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# Seasonal abundance of pod fly, *M. Obtusa* and seed damage on pigeonpea pea in relation to weather factors and cropping systems

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**Abstract**
Seasonal abundance of pod fly, *M. obtusa* on pigeon pea in organic and conventional farming systems revealed that the activity of pod fly commenced from 14 WAS (44$^{th}$ SMW), which continued till 31 was (8$^{th}$ SMW) indicating its peak (36.00 and 30.96 larvae/ 50 pods) at 4$^{th}$ SMW (27 WAS), the population later declined indicating lowest levels (0.94 and 0.70 larvae / 50 pods) at 31 WAS (8$^{th}$ SMW) in both the farming systems. Seed damage caused by pod fly initiated from 15 WAS (44$^{th}$ SMW) and continued till 31 WAS (8$^{th}$ SMW) wherein the highest seed damage (78.50 and 77.18 %) was observed at 31 WAS (8$^{th}$ SMW), while it remained lowest (7.02 and 5.21 %) at 15 WAS (44$^{th}$ SMW). correlation of podfly population and its associated seed damage with weather factors was significant and positive with bright sunshine while, it was significantly negative with the minimum and average temperature, morning, evening and average relative humidity, wind velocity and rainfall in both the farming systems, respectively. Relatively higher pod fly larval population and its associated seed damage were recorded in an organic farming system as compared to conventional farming system which could be due to more emphasis on biological control and other non chemical practices (which are initially slower as compared to chemicals) adopted in an organic farming system over the use of quick knock down chemicals used in conventional farming system.

**Keywords:** Pod fly, *M. obtusa,* conventional farming system, organic farming system, pigeon pea

## Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the most important pulse crops grown widely in India which is the world's largest producer contributing 72 per cent of total global production which is very less accounting to several factors, one of the factors being the pest load. Its importance to semi-arid cropping systems is due to its efficient nitrogen-fixing ability, tolerance to drought, and contribution to soil organic matter. Pigeonpea is an important pulse-cum-vegetable crop in India and is cultivated extensively in the recent past for its fresh tender pods, seeds and leaves as cattle feed. Endowed with several unique characteristics, it finds an important place in farming systems adopted by small farmers in large number of developing countries.

The studies revealed that the main reasons for low productivity are the cultivation of this crop on marginal lands under poor management conditions and the mounting pressure of several insect pests. Maximum economic damage is caused by the insect pests feeding upon flowers and pods. About 250 insect species belonging to 8 orders and 61 families have been found to infest pigeonpea from seedling to harvesting stage and virtually no plant part is free from insect infestation (Upadhyay *et al.*, 1998) [15].

Out of an array of insects infesting pigeonpea, gram caterpillar, *Helicoverpa armigera* (Hubner), spotted pod borer, *Maruca vitrata* (Geyer), pod fly, *Melanagromyza obtusa* (Malloch), plume moth, *Exelastis atomosa* (Walshingham), blue butterfly, *Lampides boeticus* (Linnaeus), pod bug, *Riptortus pedestris* (Fabricius), green stink bug, *Nezara viridula* (Linnaeus) and green bean bug, *Clavigralla gibbosa* (Spinola) are causing the considerable damage. Among them pod fly, *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) is the most abnoxious pest causing the grain damage ranging from 20 to 80 per cent (Subharani and Singh, 2007) [14]. Damage indicated that seed damage varied from 2 per cent to more than 90 per cent with large variation across locations, seasons, and genotypes (Shanower *et al.*, 1998) [9].

Pod fly, *Melanagromyza obtusa* (Malloch) is a key pest of pigeonpea (*Cajanus cajan*) throughout South-east Asia. It attacks the crop from pod filling to pod maturity. The oviposition of pod fly takes place on the inner surface of the pod walls. Females deposit the eggs singly under the epidermis in the green pods and the larvae after hatching mines into the pods and feeds on the soft seed thus making it unfit for human consumption as well as seed purposes (Lal and Yadav, 1993) [5].

