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Effect of natural inputs against root-knot nematode (M. incognita) on potato in pot conditions

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ABSTRACT: Studies pertaining to root-knot nematode, Meloidogyne incognita on potato with respect to test the effect of natural inputs against root-knot nematode (M. incognita) on potato in pot conditions were carried out at the Department of Nematology, B. A. College of Agriculture, Anand Agricultural University, Anand Gujarat during the year 2022-23. The pot experiment tested the effect of different natural inputs viz., Neemastra, Agniastraand Brahmastra against root-knot nematode (M. incognita) on potato variety Lady Rosetta. The application of natural inputs significantly enhanced plant growth and reduced the root-knot index. The treatment T_6 (Agniastra @ 800 ml/10 l water) was the best treatment based on the result obtained on plant growth characters and root-knot index compared to the other treatments.

KEYWORDS: Potato, Root-knot nematode, Meloidogyne incognita, Neemastra, Agniastra Brahmastra

I. INTRODUCTION

Potato is one of the most important staple food crops. The mineral content of potatoes is 3.70 times more than wheat and 11 times more than rice. Potato produces more carbohydrates, starch, fibers, amino acid and vitamins per unit area and time than the other major food crops. Potato is a low-energy food that provides 138 Kcal/200g of boiled potato (Shekhawat and Dahiya, 2000). It is rich in potassium and phosphorus. Tubers contain at least twelve essential vitamins and are a good source of vitamin ‘C’ having about 14-25 mg/10 g of fresh weight of tuber (Thornton, 1980).

Potato is used for a wide variety of purposes viz., table purposes, processed, livestock feed and industrial purposes and is eaten as vegetables or snacks. It is one of the most essential and popular vegetables throughout the year in all parts of India because it can be stored longer. Potato is processed for human consumption into various dehydrated products viz., papad, biscuits, flour, diced, shreds, etc., and fried products like chips, French fries, etc. In addition to carbohydrates, it also contains high-quality protein, a variety of minerals, rich vitamins and trace elements. Potato has very low fat, low heat and high dietary fiber, and the fat content is only 0.1% ~ 1.1%. Potato is known as the "perfect food" and "underground apple" (Dongyu, 2022). In India, potato is cultivated in almost all the states under diverse agro-climatic conditions. Nearly 82 per cent of the potatoes are grown in the plains during short winter days, about ten per cent in hills under long-day conditions during Summer and the rest eight per cent in the South Eastern and Peninsular regions. In Gujarat, the area under potato crop during 2020-21 was 1,25,000 hectares with an annual production of 39,13,000 lakh MT and productivity of 87 MT/ha (Anonymous, 2021).

Root-knot nematodes (Genus: Meloidogyne, Greek word means melon, apple or gourd-shaped female) are sedentary endoparasites of diverse crops. Root-knot nematodes (Meloidogyne spp.) are one of agriculture's most important polyphagous pests. Among the top five plant pathogens affecting the world's food production, root-knot nematodes are one of the most devastating pathogens of crops. Infestation on crops significantly impacts their health, yield and quality. They are adapted to parasitize many plants, and over 3000 wild and cultivated plant species are reported to be affected (Hussey and Janssen, 2002). They are distributed worldwide over a wide range of geographical conditions in tropical, sub-tropical and temperate regions. Several weed species (226 species belonging to 43 families) are known to act as hosts of root-knot nematodes worldwide (Rich et al., 2008). They feed on plants through typical modification of host cells known as 'giant transfer cells' and establish a parasitic relationship for their development and reproduction. Vegetables are the most preferred hosts for infestation by root-knot nematodes.

The effect of nematode infection on plant root induces typical symptoms, popularly known as ‘root-knot’ or ‘root gall’ of varying sizes depending on the species of root-knot nematode and the host.

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The characteristic symptoms produced on the host give it the identity of the nematode as a 'root-knot nematode'. The severity of gall or knot on the root systems can be easily determined by pulling a plant or digging around the root. The above-ground effects of root parasitization, though non-specific, can be recognized as lack of vigour, stunted growth, yellowing of leaves and wilting under water stress conditions (Brodie et al.,1993).

Although many species of Meloidogyne are known to infect potatoes, only six are considered to be of global importance Meloidogyne chitwoodi, M. fallax, M. hapla, M. arenaria, M. incognita and, M. javanica (Netscher, 1970; Jatala and Bridge, 1990 and Molendijk and Mulder, 1996). The first three of those six species are found in cool temperate regions, whereas the others are more important in the world's warm, tropical, and sub-tropical regions.

