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Laboratory efficacy of *Beauveria bassiana* (Balsamo) Vuillemin and chemical insecticide against onion thrips, *Thrips tabaci* Lindeman

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Abstract
The present investigation was framed with an aim to evaluate the bio-efficacy of *Beauveria bassiana* against onion thrips. The different treatments evaluated for their laboratory efficacy against *T. tabaci* showed that the treatment of dimethoate 30 EC @ 1 ml/litre alone and in combination with half dose (2.5 g/litre) of *B. bassiana* 1.15% WP recorded the highest (95.00%) mortality after 5th day of its application. Whereas, spinosad 45 SC @ 0.30 ml/litre alone and in combination with half dose (2.5 g/litre) of *B. bassiana* 1.15% WP and alone application of *B. bassiana* 1.15% WP @ 5 g/litre were found next better treatments with 86.67 to 92.50% nymphal mortality.

Keywords: *Beauveria bassiana*, Vuillemin and chemical insecticide, thrips, *Thrips tabaci* Lindeman

Introduction
Onion (*Allium cepa* L.) is one of the most important vegetable crops, among the various bulbous vegetables. It is member of Amaryllidaceae family, which is commercially grown in tropical and subtropical countries. Among the vegetable crops grown in the country, onion assumes significance in the national economy by occupying fifth position. It is grown for consumption as green leaf and mature bulbs. Both mature and immature bulbs of onion are used as vegetable and also as a condiment.

Onion possesses nutritional and medicinal properties. According to Rao and Purewal (1954) [11], it contains 86.6% moisture, 1.2% protein, 0.1% fat, 11.6% carbohydrates, 0.18% calcium, 0.7% phosphorous and 0.4% mineral matter. It also contains vitamin-B and traces of vitamin-C to the extent of 120 mg and 11 mg per 100 g fresh weight, respectively. Its pungency is due to volatile compound called "allyl propyl disulphide", which acts as gastric stimulant and promotes digestion.

A major constraint in vegetable production is poor and inadequate control of pest and diseases, which caused high yield losses (Tindall, 1983) [15]. Among the all insect pests, *Thrips tabaci* (Lindeman) is one of the most common and serious pest of onion. It belongs to family "Thripidae" and order "Thysanoptera". It was first recorded in North America in 1872. In India, the pest was recorded for the first time by Karmy in 1926 from the material collected by T.V.R. Ayyar in 1920 from cotton flower at Coimbatore (Rahman and Batra, 1945) [10].

T. tabaci has piercing and sucking type of mouthparts, consisting of a fleshy proboscis or cone, housing stylets that are used for penetration and feeding from leaves. Thrips damage the host plant *via* direct removal of cell contents. As a result, individual plant cells are killed, scarring of the leaf in the form of silvering, due to the high visibility of emptied cell cavities, is observed. Despite individual feeding sites being small, the damaged area of the leaf does not recover and becomes larger and more pronounced as the plant grows. Enumerative nymphs and adults of the thrips remain between the leaf sheaths and stems, and damaging the crop. In case of severe infestation, the bulb remains undersized and gets distorted (Butani and Verma, 1976) [3]. This can quickly lead to damage that is visible on the leaf. Due to rapid reproduction, high mobility and interstitial characteristics have led thrips to become increasing important over the years.

The thrips feeds and oviposite on leaves, flowers and fruits of various crops usually causes significant damage to quantity and quality of the produce. Plants with obvious thrips feeding damage are considered unacceptable for sale in many cases and therefore, the economic impact of a thrips infestation can be severe. Thrips have ability to transmit plant pathogens, and development of resistance to chemical insecticides (Morse and Hoddle, 2006 and Diaz-Montano *et al*., 2011) [8, 4].