Pod fly being an internal feeder, both the larva and pupal stages are present inside the pods. The white maggots feed on the developing seed and pupate inside the pod. The pod fly infested pods do not show any external symptom of damage until the fully grown larvae chew the pod wall, leaving 3 a thin papery membrane intact called as window, through which adults exit the pods. The pod fly attack remains unnoticed by farmer owing to the concealed mode of life with in the pods and thus it becomes difficult to manage the pest in time. It is an emerging constraint to increase the production and productivity of this crop under subsistence farming conditions.

Understanding the biology and seasonal incidence of pod fly will yield valuable information in strategizing the management practices. Pest management strategies for the pigeonpea pod fly have emphasized chemical control and host plant resistance (Shanower *et al*., 1998) [12]. Hence the present study is taken up with an objective to study the seasonal abundance and seed damage by pod fly in both organic and conventional faming systems.

## Materials and Methods

The studies on Seasonal abundance of pod fly *M. obtusa* in organic and conventional farming systems was carried out at certified organic farming unit and Pulses research unit, Navsari Agricultural university Navsari during 2016-18. The pigeon pea variety Vaishali was grown according the recommended package of practice in both organic and conventional farming systems.

The pod fly, larval population was counted weekly interval by visual search method (on whole plant basis) on 25 plants (Five plants/ spot) and recorded. Apart from larval population its associated seed damage was also recorded by taking randomly collected fifty pods from the field and examined for damage due to pod borer. Number of seeds damaged due to pod fly larva could be detected by the presence of maggot or pupa tunnelled grain by splitting the pods were counted and recorded separately for both the farming systems.

## Results and Discussion

### Pod fly, M. *obtusa* larval population

The larval population of pod fly recorded in organic and conventional farming systems revealed that activity commenced from 14 WAS (44th SMW), which continued till 31 WAS (8th SMW) indicating their peaks (36.00 and 30.96 larvae/ 50 pods) at 4th SMW (27 WAS), the population however declined later indicating their lowest levels (0.94 and 0.70 larvae / 50 pods) at 31 WAS (8th SMW) (Table 1, Fig. 1). Khokhar and Singh (1983) [2], Srilaxmi and Paul (2010) [13] and Pawar *et al.* (2014) [9] observed pod fly infestation during the flowering to maturity of the crop which is also indicated in the current investigation, thus confirms the above results. Similarly, Kumar and Nath, (2003) [3], Minja *et al.* (1999) [7], Subharani and Singh (2007) [14] and Ram Keval and Srivastava (2011) [10] also reported that pod fly infesting pigeon pea crop from pod filling to maturity stages of the crop witnessing the period from 4 to 14th SMW. Rathore (2015) [11] and Dwivedi *et al.* (2013) [1] observed first appearance of gram pod borer *H. armigera;* pod bug, *C. gibbosa* and pod fly, *M. obtusa* during 47, 47 and 52 SMWs, respectively which supports the present findings.

Higher population of pod fly recorded in organic farming system as compared to conventional farming system could be due to more emphasis on biological control and other non chemical practices (which are initially slower as compared to chemicals) adopted in organic farming system over use of quick knock down chemicals used in conventional farming system. Correlation between pod fly population in organic and conventional farming systems with bright sunshine was significantly positive (‘r’ = 0.378 and 0.370), while it was significantly negative with minimum (‘r’ = -0.821 and -0.802) and average (‘r’ = -0.854 and -0.849) temperature, morning (‘r’ = -0.418 and -0.428), evening (‘r’ = -0.656 and -0.638) and average (‘r’ = -0.622 and -0.612) relative humidity, wind velocity (‘r’ = -0.304 and -0.280) and rainfall (‘r’ = -0.347 and -0.331) (Table 2 & 3). Kumar *et al*. (2011) [4] recorded maximum infestation of pod fly (*M. obtusa*) during February, but it had no significant correlation with abiotic factors.

