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SOME INSECT PESTS (ARTHROPODA: INSECTA) OF SUMMER VEGETABLES, THEIR IDENTIFICATION, OCCURRENCE, DAMAGE AND ADOPTION OF MANAGEMENT PRACTICES

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ABSTRACT

Vegetable is an edible plant or its part, intended for cooking or eating raw, whose fruits, seeds, roots, tubers, bulbs, stems, leaves, or flower parts are used as food. Vegetables are relatively cheaper and rich source of vitamins, carbohydrates, proteins and minerals. Their consumption gives taste, palatability, fiber for digestion, increases appetite and checks constipation. The objective of this article is to assess the some insect pests of summer vegetables, their identification, occurrence, damage and adoption of management practices. Various insects and mites cause damage to vegetable plants at all stages of growth including aphid, thrip, whitefly, leafhopper, two spotted spider mite, squash bug, pumpkin beetles, flea beetles, hadda or epilachna beetles, eggplant shoot and fruit borer, cutworms, hornworms, tomato fruit borer, tobacco caterpillar and melon fruit fly. Most of the vegetables are susceptible to pest damage, and their seeds, roots, stems, leaves as well as fruits are all subjected to injury. Vegetables damage ranges from reduced plant vigor to plant death and ultimately heavy crop losses occur. A combination of pest control strategies is of paramount importance and usually works well to reduce damage and keep the insect population below economic injury level for minimizing the yield loss. Pest identification of the vegetables is the most important step and the correct identification of pest troubles is the beginning of a successful integrated pest management program. The integrated pest management (IPM) include use of mechanical and cultural strategies, use of tolerant plant varieties, growing healthy seedlings, practicing adequate field sanitary measures particularly removing the fallen leaves, buds or debris, undertaking weekly field checking to spot out the presence of the insects, conservation of natural control agents, application of need based insecticides and ensuring of community approach for all the suggested tactics to maximize benefits.

Keywords: Vegetable, Host, Cucurbits, Solanaceae, Insect, Pest.

Contribution/ Originality

This article is one of very few studies which have looked onto some important insect pests of summer vegetables, their identification, occurrence, damage and adoption of management practices for their control. Ultimately, practical vegetable plant protection contains detailed information on pest monitoring; keeping insect infestations below significant levels through preventative measures and specific control of pests which are the core of long-term integrated pest management.

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1. INTRODUCTION

Vegetable is any of various herbaceous plants that is cultivated for an edible part or any part of a plant which is customarily eaten. Vegetables are used as delicious meals and for better health of the family. The amount of vegetables a person needs to eat depends on age, sex and level of physical activity. Recommended total daily amounts of vegetables for a person, who is more physically active, possibly may be able to consume more quantity while staying within calorie needs. Though the vegetables are poorer in calories than a lot of other foods, but they do contain some amount of calories. Their consumptions can also play a key task in neutralizing the acids created during digestion of fatty and proteinus foods, and moreover offer important roughages that assist in forwarding of food in intestine (Sarwar, 2012). A vegetable is an edible plant or its part, intended for cooking or eating raw. A plenty of thoughts and research exist to determine and recommend the uses of vegetables to eat and protect against disease. Vegetables are eaten in a variety of ways, such as a part of main meals and as snacks (Vainio and Bianchini, 2003). The nutritional contents of vegetables vary considerably, though generally they contain little protein or fat and varying proportions of vitamins such as Vitamin A, Vitamin K and Vitamin B6, pro-vitamins, dietary minerals and carbohydrate (Woodruff, 1995; Whitaker, 2001). Vegetables contain a great variety of other phyto-chemicals, some of which have been claimed to have antioxidant, antibacterial, antifungal, antiviral and anti-carcinogenic properties. Some vegetables also contain fiber which is important for gastrointestinal function. Vegetables contain important nutrients necessary for healthy hair and skin as well (Gruda, 2005). Thus, vegetable crops posse high medical value and play a vital role for curing of certain diseases (Steinmetz and Potter, 1996). As a consequence, vegetables take part in a fundamental function on food front as they are cheapest resources of normal foods and able to commendably additional sources to the major cereals of the state.