Infection of potato tubers by Meloidogyne spp. has been reported previously in Argentina (Chaves and Torres, 2001), Brazil (Charchar, 1997), Florida (Chitwood, 1949), Japan (Nakasono et al., 1990), Libya (Dabaj and khan, 1981), Rhodesia now Zimbabwe (Mitchell et al., 1971), Saudi Arabia (Al-Hazmi et al., 1993) and Turkey (Cinarli and Eterkin, 1996).

II. REVIEW OF LITERATURE

Maru et al. (2021) conducted an experiment for the management of root-knot nematodes, Meloidogyne spp. by using three different organic inputs viz., Neemastra, Agniastra and Brahmastra in tomato. All three organic inputs were prepared by using indigenous cow urine and dung. A total of three different concentrations of each organic input were used and applied 500 ml water solution as drenching per plant near the root zone area at the time of transplanting and repeated 15, 30 and 45 days after transplanting. They found that Agniastra @ 800 ml/10 l water followed by Neemastra@ 400 l/acre and Brahmastra @ 800 ml/10 l water were effective to minimize the root-knot index (RKI) as compared with all other treatments. These organic inputs were found effective to manage root-knot nematodes and reduce RKI significantly.

Gupta et al. (2020) conducted an experiment on eco-friendly management of root-knot nematode, M. incognita (Kofoid & White) Chitwood using seed kernel extracts, cow urine and Agniastra. In which two indigenous plants aqueous seed kernel extracts viz., neem seed kernel (NSK) and dharek seed kernel (DSK), cow urine and Agniastra were evaluated for their effect on juvenile mortality and egg hatching inhibition of root-knot nematode, M. incognita. Cow urine (93.76%) @ 10% concentration was most effective for the juvenile mortality of M. incognita followed by Agniastra (91.81%) at 2% concentration. Cow urine (75.00%) was found to be most effective followed by Agniastra at 2% and NSKE (66.67%) at 10% concentration for the egg-hatching inhibition of M. incognita. Whereas, aqueous DSKE at 2% concentration was found least effective for juvenile mortality as well as egg-hatching inhibition of M. incognita.

Jyrwa et al. (2014) checked the efficacy of cytotoxicity and genotoxicity effects of a neem-based pesticide, Neemastraon meristemic cells of Allium cepa in which they studied the cytotoxic and genotoxic effects of neem-based pesticide Neemastra (90 % neem oil extract and 10 % other inert compounds) was studied using Allium cepa test model. Based on the EC50 curve, different concentrations of Neemastra were taken for conducting the experiment. It was found that the biopesticide inhibits the growth of the root length of the onion roots and it is concentration as well as time-dependent. Cytological assays were done on the root tips and showed a decrease in the mitotic index with an increase in the interphase stage of the cells along with increased abnormalities. Bridges and fragments were numerous indicating clastogenic effects and laggard chromosomes indicated spindle poisoning.

III. MATERIALS AND METHODS

Treatment details

T_1 = Neemastra @ 200 l/acre (10 ml mixed with water and made 200 ml solution).
T_2 = Neemastra @ 300 l/acre (15 ml mixed with water and made 200 ml solution).
T_3 = Neemastra @ 400 l/acre (20 ml mixed with water and made 200 ml solution).
T_4 = Agniastra @ 400 ml/10 l water
T_5 = Agniastra @ 600 ml/10 l water
T_6 = Agniastra @ 800 ml/10 l water
T_7 = Brahmastra @ 400 ml/10 l water
T_8 = Brahmastra @ 600 ml/10 l water
T_9 = Brahmastra @ 800 ml/10 l water
T_{10} = Untreated check

- Drenching was applied @ 200 ml solution at 0, 15, 30 & 45 days after planting per plant near the root zone.

