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A review on onion thrips and their management of bulb crops

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Abstract
Bulb crops are best suited as a tropical crop. Onion is popularly called as "Queen of Kitchen" as it is used as food, salad, spice, condiment and in medicine. Garlic is used as a spice. It is important because of its medicinal properties. Extract of garlic acts as fungicidal, bactericidal and insecticidal action. Full yield potential of the crop is not realized due to the number of constraints. Among them, pest and diseases are the major constraints in bulb crop production. Pest management is crucial for obtaining good quality marketable bulb. Arthropod pests and diseases that can reduce crop yield both in terms of quantity and quality. Major insect pests of bulb crops are onion thrips, reduce the yield potential. Management of bulb crops pests relies on insecticide use during crop growing period, but insecticide resistance can cause control failures that threaten the long-term viability of this strategy. IPM strategies minimize the losses and increase the marketable value of bulb crops. Infestation of onion thrips was started from the first week of February and it became gradually increased upto the first week of April and thereafter it was declined. Cultural practices such as intercropping, mixed cropping, time of planting, spacing, mulching, fertilizer doses, irrigation scheduling and blue colored traps are more effective. Bbiopesticide, botanical and some chemicals are also a very important components of the eco-friendly management of onion thrips of bulb crops.

Keywords: Onion thrips, Management, Bulb crops

Introduction
The group of bulb crops includes onion, garlic, leek, shallot, and chive. These belong to the family Amaryllidaceae (Alliaceae) and genus Allium. They are grown in India as winter vegetables. Onion, (*Allium cepa* L.) is an important commercial vegetable and Garlic (*Allium sativum* L.) as a species crop grown all over the world.

Onion is popularly called as "Queen of Kitchen" as it is used as food, salad, spice, condiment and in medicine. The presence of volatile oil known as *allyl propyl disulfide* is account for pungency in onion. Nutritionally fresh onion contains about 86.8% moisture, 11.6% carbohydrates, 1.2% proteins, 0.2-0.5% calcium, 0.05% phosphorous and traces of iron, thiamine, riboflavin and ascorbic acid. Primarily the bulbs used as vegetables. The flowering shoot part known as scape is also used as a vegetable. It is rich in minerals like phosphorus, calcium and carbohydrates. It also contains protein and Vitamin C.

Garlic is important because of its medicinal properties carminative or gastric stimulant in Unani or ayurvedic medicines. It is useful against flatulence the allicin has hypo cholesteric action it reduces the cholesterol level in the blood. Garlic used in the case of TB, rheumatism, sterility, cough, red eyes etc in the form of garlic juice. It has insecticidal action mainly repellent action. One percent garlic extract protect from mosquito and flies. The extract of garlic along with chili and ginger exhibited strong nematicidal action and it has killed the Meloidogyne nematode. Garlic extract also acts larvicidal properties the larvae of Culex, Spodoptera. Extract of garlic acts as fungicidal action. It is found to inhibit the growth of 200 pathogenic fungi and also control foot rot of French bean. Garlic extracts records a number of several medicinally important fungi. It got bactericidal properties. It is found against Staphylococcus bacteria gram positive and gram negative bacteria can be effectively damaged by garlic extract. Garlic extract kills the colonies of food poisoning bacteria and clostridium perfringens.

Onion is extremely important vegetable crop not only for internal consumption but also as highest foreign exchange earner among the fruits and vegetables. India is the 2nd largest producer of onion, in the world next only to China. It occupies an area of 1293 thousand ha, with a production of 22427.42 thousand MT in the year 2016-17. Onion production in Bihar and Jharkhand are 1248.96 & 292.59 thousand MT and contribute production share of the

country are 5.57 % and 1.30 % respectively in the year 2016-17. Garlic cultivated in an area of about 322 thousand ha with a production of 1697 thousand MT in the year 2016-17 (State Departments of Horticulture & Agriculture 2018).

Bulb crops (onion & garlic) are best suited as a tropical crop. It does best where the season is mild without the extremes of heat or cold or excessive rainfall. The crop should be grown in well-drained loamy and light texture soils which may be sandy loam or silt loam. It is sensitive to higher acidity and the optimum pH of the soil should range from 5.8 to 6.5 for better growth and development. Bulb crop is a most important culinary commodity as grown in India. Full yield potential of the crop is not realized due to a number of constraints. Among them, pest and diseases are the major constraints in bulb crop production. The onion plant is attacked by several insect pests like thrips, onion fly, cutworms and tobacco caterpillars etc**.** The major insect pest is onion thrips *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) that can cause significant yield losses. Onion thrips feeds directly on leaves, causing blotches and as well as distort the bulbs and convert them into undersize causing yield loss >50% but can be even more problematic by transmitting viral disease like *Iris yellow spot virus* (IYSV) (Diaz-Montano *et al.,* 2011).

