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49. EVALUATION OF ANIMAL AND PLANT PATHOGENS AS TERRORISM AND WARFARE AGENTS, VECTORS AND PESTS

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INTRODUCTION

Animal and plant pathogens as a biological terrorism or warfare agents have the capacity to cause disease and potentially be used to threaten animals and staple crops. From a social-economic and significant adverse human health impacts, animal and plant pathogens must be evaluated and prioritized. This paper describes two methods of evaluation of animal and plant pathogens as terrorism and warfare agents and can serve as the basis for scientific discussion and as help on defining the list of biological agents and toxins in relation to BTWC. This paper also discusses and shows the main vectors that can be used as a terrorism delivery system or biological agents in hostile activities. The main pests that include the invertebrates such as insects and arthropods with potential terrorism and military use will be presented.

High level of dissemination is criterion we used in evaluation of animal and plant pathogens. High level of dissemination or large-scale contamination or cover a large area as aerosol for respiratory exposure plays the main role in evaluation of particular animal agent. One of the main criteria for evaluation of animal and plant pathogens is that are known to have been developed, produced or used as weapons. The second very important criterion is that agents have severe socio-economic and significant adverse human health impacts to be evaluated against a combination of the following criteria: high morbidity and mortality rates; short incubation period and difficult to diagnose or identify at an early stage; high transmissibility and contagiousness; lack of availability of cost effective protection and treatment; low infective dose; stability in the environment; and ease of production. The criteria we use today for evaluation of the animal and plant biological agents are based on the characteristics of the outbreaks of infectious diseases in "natural form". Genetic engineered and modified bacteria and viruses present a difficult problem. In the criteria should be inserted new characteristics of bacterial and viral strains enhanced for infectivity, transmissibility, virulence and antibiotic resistance. As biological terrorism or warfare agents, animal and plant pathogens have the ability to cause disease, which could be used to threaten animals and staple crops. From a viewpoint of social-economic and significant adverse human health affects, animal and plant pathogens must be evaluated and prioritized as possible threats.

This paper describes two methods of evaluation of animal and plant pathogens as terrorism and warfare agents and can serve as the basis for scientific discussion and as help on defining the list of biological agents and toxins in relation to BTWC. This paper also discusses the pests and main vectors that can be used as delivery systems. These include the invertebrates, such as insects and arthropods.

MATERIALS AND METHODS

The criteria we used for evaluation of animal and plant pathogens, vectors and pests we compiled from several sources: criteria for selection of biological agents used for negotiations in Ad-hoc Group of states-parties of BWC, the Australia Group, the Centers for Disease Control and Prevention, Food and Agriculture Organization (FAO) and International Office of Epizootics (OIE). Rankings of animal and plant pathogens, vectors and pests as potential warfare and bioterrorism agents are shown in tables. As a result of evaluation we

finally present lists of animal and plant pathogens, vectors and pests as warfare and terrorism agents.

CRITERIA FOR ANIMAL PATHOGENS AS BIOLOGICAL WARFARE AGENTS

1. Agents known to have been developed, produced or used as weapons (Weaponized);
2. Agents which have severe socio-economic and/or significant adverse human health impacts;
3. High morbidity and/or mortality rates;
4. Short incubation period;
5. Difficult to diagnose/identify at an early stage;
6. High transmissibility and/or contagiousness;
7. Lack of availability of cost effective protection/treatment;
8. Low infective/toxic dose;
9. Stability in the environment;
10. Ease of production.

CRITERIA FOR ANIMAL PATHOGENS AS BIOLOGICAL TERRORISM AGENTS

1. Agents which have severe socio-economic and/or significant adverse human health impacts;
2. High morbidity and/or mortality rates: agents with an expected mortality of $\geq 50\%$ were rated higher (+++), and with lower expected mortalities (21-49%=++, and $< 21\%$ =+);
3. Short incubation period and/or difficult to diagnose/identify at an early stage;
4. High transmissibility and/or contagiousness high level of infectiousness/ intoxication by contact (+), by respiratory route (++) , or both (+++);
5. Lack of availability of cost effective protection / treatment;
6. Low infective/toxic dose;
7. Stability in the environment;
8. Ease of production.