Although several species of natural enemies including insects, mites, fungi, bacteria, virus and protozoa have been recovered from the onion ecosystem, only few are efficient in controlling the pest population. Among them, the entomopathogenic fungus, *Beauveria bassiana* (Balsamo) Vuillemin is a very potential bio-control agent for pest management. It is also very effective and widely used bio-pesticide, which controls various pests of different crops. It can be developed in laboratory for use as mycoinsecticidal agent.
Parameswaran and Sankaran (1977) [9] have first time recorded this fungus occurring naturally in India. Rao (1975) [12] reported the effectiveness of *B. bassiana* on more than 150 insect species. Likewise, Dutky (1959) [5] stated that with its wide undefined host range, *B. bassiana* referred as "Magnificent pathogen". According to Wright and Kennedy (1996) [16], *B. bassiana* did not have an adverse impact on humans, livestock, birds, fish, beneficial insects, crops, waterways or groundwater resources. In India, entomopathogenic fungi, *B. bassiana* was successfully used in reducing onion thrips population and increasing onion yield (Singh *et al.*, 2011) [14].
Management of thrips is problematic due to their minute size, hidden in crevices of flowers and leaf sheaths, and high reproductive capacity leads quickly to great numbers, infesting individual plants. In most target crops, use of synthetic pesticides is the most commonly used option for controlling thrips. The concealed habit and reproduction of thrips species make their management very difficult with the use of chemical method to be the most commonly adopted control option. These treatments caused residue and insecticide resistance problems, are costly and undesirable, with regard to risks to operators, livestock and non-target organisms. Control strategies in glasshouse and field have often relied on repeated application of chemical insecticides that not only produced environmental risks, but also resulted in widespread development of resistance. This, combined with the increasing economic impact of thrips, put considerable urgency on the development of novel control strategies. Certain plant and microbial derived products like *B. bassiana* have been promoted in recent years as alternative to traditional chemical method. Therefore, the study has been carried out to test the efficacy of *B. bassiana* against *T. tabaci* infesting onion in laboratory condition.

Rearing techniques
In order to develop the initial culture of thrips, *T. tabaci*, large number of adults were collected with the help of aspirator from the onion field. Five females and two males were picked up individually by means of moistened camel hair brush and released gently into a glass tube (3cm X 1cm) held in an inverted position. The male and female adult sex differentiation ascertained on the basis of their body colour, size and abdominal tip. The males were smaller in size, pale yellow in colour with its two pair of narrow fringed wings, with long hairs, whereas the females were dark brown to black with pointed abdominal tip. The thrips moved upward and gathered in upper portion of the inverted tube. A young leaflet of onion was introduced into a glass tube and it was closed with cotton cork. Thus, field collected adults were distributed in 25 tubes to obtain large number of progenies. The glass tube was kept in an incubator adjusted 25 ± 1 ºC temperature for oviposition.
As soon as the nymph emerged out, they reared separately into the glass tube. The leaflet was changed every 2 days until the nymph pupated. The rearing was continued till the emergence of adults.

Material and Methodology
The laboratory experiment on onion was conducted at Biocontrol Research Laboratory, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh. Fresh onion leaves collected from the unsprayed onion field were washed properly with clean water and air dried. Onion bulb were wrapped with cotton swab. The spraying of respective treatments (Table-1) was applied topically with the help of baby sprayer on onion leaves/pieces containing the second instar nymphs of thrips. Care was taken to obtain the uniform coverage of treatment. Treated leaves was allowed for drying under ceiling fan for 5 minutes. Ten second instar nymphs of thrips were tested in each treatment. Only water was kept as control.
Mortality counts were recorded at 1, 3 and 5 days after the treatment. Data on nymphal mortality were converted into corrected per cent mortality as suggested by Henderson and Tilton (1955) [7].

$$\text{Corrected per cent mortality} = 100\left[1 - \frac{Ta \times Cb}{Tb \times Ca}\right]$$

Where,
Tb = Number of thrips counted before treatment
Ta = Number of thrips counted after treatment
Cb = Number of thrips counted from untreated control plot before treatment
Ca = Number of thrips counted from untreated control plot after treatment

The data thus obtain were transformed into Arcsine and analysed statistically. The zero and cent per cent values were removed by the formulae (Bartlett, 1947 and Gomez and Gomez, 1984)

$$\text{For zero per cent} = \left[\frac{1}{4\,n}\right] \times 100$$

$$\text{For cent per cent} = \left[1 - \frac{1}{4\,n}\right] \times 100$$

Where, n = Number of nymphs per treatment

Table 1: Treatment details for laboratory efficacy of *Beauveria bassiana* along with different chemical insecticide against onion thrips, *T. tabaci.*

