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Evaluation of *Neemastra*, *Agniastra* and *Brahmastra* for the Management of Root-Knot Nematodes, *Meloidogyne* spp. in Tomato

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ABSTRACT

Three different organic inputs viz., *Neemastra, Agniastra* and *Brahmastra* were evaluated for the management of root-knot nematodes, *Meloidogyne* spp. in tomato. All three organic inputs were prepared by using indigenous cow urine and dung. Total three different concentrations of each organic input were used and applied 500 ml water solution as drenching per plant near root zone area at the time of transplanting and repeated it after 15, 30 and 45 days after transplanting. The results based on the data the root-knot index (RKI), the minimum RKI was found in *Agniastra* @ 800 ml/10l water followed by in *Neemastra* @ 400l /acre and in *Brahmastra* @ 800 ml/10l water as compared with all other treatments. These organic inputs were found effective to manage root knot nematodes and reduce RKI significantly. Whereas, the data on fruit yield showed that these organic inputs were not found effective and the result was found non-significant.

Keywords *Neemastra, Agniastra, Brahmastra,* Root-knot Nematodes, *Meloidogyne* spp.

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INTRODUCTION

Plant-parasitic nematodes are ubiquitous microscopic soil pests that feed on plant roots resulting in severe crop losses. The damage often goes unnoticed due to the hidden nature of nematodes and the non-specific damage symptoms, which can be confused with soil fertility, drought or other soil pest or pathogen problems. The nematode damage survey valued global crop losses at $100 billion annually (Sasser and Freckman1987) and in recent it was $157 billion estimated loss each year (Singh *et al.* 2015).

More than 4,000 species of plant-parasitic nematodes have been described but only a fraction of these cause economic damage to crops (Decraemer-and Hunt 2006). The most important nematode pest worldwide is the root-knot nematode (*Meloidogyne* spp.), which is estimated to account for greater than 50% of all nematicide use and 5% of crop loss globally (Haydock *et al*. 2006). The root knot nematodes, *Meloidogyne* spp. is one of the main pests that attack several crops, mainly vegetables, in tropical and subtropical regions, posing economic damages. The most important species is *Meloidogyne incognita* because of its aggressiveness and for being widespread throughout the world (Sikora and Fernandez 2005). The juveniles of root-knot nematodes penetrates the roots and establishes its feeding site transforming the cells around the stylet into giant cells and consequently, provoking the appearance of galls in the roots, thus hindering the absorption of water and nutrients by the plant (Karssen *et al.* 2013).

Tomato, *Solanum lycopersicum* production is divided into the fresh market and industrial processing, both of high economic importance. Tomato is grown as vegetable crop in all over the world and problem of nematodes increases day by day in crop. *Meloidogynes* pp. are major pests on tomatoes where they cause considerable losses in yields. A reduction in tomato yields ranging from 28 % to 68% in tomato have been reported (Adesiyan *et al*. 1990).Worldwide losses caused by root knot nematodes reach 27 % (Kaur *et al.* 2011) making nematodes one of the main research targets for its management. Since, the ban of the fumigant, there is an increasing search for new molecules and efficient modes of action in the control of nematodes (Morris *et al*. 2016). The most commonly used non-fumigant nematicides are those of the carbamates and organophosphorates both acetylcholinesterase inhibitors (Opperman and Chang 1990) and some are already restricted because of high toxicity to invertebrates, non-target organisms, humans and the environment.

In past, many effective and relatively inexpensive nematicides have been withdrawn from the market because of health hazards to production worker or because of their detection at unacceptable levels in ground water. These chemicals are also relatively unaffordable to many small-scale farmers (Johnson *et al.* 1987).

Recently, owing to incursion of COVID-19, consumers are conscious about their health and they are in search of the food which improves their immunity. Therefore, demand for such type of foods including vegetable is gradually increases, keeping in view, management of nematodes through different organic inputs was formulated for the benefit of organic farmers.