CRITERIA FOR PLANT PATHOGENS AS BIOLOGICAL WARFARE AGENTS

1. Agents known to have been developed, produced or used as weapons (Weaponized);
2. Agents which have severe socio-economic and/or significant adverse human health impacts, due to their effect on staple crops, to be evaluated against a combination of the following criteria:
3. Ease of dissemination (wind, insects, water, etc.);
4. Short incubation period and/or difficult to diagnose / identify at an early stage;
5. Ease of production;
6. Stability in the environment;
7. Lack of availability of cost effective protection / treatment;
8. Low infective dose;
9. High infectivity;
10. Short life cycle.

CRITERIA FOR PLANT PATHOGENS AS BIOLOGICAL TERRORISM AGENTS

1. Agents which have severe socio-economic and/or significant adverse human health impacts, due to their effect on staple crops;
2. Ease of dissemination: by wind (+++), by insects (++) , water, etc.(+);
3. Short incubation period and/or difficult to diagnose/identify at an early stage;
4. Ease of production;
5. Stability in the environment;
6. Lack of availability of cost effective protection/treatment;

7. Low infective dose;
8. High infectivity and causes severe crop losses: $\geq 60\%$ (+++), 21-59% (++) , and $< 21\%$ (+);
9. Short life cycle.

CRITERIA FOR VECTORS OR CARRIERS OF BIOLOGICAL TERRORISM AND WARFARE AGENTS

1. Vectors known to have been produced, used or alleged to be used as weapons;
2. Vectors which cause significant impact on human health or animal resources;
3. Short life cycle;
4. Ease of production;
5. Resistance to insecticides or bio control agents;
6. Ease of dissemination.

CRITERIA FOR PESTS AS BIOLOGICAL TERRORISM AND WARFARE AGENTS

1. Pests known to have been produced, used or alleged to be used as weapons;
2. Pests which cause sever socio-economic and/or significant adverse effect to plants;
3. Ease of production;
4. Short life cycle;
5. Resistance to pesticides;
6. High reproducibility;
7. Ease of dissemination.

ANIMAL PATHOGENS AS BIOLOGICAL WARFARE AGENTS

Viruses

African swine fever virus
 Avian influenza virus (Fowl plague virus)
 Rinderpest virus
 Classical swine fever virus (Hog cholera virus)
 Foot and mouth virus
 Newcastle disease virus
 Pest des petits ruminants virus
 Teschen disease virus (Porcine enterovirus type 1)
 Vesicular stomatitis virus
 Rift Valley fever virus
 Bluetongue virus
 African horse sickness virus
 Nipah swine encephalitis virus
 Lumpy skin disease virus
 Camel pox virus

Bacteria

Bacillus anthracis
 Bulkholderia (Pseudomonas) mallei
 Brucella spp.

Mycoplasmas

Contagious bovine (pleuropneum.) (M. mycoides var. mycoides type SC) (CBPP)
 Contagious caprine (pleuropneum.) (M. capriculum var. capri pneumoniae type F38 (CCPP))

ANIMAL PATHOGENS AS TERRORISM BIOLOGICAL AGENTS

Viruses

African swine fever virus
Avian influenza virus (Fowl plague virus)
Vesicular stomatitis virus
Classical swine fever virus (Hog cholera virus)
Foot and mouth virus
Newcastle disease virus
Rinderpest virus
Pest des petits ruminants virus
Bluetongue virus
Teschen disease virus (Porcine enterovirus type 1)
Rift Valley fever virus
Nipah swine encephalitis virus
African horse sickness virus
Camel pox virus
Lumpy skin disease virus

Bacteria

Bacillus anthracis
Bulkyholderia (Pseudomonas) mallei
Brucella spp.

Mycoplasmas

Contagious bovine (pleuropneum.) (M. mycoides var. mycoides type SC) (CBPP)
Contagious caprine (pleuropneum.) (M. capriculum var. capri pneumoniae type F38) (CCPP)

PLANT PATHOGENS AS BIOLOGICAL TERRORISM AGENTS

Fungi

Colletotrichum coffeanum var. virulans
Puccinia graminis (Stem Rust, Black Rust)
Tilletia indica (Carnal Bunt)
Sclerotinia sclerotiorum (Sclerotinia Stem Rot)
Dothistroma pini (Scirrhia pini) (Pine Needle Casts and Blights)
Puccinia striiformis (P. glumarum) (Stripe Rust, Yellow Rust)
Pyricularia oryzae (Rice Blast)
Ustilago maydis (Corn Smut)
Claviceps purpurea (Ergot)
Peronospora hyoscyami de Bary f.sp. tabacina (Adam) skalicky (Downy mildew)

