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# INFLUENCE OF WEATHER PARAMETERS ON NATURAL EGG PARASITIZATION OF POD BUG, *CLAVIGRALLA GIBBOSA* SPINOLA (HEMIPTERA: COREIDAE) ON PIGEONPEA

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## ABSTRACT
The present paper reports the occurrence of one hymenopteran egg parasitoid of pigeonpea pod bug, *Clavigralla gibbosa* Spinola (Hemiptera: Coreidae) from Pantnagar (India). The parasitoid recorded was *Gryon clavigrallae* (Scelionidae: Hymenoptera). The activity of *C. gibbosa* commenced during 42$^{nd}$ standard week (Oct. 14 to Oct. 20) and it attained peak during 45$^{th}$ standard week (Nov. 4 to Nov. 10). The per cent egg parasitization of *C. gibbosa* by this parasitoid during the course of investigation ranged from 4.16 to 64.61%. Maximum parasitization was observed during 48$^{th}$ standard week (Nov. 25 to Dec. 1). The variations of different weather variables like temperature, relative humidity, sunshine hours and wind velocity caused approximately 91.1 and 74.6 per cent variations in *C. gibbosa* population and per cent egg parasitization, respectively. Thus, this parasitoid can be exploited for the biological control of *C. gibbosa* in pigeonpea ecosystem at Pantnagar, Uttarakhand.

## INTRODUCTION

Pigeonpea, *Cajanus cajan* (L.) Millsp. is an important pulse crop grown in semi-arid tropics and sub-tropical areas of the world. India accounts for more than 90 per cent of the world's pigeonpea production and area (Mathukia *et al*., 2016). In India pigeonpea is grown on 3.88 million hectares of area with an annual production of 3.29 million tonnes and yield of 849 kg/ha (Anonymous, 2014). Though, India is largest producer of pigeonpea, its productivity has always been a concern. The low productivity of pigeonpea in the country may be attributed to many reasons, among which damage by insect pests is of paramount importance. More than 250 species of insect pests are known to infest pigeonpea crop at its various growth stages in India but of these only a few cause significant and consistent damage to the crop (Srilaxmi and Paul, 2010).

Among the pod damaging insect pests of pigeonpea, next to pod borers, pigeonpea pod sucking bug, *Clavigralla gibbosa* Spinola (Hemiptera: Coreidae) has become a real threat to quality grain production in pigeonpea. The damage in grain yield due to this bug generally ranges between 25 to 40 per cent (Gopali *et al*., 2013). Both nymphs and adults of this insect feed by piercing the pod walls and extracting nutrients from the developing grains thereby resulting in premature shedding of pods, deformation of pods and shriveling of grains which results in major reduction to grain yield in pigeonpea (Srujana and Keval, 2014). In recent years, this insect has assumed the status of a major pest on pigeonpea in Uttarakhand, India.

The main reasons for the outbreak of this pest are continuous and indiscriminate use of same insecticides, monocropping and introduction of early and extra early maturing pigeonpea cultivars (Bharthimeena and Sudharma, 2009; Hanumanthaswamy *et al*., 2009). Further, occurrence of favorable temperature and humidity conditions during reproductive stage of the crop also supports population build up of this bug (Singh *et al*., 2008). Under these circumstances, the scientific investigations for the effective management of *C. gibbosa* in pigeonpea ecosystem are needed to be further strengthened. Improving the impact of natural control agents is perhaps the most neglected area of pigeonpea pest management research. Although a number of natural enemies have been recorded from the key pests of pigeonpea (Shanower *et al*., 1997; Gupta *et al*., 2011; Yadav and Yadav, 2013), little is known of their effect on pest population dynamics.

In India, the role of egg parasitoids has received substantial attention, and it has been emperically proven that they are not only crucial for the biocontrol programme but also in several ongoing IPM programmes (Khan *et al*., 2013; Bhagat *et al*., 2015). Though relatively few natural enemies have been reported for *Clavigralla* species in India, but of them, the most important are hymenopteran egg parasitoids (Shanower *et al*., 1999). *Gryon* sp. (Hymenoptera: Scelionidae) is an important egg parasitoid of *C. gibbosa*. It parasitizes up to 60 per cent of *C. gibbosa* eggs in the field and thus plays an important role in regulating the population of this insect pest under natural conditions (Romeis *et al*., 2000; Durairaj *et al*., 2003; Paik *et al*., 2007). Keeping these points in view, present study was undertaken to know the level of field parasitism by this parasitoid on *C. gibbosa* eggs and to access the influence of weather parameters on population build up of *C. gibbosa* and its egg parasitoids on pigeonpea at Pantnagar, Uttarakhand (India).