MATERIALS AND METHODS

All the recommended agronomical practices were followed to raise the tomato crop (var Gujarat Anand tomato 3 (GAT-3)) at Nematology Farm, Department of Nematology, BA College of Agriculture, Anand Agricultural University, Anand, Gujarat during *kharif* 2020. The experimental field was infested with root-knot nematodes with population density of more than one nematode per g soil i.e. 256 infective juveniles per 200 cc soil. The experiments were carried out in Completely Randomized Block Design (RBD).

Treatments details

Treatment details with application methodology

T_1 = *Neemastra* @ 200l /acre were makeup 500 ml by adding water and applied as drenching per plant near root zone area

T_2 = *Neemastra* @ 300l /acre were makeup 500 ml by adding water and applied as drenching per plant near root zone area

T_3 = *Neemastra* @ 400l /acre will be makeup 500 ml by adding water and applied as drenching per plant near root zone area

T_4 = *Agniastra* @ 400 ml/10l water were applied 500 ml solution as drenching per plant near root zone area

T_5 = *Agniastra* @ 600 ml/10l water were applied 500 ml solution as drenching per plant near root zone area

T_6 = *Agniastra* @ 800 ml/10l water were applied 500 ml solution as drenching per plant near root zone area

T_7 = *Brahmastra* @ 400 ml/10l water were applied 500 ml solution as drenching per plant near root zone area

T_8 = *Brahmastra* @ 600 ml/10l water were applied 500 ml solution as drenching per plant near root zone area

T_9 = *Brahmastra* @ 800 ml/10l water were applied 500 ml solution as drenching per plant near root zone area

T_{10} = Untreated check

T_{11} = Treated check - Carbofuran 3% CG @ 1 kg a.i./ha at transplanting and again 25 DAT

* The treatments from T_1 to T_9 were applied at the time of transplanting and repeated it after 15, 30 and 45 days after transplanting

Replications:	Three
Plot size :	4.5 x 3.0 m
Spacing :	75 x 45 cm
Fertilizers (N:P:K)	100:50:50

Observations recorded

1. Root-knot Index (RKI: 0-5) at harvest were taken by counting of galls/knots on roots : Root-knot Index (RKI) (Taylor and Sasser 1978) The scale of 0-5 for galling index were used as follow

RKI	No. of galls on roots
0	No galls on roots
1	1-2 galls
2	3-10 galls
3	11-30 galls
4	31-100 galls
5	More than 100 galls

2. Yield (kg/plot): Fruit yield were recorded in kg/plot.

Procedure for preparation, compositions and application of organic inputs:

Organic input	Ingredients	Required quintity	Recipe and application procedure
Neemastra	Cow urine	5 l	The neem leaves paste added with water then mixed with cow dung and urine as per required quantity in the container.Let this solution to ferment for 24 h. Stirred this solution clockwise daily 2-2 minutes during morning and in evening by wooden stick. Filtered this by cloth and then used it . The solution is directly applied to plants without any further dilution and it will be useable for 6 months.
	Cow dung	1 kg	
	Neem *(Azadirachta indica)* leaves paste	5 kg	
	Water	100l	Dose**:** 200l/acre for sucking insect pest
Agniastra	Cow urine	20l	All the ingredients mix toge-together and boil it 4-5 times continuously at medium flame. Let this solution to ferment for 24 h. Filtered this by cloth and then used it for present investigation. This will be usable for three months.
	Neem (*A. indica*) leave paste	5 kg	
	Garlic (Allium sativum) paste	0.5 kg	
	Green Chillies (*Capsicum annuum*)	0.5 kg	
	Tobacco dust	0.5 kg	Dose : 400 ml/10l of water for spaying against stem borer insect pest.
Brahmastra	Cow urine	10l	All the ingredients mix together and boil it 4-5 times at medium flame and are cooled down for about 24 h.. The solution is stirred clockwise daily 2-2 minutes during morning and in evening and fermented for about 48 h. The solution is then filtered and it will be usable for six months.
	Neem (*A. indica*) leave paste	3 kg	
	Karanj (*Millettia pinnata)* leave paste	2 kg	
	Dhatura (*Datura* sp.) leave paste	2 kg	
	Custard apple (*Annona reticulate*) leave paste	2 kg	Dose: 400 ml/10l of water for spaying againist all type of insect pest
	Papaya (*Carica* papaya) leave paste	2 kg	