Bacteria

Xsanthomonas albilineans (Leaf Scald)
Erwinia amylovora (Shoot Blight)
Ralstonia solanacearum (Bacterial Wilt)
Xsanthomonas campestris pv. citri (Citrus Cancer)
Xsanthomonas campestris pv. oryzae (Rice Bacterial Leaf)

Viruses

Sugar cane Fiji disease virus (Sugar cane Fiji disease)

PLANT PATHOGENS AS BIOLOGICAL WARFARE AGENTS

Fungi

Puccinia graminis (Stem Rust, Black Rust)
Pyricularia oryzae (Rice Blast)
Colletotrichum coffeanum var. *virulans*
Tilletia indica (Carnal Bunt)
Ustilago maydis (Corn Smut)
Puccinia striiformis (*P. glumarum*) (Stripe Rust, Yellow Rust)
Dothistroma pini (*Scirrhia pini*) (Pine Needle Casts and Blights)
Sclerotinia sclerotiorum (Sclerotinia Stem Rot)
Peronospora hyoscyami de Bary f.sp. *tabacina* (Adam) skalicky
 (Downy mildew)
Claviceps purpurea (Ergot)

Bacteria

Ralstonia solanacearum (Bacterial Wilt)
Xanthomonas campestris pv. *citri* (Citrus Cancer)
Xanthomonas albilineans (Leaf Scald)
Erwinia amylovora (Shoot Blight)
Xanthomonas campestris pv. *oryzae* (Rice Bacterial Leaf)

Viruses

Sugar cane Fiji disease virus (Sugar cane Fiji disease)

Vectors

<i>Xenopsylla</i> spp. <i>Ctenocephalis</i> spp. <i>Leptopsilla</i> spp.	Siphonoptera	Insecta
<i>Ixodides</i> <i>Hyalomma marginatum</i> <i>Hyalomma Anatolicum Anatolicum</i>	Acari	Arachnida
<i>Dermacentor andersoni</i> <i>Dermacentor varabilis</i> <i>Amblyomma Cajennese</i> <i>Rhipicephalus sanguineus</i>	Acari	Arachnida
<i>Mansonia</i> spp. <i>Culex</i> spp. <i>Culiseta</i> spp.	Diptera	Insecta
<i>Pediculus humanus</i>	Anopluraa	Insect
<i>Ixodides</i> <i>Dermacentor</i> spp. <i>Rhipicephalus</i> spp. <i>Amblyomma</i> spp.	Acari	Arachnida

Pests

<i>Dociostaurus maroccanus</i>	Orthoptera	Grasshoppers <i>CRICKETS</i> Cockroaches
<i>Haplothrips Tritici</i> <i>Thrips Tabaci</i>	Thysanoptera	Thrips
<i>Eurygaster integriceps</i> <i>Lygus lineolaris</i> <i>Acrosternum milleri</i>	Hemiptera	Bugs
<i>Chilo suppressalis</i> <i>Cirphis unipunctata</i> <i>Earias insulana</i>	Lepidoptera	Butterflies Moths Skippers
<i>Leptinotarsa decemlineata</i> (Colorado potato beetle)	Coloptera	Beetles Weevils
<i>Harmolita tritici</i>	Hymenoptera	Ants, Bees, Wasps
<i>Phytophaya destructor</i>	Diptera	Flies
<i>Terranychus takestani</i>	Tetranychidae	Mites
<i>Cenopalpus spp.</i>	Errophyoidae	Mites
<i>Diabrotica virgifera virgifera</i>	Chrysomelidae	Western corn rootworm

CONCLUSION

The threat and use of biological agents for warfare and terrorism purposes has a long history. Many animal and plant pathogens, vectors and pests can be used as terrorism and warfare biological agents and cause illness. Transmissible animal diseases classified under A and B List have the potential for very serious and rapid spread, irrespective of national borders which are of serious socio-economic or public health consequence and which are of major importance in the international trade of animals and animal products. Those transboundary animal diseases are of significant economic, trade and security importance. Having a defined and good method for evaluating biological threat agents such as animal and plant pathogens, vectors and pests allows for more objective evaluation newly emerging potential threat agents. This method of evaluation can help focus public health activities, agriculture activities related to bioterrorism detection and response.

