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EFFECT OF *FUSARIUM OXYSPORUM* AND *RHIZOCTONIA SOLANI* ON THE DEVELOPMENT OF *MELOIDOGYN* INCOGNITA ON OKRA

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Interaction of *M. incognita* with *Rhizoctonia* and *Fusarium* alone and in combination was studied on *Abelmoschus esculentus.* Combined inoculations with : *M. incognita* + *R. solani* + *Fusarium* were more damaging than inoculations with *M. incognita* + *R. solani* or *M. incognita* + *Fusarium.* In combined inoculations the magnitude of each individual organism was modified. The close proximity of infection court of the nematode and fungi probably enhanced the possibility of exchange of toxic metabolites from one feeding site to the other thus interfering in the establishment of normal host parasite relationship. Multiplication rate of nematode was poor in the presence of fungi because of tissue destruction caused by fungi much before the completion of nematode life cycle. Thus, the concomitant effect of nematode and fungi caused greatst reduction in growth of okra.

Keywords : *Fusarium; Meloidogyne; Rhizoctonia.*

Introduction

Plant parasitic nematode, among the soil-biota, form a separate group constituting a significant component (about 12% of soil microflora and fauna) of the soil ecosystem. They are capable of producing recognizable disease symptoms on suitable susceptible hosts. Most of the diseases caused by nematodes are debilitating. However, in association with other pathogens the disease picture is often drastically altered, where it changes from debilitating to annihilating. In fact under field conditions there is probably no soil borne plant disease which can be said to have monopathogenic origin. Thus most of the soil borne plant diseases are often the result of interaction of two or more pathogens of the same or different groups causing complex diseases.

During the course of survey for nematode parasitiziing various vegetable crops the authors noticed severe root rotting and ultimate death of okra plants over a large area in and around Jaipur. Careful examination of the diseased plants and soil samples revealed the presence of combined infection of root-knot nematode *(Meloidogyne incognita*) and root rot fungi (*Fusarium oxysporum* and *Rhizoctonia solani).* An experiment was laid out to determine the effect of these pathogens singly and in combination on the growth of okra plants.

Individually, *Rhizoctonia solani* was the most aggressive pathogen followed by *Meloidogyne incognita* and *Rotylenchulus reniformis*[1]. While concomitance of nematode and fungus was more damaging to cowpea than the association of both nematode species but the association of *R. solani* with *M. incognita* caused distinctly greater plant growth reduction than its association with *R. reniformis.* Occurrence of *M. incognita* in combinatin with *F. oxysporum f sp. ciceri* and *F. solani,* not only increased the severity of disease but also shortened the incubation period for disease expression in chickpea[2].

Papaya was adversely affected by combined inoculation of *Meloidogyne incognita* and *Fusarium solani*[3]. The damage owing to *Rhizoctonia solani* and root-knot nematode *Meloidogyne incognita,* was maximum when the plants were inoculated with the nematode and the fungus simultaneously[4].

The interaction effect of *Fusarium oxysporum* and *Rhizoctonia solani* with *Meloidogyne incognita* on tomato revealed that the crop becomes more susceptible to these pathogens when they attack simultaneously or by one pathogen immediately after other pathogen. In such cases one pathogen interact with other and the crop is badly affected[5,6].

Materials and Methods

Surface sterilized seeds of okra CV Pusa sawani were sown in 15 cm earthen pots containing autoclaved soil. After emergence, the seedlings were thinned to one seedling per pot. Three week old seedlings were inoculated with *Meloidogyne incognita* (1000 juveniles), *Fusarium oxysporum* (1 gm fungal mat) and *Rhizoctonia solani* (1 gm fungal mat) individually and concomitantly. Both the fungus were purely cultured on Potato Dextrose Agar (PDA) liquid medium for 15 days at room temperature.

Inoculation was accomplished by adding nematodes and/ or fungus mycelium uniformly over the surface of exposed roots prior to covering with soil.

