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EFFECT OF FERTILIZER FACTORY WASTES ON SEED GERMINATION, PLANT GROWTH AND ROOT-KNOT DISEASE DEVELOPMENT IN TOMATO (*Lycopersicon lycopersicum* L.) PLANTS

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ABSTRACT

Screening of five cultivars of tomato (*Lycopersicon lycopersicum* L.) was made to determine the efficacy of fertilizer factory wastes on seed germination, plant length and against the root-knot causing pathogen *Meloidogyne incognita*, by using dual culture technique *in vitro* and percent seed germination of tomato cultivars *in vivo*. Results indicated that all the cultivars of *L. lycopersicum* significantly inhibited the growth of the test pathogen and increased the percent seed germination and length of tomato plants at the treatment of 5% concentration of fertilizer factory wastes. Among all the cultivars, cv PED was found to be most potential cultivar against *M. incognita* as it showed increased plant growth and highest percent germination of seeds of tomato. Whereas among all the treatments of fertilizer factory wastes, 5% concentration was found quite effective on all the growth parameters of plant and against root-knot nematode infestation.

Key word: Fertilizer waste, seed germination, plant growth, root-knot index, tomato.

INTRODUCTION

Tomato (*Lycopersicon lycopersicum*) is one of the most important vegetable crops grown throughout the world. This crop suffers severe yield reduction by root-knot nematode, *M. incognita* (Seshadri and DasGupta, 1980). Studies conducted by Dixit (2004) revealed that this crop is highly affected by root-knot infestation caused *M. incognita.* In the past, efforts were also made to manage root-knot nematode by only the use of chemicals (Weischer, 1994). However, recently use of chemicals was replaced by other environment friendly means to enhance the yield by increase in percent seed germination and growth of plants in different crops (Somashekar *et al.*, 1984; Sahai, 1988; Sahai and Srivastava, 1988; Chakravarty and Srivastava, 1992; Bhadra and Mahananda, 2013). Among the biocontrol agents, plant growth promoting industrial effluents and wastes have got much attention recently (Pandey and Nautiyal, 2008; Faizan and Kausar, 2010; Kumar and Maheshwari, 2010). Significantly potential treatments of industrial effluents were isolated, experimented and tested in laboratory and green house conditions for their bio-efficacy for seed germination, seedling growth and against root-knot nematode pathogen (Dixit, 2004).

However, degree of their efficacy varied greatly. Fertilizer factory liquid waste is known to contain various organic and inorganic chemicals which may affects seed germination, growth of seedlings and development of root-knot galls in tomato plants. This emphasizes the need to identify specific concentration of fertilizer waste having broad-spectrum activity against root-knot nematode and on the other hand positive correlation with growth parameters of tomato plants. In this context, five tomato cultivars of tomato were evaluated to identify the most potential treatment among different concentrations of fertilizer factory effluent on seed germination, plant growth and against root-knot disease causing pathogen, *M. incognita.*

MATERIALS AND METHODS

The causal pathogen of root-knot disease of tomato was isolated from the roots of diseased plants. Pure culture of *M. incognita* was maintained by inoculating freshly hatched larvae from a single egg mass collected from heavily infested roots near the root-zone of 6-8 weeks old tomato seedlings grown in clay pots, filled with autoclaved mixture of soil, sand and compost in 1:1:1 ratio.

The material for this investigation was freshly collected from Kribhco Shyam Fertilizer Factory, Shahjahanpur, India, in the purely sterilized glass containers and was chemically analyzed for its physico-chemical parameters.

Before the initiation of experiment, different concentrations in 1%, 2%, 5%, 10%, 25%, 50% and 100% were made from fertilizer factory effluent in separate conical flasks.

The seeds of five cultivars of tomato *viz,* Pusa Early Dwarf (PED), Pusa Ruby (PR), Rupal I, Padamshri and Malintka were pre-soaked in freshly prepared different concentrations of fertilizer factory effluent for 24 hours and then used for germination. For each cultivar, three replicates of 25 seeds were maintained in Petri dishes in an identical manner. The percentage germination was recorded on the 7th day of experiment (Table 2, Fig. 1).

