentage decrease in control

was obtained with the treatment when carbofuran @ 1 kg a.i./ha was applied followed by NSKWE @ 3 % v/v where the decrease percentage was 88.1 % which was the maximum decrease amongst the botanical treatments followed by *Parthenium argentatum* @ 3 % v/v (85.4 %). Similarly, the number of females, number of second stage juveniles per gram root and 250 cc soil were also minimum in the NSKWE treated plants (81.6 %, 79.5 % and 64.2 % respectively) followed by *Parthenium argentatum* treated plants (80.5 %, 79.7 % and 61.4 % respectively) (Table 2).

CONCLUSION

Since Parthenium is a weed and its eradication poses a great problem to the society. Its use in managing plant-parasitic nematodes like *M. graminicola* holds a great potential for its safe disposal and eco-friendly use in increasing aerobic rice yield under climate variability and uncertainty. Thus integrated management of *M. graminicola* through botanicals has a great potential in managing nematodes as well as saving the environment.

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