Botanicals- An effective tool for the management of maize cyst nematode, *Heterodera zeae* on maize (*Zea mays* L.)

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ABSTRACT

Maize cyst nematode, *Heterodera zeae* (Koshy *et al*.) has been reported to cause significant losses in Rajasthan due to monocropping of maize, favorable soil and environmental conditions and ignorance of management practices. In present investigation, an experiment was carried out to evaluate the efficacy of neem (*Azadirachta indica*), aak (*Calotropis procera*) and water hyacinth (*Eichhornia crassipes*) leaf powder for the management of maize cyst nematode, *H. zeae* on maize variety PEHM-2. Plant leaf powders were applied at 1, 2 and 4 g/plant as soil amendment at the time of sowing. A treated chemical check (Phorate 2 kg/ha) and untreated check were also maintained for interpretation of experimental results. Results indicated maximum increase in shoot length, root length, shoot weight and root weight which were observed when neem leaf powders were applied at 4 g/plant followed by aak and water hyacinth leaf powders at 4 g/plant. Significant reduction in nematode population *viz.*, cyst/plant, cyst/100 cc soil, eggs and larvae/cyst and larvae/100 cc soil was also observed with neem leaf powders at 4 g/plant over control.

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INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops of the world. Maize ranks third in importance among India's cereal crops covering about 8.67 million hectare of area with production and productivity of 22.26 million tonnes and 2566 kg/ha, respectively during 2012-13 (Anon, 2014). It is extensively grown in Rajasthan, Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab and Uttar Pradesh in India. In Rajasthan, it occupies 9.86 lakh hectare of area having a production of 17.55 lakh tonnes resulting an average productivity of 1780 kg/ha during 2012-13 (Anon, 2014). It is mainly cultivated in Ajmer, Banswara, Baran, Bhilwara, Chittorgarh, Dungarpur, Jhalawar, Kota, Pali, Rajsamand, Sirohi, Tonk and Udaipur districts of Rajasthan and maize cyst nematode *H. zeae* is widely distributed in said areas (Rathore *et al.,* 2007; Meena *et al.,* 2013). Plant parasitic nematodes *viz*., cyst nematodes (*Heterodera* spp.), lesion nematodes (*Pratylenchus* spp.), root-knot nematodes (*Meloidogyne* spp.), stunt nematode (*Tylenchorhynchus* spp.) and spiral nematode (*Helicotylenchus* spp.) have been found to be associated with maize (Kornobis, 1983; Norton, 1984; Patel *et al.,* 2000) and is responsible for causing 10.2% loss in maize (Sasser and Freckman, 1987). Nematodes apart from causing losses by themselves interact with other disease causing agents and adversely affect the quality and quantity of maize production. Among them, the maize cyst nematode, *H. zeae* is considered as one of the most important nematode pests of maize in India and abroad (Eisenback *et al.,* 1993; Singh and Rathore, 2001). Maize cyst nematode, *Heterodera zeae* was first reported by Koshy *et al.* (1970) from Chhapli village of Rajsamand district of Rajasthan and widely distributed in maize growing areas of Rajasthan, Delhi, Punjab, Haryana, Himachal

Pradesh, Uttar Pradesh, Bihar, Madhya Pradesh, Gujrat, Tamil Nadu, Karanataka, Andhra Pradesh and Maharashtra (Kaushal *et al*., 2007). The severity of losses caused by *H. zeae* on maize is higher in Rajasthan due to favourable soil and environmental conditions. But still information regarding eco-friendly management of *H. zeae* on maize is lacking. Therefore, to fill this gap of knowledge, the present investigation was carried out.

