Spodptera frugiperda (FALLAEMYWORM) MANAGEMENT BY VARIOUS NON-HOST PLANTS(BIOLOGICAL CONTROL): A REVIEW.

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Abstract:
Spodoptera frugiperda, fallarmy worm is a native pest species in the Western hemisphere. Since it was first reported in Africa in 2016, Spodoptera frugiperda has spread throughout the African continent and is also found in several countries, Australia as well as Asia. Spodoptera frugiperda which feeds upon maize, sugarcane, rice, and sorghum etc, there for the yield gets decrease and found economical losses. To control this pest uses various chemical pesticides, effects of pesticides on ecosystem and humans health and development of resistance to insect pests have exaggerated efforts to find the alternative strategy that is cost-effective, low-risk and target-specific. Therefore, biological control is widely considered as one of the most important options for insect pest management. This comprehensive review amasses the information on biological control in different phases of their development. (Spodoptera frugiperda).
Keywords: *Spodoptera frugiperda, Insect Pest, Bio-insecticide, Extract*

Introduction:

Spodoptera frugiperda is the most infesting pest (Kumar 2014). *Spodoptera frugiperda* is scientific name of fallarmyworm is an important global agricultural pest. *Spodoptera frugiperda* is a lepidopteran insect of the family Noctuidae (J.E. Smith, 1797) It is native to tropical and subtropical regions of the Americas, this insect spread to most parts of the world since 2015. It has a voracious appetite and feeds on more than 80 plant species, including maize, rice, sorghum and sugarcane etc. If we see particularly *Spodoptera frugiperda* attacked in all maize producing areas in the world and cause severe reduction in maize yield and quality. (Baloch et al, 2020; Lira et al., 2020; Wang et al., 2020; Zhou et al, 2020). Fall armyworm is emerging as the most destructive pest of maize in India reported in May 2018 (Smith 2018). Maize is the third most important crop after rice and wheat in India. In maize many insects like Stem borer, Pink Stem borer, shoot fly and *Spodoptera frugiperda* show infestation at different tropic levels (Kumar 2014). In India, *Spodoptera frugiperda* first reported in May 2018 in Shivamogga, Karnataka.

Spodoptera frugiperda was first detected in Indian state of Karnataka at College of Agriculture, Shivamogga in May 2018 (Sharana basappa et.al 2018). Based on surveys conducted by Indian Council of Agricultural Research (ICAR) National Bureau of Agricultural Insect Resources (NBAIR) team in July 2018 it was reported that 70% of maize fields in Chikka balpura district of Karnataka were infested with FAW. Within less than five months of first appearance, it was confirmed in other five states these are Tamil Nadu, Telangana, Andra Pradesh, Maharashtra and West Bengal in maize as well as sugarcane crops (Bhosale .2018). In India the recent studies reported that the total infestation of *Spodoptera frugiperda* ranged from 2 to 35 % (Naganna 2020).

Spodoptera frugiperda is an important pest of maize and other crops throughout the Americas (Sparks 1986) damaging in late planted crops. In Bangladesh, the caterpillar was first detected in November 2018 by the Bangladesh Agriculture Research Institute (BARI) on two different crops, cabbage and maize (Palma, 2018). *Spodoptera frugiperda* were reported from Sri Lanka for first time from Damana region of Ampara district of Eastern Province in June 2018 (Gunasekara .2019). *Spodoptera frugiperda* on maize were found in Bogura and Chuadanga districts where as infested cabbage was reported from Rangpur, Thakurgaon, Bogura and Jashore districts. According to Montezano in 2018 *Spodoptera frugiperda* larvae can reportedly feed 353 different plant species but in Nepal this pest is a major threat especially for maize in Nepal is highly favourable for the pest (Montezano, 2018) Scientists from the Nepal Agriculture Research Council (NARC) reported *Spodoptera frugiperda* for first time in Nawalpur in May 2019 on maize crop. Within months it was reported from other districts these are Kavre, Sindupal chowk, Bhojpur (Anonymous, 2019).

Previous damage evaluations (Hruska & Gould, 1997) have shown that infestations during mid-to-late maize growth stages can result in yield losses of 15–73% (as 55–100% of the plants are infested) and similarly an evaluation in Ethiopia indicated that FAW caused up to 30% loss at the late whorl stage unless the pest is timely controlled (Fentahun, Personal Communication, 26 October 2017). Makgoba in 2021 did literature survey of 63 small-scale maize farmers from the two villages of Limpopo province, South Africa, randomly selected for study. Results showed that all participants could correctly identify the *Spodoptera frugiperda* and reported it as the most important maize pest during 2016-2017.

Life cycle of *Spodoptera frugiperda*

The life cycle of *Spodoptera frugiperda* shows four different developmental stages i.e. egg, larva, pupa and adult moth. There are six different growth stages of caterpillar development (instars). Female lays 100-200 eggs in groups are generally on underside of the leaves near the base of the plant. Life cycle of *Spodoptera frugiperda* duration depends on temperature and relative humidity, but it takes about one month to complete its life cycle. Color of mature larvae ranges from dark green to purplish green or brown. The most common color is purplish green (Smith 1991).

