

A Review—On Molluscs as an Agricultural Pest and Their Control

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Abstract

Snails and slugs are very harmful pests for crops, vegetables, fruit, ornamental plants, and ecosystem. These creatures are known for destructive nature on cultivated plants. Several species of molluscs such as *Achatina fulicva*, *Laevicaulisalte*, *Helix aspersa*, *Theba pisana*, *Arianta arbustorum*, *Deroceras*, *Tandonia*, *Milax*, *Arion*, *Limax*, *Argiolimax metriculatus*, *Lehmanniopoirieri*, *Limacusflavus*, *Milaxgagates*, etc., are the pest which have distractive nature and cause impact on agricultural industries. Therefore, the need for sustainable approaches to control molluscs will become ever-more important. Molluscs' damages are characterizing by holes and slimy on damage part of the crops and vegetables. Snails and slugs both have similar biologies. They lay eggs during mid-autumn to mid-winter, when favorable moist conditions return after summer. After mating, these lay eggs within two to four week, spherical pearl-white eggs at moist place. After eggs laying its hatch in two to four weeks, but young snails and slugs usually become sexually mature after one year. However, population of molluscs increases accordingly climatic conditions and damage the crops. Populations of the molluscs can be control by uses of different tools and technique such as physical control, chemical control, biological control, bait formulations and by help of different plant derived molluscicides. This review of literatures tries to integrated information on various agricultural pests (molluscs) and their control.

Keywords

Snails, Slugs, Agricultural pest, Molluscs control

1. Introduction

Molluscs are the second largest phylum of the animal kingdom. Their name is derived from Latin word “mollus” meaning “soft”, which is generally protected by hard calcium containing shell [1]. This phylum divided into six taxonomic classes such as Cephalopoda, Monoplacopoda, Amphineura, Scaphopoda, Bivalvia and Gastropoda [1]. Gastropoda comes from the Greek word *gastros* (stomach) and *podos* (foot). They are the animals without backbones, having asymmetrical, unsegmented and spirally coiled body. Class gastropods include 80% species of the phylum Mollusca [2]. Snails and slugs (molluscs) are hermaphrodites, but there is reciprocal exchange of spermatozoa as they mature before development of eggs [3]. Due to the high reproductive potential, a single snail and slugs can multiply into the field and it is very difficult to control their population. However, during day time, these creatures are found in the shelter, moist shady places, but during night, they come out from the shelter and damages different crops which cause economic lass.

Several species of snails and slugs are considered as notorious pests in agro-ecosystem in different part of the world, due to their rasping feeding behaviors [4]. Land molluscs are very harmful pest to vegetables, field crops, ornamentals plants, fruit tree, and ecosystem [5, 6]. Crops are damages by gastropods due to feeding and contamination of harvested plants with their bodies, eggs, slime or faeces, leading to deterioration in the quality of the harvest and financial loss [7].

Molluscs are characterizing by holes and slimy trails over the foliage of cauliflower [8]. Invasive gastropods are significantly pest of the horticulture and agriculture in North America with many species feeding directly and reducing the yield and quality of agricultural products and decrease rating of a wide range of crops [9, 10]. In India, 1,500 species of land snails are found, but the number of species of slugs is limited. Among these, 9 species of snails and 12 species of slugs are reported as a pest of ornamental plants, fruits, vegetables, and field crops [3]. Soybean and corn crops were subjected to 50%-90% yield loss due to rapidly damage by slugs [11]. In India, 14 species of pestiferous slugs have been reported from different divers' habitats like orchards, nursery, playhouses and crop field [12] among which some are exotic to this land. These pests significant in terms of its extent of damage in standing crops and their quality which degrading capacity in agricultural sectors. This reviews of literature summaries the different snail and slug are pest for agricultural fields and their control.