MATERIAL AND METHODS

An experiment was carried out in 6" sized earthen pots filled with 1kg infested soil having initial inoculums of 5.5 larvae per g of soil. Neem (*Azadirachta indica*), aak (*Calotropis procera*) and water hyacinth (*Eichhornia crassipes*) leaf powder were applied at 1, 2 and 4 g/plant as soil application for the management of maize cyst nematode, *H. zeae* on maize variety PEHM-2. A treated chemical check (Phorate 2 kg/ha) and untreated check were also maintained for comparison of experimental results. The required quantities of leaf powders and the chemical were calculated and weighed separately for each pot and mixed well in soil. Soil samples were processed to estimate the initial nematode population before sowing. The experiment was laid out in completely randomized design with four replications. Care was taken right from sowing till harvest. Seeds were treated with 0.1 per cent carbendizim before sowing to protect them from fungal attack. To avoid insect damage, sprays of Malathion (0.05%) were given as and when required. Thinning was done to maintain desired plant population after 8-10 - days of germination. Weeding and hoeing was done to avoid weeds and to maintain proper aeration in soil. The recommended doses of nitrogenous and phosphatic fertilizers were applied for proper growth of plants. Pots were randomly rotated to eliminate the effect of sun and shade. Irrigation was made as and when required during the course of experimentation. Experiment was harvested after 50 - days of sowing. During harvesting, utmost care was taken to avoid damage of roots as well as nematodes in adhering soil. Observation on plant growth parameters *viz*., shoot weight (g), shoot length (cm), root weight (g) and root length (cm) were recorded without delay and for studying nematode infestation, roots were stained with 0.1% acid fuchsin lactophenol at 80^{o} C for 2-3 minutes (Mc Beth *et al.*, 1941). Then after gentle wash, roots were kept in clear lactophenol for at least 24 hrs and then examined under microscope for counting of cyst/plant, eggs and larvae/cyst. Soil samples were also taken to record nematode population. Hundred cubic centimeter soil was taken in a bowl, water added, stirred thoroughly and passed through 16 mesh sieve. The content obtained were again passed through 100 mesh sieve and sediments on sieve were carefully transferred to a beaker and kept on a blotting paper and examined under stereoscopic binocular microscope for counting of cyst population in soil. The filtrate of 100 mesh sieve was further passed through fine mesh sieves (Cobb's sieving and decanting techniques) and sediments on 400 mesh sieve was placed over Baermann's funnel assembly (Christie and Perry, 1951). After 24 hours, the nematode suspension was drawn and nematode larvae population was recorded. Data were statistically analyzed and experimental results have been presented in Table 1 and 2.

RESULTS AND DISCUSSIONS

Soil application with organic material is recognized as an efficient method for changing the soil environment. It adversely affects the life cycle of nematodes and enables the plant to resist the attack of nematodes. Therefore, in the present investigation, neem, aak and water hyacinth leaf powder were used at 1, 2 and 4g/plant as soil application for the management of maize cyst nematode, *H. zeae* on maize.

Results showed that shoot weight of maize enhanced with the soil application of neem, aak and water hyacinth leaf powder over untreated check. Among plant products, maximum shoot weight was obtained when neem leaf powder was applied at 4g/plant followed by aak leaf powder 4g/plant and

water hyacinth leaf powder at 4g/plant as compared to untreated check.

Table 1. Effect of botanicals as soil amendment on plant growth characters of Maize

Treatments	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)
T_1 Neem leaf powder 1g/plant	20.35	46.05	11.88	14.83
T_2 Neem leaf powder 2g/plant	23.30	50.38	13.37	18.78
T_3 Neem leaf powder 4g/plant	26.58	57.75	14.75	20.18
T_4 Aak leaf powder 1g/plant	19.85	43.48	10.38	13.58
T_5 Aak leaf powder 2g/plant	21.90	48.83	12.93	18.58
T_6 Aak leaf powder 4g/plant	25.30	55.85	14.23	19.67
T_7 Water Hyacinth leaf powder 1g/plant	19.15	41.55	9.48	12.68
T_8 Water Hyacinth leaf powder 2g/plant	20.58	47.63	12.75	17.55
T_9 Water Hyacinth leaf powder 4g/plant	24.20	53.28	13.86	19.20
T_{10} Phorate 2 kg/ha	27.65	59.00	15.14	20.51
T_{11} Untreated check	18.15	40.63	8.23	11.28
SEm±	**0.624**	**0.820**	**0.386**	**0.628**
CD at 5%	**1.796**	**2.358**	**1.110**	**1.807**

Initial nematode population: 550 larvae/100 cc soil **Data are the average of four replications**

