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Olfactory response of rove beetle, *Paederus fuscipes* (Curtis) to flower volatiles

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Abstract
Flowers of five different plant species *viz.*, green gram *(Vigna radiata)*, marigold (*Tagetes erecta)*, sunnhemp (*Crotalaria juncea)*, cowpea (*Vigna unguiculata)*, Okra (*Abelmoschus esculentus)* along with control (only air without flowers) were tested for their effectiveness in attracting predatory *Paederus fuscipes* (Curtis) in a six arm olfactometer at Indian Institute of Rice Research (IIRR), Hyderabad, Telangana, India. Flowers of different plant species acted as odour source to attract rove beetle. The order of preference of flower odours to *P. fuscipes* in descending order was cowpea > okra > green gram > marigold > sunhemp. Rove beetle attraction was high in cowpea followed by okra, green gram, marigold and the lowest population was recorded in sunhemp. These plant species could be used in rice systems as bund /border/strip crop to attract predatory rove beetle suppress rice pests.

Keywords: Rove beetle, Flower, olfactory, rice pest

Introduction
Paederus fuscipes is a small beetle of the coleopteran order and belongs to family Staphylinidae. Staphylinidae have long been known as generalist arthropod predators of several agricultural insect pests [1, 2, 3]. About 50,000 staphylinid species are distributed worldwide [7] *Paederus fuscipes* is found in whole of the world except America. *Paederus fuscipes* has a shiny head and the last two abdominal segments black, thorax and first four (visible) segments red and elytra blue. The females lay their eggs singly on moist substrate to avoid the danger of desiccation. Besides its medical importance, it also acts as scavengers in the ecosystems and predators. Large populations have been recorded from agricultural habitats which make them beneficial due to their feeding on insect pests of major crops and fodders (Devi *et al.* 2003) [5], particularly insect pests like *Corcyra cephalonica*, *Heliothis armigera*, *Aphis gossypii*, *Earias vittella*, *Spodoptera litura*, *Marasmia patnalis* (rice leaf folders), *Aphis glycines*, fruitfly and many other dipterous and other arthropodes are known as prey (Berglind *et al.* 1997; Krakerb *et al.* 2000; Devi *et al.* 2003) [6, 7, 5].
Rice (*Oryza sativa* L.) is the staple food crop of more than half of the world's population**.** Asia is the leader in rice production accounting for about 90 per cent of the world production. To meet the world's food demand, there is a growing need for sustainable pest management practices. This means that it requires fundamental changes of current practices. Moreover, it is necessary to adopt rice pest management practices with a markedly reduced reliance on pesticides. The losses occur due to moderate to serious incidence of stem borer, gall midge, planthoppers and other sporadic pests in India (Nandagopal *et al*., 2008) [8]. Gu *et al.* (1989) [9] reported that based on population and predation efficacy, *P. fuscipes* was considered as the third most important predator of rice pests, following wolf spiders (Lycosidae) and other spiders. Jadhao and Shukla (2016) [10] reported that the predatory rove beetle, *Paederus fuscipes* (Curtis) were active and effectively regulating the populations of all the four major pests of rice (*Scirpophaga incertulus, Cnaphalocrosis medinalis*, *Nilaparvata lugens* and *Sogatela furcifera*). One of the safer and best alternatives for management of rice pests is Ecological engineering (EE). Banker plants used in the Ecological engineering may provide resources, such as, shelter, pollen and nectar, or alternative preys to improve the establishment and persistence of beneficial insect populations used to control a specific insect pest. However, the literature on the olfactory response of rove beetle, *Paederus fuscipes* (Curtis) to flower odours is very scanty. Hence the present study was carried out to know the useful of some flowering/nectar plant species in attracting predatory beetle, *Paederus fuscipes* by their odour, so that suitable plants could be grown all along the bunds of rice fields to promote biological control of rice pests.

Materials and methods

The laboratory studies were conducted to study the response of plant volatiles of flowering plants used as bund crops of rice on the predatory rove beetle, *Paederus fuscipes* by using olfactometer at Indian Institute of Rice Research (IIRR) Rajendranagar, Hyderabad during 2015 to 2017. The five flowering plants *viz*., green gram, cowpea, okra, marigold and sunhemp which were used as bund crops for attracting the predatory rove beetle, *Paederus fuscipes* in the rice field were used to study the preference of the flowers of the bund crops on some of the commonly and abundantly occurring predatory rove beetle, *P. fuscipes* of rice pests. The attractiveness of the different flowers to the predatory rove beetle, *P. fuscipes* was assessed with the help of six arm olfactometer by connecting each arm to the odour source. Growing of Flowering Plants for Olfactometer Studies were done separately .The seeds of the five flowering plants *Viz.*, greengram, marigold, sunhemp, cowpea and okra were sown in pots filled with soil and were watered daily. Thinning to two plants per pot was done at ten days after emergence and plants were grown in the greenhouse (average temperature of 24.5 0C, 78% relative humidity) by exposing them to natural light with day lengths ranging from 13.5–14 h. Staggered sowing of the plants was done to ensure continuous availability of flowers throughout the laboratory studies. The flowers obtained from the potted plants were used in the study. Design of six arm Olfactometer consist of a release chamber at the center and is connected by a pure air inlet tube for creating pure air; the inlet tube was connected to a blower through an inlet chamber fitted with a filter and an air flow meter. The blower unit consists of a battery operated mini fan fitted with a glass tube to generate pure air Ranjith (2007) [11] and Hao *et al.* (2012) [12].

