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Important insect, pests diseases in arid crops

and their management

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In arid and semi-arid regions majority of crops are attacked by blights, leaf spots, powdery mildews, downy mildews, soil-borne pathogens, viral diseases, white-flies, jassids, aphids, weevils, beetles and termites causing substantial damages and yield reduction. Nematode damage in arid region is observed mostly in vegetables and fruit crops. Root-knot, reniform, root lesion and stunt nematode are the major nematode pests on these crops. Besides prophylactic management cultural practices, need-based curative integrated pest management practices of major diseases and insect pests are described.

Key words: Arid crops, Diseases, Insects, Management, Nematodes, Pest

Fig 1. Cluster bean: A. *Alternaria* blight; B. Aphids; C. Whiteflies; D. Wilt

CLUSTER bean, moth bean, pearl millet, sesame, cumin and *ber* are predominantly grown in arid and semi-arid regions of India. These crops are attacked by diseases viz., blights, leaf spots, powder mildews, downy mildews, soil-borne pathogens, viral diseases and insects such as white flies, jassids, aphids, weevils, beetles and termites with a wide host range causing substantial damages and yield reduction. Some insects also act as vectors of plant diseases. A majority of the insect pests associated with the arid rainfed crops are polyphagous in habits, with very few crop specific pests. Root-knot nematode is the most damaging pathogen because of its wide host range and occurrence. Due to its feeding behaviour galls are induced on the roots that inhibit translocation of water and food to aerial parts causing more stress to plant under harsh arid environment.

Various management measures needs to be suitably integrated to provide an integrated protection of the crop rather than management of individual pest. As an integral part of IPM prophylactic management practices such as use of certified/ resistant/tolerant variety, disease free seeds, deep summer ploughing, field sanitation, to manage insect pests, nematodes and resting spores/ sclerotia/inoculum of pathogens and crop rotation to reduce soil-borne diseases such as wilt, root rot and nematodes should be followed.

CLUSTER BEAN

Cluster bean (*Cyamopsis tetragonoloba*) also known as *guar* is drought tolerant legume, mostly grown on marginal lands in resource poor soils under rainfed conditions of arid and semi-arid regions. It is used for feed, fodder, vegetable and for gum extraction from seeds.

Diseases

Diseases caused by mycoplasma, bacteria, insect pests are discussed.

Fig. 2. Moth bean: A. *Macrophomina* leaf spots; B. Root Rot; C. YMV; D. Leaf Crinkle

Alternaria leaf blight: It is caused by *Alternaria cyamopsidis* and found in *guar*-growing areas. The pathogen is primarily seed and soil borne. Prominent symptoms are round to irregular spots varying from 2 to 10 mm in dia on leaf. Infection starts as water-soaked lesions on the leaf blades which later turn to grayish to dark brown with concentric zonations. Severely infected plants defoliate resulting in considerable loss of seed yield.

Bacterial blight: It is caused by Xanthomonas axonopodis pv. cyamopsidis is seed-borne in nature. Water-soaked spots appear on leaves, pods, petioles and stems which later turn dark, angular and necrotic. Severe infection results in defoliation, wilting and dieback.

Powdery mildew: It is caused by *Leveillula taurica* or *Erysiphe polygoni* appears as white powdery growth on the leaves having fungal spores and mycelia. The affected leaves dry up with the advancement of the disease.

Wilt/root rot: It is caused by several fungal pathogens viz., wilt (*Fusarium oxysporum, Fusarium solani, Neocosmospora vasinfecta*) and dry root rot (*Rhizoctonia bataticola*: *Macrophomina phaseolina*) in cluster bean. Most of these root pathogens are soil or seed borne, and colonize the xylem vessels by clogging and blocking completely to effect wilting and dry root rot symptoms by decaying and weathering of roots.

Insect pests

Whitefly: Among the sucking pests whitefly *Bemisia tabaci*, *Acaud aleyrodes rachipora*, cause losses in cluster bean. Whiteflies are small white insects often occurring in large numbers. The nymphs and adults feed by sucking sap from the leaves, devitalizing them. Severely infested plants show yellowing symptoms, wilting follows and the plant may ultimately dry. The flies are vectors of yellow mosaic virus.

