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The Importance and Management Option of Onion thrips, *Thrips tabaci* (L.) (Thysanoptera: Thripidae) in Ethiopia: A Review

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Abstract

Thrips attack a number of vegetable crops particularly onion thrips causing considerable economic damage on onion crops. Usually young leaves are preferred, but buds and flowers also get infested. Under severe infested conditions the leaves shed and hence plant growth is affected and their control is vital to the production and profitability of onion crop. Most onion fields need protection against onion thrips for two to three months depends on the varieties. If onion thrips are not controlled, damage can routinely reduce bulb yields. In addition to use integrated pest management, use of selective insecticides in rotation to be the most important tools for thrips control, but there are few labeled insecticides that registered in Ethiopia provide effective and consistent control. Therefore, the objective of this review was undertaken to evaluate previous work in the management of onion thrips.

Keywords: *Thrips tabaci;* Onion; Management

Introduction

Onion, *Allium cepa* L. (Amaryllidaceae (Alliaceae)) and the widely grown herbaceous biennial vegetable crop with cross-pollinated and monocotyledonous behavior having diploid chromosomes number 2n. Consumption of onions has been increasing significantly in the world partly because of the health benefits they possess [1]. In Ethiopia, it is an important vegetable produced across a wide range of latitudes. It is the most indispensable vegetable crops used as condiments in most Ethiopian cuisine. It is one of the oldest known and an important bulbous vegetable crop grown in Ethiopia. It is used in preparation of different foods and in therapeutic medicine in the country. It has a great potential to produce every year for both local consumption and export with an average yield of 10.77 tons per hectare (CSA, 2012).

Onion thrips, *Thrips tabaci* L. (Thysanoptera: Thripidae) is polyphagous and have been recorded on more than 300 species of plants [2]. It is a major insect pest in most onion growing areas of Ethiopia. Anon [3] found that large number of thrips kill onion seedlings, while damage to older plants by thrips may cause crops to mature early and, subsequently reduce yields. Adult and nymphal stages (immature) of thrips feed by rasping the leaves and other tissues of plants to release the sap, which they then consume with a punch and suck behavior that removes leaf chlorophyll causing white to silver patches and streaks. The injury caused by thrips rasping of the leaves enables various plant pathogens to gain entry, thus increasing disease problems. In addition, thrips carry plant pathogens on their mouth parts from one plant to another. In onions, entire fields can be destroyed, especially in dry seasons.

The stage of growth when an infestation occurs seems to determine the extent of yield loss. In onions, it appears that early and late-season infestations diminish yields less than those occurring in mid-season during the blubbing stage [4]. In Kenya, thrips are present in all onion growing areas and can cause up to 59% loss in yield [5].

In Ethiopia, it is an important insect pest that affect onion yield by direct feeding as well as reducing the quality and quantity by rasping the leaves and other tissues of onion crops to release the nutrients [6]. Yield losses due to onion thrips recorded 33 and 26-57% [7]. Similar studies at Upper Awash Agro Industry Enterprises revealed yield losses of 10 to 85% due to onion thrips in Ethiopia [8]. In Toke Kutaye district, West Shoa, Ethiopia the yield losses due to onion thrips ranged from 0 to 36.44% were recorded during the study period [9]. Therefore, the objective of this review was undertaken to evaluate previous work in the management of onion thrips.

Geographical distribution

The onion thrips is originated in the Mediterranean region. It was first found in Hawaii in 1915, currently it is found all over the world where onion is grown [10]. In Ethiopia, the particular insect is also distributed throughout the country particularly in onion growing areas.

Economic importance

Thrips of vegetable crops are known to be serious pests on a wide range of fruit, vegetable, flower, and agronomic crops. Thrips are members of the order Thysanoptera, which contains a number of genera and species. Among species of thrips that attack onions are onion thrips (*Thrips tabaci*) and western flower thrips (*Frankliniella occidentalis* Pergande). Both species have a wide host range, including cereals and broad-leafed crops [11]. The only major pest of onions is the onion thrips. This pest is important especially in areas where onions are grown under irrigation [6]. Onions are often emphasized, however, since much research has been directed to thrips control in this crop. Onion thrips incidence was a major problem and leaf blast seriously affected all cultivars but no control measures were taken [12].