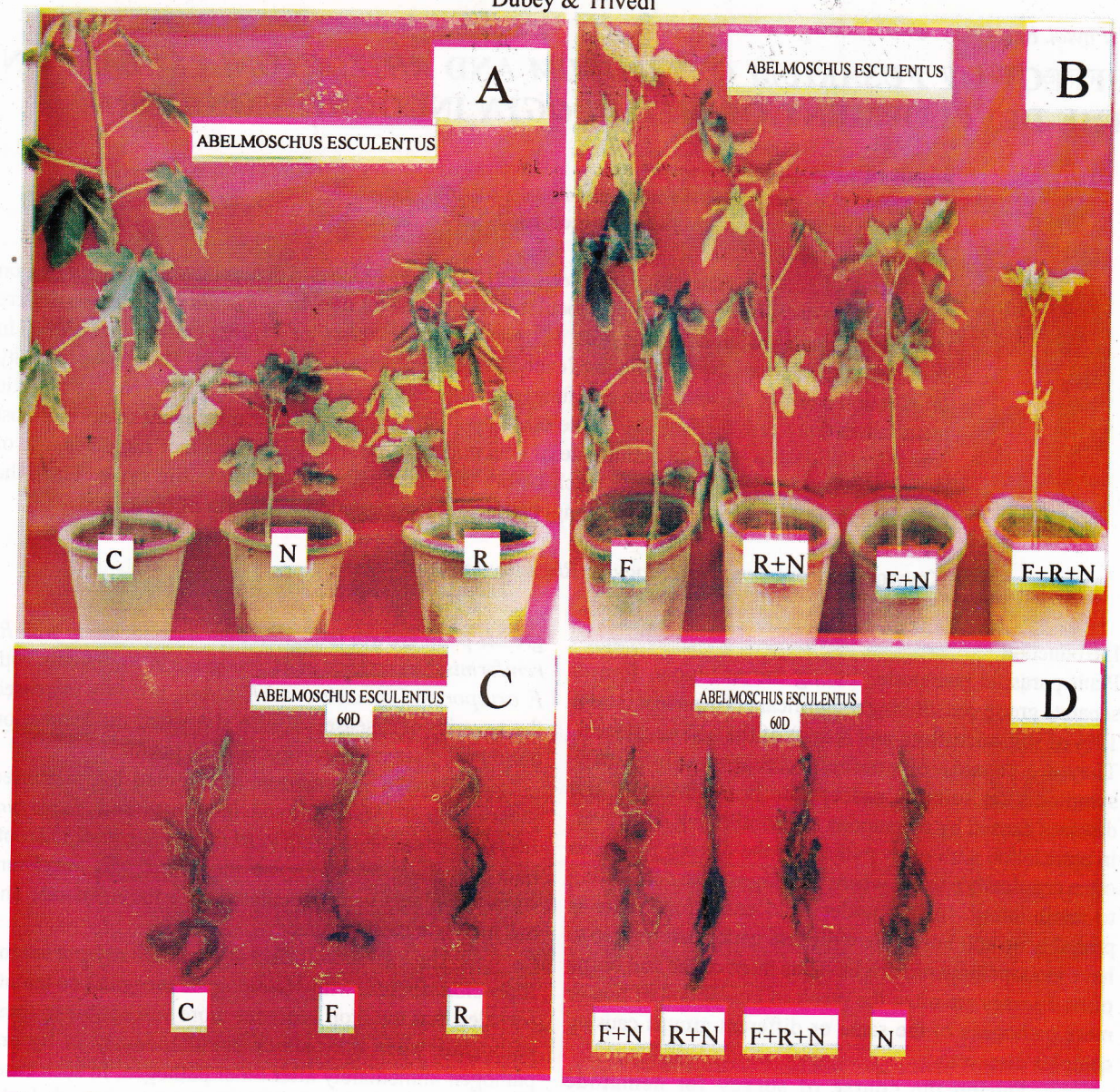

Fig.1. Effect of *Meloidogyne incognita, Rhizoctonia solani* and *Fusarium oxysporum* alone and in combination on okra.

Uninoculated plants served as controls. In all there were seven treatments and each treatmet was replicated four times and pots were arranged randomly.

Observations were taken 60 days after inoculation. The effect of treatment on vegetative growth of plants was recorded in terms of fruit weight, fresh weight, dry weight and length of shoot and root. The roots were stained with 0.1 per cent acid fuchsin in lactophenol at 80°C for two minutes and kept in clear lactophenol for destaining the root tissue. Roots were examined under stereoscopic binocular microscope for counting the number of egg masses per plant plant and number of eggs per egg mass. Number of galls per plant were also counted. Root-knot index was calculated based on Taylor and Sasser's rating scale from 0-5.