**Table 1:** Population of podfly, *M. obtusa* and seed damage (%) in pigeon pea grown under organic and conventional farming systems

| SMW | WAS | *M. obtusa* larva/ 50 pods | | | | | | *M. obtusa* seed damage (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2016-17 | | 2017-18 | | Pooled (2016-18) | | 2016-17 | | 2017-18 | | Pooled (2016-18) | |
| | | ORG | CNV | ORG | CNV | ORG | CNV | ORG | CNV | ORG | CNV | ORG | CNV |
| 33 | 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 34 | 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | 6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 36 | 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 37 | 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 38 | 9 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 39 | 10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 40 | 11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 41 | 12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 42 | 13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 43 | 14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 44 | 15 | 2.64 | 2.30 | 3.40 | 2.24 | 3.02 | 2.27 | 6.24 | 5.82 | 7.80 | 4.60 | 7.02 | 5.21 |
| 45 | 16 | 8.16 | 7.92 | 6.48 | 3.16 | 7.32 | 5.54 | 9.72 | 8.64 | 9.36 | 6.44 | 9.54 | 7.54 |
| 46 | 17 | 11.24 | 10.56 | 10.40 | 4.84 | 10.82 | 7.70 | 12.48 | 11.24 | 10.68 | 7.56 | 11.58 | 9.40 |
| 47 | 18 | 13.32 | 12.92 | 13.24 | 5.16 | 13.28 | 9.04 | 12.68 | 11.68 | 11.84 | 8.84 | 12.26 | 10.26 |
| 48 | 19 | 14.56 | 13.92 | 14.32 | 10.72 | 14.44 | 12.32 | 13.52 | 12.72 | 14.24 | 12.52 | 13.88 | 12.62 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 20 | 17.60 | 15.16 | 15.64 | 15.36 | 16.62 | 15.26 | 17.16 | 16.24 | 16.44 | 15.68 | 16.80 | 15.96 |
| 50 | 21 | 18.12 | 17.04 | 17.84 | 16.44 | 17.98 | 16.74 | 19.60 | 18.88 | 19.52 | 18.48 | 19.56 | 18.68 |
| 51 | 22 | 18.28 | 17.64 | 18.20 | 17.28 | 18.24 | 17.46 | 24.48 | 22.92 | 23.86 | 22.80 | 24.17 | 22.86 |
| 52 | 23 | 19.16 | 18.48 | 19.72 | 18.60 | 19.44 | 18.54 | 30.60 | 32.80 | 32.28 | 29.72 | 31.44 | 31.26 |
| 1 | 24 | 25.00 | 22.56 | 24.56 | 23.48 | 24.78 | 23.02 | 38.28 | 36.24 | 38.64 | 37.68 | 38.46 | 36.96 |
| 2 | 25 | 26.44 | 25.72 | 27.68 | 26.72 | 27.06 | 26.22 | 43.52 | 38.40 | 40.80 | 40.16 | 42.16 | 39.28 |
| 3 | 26 | 27.92 | 27.12 | 29.24 | 28.28 | 28.58 | 27.70 | 42.64 | 39.52 | 44.64 | 41.32 | 43.64 | 40.42 |
| 4 | 27 | 34.60 | 28.60 | 37.40 | 33.32 | 36.00 | 30.96 | 47.76 | 44.88 | 46.52 | 44.08 | 47.14 | 44.48 |
| 5 | 28 | 26.32 | 26.20 | 25.88 | 24.80 | 26.10 | 25.50 | 55.76 | 49.40 | 52.44 | 50.12 | 54.10 | 49.76 |
| 6 | 29 | 22.12 | 20.60 | 22.96 | 14.56 | 22.54 | 17.58 | 65.68 | 57.68 | 65.24 | 56.44 | 65.46 | 57.06 |
| 7 | 30 | 12.80 | 11.96 | 12.64 | 10.72 | 12.72 | 11.34 | 73.68 | 63.64 | 75.32 | 68.68 | 74.50 | 66.16 |
| 8 | 31 | 0.76 | 0.60 | 1.12 | 0.80 | 0.94 | 0.70 | 80.28 | 78.64 | 76.72 | 75.72 | 78.50 | 77.18 |
| Seasonal mean | | 10.68 | 9.98 | 10.74 | 9.16 | 10.71 | 9.57 | 21.22 | 19.62 | 20.94 | 19.32 | 21.08 | 19.47 |