Table 1: Procedure for preparation, compositions and application of organic inputs

OrganicInputs	Ingredients	Required Quantity	Recipe and application procedure
Neemastra	Cow urine	5 L	Paste of neem leaves added with water then mixed with cow dung and urine as per required quantity in the container. After 24 hrs fermentation, Stirred this solution clockwise daily 2-2 minutes during morning and in evening by wooden stick. Filtered this by cloth and then used it for the present investigation. The solution is directly applied to plants without any further dilution and it was usable up to 6 months. Dose: 200 l/acre for sucking insect pest
	Cow dung	1 kg	
	Paste of neemleaves	5 kg	
	Water	100 L	
Agniastra	Cow urine	20 l	All the ingredients mix together and boil it 4-5 times continuously at medium flame. After 24 hrs fermentation, filtered this by cloth and then used it for present investigation. This were usable for three months. Dose: 400 ml/10 l of water for spaying against stem borer insect pest.
	Neem leavepaste	5 kg	
	Garlic paste	0.5 kg	
	Green Chillies	0.5 kg	
	Tobacco dust	0.5 kg	
Brahmastra	Cow urine	10 l	All the ingredients mix together and boil it 4-5 times at medium flame and were cooled down for about 24 hours. The solution was stirred clockwise daily 2-2 minutes during morning and in evening and fermented for about 48 hours. The solution filtered this was used up to six months. Dose: 400 ml/10 l of water for spaying against all types of insect pest.
	Neem leave paste	3 kg	
	Karanj leave paste	2 kg	
	Dhatura leave paste	2 kg	
	Custard apple leave paste	2 kg	
	Papaya leave paste	2 kg	
Note: • The cow urine and cow dung were collected from fresh and taken from the indigenous cow breed. • The container was placed under a shaded area and covered by gunny bags.			

(Source: Devvrat, 2020)

Methodology

Earthen pots of 36 cm diameter werewashed with tap water and disinfected with a 4% formaldehyde (Formalin 40 EC) solution. After drying, pots werefilled with sterile and inoculated 5000 J_2/plant/pot. One tuber of potato variety Lady Rosetta was planted in each pot, and applied natural inputs (Neemastra, Agniastra, Brahmastra) at the time of planting, 15, 30 & 45 days after planting. Pots without any natural inputs application were treated as control. The experiments were carefully harvested at 60 days after planting and roots were washed with water to make them free from soil. Observations were recorded and data wereanalyzed.

Observations recorded

1. Plant height (cm)
2. Fresh shoot and root weight (g)
3. Root-knot index (0-5 scale)

Table 2: Observations on the root-knot index was recorded 0-5 scale (Taylor and Sasser, 1978) as under

0	(No galls/root system)
1	(1-2 galls/root system)
2	(3-10 galls/root system)
3	(11-30 galls/root system)
4	(31-100 galls/root system)
5	(>100 galls/root system)

Finally, the root-knot index was worked out and the varietal reaction was determined based on the maximum value as mentioned under:

Highly Resistant	(0 -1.0 RKI)
Resistant	(1.1-2.0 RKI)
Moderately Resistant	(2.1-3.0 RKI)
Susceptible	(3.1-4.0 RKI)
Highly Susceptible	(4.1-5.0 RKI)

IV. RESULT

Plant height

The data presented in Table 3 indicated that the maximum 50.67 cm plant height was observed in T_6 (Agniastra @ 800 ml/10 l water) and it was statistically at par with 47.00 cm in T_3 (Neemastra @ 400 l /acre). The treatment T_3 was statistically at per with 46.67 and 45.00 cm with T_5 (Agniastra @ 600 ml/10 l water), T_4 (Agniastra @ 400 ml/10 l water) and T_9 (Brahmastra @ 800 ml/10 l water), respectively. The minimum 32.00 cm plant height was found in T_{10} (untreated check) and it was significantly lover with the rest of the treatments (Plate 1).

Fresh shoot weight

The outcome of the experimental result shows that the maximum fresh shoot weight of 146.05 g was observed in the treatment T_6 (Agniastra @ 800 ml/10 l water) and it was statistically at par with 141.80 and 139.58 g in T_5 (Agniastra @ 600 ml/10 l water) and in T_4 (Agniastra @ 400 ml/10 l water), respectively. However, treatment T_4 was statistically at par with the treatments T3 (Neemastra @ 400 l /acre), T2 (Neemastra @ 300 l /acre), T_1 (Neemastra @ 200 l /acre) and T_9 (Brahmastra @ 800 ml/10 l water). The minimum fresh shoot weight was 120.38 recorded in treatment T_{10} (untreated check) and it was significantly lower as compared with the other treatment (Table 3, Plate 1).

Fresh root weight

The result demonstrated in Table 3 indicated that the maximum of 25.23 g fresh root weight was found with T_6 (Agniastra @ 800 ml/10 l water) followed by 22.67 and 21.20 g with T_5 (Agniastra @ 600 ml/10 l water) and T_3 (Neemastra @ 400 l /acre), respectively as compared with rest of the treatments. The minimum fresh root weight (10.13 g) was recorded in T_{10} and it was significantly lover to all other treatments (Plate 2).