For determining the impressive effect of various concentrations of fertilizer factory wastes on plant growth and suppressive impact on root-knot galls formation in tomato plants, experiment was carried out in 30cm clay pots filled with autoclaved sandy loam soil and farmyard manure (4:1) mixture. 15 days old seedlings of test plants were uprooted from test plant nursery and were placed in effluent containing conical flasks for root-dip treatment of 24 hours duration. Dipped plants were transferred to clay pots and inoculated with ±1000 J_2 / pot of *M. incognita*, after 24 hours

of their transplantation. All the treatments of fertilizer effluent were replicated 3 times and 3 pots of each inoculated by the pathogen. Two sets of control were kept i.e. one without nematode population and one with nematode but without the treatment of fertilizer effluent to compare the experimental results. On the day of termination of the experiment (i.e. 60th day), lengths of root and shoot were measured separately in centimeters (Table 3, Fig. 2 and Fig. 3). Root-knot index at 0-4 scale was recorded from uprooted plants and observations were tabulated (Zeck, 1971) (Table 4). The data were statistically analyzed by analysis of variance (Cochran and Cox, 1957). Critical differences were determined using the Critical difference (CD) test at probability level of 0.01.

RESULTS AND DISCUSSION

Data presented in Table 1, regarding the physico-chemical parameters of fertilizer factory wastes clearly indicated high values of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Dissolved Solids (TDS), pH (5.3) indicating the acidic nature of it, which suppresses various biological parameters of tomato plants in high concentrations.

Table 1: Physico-chemical parameters of fertilizer factory wastes.

Particular	Result
Color	Greenish
pH	5.3
Dissolved oxygen	2.0 mg/L
BOD	9.1 mg/L
COD	53.0 mg/ L
Total dissolved solids	1818.0 mg/ L
Total suspended solids	33.0 mg/ L
Phosphate as PO_4	1.24 mg/ L
Sulphate as SO_4	563.0 mg/ L
Chloride as Cl	726.0 mg/ L
Nitrate as N	0.96 mg/ L
Total ammonical nitrogen	23.0 mg/ L
Total kjeldahl nitrogen	35.0 mg/ L
Free ammonia	2.0 mg/ L
Oil and grease	NT (Not Traced)

Data presented in Table 2, (Fig.1) regarding the effect of different concentrations of fertilizer factory wastes on percent seed germination of five tomato cultivars separately under petri-dish conditions clearly indicated that increasing concentrations were caused significant decline in percent germination over control. Highest reduction (40%) was observed in cv Padamshri at 100% concentration of fertilizer factory wastes. However at 5% concentration, it showed 81.07% germination. It has been reported that cv PED responded fairly well with 97.9% germination at 5% concentration and 53.9% germination at 100% concentration of fertilizer wastes by producing tolerance to its salt stress and TDS. The maximum reduction in percent seed germination on higher waste treatment was observed in all the tomato cultivars. This was due to high concentration of dissolved and suspended solids in the fertilizer wastes which may disturb the osmotic relations of the seeds and thereby reduced the percent seed germination (Hadas, 1976). The results of the present studies are quite similar to the findings of other workers on different industrial effluents and wastes (Swaminathan and Vaidheeswaran, 1991; Singh, 2001; Srivastava 2001).

Table 2. Effect of fertilizer wastes on seed germination (%) of 5 tomato cultivars. (Values are mean of three replicates).

Conc. of Waste	Tomato Cultivars				
	PED	PR	Rupal I	Padamshri	Malintka
Control	98.08	87.77	90.06	86	94.4
1%	97	84.6	87.31	80.17	90
2%	95.01	80	88.06	78.02	87.03
5%	97.89	84.09	89.66	81.07	92.01
10%	81.03	75.27	78.77	77.01	80.39
25%	78.04	69.58	70.33	68.5	73.01
50%	67	54.26	55	52.73	57.97
100%	53.91	42	44.01	40	49
CD at 1% P =	1. Cultivars- 2.086				
	2.Treatments - 2.638				
	3. cv x T – 5.900				

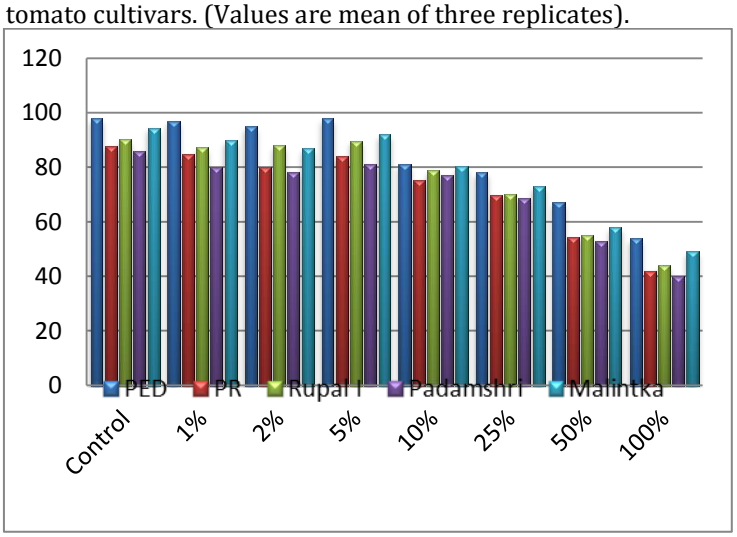

Figure 1: Effect of fertilizer wastes on seed germination (%) of five tomato cultivars.

