The Benefits of Insecticide Use: Onions

Onion Maggots Feed on the Bulb Underground

Onion Maggot Treatment

Onion Thrips Feed on Onion Leaves

Onion Thrips Treatment

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Key Points

- Onion maggots feed only on plants in the onion family.
- Untreated onion rows are often completely destroyed by onion maggots while insecticide treated plants are 99% free of maggots.
- Onion thrips infest onion acres throughout the U.S.
- Feeding by onion thrips can reduce yield by 50%.

Technical Summary

The onion is of European origin. Onion is mentioned as being under cultivation in America as early as 1629. Growers in thirteen states produce 6.9 billion pounds of onions with a value of $824 million from 174,000 acres annually. 95-99% of onion acres in northern states (MI, NY, OR, WA, WI) are treated with insecticides while 50-80% of the onion acres in more southern and western states (AZ, CA, CO, ID, NM, UT, GA, TX) receive insecticide treatments [32]. Insecticides represent approximately 1-4% of the cost of producing onions and are $6/A in California, $45/A in Georgia, $70/A in Michigan, and $87/A in Washington [39]-[42]. Without insecticide use, it is estimated that onion yields would decline by 10% in California, Arizona, and New Mexico; 12% in Idaho, Georgia, Colorado, and Utah; and 40% in Texas, Michigan, New York, Oregon, Washington, and Wisconsin [33].

There are two very widespread insect species threatening onion production in the U.S., onion maggot and onion thrips. Unchecked, either onion maggot and/or thrips can cause extensive losses over major portions of U.S. production areas [1]. Historically, the onion maggot is a threat only in northern climates. However, onion thrips can be found infesting onions throughout the U.S. Unlike the onion maggot, onion thrips feed on many vegetable, field and ornamental plants and feed on many weed species.

Onion production in the U.S. increased by 29% following the introduction of synthetic chemical insecticides [43] (Figure 1).

Onion Thrips

Onion thrips have a stylet that is used to puncture plant tissue; additional stylets form a feeding tube which is used to pump out plant liquids. They feed on the tender, newly emerging inner leaves, puncturing leaf cells and feeding on the exuding sap. Affected onion leaves develop characteristic silvery streaking. Black flecks of fecal matter may be seen on the damaged tissue. If the infestation is severe, leaves may develop brown tips, or look white from numerous scars close together. Leaves become distorted, wither and fall over. Heavy infestations of onion thrips can kill seedlings, reduce yields and bulb quality [2]. The top growth is essential for the development of the bulb. Thrips damage can reduce the size of onion bulbs due to reduced photosynthesis.

Male onion thrips are wingless, extremely rare and not needed for reproduction. Adult thrips move into onion fields from surrounding vegetation including legumes and cereal
grain fields usually during early to mid summer. Onion thrips also overwinter in the soil within onion fields. They feed and lay eggs. Each female can lay up to 80 eggs. They feed for about ten days, then drop to the ground and burrow into the soil. Adults emerge after 4 to 7 days. Females then lay eggs for the next generation. There are from three to five overlapping generations of onion thrips each season [2]. 100% of onion fields can become infested every year with onion thrips and onion yield can be reduced 40-50% [12][13].

Economical control of the onion thrips was not successful until DDT was introduced [4]. One of the early recommendations for control of onion thrips was made in 1898 with the advise to use tobacco sprays [5]. However, none of the nicotine, pyrethrum, or rotenone sprays or dusts gave satisfactory control of thrips [6]. In the 1930s, experiments showed that applications of tarter emetic would reduce thrips populations and increase yields. Research showed that 5 applications of tarter emetic at 2 pounds per application produced a 15% increase in yields as a result of thrips control [7]. Tarter emetic sprays came into rather general use in the U.S. [5].