2. Life cycle of the molluscs

Snail and slugs are hermaphrodite creatures. The behaviors of mating, egg-laying, hatching and development are not well synchronized even within single species and various stages of development are found around the year. However, most of the species live in one season or less while, adults may deposit eggs through the season. In snails mating behaviors needs introductory which play and adjust themselves in such a way that they could bring their genital organ in a position which facilitates mating. Whereas, in slugs during mating both partner twisted around to each other like spiral vine and then transfer their spermatophores into the female [1]. In general, courtship may last for 3-4 hours in both snails and slugs, which depending upon the species. In case of the snail, eggs hatches within 7-15 days and development of young ones takes place within 15-25 days and in general becomes fully matured within 45-59 days which may took 321-364 days to reach adulthood because their size and shape are slowly increase [1].

3. Snails and slugs as an agricultural pest

In India, common snails *Helix* are mostly found in Andhra Pradesh, Bihar, Himanchal Pradesh, Maharashtra, Odisha and Uttar Pradesh. However, phytophagous species, giant African snail *Achatina fulica* has been reported as a serious pest of vegetables, fruits and different ornamental plants in the costal part of Assam, Tamil Nadu, Odisha, Kerala and West Bengal. The common garden snail *Laevicaulisalte* are also feeding a number of ornamental plants like portulaca, balsam, verbena, dahlia, marigold, cosmos, lily and narcissus in Himanchal Pradesh and Punjab [3]. The brown garden snail *Helix aspersa* (*Cornuaspersum*) is a common snail which causing problems in California gardens [3]. African snail (*Achatina fulica*) has been reported for the first time causing damages ornamental plants and vegetable in Bangalore [13]. It can also cause severe damages to capsicum, mulberry, areca, betel, vine, tomato and banana crops [14]. Snails are not known to damage seeds, but it may damage the germinated seeds which close to the soil surface. *Theba pisana* is a serious pest in many part of the world and affects diverse crops like vegetables, ornamental plants, grapevines and shrubs [15]. The species *T. pisana* was first time detected in North America in La Jolla, San Diego country in 1914 [16, 17] and was considered one of the worst snail pests of agriculture and horticulture ever introduced into the continents at the time [18]. This white garden snail or Italian white snail *T. pisana* has been transported [19] out of its own native range multiple times across the globe and been introduced in many countries including United States, South Africa, Australia and other [20]. *T. pisana* have caused significant damage to vegetables, ornamental flowers, almonds, citrus and olive trees in Australia [21]. However, its native range is considered to be along the Mediterranean and much of Western Europe [20, 22], and it has established itself as an important pest in most of the regions it has invaded [21, 22]. The commonest and widespread land snail *Arianta arbustorum* occurs through Central, Eastern and Northern Europe [23]. It is an omnivorous snail that includes green plants, decaying plant material, and fungi in its diet [24].

There are numerous species of the terrestrial slugs are distributed throughout of the world which living in wide range of habitats from temperate to tropical regions [25]. Some species of slugs causes considerable amounts of economical damage in arable and horticultural crops, commercial nurseries and home gardens. The study of C. M. Post and G. R. Post [26] reported that slugs cause damage to plants both above and below the ground, in arable crops; it has greatest impact at establishment, leading to a thin crop stand or in severe cases to complete germination failure as a result of grain hollowing. However, numerous species of the terrestrial slug are across the globe and several species are listed as a crop pest in both tropical and temperate zones [4]. As Howlett [27] reported that genera *Deroceras*, *Tandonia*, *Milax*, *Arion* and *Limax* are recognized as the pestiferous slugs which prevailing in temperate climates, out of which *Arion vulgaris* and *Deroceras reticulates* are the worst pest slug species in Europe. *Deroceras panormitanum* slugs often reaches pest levels, particularly in hardy nursery stock [28], horticultural crops and legume seed [29]. These slugs are widespread throughout Britain, France and SW Europe, as well as North America, New Zealand and Australia [7]. Black slug *Limax* and *Filicaulisalte* feeds on the seedlings of several economical important plants in all part of the India [3]. According to Sallam and Wakeil [30], various species of slug can eat animal faeces, algae, fungi, lichens, carrion, centipeds, insects, green plants, worms and other slugs. As Routray and Dey [3] reported that some species of slugs like

Deroceras reticulatum, *Agriolimax meticulatus*, banded slug *Lehmanniopoirieri*, three-band garden slug *L. valentiana*, tawny slug *Limacus flavus* and greenhouse slug *Milax gagates* are damage gardens plants.

