JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

BIOLOGICAL PEST CONTROL IN ORGANIC FARMING

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Abstract

This paper deals with biocontrol agents protect plants from their natural enemies like parasites from predation, etc. They help in controlling the infestation of plant pests such as weeds, nematodes, insects, and mites. The biological control agents are specific to harmful organisms and do not kill useful organisms present in the soil. Biological control or biocontrol is a method of controlling pests, whether pest animals such as insects and mites, weeds, or pathogens affecting animals or plants by using other organisms.

Keywords: pest's management, organic agriculture

Introduction

According to Flint, Maria Louise & Dreistadt, Steve H. (1998) biological control is a bioeffector-method of controlling pests including insects, mites, weeds and plant diseases using other living organisms. It relies on predation, parasitism, herbivore, or other natural mechanisms, but typically also involves an active human management role. It can be an important component of integrated pest management programs. There are three basic types of biological pest control strategies: importation. Natural enemies of insect pests, also known as biological control agents, include predators, parasitoids, and pathogens. Biological control agents of plant diseases are most often referred to as antagonists. Biological control agents of weeds include seed predators, herbivores and plant pathogens.

Types of Biological Pest Control

Classical biological control involves the introduction of a pest's natural enemies to a new locale where they do not occur naturally. This is usually done by government authorities. In many instances, the complex of natural enemies associated with a pest may be inadequate, a situation that can occur when a pest is accidentally introduced into a new geographic area, without its associated natural enemies. These introduced pests are referred to as exotic pests and comprise about 40% of the insect pests in the United States.

Augmentation

Augmentation involves the supplemental release of natural enemies, boosting the naturally occurring population. Relatively few natural enemies may be released at a critical time of the season or millions may be released. An example of inoculative release occurs in greenhouse production of several crops. Periodic releases of the parasitoid, Intarsia Formosa, are used to control greenhouse whitefly, and the predatory mite Phytoseiulus persimilis is used for control of the two-spotted spider mite. Lady beetles, lacewings, or parasitoids such as those from the genus Trichogramma are frequently released in large numbers.

Conservation

The conservation of existing natural enemies in an environment is the third method of biological pest control. Natural enemies are already adapted to the habitat and to the target pest, and their conservation can be simple and cost-effective. Lacewings, lady beetles, hover fly larvae, and parasitized aphid mummies are almost always present in aphid colonies.

Cropping systems can be modified to favor the natural enemies, a practice sometimes referred to as habitat manipulation. Providing a suitable habitat, such as a shelterbelt, hedgerow, or beetle bank where beneficial insects can live and reproduce, can help ensure the survival of populations of natural enemies. Things as simple as leaving a layer of fallen down leaves or mulch in place provides a suitable food source for worms and provides a shelter for small insects, in turn also providing a food source for hedgehogs and shrew mice.

Biological Control Agents

Predators

Lacewings are available from biocontrol dealers.

Predators are mainly free-living species that directly consume a large number of prey during their whole lifetime. Ladybugs, and in particular their larvae which are active between May and July in the northern hemisphere, are voracious predators of aphids, and will also consume mites, scale insects and small caterpillars. The larvae of many hoverfly species principally feed upon greenfly, one larva devouring up to fifty a day, or 1000 in its lifetime. They also eat fruit tree spider mites and small caterpillars. Adults feed on nectar and pollen, which they require for egg production. Dragonflies are important predators of mosquitoes, both in the water, where the dragonfly naiads eat mosquito larvae, and in the air, where adult dragonflies capture and eat adult mosquitoes. Community-wide mosquito control programs that spray adult mosquitoes also kill dragonflies, thus reducing an important biocontrol agent.

As per the report by Kaya, Harry K. et al. (1993) several species of entomopathogenic nematode are important predators of insect pests. Phasmarhabditis hermaphrodite is a microscopic nematode that kills slugs, thereafter feeding and reproducing inside. The nematode is applied by watering onto moist soil, and gives protection for up to six weeks in optimum conditions.