Many thrips are pests of commercial crops due to the damage caused by feeding on feeding on vegetative parts or developing flowers which causes discoloration, deformities, and reduced marketability of the crop. Thrips may also serve as vectors for plant diseases, such as tospoviruses [13]. Over 20 plant infecting viruses are known to be transmitted by thrips. These enveloped viruses are considered among some of the most damaging of emerging plant pathogens around the world. Virus members include the tomato spotted wilt virus and the Impatiens necrotic spot viruses.

Thrips is damage is usually measured as an overall reduction in bulb size and weight of onions and flower corms produced. There may also be effects on the number, size, and appearance of flowers. The injury caused by thrips' rasping of the leaves enables various plant pathogens to gain entry, thus increasing disease problems. In addition, thrips carry plant pathogens on their mouth parts from one plant to another. In onions, entire fields can be destroyed, especially in dry seasons. In fruit crops, thrips damage may also result in the scarring of fruit and significant loss to culling.

Economic threshold level

Coviello et al. [11] note that reliable treatment threshold levels for onions are speculative. In California, a threshold of thirty thrips per plant at mid-season has been used successfully for dry bulb, fresh market, and drying onions, using conventional, synthetic pesticides This number would be adjusted downward for very young plants and upward for larger, mature plants. In New York State a conservative action threshold of three thrips per leaf has been suggested, and one thrips per leaf for Spanish and green bunching onions [14]. The other entomologist suggests an initial treatment threshold of one thrips per plant and then waiting until they have reached five thrips per plant for a second treatment [15]. In Ethiopia, the economic threshold level of onion thrips was reported 5 to 10 thrips per plant.

In onions, thrips must be controlled before the crop reaches the early bulbing stage, so that populations do not exceed manageable levels [11]. Plant architecture can also influence thrips population levels. In onions, cultivars with flat-sided leaves and a compact growth point (where the leaves are closely compressed) protect thrips from natural enemies, weather, and insecticides. Conversely, round, openly spaced leaves reduce thrips' hiding places [4].

Biology of onion thrips

The rate at which thrips move through their developmental cycle is highly dependent upon environmental conditions, including the temperature and nutrient quality of their food source. Stages in the developmental life cycle are the egg, first larval stage, second larval stage, pre pupa, pupa, and adult. Because of their small size, this pest species like other thrips cannot readily be identified to species even with a hand lens. Adult specimens are usually needed to make species identifications under high microscope magnification [16]. Brian [10] mentioned that the biology of onion thrips was as followed: The entire life cycle (egg to adult) requires about 19 days. Large populations are able to develop quickly under dry weather conditions where there are many overlapping generations throughout the year.

Females have a saw-like structure that helps to make an incision in plant tissue for egg laying. Eggs are placed singly just under the epidermis of succulent leaf, flower, stem or bulb tissue. Eggs are elliptical, approximately 0.2 mm in length.

They are whitish at deposition and change to an orange tint as development continues. Hatching occurs in 4-5 days. Larvae are whitish to yellowish. There are two larval stages and besides the adults they are the only damaging stages. Larval development is completed in about 9-10 days.

There are two non- feeding stages called the prepupa and pupa. They do not feed and occur primarily in the soil. Combined prepupal and pupal development is completed in 4-6 days. Adults are about 1 mm in length. Their body color ranges from pale yellow to dark brown; wings are un banded and dirty gray.

In this species has a darker form during the rainy season. Males are wingless and exceedingly rare while the females have long, narrow fringed wings. Females live for 12-30 days, and lay 50-60 kidney shaped eggs singly inside leaf tissue with a sharp ovipositor.

Figure 1: Adult Onion thrips

Figure 2: Pupa of Onion thrips

Damage and Symptoms

Onions are most sensitive to thrips injury during the rapid bulb enlargement phase that occurs in dry season particularly during irrigation season November to early June in Ethiopia. Yield reduction due to reduced bulb size is the primary crop loss caused by onion thrips. Accelerated plant maturity and senescence due to thrips injury may truncate the bulb growth period. Following harvest and during storage, thrips may continue to feed on onion bulbs, causing scars that reduce quality and aesthetic appearance of bulbs. *Thrips tabaci* feeding damage results in leaf tissue silvering and photosynthesis reduction, leading to bulb size reduction and yield loss [17].