## MATERIALS AND METHODS

To study the seasonal abundance of *C. gibbosa* and its egg parasitoid (*Gryon* sp.) on pigeonpea, a field experiment was conducted at Norman E. Borlaug Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar, during *kharif* season of 2013-14. Short duration pigeonpea cultivar Manak was used for the study and the crop field was kept free from pesticide sprays. The bug activities starting from first appearance of bug to till they disappeared were watched. Population of *C. gibbosa* was recorded on five randomly selected plants from three middle rows of the crop block at weekly intervals.

In order to study the level of field parasitism of *C. gibbosa* eggs by *Gryon* sp., the eggs of the bugs were collected from the pigeonpea fields at weekly intervals and were kept in petri dishes on moist filter paper in laboratory. These eggs were observed everyday for the hatching of nymphs and emergence of egg parasitoids. The number of unhatched eggs was also recorded. As the incubation period of this bug varies from three to seven days, the eggs which did not hatch after this period were treated as unhatched. The percentage of egg parasitism, nymphal emergence and unhatched eggs were estimated for every standard week as described by Durairaj *et al*. (2003).

Influence of weather parameters on population build up of *C. gibbosa* and its weekly per cent egg parasitization was also worked out. For this, the data was subjected to correlation and regression analysis with weather parameters *viz*., maximum and minimum temperatures, average relative humidity, sunshine hours and wind velocity in respect of the corresponding standard week. Significance of simple correlation was estimated by using *t*-test (Saxena and Ujagir, 2007) and the regression equations were derived by using the formula as suggested by Panse and Sukhatme (1985). The meteorological data for the above analysis were obtained from the meteorological observatory of G. B. Pant University of Agriculture and Technology, Pantnagar.

## RESULTS AND DISCUSSION

### Abundance and parasitization of *C. gibbosa*

The result of this study revealed that the activity of *C. gibbosa* commenced during 42nd standard week at pod formation stage of the crop and it persisted up to end of the crop season. The peak level of its population (6.4 bugs/ plant) was observed during 45th standard week after which the bug population gradually declined (Table 1). Similar trend of population build up of bug was also observed by Sujithra and Chander (2014), Misra and Das (2001). The results are also in partial accordance with Shukla and Kumar (2002) who reported that *C. gibbosa* infestation started in the 35th standard week and continued up to 48th standard week, reaching its peak in the 45th standard

**Table 1 : Seasonal incidence of pod bug, *C. gibbosa* on pigeonpea and extent of parasitization by *G. clavigrallae* on pod bug eggs during *kharif*, 2013-14**

| Standard week | Mean number of nymphs and adults of pod bug per plant | Extent of parasitization Number of eggs collected from field | Nymphal emergence (%) | Parasitization (%) | Unhatched eggs (%) |
|---|---|---|---|---|---|
| 42 | 0.6 | 93 | 58.06 | 26.88 | 15.06 |
| 43 | 2.8 | 64 | 53.12 | 28.12 | 18.75 |
| 44 | 4 | 383 | 61.09 | 30.55 | 8.36 |
| 45 | 6.4 | 621 | 65.06 | 32.36 | 2.58 |
| 46 | 5.2 | 436 | 53.67 | 36.93 | 9.4 |
| 47 | 4.4 | 374 | 28.61 | 56.15 | 15.24 |
| 48 | 3.6 | 178 | 16.29 | 64.61 | 19.1 |
| 49 | 2.4 | 128 | 39.84 | 36.72 | 23.44 |
| 50 | 1.8 | 106 | 57.55 | 14.15 | 28.3 |
| 51 | 0.2 | 24 | 58.34 | 4.16 | 37.5 |
| Crop harvested | | | | | |

**Table 2 : Correlation coefficients of *C. gibbosa* population and its egg parasitization with abiotic factors**

| Abiotic factors | *C. gibbosa* population | *C. gibbosa* parasitization |
|---|---|---|
| Maximum temperature (ºC) | 0.249 ns | 0.314 ns |
| Minimum temperature (ºC) | - 0.168 ns | - 0.064 ns |
| Average relative humidity (%) | - 0.887** | - 0.543 ns |
| Sunshine hours | - 0.303 ns | 0.093 ns |
| Wind velocity (km/hr) | 0.632* | 0.320 ns |