Red hairy caterpillar: *Amsacta moorei* locally called *Katra*, is a polyphagous pest of sporadic occurrence. The white coloured moths with a red lining on the forewings lay eggs on the wild vegetation. After hatching, the larvae feed on the wild plants before moving to the cultivated fields. The caterpillars move in large bands and are voracious feeders. Development of hairy growth on their body provides protection from predators and treated surface. In years of epidemic appearance, the entire field is devastated by this insect.

Termites: *Odontotermes obesus* and *Microterme isobesi* are the major pest. They are very small-sized, cream-coloured and polyphagous insects which live in large colonies underground. Termites feed on cellulose and cause damage to the stems and roots of plants causing significant plant mortality and yield losses. Termites prefer moist warm conditions in which they can thrive.

Insect management

Besides prophylactic management practices, seed treatment with Thiram @ 2 g/kg seed with streptocycline @ 250 ppm/kg seeds or biocontrol agent *Trichoderma harzianum* @ 5 g/kg seeds protect growing seedlings from blights caused by *Alternaria*, bacteria and wilt and root rots. Seed treatment with Chlorpyriphos 20 EC @ 4 ml/kg for is effective for termites. Two sprays at the interval of 15 days of combination of copper oxychloride and streptocycline @ 250 ppm for *Alternaria* and bacterial blight, Karathane @1.5 ml/litre for powdery mildew or Carbendazim @ 2 g/litre of water for management of wilt/root rot is recommended. Spraying of neem products: neem seed kernel extract @ 4 % or neem oil @ 3% or spray of systemic insecticides Dimethoate 30 EC @250 to 350 ml or Imidacloprid 200 SL, 100 g/ha helps in managing whitefly population. Use of light traps and Quinalphos @ 0.2 % for red hairy caterpillars, soil treatment with Quinalphos 1.5% @ 25 kg/ha or Chlorpyriphos 20 EC @ 4 litres/ha with irrigation water for management of termites is recommended.

MOTH BEAN

Moth bean (*Vigna aconitifolia*) is the most important native *kharif* pulse crop of arid region of hot and dry desert. The symptoms and management of major diseases and insect pests are described here.

Diseases

The diseases caused by bacteria, fungi, and virus are discussed here.

Bacterial blight: It is caused by *Xanthomonas axonopodis* pv. *Phaseoli*. The disease spreads fast under high humidity and heavy rains. Many small, large and irregular brown necrotic spots first appear on upper

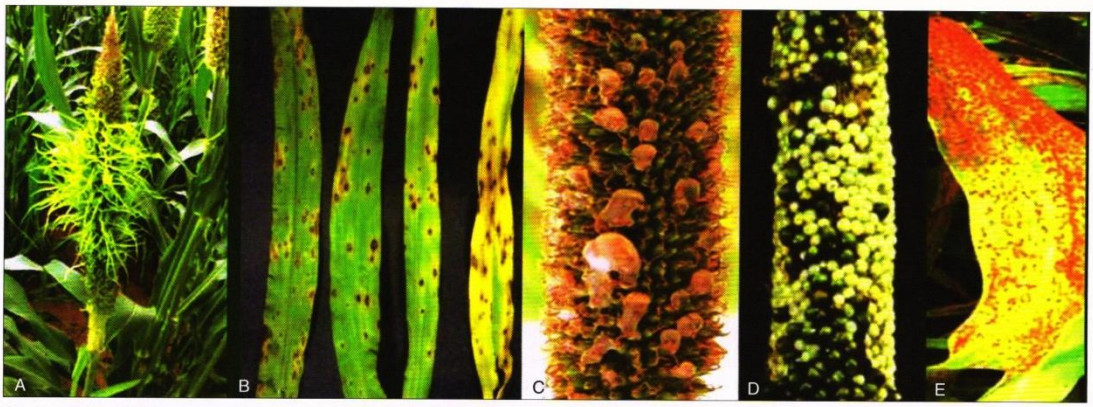

Fig 3. *Bajra*: A. Green ear; B. Blast; C. Ergot; D. Smut; E. Rust

surface than on lower leaf and later turn brown to black. These spots are surrounded by chlorotic holes. The pathogen can survive in seeds from one season to another. In the extreme cases, leaf may fall down.

Web blight: It is caused by *Rhizoctonia bataticola* and appears during heavy rains and high temperature in severe form on leaves. Dark brown spots first appear on lower surface of leaf. In severity the spots coalesce and necrosis of leaves appear. Similar symptoms appear on petiole, stem and pods. The affected leaves shed off.

