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Host Preference, Mode of Damage and Succession of Major Insect Pests of Brinjal

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Brinjal is one of the most popular solanaceous vegetables worldwide because of its nutritive and nutraceutical values. In recent decades, brinjal cultivation has been experiencing increased biotic and abiotic stresses due to the climate changes, which had affected the cultivation practices, growers' profit and consumers' choice to a larger extent. Amongst different insect pests, brinjal shoot and fruit borer (BSFB) is the major one causing significant reduction in economic yield followed by epilachna beetle, aphid, jassid and whitefly. On the other hand, proper knowledge on nature of damage, host preference, and seasonal abundance of insect pests is a pre-requisite for development and deployment of an appropriate, effective and timely management strategy against the pests. A pool of literatures on host preferences, damage pattern and succession of major insect pests of brinjal has been reviewed and presented in this paper.

Keywords: Brinjal; insect pests; nutritive and nutraceutical values; vegetables.

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1. INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) (Family: Solanaceae) is the most admired and predominant non-tuberous vegetable in Bangladesh and other parts of the world. The genus *Solanum* includes diverse flowering plants, including a few high-value economically important food crops like brinjal [1]. Global brinjal production is 51.23 m MT and China is the world's largest brinjal producer (32 m MT) followed by India (12.55 m MT) and Egypt (1.19 m MT) [2].

Brinjal is well known for its high-water content and low calorific value [3]. A brinjal fruit contains moisture 91.5 per cent along with 1.3 per cent protein, 6.5 per cent minerals, 6.4 per cent carbohydrates, 0.02 per cent calcium, 0.06 per cent phosphorus and 1.3 per cent iron, respectively [4]. It also a good source of vitamin A (5 mg/100 g), vitamin B (45 mg/ 100 g), nicotinic acid (0.08 mg/ 100 g), riboflavin (90 mg/ 100 g) and vitamin C (23 mg/ 100) [4]. Moreover, brinjal has been ranked to be amongst the top ten vegetables in terms of antioxidant capacity due to the presence of antioxidants such as arginine, 5-HT, delphinidine-3 Bioside (nasunin), solasodine, tryptophan, etc. [5,6]. Beside its food value, brinjal has been known for its medicinal values because of presence of phenols on fruits such as anthocyanins and strychnine, which have the potential to cure a variety of disease like cancer, hypertension, hepatosis [7,8]. Brinjal has also beneficial effects in the treatment of inflammatory stress, cardiac debility, neuralgias, bronchitis and asthma [9] and visual function [10] [11]. Also revealed that brinjal contains fraction of crude alkaloid that has significant analgesic effect.

Among the various causes of low productivity of the brinjal, damage inflicted by the insect pests is the most important one [12] causing 28-85% reduction in yield [13]. Some of the major insect pests attacking brinjal are, Brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.); Whitefly, *Bemicia tabaci* (Genn.); Epilachna beetle, *Epilachna vigintioctopunctata*; leafhopper, *Amrasca biguttula biguttula* (Ishida); Mealy bug, *Coccidohystrix insolita* (Green); Thrips, *Thrips palmi*, red mite (*Tetranychus urticae*) etc. The losses caused by various pests were Brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Crambidae) is the key pest [14,15,16] incurring severe damage in nearly all the brinjal cultivating nations [17], more particularly, south Asia i.e. India, Bangladesh as a whole [18]. Sucking insect pests such as jassid, aphid and whitefly are also considered to be the serious pests of brinjal in Bangladesh [19]. Increase in maximum and minimum temperature leads to increase the number of generation whereas lower temperature lengthen the duration of life cycle of insect pests. Thus, increased climate change effect makes it harder to control insect pests effectively.

Although, several eco-friendly management strategies have been evolved to manage these pests, but to develop and design economically feasible and effective pest management strategies, information on bio-ecology along with ecological footing is a pre- requisite. Similarly, influence of weather factors on pest population along with sufficient knowledge on seasonal activity of the pest is also necessary for adopting location specific suitable control measures in a particular region. Hence, this review aims at compiling and presenting the distribution, nature of damage and succession of major insect pests of brinjal.

2. MAJOR INSECT PESTS OF BRINJAL

About 53 species of insect pests are found to attack brinjal cultivation worldwide [20] of which, 20 insect pests (19 insects and 1 mite pest) were reported to cause serious damage in Bangladesh [21]. Among them, brinjal shoot and fruit borer, epilachna beetle, jassid, aphid and whitefly were described to be the major insect pests of brinjal through pest risk analysis [21]. A detail report on host preference, damage and succession of major insect pest of brinjal has been discussed below.