Root-knot index (RKI)

A perusal of data given in Table 4shows that the minimum (2.00) RKI was found in T_6 (Agniastra @ 800 ml/10 l water) and it was statistically at par with T_5 (Agniastra @ 600 ml/10 l water), T_3 (Neemastra @ 400 l /acre), T_4 (Agniastra @ 400 ml/10 l water), T_2 (Neemastra @ 300 l /acre), and T_1 (Neemastra @ 200 l /acre) as compared with untreated check (T_{10}) (Plate 2).

The treatment T_6 (Agniastra @ 800 ml/10 l water) was observed as the overall best treatment based on the result obtained on plant growth characters and root-knot index compared to the other treatments.

Use of Neemastra, Agniastra and Brahmastra were applied as drenching with different doses against root-knot nematodes in potato, the result indicated that these organic inputs were found effective to enhance the plant growth characters and reduced RKI significantly. During the preparation of all three natural inputs,Neemastra, Agniastra and Brahmastra, we were allowed to ferment properly therefore, we kept the container in the shaded area and also covered it by gunny bags. The main components, cow urine and cow dung were common in all natural inputs, that enhancing the fermentation process and releasing more amount of ammonia and other gases. That may affect root-knot nematodes and reduce RKI over control.

Earlier workers have proved the effectiveness of various plant leaf extracts, organic amendments, cow urine, cow dung, etc., individually against root-knot nematodes but very few of them have worked on Neemastra, Agniastraand Brahmastra against root-knot nematodes in potato.

Table 3: Effect of different natural inputs on plant growth of potato against root-knot nematode

Treatments		Plant height (cm)	Fresh shoot weight (g)	Fresh root weight (g)
T_1	Neemastra @ 200 l /acre	41.67^{cd}	131.45^{cde}	14.67^{f}
T_2	Neemastra @ 300 l /acre	42.67^{cd}	132.56^{cde}	16.27^{e}
T_3	Neemastra @ 400 l /acre	47.00^{ab}	$137.36b^{cd}$	21.20^{c}
T_4	Agniastra @ 400 ml/10 l water	45.00^{bc}	139.58^{abc}	15.07^{ef}
T_5	Agniastra @ 600 ml/10 l water	46.67^{b}	141.80^{ab}	22.67^{b}
T_6	Agniastra @ 800 ml/10 l water	50.67^{a}	146.05^{a}	25.23^{a}
T_7	Brahmastra @ 400 ml/10 l water	38.00^{c}	128.41^{e}	12.07^{g}
T_8	Brahmastra @ 600 ml/10 l water	40.33^{de}	131.03^{de}	14.57^{f}
T_9	Brahmastra @ 800 ml/10 l water	45.00^{bc}	133.27^{cde}	18.83^{d}
T_{10}	Untreated check	32.00^{f}	120.38^{f}	10.13^{h}

S. Em. ±	1.150	2.506	0.410
CD at 0.05%	3.392	7.393	1.210
C.V.%	4.64	3.23	4.16

Figures indicating common letters do not differ significantly from each other at 5% level of significance according to DNMRT.

Table 4: Effect of different natural inputs on root-knot index of roots of potato

Treatments		Range	RKI (0-5)* √x+1
T_1	Neemastra @ 200 l /acre	3-4	2.08[abcd] (3.33)
T_2	Neemastra @ 300 l /acre	3	2.00[bcd] (3.00)
T_3	Neemastra @ 400 l /acre	2-4	1.90[cd] (2.67)
T_4	Agniastra @ 400 ml/10 l water	3-4	2.09[abcd] (3.33)
T_5	Agniastra @ 600 ml/10 l water	2-4	1.90[cd] (2.67)
T_6	Agniastra @ 800 ml/10 l water	1-3	1.72[d] (2.00)
T_7	Brahmastra @ 400 ml/10 l water	4-5	2.31[ab] (4.33)
T_8	Brahmastra @ 600 ml/10 l water	3-5	2.29[abc] (4.33)
T_9	Brahmastra @ 800 ml/10 l water	2-5	2.23[abc] (4.00)
T_{10}	Untreated check	5	2.45[a] (5.00)
S. Em. ±			0.119
CD at 0.05%			0.351
C.V.%			9.84

*0 = Free; 5 = Maximum RKI.