Alternaria leaf spot: It is caused by *Alternaria alternata* and is first seen as pale yellow spots on leaves which gradually advance towards the petiole. Initially the spots are separated from the healthy tissue by a dark-coloured band but gradually spread over the entire leaf and become irregular, brittle, dark olive green or black due to fungal growth on either side of the leaf.

Dry root rot: It is caused by *Rhizoctonia bataticola* and is more severe in dry and hot weather conditions. Infected seeds remain small in size and may not germinate. Collar regions of the emerging seedlings turn reddish-brown showing discolouration. Discoloured area turns dark brown and infected seedlings may die in hot and dry weather. The discolouration of stem starts with reddish-browning at collar region, subsequently whole plant dry out.

Yellow mosaic virus: It is transmitted by a vector *Bemisia tabici* (white fly). The leaves showed yellow patches alternating with green areas which later turned yellow. Such yellow leaves gradually change to whitish shade and ultimately become necrotic. Plants bear few, small and curled pods which bear few and shrivelled seeds with stunted growth.

Leaf crinkle virus: It is transmitted by insect causes downward curling with crinkling and excessive growth of leaflets. The infected plants have a bushy appearance of the inflorescence. Shriveled, discoloured and over-sized seeds occur among seeds harvested from diseased plants.

Insect pests

Aphid: *Aphis craccivora,* suck sap from leaves, top shoots and stem resulting in wilting of plants. The leaves acquire curly appearance, the flowers fail to form pods and the developing pods do not produce healthy seeds. Aphids reproduce both sexually and asexually multiplying rapidly and humid conditions favour rapid multiplication.

Insect pest management: Besides prophylactic management practices, seed treatment with Streptocyline (0.01 %) + Captan (2 g/ kg seed) for bacteria blight, web blight, *Alternaria* blight and root rots is recommended. Two sprays at the interval of 15 days of Blitox (0.3%) for the management of bacterial blight and *Alternaria* leaf spot, two sprays of Carbendazim (0.2 %) for dry root rot is recommended. Two sprays of imidacloprid 17.8 SL 0.033 ml/litre or dimethoate 30 EC 2 ml/litre of water effectively reduces aphid population.

PEARL MILLET

Pearl millet (*Pennisetum glaucum*) or *bajra* is an important staple cereal of arid and semi-arid tropical production system. Downy mildew, blast, smut, ergot, rust, grasshoppers, termites and beetles are important pests of pearl millet.

Diseases

The diseases caused by fungi are discussed here.

Downy mildew: It is caused by *Sclerospora graminicola* is favoured by high relative humidity and temperatures ranging from 20 to 30°C. The pathogen is an obligate oomycetes fungus. During downy mildew stage the primary infection occurs in seedlings by seed or soil-borne oospore and systemic symptom appears on lower side of the leaves. In green ear stage, leafy structures are seen in stead of normal ear heads. As the disease advances, the malformed floral structures of ears become brown and dry.

Blast: It is caused by *Pyricularia grisea* is more severe during humid weather conditions. The disease appears as grayish, water-soaked eye shaped lesions surrounded by a chlorotic halo on foliage that enlarge and become necrotic, resulting in extensively chlorotic and premature drying of young leaves. Severely infected plants produce no grain or few shriveled grains in blasted ûorets.