2.1 Brinjal Shoot and Fruit Borer (BSFB), *Leucinodes orbonalis* Guen.

BSFB is the most notorious pest of brinjal in Bangladesh and the genus *Leucinodes* reported to consists of three main species namely *L. orbonalis* Guen., *L. diaphana* Hamps and *L. apicalis* Hamps [22].

2.1.1 Host preferences

Besides brinjal, BSFB is found to attack other solanaceous crops along with their wild relatives [23]. Caterpillar of this insect is also found to feed on pea pods [22]. *Solanum nigrum* and *Solanum myriacanthum* potentially plays significant role as

alternative host of brinjal shoot and fruit borer [24,25].

2.1.2 Nature of damage

L. orbonalis is found to attack flowering, fruiting and vegetative developing stage on fruits/units, developing parts and inflorescence of brinjal [24]. Like other holometabolan members of the insect order lepidoptera, *L. orbonalis* also undergoes four growth stages: egg, larva, pupa and adult. The larval period is the longest (11-13 days), followed by pupal (10-11 days) and incubation period (5-6 days) [26]. Oviposition takes place at night or in the morning hours of the day and eggs are laid singly on the lower surface of the young leaves, green stems, flower buds, or calyces of the fruits [24]. The oviposition rate of the insect is reported to be 80 to 253 numbers of eggs per female [27,28]. Eggs are flattened, elliptical with 0.5 mm in diameter and color is creamy-white but change to red before hatching [29]. The egg takes incubation period of 3-5 days in summer and 7-8 days in winter and hatch into dark white larvae. The larval period lasts for 12 - 15 days during summer and 14 - 22 days during winter season [30]. Larvae pass through at least five instars [31,32] and there are reports of existence of six larval instars [33].

The caterpillars of *L. orbonalis* bore into the developing points of young tender shoots which at last shrivels away. The fruiting beads droop down while the fruits indicate round about openings. The higher percent of the larvae was found in fruits taken after by shoots, flowers, flower buds and midrib of leaves [28]. Inside one hour in the wake of bring forth, *L. orbonalis* caterpillar drills into the closest delicate shoot, bloom, or fruit and immediately blocks the passageway opening (nourishing passage) with excreta [29]. Watching the drilling openings, the pervaded fruits can be distinguished without much of a stretch. Furthermore, the dull shaded excreta can be seen without much effort to the opening of pervaded fruits. Optional pervasions by specific microorganisms may create additional decay of the fruits [34] and make them unfit for human consumption. In young plants, caterpillars are accounted for exhausting inside petioles and midribs of extensive leaves [28,35,36] along these lines shriveling, drop off and shrink of the young shoots prompting delay on shoot development, decrease on yield and yield parameter. Larval infestation inside the fruit brings about pulverization of fruit tissue and in serious cases, spoiling the whole fruit [37]. Larval nourishing in flower was uncommon, if happen, inability to shape fruit from harmed flowers [29].

2.1.3 Succession of brinjal shoot and fruit borer

L. orbonalis is dynamic during the time at places having moderate atmosphere yet its movement is antagonistically influenced by serious chilling [38]. BSFB pervasion on brinjal starts in August and achieved its crest in October and afterward began declining [38]. According to [39], a low infestation (18.66%) of borer was noted in the third week of May, which got severe (75.50% infestation) in the first week of August, and moderate (42.64% infestation) in the last week of September at the end of the crop growing season [40]. Found that the pest is most dynamic amid the late spring months, i.e., from May to August. It turns out to be less dynamic amid the winter months, especially in December and January [41]. Considered the occurrence and plenitude of BSFB in Allahabad, India and watched the most elevated rate on brinjal in December [42]. Discovered shoot and fruit damage in brinjal by BSFB was higher in May transplanted (spring) crops than that of July and September transplanted (fall) crops. The damage caused by insect change from season to season since direct temperature and high moisture support the populace develop of brinjal shoot and fruit borer [43,44]. Areas with hot and humid climate are conducive for population buildup and higher incidence of the pest. [42] Reported that summer season brinjal has more susceptibility than winter season brinjal and he found highest shoot infestation during mid-September while peak fruit infestation was reported during mid-November.

2.2 Epilachna Beetle, *Epilachna dodecastigma*

Among the coccinellids, Epilachna beetles belonging to the subfamily Epilachninae constitute one-sixth species and around 500 species have been found under the genus *Epilachna* [45]. This pest is widely distributed in South East Asia, Australia, China, India and many other countries.

