Summary
The productivity of pigeonpea in India is constrained by various abiotic and biotic stresses resulting in drastic reduction in its yield. Among the biotic stresses, insect pests, particularly podfly, *Melanagromyza obtusa* Malloch is known to inflict heavy crop losses. The technology available for its effective management is far from satisfaction. Only a negligible number of farmers adopt pest control measures against this noxious pest species podfly. Its hidden nature inside the pod is considered to be a major factor for getting limited attention both from entomologists, extension workers and farmers. In these circumstances, the research on podfly needs to be strengthened. Therefore, the research work in the form of present manuscript will go a long way to help the farmers to choose the most appropriate method to contain the podfly population.

The biology of podfly, *Melanagromyza obtusa* was studied in relation to the host. The insect completed three generations on late pigeonpea cultivars. There was a significant effect of resistant and susceptible cultivars on different biological parameters. Temperature also greatly affected the duration and dynamics of podfly. The incubation period was higher (3.35 to 4.82 days) on SL12-1 (resistant) as compared to Bahar (2.14 to 4.62 days) and NA1 (2.2 to 3.8 days), the susceptibles. Similarly, fecundity showed a significant variation among the cultivars in all the three generations. However, the females reared on different cultivars did not exhibit a significant variation in egg laying, when allowed to oviposit on a common host. Therefore, this could be concluded that the resistance in pigeonpea against podfly was only due to oviposition non preference. Resistant variety prolonged the total generation time as compared to susceptible varieties. The shortest generation time, 22.4 days (NA1), 22.9 (Bahar) and 29.7 (SL12-1), was observed in third generation. Whereas, the longest generation time was
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recorded in first generation exhibiting 43.4, 48.6 and 51.5 days on NA1, Bahar and SL12-1, respectively. The variation among the generations was attributed to the varying temperature, which prevailed during the experimental period.

Three parasitoids; *Ormyrus orientalis*, *Euderus agromyzae* and *Eurytoma ranjithi* were recorded parasitizing *M. obtusa* on late pigeonpea. *Eurytoma ranjithi* Narendran was for the first time recorded on any host. The *ormyrus orientalis* was the major parasitoid causing parasitization as high as 14%, followed by *Euderus agromyzae* (7%) and *Eurytoma ranjithi* (2.5%). The parasitoids appeared in the field as soon as the pods and the podfly were available. The parasitization increased gradually and reached to its peak in 12 SW coinciding with the crop maturity. A significant effect of cultivars was noticed with respect to the overall parasitization. It was 22.5, 24.0 and 8.4% (2000-01) and 24.3, 25.0 and 9.3% (2001-02) on Bahar, NA1 and SL12-1, respectively. Variation in parasitization among cultivars with respect to the particular parasitoid species (*Ormyrus orientalis* and *Euderus agromyzae*) was also observed. Since, *Euderus agromyzae* is a larval ecto parasitoid, it might have become difficult for female parasitoid to insert eggs into these pods because of the constriction between the locules. However, the reasons for *Ormyrus orientalis*, a pupal parasitoid seem to be a mystery. It is therefore important to further investigate the reasons for the influence on the parasitization shown by cultivars.

In order to find out the most appropriate time for the application of management strategies, the staggered podding behaviour of the pigeonpea cultivars needed to be known. Keeping in view, the podding behaviour of two commonly used late pigeonpea varieties (NA1 and Bahar), sown on two different dates, was studied. Bahar undergo two
flushes of podding, one prior to cold spell (2-3 SW) and other at the post (8-10 SW). Interestingly, the critical pod stage coincided with the peak egg laying of podfly and no significant change in podding behaviour was observed, when sown on 15 August (one month late). However, major contribution of pod setting was attributed to second flush (8-10 SW). On the other hand, NA1 showed the main flush of pod setting between 8-11 SWs. The late sown crop observed the same trend as of the timely sown crop. The podding behaviour of a particular variety in relation to the podfly egg laying could be useful in choosing the most appropriate time for the application of control measures. This way, the excessive use of synthetic insecticides can easily be averted.

