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# Management of okra flea beetle (*Podagrica bowringi*) Baly by using different insecticidal dust, botanical and entomopathogenic fungi

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**Abstract**
The study was conducted on management of okra flea beetle (*Podagrica bowringi*) Baly by using different insecticidal dust, botanical and entomopathogenic fungi at Agronomy farm, College of Agriculture, Dapoli during *kharif* 2017. The observations recorded at 1st week after first soil application indicated that *Beauveria bassiana* 10 g $l^{-1}$ ($T_2$) was found to be effective treatment which recorded 8.57 shot holes/3 leaves/plant. At 2nd week minimum numbers of shot holes were recorded in *B. bassiana* ($T_2$) 7.99 shot holes/three leaves/plant. At 3rd week the treatment *B. bassiana* ($T_2$) was found to be effective treatment which recorded 7.04 shot holes per three leaves per plant. There was same trends observed during second and third soil application *B. bassiana* was found to be effective for minimizing the population of okra flea beetle.

**Keywords:** Soil application, *P. bowringi,* flea beetle, entomopathogenic fungi, neem, cypermethrin

## Introduction

Vegetables form the most important component of our balanced diet. They are also considered as "Protective food" as they contain vitamins, minerals and dietary fibers apart from proteins, lipids, and carbohydrates of biological value. The plant is rich in minerals, carbohydrates, fibers, protein, fat and phenols (Huang *et al*., 2007) [7].

In India, okra is grown over an area of 0.529 M ha with a production of 61.51 lakh MT and productivity is 12.1 tonnes/ha (Anon., 2017) [4]. It contributes 5.8 percent of the total vegetable area and 3.9 percent of total countries vegetable production. In Maharashtra, area under this crop is 0.011 M ha with a production of 0.84 lakh MT and productivity is 8.01 tonnes/ha (Anon., 2016) [3].

Okra flea beetle, *Podagrica bowringi* Baly has been noticed during kharif season on okra causing serious damage to the crop. The adult beetles initially attack tender leaves of okra by making number of shot hole injuries, which later on widen significantly during advanced stage of the crop growth. The activity of pest is also noticed on flowers and flower buds. The grubs are found in soil feeding on root system of crop causing relatively low damage. Due to overall infestation of flea beetle, reduction in vigour of crop, loss of functional leaf area and poor yield of crop have been reported by many farmers and extension agencies working in the area. Defoliation due to infestations has been reported to be up to 80 percent and severity of damage varies in different places (Egwuatu, 1982; Clementine *et al*., 2009) [6, 5]. Conventionally farmers are using various types of synthetic chemical insecticides to control okra flea beetle. Extensive use of insecticides leads to the problems of pest resistance, resurgence, pesticide residues, destruction of beneficial fauna and environmental pollution (Adilakshmi *et al*., 2008) [1]. Therefore, it is now urgent need to use safe and effective biodegradable pesticides with less toxic effects on non-target organisms. The biologically active natural products such as botanicals and microbial pesticides may play a significant role in this regard. Among these, botanical and microbial insecticides are broad spectrum in pest management and many are safe to apply, unique in action and can easily be processed and used. Agro-ecologists contend that links between healthy soils and healthy plants is fundamental to ecologically based pest management. Hence, one of means of ecologically pest management is to improve plant health via improving and providing optimal physical, chemical and biological properties of soils (Altieri and Nicholls, 1999) [2]. Such practices focus on biodiversity conservation, enhancing ecosystem services and avoiding pollution and will build resilience in production system. Therefore, the present investigation carried out to for management of okra flea beetle (*Podagrica bowringi*) Baly by using different insecticidal dust, botanical and entomopathogenic fungi