Ergot: It is caused by *Claviceps*

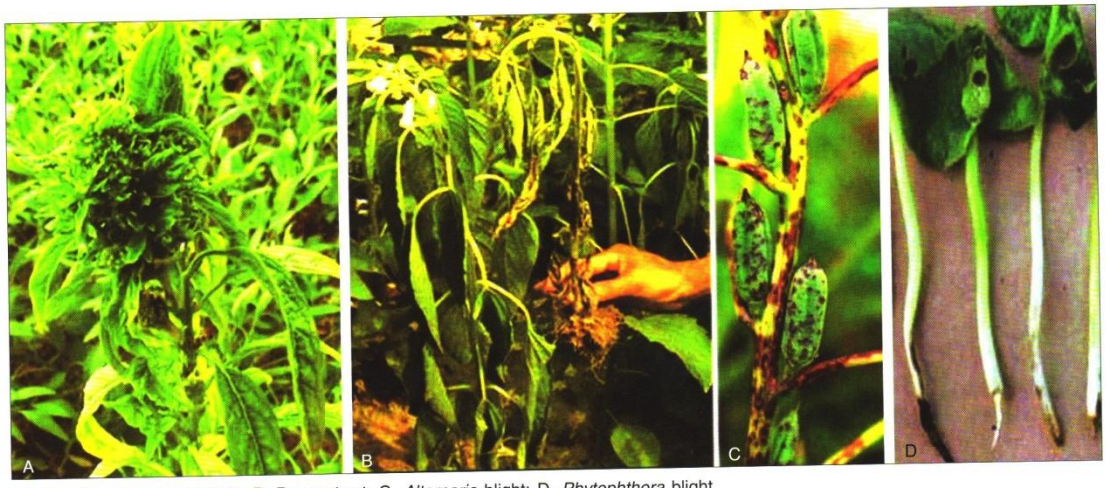

Fig 4. Sesame: A. Phyllody; B. Dry root rot; C. *Alternaria* blight; D. *Phytophthora* blight

fusiformis and spreads rapidly under cool days with temperatures below 20 °C with high humidity coupled with cloudy weather during anthesis period. The symptoms appear as small droplets of pinkish fluid exuding from the spikelet which dries up and converts into sclerotia on infected ear heads.

Smut: It is caused by *Toleposporium penicellariae* is both externally seed and soil borne in nature. Only some grains in an ear are affected which are transformed in an egg shape sori as enlarged, oval-bodies projecting beyond the glumes in place of grains. Initially, the sori are bright green but later turn brown to black powder. Infested plants should be removed up to 45 days of sowing as and when the symptoms are noticed.

Rust: It is caused by *Puccinia substriata* and *Puccinia penniseti* are obligate in nature. The symptoms appear on the lower leaf as erumpent pustules, which are initially reddish brown and turn brown to black. Infected leaves showed pinhead chlorotic checks, which later turn reddish-orange pustules which coalesce to occupy larger leaf surface.

Insect pests

Grasshoppers: Several species of grasshoppers viz. *Chrotogonus* sp., *Hieroglyphus* sp., *Oxya* sp., *Atractomorpha* sp., *Acrida* sp. and *Pyrgomorpha* sp. etc. feed on pearl millet foliage. Grasshoppers cause more damage in years when the population is high and weather is dry. Each grasshopper consumes plant material (dry weight) between 30 to 100 mg each day.

Beetles: Some beetles viz., blister beetles *Cylindrothorax balteatus* feed on pollen and damage grains, while the *Rhinyptia laeviceps* and *R. meridionalis* var. *puncticollis* beetles feed on milky and ripe grains, reducing the productivity of pearl millet.

Insect Pest Management: Besides management practices, seed treatment with Metalaxyl @ 2 g/kg seeds followed by 2 sprays of Ridomil MZ 75 WP for downy mildew, dipping the seeds in 10% brine (NaCl) solution for 10 min. for ergot or 2 sprays of propiconazole @ 1 ml/litre for blast or 2 sprays of Mancozeb @ 0.25 % for the management of rust is recommended. Dusting with carbaryl or pyrethroids or malathion 2% dust @ 25 kg/ha is effective in managing grasshoppers and beetles.

SESAME

Sesame (*Sesamum indicum*) is an important oil crop grown in the arid and semi-arid conditions. The symptoms and IPM of major diseases and insect pests are discussed here.

Diseases

The diseases caused by bacteria and fungi are discussed here.

Root and stem rot: It is caused by *Rhizoctonia bataticola* that attacks on young seedling which falls over and dies. Leaves showed bronzing of branching followed by dropping of the upper tender parts of the shoot. If infected plant is uprooted, black-coloured roots are observed having sclerotia of the fungus. The roots become brittle and heavily infected plants rarely produce any grain.

Phytophthora blight: It is caused by *Phytophthora parasitica* var. *sesame* attacks all stages of the plant. Elongated chestnut brownish black lesions girdle the stem, premature leaf fall and plant dies. Diseased plants are easily pulled out producing shrivelled seeds and gives blighted appearance.

Powdery mildew: It is caused by *Erysiphe oidium* and *E.orontii* species. Small white cottony or powdery spots appear on the infected leaves, later enlarge, coalesce and become gray-coloured. Subsequently the infection spreads on petioles and floral parts and in severely infected plants the leaves dry.

Phyllody: It is caused by *Phytoplasma* like organism and transmitted by jassids. All floral parts are transformed into green leafy structures and entire inflorescences is replaced by short-twisted leaves closely arranged on a stem with short internodes, abundant abnormal branches bend down and plants look like witches broom.