The characteristic symptom of attack is a silvery sheen of the attacked plant tissue, and white or silvery patches and streaks on leaves. Affected tissue will dry up when the damage is severe. Damaged leaves may become papery and distorted. Infested terminals lose their colour, roll, and drop leaves prematurely. Moreover, *T. tabaci* has been identified as the main vector of an emerging tospovirus, the Iris Yellow Spot Virus (IYSV), which is correlated to bulb size reduction in western states [18].

Weather factors

Relatively high temperatures and lack of rainfall have been associated with increase in onion thrips population, while high relative humidity and rainfall reduce thrips population [19].

Figure 3: Damage symptom of Onion thrips on onion crop

In addition to their effect on thrips activity, temperature and relative humidity further influence the intrinsic rate of natural increase of the thrips [20]. The rate of development of *T. tabaci* is positively affected by increased temperature and decreased by increased relative humidity [19].

Management Option

Cultural control methods

Plant health adherence through removal of volunteer onion plants and weeds around the cultivated fields and crop rotation would be useful in minimizing thrips populations in an onion field [5]

Gachu et al. [21] reported that intercropping onion with spider plant and carrot reduced thrips population by up to 45.2% and 21.6%, respectively. Waiganjo et al. [5] observed that intercropping snap bean with spider plant significantly reduced the population of spider mites on the former. Other intercropping systems which have significantly reduced thrips population and plant infestation include leek with clover [22]; leek with carrot, and clover with French bean [23]. Intercropping of various plant species has also been investigated to compare reductions in colonization rates of onion thrips and overall reductions in yield [24]. Mulching has also been reported to reduce thrips infestation considerably [25]. The potential for kaolin as a deterrent to oviposition and feeding of onion thrips on onions [26].

The effect of intercropping on thrips population densities and damage depends, among other factors, on the selection of plants species. In some cases intercropping does increase the population of thrips in susceptible crops. Thus, populations of the onion thrips increase on potatoes when intercropped with shallot and garlic, as does *Caliothrips indicus* on groundnuts intercropped with pigeon pea and mung bean. A mixed cropping habitat is likely to encourage thrips predators, as has been shown for the minute pirate bugs (*Orius tristicolor*) [27].

Ellis and Bradley [28] reported that blue sticky traps are good for monitoring thrips population and also reported the pest could be well controlled, if the crop debris is destroy properly. Parella and Murphy [29] used sticky traps to monitor thrips. Rateaver and Rateaver [30] reported that soil fertility management affects thrips infestation and damage. Lack of adequate soil calcium may invite higher population of thrips. Use of fertilizer not only affects the nutritive value of plants but also impacts the insect pest densities [31].

Soil fertility management may also affect thrips infestation and damage. According to one source, a lack of adequate soil calcium may invite higher populations of thrips [30]. Another writer suggests that nutritional balance can reduce thrips attack. High nitrate levels will invite thrips, and the effects of excessive nitrate are compounded by shortages of potassium, sulfur, boron, and manganese. Foliar applications of soluble calcium and kelp will balance the excess nitrogen. These nutrient levels can be monitored on a weekly basis, using plant tissue analysis, to make accurate adjustments [32].

The use of cover crops can affect the number of overwintering thrips. Oats is a better choice, but requires later fall planting than rye or wheat a factor that constrains its use as a cover crop in colder regions [33]. Drought stress increases the susceptibility of onions to thrips damage. Adequate irrigation throughout the growing season is a critical factor in minimizing damage [4].

The fact that thrips are color-sensitive suggests that colored mulches may be effective in their control. Louisiana researchers conducted a study to see whether aluminum-coated mulch would repel the pest [34]. The reflective mulch repelled 33 to 68% of the thrips. Ultaviolet-absorbing plastics used to build walk-in field tunnels have proved effective in protecting crops from western flower thrips [35]. Mulching with wood shavings can be used as a strategy to improve onion yield and bulb size under the agro ecological settings of the area of Mersan [36].

Regarding thrips population cultural management, the farmers are much interested in the outcome thus 30 cm inter row spacing with 20 cm plant-to-plant distance is recommended for commercial farming of onion [37].

