GENERIC PEST RISK ANALYSIS: IMPORT OF TRANSGENIC COTTON

Editors

Kavita Gupta
Baleshwar Singh
V Celia Chalam
Shashi Bhalla
Z Khan
SC Dubey

National Bureau of Plant Genetic Resources
New Delhi 110 012, INDIA

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Contents

Introduction

India accounts for about a third of global cotton area. Cotton, in India is a predominantly a *Kharif* crop, is planted from the end of April through September and harvested in the winter. Since its introduction in 2002, Bt cotton has been widely adopted and now accounts for over 92 percent of total cotton area and over 95 percent of India's cotton production. The Government of India has approved six biotech events and more than 300 hybrids for cultivation in different agro-climatic zones. In addition to the approved varieties, there are estimated 40-50 Bt cotton hybrids that are developed and multiplied informally outside of regulated marketing channels and sold at cheaper rates relative to approved hybrids (USDA, 2016).

Researchers are working on production schemes with higher plant populations that could improve yields. There are an estimated 5.8 million cotton farmers with the average farm size of 1.5 hectares. In 1999, the central government launched the Technology Mission on Cotton (TMC) to improve the availability of quality cotton at reasonable prices. The goal of the TMC is to bring about improvement in the production, productivity and quality of cotton through research, technology transfer, and improvement in the marketing and raw cotton processing sectors.

The Government of India passed the first Act in 1906 under the Sea Customs Act of 1878 to stop the entry of the Mexican cotton boll weevil *Anthonomus grandis* and ordered compulsory fumigation of imported cotton bales. The first quarantine law in India was enacted in 1914 as the Destructive Insects and Pests (DIP) Act. A gazette notification entitled Rules for Regulating the Import of Plants etc. into India was published in 1936. Over the years, the DIP Act was revised and amended several times to meet the changing global requirements. In the PQ Order 2003 also, *A. grandis* is a regulated pest and import of cotton seed or bales are required to be free of this pest. National Bureau of Plant Genetic Resources (NBPGR), New Delhi -the nodal organization for exchange of plant genetic resources in India has been empowered under the Plant Quarantine (Regulation of Import into India) Order 2003 (under the Destructive Insects and Pests Act, 1914), to undertake quarantine processing of imported germplasm including transgenics for research purposes into the country by both public and private sectors. The exchange of germplasm for cotton improvement programmes has the inherent risk of introducing new pests or their virulent strains/ races/ biotypes into the country. There are several examples of inadvertent introduction of pests (insects, mites, nematodes, fungi, bacteria, viruses and weeds) across the world such as coconut mite (*Aceria guerreronis),* potato late blight *(Phytophthora infestans), Banana bunchy top virus,* golden nematode (*Globodera rostochiensis*), congress grass (*Parthenium hysterophorus)* etc. along with the introduced seeds/ vegetatively-propagated material.

Exotic germplasm of cotton including transgenic cotton is being introduced for developing better varieties. The introduction of these lines and also bulk consignments for sowing and consumption from other countries may carry the risk of introducing pests

hitherto not known to occur in India, or new virulent strains of the ones already reported. With the increase of imports of seeds, the risk of introduction of exotic pests into the country is accordingly increased. Therefore, utmost care and all precautions need to be taken up while processing the exotic material for quarantine so as to minimize this risk.

Plant quarantine is a government endeavour enforced through legislative measures to regulate the introduction of planting materials, plant products, soil, living organisms, etc. in order to prevent inadvertent introduction of arthropod pests, pathogens, nematodes and weeds harmful to the agriculture of a country/ state/ region and if introduced, prevent their establishment and further spread. The present day definition of a pest is any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (ISPM 5- Glossary of Phytosanitary Terms, 2001).

NBPGR has *state-of-the-art* facilities and expertise to undertake quarantine processing which includes latest diagnostics for detection of pests and infected/infested/disinfection/ disinfestation of infected/ infested germplasm. Several techniques have been developed/ standardized over the years for the detection of pests and salvaging the infected/ infested material so that material is in a pest-free state before its release. The various facilities available include: Containment Facility (CL-4 level), post-entry quarantine field and greenhouses, incubation room with controlled temperature and alternative cycle of light and darkness, Real-time X-ray radiography system, Transmission Electron Microscope, Stereo and Compound microscopes, ultra-centrifuge, spectrophotometer, ELISA, molecular diagnosis using real time PCR, fumigation chambers, hot water treatment tanks etc.

A large number of pests are known to be seed-borne/ seed-transmitted in cotton and these include pests not reported from India as given in the table 1. Some of the pests of quarantine significance such as *Anthonomus grandis* (cotton boll weevil) have been intercepted at NBPGR. If not intercepted, they could have got introduced into our cotton fields and played havoc with our cotton production.

The information on various seed-borne and seed-transmitted pests is scattered in different research journals, periodicals, books and other publications. Therefore, it was considered important to compile and consolidate the information on potential quarantine pests of *Gossypium* species and its wild relatives. This compilation is the result of an endeavour by the scientists of Plant Quarantine Division and provides important information on cotton pests, their pathway of introduction, host range, geographical distribution, economic impact and phytosanitary risks involved.

The increased awareness in recent years regarding the dissemination of plant pests by seeds as well as agricultural commodities during exchange and trade has been primarily due to liberalization of trade under WTO regime. The Agreement on Application of Sanitary and Phytosanitary Measures, under it requires member countries to have uniform phytosanitary standards. The International Plant Protection Convention (IPPC) has developed International Standards for Phytosanitary Measures (ISPM) and so far 35 standards have been brought out. Of these the standards on pest risk analysis (PRA) are given in ISPM-2, ISPM-11 and ISPM-21. The preparation of PRA is divided into three main stages *viz*., process initiation, pest risk

assessment and pest risk management. The PRA should be fully documented in the event of any review or dispute. In fact, the first step is very crucial to start a PRA and requires both a list of pests reported to occur and a list of those not known to occur in the country.

Under the PQ Order 2003, planting material of cotton is restricted and permissible only by authorized institution i.e., Central Institute for Cotton Research, Nagpur with additional declarations and subject to special conditions under the Schedule V (given below)

Plant species/ variety	**Category of plants & plant material**	**Additional declarations required to be incorporated into PSC**	**Special conditions of import**	**Responsibility of authorized Institutions**
Cotton (*Gossypium* spp.)	Seeds for sowing	Freedom from: *a)* Witches" broom (*Collectotrichum gossypii* var. *cephalosporioides*) *b)* Bacterial blight (*Xanthomonas campestris* pv. *malvacearum* (African strain) c) (*Anthonomus grandis* & other *Anthonomus spp*.) d) Seed bruchids (*Amblycerus* spp., *Megacerus* spp., *Spermophagus* spp.)	i. The seed shall be given acid delinting treatment at the country of origin prior to shipment ii. The seed shall be fumigated with suitable fumigant at the country of origin and treatment to be endorsed on phytosanitary certificate.	Subject to the recommendation, supervision, monitoring and testing by Director, Central Cotton Research Institute, Nagpur, (Maharashtra).

Also, cotton is permitted for import with additional declarations and special conditions under the Schedule VI of the Order as given below:

S.No.	**Plant species**	**Category of plant material**	**Country of Origin**	**Additional declarations required to be incorporated into Phytosanitary Certificate**	**Special conditions of import**
314	*Gossypium* spp. (Cotton)	Raw cotton bales for industrial use.	Any Country	Free from Cotton boll weevils (*Anthonomus grandis*, *A. peninsularis* and *A. vestitus*)	Fumigation with Methyl bromide @ 24 g/cu. m for 24 h at 21°C and above under NAP at the port of entry or by any other fumigant/ substance in the manner

					approved by the Plant Protection Adviser.

The present compilation includes one hundred and ninety potential quarantine pests such as insects (28), mites (4), nematodes (1), fungi (6), bacteria (2) and weeds (10) infecting/ infesting/ contaminating cotton and its wild relatives. These are associated with various pathways as indicated in the respective tables. Once introduced and established, these pests or their virulent races/ strains/ biotypes can cause severe damage to agriculture.

The present compilation of data on pests of quarantine significance, their global distribution and other aspects related to biology, survival and spread of these pests are essential components of risk analysis to meet international regulations. However, it may be noted that, this compilation is based on published literature and the non- availability of published literature should not be interpreted as absence of a pest in a country. This compilation would, thus, facilitate smooth functioning of quarantine, benefit scientists while issuing import permit stating additional declarations required for cotton import in addition to supplementing information for analyzing pest risk. Therefore, it is hoped that this compilation would be of great help to scientists and others entrusted with the task of safe transboundary movement of cotton.

Table 1: Potential Quarantine Pests of Cotton for India

S No.	Pest	Common Name	Pathway of Introduction	Host Range	Geographic Distribution	Remarks
	Insects/ Mites					
1.	***Acanthacris ruficornis*** Fabricius Synonyms: *Acanthacris ruficornis citrina* (Audinet-Serville) Mungai, *Acanthacris yemenita* Uvarov, *Acridium citrinum* Audinet-Serville, *Acridium gyldenstolpei* Sjöstedt, *Acridium ruficorne,* *Acridium ruficorne var. subimmaculatum* Finot, *Acridium ruficornis,* *Cyrtacanthacris amoenula* Walker, *Cyrtacanthacris decisa* Walker, *Cyrtacanthacris ruficornis,*	Garden locust	Seed, as contaminant	*Citrus* spp., *Coffea* spp., ***Gossypium hirsutum,*** *Vitis vinifera*	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Comoros, Congo ,Côte d'Ivoire, Djibouti, Democratic Republic, Equatorial Guinea, Eritrea, thiopia, Gabon, Ghana, Guinea, Kenya, Lesotho, Liberia,Madagascar , Malawi, ali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Saudi Arabia, Senegal, Sierra Leone,Somalia,	It is univoltine, overwintering in the egg phase and, to a lesser extent, the adult stage. Eggs are laid in moist soil; enter a quiescent state in the absence of water (CAB International, 2007).

	Gryllus Locusta lineata Stoll, *Gryllus ruficornis Fabricius* Order: Orthoptera Family: Acrididae				South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Yemen, Zambia, Zanzibar, Zimbabwe	
2.	***Acrosternum hilare*** Say Synonyms: *Nezara hilaris* (Uhler), *N. (Acrosternum) sarpinus* Stål, *Pentatoma hilaris* Say, *Rhaphigaster sarpinus* Dallas Order: Hemiptera Family: Pentatomidae	Green stink bug	Seed, as contaminant	*Abelmoschus esculentus*, *Acer negundo*, *Althaea* spp., *Asparagus officinalis*, *Brassica oleracea* var. *capitata*, *Catalpa* spp., *Cephalanthus occidentalis*, *Cercis amestown*, *Citrus sinensis*, *Cornus* spp., *Coronilla varia, Corylus avellana*, *Crataegus* spp., *Datura stramonium*, *Desmodium* spp., *Fragaria ananassa*, *Fraxinus* spp., *Glycine max*, ***Gossypium* spp.**, *Ilex aquifolium, Juglans nigra*, *Lonicera* spp., *Lycopersicon esculentum*, *Malus domestica*, *Medicago sativa*, *Mimosa* spp., *Morus alba*, *Phaseolus*, *P. lunatus*, *Pisum sativum*, *Platycladus orientalis*, *Prunus*	Canada, USA	Bugs aestivate as adults in plant debris and soil. Feeding results in reduced pod filling, seed viability and vigour, value of the seed for oil, meal or seed. Crop losses by bug to soybean are well documented. It affects the yield, pod filling, of 100 seed weight, viability and vigour of soybean seeds (Russin *et al*, 1987) Caged population of pest on soybean plants from early pod development to harvest reduced average yield from 3.63 t seed/ ha with stink bugs to 3.25 t with 4 adults/

				armeniaca, *P. avium*, *P. domestica*, *P. persica*, *P. serotina*, *Pyrus communis*, *Quercus* spp., *Rhamnus cathartica*, *Rhus* spp., *Robinia pseudoacacia*, *Rubus idaeus*, *Sambucus* spp., *S. amestown*, *Solanum melongena*, *Solidago* spp., *Syringa vulgaris*, *Tilia heterophylla*, *Trifolium* spp., *Ulmus rubra*, *Vigna unguiculata*, *Vitis vinifera*, *Wisteria* spp., *Zea mays*		0.3 m of row. Average germination was decreased from 87% to 78.2% and 67.2%, respectively (Yeargan, 1977).
3.	****Alcidodes dentipes*** Olivier Synonyms: *Alcides dentipes* Olivier Order: Coleoptera Family: Curculionidae	Striped sweet potato weevil	Seeds/ stem Cuttings/ plants	*Arachis hypogaea*, ***Gossypium*** spp., *Ipomoea batatas*, *Phaseolus vulgaris*	Benin, Cameroon, Central African Republic, Congo Democratic Republic, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Malawi, Mozambique, Nigeria, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo,	The adult weevils girdle sweet potato stems, just above the ground, causing plants to wilt and die. The larvae bore inside the stems, making galls. Similar damage occurs in groundnuts (Hill, 1983). It can potentially be transported on sweet potato tubers and seedlings. (CAB International, 2007).