KEYWORDS

Animal and plant pathogens, vectors, pests, and terrorism agents

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Table 1: Animal pathogens assessment according to criteria for selecting pathogens as biological warfare agents

Animal pathogens	Weaponized	Severe socio-economic/human health impacts	High morbidity or mortality rates	Short incubation period	High transmissibility/contagiousness	Low infective or toxic dose	Difficult to diagnose/identify at an early stage	Stability in the environment	Lack of availability of cost effective protection/treatment	Ease of production	Totals +/-
Viruses											
African swine fever virus	+	+	+	+	+	+	+	+	+	+	10/0
Avian influenza virus (Fowl plague virus)	+	+	+	+	+	+	+	+	+	+	10/0
Camel pox virus	-	-	+	+	-	+	+	+	+	-	5/5
Classical swine fever virus (Hog cholera v.)	+	+	+	+	+	+	+	+	-	+	9/1
Foot and mouth virus	+	+	+	+	+	+	+	+	-	+	9/1
Bluetongue virus	-	+	+	+	-	+	+	+	+	+	8/2
Newcastle disease virus	+	+	+	+	+	+	+	+	-	+	9/1
Pest des petits ruminants virus	+	-	+	+	+	+	+	+	+	+	9/1
Rinderpest virus	+	+	+	+	+	+	+	+	-	+	10/0
Teschen disease virus (Porcine enterovirus type 1)	-	+	+	+	+	+	+	+	+	+	9/1
Rift Valley fever virus	-	+	+	+	+	+	+	+	+	-	8/2
Vesicular stomatitis virus	-	+	+	+	+	+	+	+	+	+	9/1
African horse sickness virus	-	+	+	+	+	+	+	+	+	-	8/2
Lumpy skin disease virus	-	-	-	+	-	+	+	+	+	-	4/6
Nipah swine encephalitis virus	-	+	+	+	-	+	+	+	+	-	7/3
Bacteria											
Bacillus anthracis	+	+	+	+	+	+	+	+	+	+	10/0
Brucella spp.	+	+	-	-	+	+	+	+	+	+	8/2
Bulkholderia (Pseudomonas) mallei	+	+	+	+	-	+	+	+	+	+	9/1
Mycoplasmas											
Contagious bovine (pleuropneum.) (M. mycoides var. mycoides type SC) (CBPP)	-	+	+	-	+	+	+	+	+	+	8/2
Contagious caprine (pleuropneum.) (M. capri-culm var. capri pneumoniae type F38) (CCPP)	-	-	-	-	+	+	+	+	+	+	5/5

Table 2: Animal pathogens assessment according to criteria for selecting pathogens as terrorism agents

Animal pathogens	Severe socio-economic/human health impacts	High morbidity/mortality rates	Short incubation period	High contagiousness/transmissibility by contact, respiratory route, or both	Low infective/toxic dose	Difficult to diagnose/identify at an early stage	Stability in the environment	Low effective or cost-effective prophylaxis/protection/treatment	Ease of production	Total (13)
Viruses										
African swine fever virus	+	+++	+	+++	+	+	+	+	+	13
Avian influenza virus (Fowl plague virus)	+	+++	+	+++	+	+	+	+	+	13
Camel pox virus	-	+++	+	+	+	+	+	+	-	8
Classical swine fever virus (Hog cholera v.)	+	+++	+	+++	+	+	+	+	-	12
Foot and mouth virus	+	+++	+	+++	+	+	+	-	+	12
Bluetongue virus	+	+	+	+++	+	+	+	-	+	10
Newcastle disease virus	+	+++	+	+++	+	+	+	-	+	12
Pest des petits ruminants virus	+	+++	+	+	+	+	+	-	+	10
Rinderpest virus	+	+++	+	+++	+	+	+	-	+	12
Teschen disease virus (Porcine enterovirus type 1)	-	+	+	+	+	+	+	+	+	8
Rift Valley fever virus	+	+++	+	+	+	+	+	-	+	10
Vesicular stomatitis virus	+	+++	+	+++	+	+	+	+	+	13
African horse sickness virus	-	+++	+	+	+	+	-	+	-	8
Lumpy skin disease virus	-	+	+	+	+	+	+	+	-	7
Nipah swine encephalitis virus	+	++	+	+	+	+	+	+	-	9
Bacteria										
Bacillus anthracis	+	+++	+	+++	+	-	+	-	+	11
Brucella spp.	+	+	-	++	+	-	+	-	+	7
Bulkyholderia (Pseudomonas) mallei	+	+++	+	-	+	+	+	+	+	10
Mycoplasma										
Contagious bovine (pleuropneum.) (M. mycoides var. mycoides type SC) (CBPP)	+	++	-	+++	+	+	+	-	+	10
Contagious caprine (pleuropneum.) (M. capri-culum var. capri pneumoniae type F38)(CCPP)	-	++	-	+	+	+	+	-	+	7