Insect pests

Leaf and pod caterpillar: The most destructive pest of sesame *Antigastra catalaunalis* is found in arid regions. The caterpillar rolls the leaves together, more frequently the top

Fig 5. Cumin: A. *Alternaria* blight; B. Wilt; C. Aphid

leaves and feeds on them from within. When pods are formed, it feeds on the developing grains inside.

Til hawk moth: *Acherontia styx* feed on leaves of sesame and sometimes on moth bean also. Though few in numbers, they consume considerable foliage.

Insect pest management: Besides, seed treatment with carbendazim or captan @ 2 g/kg or thiram, @ 3 g/kg or with biocontrol agents *Bacillus firmus* and *Aspergillus versicolor* reduce the seed and soil-borne inoculums of root and stem rot. Spot drench Carbendazim @ 1 g/litre in affected patches minimizes the spread of the *Phytophthora* blight. Two sprays of Karathane @1.5 ml/litre for powdery mildew or 2 sprays of Dimethoate 30 EC 500 ml/ha to manage Phyllody is recommended. Spray of neem-seed kernels extract @ 5% or Carbaryl 50 WP 1 kg/ha reduces the population of leaf and pod caterpillar and Quinalphos @ 1.5 ml/litre for management of hawk moth is recommended.

CUMIN

About 90% of cumin (*Cuminum cyminum*) of the world is produced in India of which a mojor share is contributed by Rajasthan. The economically important fungal diseases of cumin are root rots caused by several species of *Fusarium*, and *Alternaria*, and Aphids are the major insect pest affecting production and productivity in cumin.

Diseases

The diseases caused by fungi are discussed here.

Wilt: It is caused by several species of *Fusarium (F. oxysporum, F. solani, F. moniliforme, F. dimerum, F. equiseti* and *F. lateritium)*. The pathogen is both seed and soil-borne in nature. Disease produces wilting symptoms both at seedling and later stage of plant growth. The roots of the diseased plants bear dark brown markings. Seeds if formed are thin, small and shriveled.

Alternaria blight: It is caused by *A.burnsii* appears usually in mid-January and becomes severe in under humid and cloudy weather. The disease first appears as small, isolated, whitish necrotic areas on the aerial parts especially on tips of young leaves. These areas gradually enlarge and coalesce and turn purple; eventually brown and finally black. Seeds, if produced are shrunken, dark coloured, light weight and usually non-viable.

Insect pests

Aphid causes major loss by sucking sap from the plants thus devitalizing the plants and reducing productivity and yield of the crop. Two species of aphids *Hyadaphis coriandri* and *Myzus persicae* attack cumin crop in the arid region.

Insect pest management: Besides, prophylactic management practices, an integrated schedule of treatments with soil application of neem-cake and vermicompost, seed treatment with *Trichoderma viride* @ 5 g/kg seed or Carbendazim 2 g/kg seed followed by one spray each of Dithane M-45 @ 2.5 g/litre of water with Dinocap 48% EC @ 300 ml/750 litre, Imidacloprid 17.8SL @ 0.033 ml/litre of water and neem oil 2% for the management of *Alternaria* blight, wilt and aphid is recommended.

BER

Ber (*Ziziphus mauritiana*) is an important fruit crop in the arid region. This fruit tree is relatively free from diseases in arid region wherein the dry, hot weather exist coupled with low humidity. However, some diseases like powdery mildew and insects viz., fruit fly and bark eating caterpillar are

Fig 6. *Ber:* A. Powdery mildew on Leaf; B. Powdery mildew on fruits; C. Fruit fly adults; D. Fruits infested by fruit fly larvae

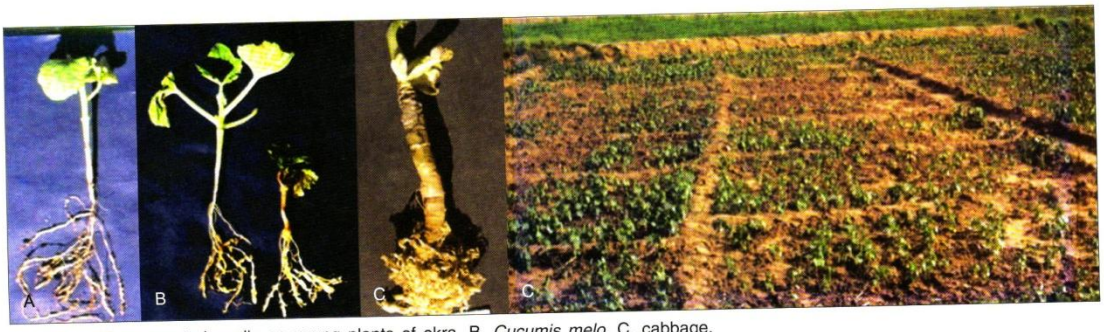

Fig 7. A. Fine nematode galls on young plants of okra, B. *Cucumis melo*, C. cabbage,

economically important pests.