2.2.1 Host preference

Epilachna beetles are phytophagous and found to attack a wide range of plants belonging to solanaceae, cucurbitaceae, fabaceae,

convolvulaceae as well as malvaceae family. Brinjal, tomato, potato, tobacco, melon, cucumber, gourds, pumpkin and many other important food crops are frequently being under attack of epilachna beetle [46]. Its presence has also been reported from medicinal plants and other naturally occurring solanaceous plant like *Solanum nigrum* and *Solanum torvum* [47,48].

2.2.2 Nature of damage

Infestation of epilachna beetle can significantly reduce yield by hampering crop growth [49]. Both adult and grub scrap off the epidermal tissue of leaves, flowers and fruits inflicting serious damage to the brinjal plant from seedling stage up to maturity [40,41,50]. [51] Reported 35-75 percent leaf injury due to the attack of epilachna beetle attack, which could go upto 80 per cent [52]. While, [53] reported 60 percent fruit damage caused by this notorious pest. Its importance increases to several folds as [54] reported that epilachna beetle had developed resistance against many commercial insecticides in recent times.

2.2.3 Succession of epilachna beetle

According to [55], maximum temperature and minimum temperature has significant positive correlation with population dynamics of the pest, while negatively correlated with rainfall and humidity. In contrast, [56] reported that highest number of epilachna found during third week of February and reaching to the least during April. However, its infestation starts from the initial crop growth period up to maturity [56]. Also reported positive correlation of relative humidity and rainfall interms of succession and population dynamics of the epilachna beetle [41]. Reported that the infestation of epilachna get started by the first week of November with an average population of 2.85 beetles per plant reaching maximum in the third week of February with the first peak at the third week of November. They also revealed a negative correlation between temperature and populace dynamics of the pest, however positive correlation among all other weather parameters. Research carried out by [57] revealed that highest population of epilachna beetle found on mid-August which get declined by the end of August and became zero during October. The maximum temperature, minimum temperature and relative humidity during peak period of infestation of the pest were reported to be 27.5±0.88°C, 19.58±0.49°C and 75.55±13.37% respectively [58]. Reported that infestation of epilachna beetle starts from December with a peak during February and March. However, [40] stated Mid-September to be the highly infested months. [59] Found 24-31°C and 58-75% relative humidity have conducive effect in population build-up of epilachna beetle.

2.3 Jassid, *Amrasca biguttula biguttula* Ishida

Jassid is a common sucking pest of brinjal around the world with wide range of host preference and capability to cause damage.

2.3.1 Host preference

Besides brinjal, jassid attacks cotton crop, which also harbours on various herbaceous plants and weeds of solanaceae, malvaceae and Cruciferae family [60]. [61] claimed jassid as the second major pest of brinjal after BSFB due to its high population intensity and damage severity [62]. Reported that brinjal is one of the most favourite host plants of *A. biguttula biguttula.* Many researchers had identified jassid to be a key pest of Brinjal [63,64]. [64] stated that oriental regions i.e. tropical and subtropical regions are suitable for jassid population due to the fact that the weather conditions prevailing in these regions are conducive for host-plant interaction.

2.3.2 Nature of damage

Jassid is phytophagous in nature and the damage percentage of jassid could extend up to 54 percent [65]. Jassid could cause devastating effect in solanaceous crops by hampering transportation through the phloem tissues of plant and possibly introducing a toxin inhibiting photosynthesis activity [66]. Most importantly, they don't cause much economic damage by reducing plant vigor by sucking cell sap only, but they affect rigorously on fruit yield by spreading virus disease as a vector [67]. According to [68], jassids prefers brinjal cultivars those have smooth textured leaves than having leaves having leathery texture or leathery texture with spines. [62] reported that the hair density and length of hair on lamina, midrib, and veins of brinjal had highly significant and negative correlation with the jassid population. Moreover, trichome density on the leaves play important role in the plant defense particularly among phytophagous insects including jassids [69].

2.3.3 Succession of jassid on brinjal

A study on population dynamics of jassid [70] revealed first appearance of brinjal jassid during 32nd SMW and continues up to 41st SMW Highest number of jassids (12.70 jassids/ leaf) was reported during 37th SMW [71]. Carried out an experiment on succession of brinjal pest complex and found that jassid population appears in the first week after transplanting of the crop and continues up to the maturity [72]. Also reported the peak population of jassid in brinjl during 16th, 18th, 24th, 33rd SMW [73]. Observed peak population of jassid in the third week of September with year round occurrence.

2.4 Aphid, *Aphis gossypii*

Aphid belongs to the family Aphididae family and is a major sucking pest of several commercially important food crop. Different species of aphid such as *Aphis craccivora*, *Aphis gossypii*, *Myzus persicae* feed on brinjal, tomato and many other vegetables as well as cereal crops [74]. [75] reported aphid as a serious threat to agricultural crops around the world.