Data presented in Table 3 regarding the effect of various concentrations of fertilizer waste on the plant growth in five tomato cultivars separately under pot conditions clearly indicates that treatments of lower concentrations significantly increased the length of plants in all the tomato cultivars. Among all the cultivars, cv PED responded fairly well followed by cv Malintka, PR, Rupal I and Padamshri in *M. incognita* inoculated pots respectively. Highest plant growth was found in the pots receiving 5% treatment. Pandey and Nautiyal (2008) also reported that lower concentrations of industrial effluents have the ability to improve the seedling growth. In this study all the cultivars of tomato showed improved plant growth at lower treatments and mid lower concentration (*i.e.* 5%) showed maximum activity, while the treatment of higher concentrations responded negatively in relation to plant growth. This may be due to increase in organic load in

Table 3. Effect of fertilizer waste on plant growth of five tomato cultivars (values are mean of three replicates).

Conc. of Waste	Plant Length/Cultivar									
	Root Length (cm)					Shoot Length (cm)				
	PED	PR	Rupal I	Padamshri	Malintka	PED	PR	Rupal I	Padamshri	Malintka
Control	30.46	26.96	25.71	19.41	28.14	33.39	29.30	27.88	21.03	32.97
1%	30.60	27.10	25.88	19.50	28.30	33.58	29.50	28.05	21.10	33.18
2%	30.88	27.39	26.15	19.65	28.65	33.88	29.79	28.3	21.34	33.56
5%	32.23	28.60	27.39	20.38	30.05	35.18	31.06	29.32	22.03	35.03
10%	32.08	25.76	24.20	18.28	27.01	32.47	28.91	27	20.10	31.88
25%	27.41	22.61	21.63	16.18	25.57	30.05	26.66	24.54	17.23	29.00
50%	24.34	2015	19.39	13.47	23.03	28.03	23.49	22.2	15.10	26.06
100%	21.00	18.03	17.00	11.88	20.03	26.08	21.02	20.00	13.50	24.20

Table 4. Effect of Fertilizer wastes on Root Knot Index (0-4 scale) of five tomato cultivars (values are mean of three replicates).

Conc. of Wastes	Root knot Index/Cultivar				
	PED	PR	Rupal I	Padamshri	Malintka
Control	4.00	4.00	4.00	4.00	4.00
1%	3.50	4.00	4.00	4.00	4.00
2%	3.00	3.50	3.50	3.50	3.00
5%	2.00	2.50	2.50	3.00	2.00
10%	3.00	2.00	3.00	4.00	2.00
25%	4.00	4.00	4.00	4.00	4.00
50%	4.00	4.00	4.00	4.00	4.00
100%	4.00	4.00	4.00	4.00	4.00