## Materials and Methods
### Experimental Details

| Location | Department of Agronomy farm, College of Agriculture, Dapoli |
|---|---|
| Crop | Okra |
| Variety | Varsha Uphar |
| Season | *Kharif 2017* |
| Design | Split Plot Design |
| Replication | Three |
| Main plot size | 7.2 m x 4.8 m (34.56 $m^2$) |
| Sub plot size | 2.4 m x 2.4 m (5.76 m2) |
| Spacing | 60 cm X 60 cm |
| Total experimental area | 453.12 $m^2$ |
| Treatments | |
| A. Main Plots Treatments | $M_1$: Transparent polythene mulch |
| | $M_2$: Silver polythene mulch |
| | $M_3$: Black polythene mulch |
| | $M_4$: No mulch (Control) |
| B. Sub plots Treatment | $T_1$ : *Verticilium lecanii* 10 g $l^{-1}$ |
| | $T_2$ : *Beauveria bassiana* 10 g $l^{-1}$ |
| | $T_3$ : *Metarrhizium anisopliae* 10 g $l^{-1}$ |
| | $T_4$ : Neem cake 695 Kg/ha (400 g/plot) |
| | $T_5$ : Cypermethrin dust 35 Kg/ha (20 g/plot) |
| | $T_6$ : Control |

The first soil application was done after initiation of the pest. Second application was done 21 days after first soil application and third soil application was done 21 days after second soil application.

### Method of recoding observation
Five plants were selected randomly to record the observations on the incidence of okra flea beetle. The shot holes made by flea beetle were counted from top, middle and bottom leaf of the plant. The observations were recorded at weekly interval till the harvesting of crop. The observations on the number of shot holes per three leaves per plant was recorded prior to and 1st, 2nd and 3rd week after soil application. The data on number of shot holes per leaf was converted into square root transformation and analyzed statistically.

## Results and Discussion
### Effect of soil application of insecticidal dust, botanical and entomopathogenic fungi on okra flea beetle
Data on numbers of shot holes of okra flea beetle per three leaves per plant at 1st, 2nd and 3rd week after first soil application is presented in Table 1.

The numbers of shot holes of okra flea beetle per three leaves per plant prior to first soil application were ranged from 3.03 to 3.81. The difference among the treatments was non-significant.

The observations recorded at 1st week after first soil application indicated that the treatment *Beauveria bassiana* 10 g $l^{-1}$ ($T_2$) was found to be effective treatment which recorded 8.57 shot holes per three leaves per plant which was at par with the treatment *Metarrhizium anisopliae* 10 g $l^{-1}$ ($T_3$), treatment Cypermethrin dust 0.25% 35 kg $ha^{-1}$ ($T_5$) and treatment *Verticilium lecanii* 10 g $l^{-1}$ ($T_1$) which recorded 8.96, 9.28 and 10.59 shot holes per three leaves per plant. The next treatment in order of efficacy was ($T_4$) Neem cake 695 kg $ha^{-1}$ (11.65). The maximum numbers (12.32) of shot holes were observed in treatment ($T_6$) Control.

**Table 1:** Effect of soil application of insecticidal dust, botanical and entomopathogenic fungi on okra flea beetle, *Podagrica bowringi* after first soil application.

| Treatments | No. of shot holes/three leaves/plant | | | |
|---|---|---|---|---|
| | Pre count | 1st WASA | 2nd WASA | 3rd WASA |
| **Sub plot: S Sub plot: Soil application** | | | | |
| $T_1$: *Verticilium lecanii* 10 g $l^{-1}$ | 3.67 (1.91)* | 10.59 (3.25) | 9.75 (3.12) | 9.33 (3.05) |
| $T_2$: *Beauveria bassiana* 10 g $l^{-1}$ | 3.81 (1.95) | 8.57 (2.93) | 7.99 (2.83) | 7.04 (2.65) |
| $T_3$: *Metarrhizium anisopliae* 10 g $l^{-1}$ | 3.08 (1.76) | 8.96 (2.99) | 8.75 (2.96) | 8.98 (3.00) |
| $T_4$: Neem cake 695 Kg $ha^{-1}$ (400g/plot) | 3.46 (1.86) | 11.65 (3.41) | 11.19 (3.34) | 10.65 (3.26) |
| $T_5$: Cypermethrin dust 0.25% 35 Kg $ha^{-1}$ (20g/ plot) | 3.03 (1.74) | 9.28 (3.05) | 9.43 (3.07) | 9.93 (3.15) |
| $T_6$: Control | 3.49 (1.87) | 12.32 (3.51) | 11.59 (3.40) | 10.75 (3.28) |
| F test | NS | Sig. | Sig. | Sig. |
| S.E. ± | 0.15 | 0.13 | 0.10 | 0.12 |
| C.D. at 5% | - | 0.36 | 0.29 | 0.35 |