Vegetables production is increasing day by day and these can be grown in different seasons of the year in certain regions. It is necessary to maintain improved vegetables production for addition to nutritional values of the community. But the yield per unit area of vegetables is quite low since the insect pests cause 30-40% losses in general and even 100% losses in case of menace if no control measure is applied. A conservative estimate puts about annual yield losses in vegetables at 25% due to insect pests alone (Rahman, 2006).During the field survey conducted to observe some major insect pests damaging various vegetables, more than 25 insect pest species under 23 genera, distributed over 6 insect orders, belonging to 13 insect families were found infesting 23 host vegetable crops. Apart from these, a number of new host-crops of the already reported pests have been observed (Mohamad *et al*., 2011). The vegetables, bitter gourd, brinjal, muskmelon and pumpkin were tested for the relative host preference or damage of melon fruit fly, *Bactrocea cucurbitae* Coquillett (Tephritidae: Diptera). The bitter gourd was found as most preferred host demonstrating the maximum pupae formation (134.08), pupae weight obtained (4.91 mg) and percent adult emergence (82.64%) of fruit flies recorded. Brinjal was observed as

moderately preferred host, while, muskmelon and pumpkin were sorted out as least preferred hosts of fruit flies (Sarwar *et al*., 2013).

Vegetable crop production requires one of the highest rupees per acre investments than that of all agricultural endeavors, which makes it extremely important to prevent insects from reducing yields, lowering quality and increasing production costs. Thus, the farmers may have a wide choice to select suitable crop protection measures to adjust in their cropping system in a given situation in rural areas. The situations of the development of resistance in insects, destruction of their natural enemies, insect resurgence and harmful residues of pesticides in vegetables have prompted to shift the practice of sole reliance on insecticide to integrated insect pest management (IPM) practice (Sarwar, 2013). The major objective of this article is improvement in vegetables production per unit area by solving insect pests problems through management practices. One of the most important strategies for dealing with insects is to learn about insects' life cycles, behaviors, habitats and diets, and to recognize which are pests and which are actually lending as helping hand in biological control. Pest identification is the most important step because misidentification is a common cause of control failure and knowing the correct pest is the key to select control measures that work effectually.

1.1. Insect Pests of Summer Vegetables, Their Identification, Occurrence and Damage

Ordinarily, the vegetables are divided into two seasons i.e., summer vegetables and winter vegetables. The former are ideal for summer planting, require warmer temperatures, longer periods of sunlight, and warmer soil to live on and flourish. These are furthermore particularly susceptible to frost that is why it is principally imperative to plant such vegetables after the last spring frost date. Warm-season or summer vegetables include, tomato, carrot, cucumber, hot pepper, sweet pepper, brinjal, okra, bottle gourd, sponge gourd, bitter gourd, tinda gourd, pumpkin, arum, potato, mint, turmeric, ginger, melon, beets and beans. The most excellent time of sowing summer vegetables is spring (February to March) and they can produce till September to October. Under the above background, the key insect pests of some major summer vegetables are given below:-

1.2. Aphid, *Aphis gossypii* Glover (Aphididae: Homoptera)

The aphids are soft bodied yellowish insects with two cornicles at the abdomen and usually live on new shoots, crowns and undersides of leaves. In general, aphids are slender and dark green to yellow in color, while adults can be either wingless or winged. Nymphs are small and similar in shape to adults. Mostly vegetable plants are damaged by sucking plant juices, injecting toxins into the plant, secreting a sticky substance (honeydew) or transmitting certain plant viruses.

1.3. Thrip, *Thrips tabaci* Lindeman (Thripidae: Thysanoptera)

The adult thrips are pointed and slender, insect is reddish yellow with two pairs of fringed wings and two long brown spots on back, while mature insects are white or yellow in color.

Onion thrip and Western flower thrip are two of the most damaging pests in vegetables like bean and cucumber plants in the early stages. Immature and adult thrips are tiny, slender, and vary in color. They live mainly in flowers and can be seen walking and feeding on leaves and other plant parts. Damage caused by large numbers of feeding by thrips appears silvery in color and plants can die. Feeding on young fruit may result in scarring and russeting, while some species can transmit viruses.