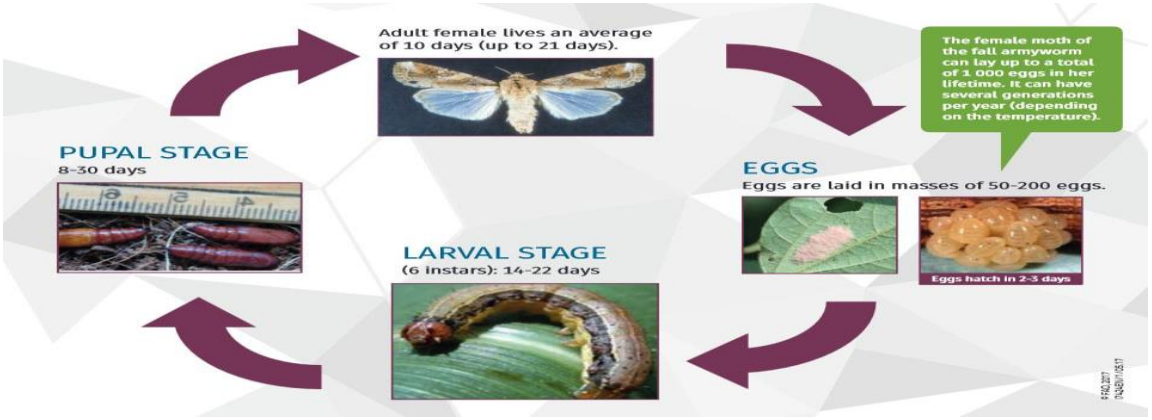

Fig . Life Cycle of *Spodoptera frugiperda*

Infection:

The *Spodoptera frugiperda* larvae feed in large numbers on the leaves, stems and reproductive parts of the plants species. Larvae eat mainly two months old crops of maize and sugarcane particularly damaging to the leaves and stalk. Fallarmyworm damages to crops by biting, sucking leaves sap and chewing which causes decrease yield of crops. Acevedo in 2017 investigates the slivery protein composition of *Spodoptera frugiperda* larvae and was determining qualitative and quantitative differences in the salivary proteome of the two host races of *Spodoptera frugiperda*. (Acevedo et.al, 2017) The recent studies in India reported that the infestation of *Spodoptera frugiperda* ranged from 2% to 35 % (Repalle Naganna 2020). *Spodoptera frugiperda* is most destructive pest of maize and other crops throughout the Americas (Sparks 1986) damaging in late planted crops. *Spodoptera frugiperda* attacked in all maize producing areas in the world and cause severe reduction in maize yield and quality.

Control:

Chemical Control:

Farmers used pesticides for controlling *Spodoptera frugiperda* (Makgoba et.al., 2021). Chemical pesticides such as chlorantraniliprole, emamectin benzoate and spinetoram are used to control this *Spodoptera frugiperda*. The residues of these pesticides are found in foods and drinking water which adversely affect the organisms consuming them. However, mixtures of pesticides in human food supply, in aquatic environment, including surface waters causes various diseases and infections (Laetz et al., 2009). So there is need to use alternative bio-insecticides.

Biological Control:

Bio-insecticides are less toxic and effective in small quantities and decompose quickly. Mostly the bio-insecticides are target-specific, do not affect to non-target organisms. Many of plant-derived products, pathogen/predator systems, insect pheromones, and plant incorporated protectants are widely used as biological control agents for insect pest management (Singh et al. 2019). Most of the plant Species of families used as insecticide or pesticide these are Fabeaceae with 9 species; Lamiaceae with 8 species; Euphorbiaceae and Asteraceae with 5 species, some of them Corymbia citriodora, Myrciaria dubia (Myrtaceae), Lippia microphylla (Verbenaceae) and Piper umbelattum (piperaceae) (Negrini, 2019). Agastache foeniculum (Ebadollahiet.al.2010) Citrulluscolocynthis, Cannabis indica and Artemisia argyi (Ahmed 2020) reported as these plants having insecticidal activity.

Rioba in 2020 studied the efficacy and potential of 69 plant species, which have been evaluated against *Spodoptera frugiperda*, and use among small-scale maize farmers with a focus on pesticidal plants for management of *Spodoptera frugiperda*. (Rioba 2020) The extract of Azadiracta indica, Schinnus molle, and Phytolacca dodecandra resulted in the more than 95 percentage larval mortality, 72 h after application. Non-treated maize plants showed extensive leaf injury compared to the synthetic insecticide and botanical-treated plants. (Sisay et,al. 2019). However, regardless of the insecticide used against *Spodoptera frugiperda* surviving on Bt maize, grain yields were similar. (Burtet et.al2017). Negrini in 2019 studied efficiency of essential oils (EOs) of Corymbia citriodora, Myrciaria dubia (Myrtaceae), Lippia microphylla (Verbenaceae) and Piper umbelattum (Piperaceae) in controlling S. frugiperda. The mortality tests conducted in second-instar caterpillars originated from insect rearing and artificial diet. As a control, he conducted tests with distilled water and acetone. Reported Eos showed more than 80% mortality rate (Negrini et.al., 2019).

Conclusion:

The use of bio-insecticide may also be an attractive way to protect plants from bacterial, fungal and viral infection. This technique may not replace the use of chemical pesticides in near future but effectively complement it. They may have the potential use for non - cytotoxic clinical agents. In this review several successful examples which play role against pest have been mentioned here in this review.

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