*Figures in parentheses are $\sqrt{n}$ transformed values.
WASA – Weeks after soil application.

**Effect of soil application of insecticidal dust, botanical and entomopathogenic fungi on okra flea beetle *Podagrica bowringi* after second soil application**

Data on numbers of shot holes of okra flea beetle per three leaves per plant at 1st, 2nd and 3rd week after second soil application is presented in Table 2.

The numbers of shot holes of okra flea beetle per three leaves per plant prior to second soil application as sub plot treatments was ranged from 7.52 to 11.40. The treatment *B. bassiana* 10 g $l^{-1}$ ($T_2$) was found to be effective treatment which recorded 7.52 shot holes per three leaves per plant which was at par with the treatment ($T_3$) *M. anisopliae* 10 g $l^{-1}$ which recorded 9.06 shot holes per three leaves per plant. The next treatments in order of efficacy were ($T_1$) *V. lecanii* 10 g $l^{-1}$ (9.60), ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ (9.68) and ($T_4$) Neem cake 695 kg $ha^{-1}$ (10.45). The highest numbers of shot holes were observed in treatment ($T_6$) Control (11.40).

The observations recorded at 1st week after second soil application indicated that the treatment *B. bassiana* 10 g $l^{-1}$ ($T_2$) was found to be effective treatment which recorded 8.60 shot holes per three leaves per plant which was at par with the treatment *M. anisopliae* 10 g $l^{-1}$ ($T_3$) which recorded 10.28 shot holes per three leaves per plant. The next treatments in order of efficacy were ($T_1$) *V. lecanii* 10 g $l^{-1}$, ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ and ($T_4$) Neem cake 695 kg $ha^{-1}$ which recorded 10.48, 10.49 and 11.06 shot holes per three leaves per plant, respectively. The maximum numbers of shot holes were observed in treatment ($T_6$) Control (12.46 shot holes/three leaves/plant).

At 2nd week after second soil application minimum numbers of shot holes were recorded in the treatment *B. bassiana* 10 g $l^{-1}$ ($T_2$) (9.87 shot holes/three leaves/plant) which was at par with the treatments ($T_3$) *M. anisopliae* 10 g $l^{-1}$ (10.21), ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ (10.93) and ($T_1$) *V. lecanii* 10g $l^{-1}$ (11.37). The next treatment was ($T_4$) Neem cake 695 kg $ha^{-1}$ (12.09 shot holes/three leaves/plant). The maximum numbers of shot holes were observed in the treatment ($T_6$) Control (13.10 shot holes/three leaves/plant).

The data at 3rd week after second soil application revealed that the treatment *B. bassiana* 10 g $l^{-1}$ ($T_2$) was found to be effective treatment which recorded 9.22 shot holes per three leaves per plant which was at par with the treatments ($T_3$) *M. anisopliae* 10g $l^{-1}$, ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ and ($T_1$) *V. lecanii* 10 g $l^{-1}$ which recorded 9.56, 9.89 and 10.68 shot holes, respectively. The next treatment was ($T_4$) Neem cake 695 kg $ha^{-1}$ (11.42). The highest numbers of shot holes were observed in treatment ($T_6$) Control (12.04).