Table 3: Plant pathogens assessment according to criteria for selecting pathogens as biological warfare agents

Plant pathogens	Weaponized	Severe socio-economic/human health impacts	Short incubation period	Ease of dissemination (wind, insects, water, etc.)	Short life cycle	Low infective dose and infectivity	Difficulty diagnose/identify at an early stage	Stability in the environment	Cost-effective protection/treatment	Ease of production	Totals +/-
Fungi											
<i>Colletotrichum coffeanum</i> var. <i>virulans</i>	-	-	+	+	-	+	+	+	-	+	6/4
<i>Dothistroma pini</i> (<i>Scirrhia pini</i>)	-	-	+	+	-	+	+	+	-	-	5/5
<i>Claviceps purpurea</i>	-	+	+	+	-	-	+	-	-	-	4/6
<i>Peronospora hyoscyami</i> de Bary f.sp. <i>tabacina</i> (Adam) Skalicky	-	-	+	+	-	+	+	+	-	-	5/5
<i>Puccinia graminis</i>	+	+	+	+	-	+	+	+	-	+	8/2
<i>Puccinia striiformis</i> (<i>P. glumarum</i>)	-	+	+	+	-	+	+	+	-	+	7/3
<i>Pyricularia oryzae</i>	+	+	+	+	-	+	+	+	-	+	8/2
<i>Sclerotinia sclerotiorum</i>	-	+	+	+	-	+	+	-	-	-	5/5
<i>Tilletia indica</i>	+	+	+	+	-	+	+	+	-	+	8/2
<i>Ustilago maydis</i>	+	+	+	+	-	+	+	+	-	+	8/2
Bacteria											
<i>Erwinia amylovora</i>	-	+	+	+	-	+	+	-	-	+	6/4
<i>Ralstonia solanacearum</i>	-	-	+	+	-	-	+	+	+	-	5/5
<i>Xanthomonas albilineans</i>	-	+	+	+	-	+	+	-	+	+	7/3
<i>Xanthomonas campestris</i> pv. <i>citri</i>	-	+	+	+	-	+	+	-	+	+	7/3
<i>Xanthomonas campestris</i> pv. <i>oryzae</i>	-	+	+	+	-	+	+	-	+	+	7/3
Viruses											
Sugar cane Fiji disease virus	-	+	+	-	-	+	+	-	-	+	5/5

Table 4: Plant pathogens assessment according to criteria for selecting pathogens as terrorism agents

Plant pathogens	Severe socio-economic/human health impacts	Short incubation period	Ease of dissemination (wind, insects, water, etc.)	Short life cycle	Low infective dose and infectivity	Difficulty diagnose/identify at an early stage	Stability in the environment	Causes severe crop losses	Cost-effective protection/treatment	Ease of production	Total (14)
<i>Viruses</i>											
<i>Colletotrichum coffeanum</i> var. <i>virulans</i>	+	+	+++	+	+	+	+	+++	+	+	14
<i>Dothistroma pini</i> (<i>Scirrhia pini</i>)	-	+	++	+	+	+	+	++	-	+	10
<i>Claviceps purpurea</i>	+	+	+++	-	-	+	-	1+	-	-	8
<i>Peronospora hyoscyami</i> de Bary f.sp. <i>tabacina</i> (Adam) Skalicky	-	+	+++	-	-	+	+	+	-	+	8
<i>Puccinia graminis</i>	+	+	+++	+	+	+	+	+++	-	+	14
<i>Puccinia striiformis</i> (<i>P. glumarum</i>)	-	+	++	+	+	+	+	+	-	+	9
<i>Pyricularia oryzae</i>	-	+	++	-	+	+	+	+	-	+	9
<i>Sclerotinia sclerotiorum</i>	+	+	+++	+	+	+	+	+++	-	+	13
<i>Tilletia indica</i>	+	+	+++	+	+	+	+	+++	-	+	14
<i>Ustilago maydis</i>	-	+	++	-	+	+	+	++	-	+	9
<i>Bacteria</i>											
<i>Erwinia amylovora</i>	+	+	+++	+	+	+	-	+++	-	+	12
<i>Ralstonia solanacearum</i>	+	+	++	+	+	+	+	++	1	-	11
<i>Xanthomonas albilineans</i>	+	+	+++	+	+	+	+	+++	+	+	14
<i>Xanthomonas campestris</i> pv. <i>citri</i>	-	+	++	-	+	+	+	++	+	+	10
<i>Xanthomonas campestris</i> pv. <i>oryzae</i>	-	+	++	-	+	+	-	++	+	+	9
<i>Viruses</i>											
Sugar cane Fiji disease virus	+	+	++	-	+	+	-	++	-	-	8