Neem, aak and water hyacinth leaf powder at 4g/plant increased shoot weight to the tune of 46.45%, 39.39% and 33.33%, respectively. Similar trend was noticed with regards to shoot length, root weight and root length. The findings of present investigation are in accordance with the results of previous workers (Reddy *et al*., 1993; Bhargava *et al*., 2005; Saravanapriya and Sivakumar, 2005) who reported the efficacy of plant products against nematodes. Reddy *et al.* (1993) observed that neem leaves increased shoot length and weight when applied at 100 g/2 kg soil against *M. incognita* on papaya. Similarly, Bhargava *et al.* (2005) found improved plant growth when water hyacinth was applied at 25q/ha against root-knot (*M. incognita*) and reniform nematode (*R. reniformis*) infecting tomato. Seed treatment with the dry leaf powder of *C. procera* resulted in the highest seed germination and seedling establishment

against root-knot nematode, *M. incognita* on tomato as reported by Saravanapriya and Sivakumar (2005).

Table 2. Effect of botanicals as soil amendment against maize cyst nematode, *Heterodera zeae* on maize.

Treatments	**No. of Cyst / plant**	**No. of Cyst / 100 cc soil**	**No. of Eggs & larvae/ cyst**	**No. of larvae / 100 cc soil**
T_1 Neem leaf powder 1g/plant	18.25	17.00	98.25	460.00
T_2 Neem leaf powder 2g/plant	15.50	14.50	84.50	400.00
T_3 Neem leaf powder 4g/plant	12.50	11.75	72.25	340.00
T_4 Aak leaf powder 1g/plant	18.75	17.50	107.75	480.00
T_5 Aak leaf powder 2g/plant	16.00	15.25	86.75	430.00
T_6 Aak leaf powder 4g/plant	14.00	12.75	75.00	360.00
T_7 Water Hyacinth leaf powder 1g/plant	19.00	18.50	111.75	500.00
T_8 Water Hyacinth leaf powder 2g/plant	16.75	16.25	91.75	450.00
T_9 Water Hyacinth leaf powder 4g/plant	14.75	13.25	77.75	390.00
T_{10} Phorate 2 kg/ha	11.00	10.50	70.25	330.00
T_{11} Untreated check	20.50	20.00	131.00	510.00
SEm±	**0.844**	**0.777**	**3.913**	**11.481**
CD at 5%	**2.428**	**2.236**	**11.258**	**33.034**

Initial nematode population: 550 larvae/100 cc soil **Data are the average of four replications**

These findings support that soil application with plant products enhanced plant growth in nematode prone areas. This might be due to the fact that soil application with plant products improved physical condition of the soil, reduced the population of plant parasitic nematodes and enhanced the activity of beneficial soil microbes.

Nematode reproduction parameters were also recorded to discuss and interpret the experimental findings. Data pertaining to cyst per plant revealed that among plant products tested, minimum cyst per plant was obtained with neem leaf powder at 4g/plant followed by aak leaf powder and water hyacinth leaf powder at 4g/plant. These treatments significantly decreased cyst per plant as compared to untreated check. Maximum reduction in cyst per plant was observed with neem leaf powder at 4g/plant followed by aak

leaf powder and water hyacinth leaf powder at 4g/plant. Minimum reduction was observed with water hyacinth leaf powder at 1g/plant over untreated check. Similar trend was noticed with regard to cyst per 100 cc soil, eggs and larvae per cyst and larvae per 100 cc soil. The results of present investigation are in accordance with the findings of Ajith and Sheela (1996) who reported that application of chopped green leaf of neem effectively reduced plant parasitic nematodes on okra and cowpea. Similarly, Devi and Das (1998) reported the efficacy of neem cake sawdust, poultry manure and water hyacinth against root-knot nematode, *M. incognita* on carrot. Bhardwaj and Trivedi (1999) observed that *Azadirachta indica* significantly controlled *Heterodera cajani* on cowpea. Umamaheswari and Babu (2001) reported the efficacy of *C. procera* leaf powder 10% w/w as seed treatment against root-knot and reniform nematode on cowpea. Chimbekujwo and Bukar (2013) observed that application of *A. indica* leaf powder gave the highest reduction in *M. incognita* population on cowpea.

The suppression of nematodes with soil amendment with plant products may be due to the effect of several combined factors. Production of volatile fatty acids, phenols, ammonia, amino acids, HCN etc. during decomposition of plant products may cause inhibitory effect on the nematodes. Either the decomposed product or the microbial metabolite derived during decomposition may be toxic to nematodes or enhance activity of predators and parasites which feed on the nematodes.

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