T. tabaci is the major insect pest of onion in Sokoto State, Nigeria as reported worldwide and that the pest can be effectively managed by early planting/transplanting with bulb yields [38].

Use of resistance varieties

To prolong the effectiveness of insecticides, it is important to limit the number and frequency of insecticide applications, rotate insecticide classes or modes of action between applications, and apply insecticides with thorough coverage. Sprays applied with high pressure and high water volume penetrate better into the inner neck where thrips reside

There is no known “true resistance variety” in onions thrips population density reduction known under Ethiopian condition. However, some onion varieties can tolerate effects of thrips feeding with only mild yield loss. Varieties with tolerance to thrips require fewer insecticide applications. Reduced insecticide use lowers control costs, slows development of resistance to insecticides in the thrips population, and may encourage biological control through preservation of natural enemies. Onion varieties with an open neck growth and dark, glossy leaves are less attractive to thrips than varieties with tight necks and lighter green leaves [39].

Use of botanicals

To avoid further resistance in onion thrips pest different entomologist tried different non-chemical methods. Coll and Bottrell [40] encouraged Orius insidiosus as a biological agent in the thrips niche. Gami et al. [41] obtained 96% thrips mortality by *Humicola* sp.. Neem (*Azadirachta indica*) extracts used to control thrips [42-45]. On the other hand, even the botanical insecticides disappointed the users when neem products were reported toxic to beneficial insects like lady beetles [46].

The efficacy of botanicals viz., *Phytolacca dodecandra*, *Chrysanthemum cinerariaefolium Nicotiana tabacum* and *Azadirachta indica* for the controlling the onion thrips has been reported by Stoll [47] earlier. Dodia et al. [48] also mentioned that in addition to the above botanicals *Cymbopogon citrates* and *Parthenium hysterophorous* were found effect on the onion thrips. According to Ayalew [49] found that the ethanol extracts of neem seed powder evaluated against onion thrips, reduced thrips population under field condition

PAN [50] reported that *Bidens. pilosa* minimized the number of onion thrips population but exhibited low mortality rate percentage when compared to other treatments. *Securidaca longepedunculata* showed a better performance than commonly used botanicals, *Azadirachta indica* and *Chrysanthemum cinerariaefolium*, *Securidaca longepedunculata* is a toxic plant and its root bark contains “Chamana’e” which is commonly used for washing clothes as well as medicinal value against snake attack in areas where the plant is grown. Under Ethiopian condition there is a study made on the use and toxicity potential of the plant against any insect pest. In this study, this plant was found performance better than the already known botanicals, *Azadirachta indica* and *Chrysanthemum cinerariaefolium* [9].

A broad spectrum insecticide used to control whiteflies, aphids, mites, thrips and beetles and also reported the level of pest control is likely to be higher on field condition when properly applied [51]. Shiberu et al. [9] also reported that *Cymbopogon citratus* was at 1st, 3rd, 5th, and 7th day scored lesser efficacy percent against onion thrips under field condition but Stoll [47] reported that lemongrass, the whole plant extract was very effective against rice pest. *Parthenium hysterophorous* root extract was minimized onion thrips at 1st day but prolonged to decline within 7 days [9].

Klein et al. [43] found that neem (*Azadirachata indica*) seed extract retarded the growth of onion thrips. Onu and Aliyu [52] successfully used as *Capsicum* sp. Powder against the same pest. Bekele et al. [53] used fresh leaves, the inflorescence and succulent stems of *Ocimum suava* for thrips control. Hazara et al. [45] used a neem extract against onion thrips successfully.

Biological control

There are many beneficial organisms prey to harm onion thrips. Some of these include ladybird beetles, minute pirate bugs, ground beetles, lacewings, hover flies, predatory mites, and spiders [14].

Some authors observed that the effect of *Beauveria bassiana* against the onion thrips was significantly increased after 3 days whereas the effect of *Metarhizium* against the onion thrips was prolonged unlikely decreasing trend resulting unsatisfactory control of the pest [9]. *Beauveria bassiana* was most effective when used early at economic threshold level, before large thrips populations have built up. The influence of temperature on the infection process is very important. According to them, the temperature at which *Metarhizium* infecting adult thrips is about 23°C and decreases in temperature of 3 to 5°C increase the time to death of the insect about a day. *Beauveria* species is used as a contact myco-insecticide but survives a relatively short period of time when exposed on a leaf surface. The killing capacity of this fungus at 3rd, 5th, and 7th day was 46.18, 54.31 and 60.67%, respectively [9].