					Uganda, Zambia, Zimbabwe	It is a quarantine pest for Mexico and the Caribbean (CAB International, 2007).
4.	****Amphitetranychus viennensis*** Zacher Synonyms: *Amphitetranychus crataegi* (Hirst), *Apotetranychus longipenis* Ugarov and Nikolskii, *Apotetranychus virginis* Ugarov, *Epitetranychus viennensis* Zacher, *Tetranychus crataegi* Hirst, *Tetranychus viennensis* Zacher Class: Arachnida Subclass: Acari Suborder: Prostigmata Family: Tetranychidae	Hawthorn (spider) mite, sweet cherry spider mite	Seeds/ stem Cuttings/ plants	*Amelanchier canadensis*, *Arachis hypogaea*, *Chaenomeles*, *Corylus avellana*, *Crataegus azarolus*, *C. monogyna*, *Cydonia oblonga*, *Deutzia* spp., *Ficus carica*, *Fragaria* spp., ***Gossypium* spp.**, *Malus domestica*, *M. toringo*, *Mespilus*, *Plumeria*, *Prunus avium*, *P. campanulata*, *P. cerasifera*, *P. cerasus*, *P. divaricata* , *P. domestica*, *P. dulcis*, *P. mume*, *P. persica*, *P. pseudocerasus*, *P. salicina*, *P. spinosa*, *P. yedoensis*, *Pyrus communis*, *P. pyrifolia Pyrus* spp., *Quercus mongolica* spp. *mongolica*, *Rubus idaeus*, *Sorbus* spp.	Austria, Azerbaijan, Bulgaria, China, DPR Korea, Georgia, Germany, Hungary, Iran, Japan, , Pakistan, Poland, Romania, Russian Federation, Spain, Sweden, Turkey, Ukraine, United Kingdom, Uzbekistan	*A. viennensis* is on the quarantine pest list in Australia and in the USA. The number of generations per year is estimated to be 4-6 in Iran (Sepasgozarian and Schruft, 1975); 7 or less in the Ukraine (Chepurnaya and Myalova, 1981); 5-6 in Germany; and 9-10 in Turkey (Jeppson *et al*., 1975). In Iran, the generation time is 84-106 days, and females lay 36-154 eggs. A host plant carrying either mites on the leaves or diapausing adult females under the bark has potential to distribute this mite to a new region or country. In apple, 100 or more mites per leaf may result in a yield loss of 40-65% (Bulgak, 1979).

5.	*#***Anthonomus grandis** Boheman Order: Coleoptera Family: Curculionidae	Mexican cotton boll weevil, cotton boll weevil, Thurberia boll weevil	Seed (with and without lint) and as contaminant	*Abutilon, Cienfuegosia, Eragrostis curvula,* ***Gossypium barbadense, G. hirsutum, Gossypium* spp.**, *Hampea nutricia, Hibiscus syriacus, Hibiscus, Opuntia lindheimeri, Prosopis glandulosa, Thespesia populnea,* Poaceae	Argentina, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Martinique, Mexico, Nicaragua, Paraguay, Saint Kitts and Nevis, USA, Venezuela	It is listed as an A1 quarantine pest by EPPO (OEPP/EPPO, 1979), and also has quarantine significance for Africa, Asia and the Caribbean. It first appeared in Georgia, USA, in 1915, causing cotton production to decline rapidly from 2.8 million bales in 1914 to 600,000 bales in 1923. During the 1970s, USA cotton producers lost US$ 200 million or more annually, whilst boll weevil supp.ression cost an additional US$ 75 million annually. It is the most costly insect pest of US cotton. In USA, with optimum control measures, losses would be 21%. (CAB International, 2007) In international trade, boll weevils may be carried with cotton seeds or bolls, with

						raw cotton and various cotton products (EPPO/CABI, 1992). Since its entry into Texas in the 1890s from Central America, the boll weevil has destroyed and reduced the quality of cotton worth several billion US$, averaging over 3 million hectares (CAB International, 2007). *A. grandis* hibernates in forest litter or on various Malvaceous hosts. The Mexican boll weevil (intermediate form) survives in larval cells in cotton bolls, but adults have also been found overwintering in suitable litter (EPPO/CABI, 1992). The offspring of a single pair of boll weevils could amount to several million in one season (EPPO/ CABI, 1992).

6.	****Anthonomus vestitus*** Boheman Order: Coleoptera Family: Curculionidae	Peruvian boll weevil, Peruvian cotton weevil, Peruvian cotton-bud weevil, Peruvian square weevil	Seed (with and without lint), As contaminant	*Abutilon* spp., *Alcea rosea*, *Althaea* spp., ***Gossypium* spp.,** *Hibiscus* spp., *Hibiscus rosa-sinensis*, *Thespesia* spp.	Ecuador, Peru, South America	It is a quarantine pest of the USA, and cotton imports from South America require Federal Phytosanitary Certificates within 30 days of shipment, after close inspection for *A. vestitus*, along with several other cotton pests. Crop losses may be ~ 10%, (Townsend, 1913; Willie, 1942; Beingolea, 1973)
7.	****Clavigralla tomentosicollis*** Stål Synonyms: *Acanthomia brevirostris* Stål , *A. tomentosicollis* (Stål) Order: Hemiptera Family: Coreidae	African pod bug, bean bug, spiny brown bug	Seed	*Cajanus cajan, Cicer arietinum, Glycine max,* ***Gossypium hirsutum,*** *Lablab purpureus,* *Phaseolus vulgaris, Spinacia oleracea, Tephrosia* spp., *Vigna unguiculata*	Algeria, Angola, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo, Ethiopia, Gambia, Ghana, Kenya, Ivory Coast, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa,	*C. tomentosicollis* is a major pest of grain legumes in Africa and could be of phytosanitary risk in Asia where grain legumes are also an important crop. An infestation level of 40-60% may cause reduction in weight of pigeon pea, pea seeds by 40-60%, the number of seeds reduced by 25-36%, and the seed quality by 94-98% (Hill and Waller, 1988).

					Sudan, Tanzania, Uganda, Zambia, Zanzibar, Zimbabwe	
8.	***Diabrotica speciosa** (Germar) Synonyms: *Diabrotica amabilis* Baly, *D. hexaspilota* Baly, *D. simoni* Jacoby, *D. simulans* Baly, *D. vigens* Erichson, *Galeruca speciosa* Germar Order: Coleoptera Family: Chrysomelidae	Cucurbit beetle, Chrysanthemum beetle, San Antonio beetle	Seed, as contaminant	*Amaranthus quitensis, Arachis hypogaea, Beta vulgaris, Brassica* spp., *Capsicum* spp., *Citrus* spp., *Cucumis* spp., *Cucurbita maxima, C. pepo, Cynara cardunculus, Glycine max,* ***Gossypium* spp., *G. hirsutum,*** *Helianthus annuus, Lactuca sativa, Lagenaria siceraria, Luffa aegyptiaca, Lycopersicon esculentum, Nicotiana tabacum, Oryza sativa, Phaseolus* spp., *P. vulgaris, Pisum sativum, Prunus persica, Sechium edule, Solanum tuberosum, Sorghum bicolor, Triticum aestivum Triticum* spp., *Zea mays*	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Panama, Paraguay, Peru, Uruguay, Venezuela	An important pest throughout southern South America (except Chile), but, being highly polyphagous, qualitative reports of its impact on different crops vary in different regions. Also an important pest of maize, cucurbits and orchard crops throughout its distribution. (CAB International, 2007) Eggs are laid in the soil near a host plant. Number of overlapp.ing generations depends on climatic conditions, being continuous in tropical areas while in Argentina, there are about three generations per year (USDA, 1957).
9.	***Diaprepes abbreviatus*** Linnaeus	Citrus weevil,	Seed, as contaminant	*Aeschynomene americana, Aloe vera, Apium graveolens, Arachis*	Antigua and Barbuda, Barbados, Dominica, French	Pupation occurs in soil and newly formed adults can remain in the pupal chamber

	Synonyms: *Curculio abbreviatus* Linnaeus, *Diaprepes festivus* (Fabricius), *D. irregularis* (Panzer), *D. quadrilineatus* (Olivier) *Exophthalmus abbreviatus* Order: Coleoptera Family: Curculionidae	West Indian weevil, sugarcane rootstalk borer, weevil weevil, sugarcane rootstalk borer, West Indian sugarcane root borer		*hypogaea, Ardisia crispa, Bauhinia* spp., *Byrsocarpus* spp., *Cajanus cajan, Calophyllum* spp., *Canavalia gladiata, Capsicum annuum, Cedrela odorata, Ceiba pentandra, Centrosema pubescens, Chrysobalanus icaco, Chrysophyllum cainito, Citrus* spp., *Codiaeum variegatum* var. *pictum, Coffea* spp., *Conocarpus erectus, Crotalaria* spp., *Cyperus* spp., *Delonix regia, Dieffenbachi* spp., *Dimocarpus longan, Dioscorea* spp., *D. batatas, Diospyros virginiana, Dizygotheca elegantissima, Dracaena* spp., *Eriobotrya japonica, Erythrina berteroana, E. poepp.igiana, Eugenia uniflora, Faramea occidentalis, Ficus* spp., *Gladiolus hybrids, Gliricidia sepium,* ***Gossypium* spp.,** *Guaiacum officinale, Hoya carnosa, Ilex* spp., *Ipomoea batatas, Jatropha curcas, Juniperus conferta, J. virginiana, Lablab*	Guyana, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, USA	for several months before they emerge (Hall, 1995). Losses on citrus in Florida, USA were estimated at US $73 million during 1995. The mechanical transportation is an important factor in dispersal of *D. abbreviatus* as its immature stages in the soil and adults clinging to farm vehicles have infested several citrus groves in Florida, USA (Beavers and Selhime, 1978).

				purpureus, Lagerstroemia speciosa, Liriope spp., *Lonchocarpus* spp., *Malachra* spp., *Mangifera indica, Manihot esculenta, Manilkara zapota, Maranta leuconeura, Mucuna pruriens, Musa* spp., *Passiflora* spp., *Nephelium lappaceum, Ocotea* spp., *Persea americana, Phaseolus lunatus, P. vulgaris, Phoenix dactylifera, Pimenta* spp., *Piper* spp., *Psidium* spp., *P. guajava, Rhizophora mangle, Ricinus communis, Saccharum officinarum, Schinus terebinthifolius, Solanum melongena, S. tuberosum, Sorghum bicolor, Spondias mombin, S. purpurea, Swietenia macrophylla, S. mahagoni, Swietenia* spp., *Syzygium jambos, Tamarindus indica, Terminalia catapp.a, Theobroma cacao, Urena lobata, Ximenia americana, Zanthoxylum* spp., *Zea mays*		

10.	***Diaprepes famelicus* (**Olivier) Synonyms: *Curculio famelicus* Olivier, *C. affinis* Fabricius, *Diaprepes famelicus barbadensis* Marshall, *D. famelicus elegantulus* Gyllenhal, *D. famelicus esuriens* Gyllenhal, *D. lepidopterus* Gyllenhal, *D. purvesi,* *Exophthalmus famelicus* Order: Coleoptera Family: Curculionidae	Root borer, sugarcane root borer, Leeward islands leaf weevil, white grub	Seed, as contaminant	*Cajanus cajan, Calotropis procera, Citrus aurantiifolia, Citrus* spp., ***Gossypium hirsutum,*** *Ricinus communis, Saccharum officinarum*	Antigua and Barbuda, Barbados, Bermuda, Cuba, Dominica, Grenada, Guadeloupe, Martinique, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines	In Dominica, it is a key pest of citrus plants in nursery propagation. Larvae feed on root bark, girdling the major roots and causing severe chlorosis, wilting and death of the seedlings (Whitwell, 1986). Pupation occurs in soil. In St Kitts, app.roximately 40,000 adults were collected from soil of sugarcane fields. Concurrently, in a lime plantation in Antigua, almost 24,000 adults were collected in 4 days. Heavy infestations also recorded in Montserrat and Barbados (Anonymous, 1914).
11.	***Dociostaurus maroccanus* (**Thunburg) Synonyms: *Baranov degenerates,*	Moroccan locust, Mediterranean locust	Seed, as contaminant	*Avena* spp., *Beta vulgaris, Cannabis sativa, Capsicum annuum, Carduus* spp., *Carum carvi, Cicer arietinum, C. sativus, Cucurbita* spp., *Elymus repens, Fragaria ananassa, Glycine max*, ***Gossypium***	Afghanistan, Albania, Algeria, Armenia, Austria, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France, Georgia, Greece,	Univoltine hibernates as a diapausing egg stage just under the soil (Grigorov, 1976). Periodically recorded in high densities, but outbreaks

	D. maroccanus, *D. vastator* (Fischer-Waldheim), *Oedaleus infernalis pendulus* (Steinmann), *Stauronotus cruciatus* (Charpentier), *S. maroccanus* (Thunberg), *S. vastator* (Fischer-Waldheim) *Dociostaurus cruciatus* (Charpentier), <u>Order:</u> Orthoptera <u>Family</u>: Acrididae			***hirsutum***, *Helianthus annuus, Hordeum* spp., *H. vulgare*, *Humulus lupulus*, *Lycopersicon esculentum*, *Malus* spp., *Medicago* spp., *Nicotiana tabacum*, *Panicum miliaceum*, *Pyrus* spp., *Quercus* spp., *Rosa* spp., *Rubus idaeus*, *Secale cereale*, *Solanum* spp., *Spinacia oleracea*, *Trifolium* spp., *Triticum* spp., *Vicia sativa*, *Vitis vinifera*, *Zea mays*	Hungary, Iran, Iraq, Israel, Italy, Kazakhstan, Kyrgyzstan, Macedonia, Morocco, Romania, Russian Federation, Spain, Syria, Tajikistan, Turkey, Turkmenistan, Uzbekistan	occurred at 10-year intervals: 1919, 1929, and 1939. From 1944 to 1990, there were no locust plagues in Bulgaria; the government called for suitable soil to be plugged and very intensive plant protection measures. After 1990, many agricultural areas abandoned and pest populations began to build up. The last outbreak of Moroccan locust was in 2000 and it is now a real menace for farmers in that area (Andreev, 2002)
12.	****Edessa meditabunda*** **(**Fabricius) <u>Synonyms:</u> *Aceratodes nuditabundus* Stål, *Cimex glaucescens* Fabricius, *C. meditabundus* Fabricius, *Edessa consentanea* Walker,	Green and brown stink bug	Seed, as contaminant	*Abelmoschus esculentus*, *Cajanus cajan*, *Capsicum annuum, Citrus* spp., *Datura stramonium, Desmodium* spp., *Glycine max*, ***Gossypium* spp.,** *Helianthus annuus, Linum usitatissimum, Lolium multiflorum* sspp. *gaudini*, *Lupinus albus, L. luteus, Lycopersicon esculentum, Manihot esculenta, Medicago sativa*, *Nicotiana tabacum, Phaseolus* spp.,	Antigua, Amazonas, Argentina, Barbados, Barbuda, Brazil, Cuba, Colombia, Espirito Santo, French Guiana, Guyana, Goias, Grenada, Grenadines, Haiti, Jamaica, Montserrat, Minas Gerais, Paraguay, Parana, Rio Grande	Overwinters as adult under tree barks, bushes or litter, with one generation per year. In soybean, percentage infestation varied with the variety and affects the weight, oil and protein content, and germination of the seeds (Link *et al.*, 1973).

