Summary & Conclusions

Investigations on the pathogenicity of *Meloidogyne incognita, F. oxysporum* f. sp. *ciceri* and *Rhizoctonia solani* confirmed the destructive effect of these three pathogens on chickpea cv. Avrodhi. Lowest population of the three test pathogens caused no significant reduction in plant growth. Significant damage to plant growth occurred at or above 1000 juveniles of *M. incognita* and or/ 1.0 g or above inocula of *Fusarium 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/ 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 rate of nematode multiplication decreased with the increase in inoculum level. Root galling was however, directionally 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 both fungi *F.oxysporum* f. sp. *ciceri* and *R. solani*.

Interactive Effect on Nematode and Fungi on Chickpea:

Interaction between *M. incognita, F. oxysporum* f. sp. *ciceri* and *R. solani* was studied using variable inoculum levels and their combinations, were found to be highly detrimental to plant growth as measured in terms of plant length, fresh weight, dry weight, number of pods, chlorophyll contents and nodulation. In the individual inoculation of the test pathogens, the reduction in plant growth, photosynthetic pigments were directly proportional to the increase in the inoculum levels of the pathogens. Initial levels did not caused significant reduction in plant growth; however, in the increasing inoculum levels the reduction was quite high over

uninoculated control. In concomitant inoculations highest reduction in plant growth was observed with *M. incognita* (Mi) + *F. oxysporum* f.sp.*ciceri* (Foc) followed by *M. incognita*+ *R. solani*(Rs) combination in chickpea.

The combinaton of variable inoculum levels of Mi+Foc and Mi+Rs in the test crop showed significant effect on plant reduction. Nematode multiplied to a varying degree when inoculated alone but with the increase in the inoculum levels, there was gradual decrease in the rate of nematode multiplication in unbacterized and bacterized plants. The fungi *F. oxysporum* f.sp. *ciceri* and *R. solani* showed an antagonistic effect on the nematode multiplication and root galling. This effect was higher when highest inoculum levels were used with lowest nematode inocula. Wilt and root-rot showed considerable enhancement with the increase in fungal inocula alone and its various combinations with nematode. Maximum wilting and root- rot was observed at highest inoculum levels of both the fungus, *F. oxysporum* f.sp. *ciceri* and *R. solani* respectively. Wilting and root-rotting due to fungus increased markedly in all combinations with nematode, the highest being in simultaneous inoculation at higher doses of both the pathogens and least in the lower inocula of the test pathogens.

Unbacterized plants 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 of both the pathogens. Wilting and root- rot was also highest in concomitant inoculation of both the pathogens in absence *of Rhizobium*.

Effect of *Trichoderma harzianum* on nematode and fungi:

In a pot study, effect of antagonistic fungus, *T. harzianum* was assessed against test fungus singly or in combination with nematode on chickpea. *T. harzianum* was found effective against all the pathogens in different treatments. As a consequence, all

plant growth parameters such as plant length, fresh weight, dry weight, number of pods, chlorophyll content and nodulation were increased (Tables 11, 12). The improvement in all growth parameters was greater in the presence of *Rhizobium* as compared to unbacterized plants. Nematode population, wilting and root-rot reduced in *T. harzianum* treated plants. This effect was greater in presence of *Rhizobium* than the unbacterized plants.

Effect of oil seed cakes *and Trichoderma harzianum* on fungi and nematode on chickpea plant:

Pot experiments were conducted to study the effect of different oil seed cakes (neem, castor, piludi and sunflower) against *F. oxysporum* f.sp. *ciceri*, *R. solani* and *M. incognita* on chickpea. Incorporation of different oil seed cakes in soil proved to be highly effective against the test pathogens. Among all oil cakes, neem cake was found to be highly effective followed by castor, piludi and sunflower cake in limiting the detrimental effect of the pathogens. Highest inhibition of population of *M. incognita* and frequency of pathogenic fungi was recorded with neem seed cake in combination with *T. harzianum* followed by castor, piludi and sunflower. As a consequence, of reduction in the population of *M.incognita* and frequency of *F.oxysporum* f. sp. *ciceri* and *R. solani*, the plant growth (plant length, fresh weight, dry weight), number of pods, chlorophyll content and nodulation of chickpea plant improved. Moreover, there was positive correlation between the improvement in plant growth and reduction in population of test pathogens.

In the absence of either of the pathogen the plant also showed improved plant growth and nodulation in comparison to untreated controls, when subjected to the oil cake amendments. In unbacterized seeds, the plant growth was less both in pathogen inoculated as well as in uninoculated plants. (Tables 13, 15).