1.4. Whitefly, *Bemisia tabaci* (Genn.) (Aleyrodidae: Homoptera)

Adults are tiny, moth-like insects and nymphs are flat, elliptical in shape, and clear or creamy yellowish in color that inhabit undersurfaces of leaves and cause damage by penetrating tissue and removing plant sap with piercing-sucking mouth parts. In general, whiteflies go through an egg stage, four nymphal stages and an adult form, while only the first nymphal stage (crawler) is mobile. Both nymphs and adults feed on leaves and other plant parts particularly problematic on tomatoes, squashes, cucumbers, beans, and other hosts. Direct crop damage occurs when whiteflies feed in plant phloem, remove plant sap and reduce plant vigor. With their high populations, excess sugar (excrement) causes accumulation of honeydew and subsequent growth of sooty mold where plants may die, while some species transmit plant diseases.

1.5. Leafhopper, *Amrasca biguttula biguttula*, Distant (Cicadellidae: Homoptera)

The slender pointed bodied greenish yellow adult insect has two distinct black spots at distal end of wings. The legs are provided with few rows of sharp thorns. Leafhoppers can increase to extremely large numbers in a short time and many vegetables including bean, eggplant, beet, tomato are attacked. Leafhoppers suck plant juices from the underside of leaves. Potato leafhoppers may cause a condition called tip burn or hopper burn on bean, potato and eggplant. Beet leafhoppers transmit a disease called curly top to beet.

1.6. Two Spotted Spider Mite, *Tetranychus urticae* Koch (Tetranychidae: Acarina)

The mite is very small, red in color and adults resemble with spider. Mites are more severe problem in hot, dry weather and plants attacked include bean, tomato, vines and eggplant. Mites suck plant juices from the underside of leaves. The leaves become bronze or yellow and the foliages take on a general wilted appearance. The symptoms of mite damage may be caused by other factors, so be sure to look for mites with a hand lens.

1.7. Squash Bug, *Anasatristis* (Degeer) (Coreidae: Hemiptera)

Adults are brownish-black or gray and flat across the back, while eggs produce tiny, light gray, wingless nymphs usually found in colonies. Plants attacked by squash bug are all cucurbits, but especially squash and pumpkin. Nymphs and adults suck plant juices causing leaves to wilt and die. Both also can feed on developing fruit. It may also transmit a disease organism that causes yellow vine.

1.8. Pumpkin Beetles, *Raphidopalpa (Aulacophora) foveicollis* (Lucus), *R. abdominalis* (F.) and *R. frontalis* (Baly) (Chrysomelidae: Coleoptera)

Adult beetles have glistering yellowish-red to yellowish-brown elytra that are uniformly covered with fine punctures. Freshly hatched grubs are dirty white in color while full-grown ones are creamy-yellow, and pupae are pale white and found in earthen cells in the soil. The adult beetles cause damage to young seedlings by feeding on leaves making shot holes. On hatching, the grubs start feeding on the roots. They live in the soil and cause damage to seedlings and mature plants by feeding on roots. The damage at the young stage may even kill the seedlings.

1.9. Flea Beetles, *Phyllotreta* spp., (Chrysomelidae: Coleoptera)

Flea beetles are in various sizes and colors, but they all have enlarged hind legs that allow them to jump like a flea when disturbed. Many vegetables, especially tomato, potato, eggplant, are attacked. Flea beetles eat small holes in leaves and can be primarily serious on small plants.

1.10. Hadda or Epilachna Beetles, *Epilachna vigintioctopunctata* Fab. and *E. dodecstigma* (Coccineliidae: Coleoptera)

The adults insect look oval shaped possessing black spots on back and often found along with grubs. Both adults and grubs of the insect feed on the leaves by scraping the leaf surface leaving the midrib. They also feed on the epidermis of leaves. As a result, the infested leaves dry and fall off. They may also feed on the fruit surface or make small bores in fruits.

1.11. Eggplant Shoot and Fruit Borer, *Leucinodes orbonalis* Guenee (Pyralidae: Lepidoptera)

The adult insect is a white moth having brown spots on wing and female moths lay creamy white eggs singly on shoots, flower buds, near the peduncle of fruits and on the lower surface of leaves. The eggs hatch into dark white larvae and gradually become light rose with ages. This is the most serious pest of eggplant and larvae start infesting eggplant from their very young stage and continue up to the last day of the crop's life. In the vegetative phase of the plant, the larvae bore into the young shoots, petioles and midribs of the large leaves, and feed on the internal tissues from within the attacked plant part. The infested shoots droop down and subsequently wither. In the reproductive phase when the plants start bearing flowers and fruits, the larvae bore into the flower buds and fruits. The infested flower buds drop and fruits show the sign of infestation from the oozed out frass of the larvae through the holes made on the fruit by the larvae prior to their jumping out of the fruits upon attaining maturity. The larvae while feeding on the internal soft tissues of the fruit often make tunnels inside the fruit and make the fruit unfit for consumption.