2.4.1 Host preference

Aphid is a versatile crop pest reported from all over the world [76]. Reported 29 plant species of the family Solanaceae to be the host for the *A. gossypii* from India and recognized *C. annuum* as the most preferred one [77]. Prepared a checklist of aphids of Honduras on different host plants and reported *A. gossypii* and *M. persicae* to be the most common on *Solanum melongena*. [78] Reported that *Aphis craccivora* is the most common aphid species infesting a wide range of vegetables and pulse crops.

2.4.2 Nature of damage

[79] Stated that the direct consequences of aphid infestation causes yield losses, decline in quality and increased agricultural potential risks. Aphids can accumulate in high densities on young tender parts of the plants because they have high colonizing capacity; eventually they suck the sap especially from the lower side of the young leaves. Infested plants turn pale, leaves become distorted, curled and crinkled leading to stunted growth of the plants. Aphids secrete honey dew, which encourages growth of sooty molds over the leaves reducing photosynthetic activity of the crop and can further deter natural enemies of aphids. Severe attack of aphid could lead to production of fruits with reduce size as well as the market value [80].

2.4.3 Succession of aphid in brinjal

Aphid population development in brinjal had a major negative association with maximum temperature, minimum temperature, and rainfall, while relative humidity was positively associated with population size in February with peak aphid population [75]. Studies by [81] showed that *A. gossypii* is abundant in population and spatial distribution and the weather conditions varied. Then, after 56 days of transplantation, max aphid population was found. According to [82] peak aphid nymphal density was reported in March while peak adult aphid abundance was reported in February and March [83]. According to their analysis *A. Gossypii* population started to grow in August and peaked in January and nearly marginal in April at *Solanum melangena* in Bangladesh. In Solanum the second period of aphid infestation can be found around May-June [84].

2.5 Whitefly, *Bemisia tabaci*

Whitefly is a polyphagous pest belonging to the family Aleyrodidae of Homoptera order. About 12,000 different species of whitefly were reported worldwide [85]. Importantly, whitefly includes 41 distinctly isolated species population with 24 populations of specific biotypes [86]. Whitefly can cause considerable yield loss and damage to brinjal plants [87].

2.5.1 Host preference

Whitefly is the most abundant and versatile crop pests and known to infest around 600 different crop plants and wild plants [88,89]. Reported that whitefly can attack 500 species of plants belong to 74 taxonomic families. Among the plants squash, tomato, brinjal, potato, pumpkin, cucurbits, okra, beans are noteworthy. Parthenium is one of the most favourite host of whitefly [90]. It also known to feed on weed like Itsit, datura, milkweed, *Chenopodium* sp. [91].

2.5.2 Nature of damage

Whitefly can cause chlorosis, leaf withering, premature leaf drops and wilting of the crop plants by sucking the phloem sap of plant tissue

[92]. Whitefly excretes honeydew which leads to development of sooty mould reducing the effective leaf area for photosynthesis [93]. This may also results in irregular ripening of fruit [94]. Whitefly acts as a vector of virus disease and surprisingly, it can transmit nearly 114 virus species and some can bring havoc to crops [95]. Due to the fact that whitefly lives on the lower side of the leaves, it becomes trouble worthy to control whitefly with contact insecticides [96]. Whitefly is also reported to be possessed resistance to a wide range of insecticides [97].

2.5.3 Succession of Whitefly, *Bamisia tabaci* Genn.

[98] Recorded that white fly activity started from the second week of August (33rd SMW) and lasted until the first week of February. The highest white fly population (19 Nos./plant) was registered in the last week of September (39th SMW), where the maximum and minimum temperature and relative humidity are 34.3, 26.2 and 71.7% accordingly. Whitefly was first recorded in the third week of December (50th SW) according to the experiment of [99] and pest activity continued from the second week of December on until the first week of May. While, he believed that weather factors had no major impact on population dynamics, on the contrary [60] stated that relative humidity had positive effects on the pest population. [100] performed an experiment on the population ecology of whitefly on brinjal and observed peak larval production at 4 to 7 weeks after the crop was transplanted and the highest number was observed on the middle plant canopy. There was no meaningful association between temperature, daylight hours and RH with the populations while wind intensity had a strong correlation. [101] recorded strong plague activity during the third week of February.

3. CONCLUSION

To circumvent the huge production loss and crop damage inflicted by insect pest complex of brinjal, it is important to know the host preferences, nature of damage and seasonal abundance of insect pests for development of an effective management strategy. The pertinent literatures cited and overviews prepared in this paper could help the end users in successful implementation of management tactics of the major insect pests of brinjal in future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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