Other useful garden predators include lacewings, pirate bugs, rove and ground beetles, aphid midge, centipedes, spiders, predatory mites, as well as larger fauna such as frogs, toads, lizards, hedgehogs, slow-worms and birds. Cats and rat terriers kill field mice, rats, June bugs, and birds. Dachshunds are bred specifically to fit inside tunnels underground to kill badgers.

Parasitoid Insects

Parasitoids lay their eggs on or in the body of an insect host, which is then used as a food for developing larvae. The host is ultimately killed. Most insect parasitoids are wasps or flies, and usually have a very narrow host range.

Parasitoids are one of the most widely used biological control agents. Commercially there are two types of rearing systems: short-term daily output with high production of parasitoids per day, and long-term low daily output with a range in production of 4-1000million female parasitoids per week. Larger production facilities produce on a yearlong basis, whereas some facilities will produce only seasonally.

Smith SM (1996) reports that rearing facilities are usually a significant distance from where the agents will be used in the field, and transporting the parasitoids from the point of production to the point of use can pose problems. Shipping conditions can be too hot, and even vibrations from planes or trucks can disrupt the parasitoids.

Micro-Organisms

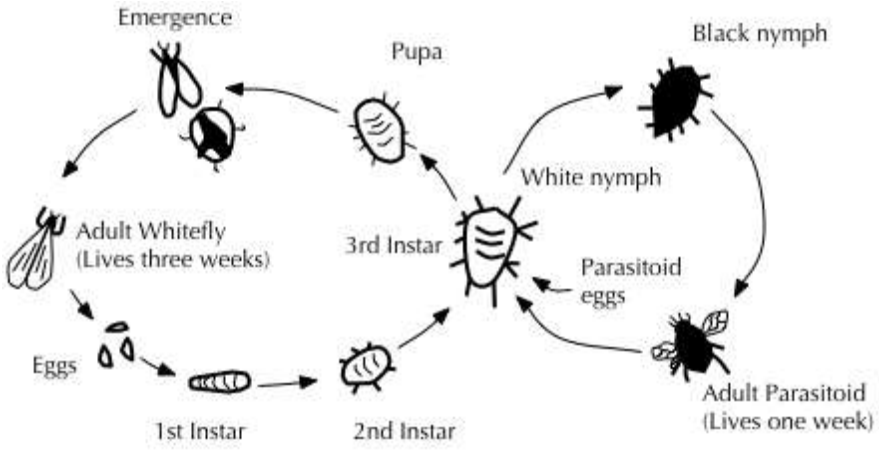

Diagram illustrating the life cycles of Greenhouse whitefly and its parasitoid wasp Encarsia Formosa

Pathogenic micro-organisms include bacteria, fungi, and viruses. They kill or debilitate their host and are relatively host-specific. Various microbial insect diseases occur naturally, but may also be used as biological pesticides. When naturally occurring, these outbreaks are density-dependent in that they generally only occur as insect populations become denser.

Bacteria

Bacteria used for biological control infect insects via their digestive tracts, so insects with sucking mouth parts like aphids and scale insects are difficult to control with bacterial biological control. Bacillus thuringiensis is the most widely applied species of bacteria used for biological control, with at least four sub-species used to control Lepidopteron (moth, butterfly), Coleopteran (beetle) and Dipteran (true flies) insect pests. The bacteria are available in sachets of dried spores which are mixed with water and sprayed onto vulnerable plants such as brassicas and fruit trees. Bacillus thuringiensis has also been incorporated into crops, making them resistant to these pests and thus reducing the use of pesticides.

Fungi

Fungi that cause disease in insects are known as entomopathogenic fungi, including at least fourteen species that attack aphids. Beauvoir bassinet is used to manage a wide variety of insect pests including: whiteflies, trips, aphids and weevils. A remarkable additional feature of some fungi is their effect on plant fitness. Trichoderma species may enhance biomass production promoting root development, dissolving insoluble phosphate containing minerals.