1.12. Cutworms, *Agrotis ipsilon* (Rottenburg) (Noctuidae: Lepidoptera)

Most adult cutworms are dull colored moths with hind wings usually light in color when full grown, and have grayish-brown wavy lines and spots on fore wings, while hind wings are hyaline having dark terminal fringe. They generally pupate underground or over winter in the soil in the larval or pupal stage. The cutworms curl up into a tight C shape when disturbed. Cutworms attack nearly all vegetables and the most common damage is to young plants which are cut off at soil surface. May also climb up the plant and feed on foliage and fruit of planted vegetables.

1.13. Hornworms, *Manduca* spp., (Sphingidae: Lepidoptera)

The adults are large moths with stout, narrow wings, forewings much longer than the hind wings. Species are dull grayish or grayish brown in color, and the sides of the abdomen usually are marked with six orange-yellow spots in tobacco hornworm and five spots in tomato hornworm. The hind wings of both species bear alternating light and dark bands. The most striking feature of the larva is a thick pointed structure or horn located dorsally on the terminal abdominal segment. It is easily detected by presence of droppings resembling to those produced by rabbits. The plants attacked include tomato, potato, pepper and eggplant. The tomato and tobacco hornworms consume large amounts of green foliage and sometimes fruit.

1.14. Tomato Fruit Borer, *Helicoverpa armigera* (Hubner) (Noctuidae: Lepidoptera)

Adult moths are stout, ochreous with pale-brown or reddish-brown tinge, fore wings are olive-green to pale brown in color with a dark brown circular spot in the center and indistinct double waved antmedial lines, while hind wings are pale smoky-white with a broad blackish outer border. Freshly hatched larvae are yellowish-white in color, but gradually change and acquire greenish tinge. Full-grown larvae are apple-green in color with whitish and dark-gray broken longitudinal stripes. Many, plants including corn, tomato, bean, pepper, okra, and eggplant are attacked by this pest. This worm feeds on the marketable portion of each vegetable crops and its attack often causing them to be unusable.

1.15. Tobacco Caterpillar, *Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera)

The adult moths are stout, pale ochreous suffused with dark-brown, and larvae in gregarious form feed inside the infested host. The caterpillars also tunnel into soft tissues such as soft stems, midribs and leaf stalks.

1.16. Melon Fruit Fly, *Bactrocera cucurbitae* Coquillett (Tephritidae: Diptera)

The fruit fly adults are free living, reddish brown with lemon yellow in color having curved vertical markings and fuscous shading on the outer margin of the wings. The adults female lay eggs usually just below the epidermis of the fruits by inserting their ovipositor. Generally due to fruit flies attack, watery juices come out at the point of puncture and later appear as a solidified material. The larvae (maggots) hatched inside the fruits eat away the pulpy tissues inside and

make tunnels in hosts and destroy the fruits. The infested fruits are completely destroyed. Generally fruit flies young maggots soon after hatching bore into the flower buds or start feeding the young and tender fruits of various cucurbits.

1.17. Adoption of Insects Management Practices for Summer Vegetables Protection

The best way to control insect problems in vegetables is to prevent pests before they get a foothold in the hosts. Integrated Pest Management (IPM) is an environmentally sensitive and effective approach to pest management that relies on a combination of common practices. In practicing IPM, growers should follow the four steps including setting an action threshold (a point at which pest populations or environmental conditions indicate that pest control action should be taken), pest scouting and identifying them accurately, and preventing pests from becoming a threat (using cultural methods, selecting pest resistant varieties and planting pest free rootstock). Once monitoring, identification and action thresholds indicate that pest control is required, and preventive methods are no longer effective, then fourth approach is chemical control (Alam *et al*., 2003; Ronald and Celeste, 2009).