The final soil population per kg soil was estimated per treatment at harvest by using Cobb's sieving and decantation technique followed by Baermann's funnel assembly for 24 hours. Rate of population increased (R.P.I.) of the nematodes was calculated by the formula (Pf-Pi/Pi) where Pi= initial population and Pf= final population of nematode.

The significance of differences between nematode densities or between length and weight of host and number of galls and other quantitative data were calculated from original figures by analysis of variance. Critical difference (CD) at 5% and 1% level of significance were calculated for significant comparison.

Results and Discussion

A series of characteristic symptoms like stunting of plant, yellowing of the leaves and wilting have been produced in

Table 1. Effect of pathogens singly and in combination on growth of okra (observations are mean of 4 replicates).

S. No.	Treatment	Length (cm)		Fresh wt. (g)		Dry wt. (g)		Fruit wt. (g)	No. of galls per plant	No. of egg masses per plant	No. of eggs per egg mass	R.K.I.	Final nema. popu.	Rate of popu. increase (R.P.I.)
		Shoot	Root	Shoot	Root	Shoot	Root							
1.	C	63.0	60.3	45.8	21.0	4.5	2.10	15.0	0	0	0		(1)	0
2.	N	22.5	46.0	34.6	13.4	3.3	1.30	4.5	210.4	38.5	285	5.0	6408	5.40
													(80.0)	
3.	R	34.8	45.4	35.0	13.8	3.5	1.40	6.0	0	0	0	0	0	0
4.	F	43.6	49.6	35.2	14.0	3.4	1.35	6.5	0	0	0	0	0	0
													(1)	
5.	R+N	35.0	47.2	33.8	12.2	3.0	1.26	4.0	138.7	32.4	252.0	5.0	4852.6	3.85
6.	F+N	32.3	45.5	33.1	11.8	2.9	1.20	3.8	131.2	28.0	260.2	5.0	(69.6)	3.80
7.	F+R+N	27.0	45.0	32.2	11.0	2.7	0.90	3.0	72.0	24.3	240.8	4.5	4009.5	3.0
													(63.3)	
	SEM ±	0.54	0.48	0.40	0.59	0.12	0.06	0.25	1.04	0.93	5.42		0.38	0.24
	CD at 5%	1.12	0.99	0.83	1.22	0.24	0.12	0.52	2.16	1.93	11.27		0.79	0.49
	at 1%	1.52	1.35	1.13	1.67	0.33	0.16	0.70	2.94	2.63	15.34		1.07	0.67

C = Control N = *Meloidogyne incognita* *R = Rhizoctonia solani* *F = Fusarium oxysporum*

Figures in parenthesis are $\sqrt{n+1}$ transformed values.

all the treatments. However, the effect was more severe when *M. incognita* was inoculated with both *F. oxysporum* and *R. solani* (Fig. 1 & Table 1).

The perusal of data reveals that okra is severely affected by these pathogens and reduction in shoot length of the plant in all treatments was observed but it was more pronounced when *F. oxysprum* and *R. solani* were combined with *M. incognita* (27.0 cm) and (N) alone (22.5 cm) as compared to control (63 cm) and pathogen alone. Significant reduction in root length was observed when *F. oxysporum* and *R. solani* was inoculated with *M. incognita* than either of the pathogen alone.However, it was minimum (45.0 cm) where all the three pathogens occur concomitantly as compared to control (60.3 cm) (Fig. 1 & Table 1). Maximum fresh and dry weight of shoot and root and fruit weight was recorded in control plants as compared to inoculated plants. Though *F. oxysporum* + *R. solani* + *M. incognita* showed greater reduction as compared to (F), (R) and (N) alone (Fig. 1 & Table 1).

The root galling decreased with fungal inoculum. It was 210.4, 138.7, 131.2 and 72.0 galls per plant in (N) alone, R+N, F+N and F+R+N treated plants respectively. These differences in galls formed per plant among treatments were statistically significant (Fig. 1 & Table 1). Though the root knot index (RKI) was 5.0 in all nematode inoculated plants except F+R+N treated where it was 4.5. The number of eggmasses per plant and number of eggs per reggmass also decreased in fugus treated plants. It was maximum in (N) alone treated plants and minimum in F+R+N treated plants (Fig. 1 & Table 1).