*Correlation is significant at the 0.05 level (Two-tailed), ** Correlation is significant at 0.01 level (Two-tailed), ns = non significant

**Table 3 : Multiple regressions of *C. gibbosa* population with abiotic factors**

| Multiple regression | Temperature (° C) Maximum ($X_1$) | Minimum ($X_2$) | Average Relative humidity (%) ($X_3$) | Sunshine hours ($X_5$) | Wind velocity (km/hr) ($X_6$) |
|---|---|---|---|---|---|
| Coefficient | - 0.157 | 0.296 | - 0.654 | - 0.200 | - 0.127 |
| Standard Error | 0.883 | 0.586 | 0.262 | 0.608 | 0.611 |
| T value | - 0.178 | 0.505 | - 2.497 | - 0.329 | - 0.208 |
| F value | 8.213 | | | | |
| $R^2$ | 0.911 | | | | |
| Regression equation:$Y_1$ = | 51.487 – 0.157 ($X_1$) + 0.296 ($X_2$) – 0.654 ($X_3$) – 0.200 ($X_4$) – 0.127 ($X_5$) | | | | |

$Y_1$ = *C. gibbosa* population, $X_1$ = Maximum temperature (°C), $X_2$ = Minimum temperature (°C), $X_3$ = Average relative humidity (%), $X_4$ = Sunshine (hours), $X_5$ = Wind velocity (km/hr)

**Table 4 : Multiple regressions of *C. gibbosa* egg parasitization with abiotic factors**

| Multiple regression | Temperature (° C) Maximum ($X_1$) | Minimum ($X_2$) | Average Relative humidity (%) ($X_3$) | Sunshine hours ($X_5$) | Wind velocity (km/hr) ($X_6$) |
|---|---|---|---|---|---|
| Coefficient | - 1.411 | 0.687 | - 0.153 | 9.365 | 10.572 |
| Standard Error | 17.740 | 11.767 | 5.264 | 12.210 | 12.262 |
| T value | - 0.080 | 0.058 | - 0.029 | 0.767 | 0.862 |
| F value | 1.002 | | | | |
| $R^2$ | 0.746 | | | | |
| Regression equation | : $Y_1$ = – 21.440 – 1.411 ($X_1$) + 0.687 ($X_2$) – 0.153 ($X_3$) + 9.365 ($X_4$) + 10.572 ($X_5$) | | | | |

**$Y_2$** = *C. gibbosa* egg parasitization, **$X_1$** = Maximum temperature (°C), **$X_2$** = Minimum temperature (°C), **$X_3$** = Average relative humidity (%), **$X_4$** = Sunshine (hours), **$X_5$** = Wind velocity (km/hr)

week on pigeonpea variety ICPL-87. Similarly, Pandey *et al.* (2016) also reported that the first occurrence of *C. gibbosa* on short duration pigeonpea was recorded in 40th standard week and it attained peak during 44th and 45th standard week.

During the course of this investigation one egg parasitoid, *Gryon clavigrallae* Mineo (Scelionidae: Hymenoptera) was recorded on *C. gibbosa*. The peak level of weekly egg parasitization (64.61%) by this parasitoid was recorded during the 48th standard week at pod maturity stage of the crop followed by 47th standard week (56.15%). The decline in bug population after 45th standard week might be due to increase in egg parasitization. The nymphal emergence from the eggs was inversely related to the level of parasitism. Natural mortality of the eggs was also observed under laboratory conditions. Until recently, only two species of *Gryon i.e.*, *Gryon (Hadronotus) fulviventris* and *Gryon clavigrallae* have been reported from *Clavigralla* spp. in India (Bindra, 1965; Romeis *et al.*, 2000 and Durairaj *et al.*, 2003). These parasitoids, alone or in combination, have been reported to parasitize more than 55.0% of available hosts of pigeonpea in India (Nawale and Jadhav, 1978).