Diseases

Powdery mildew: It is caused by *Oidium erysiphoides f.* sp. *ziziphi* occurs in moderate to severe form under cloudy, humid and moderate temperatures. The initial symptoms appear as white specks on young fruits at pea stage. In severe incidence the floral parts, whole fruits, pedicel, tender branches and leaves showed powdery mass of conidia of the fungus. Eventually the infected leaves shrink and defoliate and fruits drop.

Insect pests

Fruit fly: The adult of *Carpomyia vesuviana* is yellowish-brown insect with hyaline wings and black dots on thorex lays eggs inside the *ber* fruits. The maggots after hatching from these eggs feed on the pulp and cause rotting of the fruits. Varieties like *Tikadi* and *Ilaichi* have low fly incidence. The mature maggots of the *ber* fruit fly come out of the fruits for pupation in soil. Incorporation of dust formulation of contact insecticide in soil at this stage expose larvae heading for pupation. Exposure of the pupae to sun during hot summer serves to reduce the number of emerging flies in the next season.

Bark eating caterpillar: *Indarbela quadrinotata* feed on the bark during night, remaining concealed during day time in the tunnel made at the junction of branches. The junction point becomes weak due to tunnel. During the fruit bearing period pressure at the forks is greatly increased due to weight of fruits, resulting in cleavage of the branch at the fork or angle and results in drying of the entire branch. Thus a single larva can spoil the produce of the entire branch. Infestation of the bark-eating caterpillar is easily detected by the presence of frassy webs at the forks or angles.

Insect pest management

Ploughing of fields in summer helps in destroying the clestothecia and other dormant structures of powdery mildew fungus and pupa of fruit fly. Infected fruits at early pea stage should be removed and destroyed. Karathane @ 0.1 % is the most effective fungicide to control this disease. Spray with biocontrol agents such as *Trichoderma* and *Pseudomonas fluorescens* can also provide effective control. Two sprays of Quinalphos 30 EC@ 1.5 ml/litre of water starting from pea stage of fruit are effective against the fruit fly. Quinalphos 30 EC@ 1.5 ml/litre of water should be applied on around the feeding site of the bark eating caterpillar, by injecting the insecticidal solution in the hole through a syringe. The treated holes should be plugged with mud or clay to prevent escape of the larva and to ensure its exposure to insecticide.

NEMATODE DISEASES

Nematodes cause huge loss as they damage pulses, vegetables, fruits, in arid and semi-arid areas. Some of these are discussed here.

Pulses

Nematodes damage crop are *Tylenchorhynchus* sp. and *Prarylenchus* sp. on pearl millet; *Hoplolaimus* sp., *Prarylenchus* sp. and *Helicotylenchus* sp. on grass (*Cenchrus ciliaris*); and *M. javanica* and *M. incognita* on moongbean. In tree nurseries presence of *Pratylenchus* sp., and *Tylenchorhynchus* sp. on *Prosopis cineraria*; *Pratylenchus* sp. on *Acacia nilotica*; and *Tylenchorhynchus* sp., on *Tecomella undulata, A. tortilis, A. samia, A. annura,* and *A. salicina* were detected. Under irrigated

Fig 8. A. C. Brinjal root with excessive galling; B. Obese female and cylinderical 4th stage male in root gall; C. Female with eggs and larvae

conditions, nematode damage is mostly observed on vegetables and fruit crops and spices. Stunted growth of crops in patches is often indicative of nematode attack. Root-knot nematode, reniform nematode, root-lesion nematode and stunt nematode are the most common plant nematodes parasitizing horticultural crops in arid zone.

Vegetable crops

The nematode (*Meloidogyne* sp.) is polyphagus in nature with a wide-spread occurrence and host range. The infected plants showed stunt growth. Foliage turns yellow green to yellow. Plants may wilt easily in dry and hot weather. The most characteristic symptom of the disease is the formation of galls or knots on the root system. Tomato, brinjal, cucurbits, chilli etc. are affected by one or the other species of this nematode. The common *Meloidogyne* species attacking the vegetable crops are *M. incognita* and *M. javanica*.