The flowers of each treatment were picked before commencing assays each day and the cut end of each flower was embedded into a cotton wool swab soaked in distilled water to keep the freshness of the cut flower. The studies were done in the climate room (26 ± 1 0C). About 10 flowers each of blackgram, cowpea, sunhemp and sesamum and one flower of marigold were inserted separately in to each arm and the sixth arm was treated as control. After inserting the flowers in to the arms of the olfactometer, an airstream was generated and led through a flow meter with activated charcoal. The predatory rove beetle, *P. fuscipes* used in the study was allowed to acclimatize to the laboratory for 30 min before using them in assays. Twenty predators of each species were released in to the central chamber of the olfactometer through the hole. The observations were recorded on number of predator/ parasitoids settled on each arm at 5, 10, 15 and 20 minutes after release (MAR). The experiment was replicated three times. After conducting the experiment with each predator, the glassware was cleaned and rinsed with double distilled water.

Statistical Analysis

The data obtained from the plant volatile studies were pooled and subjected to CRD analysis of variance (ANOVA) after subjecting the values to square root transformation.

Results and discussion

The rove beetle which is a general predator on rice pests was attracted to all flower odours. When compared to control, the number of adults beetles attracted to the odours of different flowers varied from 0.67 to 2.33 at 5 MAR and they were significantly superior to control and were on par with each other. At 10 MAR, sunhemp was significantly less preferred to the predators (Table 1) when compared to other treatments and the number of rove beetles attracted to the four treatments varied from 1.67 to 2.67. At 15 MAR though all the five treatments were significantly on par with each other but at 20 MAR, the sunhemp was significantly less preferred (1.67) when compared to cowpea (4.33). The order of preference of flower odours to *P. fuscipes* in descending order was cowpea > okra > green gram > marigold > sunhemp (Fig 1). Whereas control recorded least number of rove beetles compare to all other treatments. Chandrasekar (2017) [13] studied the olfactory response of predators like cocoinellids and rove beetles to the flowers of different plants. The results revealed that the coccenellids and rove beetles were highly attracted to leaves and flowers of sunflower followed by gingelly and cowpea in six arm olfactometer. Also they observed that out of seven bund crops, cowpea and sunflower registered high population of rove beetles, *Paederus fuscipes* (staphylinidae) and other predators on rice and as well as on bund crops whereas rice+cowpea and rice+sunflower significantly reduced the population of leafhopper like *Nephottetix virescens* and *Cofana spectra* and planthopper, *Nilaparvata lugens and Sogatella furcifera* on rice. Jadhao and Shukla (2016) [10] stated that the among the predatory beetles rove beetle, *Paederus fuscipes* (Curtis) was found to be abundantly predating on immature and mature stages of major and minor pests of rice.

Conclusion

olfactometer studies shows that rove beetle attracts to flower odours and its effectively manages rice pests. Whereas flowering crops acts as food source and it enhances biological method to control pests by planting flowering plants as bund crops.

Table 1: Olfactory response of rove beetle, *Paederus fuscipesi* to different flower odours

Treatments	**No. of *P. fuscipes* (no. per arm)**				
	5 Mar	**10 Mar**	**15 Mar**	**20 Mar**	**Mean**
Green gram	1.33 (1.34)	2.33 (1.68)	3.00 (1.87)	3.33 (1.93)	2.50
Cowpea	1.67 (1.46)	2.67 (1.76)	3.67 (2.03)	4.33 (2.20)	3.08
Okra	2.33 (1.64)	2.67 (1.74)	3.33 (1.95)	3.67 (2.04)	3.00
Marigold	1.33 (1.27)	1.67 (1.46)	2.33 (1.54)	2.33 (1.66)	1.92
Sunhemp	0.67 (1.05)	1.00 (1.22)	1.33 (1.34)	1.67 (1.44)	1.17
Control	0.00 (0.71)	0.67 (1.05)	0.33 (0.88)	0.33 (0.88)	0.33
C.D	0.66	0.49	0.71	0.49	
SE(m)	0.21	0.16	0.22	0.16	

Values in parentheses are subjected to square root transformation
MAR=Minutes after Release

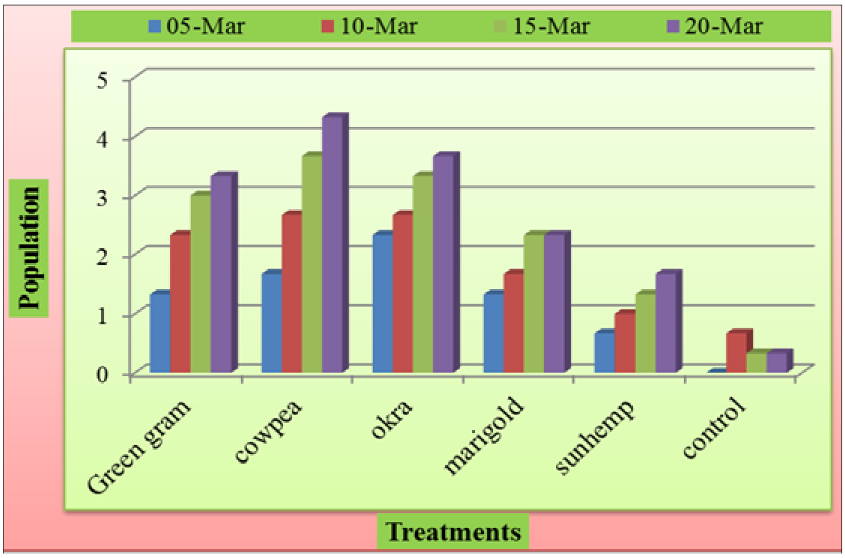

Fig 1: Olfactory response of rove beetle, *Paederus fuscipesi* to different flower odours

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