**Table 2:** Effect of soil application of insecticidal dust, botanical and entomopathogenic fungi on okra flea beetle, *Podagrica bowringi* after second soil application.

| Treatments | No. of shot holes/three leaves/plant | | | |
|---|---|---|---|---|
| | Pre count | 1st WASA | 2nd WASA | 3rd WASA |
| Sub plot: Sub plot: Soil application | | | | |
| $T_1$: *Verticilium lecanii* 10 g $l^{-1}$ | 9.60 (3.10)* | 10.48 (3.24) | 11.37 (3.37) | 10.68 (3.27) |
| $T_2$: *Beauveria bassiana* 10 g $l^{-1}$ | 7.52 (2.74) | 8.60 (2.93) | 9.87 (3.14) | 9.22 (3.04) |
| $T_3$: *Metarrhizium anisopliae* 10 g $l^{-1}$ | 9.06 (3.01) | 10.28 (3.21) | 10.21 (3.20) | 9.56 (3.09) |
| $T_4$: Neem cake 695 Kg $ha^{-1}$ (400g/plot) | 10.45 (3.23) | 11.06 (3.33) | 12.09 (3.48) | 11.42 (3.38) |
| $T_5$: Cypermethrin dust 0.25% 35 Kg $ha^{-1}$ (20g/ plot) | 9.68 (3.11) | 10.49 (3.24) | 10.93 (3.31) | 9.89 (3.14) |
| $T_6$: Control | 11.40 (3.38) | 12.46 (3.53) | 13.10 (3.62) | 12.04 (3.47) |
| F test | Sig. | Sig. | Sig. | Sig. |
| S.E. ± | 0.10 | 0.10 | 0.09 | 0.09 |
| C.D. at 5% | 0.29 | 0.29 | 0.25 | 0.27 |

*Figures in parentheses are $\sqrt{n}$ transformed values. WASA – Weeks after soil application.

**Effect of soil application of insecticidal dust, botanical and entomopathogenic fungi on okra flea beetle *Podagrica bowringi* after third soil application**

Data on numbers of shot holes of okra flea beetle per three leaves per plant at 1st, 2nd and 3rd week after third soil application is presented in Table 3.

The numbers of shot holes of okra flea beetle per three leaves per plant prior to third soil application as sub plot treatments was ranged from 9.16 to 12.09. The treatment *B. bassiana* 10 g $l^{-1}$ ($T_2$) was found to be effective treatment which recorded 9.16 shot holes per three leaves per plant which was at par with the treatments ($T_3$) *M. anisopliae* 10 g $l^{-1}$ (9.55), ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ (9.99) and ($T_1$) *V. lecanii* 10 g $l^{-1}$ (10.42). The treatment ($T_4$) Neem cake 695 kg $ha^{-1}$ recorded 11.17 shot holes per three leaves per plant. The maximum numbers of shot holes were observed in treatment ($T_6$) Control (12.09).

The observations recorded at 1st week after third soil application indicated that the treatment *B. bassiana* 10 g $l^{-1}$ ($T_2$) was found to be effective treatment which recorded 8.74 shot holes per three leaves per plant which was at par with the treatments ($T_3$) *M. anisopliae* 10g $l^{-1}$, ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ and ($T_1$) *V. lecanii* 10 g $l^{-1}$ which recorded 9.22, 9.58 and 10.11 shot holes, respectively. The next treatment was ($T_4$) Neem cake 695 kg $ha^{-1}$ (10.83). The maximum numbers of shot holes were observed in treatment ($T_6$) Control (11.93 shot holes/three leaves/plant).

At 2nd week after third soil application minimum numbers of shot holes were recorded in the treatment ($T_2$) *B. bassiana* 10 g $l^{-1}$ (8.01 shot holes/three leaves/plant) which was at par with the treatments ($T_3$) *M. anisopliae* 10 g $l^{-1}$ (8.52), ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ (8.91) and ($T_1$) *V. lecanii* 10g $l^{-1}$ (9.41). The next treatment was ($T_4$) Neem cake 695 kg $ha^{-1}$ (10.11 shot holes/three leaves/plant). The maximum numbers of shot holes were observed in treatment ($T_6$) Control (11.27 shot holes/three leaves/plant).