Sr. No.	Treatment	Dose/litre
T_1	*B. bassiana* 1.15% WP	5.00 g
T_2	Dinotefuran 20 SG	0.53 g
T_3	Diafenthiuron 50 WP	1.00 g
T_4	Spiromesifen 22.9 SC	1.00 ml
T_5	Spinosad 45 SC	0.30 ml
T_6	Dimethoate 30 EC	1.00 ml
T_7	*B. bassiana* 1.15% WP @ 2.50 g + Dinotefuran 20 SG	2.50 g +0.27 g
T_8	*B. bassiana* 1.15% WP @ 2.50 g + Diafenthiuron 50 WP	2.50 g +0.50 g
T_9	*B. bassiana* 1.15% WP @ 2.50 g + Spiromesifen 22.9 SC	2.50 g +0.50 ml
T_{10}	*B. bassiana* 1.15% WP @ 2.50 g + Spinosad 45 SC	2.50 g +0.15 ml
T_{11}	*B. bassiana* 1.15% WP @ 2.50 g + Dimethoate 30 EC	2.50 g +0.50 ml
T_{12}	Control	-

Result and Discussion

The results revealed that there was a significant difference in per cent nymphal mortality at every observation day. All the treatments were found significantly superior by giving higher mortality of thrips over the control. After 1 day, the treatment of *B. bassiana* 1.15% WP @ 2.5 g/litre + dimethoate 30 EC @ 0.5 ml/litre found superior among all the treatments, which gave 73.33% mortality and it was at par with *B. bassiana* 1.15% WP @ 2.5 g/litre + spinosad 45 SC @ 0.15 ml/litre (70.00%), dimethoate 30% EC @ 1 ml/litre (70.00%) and spinosad 45 SC @ 0.3 ml/litre (70.00%).

The treatments of diafenthiuron 50 WP @ 1 g/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + diafenthiuron 50 WP @ 0.5 g/litre, dinotefuran 20 SG @ 0.53 g/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + dinotefuran 20 SG @ 0.27 g/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + spiromesifen 22.9 SC @ 0.50 ml/litre and spiromesifen 22.9 SC @ 1.00 ml/litre were found next to cause mortality of 56.67 to 63.33%. After first day, *B. bassiana* 1.15% WP @ 5 g/litre was found poorest among all treatments due to slow action of fungi against target pest.

Data recorded at 3 days after treatment indicated that *B. bassiana* 1.15% WP @ 2.5 g/litre + dimethoate 30 EC @ 0.5 ml/litre gave 90.00% mortality and it was found at par with dimethoate 30 EC @ 1 ml/litre, which exhibited 86.67% mortality. Whereas, spinosad 45 SC @ 0.3 ml/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + spinosad 45 SC @ 0.15 ml/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + dinotefuran 20 SG @ 0.27 g/litre, dinotefuran 20 SG @ 0.53 g/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + diafenthiuron 50 WP @ 0.5 g/litre and diafenthiuron 50 WP @ 1 g/litre stood next in order with 83.33, 83.33, 80.00, 76.67, 76.67 and 73.33% mortality, respectively. Spiromesifen 22.9 SC @ 1.00 ml/litre and *B. bassiana* 1.15% WP @ 2.5 g/litre + spiromesifen 22.9 SC @ 0.50 ml/litre were found poor in mortality (66.67%) of onion thrips. Mortality percentage had significantly increased over 1 day after treatment in *B. bassiana* 1.15% WP @ 5 g/litre but it was found poorest among all the treatment at 3 days after treatment with 53.33% mortality.

The data after 5 days of treatment unveiled that dimethoate 30 EC @ 1 ml/litre and *B. bassiana* 1.15% WP @ 2.5 g/litre + dimethoate 30 EC @ 0.5 ml/litre were found the most superior over all treatments with 95.00% mortality, which was at par with *B. bassiana* 1.15% WP @ 2.5 g/litre + spinosad 45 SC @ 0.15 ml/litre (92.50%), spinosad 45 SC @ 0.3 ml/litre (90.00%) and *B. bassiana* 1.15% WP @ 2.5 g/litre + diafenthiuron 50 WP @ 0.5 g/litre (90.00%). The treatments of *B. bassiana* 1.15% WP @ 5 g/litre, diafenthiuron 50 WP @ 1 g/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + dinotefuran 20 SG @ 0.27 g/litre, *B. bassiana* 1.15% WP @ 2.5 g/litre + spiromesifen 22.9 SC @ 0.50 ml/litre and *B. bassiana* 1.15% WP @ 5 g/litre were found second better treatments with 86.67% mortality. Dinotefuran 20 SG @ 0.53 g/litre and spiromesifen 22.9 SC @ 1.00 ml/litre were found poorest treatments (83.33%).