	E. rugulosa Uhler Order: Hemiptera Family: Pentatomidae			*Pisum sativum, Solanum melongena, S. tuberosum, Theobroma cacao, Vigna umbellate, Zea mays*	do Sul, Saint Kitts and Nevis, Saint Lucia, Saint Vincent, Suriname, Trinidad and Tobago, Uruguay	Attack by the pest in Brazil caused increase in number of pods falling prematurely and number of empty pods/ plant, reduced seed weight and decrease in number of beans/ pod (Corso *et al*., 1978).
13.	***Gonocephalum macleayi** (Blackburn) Synonym: *Dasus macleayi* (Blackburn) Order: Coleoptera Family: Tenebrionidae	Southern false wireworm	Seed, as contaminant	*Cicer arietinum*, *Glycine max*, ***Gossypium* spp.**, *Helianthus annuus*, *Sorghum almum, S. bicolor*, *Triticum* spp., *Zea mays*	Australia	Adults and larvae attack seeds or seedlings of a wide variety of crops in eastern Australia (Robertson, 1993). Eggs are laid under weeds/ crop residues, univoltine, with over wintering adults/ larvae. Larvae remain in the soil for 10-12 months. Adults and larvae congregate under crop residues (Robertson and Simpson, 1988).
14.	***Helicoverpa punctigera** Wallengren Synonyms:	Native budworm, climbing cutworm, budworm,	Seeds, pods, soil	*Arachis hypogaea*, *Cajanus cajan*, *Carthamus tinctorius*, *Cicer arietinum*, *Echium plantagineum*, *Glycine max*, ***Gossypium***	Australian, New Zealand, Tasmania	Highly migratory, has a complex diapause strategy and is highly fecund laying 1500-1800 eggs over the reproductive period of 10-12

	Chloridea marmada Swinhoe *Heliothis punctigera* Wallengren, Order: Lepidoptera Family: Noctuidae	native cutworm		***hirsutum***, *Helianthus annuus*, *Linum usitatissimum*, *Lupinus angustifolius*, *Lycopersicon esculentum*, *Medicago sativa*, *Nicotiana tabacum*, *Pisum sativum*, *Sesbania cannabina*, *Sonchus oleraceus, Trifolium pratense*, *T. repens*, *Trifolium* spp., *T. subterraneum*, *Vicia faba, Vigna unguiculata*		days. These four features (polyphagy, mobility, diapause and high fecundity) allow *H. punctigera* to multiply and survive under diverse conditions. In sub-tropical and temperate areas of eastern Australia pupae enter a winter diapause, but some survive the winter as non-diapausing individuals, emerging before the bulk of the diapausing population (Murray and Zalucki, 1994). It causes severe damage on grain legumes costing about $A 20 million for control in Western Australia, Victoria and South Australia. *H. punctigera* and *H. armigera* together cause an estimated cost of control and damage at $A250 million annually in Australia (Adamson *et al.*, 1997).

15.	***Helicoverpa zea*** Boddie Synonyms: *Bombyx obsoleta* Fabricius, *Chloridea obsoleta* Fabricius, *Heliothis armigera* Hübner, *H. ochracea* Cockerell, *H. umbrosa* Grote, *H. zea* Boddie, *Phalaena zea* Boddie Order: Lepidoptera Family: Noctuidae	American cotton bollworm, bollworm, corn earworm, tomato fruit worm	Seed, As contaminant	*Abelmoschus esculentus*, *Abutilon theophrasti*, *Amaranthus* spp., *Arachis hypogaea*, *Brassica oleracea* var. *capitata*, *B. oleracea*, *Cajanus cajan*, *Capsicum* spp., *C. annuum*, *Cicer arietinum*, *Citrus* spp., *Coronilla varia*, *Cucumis melo*, *C. sativus, F. ananassa*, *Fragaria* spp., *Geranium carolinianum*, *Gerbera* spp., *Glycine max*, ***Gossypium* spp.,** *Helianthus annuus*, *Lactuca sativa*, *Lespedeza cuneata*, *Lonicera japonica, Lycopersicon esculenta, Medicago lupulina*, *M. sativa*, *Nicotiana tabacum*, *Panicum miliaceum, Pharbitis purpurea, Phaseolus vulgaris, Quercus* spp., *Salix* spp., *Solanum melongena, Sorghum* spp., *Trifolium* spp., *T. incarnatum*, *Vicia sativa*, *V. villosa, Vigna unguiculata, Zea mays*	Antigua and Barbuda, Argentina, Bahamas, Barbados, Bermuda, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Cuba Dominica, Ecuador, El Salvador, Falkland Islands, French Guiana, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, USA, Venezuela	*H. zea* undergoes pupal diapause and pupation occurs in the soil. It has a high fecundity (1500-3000) and in tropics, 10-11 generations per year have been recorded. Second most important pest in North America. Annual loss by *H. zea* and *H. virescens* together on all crops in USA is more than US$ 1000 million, despite the expenditure of 250 million US$ on insecticide app.lication (Fitt, 1989). It is migratory in nature and can fly hundreds of kilometers. *H. zea* resistant transgenic maize is under commercialization in USA. Recently added to EPPO A1 list of quarantine pests, and is a quarantine pest by APPPC.

16.	***Heliothis virescens*** (Fabricius) Order: Lepidoptera Family: Noctuidae	Tobacco budworm, tomato flaxworm, pigeonpea pod borer, tomato budworm	Seed, as contaminant	*Abelmoschus esculentus*, *Abutilon theophrasti*, *Antirrhinum majus*, *Arachis hypogaea*, *Cajanus cajan*, *Capsicum annuum*, *Cicer arietinum*, *Coronilla varia*, *Cucurbita pepo*, *Desmodium tortuosum*, *Eucalyptus* spp., *Geranium* spp., *G. carolinianum*, *Glycine max*, ***Gossypium* spp.,** *Helianthus annuus*, *Ipomoea batatas*, *Lactuca sativa*, *Linum usitatissimum*, *Lonicera japonica*, *Lycopersicon esculentum*, *Medicago lupulina*, *Nicotiana tabacum*, *Petunia* spp., *Phaseolus* spp., *P. vulgaris*, *Pisum sativum*, *Sorghum bicolor*, *Trifolium incarnatum*, *Vicia sativa*, *V. villosa*, *Zea mays*, Poaceae	Antigua and Barbuda, Antilles, Argentina, Bahamas, Barbados, Bermuda, Bolivia, Brazil, Canada, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Ecuador, El Salvador, French Guiana, Grenada, Guatemala, Grenadines, Guyana, Haiti, Honduras, Jamaica, Lesser Antilles, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts Nevis, Saint Lucia Saint, Trinidad and Tobago, Uruguay, USA,Vincent, Virgin Islands, Venezuela	The high mobility, polyphagy, high reproductive rate and diapause make *H. virescens* well suited to act as a serious pest on a wide range of crops. Harvestable parts of cotton, tomato, tobacco and maize attacked, representing a significant economic cost (King, 1994). Larval stages tunnel 5-15 cm into the soil and pupate for app.roximately 2-3 weeks before emergence. *H. virescens* exhibits a facultative diapause which enables it to survive low winter temperatures or hot, dry, summers. In Arizona and California, USA, it enters summer diapause when larvae are exposed to 43°C for 8 hours per day (Butler *et al.*, 1985).

17.	***Keiferia lycopersicella*** Walsingham Synonyms *Gnorimoschema lycopersicella* Busck *Gnorimoschema elmorei* *Keiferia elmorei* *Phthorimaea elmorei* *Phthorimaea lycopersicella* Order: Lepidoptera Family: Gelechiidae	Tomato pinworm	Seed, soil as contaminant	*Lycopersicon esculentum,* ***Gossypium* spp.,** *Nicotiana tabacum, Solanum melongena, S. tuberosum*	Bermuda, Costa Rica, Cuba, Haiti, Jamaica, Mexico, USA, Bolivia, Colombia, Venezuela	Pupation takes place within a cocoon in the soil. It has been identified as a potential threat to tomato-growing areas of Central Europe (Shutova, 1984)
18.	***Limothrips cerealium*** Haliday Synonyms: *Limothrips avenae* *Thrips cerealium* Order: Thysanoptera Family: Thripidae	Corn thrips, grain thrips, wheat thrips	Seed, as contaminant	226 species of host plant recorded in Britain, of which 47 are Gramineae. May attack all cereals *Agropyron*, *Avena sativa*, *Brassica eracea* var. *capitata*, *Citrus,* ***Gossypium* spp.,** *Linum usitatissimum*, *Nicotiana tabacum*, *Pinus nigra*, *Poa* spp., *Raphanus raphanistrum*, *Sinapis arvensis*, *Secale cereale*,	Australia, Austria, Azores, Belgium, Bulgaria, Canada, Canary Islands, Caribbean, Chile, Cyprus, Czechoslovakia (former),Denmark, Egypt, Finland, Guatemala, Libya, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Morocco,	Larvae and adults cause internal feeding, grains discolored, empty and shriveled. Vector of tomato spotted wilt tospovirus (TSWV) (CAB International, 2007). Cold storage and controlled atmosphere treatment are effective against the pest.

				Triticum aestivum, *Vitis vinifera, Zea mays*, Poaceae (grasses)	Netherlands, New Zealand, Portugal, Sardinia, Seychelles, South Africa, Spain, Switzerland, Syria, Turkey, USA, USSR (former), Yugoslavia (former)	
19.	***Loxostege sticticalis*** Linnaeus Order: Lepidoptera Family: Crambidae	Beet webworm, sugarbeet webworm	Pods, as contaminant	*Allium cepa*, *Arachis* spp., *Arachis hypogaea*, *Artemisia frigida*, *Asparagus officinalis*, *A. adsurgens*, *Atriplex patula*, *Avena sativa*, *Beta vulgaris* var. *saccharifera*, *Brassica juncea* var. *juncea*, *B. napus* var. *napus*, *B. nigra*, *B. oleracea*, *B. rapa* sspp. *oleifera*, *Cannabis sativa*, *Capsicum annuum*, *Chenopodium album*, *C. ficifolium*, *Citrullus lanatus*, *Cucumis melo*, *C. sativus*, *Daucus carota*, *Echinochloa crus-galli*, *Glycine max*, ***Gossypium* spp.**, *Helianthus annuus*, *Hibiscus trionum*, *Illicium verum*, *Lactuca sativa*, *Linum usitatissimum*,	Bulgaria, China, Italy, Kazakhstan, Mongolia, Netherlands, Romania, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Yugoslavia	Pre-pupae exhibit diapause. The pupa in white silk cocoon is glued to soil particles. It showed intermittent abundance with population cycles of about 20 years periodicity in the twentieth century (Knor, 1986). Migration and intermittent abundance enable this species to suddenly emerge in an area. Knor (1986) described outbreak population on a large number of agricultural crops in Western Siberia that immigrated from further east where the population

				Medicago falcata, *M. sativa*, *Melilotus albus*, *Nicotiana tabacum*, *Pisum sativum* var. *arvense*, *P. sativum*, *Polygonum aviculare*, *Raphanus sativus*, *Ricinus communis*, *Sesamum indicum*, *Solanum tuberosum*, *Sorghum bicolor*, *Triticum* spp., *Vicia faba*, *Zea mays*		had been building up over several years.
20.	***Lygus lineolaris*** Palisot de Beauvois Synonyms: *Capsus lineolaris* Palisot de Beauvois, *C. oblineatus* Say, *C. flavonotatus* Provancher, *C. strigulatus* Walker, *Lygus pratensis* var. *rubidus* Knight Order: Hemiptera Family: Miridae	Tarnished plant bug	Pods, Seed, as contaminant	*Amaranthus cruentus*, *Anethum graveolens*, *Apium graveolens* var. *dulce*, *Asparagus officinalis*, *Aster* spp., *A. pilosus*, *Bellis perennis*, *Beta vulgaris*, *Brassica napus* var. *napus*, *B. oleracea* var. *botrytis*, *B. oleracea* var. *capitata*, *Calendula officinalis*, *Cosmos* spp., *Cucumis sativus*, *Dahlia* hybrids, *Daucus carota*, *Erigeron* spp., *Fragaria ananassa*, *Gladiolus* hybrids, *Glycine max*, ***Gossypium hirsutum,*** *Helianthus* spp., *Lespedeza cuneata*, *Malus* spp., *Medicago sativa*, *Papaver*	Bermuda, Canada, El Salvador, Georgia, Republic, Guatemala, Honduras, Mexico, USA	Adults overwinter in dead plants and soil. *L. lineolaris* has a very wide host range in North America including 328 plant species, of which 130 are economically important. This represents 55 plant families belonging to 30 of the 70 orders of angiosperms in North America (Young ,1986). It causes significant yield losses in different crops in eastern and southern USA (Schwartz and Foottit, 1992)

				nudicaule, Phaseolus lunatus, P. vulgaris, Pinus echinata, Populus spp., *Prunus persica, Pyrus communis, Rubus* spp., *Salvia officinalis, Sinapis alba, Solanum tuberosum, Tragopogon porrifolius, Trifolium incarnatum, Verbena* spp., *Vicia sativa, Zinnia elegans*		
21.	***Mussidia nigrivenella*** Ragonot Order: Lepidoptera Family: Pyralidae	Cob borer, corn earworm, yam bean borer	Seeds, as contaminant	*Cola acuminata, Canavalia,* ***Gossypium hirsutum,*** *Musa* spp., *Mucuna* spp., *Phaseolus lunatus, Theobroma cacao, Zea mays*	Benin, Cameroon Congo, Congo Democratic Republic, Ghana, Ivory coast Mali, Mozambique, Niger, Nigeria, Senegal Sierra Leone, Tanzania, Togo, Zimbabwe	Pest remains inside the maize cob. Percent of grains attacked (15-20%) renders them worthless for sowing (Moyal and Tran, 1991). Serious threat to seed producers. Damage results in higher aflatoxin contamination of maize (Setamou *et al*., 1999).
22.	***Ostrinia nubilalis*** (Hübner) Synonyms:	European maize borer, European corn borer,	Seed, as contaminant	*Amaranthus retroflexus, Arctium minus, Artemisia vulgaris,*	Africa, Algeria, Austria, Belgium, Bulgaria, Cyprus Czechoslovakia	Full-grown larva is an over wintering stage. Several reports on the losses on maize, sorghum, cotton,