The data at 3rd week after third soil application revealed that the treatment ($T_2$) *B. bassiana* 10 g $l^{-1}$ was found to be effective treatment which recorded 7.68 shot holes per three leaves per plant which was at par with the treatments ($T_3$) *M. anisopliae* 10g $l^{-1}$, ($T_5$) Cypermethrin dust 0.25% 35 kg $ha^{-1}$ and ($T_1$) *V. lecanii* 10 g $l^{-1}$ which recorded 8.08, 8.39 and 8.82 shot holes, respectively. The next treatment was ($T_4$) Neem cake 695 kg $ha^{-1}$ (9.41). The highest numbers of shot holes were observed in treatment ($T_6$) Control (10.91).

The present findings are confirmed with the results of Parker *et al.* (2012) [9]. They stated that the *Beauvaria bassiana* was found effective to reduce flea beetle populations. The *B. bassiana* strains GHA and ATCC 74040 were effective for controlling flea beetles.
James *et al.* (2014) [8] conducted the field trials to assess the efficacy of aqueous extract of leaves and bulb of some botanicals for the control of two species of flea beetles (*Podagrica sjostedti* and *Podagrica uniforma*). The treatments consisted of leaf extracts of neem (*Azadirachta indica*) and pawpaw (*Carica papaya*), and bulb extract of onion (*Allium cepa*) and untreated control. The results showed that all the extracts of the three botanicals significantly ($P$<0.05) reduced the population of two flea beetles with the least percent efficacy of 56.4 percent and the highest 83.8 percent.

**Table 3:** Effect of soil application of insecticidal dust, botanical and entomopathogenic fungi on okra flea beetle, *Podagrica bowringi* after third soil application.

| Treatments | No. of shot holes/three leaves/plant | | | |
|---|---|---|---|---|
| | Pre count | 1st WASA | 2nd WASA | 3rd WASA |
| **Sub plot: Sub plot: Soil application** | | | | |
| $T_1$: *Verticilium lecanii* 10 g $l^{-1}$ | 10.42 (3.23)* | 10.11 (3.18) | 9.41 (3.07) | 8.82(2.97) |
| $T_2$: *Beauveria bassiana* 10 g $l^{-1}$ | 9.16 (3.03) | 8.74 (2.96) | 8.01 (2.83) | 7.68 (2.77) |
| $T_3$: *Metarrhizium anisopliae* 10 g $l^{-1}$ | 9.55 (3.09) | 9.22 (3.04) | 8.52 (2.92) | 8.08 (2.84) |
| $T_4$: Neem cake 695 Kg $ha^{-1}$ (400g/plot) | 11.17 (3.34) | 10.83 (3.29) | 10.11 (3.18) | 9.41 (3.07) |
| $T_5$: Cypermethrin dust 0.25% 35 Kg $ha^{-1}$ (20 g/ plot) | 9.99 (3.16) | 9.58 (3.10) | 8.91 (2.99) | 8.39 (2.90) |
| $T_6$: Control | 12.09 (3.48) | 11.93 (3.45) | 11.27 (3.36) | 10.91 (3.30) |
| F test | Sig. | Sig. | Sig. | Sig. |
| S.E. ± | 0.09 | 0.09 | 0.10 | 0.10 |
| C.D. at 5% | 0.27 | 0.25 | 0.27 | 0.28 |

*Figures in parentheses are $\sqrt{n}$ transformed values.

## Conclusion

From the present investigation it can be concluded that among the sub plot treatments *Beauveria bassiana* can be effectively used for the management of okra flea beetle. The present studies has opened a new way to the farmers to increase the cultivation of okra in the region with the help of integration of entomopathogenic fungi to maximize the production free from flea beetle infestation and at the same time to minimize the residual toxicity of hazardous insecticides.

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