Thrips are small cylindrical and highly mobile insect, thrips belong to the family Thripidae (order; Thysanoptera), are fast-moving, pale yellow to brown in color with characteristic fringed wings. Attack of thrips in onion at all the stages of crop growth, but their number increases from bulb initiation and remains high up to bulb development till maturity. It is approximately 2 mm long pale yellow to brown in color. Both nymphs and adults cause direct damage by puncturing the leaves and sucking the sap resulting in silvering, curling and eventually reduction in bulb size and weight. The affected plant show twisting and curling and results in yield losses upto 50%. The damage gets accentuated in summer when plants lose a lot of moisture through microscopic pores caused by thrips feeding. In addition to direct damage, thrips attack predisposes the crop to an increased threat of purple blotch and stemphylium blight (Bhangale and Joi, 1983). Pest management is crucial for obtaining a good quality of marketable bulb.

Seasonal Incidence of Onion thrips

Sathe and pranothi (2015) recorded that the incidence of thrips on onion and garlic was started from November and steadily increased during the hot months. Infestation of onion thrips was started from the first week of February and it became gradually increased up to the first week of April then it was declined. Thrips population was positively correlated with temperature and negatively with relative humidity and rainfall (Hossain *et al*. 2015). Population increased during early October onwards at the time of withdrawal of monsoon and the increase of temperature induced the positive relation between the temperature and thrips population (Lorine *et al*. 1986). Thrips population 20.78 nymphs and adult per plant during the 2nd week of November. Thereafter, the nymph and adult population gradually declined upto 2.14 per plant during the 3rd week of December (Kumar *et al.* 2017). Raising of thrips population started from 1st week of September (0.06 thrips/plant), peaked during the month of November (20.78 thrips/plant) and reduced in the third week of December (2.14 thrips/plant). Peak population of *T. tabaci* in onion has been reported during September (122.32 thrips/plant) (Liu, 2004), November (174.6 thrips/plant) (Lorini *et al.*, 1986), November to March (Ibrahim, 2010). Relatively high temperature and lack of rainfall have been associated with increase in onion thrips population, while high relative humidity and rainfall reduce thrips population (Hamdy and Salem 1994). In addition to their effect on thrips activities, temperature and relative humidity further influence the intrinsic rate of natural increase of the thrips (Murai, 2000). The rate of development of *T. tabaci* is positively affected by increased temperature and decreased by increased relative humidity (Hamdy and Salem, 1994).Thus; variation in population peak of *T. tabaci* may be due to weather condition, location and genotypes.

Management of bulb crops

Cultural practices

Cultural practices such as intercropping are a very important component of the eco-friendly management of many economic pests. Intercropping and plant spacing are very important agronomic techniques that can keep thrips population below economic injury level in onion crop.

Adjustment of planting date

Ibrahim and Adesiyun (2009) reported that 13-week old onion crop was transplanted from December to April in 2001-2002 and November to March in 2002-2003 growing seasons to the highest level of thrips damage and its effect on onion bulb yield. Thrips attacked onion at all the stages of crop growth, but their number increased from bulb initiation. Results revealed that thrips started appearing from January but the number was very low until the end of February when the population reached 12 thrips/plant. November transplanted was free of thrips up to 9 weeks after transplanting (WAT), December transplanted up to 8 WAT, January transplanted up to 6 WAT, while February, March, and April transplanted had a population of >5 thrips/plant at 4 WAT. There was a significant difference between plantings from 4-14 WAT. The peak of thrips incidence in the various transplants were as follows: November at 13 WAT (90), December at 12.5 WAT (234), January at 9.5 WAT (373), February at 8.5 WAT (217), March at 6 WAT (41.2) and April at 5 WAT (20). Onion bulb yields were also found to differ in descending order as follows: November (48 t/ha), December (42 t/ha), January (13.5 t/ha), February (5.5 t/ha) and March (1.5 t/ha). The early transplant (November) had a peak thrips population at maturity and middle transplant recorded the peak population in the middle of the season and late transplant had their peaks at an early part of the growing season. The findings of this work revealed that onion thrips in Sokoto, Nigeria, breed from January to May with the peak in March (Ibrahim and Adesiyun, 2010). He also reported that the worldwide pest can be effectively managed by early planting/transplanting with bulb yields (Ibrahim and Adesiyun, 2008).