	Pyrausta nubilalis Meyrick, *Micracris nubilalis* Botys *nubilalis* Robin & Laboulbène Order: Lepidoptera Family: Pyralidae	corn moth, corn borer, European stalk borer		*Avena sativa, Capsicum* spp.,*C. annuum, Chrysanthemum* spp., *Cynara scolymus, Datura stramonium Echinochloa crus-galli, Glycine max,* ***Gossypium*** spp.**,** *Helianthus annuus***,** *Hordeum vulgare, Humulus lupulus, Lycopersicon esculentum, Malus domestica, Pennisetum glaucum, Phaseolus vulgaris, Prunus persica, Setaria italica, Solanum tuberosum, Sorghum* spp., *S. halepense, Triticum aestivum, Zea mays*, Poaceae	(former), Canada, Denmark, Egypt, England, France, Georgia, Germany, Greece, Hungary, **India (absent, reported but not confirmed)**, Iran, Ireland, Israel, Italy, Lebanon, Libya, Middle East, Moldova, Morocco *Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Sardinia, Sicily, Spain, Sweden, Switzerland, Syria, Ukraine, Yugoslavia, Turkey, Tunisia, USA*	capsicum, potato and other crops are given. (CAB International, 2007)
23.	****Pachnoda interrupta*** (Olivier) Order: Coleoptera Family: Scarabaeidae	chafer beetle sorghum chafer flower beetle pollen beetle	Seed as contaminant	*Abelmoschus esculentus, Balanites aegyptiaca, Cinnamomum burmannii, Cucumis sativus,* ***Gossypium* spp.,** *Helianthus annuus, Helianthus* spp., *Lawsonia inermis, Mangifera indica, Oryza sativa, Pennisetum*	Burundi , Cameroon, Mali, Nigeria, Senegal, Somalia, Sudan	The beetle has one generation per year. Late season beetles survive the dry season in the soil as quiescent adults or as pupae encased in protective pupation cells (CAB International, 2007).

				glaucum, Psidium guajava, Rosa spp., *Sorghum bicolor, Zea mays*		*P. interrupta* may be restricted in its distribution to the African continent.
24.	***Pectinophora scutigera*** Holdaway Synonyms *Platyedra scutigera* Holdaway Order: Lepidoptera Family: Gelechiidae	Pink spotted bollworm Queensland pink bollworm	Seed, as contaminant	***Gossypium* spp.,** *Hibiscus divaricatus*	Australia, Federated states of Micronesia, Guam, New Caledonia, Northern Mariana Islands, Papua New Guinea, USA	Infestations are very difficult to detect early as the eggs are small and the neonate larvae bore directly into cotton bolls leaving little external evidence of their presence (CAB International, 2007).
25.	***Peridroma saucia*** (Hübner) Synonyms: *Agrotis angulifera* Wallengren *A. impacta* Walker *A.inermis* Harris *A. intecta* Walker *A. ortonii* Packard *A. saucia* (Hübner) *Lycophotia margaritosa* (Haworth)	Pearly underwing moth, underwing moth, pearly variegated cutworm	Seed, pods, stem cuttings, plants, as contaminant	*Abies balsamea, A. grandis, Acer* spp., *A. negundo, A. saccharum, Alcea rosea, Allium cepa, Alnus rubra, Ambrosia artemisiifolia, Amelanchier canadensis, Anthemis cotula, Apium graveolens, Arachis hypogaea, Asparagus officinalis, A. setaceus, Aster* spp., *Avena sativa, Beta vulgaris, B. vulgaris var. saccharifera, Brassica napus* var. *napus, B. nigra, B. oleracea* var. *capitata, B. rapa* subsp.	Albania, Argentina, Armenia, Austria, Belgium, Bermuda, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Denmark, Faroe Islands, Finland, France, Germany, Greece, Guatemala, Hungary, Iceland, Ireland, Israel, Italy, Jamaica, Japan,	Major pest in most of USA. Losses in major outbreak on potato in 1900s were estimated $2.5m (Crumb 1929). Mature larva buries in soil and pupates in silk-lined chamber.

	L. ochronota Hampson *L. saucia* (Hübner) *Noctua aequa* Hübner, *N. majuscula* Haworth *N. margaritosa* Haworth *N. saucia* Hübner, *Peridroma margaritosa* Haworth *Rhyacia margaritosa* Haworth *R. saucia* Hübner <u>Order</u>: Lepidoptera <u>Family</u>: Noctuidae			*oleifera, Capsella bursa-pastoris , Capsicum annuum, Chamaecyparis thyoides, Chenopodium quinoa, Chrysanthemum, Cicer arietinum, Cichorium* spp.,*Cirsium* spp., *Citrullus lanatus, Citrus limon, C. sinensis, Conyza canadensis, Corylus* spp., *Cucumis melo, C. sativus, Cucurbita moschata, Cynara scolymus, Dahlia* spp., *Datura stramonium, Daucus carota, Dianthus* spp., *Epilobium angustifolium, Erigeron* spp., *Eupatorium* spp., *Fragaria ananassa, Geranium* spp., *Gladiolus hybrids, Gleditsia triacanthos,* ***Gossypium* spp.,** *Helianthus* spp., *H. annuus,* *Hordeum vulgare,* *Humulus lupulus,* *Inula helenium,* *Ipomoea batatas,* *Lactuca sativa,* *Lathyrus odoratus,* *Linum usitatissimum,*	Lithuania, Luxembourg, Malta, Morocco, Mexico, Netherlands, Norway, Peru, Poland, Portugal, Puerto Rico, Romania, Russian Federation, Slovakia, Spain, Sweden, Switzerland, Sri Lanka, Syria, Taiwan, Tunisia, Turkey, UK, USA, Uruguay, Venezuela, Yugoslavia (former)	

				Lolium spp., *Lycopersicon esculentum, Maclura pomifera, Malus pumila, Medicago sativa, Melia azedarach, Melilotus alba, Mentha piperita, M. spicata, Morus alba, Nicotiana tabacum, Parthenium argentatum, Persea americana, Petunia* spp., *Phaseolus lunatus, P. vulgaris, Phleum pratense, Picea glauca, Pimenta dioica, Pisum sativum, Plantago* spp., *Polygonum* spp., *Populus* spp., *Portulaca oleracea, Prunus armeniaca, P.cerasus, P. domestica, P. persica, Prunus* spp., *Pseudotsuga menziesi, Pteridium aquilinum, Pyrus communis, Raphanus sativus, Rheum hybridum, Rhus* spp., *Ribes uva-crispa, Rosa* spp., *Rubus fruticosa, R. idaeus, R. occidentalis, Rumex* spp., *Salix* spp., *Salvia officinalis, Secale cereale, Sinapis alba, Solanum tuberosum, Solidago* spp., *Sonchus* spp., *Spinacia*		

				oleracea, Stellaria media, Trifolium spp., *Triticum aestivum, Tropaeolum majus, Tsuga canadensis, turfgrasses, Vaccinium* spp., *Vicia* spp., *V. faba, Viola* spp., *Vitis vinifera, Xanthium strumarium, Zea mays, Z. mexicana, Zinnia* spp.		
26.	****Scirtothrips aurantii*** Faure Synonyms *Scirtothrips acaciae* Moulton Order: Thysanoptera Family: Thripidae	South African citrus thrips	Seeds as contaminant. Stem cuttings, plants	*Acacia* spp., *Arachis hypogaea, Asparagus officinalis , Bryophyllum pinnatum, Camellia sinensis, Citrus* spp., *C. limon, C. sinensis, Complyomma* spp., ***Gossypium* spp.,** *Grevillea robusta, Mangifera indica, Musa* spp., *Musa x paradisiaca, Ricinus communis, Vitis vinifera*	Angola, Cape Verde, Egypt, Ethiopia, Ghana, Kenya, Malawi , Mauritius, Nigeria, Réunion, South Africa, Sudan, Swaziland, Tanzania, Uganda, Yemen, Zimbabwe	*S. aurantii* has been declared to be a quarantine pest for the following Regional Plant Protection Organizations: APPPC, EPPO, OIRSA, PPPO (CAB International, 2007). The pest could be carried on plants for planting.
27.	****Spodoptera littoralis*** (Boisduval) Synonyms: *Hadena littoralis* Boisduval,	Cotton leafworm	Stem cuttings, plants	*Abelmoschus esculentus, Acacia nilotica, Actinidia arguta, Alcea rosea, Allium cepa, A. fistulosum, Amaranthus* spp., *Anemone* spp., *Antirrhinum majus, Apium*	Algeria, Angola, Bahrain, Benin, Botswana, Burundi, Cameroon, Congo, Congo Democratic Republic, Côte d'Ivoire, Cyprus,	A2 quarantine pest of EPPO (OEPP/ EPPO, 1981). Caribbean Plant Protection Commission, North American Plant Protection Organization and Organismo Internacional

	Noctua gossypii, *Prodenia littoralis* Boisduva, *P. litura* Fabricius sensu auctorum, *P. retina* Freyer, *P. testaceoides* Guenee <u>Order:</u> Lepidoptera <u>Family:</u> Noctuidae			*graveolens*, *Arachis hypogaea*, *Asparagus officinalis*, *Beta vulgaris*, *Beta vulgaris* var. *saccharifera*, *Brassica oleracea* var. *capitata*, *B. oleracea*, *B. rapa* subsp. *chinensis*, *Caladium* spp., *Callistephus chinensis*, *Camellia sinensis*, *Canna* spp., *Capsicum* spp., *C. annuum*, *Casuarina equisetifolia*, *Chloris gayana*, *Convolvulus* spp., *Chrysanthemum indicum*, *Citrullus lanatus*, *Citrus aurantium*, *Citrus* spp., *Coffea arabica*, *Corchorus capsularis*, *C. olitorius*, *Cryptomeria* spp., *Cucurbita pepo*, *Cucurbita* spp., *Cynara scolymus*, *Dalbergia sissoo*, *Datura* spp., *Daucus carota*, *Dianthus barbatus*, *D. caryophyllus*, *Eucalyptus globulus*, *Ficus carica*, *Fragaria vesca*, *Gerbera* spp., *Gladiolus* hybrids, *Glycine max*, ***Gossypium barbadense*, *Gossypium* spp.,** *Guizotia abyssinica*,	Egypt, Equatorial Guinea, Eritrea, Ethiopia, France, Gambia, Ghana, Greece, Guinea, Iran, Iraq, Israel, Italy, Jordan, Kenya, Lebanon, Libya, Madagascar, Madeira, Malawi, Mali, Malta, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Netherlands, Niger, Nigeria, Oman, Portugal, Rwanda, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Spain Sudan, Swaziland, Syria, Tanzania, Togo, Tunisia, Turkey, Uganda, United Arab Emirates, Yemen, Zambia, Zimbabwe	Regional de Sanidad Agropecuaria also consider it to be of quarantine significance. One of the most destructive pests within subtropical and tropical range. Pods of cowpea and seed inside pods are badly damaged. *S. littoralis* shows differences in response to cold both between strains and within developmental stages of the pest (Powell and Gostick, 1971. It is a potential pest of areas where the average annual minimum temperature does not go below -10°C (CAB International, 2007). There are many reports of resistance to some of the insecticides and also lack of available biological control agents also in Green houses (CAB International, 2007).

				Helianthus annuus, *H. tuberosus*, *Hibiscus cannabinus*, *H. mutabilis*, *Indigofera tinctoria*, *Ipomoea batatas*, *Jatropha curcas*, *Lactuca sativa*, *Lantana* spp., *Luffa aegyptiaca*, *Lycopersicon esculentum*, *Lycopersicon* spp., *Malus sylvestris*, *Medicago sativa*, *Melilotus* spp., *Mentha spicata*, *Monstera deliciosa*, *Morus* spp., *Musa* spp., *Musa* x *paradisiaca*, *Nicandra physalodes*, *Nicotiana tabacum*, *Opuntia* spp., *Oryza sativa*, *Persea americana*, *Phaseolus* spp., *Phaseolus vulgaris*, *Phoenix dactylifera*, *Piper* spp., *Pistia stratiotes*, *Pisum sativum*, *Populus alba*, *Portulaca oleracea*, *Prunus domestica*, *Psidium guajava*, *Punica granatum*, *Quercus petraea*, *Raphanus sativus*, *Ricinus communis*, *Rosa* spp., *Saccharum officinarum*, *Salvia officinalis*, *Senecio* spp., *Sesamum indicum*,		The standard treatment used in UK is cold storage for 2-4 days at 7°C, followed by methyl bromide fumigation at 15-20°C (Mortimer and Powell, 1988). This has also been adopted as an EPPO quarantine procedure (OEPP/ EPPO, 1990)

				Sesbania sesban, *Solanum melongena*, *S. tuberosum*, *Sorghum bicolor*, *Spinacia oleracea*, *Tectona grandis*, *Theobroma cacao*, *Trifolium alexandrinum*, *T. repens*, *Trifolium* spp., *Trigonella foenum-graecum*, *Triticum aestivum*, *Verbena* spp., *Vicia faba*, *Vigna angularis*, *V. mungo*, *V. radiata*, *V. unguiculata*, *Viola odorata*, *Vitis vinifera*, *Zea mays*, *Zinnia elegans* Brassicaceae, Euphorbiaceae, Fabaceae, Poaceae		
28.	***Thaumatotibia leucotreta*** Meyrick Synonyms *Cryptophlebia roerigii* Zacher *Thaumatotibia roerigii* Zacher *Cryptophlebia leucotreta* Meyrick *Olethreutes leucotreta* Meyrick	false codling moth orange moth citrus codling moth orange codling moth	Cuttings/ plants	*Abutilon hybridum, Ananas comosus, Annona muricata, Averrhoa carambola, Camellia sinensis, Capsicum* spp., *Ceiba pentandra, Citrus sinensis, Citrus* spp., *Coffea arabica,* ***Gossypium* spp.,** *Litchi chinensis, Macadamia ternifolia, Mangifera indica, Olea europaea* subspp. *europaea, Persea americana, Prunus persica, Psidium guajava, Punica*	Angola, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad , Congo Democratic Republic, Côte d'Ivoire, Eritrea, Ethiopia, Gambia, Ghana, Kenya, Madagascar, Malawi, Mali,	The female moth lays eggs by night, usually singly on the bolls or fruits of the plant. On cotton it first mines the boll wall, but later transfers to the seeds. This moth is a serious pest of citrus in Southern Africa and of cotton in many parts of Africa.