4. Crops damaging nature of molluscs

Land molluscs are attacks on raw succulent vegetables, seedlings, roots, seeds, tuber crops and leave unpleasant slimy tracks on the injured parts [31]. The study of Zala et al. [1] reported that land molluscs damage vegetables, potatoes, cereal, lettuce, cabbage, carrots, maize, clover as well as other horticultural and agricultural crops. Land snail eats roots, seedling, seeds and tuber of nearly all vegetables, oil plants, field crops, ornamental plants as well as fruits in field, garden and green house [30]. Most of the slugs eat a wide array of broadleaf plants and grasses including most crops and many weeds which harm the crops both by killing seedling [1] outright, causing poor stands and damage to the leaves of young plants. They feed by scraping the surface of host plants. It is feed by scraping the surface of host plants. However, damaging symptoms of the molluscs varies by crop to crop such as some feed on recently-planted seeds of wheat, scraps strips of leaves in corn and many small grain plants; create craters in the cotyledons and ragged holes on the leaves of soybean crops [1].

5. Agricultural pest (Molluscs) control

This pest can be control by some useful techniques.

5.1. Physical and mechanical control

Hand collection with subsequent squashing of the snail and slug is the oldest mechanical method [32]. This method has two primary constraints: the high labor costs, and the physical disturbance of the natural habitat. Most of the time the snail are damages crops during the night than the day time. These damages cause heavy agricultural losses to the farmers. Hand-picking during night when the snails and slugs have left their hiding places was found effective [33]. Common salt like sodium chloride is also an effective dehydrating agent which can be applied as barrier of the snail and slugs in infested area. Molluscs can be collected daily and kill them by using boiling water or common salt solution [1]. The study of Joubert and Walters [34] has been reported burning the vegetation on which aestivating snails attach reduce the snail population. But this technique is very cruelly and its cause impact on non-target organisms.

5.2. Legislative control

Effective management of molluscs' infestation, it is very important to check the spread of molluscs to unaffected areas. In globalization of the transporting materials the dispersal of economic pest molluscs accrued by man, ships, soil, plants, seeds, trains, cars, airoplane, cargo, baggage, postal packages and food stuffs [5, 35] and hence required plant quarantine treatments. International as well as domestic quarantine measures should therefore be implemented strictly in different countries to check the entry of pest molluscs. Therefore, the population of snails and slugs can be control by legislative level.

5.3. Biological control

Biological control is a way which providing relatively permanent management of pests and critically, that the control organisms and pest populations remain in equilibrium. Snails and slugs management by natural enemies is have been known for many years [36]. The combination of *Bacillus thuringiensis* and the parasitic nematode *Rhabditis* are played an effective role in control the terrestrial snail and slugs in Egypt [37]. The study of Wilson et al. [38] has been reported that the nematode *Phasmarhabditis hermaphrodita* has been used successfully for the control of field slugs. The parasitic nematode, *Rhabditis* was recorded for the first time in Egypt and showed high infectivity on different snails and slugs [39]. Protozoa, lung worm, flat worm, carabid beetles and glowworm larvae of lampyrid beetles [40] as well as the larvae of *Sciomyzidae* (Diptera) are found the major parasitic predators are associated with molluscs. Commercial uses of black carp fish is one of the highest potentials for biological control of the snails [41]. Rodents, rove beetles, ground beetles and birds are feeding on slugs [33, 42, 43]. Therefore, biological control of molluscs may seem attractive, sometimes misguided attempts can terribly damage non-target, indigenous molluscs.