Tripathy *et al.* (2012) conducted a field experiment at Odisha to study the population dynamics and seasonal incidence of thrips in onion (Agrifound Light Red), planted at 15 days interval with treatments consisted of 14 dates of planting (1st July 2010 to 15th January 2011 at 15 days intervals). Each date of planting again consisted of four treatments with three replications in a Randomized block design. The injury rating was done at 75 days after transplanting using a 5-point scale. Transplanting of Rabi onion should be completed upto the 1st week of November, preferably to obtain higher bulb yield with a lower incidence of disease and pests. Irrespective of planting dates, the yield loss was more by thrips infestation (2.5 % to 68.7%).

Dharmatti *et al.* (2013) conducted an experiment at University

of Agricultural Sciences, Dharwad, Karnataka, India, to find out the thrips population attacking onion sown at different dates to determine the optimum dates of sowing. There were twelve transplants in 2009-2010, sixteen transplants in 2010-2011 and 2011-2012. Results indicated that in 2009-10, November 1st transplanted seedlings had a peak population of onion thrips in protected (8.95 thrips/plant) as well as in unprotected plots (53.30 thrips/plant). Whereas in 2010-11 and 2011-12, December 1st transplanted seedlings had a peak population of thrips *i.e.* 10.75 thrips/plant in protected plot and 55.49 thrips/plant in an unprotected plant (2010-11) and 11.58 thrips/plant in protected plot and 57.83 thrips/plant in an unprotected plant (2011-12). The seedlings transplanted in Rabi season had peak thrips population compared to Kharif season transplanting dates. Therefore, the findings of this work revealed that onion thrips in Dharwad, Karnataka breed from November 1st to January 1st with a peak in December.

Spacing between plant to plant and row to row

Malik *et al*. (2003) recommended 30 cm row to row and 20 cm plant to plant distance, most suitable thrips suppression and also produce a better yield. The increases in bulb weigh with an increase in plant spacing. Increase plant spacing provides more space to the bulb for expression and reduce competition for nutrient and light Saud *et al.* (2013), affect food searching and egg laying behavior of insect pests (Ferro,2002) and reduced pest damage with an increase in plant spacing (Anyim 2002). Regarding thrips population, they said two treatments got an optimum number of thrips per plant. Since 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 (Muhammad *et al.*, 2003).

Field sanitation

Plant health adherence through the 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 (Waiganjo *et al*., 2008).

Mixed cropping

A mixed cropping habitat is likely to encourage thrips predators, as has been shown for the minute pirate bugs (*Orius tristicolor*) (Parella and Lewis, 1997).

Intercropping

Intercropping has a wide range of benefits including suppression of weeds, improvement in soil fertility, conservation of natural predatory fauna and higher production. When the onion was intercropped with cotton, the thrips population moved towards cotton seedlings. Cotton seedlings are more susceptible to thrips attack. So cotton can be used as a trap crop in onion and when thrips populations reached a certain level, the trap crop should be sprayed with insecticide (Alston and Drost, 2008).

Hossain *et al.* (2015) evaluated that the effectiveness of intercropping of carrot, tomato and French bean with onion for the management of thrips attacking onion. The result showed that the infestation of onion thrips was started from the first week of February and it became gradually increased up to the first week of April then it was declined. This study showed that carrot or tomato intercrop may be utilized as intercrop for the management of onion thrips.

Abdul *et al*. (2016) revealed that if six alternate rows including intercrops and onion were planted in each plot. The row to row distance between plants was 30 cm while plant to plant distance between onion and intercrop was 15 cm and 30 cm, respectively. Cotton is intercropped with onion as a trap crop and is planted with a spacing of 20-25 cm thrips infestation is reduced. Moreover, the bulb size, as well as the yield, is also increased.

Gachu *et.al* (2012), Field experiments were conducted and evaluate the effectiveness of intercropping carrot (*Daucus carota*), spider plant (*Cleome gynandra*) and French bean (*Phaseolus vulgaris*) with onion in the management of thrips *(Thrips tabaci)* in onion. On each plot where intercropping was done, one row of intercrop was alternated with four rows of onion. A spacing of 30 x 10 cm for onion, 45 x 10 cm for carrot, 45 x 20 cm for French bean and 45 x 15 cm for spider plant was maintained. Spider plant and carrot can be utilized in the management of onion thrips.