Plants

The legume vine Mauna prurient is used in the countries of Benin and Vietnam as a biological control for problematic Imperator cylindrical grass. Mauna prurience is said not to be invasive outside its cultivated area.[21] Disodium uncinatum can be used in push-pull farming to stop the parasitic plant, Strata.

Indirect Control

Pests may be controlled by biological control agents that do not prey directly upon them. For example, the Australian bush fly, Muscat vetustissima, is a major nuisance pest in Australia, but native decomposers found in Australia are not adapted to feeding on cow dung, which is where bush flies breed.

Effects of Biological Control

Biological control can potentially have positive and negative effects on biodiversity. The most common problems with biological control occur via predation, parasitism, pathogen city, competition, or other attacks on non-target species. Often a biological control agent is imported into an area to reduce the competitive advantage of an exotic species that has previously invaded or been introduced there, the aim being to thereby protect the existing native species and ecology. However the introduced control does not always target only the intended species; it can also target native species.

Living organisms, through the process of evolution, may achieve increased resistance to biological, chemical, and physical methods of control over time. In the event the target pest population is not completely exterminated or is still capable of reproduction were the pest control means a form of sterilization, the surviving population could acquire a tolerance to the applied pressures - this can result in an evolutionary arms race with the control method. Successful biological control reduces the population density of the target species over several years, thus providing the potential for native species to re-establish. In addition, regeneration and reestablishment programs can aid the recovery of native species. To develop or find a biological control that exerts control only on the targeted species is a very lengthy process of research and experiments.

Effects on Invasive Species

Biological control programs aim to reduce or eliminate populations of ecologically and agriculturally harmful invasive species. Examples where this has been achieved include: The alligator weed was introduced to the United States from South America. This aquatic weed

spreads rapidly and causes many problems in lakes and rivers. The weed takes root in shallow water causing major problems for navigation, irrigation, and flood control. The alligator weed flea beetle and two other biological controls were released in Florida. Because of their success, Florida banned the use of herbicides to control alligator weed three years after the controls were introduced.

Grower Education

A potential obstacle to the adoption of biological pest control measures is growers sticking to the familiar use of pesticides. It has been claimed that many of the pests that are controlled today using pesticides, actually became pests because pesticide use reduced or eliminated natural predators. A method of increasing grower adoption of biocontrol involves is letting growers learn by doing, for example showing them simple field experiments, having observations of live predation of pests, or collections of parasitized pests.

In sectary Plant

In sectary plants are those that attract insects. As such, beneficial in sectary plants are intentionally introduced into an ecosystem to increase pollen resources and nectar resources required by the natural enemies of harmful or unwanted insect pests. Beyond an effective natural control of pests, the friendly insects also assist in pollination.

The "friendly insects" include ladybeetles, bees, ground beetles, hoverflies, and parasitic wasps. Other animals that are frequently considered beneficial include lizards, spiders, toads, and humming birds. Beneficial insects are as much as ten times more abundant in the in sectary plantings area. Mortality of scale insects caused by natural enemies can be double within sectary plantings. In addition, a diversity of in sectary plants can increase the population of beneficial insects such that these levels can be sustained even when the in sectary plants are removed or die off. For maximum benefit in the garden, in sectary plants can be grown alongside desired garden plants that do not have this benefit. The insects attracted to the in sectary plants will also help the other nearby garden plants.

Beneficial Weed

A beneficial weed is any of various plants not generally considered domesticated, but which nonetheless has some companion plant effect, or else is edible or somehow beneficial. Beneficial weeds include a great many wildflowers, as well as other weeds that are commonly removed or poisoned.

For example, legumes, such as white clover, if they are colonized by the right bacteria (Rhizobium most often) add nitrogen to the soil through the process of nitrogen fixation, where said-bacteria has a symbiotic relationship with its hosts roots, "fixing" atmospheric nitrogen (combining it with oxygen or hydrogen) making the nitrogen plant-available (NH4 or NO3). Others use deep tap roots to bring up nutrients and moisture from beyond the range of normal plants so that the soil improves in quality over generations of that plant's presence. Weeds with strong, widespread roots also introduce organic matter to the earth in the form of those roots, turning hard, dense clay dirt into richer, more fertile soil.