Table 5: Vectors assessment according to criteria for selecting vectors as terrorism and warfare agents

Vectors	Order	Class	Biological Agent	Disease	Weaponized	Significant impact on human health or animal resources	Short life cycle	Ease of production	Resistance to insecticides or bio control agents	Ease of dissemination	Total (6)
<i>Xenopsylla</i> spp. <i>Ctenocephalis</i> spp. <i>Leptopsylla</i> spp.	Siphonoptera	Insecta	<i>Yersinia pestis</i>	Plague	+	+	+	+	+	+	6
<i>Ixodides</i> <i>Hyalomma marginatum</i> <i>Hyalomma Anatolicum</i> <i>Anatolicum</i>	Acari	Arachnida	Arbovirus	Crimean-Congo hemorrhagic fever (CHF)	+	+	+	+	+	+	6
<i>Dermacentor Andersoni</i>	Acari	Arachnida	<i>Coxiella burnetti</i>	Q-Fever	-	+	+	+	+	+	5
<i>Dermacentor Andersoni</i> <i>Dermacentor varabilis</i> <i>Amblyomma Cajennese</i> <i>Rhipicephalus sanguineus</i>	Acari	Arachnida	<i>Rickettsia rickettsii</i>	Rocky Mountain Spotted Fever	-	+	+	+	+	+	5
<i>Mansonina</i> spp. <i>Culex</i> spp. <i>Culiseta</i> spp.	Diptera	Insecta	Arbovirus	Eastern Equine Encephalitis	+	+	+	+	+	+	6
<i>Pedicular humanus</i>	Anoplura	Insect	<i>Rickettsia prowasekii</i>	Typhus exanthematicus	+	+	+	+	+	+	6
<i>Ixodides</i> <i>Dermacentor</i> spp. <i>Rhipicephalus</i> spp. <i>Amblyomma</i> spp.	Acari	Arachnida	<i>Francisella tularensis</i>	Tularemia	+	+	+	+	+	+	6

Table 6: Pests assessment according to criteria for selecting pests as terrorism and warfare agents

Pests	Order	Common Names	Host	Weaponized	Severe socio-economic/significant adverse effect to plants	Short life cycle	Ease of production	Resistance to pesticides	High reproducibility	Ease of dissemination	Total (7)
<i>Diastatus maroccanus</i>	Orthoptera	Grasshoppers CRICKETS Cockroaches	Plants	-	+	+	+	+	+	+	6
- <i>Haplothrips tritici</i> - <i>Thrips Tabaci</i>	Thysanoptera	Thrips	- Wheat, maize - Tobacco, tomato	-	+	+	+	+	+	+	6
- <i>Eurygaster integriceps</i> - <i>Lygus lineolaris</i> - <i>Acrosternum milleri</i>	Hemiptera	Bugs	- Wheat - Pistachio - Pistachio	-	+	+	+	+	+	+	6
- <i>Chilo suppressalis</i> - <i>Cirphis unipunctata</i> - <i>Earias insulana</i>	Lepidoptera	Butterflies Moths Skippers	- Rice - Rice, maize - Cotton	-	+	+	+	+	+	+	6
<i>Leptinotarsa decemlineata</i> (Colorado potato beetle) <i>Harmolita tritici</i>	Coloptera Hymenoptera	Beetles Weevils Ants Bees Wasps	Potatoes Wheat	-	+	+	+	+	+	+	6
<i>Phytophaya destructor</i>	Diptera	Flies	Wheat (Barley) Oats	-	+	+	+	+	+	+	6
<i>Tetranychus takesiani</i> <i>Cenopalpus</i> spp. <i>Dibrotica virgifica</i> <i>virgifica</i>	Tetranychidae Erotyhoidae Chrysomelidae	Mites Mites Western corn rootworm	Plants Fruit trees Maize	-	+	+	+	+	+	+	6