DDT was a more effective insecticide for onion thrips control producing 40-80% increase in onion yield as a result of onion thrips control [5][9]. DDT dusts and sprays became standard treatments for the control of onion thrips in most parts of the U.S. [3]. Research in California demonstrated that the most profitable spray schedule was six DDT applications totaling 180 pounds of 30% dust per acre [8]. Reduction in larval populations were above 92% and the net financial gain was $5 for every $1 spent on DDT [8]. Research in the 1960s showed that four applications of parathion at .25lb/acre increased onion yields by 35% as a result of onion thrips control [10]. Parathion became the standard for onion thrips control.

Recent research in Texas with pyrethrroids showed that 8 applications of cypermethrin at 0.08 lbs/acre increased yield by 40% and produced three times as many jumbo bulbs resulting in a net return of $1291/acre [11]. The research indicated that the insecticide applications for onion thrips resulted in yields of such increase in size and value as to more than pay for the cost of insecticide application ($162/A for 8 sprays) in South Texas [11].

Due to their broad host range and the high mobility of adults, recolonization of treated fields from surrounding habitats can occur in as little as one week. This is further compounded by their high reproductive capacity which quickly reestablishes pest densities.

Predatory mites attack onion thrips but the commercially available species were ineffective in preliminary experiments [2]. Reliance on natural enemies for control of onion maggots and onion thrips is currently unrealistic [2]. None of the available biological control agents provide acceptable control of thrips [14].
Research in Colorado with Safers soap and nicotine demonstrated reductions in thrips populations of 44-76% [15]. Organic onion growers are permitted the use of the Entrust formulation of spinosad for control of onion thrips [44].

Onion Maggot

The onion maggot first reached North America from Europe in 1841-possibly in soil used as ballast in sailing ships [38]. Onion maggots are highly host-specific to plants in the onion family. Onion is the preferred host of the insect, but it also infests garlic, leek, shallots, and chives.

Only the larval or maggot stage causes damage. The maggots feed on roots and burrow into the developing bulb. Onion seedlings, the most severely affected stage, wilt and typically die due to maggot damage. Whole sections of an onion field may be affected with up to 90% crop loss [2]. Later-season damage appears as tunneling in mature bulbs, often accompanied by distorted growth and soft rot. In the northern U.S. there are normally three generations of onion maggots each year. The pupae of the third generation overwinter. Flies from the overwintered generation emerge in mid-May to feed on pollen from wildflowers. Females lay their eggs at the base of onion seedlings. The average number of eggs laid by a single female fly is probably about 50 [19]. Onion maggots can disperse over a wide area and are attracted to onion plants for egglaying. The flies use organic sulfur compounds produced by the onions to locate the onions. Flies easily colonize new onions planted up to 1.2 miles from overwintering sites. The emerging maggots seek out the roots and bulbs of onions and either feed externally or tunnel into the bulb. Maggots feed for two to three weeks. Maggot feeding kills seedlings. If onion seedlings are not protected with an insecticide applied at planting, onion maggots can reduce plant stands by one-half to near 100% [48]. More than 20 seedlings may be killed by a single maggot. The maggots frequently destroy groups of plants that result in a patchy crop.

Eggs are laid around the stems of the plant or in cracks of the soil in close proximity to the onions. When the eggs hatch, the larvae crawl to a stem and then follow the stem underground to the roots. Damaged plants are usually so severely injured that they wilt, dry out and soon disappear leaving uneven stands. The eggs hatch in 3 to 8 days and the young maggots at once seek the onions and tunnel within. When full grown, the maggots crawl out of the onion to change to the puparium in the adjacent soil. There is a second and third brood of flies attacking the older onions. A single maggot will kill a young seedling by tunneling up the interior of the stem. In the older bulbs a large number of maggots may be found eating out the interior [19].

The larvae feed directly on the onion bulb, disrupting the vascular system of the plant. This direct physical damage coupled with the secondary invasion of soft rot bacteria quickly produces signs of acute water stress. Characteristic symptoms include flaccid leaves, yellowing of the leaf tips, and complete foliage dehydration [16]. During outbreak years, the onion maggot has caused extensive damage (80-90%) [16].
Experiments in New York estimated that 93,000 to 271,000 onion maggots overwintered per acre of bulb onions [17].

