

Agronomic Manipulations for Pests and Diseases Management in Chickpea: A Review

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ABSTRACT

Chickpea (Cicer arietinum L.) is one of the most popular vegetables in many regions of the world and commonly known as gram. The pod borers, Helicoverpa armigera, sap-sucking pests (especially Aphis craccivora) and nematodes cause damage to chickpea. Resistant cultivars, intercropping, trap crop, border cropping were used for management of pests. The major diseases affecting chickpea are Fusarium oxysporum f. sp. ciceri and Rhizoctonia solani. R. solani is an important component of the disease complex that causes seedling blight and root rot on pea. Resistant cultivars, tillage practices, crop rotation, inter cropping and soil solarization are effective measures for control of diseases in chickpea.

Key words: Chickpea, Pod borer, Nematode, Dry root rot and Fusarium wilt

INTRODUCTION

In India, chickpea ranks second in area and third in production, perhaps is the largest producer of chickpea in the world covering 80 per cent area and 85 per cent of total production. Chickpeas are damaged by a large number of insect species, both under field conditions and in storage⁷. Amongst the many insect pests damaging food legumes, the pod borers, *Helicoverpa armigera* (Hubner), sap-sucking pests especially *Aphis craccivora* and nematodes are the most devastating pests of chickpea in Asia, Africa, and Australia⁴⁴. Among the several constraints affecting the productivity of chickpea, 10-25 per cent loss in

yields are due to wilt and dry root rot diseases²⁹. Among them, dry root rot caused by *Rhizoctonia* spp. is becoming severe in most of the chickpea growing regions of India³⁰.

POD BORER (*Helicoverpa armigera*)

The legume pod borer is one of the largest yield reducing factors in food legumes. Its serious pest status has mainly been attributed to the high fecundity, extensive polyphagy, strong dispersal ability and a facultative diapause. The larval preference for feeding on plant parts rich in nitrogen such as reproductive structures and growing tips results in extensive crop losses¹³.

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Cultural control options such as manipulation of plant spacing, time of sowing, intercropping and soil operations such as ploughing have also been shown to have some potential to reduce the damage caused by *H. armigera*³⁸. Mehta *et al*³¹, studied the effect of intercropping mustard, wheat, barley, lentil and linseed with chickpea and concluded that intercropping generally delayed the appearance of major pests of chickpea and reduced their incidence, particularly the linseed intercrop, while the incidence of pests with the lentil intercrop was highest. Since 1976, more than 14,000 chickpea germplasm accessions and breeding lines have been screened for resistance to *H. armigera* at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) under open-field, pesticide-free conditions. Several genotypes with low to moderate levels of resistance were identified²⁷. Chickpea germplasm with resistance to insect pests has been identified, but the sources of resistance have not been used extensively in breeding programmes⁴⁰. In northern India, larval peaks of *H. armigera* occur during 10-16 standard weeks and hence early sowing (in October) or use of short duration chickpea cultivars should permit crop maturity before peak pest load⁴⁶. Chickpea intercropped with mustard in North-east Plains Zone, and chickpea intercropped with safflower or linseed in the Peninsular Zone of India, have been found highly attractive in comparison with sole crops. Wheat, coriander, safflower and sunflower intercropped with chickpea considerably decreased pod borer damage (5-6%) as compared to 16% pod damage in a sole crop. Das *et al*⁸, reported chickpea intercropping with wheat and mustard with a row ratio of 2:1 harbored 25% and 14% less larval population of *H. armigera* at 50% flowering and 50% podding stage, respectively, in comparison with the sole crop. They further showed that intercropping of chickpea with coriander with a row ratio of 2:2 harbored significantly lower larval population and was economically more profitable as compared to a sole crop; a row ratio of 8:2 had intermediate values. Lal²⁶,

concluded that intercropping of chickpea with mustard, linseed, wheat, barley resulted in low pod borer damage. Intercropping with a crop (such as coriander) that attracts parasitoids for control of pod borer. Plant spacing also affects incidence of *H. armigera* damage. In general, denser plant population favors increased pod damage, per plant and per unit area⁵. Avoidance of a dense canopy in chickpea is beneficial for both foliar disease control and build-up of *Helicoverpa* larvae. Chickpea was sown with intercrops (wheat, barley, mustard, carrot and lentil) and trap crops (pea, tomato, marigold, faba bean and berseem) in ratio of 4:2, 6:2 and 8:2 during 2010-11, 2011-12 and 2012-13. Two way analysis of intercropping showed that the average population of *Helicoverpa armigera* significantly reduced on chickpea under different intercrops as compared to chickpea alone. From 120 DAS onwards, chickpea + carrot (4:2) was superior to other intercrops in reducing the larval count over chickpea alone, while 4.8 larvae/ meter row were observed at the time of harvesting. Pod damage was 34.83% with highest yield of 1033.60 kg/ha in chickpea + carrot (4:2) as compared to that under chickpea alone condition. Chickpea + tomato (4:2) was superior in reducing the density to 0.33 and 2.10 larvae/meter row at 90 and 105 DAS, respectively as compared to that in chickpea alone condition. However, chickpea + pea (4:2) were efficient in bringing down the density to 5.7 larvae/meter row as compared to control (9.93 larvae) at 150 DAS. At the time of harvesting, pod damage was 39.0% with highest yield of 1018 kg/ha in chickpea + tomato (4:2) intercrop which was statistically similar with chickpea + pea (4:2). Hence, chickpea + tomato (4:2) and chickpea + pea (4:2) can be used as trap crops for *H. armigera* management in chickpea³⁹.