	Order: Lepidoptera Family: Tortricidae			*granatum, Ricinus communis, Sorghum bicolor, Zea mays*	Mauritius, Mozambique, Niger, Nigeria, Rwanda, Réunion, Saint Helena, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe	Losses of between 42 and 90% in late crops of cotton have been reported in Uganda (CAB International, 2007).
	MITES					
29.	***Tetranychus arabicus** Attiah Class: Arachnida Family: Tetranychidae	Spider mite	Seed, as contaminant	*Ficus carica, Glycine max,* ***Gossypium* spp.,** *Malus domestica*	Egypt	Eggs laid in soil. *T. arabicus* has been reported to display resistance to dicofol, parathion-methyl and phosalone from Egypt (http://www.pesticideresistance.org/DB/species_profile.php?arthropodid=794 accessed on 26.5.12)
30.	***Tetranychus cucurbitacearum** Sayed Class: Arachnida Family: Tetranychidae	Spider mite	Seed, stem cuttings, plants, as contaminant	*Arachis hypogaea, Glycine max,* ***Gossypium* spp.**	Egypt	Eggs laid in soil and pest has been reported to display resistance to dicofol and parathion-methyl (http://www.pesticideresistance.org/DB/species_profile

						.php?arthropodid=800 accessed on 26.5.12)
31.	***Tetranychus pacificus*** McGregor Class: Arachnida Family: Tetranychidae	Pacific spider mite	Seeds, pods	*Asclepias* spp., *Ceanothus* spp., *Chenopodium album, Citrullus lanatus* , *Cotoneaster* spp., *Cucumis melo, Ficus carica*, *Fragaria* spp., *Glycine max,* ***Gossypium barbadense, G. hirsutum, Gossypium* spp.,** *Helianthus* spp., *Medicago sativa, Melia azadirachta, Phaselus vulgaris*, *Prunus* spp., *Ribes* spp., *Robinia pseudoacacia, Rosa* spp., *Rubus* spp., *Salvia* spp., *Swietenia* spp., *Ulmus* spp., *Vicia* spp., *Vitis vinifera, Zea mays*	Canada, Mexico, USA	*T. pacificus* is a quarantine pest in Japan and Australia (and possibly in Europe). All fresh fruits entering these countries have to be certified free of *T. pacificus* (Ahumada *et al*., 1996).
32.	***Tetranychus truncatus*** Ehara Class: Arachnida Subclass: Acari Suborder: Prostigmata Family: Tetranychidae		Seed, seed sprouts, stem cuttings, plants, as contaminant	*Arachis hypogaea, Cucumis melo, Daucus carota, Elaeis guineensis,* ***Gossypium*** spp., *Manihot esculenta, Morus alba , Phaseolus* spp., *Ricinus communis, Solanum melongena, Zea mays, Ziziphus jujube*	China, Guam, Japan, Korea, Republic of, Malaysia, Philipp.ines, Thailand	*T. truncatus* is polyphagous, attacking many plant species. In China it is an important pest of maize and cotton, and *Sophora japonica* and jujube *(Ziziphus sativa)* trees (CAB International, 2007).

	NEMATODE					
33.	*Ditylenchus africanus* Wendt *et al*. Synonym: *Ditylenchus destructor* Thorne, 1945 Family: Anguinidae	Peanut pod rot nematode	Seed and soil	*Glycine max*, ***Gossypium hirsutum,*** *Helianthus annuus*, *Luoinus albus*, *Medicago sativa*, *Nicotiana tabacum, Phaseolus vulgaris*, *Pisum sativum, Sorghum bicolor*, *Triticum aestivum*, *Vigna unguiculata*, *Zea mays*	South Africa	Undergoes dehydration and enters a state of anhydrobiosis. Reproduces within the pod and seed and at 28° C the life cycle from adult to adult is 6-7 days (Waele De and Wilken, 1990). Nematodes can survive either in anhydrobiotic state or as eggs in hulls left in the field in the absence of host plants for at least 32 weeks. Besides being a parasite of plants, it can also feed and reproduce on the hyphae of common plant pathogenic fungi, such as *Aspergillus parasiticus, Botrytis cinerea, Fusarium oxysporum,* and *Rhizoctonia solani*.
	FUNGI					
34.	*#¥***Fusarium proliferatum** (Matsushima) Nirenberg Synonym	Fusarium kernel rot	Seed	*Asparagus officinalis, Cymbidium* spp. , ***Gossypium* spp.**, *Musa* spp., *Oryza sativa, Pinus* spp., *P. strobus, Secale*	American Samoa, Argentina, Australia, Canada, Yugoslavia (erstwhile), Greece, Guam, Hungary,	Mulè *et al*. (2004) developed a species-specific PCR assay diagnosis technique which provided a powerful tool for the detection of toxigenic fungi (*Fusarium proliferatum,*

	Fusarium moniliforme var. *intermedium* Neish & Legg.			*cereale, Triticum aestivum, Vitis vinifera,*	Iran, Italy, South Africa, Spain, USA	*F. subglutinans* and *F. verticillioides*) in maize kernels. **Laday *et al*. (2004) used restriction fragment length polymorphisms (RFLP) to assess genetic diversity of mitochondrial DNA (mtDNA) among 184 isolates of *F. proliferatum* from different hosts and reported the mtDNA RFLP analysis as a useful indicator of genetic divergence in *F. proliferatum*.**
35.	**Gibberella xylarioides* Heim & Saccas [teleomorph] Synonyms *Fusarium oxysporum* forma *xylarioides* (Steyaert) Deassus, *Fusarium xylarioides* Steyaert [anamorph]	Coffee wilt, sudden death of coffee, tracheomy cosis of coffee, vascular wilt of coffee,	Stem, wood, plant debris, soil	*Coffea arabica, C. canephora, C. liberica,* ***Gossypium* spp.,** *Musa x paradisiaca, Solanum lycopersicum (=Lycopersicon esculentum)*	Angola, Burkina Faso, Central African, Republic Congo, , Côte d'Ivoire, Democratic Republic Congo, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Swaziland,	In Congo, two of every six coffee producing provinces, more than 90% of farms were affected with coffee wilt disease and in 27 districts of Uganda yield losses averaged 70% (Girma, 1997; Girma and Hindorf 2001). Unlike other coffee diseases, coffee wilt kills the plant, causing up to 100% losses. (http://www.cabi.org/Uplo

					Tanzania, Togo, Uganda, Zimbabwe	ads/File/CABIDotOrg/Annual%20Review/Annual%20Review%202009%20(2).pdf-down load on 2.11.10).
36.	*# ***Phymatotrichopsis omnivora*** (Duggar) Hennebert Synonyms *Hydnum omnivorum* Shear [teleomorph], *Ozonium auricomum* Pammel [anamorph], *Ozonium omnivorum* Shear [anamorph], *Phymatotrichum omnivorum* Duggar [anamorph]	Cotton root rot, Texas root rot of cotton, soft rot of cotton, grapevine Texas root rot	Stem, wood, plant debris,	*Abelmoschus esculentus, Arachis hypogaea, Beta vulgaris* var. *saccharifera, Carya illinoinensis, Ficus carica, Glycine max*, ***Gossypium* spp.**, *Juglans regia, Malus domestica, Malus* spp., *Medicago sativa, Petroselinum crispum, Phaseolus* spp., *Populus* spp., *Prunus dulcis, P. persica, Pyrus communis, Robinia pseudoacacia, Salix* spp., *Ulmus* spp., *Vitis vinifera* Fabaceae, Juglandaceae, Malvaceae, Rosaceae, Umbelliferae	Libya, Mexico, USA, Venezuela	Arif *et al.* (2010) described PCR assays for detection of *P. omnivora* useful for rapid and sensitive diagnosis in several dicots from USA and Mexico. Streets and Bloss (1973) reported that in 1973 the disease caused losses worth 100 million US dollars in Texas alone. In 1998 La Laguna, Coahuila region Mexico, approximately one million dollars of annual losses were estimated due to the reduction of nut yield in affected pecan trees (Samaniego *et al.*, 1998). Mulrean *et al.* (1984) reported that yields of cotton, grown in infected field, were reduced by 10 to 13% and losses were 0.46

						bales/infested ha to 0.26 bales.
37.	*#¥***Pleospora herbarum** (Fr.) Rabenh. Synonyms *Clasterosporium putrefaciens* Sacc., *C. putrefaciens* var. *crucipes* Speshnev, *Macrosporium commune* Rabenh., *M. parasiticum* Thüm., *Phoma albicans* Roberge & Desm., *Pleospora albicans* Fuckel, *P. frangulae* Fuckel, *P. fruticola* Ruehle, *P. grossulariae* (FR.) Fuckel, *P. labiatarum* Cooke & Harkn., *P. leguminum* (Wallr.) Rabenh., *P. lycopersici* El.Marchal & Em.Marchal, *P. mali* Newton,	Leaf blight of onion, melanosis of onion, burn spot of pepper, grey spot of lupin leaf, leaf spot of clover, leaf spot of lettuce, leaf spot of Lucerne, leaf blight of soybean	Seeds (contaminants)	*Allium* spp., *A. cepa, A. sativum, Asparagus officinalis, Cryptomeria japonica, Dianthus caryophyllus,* ***Gossypium* spp.,** *Hordeum vulgare, Malus domestica, Medicago sativa, Petroselinum crispum, Phaseolus vulgaris, Raphanus sativus, Solanum lycopersicum (=Lycopersicon esculentum), Triticum aestivum, Vicia faba, Zinnia elegans*	Australia, China, France, Germany, Greece, Hungary, India, Italy, Poland, Portugal, Saudi Arabia, USA	

	P. meliloti Rabenh., *P. putrefaciens* Frank, *P. salsolae* Fuckel, *P. typhae* Pass., *Sphaeria herbarum* Fr., non Pers., *Stemphylium botryosum* Wallr., *S. botryosum* f.spp. *lycopersici,* *S. herbarum* Simmons					
38.	*__Puccinia cacabata__* Arthur & Holw Synonyms *Aecidium gossypii* Ellis & Everh., *Puccinia stakmanii* Presley, *Uredo chloridis-berroi* Speg., *Uredo chloridis-polydactylidis* Viégas,	South western cotton rust, rust of cotton	Seed (contaminant), plant debris	*Bouteloua aristidoides, B. barbata, B. barbata* var. *rothrockii, B. eriopoda, B. hirsuta, Chloris* spp., *C. ciliata,* ***Gossypium barbadense, G. herbaceum, G. hirsutum, Gossypium* spp, *G. thurberi***	Argentina , Bahamas, Bolivia, Brazil, Dominican Republic, Guatemala, Mexico, USA	More prevalent in West Texas, Southeastern New Mexico, Southern Arizona, and Northern Mexico. Some growers in the Fort Hancock area lost their entire cotton crop due to rust in 1991, but most growers in Far West Texas lost about 75 per cent of the yield (http://southwestfarmpress.com/cotton/west-texas-cotton-survives-challenges-2008-crop). Percy (1993) reported reduction of cotton yields 50 to 75% in USA and Mexico.