Pest Prevention

Many weeds protect nearby plants from insect pests. One way they can do this is to repel insects and other pests through their smell, as do alliums and wormwood. Another is to entirely mask a companion's scent, or the pheromones of pest insects, as with ground ivy and wild oregano. Some also are unpleasant to small animals, because of their spines or other features, keeping them away from an area to be protected.

Trap Crops

Some weeds act as trap crops, distracting pests away from valued plants. Insects seeking a food plant search by smell, and then land at random on anything green in the area of the scent. If they land on an edible "weed", they will stay there instead of going on to the intended victim. Sometimes, they actively prefer the trap crop.

Host-Finding Disruption

Recent studies on host-plant finding have shown that flying pests are far less successful if their host-plants are surrounded by any other plant or even "decoy-plants" made of green plastic, cardboard, or any other green material.

- First, they seek plants by scent. Any “weed” that has a scent reduces the odds of them finding crop plants. Obvious examples are Crow Garlic and Ground Ivy, the former being “wild chives” and the latter a form of wild mint, both dramatically masking both plant scent and insect pheromones. They cut down Japanese beetle infestation, and caterpillar infestation, for example cabbage worm, tomato hornworm, and even squash bugs.
- Second, once an insect is near its target, it avoids landing on dirt, but lands on the nearest green thing. Bare earth gardening helps them home in perfectly on the victim crop. But if one is using “green mulch”, even grass or clover, the odds are that they will make what's called an “inappropriate landing” on some green thing they don’t want.

Companion Plants

Many plants can grow intercropped in the same space, because they exist on different levels in the same area, providing ground cover or working as a trellis for each other. This healthier style of horticulture is called forest gardening. Among the obvious benefits are providing a wind break or shelter from noonday sun for more delicate plants.

Green Mulch

Conversely, some intercropped provide living mulch effect, used by inhibiting the growth of any weeds that are actually harmful, and creating a humid, cooler microclimate around nearby plants, stabilizing soil moisture more than they consume it for themselves.

Herbicide

Repel plants or fungi, through a chemical means known as allelopathy. Specific other plants can be bothered by a chemical emission through their roots or air, slowing their growth, preventing seed germination, or even killing them.

Beneficial Insects

A common companion plant benefit from many weeds is to attract, or be inhabited by, beneficial insects or other organisms which benefit plants. For example, wild umbel lifers attract predatory wasps and flies, that eat nectar, but reproduce by feeding common garden pests to their offspring. Likewise, some weeds attract ladybugs or the "good" types of nematode, or provide ground cover for predatory beetles.

Inherited Sterility in Insects

The inherited sterility in insects is induced by sub sterilizing doses of ionizing radiation. When partially sterile males mate with wild females, the radiation-induced deleterious effects are inherited by the F1 generation. As a result, egg hatch is reduced and the resulting offspring are both highly sterile and predominately male. Compared with the high radiation required to achieve full sterility in Lepidoptera, the lower dose of radiation used to induce F1 sterility increases the quality and competitiveness of the released insects as measured by improved dispersal after release, increased mating ability, and superior sperm competition.

References

Horticulture Research International, Wellesbourne : “Insects can see clearly now the weeds have gone.” Finch, S. & Collier, R. H. (2003). Biologist, 50 (3), 132-135.

"Journal of Chemical Ecology , Volume 9, Number 8". SpringerLink. Retrieved 2012-06-13
Pauline Pears (2005), HDRA encyclopedia of organic gardening, Dorling Kindersley, ISBN 978-1405308915

Flint, Maria Louise & Dreistadt, Steve H. (1998). Clark, Jack K., ed. Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control. University of California Press. ISBN 978-0-520-21801-7.

Biological control: Approaches and Applications". University of Minnesota. Retrieved 3 September 2012.