Note: SMW- Standard meteorological week; WAS- Weeks after sowing, ORG- Organic farming system, CNV- Conventional farming system

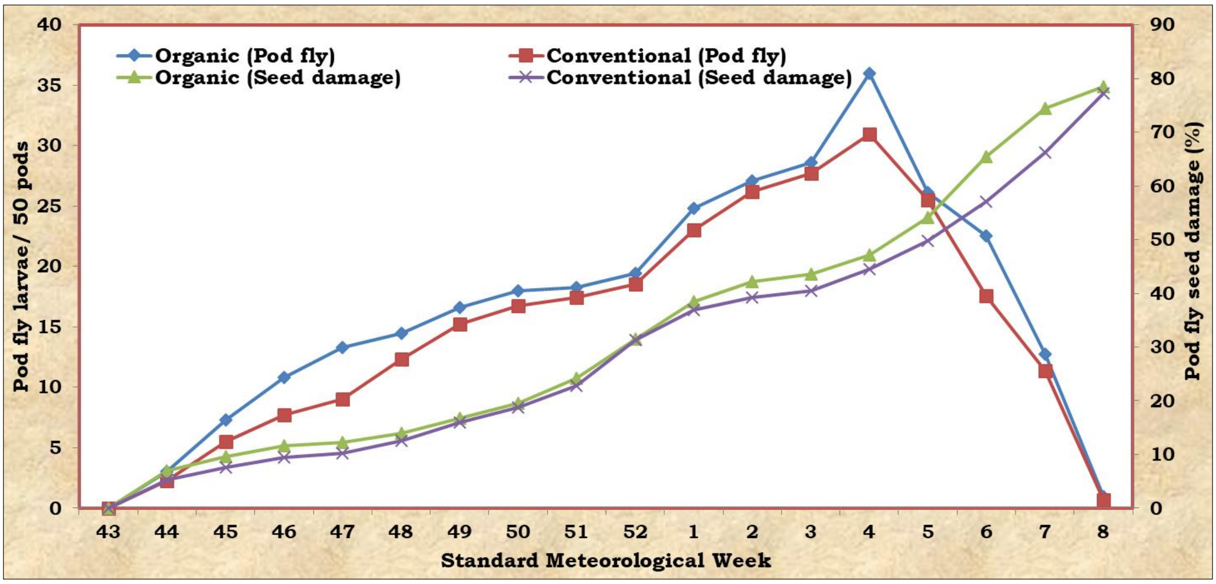


**Fig 1:** Abundance of pod fly, *M. obtusa* and seed damage (%) in organic and conventional farming systems

**Table 2:** Correlation and regression coefficient between podfly population, seed damage (%) and weather parameters at organic farm