39.	*****Verticillium nigrescens*** Pethybridge	Seed reduction of soybean	Seed, soil, plant debris	*Glycine max,* ***Gossypium* spp.,** *Solanum tuberosum*	China, Japan, USA	Millar and Roy (1982) reported isolating it from leaves, pods and seeds of soybean.
	BACTERIA					
40.	**♠* ***Burkholderia cepacia*** (ex Burkholder) Y abuuchi *et al.* Synonyms *Pseudomonas cepacia* (ex Burkholder) Palleroni & Holmes, *P . kingii* Jonsson, *P . multivorans* Stanier , Palleroni & Doudoroff	Slippery skin of onion, sour skin of onion	Seed, bulb, plant debris	*Allium* spp., *A. cepa*, *A. sativum*, *Brassica rapa* spp. *pekinensis*, *Cymbidium* spp., *Dendrobium* spp., *Euphorbia pulcherrima*, *Glycine max*, ***Gossypium* spp.**, *Hordeum vulgare*, *Lactuca sativa* , *Malus domestica*, *Nicotiana tabacum*, *Paphiopedilum* spp., *Phaseolus vulgaris*, *Pisum sativum*, *Solanum lycopersicon, S. tuberosum*, *Zea mays*	Argentina, Australia, Brazil, Canada, Egypt, Italy , Japan, Korea, Nigeria, Papua New Guinea, USA, Venezuela	Amplification of genomic DNA via repetitive sequence-based PCR using primers specific for repetitive extragenic palindromic elements, followed by cloning of amplified fragments can detect presence of as few as 10 cells in a mixed sample (Matheson *et al*., 1997) Yield losses of 5-50% recorded in onion and other crops (Schwartz and Mohan, 1995)
41.	**#****Rhizobium rhizogenes*** (Riker *et al*.) Young *et al.*	Gall, burr knot, crown knot, root knot, root gall, crown gall,	Contaminated seed, soil, vegetative propagules contaminated with bacterium,	*Abies alba*, *A. concolor*, *A. firma*, *A. grandis*, *A. nordmanniana*, *Acalypha* spp., *Acer* spp., *A. saccharinum*, *Achillea millefolium*, *Actinidia chinensis*, *Aesculus*	Algeria, Australia, Brazil, Bulgaria, Canada, China, Colombia, Estonia, France, French West Indies, Indonesia, Italy,	Velazquez *et al* (2005) reported that the legume endosymbionts contain *nod* and *nif* genes responsible for nodule formation and nitrogen fixation, respectively, whereas the

	Synonyms *Agrobacterium* biovar 2 (Riker *et al.*) Conn, *Agrobacterium radiobacter* (Beijerinck & Van Delden) Kerr *et al.*, *Agrobacterium rhizogenes* (Riker *et al.*) Conn, *Agrobacterium tumefaciens* biovar 2, *Bacterium rhizogenes* Riker *et al.*, *Erwinia rhizogenes* (Riker *et al.*) *Dowson*, *Phytomonas rhizogenes* Riker *et al.*,	bacterial gall, bacterial stem gall, beet crown gall, crown gall of beet, hairy root of apple, Rosaceae crown gall		*hippocastanum*, *Aesculus* spp., *Ageratum houstonianum*, *Alcea rosea*, *Allamanda* spp., *Althaea cannabina*, *Allium cepa*, *Alnus rubra*, *Alsobia dianthiflora*, *Amaranthus caudatus*, *Anagallis arvensis*, *Anemone* spp., *Antirrhinum majus*, *Apium graveolens*, *Apocynum cannabinum*, *Aporocactus flagelliformis*, *Aralia cordata*, *Arbutus unedo*, *Ardisia crispa*, *Armoracia rusticana*, *Artemisia* spp., *Asclepias curassavica*, *A. syriaca*, *Asparagus densiflorus*, *A. officinalis*, *A. setaceus*, *Aster* spp., *A. amellus*, *Atropa belladonna*, *Begonia* spp., *Bellis perennis*, *Benincasa hispida*, *Beta vulgaris* var. *saccharifera*, *Betula* spp., *B. pendula*, *Borago officinalis*, *Brassica* spp., *B. napus* var. *napus*, *B. nigra*, *B. oleracea*, *B. oleracea* var. *botrytis* subvar. *cymosa*, *B. rapa* spp. *rapa*, *Bryophyllum pinnatum*,	Japan, Malawi, Malaysia, Portugal, Russian Federation, South Africa, Spain, Taiwan, Ukraine, USA	pathogenic strains carry *vir* genes responsible for the formation of tumors or hairy roots. They report for the first time that the occurrence of two rhizobial strains belonging to Rhizobium rhizogenes able to induce hairy roots or tumors in plants and also to nodulate *P. vulgaris* under natural environmental conditions. Symbiotic plasmids (pSym) containing *nod* and *nif* genes and pTi- or pRi-type plasmids containing *vir* genes were found in these strains. Pathogen can be detected by amplified PCR (Aida *et al.*, 2004). Wide diversity reported among strains from various plant hosts, planting sites and even the same gall. Variability exists between strains from the same tumour also.

				Cajanus cajan, *Calendula* spp., *Callistephus chinensis*, *Calocedrus decurrens*, *Calotropis procera*, *Calystegia sepium*, *Camellia japonica*, *C. sinensis*, *Campanula pyramidalis*, *Canavalia ensiformis*, *Cannabis sativa*, *Capsicum annuum*, *Caragana arborescens*, *Carthamus tinctorius*, *Carya illinoinensis*, *Castanea dentata*, *C. sativa*, *Catharanthus roseus*, *Ceanothus* spp., *Celtis occidentalis*, *Centaurea cyanus*, *Chaenomeles japonica*, *Chamaecyparis lawsoniana*, *Chenopodium album*, *C. giganteum*, *Chimonanthus praecox*, *Chrysanthemum coronarium*, *C. frutescens*, *Cichorium* spp., *Cirsium arvense*, *Citrullus lanatus*, *Citrus aurantium*, *C. limetta*, *C. limon*, *C. maxima*, *C. sinensis*, *Citrus* x *paradisi*, *Clematis* spp., *Codiaeum variegatum*, *Coleus blumei*, *Conium*		

				maculatum, Corchorus capsularis, Coriandrum sativum, Cornus florida, Corylus avellana, Cosmos bipinnatus, Crataegus spp., *Cucumis melo, C. sativus, Cucurbita maxima, C. pepo, Cunninghamia lanceolata, Cupressus macrocarpa, Cydonia oblonga, Cynara scolymus, Dahlia pinnata, Daphne mezereum, Datura innoxia, D. metel, D. stramonium, Daucus carota, Delonix regia, Dianthus barbatus, D. caryophyllus, Digitalis purpurea, Dioscorea* spp., *D. alata, Diospyros kaki, D. lotus, Elaeagnus angustifolia, Epilobium hirsutum, Eriobotrya japonica, Erodium cicutarium, Erysimum cheiri, Eucalyptus citriodora, Euonymus fortunei, Euphorbia helioscopia, E. marginata, E. pulcherrima, Ficus carica, F. elastica, Foeniculum vulgare, Forsythia intermedia, F.*		

				suspensa, Fragaria vesca, Fraxinus spp., *F. americana, Fuchsia magellanica, Galinsoga parviflora, Gardenia* spp., *Geranium carolinianum, Glycine* spp., ***Gossypium hirsutum,*** *Gypsophila paniculata, Hatiora gaertneri, Helianthus annuus, H. tuberosus, Hibiscus sabdariffa, Humulus lupulus, Hydrangea* spp., *Ilex aquifolium, Impatiens balsamina, Ipomoea batatas, Juglans cinerea, J. nigra, J. regia, Juniperus chinensis, J. virginiana, Kalanchoe* spp., *K. blossfeldiana, Kerria japonica, Lactuca sativa, Lantana camara, Larix* spp., *Lathyrus odoratus, L. sativus, Lespedeza* spp., *Lens culinaris* sspp. *culinaris, Leucanthemum vulgare, Ligustrum* spp., *Linum usitatissimum, Lonicera periclymenum, L. tatarica, Lupinus* spp., *Lycium* spp., *Lythrum salicaria,*		

				Macadamia ternifolia, Maclura pomifera, Malva spp., *Mangifera indica, Manihot esculenta, Medicago sativa, Momordica balsamina, Morus alba, M. nigra, Musa* x *paradisiaca, Myoporum* spp., *Myosotis* spp., *Nerium oleander, Nicandra physalodes, Nicotiana alata, N. glauca, N. rustica, N. tabacum, Oenothera biennis, Pachysandra terminalis, Paeonia lactiflora, P. officinalis, Parthenocissus* spp., *P. quinquefolia, P. tricuspidata, Passiflora* spp., *Pastinaca sativa, Pelargonium* spp., *P. grandiflorum* hybrids, *P. graveolens, Penstemon hybrida, Pericallis cruenta, Persea americana, Petroselinum crispum, Petunia hybrida, Phaseolus lunatus, P. vulgaris, Philadelphus* spp., *Philodendron* spp., *Phlox* spp., *P. drummondii, P. paniculata, Pinus* spp.,		

				Piper spp., *Pisum* spp., *P. sativum*, *Platycladus orientalis*, *Populus* spp., *P. alba*, *P. balsamifera*, *P. canescens*, *P. deltoides*, *Primula obconica*, *Prosopis chilensis*, *P. juliflora*, *Prunus* spp., *P. americana*, *P. amygdalus*, *Prunus angustifolia*, *P. armeniaca*, *P. avium*, *P. cerasifera*, *P. cerasus*, *P. domestica*, *P. dulcis*, *P. mume*, *P. nigra*, *P. persica*, *P. salicina*, *P. serotina*, *P. serrulata*, *P. spinosa*, *P. tomentosa*, *P. umbellata*, *Pseudotsuga menziesii*, *Punica granatum*, *Pyracantha coccinea*, *Pyrus communis*, *Pyrus* spp., *Raphanus sativus*, *Rheum hybridum*, *Rhododendron* spp., *Ribes nigrum* spp., *Ribes rubrum*, *Ricinus communis*, *Rosa centifolia*, *R. chinensis*, *R. multiflora*, *R. rugosa*, *Rosmarinus officinalis*, *Rubus* spp., *R. idaeus*, *R. loganobaccus*, *R. occidentalis*, *Rosa* spp., *Rudbeckia laciniata*, *Ruta*		

				graveolens, *Saintpaulia ionantha*, *Salix* spp., *S. alba*, *S. babylonica*, *S. caprea*, *Salvia officinalis*, *Scabiosa atropurpurea*, *Schinus molle*, *Sciadopitys verticillata*, *Scorzonera hispanica*, *Sechium edule*, *Sedum* spp., *S. sieboldii*, *S. spectabile*, *Sequoia sempervirens*, *Sesamum indicum*, *Sinapis alba*, *Solanum lycopersicum (=Lycopersicon esculentum)*, *Solanum* spp., *S. laciniatum*, *S. melongena*, *S. nigrum*, *S. tuberosum*, *Solidago canadensis*, *Sorbus americana*, *Spiraea vanhouttei*, *Stapelia* spp., *Symphoricarpos albus*, *Syringa* spp., *S. vulgaris*, *Tagetes erecta*, *T. patula*, *Tanacetum coccineum*, *Taraxacum officinale* complex, *Taxus baccata*, *T. brevifolia*, *T. media*, *Theobroma cacao*, *Thuja occidentalis*, *T. plicata*, *Tilia platyphyllos*, *Torreya californica*, *Tragopogon porrifolius*, *Trifolium*		

				pratense, *T. repens*, *Tropaeolum majus*, *Ulmus americana*, *U. glabra*, *U. pumila*, *Urtica urens*, *Vaccinium* spp., *Valeriana officinalis*, *Viburnum* spp., *Vicia faba*, *V. sativa*, *V. villosa*, *Vigna radiata*, *Vinca major*, *V. minor*, *Vitis labrusca*, *Vitis vinifera*, *Wisteria sinensis*, *Xanthium strumarium*, *Zinnia elegans*, Cactaceae		
	WEEDS					
42.	**Abutilon theophrasti* Medic. Synonyms *Abutilon avicennae* Gaertn. *Sida abutilon* L. Family: Malvaceae	China jute, Chinese velvet leaf, lantern, velvet leaf	Seed as contamination	*Allium cepa, Beta vulgaris, Brassica oleracea* var. *capitata, B. rapa* subsp. *rapa, Citrus* spp., *Glycine max,* ***Gossypium hirsutum****, Helianthus annuus, Hordeum vulgare, Lycopersicon esculentum, Pennisetum glaucum, Phaseolus vulgaris, Solanum tuberosum, Sorghum bicolor, Triticum aestivum, Zea mays*	Bulgaria, Canada, China, Croatia, Denmark, France, Germany, Greece, Hungary, Italy, Japan, Kazakhstan, Korea (Republic), Netherlands, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, UK, USA,	Causes severe crop loss in soybean and cotton. In USA, it is listed as a noxious weed in the state of Colorado. (Anonymous, 1998)

					Yugoslavia (erstwhile)	
43.	*__Amaranthus albus__ L. Family: Amaranthaceae	Tumble pigweed	Seed as contamination	*Arachis hypogaea, Beta vulgaris, Glycine max,* ***Gossypium hirsutum,*** *Helianthus annuus, Lycopersicon esculentum, Medicago sativa, Olea europaea* subsp. *europaea, Solanum tuberosum, Zea mays*	Albania, Argentina, Australia, Austria, Belgium, Bulgaria, Cambodia, Canada, China, Colombia, Cyprus, Czechoslovakia (erstwhile), France, Germany, Greece, Hungary, Italy, Mexico, Morocco, Netherlands, New Zealand, Portugal, Romania, Russia, Switzerland, Turkey, Ukraine, Uruguay, USA	Holm *et al*. (1979) listed *A. albus* as a 'principal' weed in Portugal and Mexico. It is also listed as a significant weed in a wide range of crops in USA, Spain, Hungary, Turkey and Ukraine.
44.	*__Cirsium vulgare__ Savi (Ten.) Synonyms *Ascalea lanceolata* (L.) Hill, *Carduus lanceolatus* L., *C. vulgaris* Savi,	Bull thistle, spear thistle	Seed as contamination	*Allium cepa, Avena sativa, Brassica napus* var. *napus, Citrus sinensis, Fragaria ananassa,* ***Gossypium herbaceum,*** *Hordeum vulgare, Linum usitatissimum, Medicago sativa, Oryza sativa, Pinus ponderosa, Pisum sativum, Solanum tuberosum,*	Afghanistan, Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Bolivia, Bulgaria, Canada, Chile, China, Costa Rica, Czech Republic,	Weed of rangelands in 20 countries (Holm *et al*., 1997). Estimated loss of US$15 million a year in the agricultural crops in Australia has been reported (Davidson, 1990).