Note : * The container must be placed under shaded area and covered by gunny bags. ** The cow urine and cow dung should be fresh and taken from indigenous cow breed.

(Source: Devvrat 2020)

RESULTS AND DISCUSSION

All three organic inputs viz., *Neemastra*, *Agniastra* and *Brahmastra* are advised and used for the management of insect pests (Devvrat 2020, Kumar *et al.* 2020). Due to its eco-friendly, cost effective, sustainable and organic management abilities against insect pest, we had formulated this experiment and evaluated these organic inputs to manage root-knot nematodes on tomato in nematode infested field.

Based on the data presented in Table 1 on root-knot index (RKI), the minimum RKI 2.38 was found

Table 1. Effect of organic inputs on Root-Knot Index (RKI) in tomato. 0= Free, 5= Maximum disease intensity (RKI), Figures in parentheses are retransformed of √X values; those outside are √X transformed values, Figures indicating common letters do not differ significantly at 5% level of significance according to DNMRT

	Treatments	RKI (0-5)
T_1	*Neemastra* @ 200l /acre	1.63^{c} (2.69)
T_2	*Neemastra* @ 300l /acre	1.62^{c} (2.65)
T_3	*Neemastra* @ 400l /acre	1.60^{c} (2.56)
T_4	*Agniastra* @ 400 ml/10l water	1.67^{bc} (2.81)
T_5	*Agniastra* @ 600 ml/10l water	1.66^{bc} (2.75)
T_6	*Agniastra* @ 800 ml/10l water	1.54^{c} (2.38)
T_7	*Brahmastra* @ 400 ml/10l water	1.62c (2.66)
T_8	*Brahmastra* @ 600 ml/10l water	1.62^{c} (2.63)
T_9	*Brahmastra* @ 800 ml/10l water	1.61^{c} (2.63)
T_{10}	Untreated check	1.92^{a} (3.70)
T_{11}	Carbofuran 3% CG @ 2 kg a.i./ha	1.89^{ab} (3.60)
	SEm ±	0.07
	CD (0.05)	0.20
	CV %	7.12

Table 2. Effect of organic inputs on fruit yield in tomato. Figures indicating common letters do not differ significantly at 5% level of significance according to DNMRT.

	Treatments	Yield (kg/ha)
T_1	*Neemastra* @ 200l /acre	24352[a]
T_2	*Neemastra* @ 300l /acre	28996[a]
T_3	*Neemastra* @ 400l /acre	30117[a]
T_4	*Agniastra* @ 400 ml/10l water	23013[a]
T_5	*Agniastra* @ 600 ml/10l water	25995[a]
T_6	*Agniastra* @ 800 ml/10l water	29250[a]
T_7	*Brahmastra* @ 400 ml/10l water	25888[a]
T_8	*Brahmastra* @ 600 ml/10l water	26102[a]
T_9	*Brahmastra* @ 800 ml/10l water	29598[a]
T_{10}	Untreated check	22682[a]
T_{11}	Carbofuran 3% CG @ 2 kg a.i./ha	26522[a]
	SEm ±	3709.14
	CD (0.05)	NS
	CV %	24.16

in *Agniastra* @ 800 ml/10l water followed by 2.56 in *Neemastra* @ 400l /acre and 2.63 in *Brahmastra* @ 800 ml/10l water and *Brahmastra* @ 600 ml/10l water as compared with all other treatments. The data on fruit yield (Table 2) indicated that the maximum 30117 kg/ha was observed in *Neemastra* @ 400l /acre followed by 29598 kg and 29250 kg/ha in *Brahmastra* @ 800 ml/10l water and *Agniastra* @ 800 ml/10l water, respectively. Statistically result on fruit yield was non-significant and as per DNMRT all treatments were at par.