Follett PA, Duan JJ (2000) 'Nontarget effects of biological control.' (Kluwer Academic Publishers).

Pauline Pears (2005), HDRA encyclopedia of organic gardening, Dorling Kindersley, ISBN 978-1405308915

Kaya, Harry K. et al. (1993). "An Overview of Insect-Parasitic and Entomopathogenic Nematodes". In Bedding, R.A. Nematodes and the Biological Control of Insect Pests. CSIRO Publishing. ISBN 978-0-643-10591-1.

Hoddle M.S., Grandgirard J., Petit J., Roderick G.K., Davies N. (2006). "Glassy-winged sharpshooter Ko'ed - First round - in French Polynesia". Biocontrol News and Information 27 (3):

Smith SM (1996) Biological control with Trichogramma: advances, successes, and potential of their use. In 'Annual Review of Entomology' pp. 375–406.

Beard, Karen H., and Eric M. O'Neill. "Infection of an invasive frog Eleutherodactylus coqui by the chytrid fungus Batrachochytrium dendrobatidis in Hawaii." Biological Conservation 126.4 (2005): 591-595.

Bauer, L.S.; Liu, H-P; Miller, D.; Gould, J. (2008). "Developing a classical biological control program for Agrilus planipennis (Coleoptera: Buprestidae), an invasive ash pest in North America" (PDF). Newsletter of the Michigan Entomological Society 53 (3&4): 38–39.

Bornemissza, G. F. (1976). "The Australian dung beetle project 1965–1975". Australian Meat Research Committee Review 30: 1–30.

Wright, MG; Hoffmann, MP; Kuhar, TP; Gardner, J; Pitcher, SA (2005). "Evaluating risks of biological control introductions: A probabilistic risk-assessment approach". Biological Control 35: 338–347.

Cane Toad". Exotic Animals - Major Pests. Northern Territory Government, Australia. Retrieved 14 March 2011.

National Research Council (U.S.). Board on Agriculture and Natural Resources (June 2000). Incorporating science, economics, and sociology in developing sanitary and phytosanitary standards in international trade: proceedings of a conference. National Academies Press. p. 97.

Heong, K.L.; Escalada, M. M. (1998). "Changing rice farmers' pest management practices through participation in a small-scale experiment". Int. J. Pest Management 44: 191–197.

Proverbs MD and Newton JR 1962. Influence of gamma radiation on the development and fertility of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). Canadian Journal Zoology, 40: 401-420.

Proverbs M.D. 1982. Sterile insect technique in codling moth control. pp. 85-99. Proceedings of the international symposium on the sterile insect technique and the use of radiation in genetic insect control. Jointly organized by the IAEA and the FAO and held in Neuherberg, 29 June - 3July, 1981. Vienna. IAEA. 1982. 495 p.

Astaurov, B. I., and S. L. Frolova . 1935. Artificial mutations in the silkworm (Bombyx mori L.). V. Sterility and spermatogenic anomalies in the progeny of irradiated moths concerning some questions of general biological and mutagenic action of X-rays. Biol. J. 4: 861-894 (in Russian).

Ostriakova-Varshaver, V.P. 1937. The bee moth, Galleria mellonella, as a new object for genetic investigations. II. Cytogenetic analysis of sterility initiated by X-rays in males. In Russian. Biologicheskii Zhurnal, 6: 816–836.

Proverbs MD. 1962. Sterile insect technique in codling moth control. pp. 85-99. Proceedings of the international symposium on the sterile insect technique and the use of radiation in genetic insect control, jointly organized by the IAEA and the FAO and held in Neuherberg, 29 June - 3July, 1981. Vienna. IAEA. 1982. 495 p.

LaChance, L. E. and Degrugillier, M. 1969. Chromosomal fragments transmitted through three generations in Oncopeltus (Hemiptera). Science, 166: 236–237.