	Cirsium lanceolatum (L.) Scop., Family: Asteraceae			*Sorghum bicolor, Triticum aestivum, Vitis vinifera, Zea mays*	Denmark, Ecuador, Estonia, Finland, Georgia, Germany, Greece, Guatemala, Hungary, Iran, Iraq, Ireland, Italy, Japan, Kazakhstan, Kenya, Kyrgyzstan, Latvia, Lithuania, Moldova, Morocco, Netherlands, New Zealand, Norway, Pakistan, Peru, Poland, Portugal, Romania, Russia, Serbia and Montenegro, Slovakia, South Africa, Spain, Sweden, Switzerland, Tunisia, Turkey, Turkmenistan, Ukraine, UK, Uruguay, USA	
45.	*__Galium aparine__ L. Family: Rubiaceae	Cleavers	Seed as contamination	*Avena sativa, Beta vulgaris, Brassica napus, Glycine max,* ***Gossypium* spp.,** *Hordeum vulgare, Linum usitatissimum, Medicago sativa, Oryza sativa, Secale*	Afghanistan, Australia, Belgium, Canada, China, Ethiopia, Finland, France, Germany, Greece , Hong	It may be confused with *G. spurium* which is closely related to it.

				cereale, Solanum tuberosum Triticum aestivum, Vitis vinifera	Kong, Hungary, Iceland, Israel, Japan, Korea, New Zealand ,Norway, Pakistan Poland, Portugal, Russia ,Spain, Sweden, Tunisia, Turkey, UK, USA	
46.	*__Lepidium draba__ L. Synonym *Cardaria draba* (L.) Desv. Family: Brassicaceae	Heart-podded hoary cress, hoary cress, perennial pepper grass, thanet cress, white top, white weed	Seed as contamination	*Avena sativa, Beta vulgaris* var. *saccharifera, Citrus* spp., *Crocus sativus, Fragaria ananassa,* ***Gossypium hirsutum****, Helianthus annuus, Hordeum vulgare, Lens culinaris* ssp. *culinaris, Malus domestica, Medicago sativa, Nicotiana tabacum, Pistacia vera, Pyrus communis, Secale cereale, Solanum tuberosum, Triticum aestivum, T. turgidum, Vitis vinifera, Zea mays*	Afghanistan, Argentina, Australia, Bulgaria, Canada, Chile, Czechoslovakia (erstwhile), Egypt, France, Germany, Greece, Guatemala, Hungary, Iran, Iraq, Israel, Italy, Jordan, Lebanon, Mexico, Netherlands, New Zealand, Pakistan, Poland, Portugal, Romania, Russia, Saudi Arabia, South Africa, Spain, Syria, Tunisia, Turkey, UK, USA, USSR (erstwhile), Yugoslavia	It has spread as a noxious weed in many regions of Canada and USA. It is a serious weed of sunflower, in Europe and toxic to cattle (Anonymous, 1998).

					(erstwhile), Zimbabwe	
47.	*__Raphanus raphanistrum__ L. Synonyms *Raphanus landra* Moretti ex DC. *R. segetum* Clav. Family: Brassicaceae	Charlock, jointed charlock, jointed radish, runch, white charlock, wild radish, wild turnip	Seed as contaminatio n	*Allium cepa, Avena sativa, Beta vulgaris, Brassica napus* var. *napus, Coffea* sp., *Daucus carota, Fragaria ananassa, Glycine max,* ***Gossypium* spp.**, *Helianthus annuus, Hordeum vulgare, Linum usitatissimum, Lupinus* sp., *Medicago sativa, Nicotiana tabacum, Olea europaea* subsp. *europaea, Pisum sativum, Saccharum officinarum, Solanum tuberosum, Triticum aestivum, Vitis vinifera, Zea mays*	Afghanistan, Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Cyprus, Czechoslovakia (erstwhile), Denmark, Ecuador, Egypt, Estonia, Ethiopia, Finland, France, Georgia, Germany, Greece, Honduras, Hungary, Iceland, Iran, Iraq, Ireland, Israel, Italy, Japan, Jordan, Kenya, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Mexico, Moldova, Morocco,	It is classified as a serious weed in nine countries and a principal weed in 14 countries (Holm *et al*., 1991). Longevity of *R. raphanistrum* seed is increased by burial in the soil (Piggin *et al*., 1978). Kurth (1967) in Germany reported that seeds could remain viable for 15 to 20 years in the soil. Cheam and Code, (1995) reported that 25 wild radish plants/ m^2 reduced wheat yield by 7-11%, but yield reduction increased to 25-33% when its density was 100 plants/ m^2.

					Mozambique, Netherlands, New Zealand, Norway, Paraguay, Peru, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Syria, Tunisia, Turkey, Ukraine, UK, Uruguay, USA, Zimbabwe, Yugoslavia (erstwhile)	
48.	**Richardia brasiliensis* Gomes Synonyms *Richardia pilosa* Ruia & Pav., *R. rosea* (St Hil.) Schult., *Richardsonia brasiliensis* (Gomez) Hayne, *R. emetica* Mart.*R. rosea* St Hil., *R. scabra* St Hil.,	Mexican clover, Mexican richardia, tropical richardia, white-eye	Seed as contaminatio n	*Allium cepa, Arachis hypogaea, Cajanus cajan, Camellia sinensis, Capsicum annuum, Carya illinoinensis, Cinchona officinalis, Citrullus lanatus, Citrus* spp., *Coffea arabica, Glycine max,* ***Gossypium* spp.**, *Helianthus annuus, Hevea brasiliensis, Ipomoea batatas, Lycopersicon esculentum, Malus domestica, Medicago sativa, Nicotiana tabacum, Oryza sativa, Phaseolus vulgaris,*	Argentina, Australia, Brazil, Cuba, Ghana, Indonesia, Kenya, Malawi, Mozambique, Myanmar, Nigeria, South Africa, Swaziland, Thailand, USA, Zambia, Zimbabwe	Considered as crop seed contaminant in South Africa. It is a nuisance in lawns and gardens, and has also invaded and replaced native vegetation in South Africa (Wells *et al*., 1986).

	Spermacoce hexandra A. Rich. Family: Rubiaceae			*Philodendron* sp., *Prunus persica, P. salicina, Saccharum officinarum, Solanum tuberosum, Sorghum bicolor, Stylosanthes gracile, Vitis vinifera, Zea mays*		
49.	*__Thlaspi arvense__ L. Family: Brassicaceae	Bastard cress, fanweed, field pennycress, pennycress, stinkweed, THLAR	Seed as contamination	*Allium cepa, A. porrum, Asparagus officinalis, Avena sativa, Beta vulgaris, Brassica napus* var. *napus, Carthamus tinctorius, Cicer arietinum, Daucus carota, Glycine max,* ***Gossypium* spp.,** *Helianthus annuus, Hordeum vulgare, Lens culinaris* ssp. *culinaris, Linum usitatissimum, Medicago sativa, Oryza sativa, Pisum sativum, Solanum tuberosum, Triticum aestivum, Vicia faba, Zea mays*	Afghanistan, Albania, Argentina, Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Bhutan, Bulgaria, Canada, China, Colombia, Czechoslovakia (erstwhile), Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Iran, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Korea (DPR), Korea (Republic), Kyrgyzstan, Latvia, Lebanon, Lithuania, Luxembourg, Mongolia,	Considered as a weed of 30 crops in 45 countries (Holm *et al*., 1997). It is classified as a serious or principal weed in 12 countries (Holm *et al*., 1991). Prolific seed producer, capable of building up large reserves of seed in the soil and exhibits long-term dormancy. Light infestation can reduce crop yields by 35% and a heavy infestation by 50% (CAB International, 2007).

					Netherlands, New Zealand, Norway, Pakistan, Poland, Portugal, Romania, Russia, South Africa, Spain, Sweden, Switzerland, Tajikistan, Tunisia, Turkey, Turkmenistan, UK, USA, Yugoslavia (erstwhile)	
50.	*__Urochloa plantaginea__ (Link) RD Webster Synonyms *Brachiaria plantaginea* Link, *Panicum distans*. Salzm. & Doell, *P. plantagineum* Link, Family: Poaceae	Alexander grass, marmelade grass	Seed as contamination	*Citrus* spp., *Daucus carota*, *Glycine max*, **_Gossypium_ spp.**, *Helianthus annuus, Lactuca sativa, Oryza sativa, Phaseolus* spp., *Prunus domestica, Saccharum officinarum, Zea mays*	Argentina, Brazil, Costa Rica, France, Guatemala, Honduras, Mexico, Nicaragua, USA	Seed survival under soybean crops in south Brazilian agro-ecosystems is 11 years with survival decreasing annually by 37% (Voll *et al.*, 1996). In Brazil, uncontrolled weed infestation decreased cotton yields by 94% (Blanco and Oliveira, 1976).
51.	*__Urtica urens__ L. Synonym	Annual nettle bush, stinging	Seed as contamination	*Allium ampeloprasum, A. cepa, Beta vulgaris, Brassica napus* var. *napus, B. oleracea, Citrus* spp.,	Albania, Algeria, Argentina, Australia, Austria, Belgium, Bolivia,	Ranked amongst the 200 worst weeds of the world (Holm *et al*., 1997).

	Urtica minor Moench. Family: Urticaceae	nettle, burning nettle dognettle, nettle, dwarf (stinging) nettle, small nettle, stinging nettle		*Daucus carota, Fragaria ananassa,* ***Gossypium*** spp., *Humulus lupulus, Lolium perenne, Medicago sativa, Nicotiana tabacum, Phaseolus vulgaris, Pisum sativum, Saccharum officinarum, Solanum tuberosum, Triticum* sp., *Vicia faba, Vitis vinifera, Zea mays*	Brazil, Bulgaria, Canada, Chile, Colombia, Cyprus, Czechoslovakia (erstwhile), Denmark, Djibouti, Egypt, Ethiopia, Finland, France, Germany, Greece, Hungary, Iceland, Iran, Ireland, Israel, Italy, Japan, Jordan, Lebanon, Lesotho, Luxembourg, Malta, Mauritius, Morocco, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Saudi Arabia, South Africa, Spain, Sweden, Switzerland, Tunisia, Turkey, UK, Uruguay, USA, Yugoslavia (erstwhile)	Weed of 27 crops in 50 countries and is a frequently reported weed of vegetables and orchards (Holm *et al*., 1997, Abusteit and Shehata, 1993).

* pest not reported from India,
# pest included in PQ Order, 2003,
[I] insect-pest intercepted during quarantine processing
¥ Pest included in PQ Order but not on cotton

References

1. Abusteit EO and SA Shehata (1993) Critical period of weed competition in potatoes (*Solanum tuberosum* L.) summer plantation. *Bulletin of Faculty of Agriculture, University of Cairo* **44**: 533-548.
2. Adamson D, G Thomas and E Davis (1997) An economic assessment of *Helicoverpa*'s effect on Australian agricultural production. CRC for Tropical Pest Management Report June 1997. Brisbane, Australia: CPCTPM.
3. Ahumada MH, EJ Mitcham and DG Moore (1996) Postharvest quality of 'Thompson Seedless' grapes after insecticidal controlled-atmosphere treatments. *HortScience* **31(5)**: 833-836.
4. Aida R, P Gerardo, P Raffaele, C Lucia and Z Astolfo (2004) Detection of tumorigenic rhizobia in asymptomatic peach plants by PCR. *Phytopathologia mediterranea* **43**: 281-284.
5. Andreev R (2002) The Moroccan locust - former, recent or future problem? Agronet Online. http://www.agro.ttm.bg/.
6. Anonymous (1914) Insect pests of sugar-cane in Antigua and St. Kitts. Imperial Department of Agriculture for the West Indies. Imperial Commissioner of Agriculture, pp. 21-23.
7. Anonymous (1998) *Weeds of the United States and Canada. CD-ROM*. Southern Weed Science Society. Champaign, Illinois.
8. Arif M, SM Marek, FMO Corona, C Young and CD Garzon (2010) PCR detection and identification of *Phymatotrichopsis omnivore*. *Phytopathology* **100 (suppl. 1):** S7. Jun 2010.
9. Beavers JB and AL Selhime (1978) Flight behaviour and dispersal of *Diaprepes abbreviatus*. *Florida Entomologist* **61(2)**: 89-91.
10. Beingolea O (1973) Estimacion actualizada de las pTrdidas que las plagas ocasionan a la agricultura en al per·. *Boletin de la Sociedad Entomologia*, Peru **7(1)**: 3-11.
11. Blanco HG and DA Oliveira (1976) Contribution on the determination of the period of weed competition in cotton crops. *Biologico* **42**: 201-205.
12. Bulgak VD (1979) Harmfulness of spider mites on app.le in the Crimea. *Proceedings of the All-Union Research Institute for Plant Protection*. Injuriousness of insect pests and diseases of agricultural crop. pp. 80-86.
13. Butler GDJr, LT Wilson and TJ Henneberry (1985) *Heliothis virescens* (Lepidoptera: Noctuidae): initiation of summer diapause. *Journal of Economic Entomology* **78(2)**: 320-324.

14. CAB International (2007) *Crop Protection Compendium*. Wallingford, UK: CAB International.

15. Cheam AH and GR Code (1995) The biology of Australian Weeds 24 (*Raphanus raphanistrum* L). *Plant Protection Quarterly* **10**: 2-13.

16. Chepurnaya VI and LA Myalova (1981) Pests and diseases of cherry. *Zashchita Rastenii* **7**: 53-55.

17. Corso IC, MDM Porto, EA Heinrichs and PS Lehman (1978) Combined effect of bugs and fungi on the dropp.ing of pods and the yield components of soyabean (*Glycine max* (L.) Merrill). *Anais da Sociedade Entomologica do Brasil* **7(2)**: 105-114.

18. Crumb SE (1929) Tobacco cutworms. Technical Bulletin No. 88. Washington DC, USA: United States Department of Agriculture.

19. Davidson S (1990) Goats help eliminate thistles. *Rural Research* **147**: 16-19.

20. EPP.O/CABI (1992) *Anthonomus grandis*. Data sheets on Quarantine Pests. In: Smith IM, McNamara DG, Scott PR and Harris KM, eds. Quarantine Pests for Europe. Wallingford, UK: CAB International.pp. 45-49.

21. Fitt GP (1989) The ecology of *Heliothis* species in relation to agroecosystems. *Annual Review of Entomology* **34**: 17-52.

22. Girma A (1997) Status and economic importance of Fusarium wilt disease of Arabica coffee in Ethiopia. *In*: *Proceedings of the First Regional Workshop on Coffee Wilt Disease (Tracheomycosis)*. GJ Hakiza, B Birkunzira and P Musoli (eds). International Conference Centre, Kampala, Uganda, pp. 53-61

23. Girma A and H Hindorf (2001) Recent investigations on coffee tracheomycosis, *Gibberella xylarioides* (*Fusarium xylarioides*) on Arabica coffee in Ethiopia. Proceedings 19th International Scientific Colloquium on Coffee (ASIC). ASIC, Trieste, Italy.