The use of *Neemastra, Agniastra* and *Brahmastra* were applied as drenching with different doses against root-knot nematodes in tomato, the result indicated that these organic inputs were found effective to manage root knot nematodes and reduce RKI significantly. Whereas, the data on yield showed that these organic inputs were not found effective to increase fruit yield significantly over control.

During the preparation of all three organic inputs, *Neemastra, Agniastra* and *Brahmastra,* we allowed to ferment properly therefore, we kept the container in shaded area and also covered it by gunny bags. The main components, cow urine and cow dung were common in all organic inputs, that enhancing the fermentation process and release more amount of ammonia and other gases. That may affect to root-knot nematodes and reduced RKI over control. Several

Fig. 1. Effect of *Neemastra, Agniastra* and *Brahmastra* against root-knot nematodes on tomato. T_1 *Neemastra* @ 200l /acre, T_2 *Neemastra* @ 300l /acre, T_3 *Neemastra* @ 400l /acre, T_4 *Agniastra* @ 400 ml/10l water, T_5 *Agniastra* @ 600 ml/10l water, T_6 *Agniastra* @ 800 ml/10l water, T_7 *Brahmastra* @ 400 ml/10l water, T_8 *Brahmastra* @ 600 ml/10l water, T_9 *Brahmastra* @ 800 ml/10l water, T_{10} Untreated check, T_{11} Carbofuran 3% CG @ 2 kg a.i./ha.

studies have shown that when organic amendments applied in soil, especially those with high nitrogen/carbon ratios, have been reported to exhibit nematicidal and fungicidal activity, mainly through the release of ammonia from the amendments during their decomposition in the soil or through increased populations of antagonistic microorganism (Rodrı´-guez-Ka´ bana 1986, Rodrı´guez-Ka´bana *et al*. 1987, Spiegel *et al.* 1987, Oka *et al.* 1993). These ammonia concentrations were probably high enough to account for the control of nematodes (Oka and Pivonia 2002,Tenuta and Lazarovits 2002, Ben-Yephet *et al.* 2005, Oka *et al*. 2006). Similarly, Gupta *et al.* (2020) found that cow urine (93.76%) @ 10% concentration was most effective for the juvenile mortality of *M. incognita* followed by *Agniastra* (91.81%) at 2% concentration. Whereas the egg hatching inhibition of *M. incognita* was found effective in cow urine (75.00%) most followed by *Agniastra* at 2%.

Feyisa *et al.* (2016) reported in their studies that neem leaf extract alone accounted for maximum per cent juvenile mortality of *M. incognita* after 72 h. Adegbite (2011) reported that *A. indica* was effective inhibitors of egg hatch of root-knot nematode *Meloidogyne* incognita. Feyisa *et al*. (2016) reported that neem leaf extract accounted for maximum inhibition over control after the exposure period of seven days. Haroon *et al.* (2018) reported from their studies that leaf extract of *A. indica* extract was the most effective in preventing egg hatching. Ladi *et al.* (2019) reported that *A. indica* accounted for maximum egg hatch inhibition over the control.

Among all organic input treatments, *Agniastra* @ 800 ml/10l water gave maximum reduction of RKI and was superior over all the treatments. Because it contains neem leave paste, garlic paste, green chili paste and tobacco dust that may responsible to minimizing the RKI. The tobacco dust having nematicidal action of nicotine and organic acids are very well reported by several scientists (Davis and Rich 1987, Rich *et al.* 1989, Yu and Potter 2008, Desai *et al.* 1972). Agbenin *et al.* (2005) also reported that neem leaf and garlic bulb extracts inhibited hatching of eggmasses and were lethal to larva.

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