Likewise, Bhagwat *et al.* (1994) reported that the females of *Gryon* sp. successfully oviposited in 3-day-old eggs of *C. gibbosa*. Significantly, greater per cent parasitization was observed in sole pigeonpea crop than in cotton intercrop. *Gryon clavigrallae* Mineo parasitized up to 69.0% of eggs of *C. gibbosa* in India and large egg clusters were more frequently attacked, probably because they were more easily located (Shanower *et al.*, 1996). Ombir and Dahiya (1996) also reported that eggs of pod bug, *C. gibbosa* were found parasitized by *Gryon* sp. and maximum per cent parasitization was noticed in the first half of November. Romeis and co workers (2000) also found that all the parasitoids that emerged from *Clavigralla* spp. were *G. clavigrallae*, with positive correlation between percentage of egg parasitized and size of the egg clusters. In addition, eggs of pentatomid bug, *Nezara viridula* L. collected from the pigeonpea fields were also found parasitized by *G. clavigrallae* (Khan *et al.*, 2013).

**Influence of weather parameters on population build up of *C. gibbosa* and its egg parasitoid, *G. clavigrallae***

Simple correlation was worked out between *C. gibbosa* population and the weather parameters as presented in Table 2. It revealed that there was a positive significant correlation with wind velocity (r = 0.632) and a positive but non-significant correlation with maximum temperature (r = -0.249). It also exhibited a negative significant association with average relative humidity (r = - 0.887) and a non-significant negative correlation with minimum temperature (r = - 0.064) and sunshine hours (r = - 0.303). Correlation between per cent egg parasitization and weather parameters revealed that a non-significant positive association was maintained with maximum temperature (r = 0.314), sun shine hours (r = 0.093) and wind velocity (r = 0.320) (Table 2).

The regression coefficient revealed that the various abiotic factors were found to be most influencing factor, which contributed ($R^2$ = 0.911 and 0.746) 91.1 and 74.6 per cent variation in *C. gibbosa* population and per cent egg parasitization, respectively. The regression equation was fitted to study the effectiveness of weather parameters indicated that for every 1°C increase in minimum temperature there would be an increase of 0.687 numbers of *C. gibbosa* population, while for every 1°C increase in maximum temperature, one per cent increase in average relative humidity, one hour increase in sunshine hour and one km/hr increase in wind velocity there would be a decrease of 0.157, 0.654, 0.200 and 0.127 numbers of *C. gibbosa* population respectively (Table 3).

Similarly for every 1°C increase in minimum temperature, one hour increase in sunshine hour and one km/hr increase in wind velocity there would be an increase of 0.687, 9.365 and 10.572 per cent egg parasitization respectively, while for every 1°C increase in maximum temperature and one per cent increase in average relative humidity there would be a decrease of 1.411 and 0.153 per cent egg parasitization respectively (Table 4). The results are in accordance with Pandey and Das (2014) who reported that temperature (maximum and minimum) and sunshine hours had non-significant correlations with the population build up of this bug but relative humidity had a negative impact on bug population.

The present results also confirm the findings of Mishra and Das (2001) and Kaushik *et al*. (2008), they also reported negative impact of relative humidity on the pest population. In our findings, though minimum temperature showed negative effect on pest population but it was non-significant. Kumar and Nath (2005) also reported that the temperature, relative humidity and water evaporation had negative non-significant correlation with population build-up of pod bug (*C. gibbosa*) that further supported the present findings. On the contrary, Kaushik *et al*. (2008) reported that both maximum and minimum temperature exhibited positive impact on the pest population. Yadav and Patel (2015) also found that the variations of temperature, relative humidity and rainfall caused approximately 64, 42 and 20 per cent variation in per cent parasitization of *Chromatomyia horticola* at Pantnagar.

Since *C. gibbosa* is a major pest of pigeonpea crop at Pantnagar and difficult to control because of its ability to develop resistance against insecticides and destruction of natural enemies by continuous use of harmful pesticides. Therefore, there is a need to understand the natural enemy complex of this pest in order to promote natural biological control as well as to avoid the use of harmful pesticides in pigeonpea ecosystem at the time when they are actively involved in reducing the population of this pest. The present study helps the pigeonpea growers of *terai* region of Uttarakhand by providing information regarding a predominant egg parasitoid of this pest and its peak activity during the cropping season. Thus farmers can make suitable decisions for conservation of this hymenopteran parasitoid by adopting selective chemicals or the use of other non-chemical methods and minimize the infestation of this pest.

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