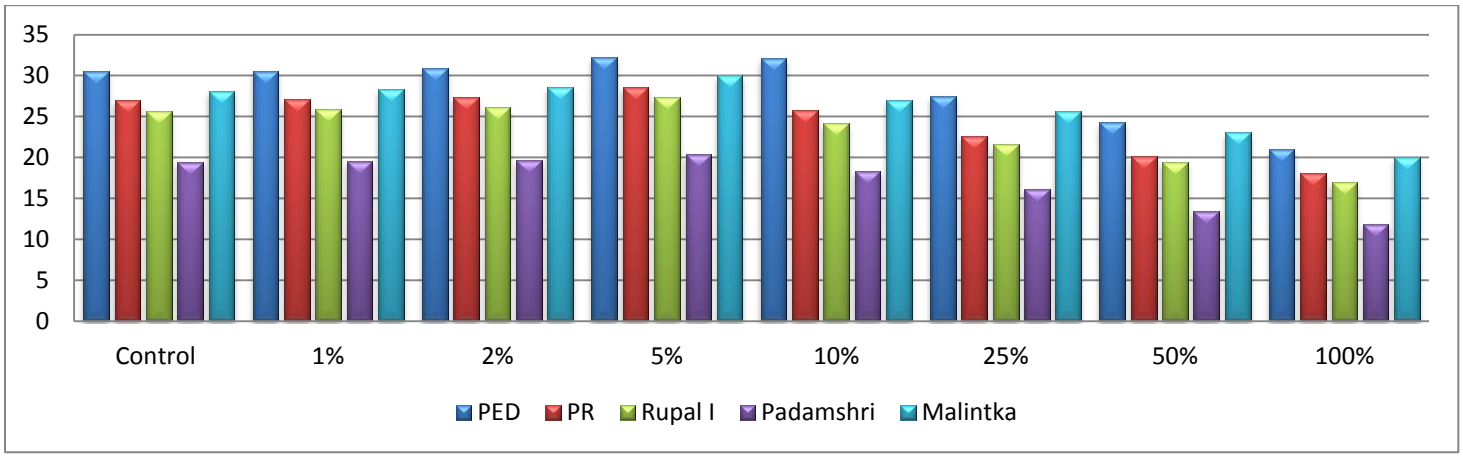

Figure 2: Effect of fertilizer waste on root length (cm) of five tomato cultivars.

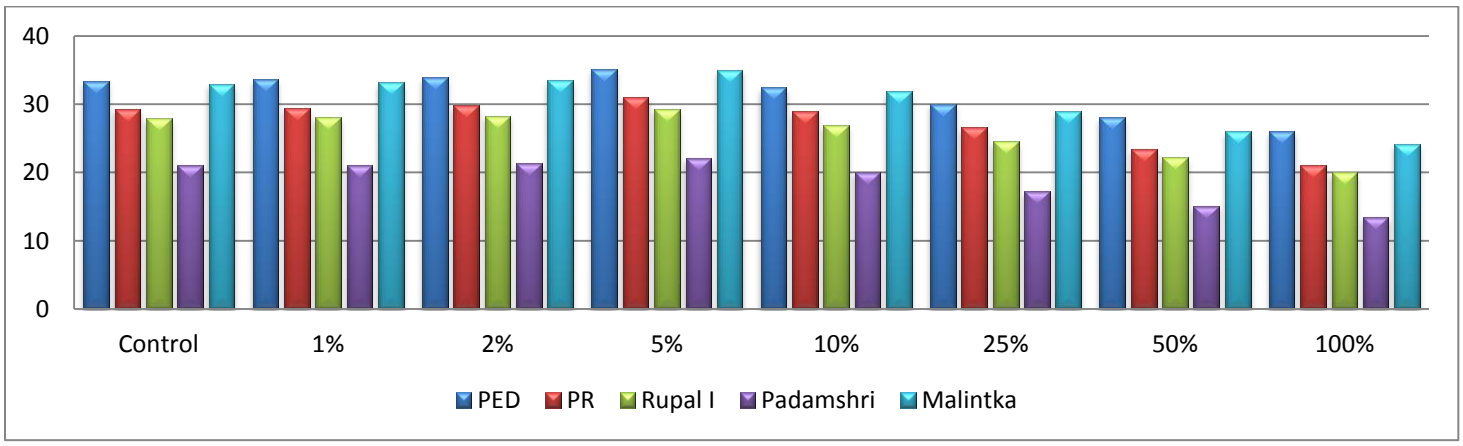

Figure 3: Effect of fertilizer waste on shoot length (cm) of five tomato cultivars.

the fertilizer wastes, which may cause disturbances in the metabolic activities in tomato plants.

Finally, Table 4 shows the effect of fertilizer wastes on root knot index (0-4 scale) in five tomato cultivars under potconditions. Result shows the severity of root-knot infestation, caused by nematode *M. incognita,* in all the five cultivars of tomato studied. Severity was found increasing with the increase in concentrations of fertilizer wastes over the control. However, treatments of lower concentrations of fertilizers effluents were found significantly inhibiting the development of root-knot galls of test pathogen *M. incognita* at varying degree in all the tomato cultivars. Highest reduction (2.00-2.50) in root-knot index was observed at 5% concentration of fertilizer wastes as per the order, PED=Malintka>PR=Rupal I>Padamshri. Reduction in root-knot index by application of low concentrations of fertilizer wastes might have interfered with chemicals affecting the susceptibility of tomato plants towards nematodes. Inhibition in root-knot index at low concentration of wastes resulted in the significant and improved tomato plant growth in all cultivars. Similar results using different organic amendments were found in different crops (Sarangi, 2014; Kaur *et al.*, 2015). It is clear that less organic load from low concentrations of fertilizer wastes may be useful in improving plant tolerance to plant parasitic nematodes in tomato cultivars.

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