5.4. Chemical control

The population of molluscs can be control by the use of synthetic molluscicides. Niclosamide are used in Asia and Africa to eradicate the snails' population [44]. The world Health Organization (WHO) has tested thousands of synthetic compounds for the eradication of molluscs. Metaldehyde, methiocarb, common salt or combinations of these chemicals are known molluscicides [1]. Metaldehyde are stimulating the mucous secreting gland which cause excessive sliming and leading to death of molluscs due to dehydration of body [45, 46, 47]. According to Bhavsar and Patel [48], thiamethoxam and diafenthiuron are effective molluscicides against terrestrial snail. The carbamate compounds had a wide

range of effects [49] and they are little affected by environmental conditions and their toxicity increase in humid surrounding, which are optimal for gastropods. This compound is more effective against land snails under laboratory and field conditions [50]. The study of El-Massry et al. [51] has been reported that ferrous sulphate, urea, calcium super phosphate can be use against many species of land snails. Methomyl, dothiocarb, carbaryl, chlorpyrifos and dimethoate [52] is effective chemicals against snails after 12 days under lab conditions. These chemical substances can be use for the control of the agricultural pest of the snails. However, eradication of the molluscs by chemicals, it may be harmful to crops and environment.

5.5. Bait formulations and molluscs control

Bait formulation is one of the most common methods for the control of molluscs, in which bait contain effective molluscicidal components and molluscs attractants foods. Molluscicidal bait containing thiodicarb are developed and registered in Europe [53]. Initial field trials have indicated good activity against slugs in field and horticulture crops, with a long period of activity [54]. As Firth et al. [53] reported that the thiodicarb bait formulation for slugs was highly toxic to *Deroceras reticulatum* and *D. panormitanum*. The study of Srivastava et al. [55] has been reported 3% and 5% pellets of metaldehyde were used as bait against *Achatina fulica*. Moreover, bait technique is simple for use, local treatment not are wide, thus it is usually low costly [56].

5.6. Plant derived molluscicides

The use of plants as molluscicides has more attention in the world because of the high cost of synthetic molluscicides and pollution to environment [57]. Molluscicidal properties have been demonstrated in extracts from a variety of plants [58, 59]. Clove oil possesses strong bioactivity [60], and it has also exhibited ovicidal properties against eggs of several varieties of snail including *Achatina fulica* [61, 62]. Some test results prove the neem oil have molluscicidal activity. Phytophagous land snail in horticulture and greenhouses were killed by neem preparations [63]. Neem oil significantly reduced fecundity, hatchability and survival of the hatched young of the giant African snail *A. fulica* [64]. According to Ploomi et al. [65], spraying neem oil is effective in the control of *Arianta arbustorum*. The study of K. Singh and D. K. Singh [66] has been reported that the effect of *Allium sativum*, *Azadirachta indica*, and *Zingiber officinale* on the reproduction of snail *Lymnaea acuminata* and their active molluscicidal constituents allicin, azadirachtin, and gingerol [67, 68, 69] cause a significant reduction in the fecundity, egg laying and survival of the young snail.

6. Conclusion

Molluscs (snails and slugs) are causes economical and agricultural loss, which damage vegetables, cereal, potatoes, carrots, maize, crops and other horticulture. Human activities in mollusc's migration, rapid change in the global climatic scenario due to poor crop and agriculture management tactics, which act as catalytic factors in the population of molluscs' explosion in agriculture field. These pests globally distributed in the all over world. However, damages to nursery stock, horticultural or vegetables field by molluscs can have a greater impact economically by contamination of slime, faeces and significantly reduces the value to retailers. Some species of snails and slugs are serious pest of the crops, vegetables, fruits, ornamental plants which causes economical lass of country. However, most of the species of snails and slugs are live one of the season or less and adults may deposit eggs throughout of the season. Infected areas of the snails and slugs pest should be useful treatments for the control of their populations. Selective molluscicides like plant derived molluscicides may be effective due to eco-friendly, species specific in nature. In future selective plant derived molluscicides can be use for protection of agriculture.

Conflict of Interest

There is no conflict of interest

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