Sap Sucking Pests

Sap-sucking pests infesting chickpeas reach pest status mainly due to the fact that they act as virus vectors. Aphids, especially *A. craccivora*, are known to transmit a large number of viral diseases in chickpea²⁴. The most important is a strain of the bean leaf roll

luteovirus, the main cause of chickpea stunt, which is transmitted in a persistent manner by *A. craccivora*. Another chickpea disease is caused by the chickpea chlorotic dwarf virus¹⁹, a tentative master virus¹². This virus is transmitted in a persistent, non-propagative and circulative manner by the leafhopper *Orosius orientalis* (Matsumura) (Hemiptera: Cicadellidae)⁶. Border cropping reduces the insect pests population because of the diversity of the crops grown. Under the above perspective, border cropping has been thought to be an environment friendly option for the management of insect pests in gram. Aphid, whitefly, butterfly, grasshopper, cutworm were found as the insect pests and lady bird beetle, ant, spider, syrphid fly, rove beetle were found as predators in gram agro ecosystem. The lower population of aphid (4.28/plant), butterfly (1.00/plot), grasshopper (1.33/plant), whitefly (2.00/plant), cutworm (0.00/plot) was found when gram border cropping with garlic at vegetative and reproductive stage. Garlic was found to be more effective as border crop for the management of insect pests of gram¹¹.

Nematode Pests

Chickpea production is limited by root-knot nematode infections, particularly in the Indian subcontinent. Root-knot nematodes of the genus *Meloidogyne* cause serious yield loss⁴¹. Parasitism by root-knot nematodes is characterized by the establishment of permanent feeding sites which act as sinks for plant photosynthates and impair plant growth and development. In addition, deformation and blockage of vascular tissues at feeding sites limits translocation of water and nutrients in the plant, further suppressing plant growth and crop yield. Tissues surrounding the feeding sites of root-knot nematodes usually swell, giving rise to large, characteristic galls on the roots of infected plants. However, infection of chickpea roots by *M. artiellia* (Ma) only gives rise to very small galls surrounding the feeding sites⁴⁵. Organic soil amendments are now widely recognized as 'nonconventional' nematode management options. Following the addition of organic and inorganic fertilizers to soil, populations of free-living microbivorous

nematodes can increase rapidly and densities of plant-parasitic nematodes may decline. Some researchers suggested that free living nematodes accelerate the decomposition of organic soil amendments and increase the mineralization of nitrogen and phosphorus¹⁴. Transplanting of neem seedlings with chickpea plants was highly effective in reducing the impact of *M. incognita*³².

Dry Root Rot

Rhizoctonia solani is an important component of the seedling blight and root rot disease complex in chickpea²¹. Root rot limits plant vigour and ultimately seed production by reducing the number of roots available for nutrient and water uptake and for symbiotic nodulation. The pathogens that cause root rot are also responsible for seedling blight in younger plants. This can reduce canopy density and uniformity in growth stage. Early injury to the roots can result in thin, uneven stands that are more prone to weed invasion and have a low yield potential. Therefore, where root rot is severe, yield losses in pulses can be high. Previous studies indicated that the level of root rot was influenced by genetic resistance, soil temperature and the timing of seeding and seeding depth²⁰. Populations of pathogenic *R. solani* are expected to increase in the soil, along with losses due to disease, as chickpea acreage increases and the crop is grown repeatedly in the same fields. Ratan *et al*³⁷, reported that the variation in date of sowing was tested as an effective and economic strategy against dry root rot disease of chickpea. seed treatment with carbendazim @ 2 g/kg of seed+ seed treatment with *T. viride* @ 4 g/kg of seed +soil application of FYM fortified with *T. viride* decreased the per cent mortality of root rot caused by *R. bataticola*³³. Combined soil application of *T. harzianum* @ 5 kg in 500 kg neem cake/ha in furrow 5 days prior to sowing resulted in higher seed germination. In case of disease incidence and yield of crop, soil application of *T. harzianum* @ 5 kg in 500 kg FYM/ha in furrow 5 days prior to sowing has lowest disease incidence and gave highest yield⁹.