Data showed that when chemical are mixed with *B. bassiana*, mortality per cent had found significantly increased rather than chemical alone, but this scenario was limited to the certain chemicals which were compatible with *B. bassiana*. Among all treatments dimethoate 30 EC @ 1 ml/litre and *B. bassiana* 1.15% WP @ 2.5 g/litre + dimethoate 30 EC @ 0.5 ml/litre were found most superior over all treatments with 95.00% mortality, which was found at par with *B. bassiana* 1.15% WP @ 2.5 g/litre + spinosad 45 SC @ 0.15 ml/litre (92.50%), spinosad 45 SC @ 0.3 ml/litre (90.00%) and *B. bassiana* 1.15% WP @ 2.5 g/litre + diafenthiuron 50 WP @ 0.5 g/litre (90.00%) followed by *B. bassiana* 1.15% WP @ 5 g/litre.

During present study, *B. bassiana* caused 86.67% mortality in *T. tabaci*, which in close agreement with the work of Beratlief (1979) [2], who stated that *B. bassiana* caused 92 - 100% mortality of *B. punctiventris* under laboratory conditions. It was also similar to the findings of Reyhaneh *et al.* (2009) [13], who found that *B. bassiana* with salts showed cent per cent mortality of thrips in laboratory which was corroborate with the present findings.

Table 2: Laboratory efficacy of *B. bassiana* alone and in combination with insecticides against *T. tabaci*

Sr. No.	Treatments (Dose/litre)	Per cent mortality		
		1 DAT	1 DAT	1 DAT
1	*B. bassiana* 1.15 WP @ 5 g	21.14 (13.33)	21.14 (13.33)	21.14 (13.33)
2	Dinotefuran 20 SG @ 0.53 g	50.77 (60.00)	50.77 (60.00)	50.77 (60.00)
3	Diafenthiuron 50 WP @ 1 g	52.78 (63.33)	52.78 (63.33)	52.78 (63.33)
4	Spiromesifen 22.9 SC @ 1.00 ml	48.85 (56.67)	48.85 (56.67)	48.85 (56.67)
5	Spinosad 45 SC @ 0.3 ml	56.79 (70.00)	56.79 (70.00)	56.79 (70.00)
6	Dimethoate 30 EC @ 1 ml	56.79 (70.00)	56.79 (70.00)	56.79 (70.00)
7	*B. bassiana* 1.15 WP @ 2.5 g + Dinotefuran 20 SG @ 0.27 g	50.77 (60.00)	50.77 (60.00)	50.77 (60.00)
8	*B. bassiana* 1.15 WP @ 2.5 g+ Diafenthiuron 50 WP @ 0.5 g	52.78 (63.33)	52.78 (63.33)	52.78 (63.33)
9	*B. bassiana* 1.15 WP @ 2.5 g+ Spiromesifen 22.9 SC @ 0.50 ml	50.77 (60.00)	50.77 (60.00)	50.77 (60.00)
10	*B. bassiana* 1.15 WP @ 2.5 g+ Spinosad 45 SC @ 0.15 ml	56.79 (70.00)	56.79 (70.00)	56.79 (70.00)
11	*B. bassiana* 1.15 WP @ 2.5 g+ Dimethoate 30 EC @ 0.5 ml	59.00 (73.33)	59.00 (73.33)	59.00 (73.33)
12	Control	9.10 (00.00)	9.10 (00.00)	9.10 (00.00)
	S.Em.±	1.4143	2.0105	2.2754
	C.D. at 5%	4.1283	5.8685	6.6417
	C.V.%	5.19	6.12	5.99

*Data in the parentheses are original values, while outside values are arcsine transformed.
DAT = Days After Treatment. Local strain of *B. bassiana* @ $2x10^6$cfu/g was used.

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