ABSTRACT

The pathogenicity tests were conducted using five inoculum levels of each pathogens i.e. *Meloidogyne incognita, F. oxysporum* f.sp. *ciceri* and *R. solani* separately on chickpea. Investigations on the pathogenicity of *M. incognita, F. oxysporum* f.sp. *ciceri* and *R. solani* confirmed the destructive effect of these three pathogens on chickpea cv. Avrodhi. Lowest populations of the three test pathogens caused no significant damage or plant growth reduction. Significant damage to plant growth occurred at or above 1000 juveniles of *M. incognita* and/or 1.0 g or above of *F. oxysporum* f.sp. *ciceri* and *R. solani* per kg soil both in unbacterized and bacterized plants. The test pathogens also reduce the number of pods, chlorophyll content, and nodules per plant. However, significant reduction in nodulation was recorded at 500 larvae of nematode and/or 0.50 g fungus. *F. oxysporum* f.sp. *ciceri* was more damaging than *R. solani* and *M. incognita*. A significant linear relationship between initial and final nematode population was observed but, the rate of nematode multiplication decreased with the increase in the inoculum level. Root galling was, however, directly proportional to inoculum level showing an increase with the increasing inocula of nematodes. Similar trend was observed with respect to increase in wilt incidence and root-rotting in the increasing inoculum levels of fungus.

Interactions between *M. incognita, F. oxysporum* f.sp. *ciceri* and *R. solani* was studied using variable inoculum levels and their combinations. In the individual inoculation of the test pathogens, the reduction in plant growth, pod yield and nodulation was inoculum dependent. The reduction in plant growth, pod numbers and nodulation was directly proportional to the increase in the inoculum level of test pathogens. Initial incoulum level did not cause any significant reduction in plant growth, however, in the increasing inocula and all concomitant inoculations of the test pathogens, the reduction was statistically significant over uninoculated control.

Nematode multiplied to varying degree when inoculated alone. Nematode multiplication rate (Rf) decreased at the higher inoculum levels of nematode both in bacterized and unbacterized plants. Number of root galls increased in the increasing inocula of nematode. Both fungus (*Fusarium oxysporum* f.sp. *ciceri* and *Rhizoctonia solani*) showed an antagonistic effect on the rate of nematode multiplication and root galling. The antagonistic effect was higher at highest fungal inoculum levels when used with lowest inocula of nematode. Wilt and root-rot enhanced with the increase in the inoculum levels of both fungus alone and in its different combinations with nematodes. Maximum wilting and root-rot was observed at highest inoculum level of both fungus *F. oxysporum* f.sp.*ciceri* and *Rhizoctonia solani* respectively. In all the concomitant inoculations, the effect of interaction on plant growth and nodulation, pod yield was less. On the other hand, the wilting and roo rotting due to fungus increased markedly in all combinations with nematode, the highest being in simultaneous inoculation at higher doses of both pathogens and least in the lower inocula of the test pathogens.

Unbacterized plant showed lesser growth and greater damage than bacterized ones, when inoculated singly or in various combinations. Rate of nematode multiplication and root galling was highest in absence of *Rhizobium* as compared to bacterized ones either individually or in different combinations the both of pathogens. Wilting and root-rotting was also highest in concomitant inoculation of both the pathogens in absence of *Rhizobium*.

Studies were conducted to investigate the impact of *M. incognita, F. oxysporum* f.sp. *ciceri* and *R. solani* singly or concomitantly on chlorophyll contents of chickpea plant cv. Avrodhi in absence and presence of *Rhizobium*. Pathogenic infections caused a considerable variation in chlorophyll contents. Chlorophyll contents were reduced in individual and concomitant inoculations of the test

pathogens. The loss was significantly high in concomitantly inoculated plants than in those inoculated singly. The chlorophyll content was less in unbacterized plants than the bacterized ones.

Effect of biocontrol agent, *Trichoderma harzianum* on nematode and fungi:

Trichoderma harzianum was tested against wilt-fungus, *F. oxysporum* f.sp. *ciceri* and root-rot fungus, *R. solani* singly or in combination with root-knot nematode *Meloidogyne incognita* on chcikpea plant. *T. harzianum* was found effective against all the pathogens in different treatments. As a consequence, all the plant growth parameters i.e., plant length, fresh weight, dry weight, number of pods, chlorophyll contents and nodulation were increased (Tables 11,12,13,14, 15, 16). The improvement in all the growth parameters were greater in presence of *Rhizobium* as compared to unbacterized plants. Nematode population, wilting and root-rot reduced in *T. harzianum* treated plants.

Effect of *T. harzianum* in combination with different oil cakes against fungi and nematode on chickpea:

Pot experiments were conducted to study the effect of different oil cake (neem, castor, piludi and sunflower) against *F. oxysporum* f.sp. *ciceri*, *R. solani* and *M. incognita* on chickpea. Incorporation of oil seed cakes of neem, castor, piludi and sunflower proved to be highly effective against all the three pathogens alone and in combination on chcikpea. Among all the oil seed cakes, neem cake was found highly effective followed by castor, piludi and sunflower in limiting the detrimental effects of the pathogens and increasing the growth parameters of chickpea

Nematode population was highly reduced in neem cake amended soil followed by castor, piludi and sunflower. Highest reduction in frequency of pathogenic fungi was also recorded in neem cake amended soil followed by castor, piludi and

sunflower. Greatest reductions in nematode population and frequency of pathogenic fungi were recorded when *T. harzianum* was applied along with oil seed cakes. Neem seed cake with *T. harzianum* gave the best results followed by *T. harzianum* with castor, piludi and sunflower (Tables 13-16).

As a consequence of decrease in the population of *M. incognita*, and frequency of *F. oxysporum* f.sp. *ciceri* and *R. solani*, the plant growth treatments, number of pods and nodulation of chickpea increased. There was a positive correlation between the improvement in plant growth and reduction in pathogenic nematode and fungi (Tables 13-16). In the absence of either of the pathogen, the plant also showed improved growth, number of pods, and nodulation in comparison to untreated controls when subjected to the oil cake amendments and *T. harzianum*.