In 1867, it was noted that the onion maggot had caused some onion growers in eastern states to give up growing the crop [18]. The only recommendations at that time were to pour boiling water over the young plants or to pull up the infested plants and destroy them [18]. With the increase in maggots, growers would compensate by planting 50% more seed [28].

In the early 1900s onion growers did not practice rotation and grew onions on the same land year after year until the insect pests rendered onion growing unprofitable [26].

Experiments in the early 1900s with carbon disulfide, hellebore, soap, carbolic acid, lime and kerosene did not produce satisfactory control and were prohibitive because of their expense [21]. In 1918 experiments began with bait treatments which included molasses and onion slices laced with arsenic; 24 bait cans per acre gave good control [22].

Until the development of synthetic residual insecticides in the 1940s very little control practice was directed against the onion maggot because older methods entailed considerable labor and expense [22]. 30-50% losses were not uncommon [22]. When onions were so seriously infested and not worth harvesting, growers simply plowed under the maggoty onions [26]. Onion growers in some parts of the country were forced to give up the growing of onions because of the onion maggot [26].

In 1928, there was a million dollar loss in Hardin County, Ohio alone due to the onion maggot [23]. In 1925 onion maggot caused the loss of about 50% of the onion crop in Cook County, Illinois [27]. By 1929 maggot populations had increased so dramatically in New York State that the assessment was that a practical means of control had to be found if onion growing was to be continued [24].

One effective treatment was to make five applications of 150 gallons per acre of lubricating oil [24]. This oil treatment yielded 94% undamaged plants as compared with 50% in the untreated checks [25]. The most effective early treatment was the use of mercury as a seed treatment followed by three dustings with mercury [25]. This treatment produced 99.8% undamaged plants but was impractical due to its high cost [25].

The onion maggot was controlled satisfactorily by foliar applications of DDT or chlordane from 1946-1950. Experimental control of onion maggots increased yields by 200% [37]. In the early 1950s, seed treatment or furrow applications of aldrin, dieldrin, or heptachlor provided excellent control [29]. Applied at the rate of .25 pound of aldrin per acre as a granule, maggot damage on treated farms varied from 3-6% whereas the check plots had 58-95% injury [30].

In the 1950s experiments with organophosphate insecticides showed that the percent of damaged plants could be reduced from 62% to 1% [31].
Reduction of the first generation of onion maggots by careful furrow application of a soil insecticide at planting is key to managing the onion maggot [2]. Without an insecticide at this stage, crop losses would exceed 70% [20].

There are no commercial varieties resistant to attack by early or midseason onion maggot larvae [2][46]. There are no indications that there exists a predator that limits its activities to the onion maggot.

Because onion production is specialized and costly, many growers concentrate primarily on the one crop, resulting in minimal rotations to other plant species. This practice invariably increases onion maggot pressure [36]. The onion-growing regions in northern states are confined to high organic muck soils which are discrete areas and are limited in size. The muck soil holds water well and allows the onion bulbs to expand [34]. The recommendation has been made that if rotation of fields is to be relied upon as a control strategy that there should be no other production areas within 0.75 mile [35].

Severe onion maggot damage on organic farms ranges from 10 to 50% of the onion crop [45]. Crop rotation is not a practical control for small scale organic onion farms since the fields would have to be located over a mile apart to avoid the flies [45]. Experiments on organic onion farms with row covers to prevent fly egglaying were abandoned after they kept ripping and flies were getting inside. Additionally, the tops of onion plants were being damaged by the row covers [45].

In theory, polyester row covers should work as an effective barrier against onion maggot because the insect lays its eggs after seedlings have emerged [47]. Row covers are expensive and may increase the risk of bacterial rot to the crop by increasing relative humidity. The use of nonwoven fiber barriers was researched and resulted in 70-90% fewer eggs than the nontreated control. However, the use of ethylene vinyl acetate is too expensive and impractical for large scale agricultural use because the fiber mat requires removal from the field and disposal after each use [47].

References


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Figure 1. U.S. Onion Production

Note: Five year averages