Reniform nematode (Rotylenchulus reniformis): Leaves turn pale yellow and become smaller in size. Fruit size is reduced which results in decrease in the yield. This nematode often occurs with root-knot nematode and depending upon the population level, it may cause even more damage than root-knot nematode.

Root-lesion nematode: The nematode (*Pratylenchus* sp.) is a migratory endoparasite of roots. Usually outer tissue of root is destroyed by the nematode. The nematode causes necrosis of roots. Heavy infection by nematode may lead to drastic reduction of root system. Foliage of plant showed chlorotic symptoms.

Nematode Management

In transplanting crops: During summer, soil solarization of nursery beds using polythene sheets (25 to 50 μm) for 15 days reduces nematode population to a great extent. Light irrigation of soil followed by soil solarization is more efficient in causing drastic reduction of nematode population. Treatment of nursery beds at the sowing with Carbofuran @ 0.3 g a.i./m^2 + neem cake @ 500 kg/ha reduces nematode infection. If the soil is heavily infested, application of Carbofuran to soil @ 1 to 2 kg a.i./ ha before transplanting followed by root dip treatment to seedlings of with Carbosulfan (25 EC) @ 500 ppm at the transplanting in the field greatly reduces the infection by the nematode.

Nematode infested field: During summer (May and June) deep ploughing twice at an interval of two weeks resulted in the reduction of nematode population in the soil. Use of organic amendments including neem, mustard and castor cakes @ 1 tonne/ha was found to reduce root-knot nematode. In direct seeded vegetables, solarization of nematode infested field coupled with seed dressing with Carbosulfan (25 DS) @ 3% a.i. (w/w) reduced the attack of root-knot, reniform and lesion nematodes. Rotation with non-host crops often results in the reduction of nematode population. For root-knot and reniform nematode it is advisable to rotate vegetables with cereals and millets. Use of non-host crops like mustard, garlic, onion and cereals at least for 2 to 3 years in a suitable cropping system helps in controlling the nematode. Intercropping of vegetables with enemy crops such as marigold was found effective in checking root-knot nematode infection of roots. Application of *Paecilomyces lilacinus*, *Trichoderma virdi* and *T. harzianum* can provide good control of plant nematodes.

Nematode problems in arid fruit crops

Pomegranate: Root-knot nematode (*Meloidogyne* sp.) is most important nematode pest of this crop. Diseased plants exhibit poor growth. Heavy infestation by the nematode often leads to the chlorosis of the foliage and during summer defoliation and drying of twigs is observed. Nursery infected pomegranate plants are often difficult to establish when transplanted in the field. The fruit size and yield are greatly reduced due to the moderate and heavy infection of the roots.

Management: The nursery plants should be raised in nematode free soil. Application of Carbofuran (3G) @ 15 to 25 g/plant as a basin

Fig 9. Galled root of pomegranate

treatment helps in managing this nematode. Soil application of two tonne of farmyard manure or 500 kg of neem-cake/*Pongamia*-cake or one tonne of vermi-compost enriched with *Pseudomonas fluorescens* + *Trichoderma harzianum* + *Paecilomyces lilacinus* at the land preparation is effective for the management of root-knot nematode. Similarly, application of *T. virdi* + *P. lilacinus* (1 × 10^6 cfu/g) @ 10 kg/ha (14 g/plant) at the flowering and 10 kg/ha again at 90 days after flowering (14 g/plant) by ring method along with 100 kg moist decomposed farmyard manure was found to manage the root-knot nematode in pomegranate under field conditions.

Citrus: Tylenchulus semipenetrans is the major nematode of citrus. Affected trees are generally stunted with little bearing and exhibit die back of twigs. Foliage is sparse often dull grey green or bronze green in colour. Leaves are smaller than normal size and roots of such trees are dark with shortened rootlets which often become swollen and irregular in appearance. The roots may show necrotic stripes and sloughing off over a period of time leading to root decay.

Management: Infected root stocks can be treated with hot water at 46.7°C for 10 min or at 45°C for 25 min. *Poncirus trifoliata* is a resistant root stock against this nematode. Application of neem cake @1 kg/plant along with carbofuran (3G) @ 60 g /plant as basin application reduces nematode population and increases yield of the plant.

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