Figures in parentheses are transformed values of √x+1 transformation.

Figures indicating common letters do not differ significantly from each other at 5% level of significance according to DNMRT.

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T_1 T_2 T_3

T_4 T_5 T_6

T_7 T_8 T_9 T_{10}

Plate 1: Effect of different natural inputs against root-knot nematode (M.incognita)on plant growth of potato.

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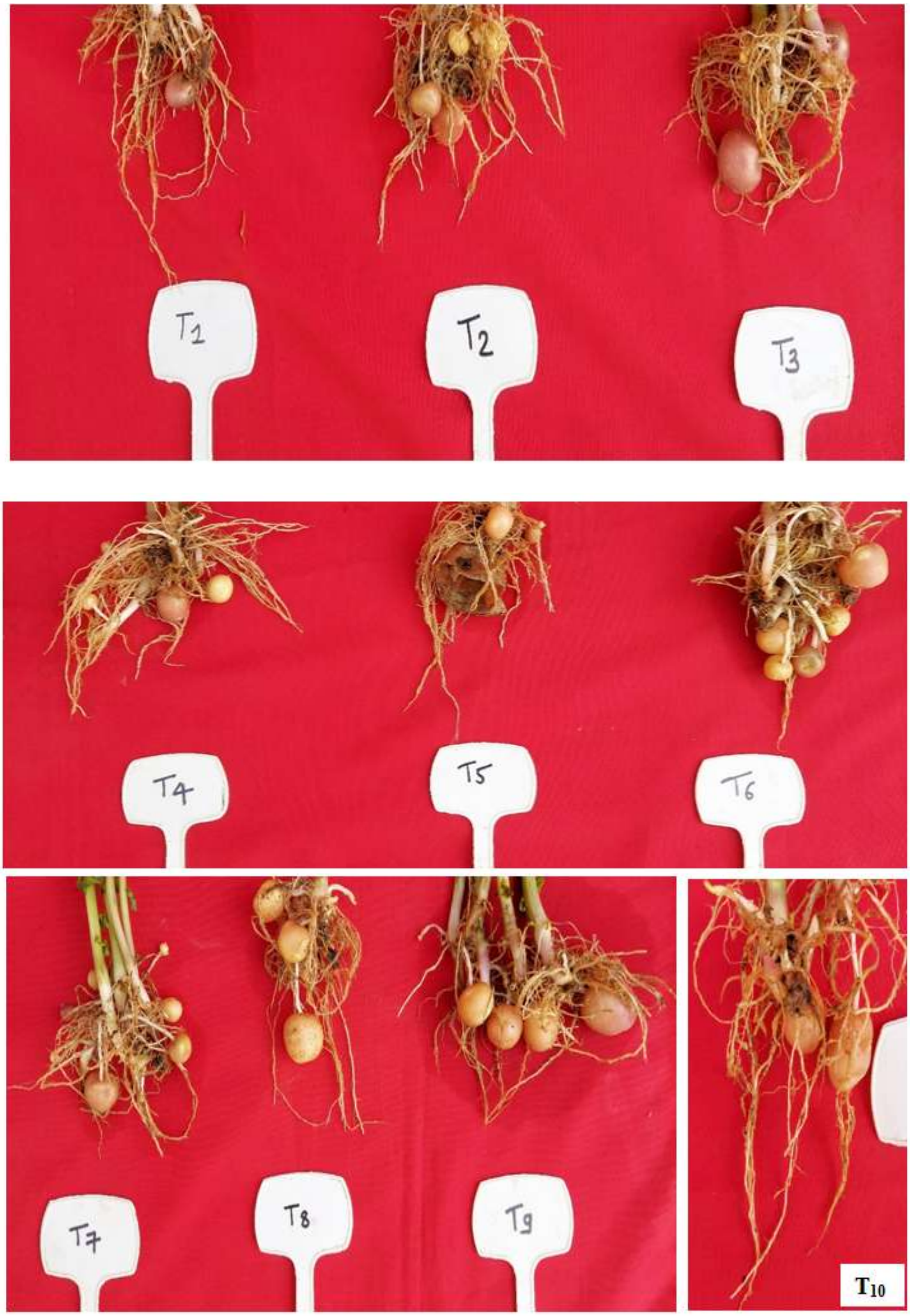

Plate 2: Effect of different natural inputs against root-knot nematode (M.incognita)on root-knot index

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