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Final nematode population at harvest was significantly correlated with fungal inoculum. It was 6408, 4852.6, 4800.4 and 4009.5 in plants treated with (N) alone, R+N, F+N and F+R+N treated palnts (Fig. 1 & Table 1). However, the rate of population increased (R.P.I.) decreased with fungal interaction. It was 5.40, 3.85, 3.80 and 3.0 in plants treated with (N) alone, R+N, F+N and F+R+N treated plants. All the above data among different treatments were statistically significant.

The results (Fig. 1 & Table 1) suggested that the nematode and the two fungi inoculated individually were able to cause appreciable reduction in plant growth characters. Inividually, *Meloidogyne incognita* inflicted more damage to plant growth followed by *Rhizoctonia solani* and *Fusarium oxysporum.* When the nematode and fungus were inoculated in combinations, F+N was more damaging as compared to R+N, May *Fusarium oxysporum* was more virulent then *Rhizoctonia solani* and readily interacted witht he nematode and caused adverse effect on plant growth. Such adverse effect of *F. oxysporum* in combination with *M. incognita* on Chickpea plants was also recorded.

However, combined inoculation of *M. incognita* +*R. solani* + *F. oxysporum* brought about significant reduction in fruit weight, length, fresh and dry weight of shoot and root in okra as compared to control and pathogen alone or in dual combination. The diagnostic symptoms like stunting of plant, yellowing of the leaves and wilting have been produced in all the treatments but the effect was more severe when *M. incognita was inoculated with both, Fusarium oxysporum* and *Rhizoctonia solani.* This is mainly due to injuries in the root system of the plant which was caused by the pathogen hence they adversely affected the translocation in the stem. *M. incognita* attacks on the root and cause hypertrophy which results in the stunting of roots along with *F. oxysporum* and *R. solani,* the wilting occurs primarity due to excretory toxic substances produced by the fungus in vascular system and translocated throughout the plant. Fusaric acid and lycomarismin, the wilt toxins known to be produced by the fungus *(F. oxysporum)* in the plant tissue, in the rhizosphere, as well as in the soil[9,10]. Pectinolytic enzymes are also produced by the fungus to help in breakdown of the cell wall components[11]. The fungal hyphae and their metabolic products caused choking of water conducting vessels hence multiplying the wilt syndrome.

It was evident from the results that in general, the incidence of drying of shoot and the final root rot were maximum in treatments receiving the combined inoculation (F+R+N). It also brought out the fact that the presence of nematode not only increased the severity of disease but also shortened the incubation period of disease expression. While the fungi in dual combination with nematode (F+N, R+N) caused drying of shot/wilt within a period of 30-42 days, the same effect with increased severity was discernible in 15-28 days with nematode plus F plus R. Early disease expression as well as increased disease incidence were recorded in combined infections by nematode and fungi[12,13] and the present findings were in agreement with the earlier reprots.

Host infestation by nematode, as represented by number of galls and eggmasses per plant was found to be maximum when nematode occurred individually. Presence

of either or both the fungi, irrespective of the time of inoculation effected root galling to varying degrees. However the number of galls and egg masses per plant were manimum in F+R+N treated plants. Reduction or increase in root galling in presence of some fungi have been recorded[14].

The reduction in galling and nematode multiplication, in the present investigation, could be possibly attributed to deleterious effects of metabolites of *R. solani* and *F. oxysporum* on the juveniles. This is further supported by greater reduction when, fungi and nematodes were inoculated concomitantly. It was suggested that the nematode modified the host's physiology so as to make it more favourable for the infection and colonization of the fungi, than a healthy plant, thereby affecting the development of nematode itself. Infection by fungi resulted in root rotting (necrosis) which covered the entrie root system, an unfavourable environment for the nematode development.

In conclusion, it can be said that, in combined inoculations the multitude of each individual organism was modified. The close proximity of infection court of the nematode and fungi probably enhanced the possibility of exchange of toxic metabolites from one feeding site to the other thus interfering in the establishment of normal host parasite relationship, Multiplication rate of nematode was poor in the presence of fungi because of tissue destruction caused by fungi much before the completion of nematode life cycle. Any benefit to the plant from an adverse effect on the nematode would be difficult to determine since it would be masked by the synergistic increase of the fungus infection. Thus, the concomitant effect of nematode and fungi caused greatest reduction in growth of okra.

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