| Weather Parameters | ***M. obtusa* larval population ($Y_1$)** | | | | | | **Seed damage (%) ($Y_2$)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Correlation coefficient (r)** | | | **Regression coefficient** | | | **Correlation coefficient (r)** | | | **Regression coefficient** | | |
| | **2016-17** | **2017-18** | **Pooled (2016-18)** | **2016-17** | **2017-18** | **Pooled (2016-18)** | **2016-17** | **2017-18** | **Pooled (2016-18)** | **2016-17** | **2017-18** | **Pooled (2016-18)** |
| Maximum Temp. ($X_1$) | 0.126 | -0.491* | -0.234 | - | - | - | 0.296 | -0.184 | 0.016 | - | - | - |
| Minimum Temp. ($X_2$) | -0.812** | -0.830** | -0.821** | - | - | - | -0.612** | -0.744** | -0.678** | - | -3.59 | -3.970 |
| Average Temp. ($X_3$) | -0.829** | -0.893** | -0.854** | -4.184 | -3.356 | -3.617 | -0.544** | -0.696** | -0.622** | - | - | - |
| Morning RH ($X_4$) | -0.505** | -0.339 | -0.418** | - | - | - | -0.525** | -0.378* | -0.451** | - | - | - |
| Evening RH ($X_5$) | -0.695** | -0.621** | -0.656** | - | - | - | -0.634** | -0.647** | -0.638** | - | - | - |
| Average RH ($X_6$) | -0.671** | -0.580** | -0.622** | - | - | - | -0.633** | -0.613** | -0.620** | -0.704 | - | -3.965 |
| Wind velocity ($X_7$) | -0.349 | -0.266 | -0.304* | - | - | - | -0.235 | -0.183 | -0.206 | - | - | - |
| Rainfall ($X_8$) | -0.380* | -0.324 | -0.347** | - | - | - | -0.336 | -0.315 | -0.319** | - | - | - |
| Bright sunshine ($X_9$) | 0.527** | 0.221 | 0.378** | - | - | - | 0.522** | 0.338 | 0.434* | - | - | - |
| 'A' value | | | | 113.96 | 94.97 | 100.74 | | | | 53.93 | 85.79 | 78.567 |
| '$R^2$' value | | | | 0.683 | 0.797 | 0.730 | | | | 0.401 | 0.553 | 0.493 |
| Variation Explained (%) | | | | 68.30 | 79.70 | 73.00 | | | | 40.10 | 55.30 | 49.30 |
| 'R' value | | | | 0.892 | 0.893 | 0.854 | | | | 0.634 | 0.744 | 0.702 |

Note: *Correlation is significant at 5%; **Correlation is significant at 1%

*Regression is significant at 5%; **Regression is significant at 1%

Regression coefficients are mentioned on the basis of significant variables in stepwise analysis

**Table 3:** Correlation and regression coefficient between podfly, *M. obtusa* population, seed damage (%) and weather parameters at conventional farm

| Weather Parameters | ***M. obtusa* larval population ($Y_1$)** | | | | | | **Seed damage (%)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Correlation coefficient (r)** | | | **Regression coefficient** | | | **Correlation coefficient (r)** | | | **Regression coefficient** | | |
| | **2016** | **2017** | **Pooled (2016-17)** | **2016** | **2017** | **Pooled (2016-17)** | **2016** | **2017** | **Pooled (2016-17)** | **2016** | **2017** | **Pooled (2016-17)** |
| Maximum Temp. ($X_1$) | 0.116 | -0.525** | -0.263 | - | - | - | 0.303 | -0.190 | 0.013 | - | - | - |
| Minimum Temp. ($X_2$) | -0.827** | -0.779** | -0.802** | - | - | - | -0.618** | -0.732** | -0.677** | - | -3.49 | -3.69 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Temp. ($X_3$) | -0.849** | -0.864** | -0.849** | -4.00 | -3.02 | -3.21 | -0.548** | -0.689** | -0.622** | - | - | - |
| Morning RH ($X_4$) | -0.514** | -0.337 | -0.428** | - | - | - | -0.525** | -0.374* | -0.447** | - | - | - |
| Evening RH ($X_5$) | -0.704** | -0.569** | -0.638** | - | - | - | -0.639** | -0.634** | -0.635** | -0.65 | - | - |
| Average RH ($X_6$) | -0.680** | -0.540** | -0.612** | - | - | - | -0.637** | -0.602** | -0.616** | - | - | -3.704 |
| Wind velocity ($X_7$) | -0.354 | -0.220 | -0.280* | - | - | - | -0.241 | -0.175 | -0.205 | - | - | - |
| Rainfall ($X_8$) | -0.382* | -0.290 | -0.331* | - | - | - | -0.339 | -0.306 | -0.316* | - | - | - |
| Bright sunshine ($X_9$) | 0.532** | 0.187 | 0.370** | - | - | -0.025 | 0.530** | 0.326 | 0.430** | - | - | - |
| 'A' value | | | | 108.03 | 85.04 | 90.14 | | | | 49.94 | 79.72 | 72.93 |
| '$R^2$' value | | | | 0.721 | 0.746 | 0.734 | | | | 0.409 | 0.537 | 0.492 |
| Variation Explained (%) | | | | 72.10 | 74.60 | 73.40 | | | | 40.90 | 53.70 | 49.20 |
| 'R' value | | | | 0.849 | 0.864 | 0.857 | | | | 0.639 | 0.733 | 0.701 |