Fertilizer management

Soil fertility management may also affect thrips infestation and damage. According to one source (Rateaver and Rateaver, 1993), a lack of adequate soil calcium may invite higher populations of thrips. 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 (Cantisano, 1999).

Irrigation management

Drought stress increases the susceptibility of onions to thrips damage. Adequate irrigation throughout the growing season is a critical factor in minimizing damage (Fournier *et al*., 1995).

Mulching

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 (Quarles, 1990). The reflective mulch repelled 33 to 68% of the thrips. Ultraviolet absorbing plastics used to build walk-in field tunnels have proved effective in protecting crops from western flower thrips (Antignus, 1996).

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 (Ludger and Jean, 2005).

Cover crop

The use of cover crops can affect the number of overwintering thrips. Oats and wheat is a better choice, its use as a cover crop.

Mechanical methods

Preference of insects towards specific color is a much-known phenomenon. Most often yellow colored sticky traps are used to trap aphids and whiteflies. Onion growers in particular face miserable problem of thrips infestation during winter months. There is virtually no effective alternative to tackle the menacing effects of thrips in onion crop. Generally, yellow traps are particularly used for catching coleopteran, hemipteran, hymenopteran and thysanopteran insects (Riley *et al.*1994).

Authors have also reported the maximum catch of coccinellid predators, honey bee, hoverfly and parasitic wasp in the

yellow sticky trap. Mass trapping of beneficial or non targeted insects by sticky traps may have negative effects, such as reducing their numbers, thus leading to an increase in pest population (Mondor *et al*. 1995).

Blue and green colored trap were observed to be less attractive to pollinating hoverfly and honey bees (2015) Blue colored traps were found more effective in trapping *T. tabaci* as compared to yellow, white and fluorescent green trap. Use of blue colored sticky traps may not be solely able to restrict the buildup of thrips population during the entire crop growing period. However, they can be integrated with other components of IPM program where detection and monitoring of thrips population is an integral part to decide upon commencement of pesticide application (Devi & Roy 2017).

Biological methods

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 Entomopathogenic fungi are currently being investigated for the control of many important insect pests on various crops around the world, and some are commercially available.

Biopesticides for use in integrated pest management (IPM), as they combine host specificity with proven safety. *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* against the onion thrips was prolonged unlikely decreasing trend unsatisfactory control of the pest. *B. bassiana* was most effective when used early at the 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* is used as a contact mycoinsecticide 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 (Shiberu *et al.*, 2013).

Botanical methods

Mishra *et al*.,(2007) among the several factors attributed to low productivity of onion, damage to crop due to onion thrips is substantially important. Farmers were using parathion dust 2% to control the menace. However, neem-based bio-pesticides *i.e*., neem seed extract (NSE) neem leaf extract (NLE) or neem oil constitute the recommendation for managing onion thrips. Preparation of NSE and NLE is a time-consuming process, while neem oil was readily available with the local vendors. The results of the On-Farm Trial brings out that the recommended practice of using neem oil to manage thrips is feasible and economically viable over farmers practice. In order to overcome the drudgery involved in the preparation and lack of free availability of neem leaf or neem seed for making bio-pesticide, the neem oil, which is easily available in local market, is better option to adopt for controlling onion thrips using eco-friendly management.

Pandy *et al.*,(2007) develop an Integrated Pest Management package for thrips in onion (Agrifound Light Red) at Nasik and Karnal. The pooled analysis of data revealed that two foliar sprays of Spinosad 45% SC @ 1 ml/lit., neem oil @ 2 ml/lit., Acetamiprid 10 WP @ 1ml/lit. at fortnightly intervals proved effective in controlling thrips population, giving higher yield at both the stations.

Tadele and Mulugeta (2014) evaluated the effect of insecticides and botanicals (*Azadirachta indica* L. and *Dodon aeangustifolia* L.) on onion thrips, and revealed that the botanicals, *A. indica* and *D. Angustifolia* fresh leaf extracts with foliar application gave promising mortality rate when used as alternative control measures for onion thrips, while the combination of two botanicals was found less effective as compared with other treatments but significantly differed from untreated check. The study concluded that botanicals are a better option and eco-friendly for controlling onion thrips.