The population build up of podfly and its parasitoids was studied for two successive cropping seasons. The podfly started egg laying as soon as the pods appeared in pigeon pea fields. Two peaks of egg laying were observed, one before (2-4 SW) and other after the cold spell (9-11 SW). The parasitoids appeared simultaneously with the presence of podfly immature stages. There was a gradual increase in parasitization with respect to temperature and crop maturity. The eggs and maggots showed a negative correlation with climatic parameters as well as parasitoids except relative humidity. Conversely, parasitoids exhibited a strong positive correlation with temperature and negative with relative humidity. There was a cumulative effect of biotic and abiotic factors on the population build up of podfly. On the other hand, temperature greatly influenced the population build up of parasitoids.

Evaluation of different IPM modules against podfly revealed that intercropping of pigeon pea with sorghum and urdbean exhibited no effect on podfly incidence, however, the pigeon pea equivalent yield was increased as compared to the sole crop. Since, the intercrops were harvested before the podding stage of pigeon pea, the open rows could
facilitate the spraying of the different treatments. The IPM modules tested against the podfly revealed that CIPM was the most effective in reducing the grain damage and increasing the grain yield which was also at par with BIPM and significantly superior to NIPM. Keeping in view the demerits of synthetic insecticides, BIPM proved to be the most appropriate strategy against podfly with two sprays of NSKE, a widely and easily available bio-pesticide.

When the relative performance of most widely used relatively eco-friendly insecticides to manage the podfly was evaluated, it was found that dimethoate, profenophos and quinolphos, sprayed twice, were superior to others. Maximum yield (1660 to 2046 kg/ha) and minimum grain damage (13.5 to 21.6%) was recorded in these treatments. The other treatments also showed a significant reduction in grain damage and increase in grain yield as compared to untreated check (38.4 to 44.8). To determine the effect of plant products, it was found that NSKE 5%, garlic and onion 2% each, were the most effective against podfly. Among the commercial formulations of neem, Multineem (Multiplex Ltd.) and Achook (Godrej Agrovet Ltd.) proved to be the most promising, showing the results at par with NSKE.

The ovipositional deterrent property of plant products was evaluated at 2, 5 and 10 days intervals. It was observed that NSKE 5%, onion and garlic (2% each), eucalyptus oil, cedar wood oil (0.2% each) reduced the egg laying significantly upto 5 days as compared to untreated control. These products, however, could not influence beyond 5 days except NSKE that managed to reduce 50% egg laying upto 10 days after spray.

The most commonly used insecticides along with NSKE were evaluated for their performance against podfly and its parasitoids. The results indicated a common trend of population fluctuation of podfly and
its parasitoids, recorded at weekly intervals. A significant variation between the treatments was, however, observed. The results based on the two successive cropping seasons revealed that profenophos and dimethoate were potential insecticides against podfly and also relatively safe to parasitoids. NSKE proved to be the safest to parasitoids being at par with untreated check, but was not very effective to contain podfly population as compared to synthetic insecticides. Endosulfan and monocrotophos were found toxic to the parasitoids, exhibiting a significant reduction (8.3 to 9.9%) in parasitization against untreated check (19.9%).

The IPM modules tested in the station trials were validated in the farmer's fields. Two IPM modules (BIPM and CIPM) were compared with farmer's practice. The results revealed that both modules were equally effective being statistically at par with each other. The CIPM module was, however, the most cost effective (1:2.75).

FUTURE THRUST AREAS

The fact that podfly, *M. obtusa* is a key and most serious insect pest of pigeonpea and hence should receive priority in research but unfortunately has altogether been ignored. Podfly, *M. obtusa* Malloch is a specific pest of pigeonpea and its status as a pest has been quite underestimated because of being confined to the areas of northern and central India. The pest has thus escaped the attention of research workers, leading to major yelling gaps in the knowledge about this pest. The areas that need emphasis on research and considerations include mainly the attention of research workers towards this pest. As far as the pest is concerned, working out its population dynamics through life table studies will be a milestone. Development of suitable artificial rearing technique is a pre-requisite for any further study on the basic
aspects of this pest and its parasitoids. Studies on biophysical and biochemical basis of host plant resistance as well as genetics of the resistance should receive priority. The studies on tritrophic interaction are very important to investigate the reasons for the influence on the parasitization shown by cultivars. In addition, most importantly, the farmers need to make aware of the pest and its mode of damage. Neem can be a very good alternative of synthetic insecticides and is widely available, but needs to be introduced among the farmers as a good friend of them in combating this serious pest.