Note: *Correlation is significant at 5%; **Correlation is significant at 1%
*Regression is significant at 5%; **Regression is significant at 1%
Regression coefficients are mentioned on the basis of significant variables in stepwise analysis

**Seed damage (%) by pod fly, *M. obtusa***

The seed damage caused by pod fly observed in organic and conventional farming systems revealed initiation of infestation from 15 WAS (44th SMW) which continued till 31 WAS (8th SMW) wherein the highest seed damage (78.50 and 77.18 %) was observed at 31 WAS (8th SMW), while it remained lowest (7.02 and 5.21 %) at 15 WAS (44th SMW) (Table 1, Fig. 1). The higher seed damage by pod fly in organic farming system might be due to higher larval population of pod fly and non use of highly toxic chemical insecticides as compared to conventional farming system. Nair *et al.* (2017) [9] recorded 34.8 and 36.5 per cent pod damage by pod fly, 5.2 and 6 per cent by *Helicoverpa*, during two consecutive seasons which was more or less similar to the present findings.

Correlation between seed damage by pod fly in organic and conventional farming systems and bright sun shine was significantly positive ('r' = 0.434 and 0.430), while it was significant and negative association with minimum ('r' = -0.678 and 'r' = -0.677) and average ('r' = -0.622 and -0.622) temperature, morning ('r' = -0.451 and -0.447), evening ('r' = -0.638 and -0.635) and average ('r' = -0.620 and -0.616) relative humidity and rainfall ('r' = -0.319 and -0.316) (Table 2 and 3). Similar results were also observed by Meena *et al.* (2010) [6] who reported major activity of *M. obtusa* in terms of infested pods per plant at 10 and 8 SMW (SW) during 2008-09 (57.0%) and 2009-2010 (28.5%), respectively. Maximum incidence of maggot population was also recorded in 9 SW with population of 35.6 and 2.6 per plant in both the years, respectively. The present findings are also supported by Kumar *et al*. (2011) [9] who revealed the maximum infestation of pod fly in February reached an average of 52.41, 54.52 and 53.69 per cent during 2005-06, 2006-07 and 2008-09, respectively. The average infestation was 39.95 per cent and correlation studies were not able to establish any relationship between the infestation and the abiotic factors. The trend of the earlier workers indicates the same pattern of pod fly damage and relationship with weather factors which indicated in the present investigation (Multiple Correlation coefficient (R) remained non- Significant, thus confirms the current investigation.

**Conclusion**

It can be concluded that the pod borer larval population and its associated pod damage commences at the same time and reaching its peak population and damage in the same standard meteorological week in both the farming system. Sufficient control measures can be taken to manage this pest before reaching its peak population in both organic and conventional farming systems. Relatively higher pod borer larval population and its inflicted pod damage was recorded at organic farming system and this might be due to non-use of quick knock down insecticides in organic farming than conventional farming system. In conventional farming system, application of insecticides might have reduced the pod borer population instantaneously.

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