Abdul *et al.* (2014) Tested the effectiveness of three botanical insecticides (Neem, Datura, and bitter apple), and three new chemical synthetic insecticides (Acephate, Spirotetramat, and Spinetoram) against onion thrips (*Thrips tabaci*) in experimental field plots in Pakistan. All the botanicals and chemical insecticides tested caused significant reductions (45– 70%) in thrips populations; the botanicals gave more than 60% control of thrips, while among chemical insecticides, Acephate was found to be the most effective followed by Spirotetramat and Spinetoram. These insecticides gave better control than the botanicals. The adverse effects of the botanicals on predator populations were negligible compared to the chemical insecticides.

Chemical management

The experiment results were indicated in all locations the mortality rate percentage of the two newly introduced insecticides (Cutter 112 E. C and Triger 5 E.C) were found to be comparable and effective to the standard check (Diazinon 60 E.C) in controlling onion thrips, *Thrips tabaci* L. population. The yield of all treatments except untreated check gave similar yield results compared with the standard check. Therefore, the newly introduced insecticides Cutter 112 E.C ™ and Triger 5 E.C ™ could be recommended to be registered for control of onion thrips and also both botanicals used as alternative insecticides for the control of onion n thrips (Shiberu and Negeri, 2014).

The effect of insecticides (Imidacloprid 200SL, 250 ml/acre; Imidacloprid + Fipronil 80 WG, 60 gm/acre, Chlorfenapyr 36SC, 50WDG, 100 ml/acre) and leaf extracts of (*Nerium indicum*, *Calotropis procera* and *Datura stramonium* seed extract of each at 5%) were evaluated against *Thrips tabaci* in farmers field. Data recording intervals were 24, 48, 72-hours and 7-days. The results revealed that maximum population reduction was observed in Imidacloprid + Fipronil 80WG (94.28%) followed by Chlorfenapyr 50WDG (93.37%), Chlorfenapyr 36SC (91.26%) and Imidacloprid 200SL (85.06%) and where mean population of thrips per five plants was recorded 2.33, 2.33, 2.73 and 6.26 respectively. After 24-hours of data recording interval among the botanicals, *D. stramonium* gave significantly lower population of thrips (9.700 per five plants) and highest reduction percentage (82.36) after 48-h of intervals followed by *C. procera* and *N. indicum* with mean population 11.36, 13.90 showing reduction percentage 79.33 and 74.76 respectively (Din *et al.* 2016).

Patil and Patil (2018), showed that fipronil was the most effective treatment in controlling thrips and in recording highest yield of onion bulbs. Basil oil, geranium oil and neem products like NSE can also be used for effective control of thrips. Result revealed that the bioefficacy of Basil oil (Ocimum tenuiflomm syn. O. sanctum) (0.2%), geranium oil (0.2%) along with commonly used synthetic insecticides viz.,

fipronil 5 SC (0.005%) profenophos 50 EC (0.05%), acephate 75 SP @ (0.075%), N.S.E (4%) and dimethoate @ (0.06%) against onion thrips, *Thrips tabaci* L. The data revealed that fipronil 0.005 percent excelled over all other treatments and was effective in controlling thrips population.

Conclusion

Major insect pests of bulb crops are onion thrips, reduce the yield potential. Management of bulb crops pests relies on insecticide use at planting, but insecticide resistance can cause control failure that threaten the long-term viability of this strategy. IPM strategies minimize the loss and increase the marketable value of bulb crops. Infestation of onion thrips was started from the first week of February and it became gradually increased up to the first week of April then it was declined. Thrips population was positively correlated with temperature and negatively with relative humidity and rainfall. Cultural practices such as intercropping with cotton, carrot, tomato spider plant, mixed cropping, time of planting, spacing (30 x 20); mulching with aluminum-coated & colored mulches, balance nitrogenous fertilizer dose, irrigation application increase RH %, blue coloured traps are more effective, biopesticide *B. bassiana* most effective, basil oil, neem oil, geranium oil, datura and neem products like NSE can also be used for effective control of thrips and some newly introduced insecticides Cutter 112 E.C ™ & Triger 5 E.C ™ and chemicals viz. Spinosad 45% SC, Acetamiprid 10 WP, Imidacloprid + Fipronil 80 WG, fipronil 5 SC, acephate 75 SP, Diazinon 60 EC are can also be used for effective control of thrips. These are a very important components of the eco-friendly management of onion thrips in bulb crops.

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