Controlling insect pests on commercial vegetables organically is not impossible, but it is a challenging task for vegetable producers. The key to success is to choose crops and planting times wisely, and rely more upon non-insecticidal management methods than using insecticides. Some of the more important non-insecticidal management tools are choosing crops that have relatively few insect pests and growing crops at a time of year when the insect pests have least abundance. Usually, an early planted crops experience less insect pressure than late-planted crop. When possible, choosing varieties that are resistant to key pests is crucial. Practicing proper crop rotation is important, as repeatedly growing the same crop in the same field can result in increased insect pressure. Destroying old crop residue as soon as possible after the final harvest is an extremely important insect management tool. It can destroy a large numbers of immature insect pests before they have a chance to become adults and move to nearby crops, destroying adult insects before they have a chance to lay eggs, removing the crop as a breeding site for future generations of pests, and destroying over-wintering pests are indispensable (Sarwar, 2004).

Knowing when to protect a crop because pest populations usually increase as a crop grows, deliberating which pests are likely to occur on the growing crops and understanding the biology of these pests are necessary. Planting vegetables into weed free fields and maintaining good weed control should be adopted. Use of trap crops when feasible is vital, as the idea behind it, is to plant a crop that is more attractive to the insect pests than the main crop. Using metalized reflective plastic mulches to reduce early season infestations of pests such as thrips, aphids and whiteflies is critical. Research has shown that reflective mulches can greatly reduce the number of thrips and aphids attracted to seedling crops. The increased light reflectance prevents the insects from recognizing and landing on seedling plants. Using of physical exclusion methods when feasible to protect against early season pests like cucumber beetles on melon or squash is very helping (Sarwar, 2005).

Relying on naturally-occurring biological control agents like predators, parasites and pathogens is most important means of defense against insect pest populations. Growing healthy, vigorous plants is important because healthy plants are less susceptible to insect attack and better able to tolerate low to moderate insect infestations and still can produce. Monitoring pest populations at least once or twice weekly is better to know what pests are present and how abundant they are. Use of mechanical control devices such as specially designed vacuums or blowers to remove insects from plants can provide adequate control. A forceful spray of water can be used to dislodge pests such as aphids and mites. Through hand picking of insects and egg masses can help to delay pest population build up on small plantings. Use of organic insecticides like azadirachtin, botanical and horticultural oils, and insecticidal soaps can be effective against aphids, whiteflies and many early instars caterpillar pests (Sarwar, 2014 a; 2014 b).

The uses of pheromone traps and other survey tools are appropriate for the particular pests, for instance yellow sticky traps can help to scrutinize pests like aphids, thrips and whiteflies. Pheromone traps are available for moths of many caterpillar pests and a few other types of pests. Mating disruption pheromones are also available for few vegetable insect pests (Ahmad and Sarwar, 2013). For controlling fruit flies, a mixture of methods such as plowing well the soil to expose the pupae to birds, removing and destroying the infested and fallen fruits regularly, covering of fruits immediately after fruit setting with polythene bag having pin-holes and spraying cypermethrin at 10 days interval or spraying bait spray made of 1.0 g Dipterex 80 SP and 100 g molasses per liter, are significant. Placing pheromone bait traps each consisting of a 2.5×1.5 cm cotton wad having soaked in 15-20 drops of pheromone bait "Cuelure" above the crop canopy with the support of bamboo sticks and hung by a thin wire is very effective (Rajotte, 2004; Riaz and Sarwar, 2013; 2014).

2. CONCLUSION

Development of a large number of improved varieties their wider adaptability and standardization of production technologies for various agro-climatic conditions, seed treatment, regular pest scouting, and application of IPM can make it possible to produce vegetables in wider areas and improve the prospects of their supply tremendously. In any event of vegetables insects control, growers should consider all possible factors in pest management and integrate them as many as possible into overall production system. Vegetables insect pests can be effectively managed by incorporating the subsequent practices such as proper field selection, growing insect-free transplants, planting early, controlling weeds and diseases, operating insect traps, examining fields periodically, timing and applying insecticides properly, and immediate destruction of crop on completion of harvest to ensure success in pest management. Insecticides can control insect pests effectively when used as partners in crop management program based on need. Implementing of IPM practices can enhance the environmental benefits, and improve the health of vegetables and the farm system.

3. SUGGESTED PRIORITIES

Though note worthy progress has already been made in vegetable protection, however, there are still several troubles to be attempted. For this, the subsequent research priorities have been recognized, such as breeding of vegetables resistant to insect pests, use of biotechnology for incorporation of resistance to pests, intensification of research on seed production programs, export oriented research on vegetables, developing efficient cropping systems, research on growing vegetables in protected environments and on off-season vegetable production, and finally studies on insecticidal residues.

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