24. Grigorov S (1976) *Special Entomology*. Sofia, Bulgaria: State Publisher for Agricultural Literature **2**: 545.

25. Hall DG (1995) A revision to the bibliography of the sugarcane rootstalk borer weevil, *Diaprepes abbreviatus* (Coleoptera: Curculionidae). *Florida Entomologist* **78(2)**: 364-377.

26. Hill DS (1983) *Agricultural insect pests of the tropics and their control*. Cambridge, UK.

27. Hill DS and JM Waller (1988) *Pests and diseases of tropical crops*. Volume 2. Field handbook. Harlow, Essex, UK: Longman Group UK Limited.

28. Holm L, J Doll, E Holm, J Pancho and J Herberger (1997) *World Weeds: Natural Histories and Distribution*. John Wiley and Sons, New York, USA.

29. Holm L, JV Pancho, JP Herberger and DL Plucknett (1979) *A Geographical Atlas of World Weeds*. John Wiley and Sons, UK.

30. Holm L, JV Pancho, JP Herberger and DL Plucknett (1991) *A Geographical Atlas of World Weeds.* Krieger Publishing Co., Florida, USA.

31. http://southwestfarmpress.com/cotton/west-texas-cotton-survives-challenges-2008-crop- Accessed on 30.08.2011

32. http://www.cabi.org/Uploads/File/CABIDotOrg/Annual%20Review/Annual%20Review%202009%20(2).pdf- Accessed on 2.11.10.

33. http://www.pesticideresistance.org/DB/species_profile.php?arthropodid=794 accessed on 26.5.12

34. http://www.pesticideresistance.org/DB/species_profile.php?arthropodid=800 accessed on 26.5.12

35. Jeppson LR, HH Keifer and EW Baker (1975) *Mites injurious to economic plants*. Berkeley, California, USA: University of California Press.

36. King ABS (1994) *Heliothis/Helicoverpa* (Lepidoptera: Noctuidae) In: Matthews GA, Tunstall JP (eds) *Insect Pests of Cotton*. Wallingford, UK: CAB International, Wallingford, pp. 39-106.

37. Knor IB (1986) The problem of outbreaks of the meadow moth in Siberia. *Trudy Vsesoyuznogo entomologicheskogo Obshchestva* **68**: 162-

38. Kurth H (1967) The germination behaviour of weeds. *SYS Reporter* **3**: 6-11.

39. Láday M, G Mule, A Moretti, Z Hamari, A Juhász, A Szécsi and ALogrieco (2004) Mitochondrial DNA variability in *Fusarium proliferatum* (*Gibberella Intermedia*). *European Journal of Plant Pathology* **110**: 563-571. DOI: 10.1023/B:EJPP.0000032396.18183.76.

40. Link D, V Estefanel, OSdos Santos, MC Mezzomo and LEV Abreu (1973) The influence of attacks by Pentatomids on the agronomic characters of seeds of soy bean, *Glycine max* (L.) Mer. *Anais da Sociedade Entomologica do Brasil* **2(1)**: 59-65.

41. Matheson VG, J Munakata-Marr, GD Hopkins, PL McCarty, JM Tiedje and LJ Forney (1997) A novel means to develop strain-specific DNA probes for detecting bacteria in the environment. *Applied and Environmental Microbiology* **63**: 2863-2869.

42. Millar WA and KW Roy (1982) Microflora of soybean leaves, pods and seeds in Mississippi. *Canadian J. Bot*. **60:** 2716-2723.

43. Mortimer EA, DF Powell (1988). Factors affecting the efficacy of methyl bromide fumigation to control Liriomyza trifolii in imported chrysanthemum cuttings. Annals of App.lied Biology, **112(1):**33-39.

44. Moyal P and M Tran (1991) Cob borer *Mussidia nigrivenella* Ragonot (Lepidoptera: Pyralidae) of maize in Ivory Coast. II - Ecological data. *Insect Science and its App.lication* **12(1-3)**: 215-223.

45. Mule G, A Susca, G Stea and A Moretti (2004) A Species-Specific PCR Assay Based on the calmodulin partial gene for identification of *Fusarium verticillioides*, *F. proliferatum* and *F. subglutinans*. *European Journal of Plant Pathology* **110**: 495-502. DOI: 10.1023/B:EJPP.0000032389.84048.71.

46. Mulrean EN, RB Hine and JP Mueller (1984) Effect of Phymatotrichum root rot on yield and seed and lint quality in *Gossypium hirsutum* and *G. barbadense*. *Plant Disease* **68**: 381-383.

47. Murray DAH and Zaluki MP (1994) Spatial distribution and mortality of *Helicoverpa* spp. pupae (Lepidoptera: Noctuidae) under field crops on the Darling Downs, Queensland. *Journal of the Australian Entomological Society* **33(3)**: 193-198.

48. OEPP/EPPO (1990) Specific quarantine requirements. EPPO Technical Documents, No. 1008. Paris, France: EPPO.

49. OEPP/EPPO, 1979. Data sheets on quarantine organisms No. 34, *Anthonomus grandis*. *Bulletin OEPP/EPPO Bulletin*, **9(2)**.

50. OEPP/EPPO, 1981. Data sheets on quarantine organisms No. 105, *Ceratitis capitata*. *Bulletin OEPP/EPPO Bulletin*, **11(1).**

51. Percy RG (1993) Southwestern cotton rust. In: *Watkins GM, ed. Compendium of cotton diseases*. Minnesota, USA: APS Press, pp. 37-39.

52. Piggin CM, TG Reeves, HD Brooke and GR Code (1978) Germination of wild radish (*Raphanus raphanistrum* L.). In: *Proceedings of the First Conference of the Council of Australian Weed Science* Societies, Melbourne, Australia, pp. 233-240.

53. Plant Quarantine (Regulation of Import into India) Order, 2003 and amendments. Department of Agriculture and Cooperation, Ministry of Agriculture, India, http://www.agricoop.nic.in/gazette.htm. Accessed on 10.2.2011.

54. Powell DF and KG Gostick (1971) Control of *Spodoptera littoralis* (Boisd.), *Myzus persicae* (Sulz.) and *Tetranychus urticae* (Koch) by cold storage and fumigation. *Bulletin of Entomological Research* **61**: 235-240.

55. Robertson LN (1993) Population dynamics of false wireworms (*Gonocephalum macleayi, Pterohelaeus alternatus, P. darlingensis*) and development of an integrated pest management program in central Queensland field crops: a review. *Australian Journal of Experimental Agriculture* **33(7)**: 953-962.

56. Robertson LN and GB Simpson (1988 Sampling and dispersion of *Pterohelaeus alternatus* Pascoe and *Gonocephalum macleayi* (Blackburn) (Coleoptera: Tenebrionidae) larvae in soil. *Queensland Journal of Agricultural and Animal Sciences* **45(2)**: 189-193.

57. Russin JS, MB Layton, DB Orr and DJ Boethel (1987) Within-plant distribution of, and partial compensation for, stink bug (Heteroptera: Pentatomidae) damage to soybean seeds. *Journal of Economic Entomology* **80(1)**: 215-220.

58. Samaniego GJA, PT Herrera, y CJ Santamaría (1998) Influencia de las condiciones de suelo y manejo de las huertas de nogal pecanero con el incremento de la pudrición texana y pérdidas en el cultivo. In: *VI Simposium Internacional Nogalero. Instituto Tecnológico de Estudios Superiores de Monterrey (ITESM), campus Laguna*. Torreón, Coahuila, México, pp. 56–62.

59. Schwartz HF and SK Mohan (1995) *Compendium of Onion and Garlic Diseases*. American Phytopathological Society Press, St. Paul, Minnesota, USA, 123p.

60. Schwartz MD and RG Foottit (1992) Lygus bugs on the prairies. Biology, systematics, and distribution. *Technical Bulletin - Agriculture Canada* **4E**: 44.

61. Sepasgozarian H and G Schruft (1975) The spider mite *Tetranychus viennensis* Zacher (Acari; Tetranychidae), a new fruit-tree pest in Iran. *Journal of Entomological Society of Iran* **2(2)**: Pe 65-75; de 59-60.

62. Sétamou M, F Schulthess, NA Bosque-Pérez, HM Poehling and C Borgemeister, (1999) Bionomics of *Mussidia nigrivenella* (Lepidoptera: Pyralidae) on three host plants. *Bulletin of Entomological Research* **89(5)**: 465-471.

63. Shutova NN (1984) The tomato moth. *Zashchita Rastenii* **11**: 54-55.

64. Streets RB and HE Bloss (1973) Phymatotrichum Root Rot. *Phytopathological Monograph 8*, American Phytopathological Society. St. Paul, MN, USA, 38 p.

65. Townsend CHT (1913) Preliminary report on the picudo of cotton in Peru. *Journal of Economic Entomology* **6(3)**: 303-312.

66. USDA (1957) *Cooperative Economic Insect Report* **7(2)**: 5-6.

67. USDA (2016) Foreign Agricultural Services, GAIN Report No. IN6046 India Cotton and Products Annual. Available at http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Cotton%20and%20Products%20Annual_New%20Delhi_India_4-1-2016.pdf; accessed on September 16, 2016.

68. Velazquez E, P Alvaro, ZJ Luis, PJ Luis, FM Pedro, R Paul, M Estefania, T Nicolas, G Pablo and M Eustoquio (2005) The coexistence of symbiosis and pathogenicity-determining genes in Rhizobium rhizogenes strains enables them to induce nodules and tumors or hairy roots in plants. *Molecular plant-microbe interactions* **18**: 1325-1332.

69. Voll E, DLP Gazziero, E Quina and FC Krzyzanowski (1996) Evaluation of seed physiology of *Brachiaria plantaginea* (Link) Hitchc. with dormancy breaking procedures. *Revista Brasileira de Sementes* **18**: 186-192.

70. Waele De and R Wilken (1990) Effect of temperature on the in vitro reproduction of *Ditylenchus destructor* isolated from groundnut. *Revue de Nematologie* **13**: 171-174.

71. Wells MJ, AA Balsinhas, H Joffe, VM Engelbrecht, G Harding and CH Stirton (1986) *A Catalogue of Problem Plants in Southern Africa. Memoirs of the Botanical Survey of South Africa,* No. **53**. Botanical Research Institute, Pretoria, South Africa.

72. Whitwell A (1986) TDRI identifies cause of citrus damage. *Tropical Pest Management* **32(4)**: 351.

73. Willie JE (1942) *Entomologia Agricola del Per ·*, Lima, Peru: Ministerio de Agricultura.

74. Yeargan KV (1977) Effects of green stink bug damage on yield and quality of soybeans. *Journal of Economic Entomology* **70(5)**: 619-622.

75. Young OP (1986) Host plants of the tarnished plant bug, *Lygus lineolaris* (Heteroptera: Miridae). *Annals of the Entomological Society of America* **79(4)**: 747-762.

Glossary

Contaminant	Soil, fungal spores, fruiting bodies, plant debris, live/ dead/ dormant insects/ stages thereof
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (http://wInNv.ippc.org
Grain	A commodity class for seeds intended for processing or consumption and not for planting (http://www.ippc.org)
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment((http://www.ippc.org)
Pathway	Any means that allows the entry or spread of a pest (http://www.ippc.org)
Pest	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plant or plant products (http://www.ippc.org)
Pest risk analysis	The process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it (http://www.ippc.org)
Plant debris	Dried plant parts or pieces thereof other than seed
Plant products	Unmanufactured material of plant origin (including grain) and those manufactured products that, by their nature or that of their processing, may create a risk for the introduction and spread of pests
Plant quarantine	All activities designed to prevent the introduction and/or spread of quarantine pests or to ensure their official control (http://www.ippc.org)
Plants for planting	Plants intended to remain planted, to be planted or replanted
Post-entry quarantine	Quarantine applied to a consignment after entry
Quarantine	Official confinement of regulated articles for observation and research or for further inspection, testing and/or treatment (http://www.ippc.org)
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (http://www.ippc.org)
Seed	A commodity class for seeds for planting or intended for planting and not for consumption or processing (http://www.ippc.org)
Seed-borne	The pest present on, in or along with the seed

Seed-transmitted	The pest present in or with the seed and transmitted to the next generation of growing seedlings
Stored products	Stored grain, flour or processed plant products

Acronyms

AFLP	Amplified fragment length polymorphism
APHIS	Animal and Plant Health Inspection Service
APPPC	Asia and Pacific Plant Protection Commission
ATMT	Agrobacterium tumefaciens–mediated transformation
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional Agricultura Tropical (=International Center for Tropical Agriculture)
CPPC	Caribbean Plant Protection Commission
DIBA	Dot lmmuno-binding Assay
ELISA	Enzyme-linked lmmunosorbent Assay
EM	Electron Microscopy
EMBL	European Molecular Biology Laboratory
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
ICARDA	International Center for Agricultural Research in the Dry Areas
ICTV	International Committee on Taxonomy of Viruses
IGS	Intergenic spacer
IITA	International Institute of Tropical Agriculture
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
ITS	Internal transcribed spacer
mtDNA	mitochondrial DNA
NBPGR	National Bureau of Plant Genetic Resources
NPPO	National Plant Protection Organization
OEPP	Organisation Europeenne et Mediterraneenne pour la Protection des
OIRSA	Organismo Internacional Regional de Sanidad Agropecuaria
PAGE	Polyacrylamide gel electrophoresis
PCR	Polymerase Chain Reaction
PQ Order	Plant Quarantine (Regulation of Import into India) Order
PPPO	Pacific Plant Protection Organization
PQP	Potential Quarantine Pest
PRA	Pest Risk Analysis
RAPD	Random Amplified Polymorphic DNA
rDNA	ribosomal DNA
RFLP	Restriction Fragment Length Polymorphism

RPPO	Regional Plant Protection Organization
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SCAR	Sequence Characterized Amplified Regions
SPS	Sanitary and Phytosanitary
USDA	United States Department of Agriculture
VCGs	Vegetative compatible groups
WTO	World Trade Organization

Selected Reading/ Useful Websites

1. www.padil.gov.au PaDIL – High quality images and information tools designed for biosecurity and biodiversity
2. http://www.cabi.org/ISC/ Invasive Species Compendium