Delrio G.;Cavalloro R. 1975. Sterilite hereditaire chez Gonocerus aculteangulatus Goenze (Rhyncote, Coreidea), pp.423-436 In: Sterility principles for insect control. proceedings Symposia, Innsbruck, Austria, 22–26 July 1974. STI/PUB/377. IAEA, Vienna 1975

Maudlin I. 1976. The inheritance of radiation induced semi-sterility in Rhodnius prolixus. Chromosoma 58 (1976), pp. 285–306.

Henneberry, T. J. 1964. Effects of gamma radiation on the fertility of the two-spotted spider mite and its progeny. J. Econ. Entomol. 57:672–674.

Smith R.H. and R.C. von Borstel 1972. Genetic control of insect populations. Science 178: 1164-1174

LaChance L.E. 1967. The introduction of dominant lethal mutations by ionizing radiation and chemical as related to sterile-male technique of insect control, pp. 617-650. In J.W. Right and R. Pal (eds.), Genetics of insect vectors of disease. Elsevier, Amsterdam, The Netherlands.

Robinson A.S. 2005. Genetic basis of the sterile insect technique, pp. 95-114. In V.A. Dyckn J. Hendrichs, A.S. Robinson (eds.), Sterile insect technique: principles and practice in Area-wide integrated pest management. Springer, Dordrecht, The Netherlands

Bakri, A., K. Mehta, and D. R. Lance. 2005. Sterilizing insects with ionizing radiation. pp. 233-268 In V. A. Dyck, J. Hendrichs, and A. S. Robinson (eds.), Sterile Insect Technique: Principles and Practice in Area-wide Integrated Pest Management. Springer, Dordrecht, The Netherland. 787 pp.

Bauer H. 1967. Die kinetische Organisation der Lepidopteren-Chromosomen. Chromosoma 22: 101-125.

LaChance, L. E. and Degrugillier, M. 1969. Chromosomal fragments transmitted through three generations in Oncopeltus (Hemiptera). Science, 166: 236–237.

Murakami A, Imai H.T. 1974. Cytological evidence for holocentric chromosomes of the silkworms, <i<Bombyx mori and B. mandarina (Bombycidae, Lepidoptera). Chromosoma 47: 167-178.

Wrensch, D.L., J.B. Kethley & R.A. Norton. 1994. Cytogenetics of Holokinetic Chromosomes and Inverted Meiosis: Keys to the Evolutionary Success of Mites, with Generalizations on Eukaryotes. pp. 282 – 342. In M. A. Houck (Ed.), Mites: Ecological and Evolutionary Analyses of Life-History Patterns. Chapman & Hall, NY.

Wolf K.W. 1996. The structure of condensed chromosomes in mitosis and meiosis of insects. International Journal of Insect Morphology and Embryology Volume 25, Issues 1-2, January–April 1996, Pages 37-62.

Carpenter, J. E., S. Bloem, and F. Marec. 2005. Inherited sterility in insects. pp. 115-146 In V. A. Dyck, J. Hendrichs, and A. S. Robinson (eds.), Principles and Practice in Area-wide Integrated Pest Management. Springer, Dordrecht, The Netherlands. 787 pp.

LaChance, L.E., and Graham, C.K. 1984. Insect radiosensitivity: Dose curves and dose-fractionation studies of dominant lethal mutations in the mature sperm of 4 insect species. Mutat. Res. 127: 49–59.

Koval, T. M. 1996. Moths: myths and mysteries of stress resistance. BioEssays, 18, 149-156.

Tothová A. and F. Marec 2001. Chromosomal principle of radiation-induced F1 sterility in Ephestia kuehniella (Lepidoptera: Pyralidae). Genome 44: 172–184

Wolf, K. W., Novak, K. & Marec, F., 1997. Kinetic organization of metaphase I bivalents in spermatogenesis of Lepidoptera and Trichoptera species with small chromosome numbers. Heredity 79: 135–143.

Marec, F., Tothova, A., Sahares, K., and Traut, W. 2001. Meiotic pairing of sex chromosome fragments and its relation to atypical transmission of a sex-llinked marker in Ephistia kuehniella (Insecta: Lepidoptera). Heredity 87, 659-671.