Entomopathiogenic fungi, particularly *Metharhizium* and *Beauveriain* class Deuteromycetes, are as attractive as biopesticides for use in Integrated Pest Management (IPM), as they combine host specificity with proven safety [54]. Neil et al. [55] reported that *Beauveria* infection can kill the insect from 3 to 7 days, leaving a while mass of spores which can spread to other insects.

Some authors observed that the effect of *Beauveria bassiana* against the onion thrips was significantly increased after 3 days whereas the effect of *Metarhizium anisopliae* against the onion thrips was prolonged unlikely decreasing trend resulting unsatisfactory control of the pest [9]. *Beauveriain bassiana* was most effective when used early at economic threshold level, before large thrips populations have built up.

Chemical

Development of resistance by onion thrips to most commonly used insecticides has been reported. Chemicals are the most common practices for onion thrips management. Despite their ease of use and availability of numerous classes or modes of action, rapid development of resistance to insecticides has been a key problem. Many of the earlier registered products for control of onion thrips are losing control efficacy. The main reasons lay in the life history characteristics of onion thrips: reproduction by parthenogenesis (eggs develop without male fertilization so females pass all of their genes to their offspring), high reproductive potential, and short generation time.

Earlier studies conducted in 1980s at Melkassa showed that cypermethrin was effective against onion thrips [56]. Three to four sprays of cypermethrin at rate of 50 to 75 g a.i/ha when the threshold of five thrips per plant is exceeded was recommended [57]. Debere Berehane Agricultural Research Center (DBARC) (2005) reported that the performance of cyhalothrin was lower than that of the insecticide selecron and botanical treatments in experiment carried out in 2003 and 2004 at Shoa robit. Several alternative pesticides are available for controlling thrips. Sulfur, insecticidal soap, and diatomaceous earth have all demonstrated efficacy in suppressing thrips in several crops [58,28]. Being contact pesticides, however, their effectiveness in onions would probably be limited, because the thrips can hide between the leaves.

Insecticides vary in their toxicity to thrips life stages. Most insecticides are effective in killing the early larval stages (Instars I and II) because the young stages are small and actively feeding. Some insecticides are active against adults and only a few have ovicidal (egg) activity. Ludger and Jean [36] suggested that the pyrethroid insecticide lambda cyhalothrin can be recommended in rotation with other classes of insecticides for the control of onion thrips. However, straight lambda cyhalothrin is not recommended because of the quick resistance buildup to the synthetic pyrethroids [59].

Eggs are laid within the leaf so are not accessible except to systemic insecticides that are absorbed through the leaf. Prepupa and pupa (Instars III and IV) are non-feeding and seek protection in the soil or at the base of onion plants, escaping contact by most insecticides.

Recent research has shown that the majority of onion thrips on a plant are in the non-feeding egg stage (60-75% of total population on an onion plant during late June to August), and thus, not exposed to insecticides and other suppressive tactics [60].

Conclusion

Generally, onion production is still very low in Ethiopia as compared to the other countries of the World. It could be attributed to the problem of insect and disease pests particularly onion thrips and white root rot disease, respectively. These pests are greatly influenced quality, texture, taste and yield of onion production. Onion thrips is difficult to control because the mobile stages of this insect are found mainly in the narrow spaces between the inner leaves where spray coverage is difficult to accomplish. Keeping in view the above facts that the present research review was initiated to review the past research work was not solved the challenges. Still now the problem of this particular insect pest is existing. Therefore, it needs to focus on the future the management aspects of onion thrips is need attention to the researchers.

It's important to develop resistant varieties, use of entomopathogenic fungi effectively, mass rearing and release of natural enemies, use selective different classes of insecticides within a season (insecticide rotations and combinations) to avoid resistance and resurgence and use all available cultural practices. In addition to these it is necessary to develop alternative tactics that are practical to implement.

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