Fusarium Wilt

Wilt caused by *Fusarium oxysporum* f. sp. *Ciceris* (FOC) Matuo and K. Sato is considered one of the limiting factors for its low productivity¹⁷. It is an important disease in chickpea growing areas of the world particularly in United State, India, Mexico and in the Mediterranean region^{2,4,16}. This disease causes yield losses up to 100% under favorable conditions in chickpea³. *Fusarium* wilt is prevalent in almost all chickpea-growing areas of the world, and its incidence varied from 14% to 32% in the different states of India¹⁰. *F.oxysporum* survive as mycelium and chlamydo spores in seed and soil, and also on infected crop residues, roots and stem tissue buried in the soil for up to 6 years and yield losses of up to 72.16 per cent may occur under favourable condition²⁵. The use of resistant cultivars appears to be the most practical and economically efficient measure for management of root diseases of chickpea and is also a key component in Integrated Disease Management programs. Early planted crops usually attract more disease. The spores of fungus enter in the plants passing through the roots. When the spore reaches in the vascular system they produce certain enzymes that disorganize the cell walls and obstruct the plant's transport system. Discoloration occurs inside tissues from the root to the aerial parts. Yellowing and wilting of the foliage occur and finally there is necrosis²⁸. The pathogen of chickpea wilt disease is seed-borne³⁶ as well as soil borne²³. Tillage practices like burial of infected residue and controlling volunteer chickpeas will also be beneficial³⁵. Deep ploughing during summer and removal of undecomposed debris from the field. Removal of debris from *Fusarium* wilt affected chickpea crops and burning or flaming them to achieve thermal killing of chlamydo spores would reduce disease risk in the subsequent crop. Burning affected crop residues has been shown to greatly reduce the amount of soil borne inoculum of several plant pathogenic fungi²². Seed treatment with *Trichoderma viride* @ 4 g per kg seed has been found effective in reducing incidence of wilt. Follow crop

rotation. Exclude chickpea from the crop rotations of infested fields for at least 3 years for root disease management. Several studies have suggested that higher disease control and yield are obtained when the planting is delayed until the last week of October. The lower disease incidence in late-sown crop was considered to be due to low temperature prevailing during the period of late-sown crop. It has been demonstrated that some cultural practices, such as planting date proved to be very effective in reducing fungal attack to plants, but they are insufficient under high disease pressure, especially when weather conditions are particularly conducive to disease development¹. The disease is more severe in light sandy soil than heavy clay. High soil temperature and deficiency of moisture appear to have a definite bearing on its incidence. The amount of organic matter is inversely related to wilt incidence. The development of wilt is favoured by increase in nitrogen. Delay in sowing helps in minimizing disease. Mixed cropping of chickpea with wheat and berseem gives measurable disease control¹⁵. *Fusarium* wilt diseases of several crops have been successfully controlled by soil solarization⁴². Soil solarization (covering soil with transparent 100 mm thick polythene sheet for 6-8 weeks from April to May) decreased population of *Fusarium* and plant parasitic nematodes. The heat generated by solarization may not kill a pathogen outright, but the organism may be weakened, resulting in a reduction of its aggressiveness for its host and greater susceptibility to attack by other components of the soil microflora⁴³. Solarization of soil and advanced sowing date are some of the measures usually employed to control *Fusarium* wilt in chickpea, but with limited success^{18,34}. Plants spaced at 15-20 cm had much higher disease incidence than those spaced at 7.5 cm; this was attributed to the shallower root system in widely spaced plants which were susceptible to wilt when subjected to moisture stress. Planting of seeds at proper depth (10-12 cm) was helpful in reducing the disease incidence, while shallow sown crop seemed to attract more disease. Planting the

crop with “Pora” method using lower seed rate helped to minimise disease, whereas broadcast method of planting increased wilt incidence. In addition, soil borne plant pathogen control could be realized by flooding that destroys many soil borne pathogens^{23,43}. Development of wilt is more prominent under moisture stress conditions. One irrigation before flowering decreases disease incidence and increases yield. The disease incidence (root rot/ wilt) increased by 2 to 3 fold as the number of irrigations increased. The pathogen was most frequently isolated from the infected stem and root samples of chickpea receiving one irrigation. Intercropping/mixed cropping reduced wilt incidence and increased yield of chickpea. Lowest wilt incidence obtained with intercropping and mixed cropping with linseed. Wilt incidence was significantly reduced by amending the soil with deoiled mustard cake, groundnut cake and farm yard manure.

CONCLUSION

Chickpea (*Cicer arietinum L.*) is grown widely under a range of climatic conditions from temperate to subtropical and it hosts a wide variety of regional, native and exotic cosmopolitan insect pests and fungal pathogens so a generalized integrated management strategy is unlikely to be realized. Agronomic and cultural practices developed help in management some pests and pathogens but can't immune the chickpea against all severe conditions and pest. Incorporation of soil with bioagents and organic manures are reported here for the first time and constitute new information for the management of chick pea root rot disease. Use of resistant varieties, which are available, is best mean of wilt control. It is recognized that optimum agronomic components of an integrated crop management (ICM) package need to be compatible with Integrated Pest and Disease Management.

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