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Evaluation of diverse bait formulations for attracting and managing predatory wasps in honey bee colonies of Himachal Pradesh

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Abstract
The present studies evaluate comparison of fresh and fermented fruit baits, fresh and rotten meat baits, fruit juices and extract and meat baits treated with different insecticides concentration. Data revealed that among fresh fruits Chikoo has highest attractancy (5.82%) while in fermented fruits, chikoo was also the leading fruit bait (4.99%). Beside it in fresh meat baits categories mutton was the most attractive (35.29%), whereas in rotten meat categories fish has maximum attractancy (31.65%). From these studies, it was inferred that insecticidal baits did not prove as effective as non-insecticidal baits for attracting the predatory wasps in experimental apiaries during study period at Apple Valley in Shimla hills at Himachal Pradesh.

Keywords: Apis spp., predatory wasp, honey bee predation, fruit bait, meat baits, wasp management

Introduction

Presently beekeeping industry is facing many challenges throughout the world and one of the major constraints in beekeeping developmental programms in India is the damage caused to honeybee colonies by various pests, predators and pathogens. This may be due to the diversity in ecological conditions as well as in number of species of honeybees in this sub-continent (De Jong *et al*., 1982; Nagaraja and Rajagopal, 2003) [13]. Amongst the predators, wasps and hornets pose by far the most serious threat to beekeeping industry. Wasps are either semi-social or social insects which build their nests in cavities of trees, walls, cracks in the ground or hang them down from the trees. They are predacious by nature and catch bees from blossoms or at the entrances of the hives (Spradbery, 1991) [18]. Wasps are not only fatal to bees, but also rob their eggs, brood and honey stores. A serious attack sometimes results in absconding of bee colonies leaving behind a lot of honey and brood (Akre and Davis, 1978). Honeybee pests, predators and pathogens thus can create serious problems, which must be met not only by the beekeepers, but also by the bees themselves (Gochnauer *et al*., 1992; Morse and Flottum, 1997) [6, 12]. Laterally Brar *et al*., 2018 [1] also reported that weather conditions like temperature and relative humidity are the environmental variables to be considered when monitoring wasp pressure around apiaries that can influence activity, foraging, colony development and the seasonal availability of prey in different parts of Himalayan region. By keeping the above view in the mind the present efforts were made to compare the attractiveness of fresh and fermented fruit baits, juices & extract and untreated & insecticidal meat baits with honeybee predation throughout the day. The comparative performance of untreated and insecticide treated baits is also assessed to identify their potential role in managing Vespa spp. activities and reducing predation pressure on honey bee colonies

Material and Methods

A survey of different *Vespa spp.* infesting colonies of Indian hive bee, *Apis cerana* F. and European bee, *Apis mellifera* L. was made in 41 apiaries of Himachal Pradesh having different altitudes, latitudes and climatic conditions. Some efforts were also made on hourly variation in the population of different predatory wasp attacking honeybee colonies was made from May, 2024 to April, 2026 in local apiary at Apple valley of Shimla Hills (Altitude, 2200 m, latitude 31º26' N and longitude 77º37' E). Mainly present work focus on the studies on the management of Vespa spp., attacking honeybee colonies by following baits.

Non- Insecticidal Baits

1. Fruit Baits

Apple (*Malus domestica*. cv. Royal delicious), banana (*Musa paradisiaca*), chikku (*Achras sapota*, cvthen placed on a platform attached to the alighting board of a hive (replicated 8 times). Visit of predatory wasps to different baits were recorded continuously from 0900 in morning to 1600 hours in evening. Data were expressed in terms of number of predatory wasps/hour/hive. All the observations were taken thrice a week of every month. Number of bees preyed upon by different wasps during this period was also recorded (Mishra *et aI*., 1989) [11].

2. Meat, Fish and Egg Baits

These baits mainly divided into two types fresh and rotten baits of mutton, chicken, pork, fish and egg were tested for their attractiveness to wasps. Fresh and rotten baits were put in separate Petri dishes on platforms attached to alighting boards of the hives. Visits of predatory wasps to different baits were recorded from 0900 in the morning to 1600 hours in evening. Data was expressed in terms of number of predatory wasps/hour/hive. All these observations were taken thrice a week of every month. Number of bees preyed upon by different wasps during this period was also recorded (Sharma *et aI*., 1979) [16].

3. Fruit and Flower Juices

Different fruit and flower juices were prepared from brass (*Rhododendron* sp.), pineapple (*Ananas sativlIs*), plum (*Prunus domestica* cv. Santarosa) and orange (*Citrus aurantium*) respectively. Extracted juice of each were put in separate Petri dishes placed on the alighting boards of the hives. Visits of the predatory wasps to different juice baits were recorded from 0900 in morning to 1600 hours in evening. All these observations were taken thrice a week of every month (Lim *et aI*., 1989) [9].

4. Extracts of Gur, Candy and Milk (Whey)

Candy syrup, gur and fermented milk (whey) were tested for their respective attractiveness to predatory wasps. They were put in separate Petri dishes and then placed on alighting board of a hive. Visits of predatory wasps to different baits were recorded from 0900 hours in morning to 1600 hours in evening. All these observations were taken thrice a week of every month (Ono *et aI*., 1992) [15].

Insecticidal Baits

Insecticidal baits were prepared by taking the desired concentration of a particular insecticide and dissolving it in acetone or water. Afterwards, 10 gms each of fresh mutton and rotten fish, which were used as attractants for predatory wasps, were dipped in the respective insecticidal solution for a particular duration varying from 2-3 hours. Different insecticides selected were: Dichlorvos and Methyl parathion (Contact and Stomach poison), Carbaryl (Systemic insecticide), all three belonging to the groups of organophosphate compounds and Benzene Hexa-Chloride (B.H.C.) belonging to Organochlorine compounds. Only technical grade insecticides were used so as to avoid the offensive repelling smell emanating from formulated products.

Following concentration of different insecticides were used for making the mutton and fish baits.

Dichlorvos = 2%, 1%, 0.5%, 0.2% and 0.1%
Methyl parathion= 0.1%, 0.08%, 0.06%, 0.04% and 0.02%
Carbaryl = 0.2%, 0.1%, 0.05%, 0.02% and 0.01%
B.H.C. = 1%, 0.8%, 0.6%, 0.4% and 0.2%

Visits of predatory wasps to different poison baits were recorded at hourly intervals from 0900 hours in morning to 1600 hours in the evening. These observations were taken twice a week, during the months of September and October, 2025. Results were expressed in terms of percent attractancy of wasps towards different baits, calculated by following formula:

$$\frac{\text{Mean number of wasps attracted to a particular bait}}{\text{Mean number of wasps visiting the bee colony}} \times 100$$

Result

Present results deal with the evaluation of some methods used for the control of predatory wasps attacking *A. mellifera* and *A. cerana* colonies in different agro-climatic zones of Himachal Pradesh. For this purpose, two types of baits were used. First were 'non-insecticidal' (without any insecticide) and second were 'insecticidal baits' (with insecticide). Non insecticidal baits were prepared from macerated fruits, meat, fish, egg, juices and extracts and for insecticidal baits, only fresh mutton and rotten fish were used as the attractants which were then mixed with different types of insecticides.

Non-Insecticidal Baits

a. Fruit baits

1. Fresh

Comparative attractancy data for different fresh fruit baits showed the following trend:

Bees*	> Chikku	> Pear	> Apple	> Grapes	> Guava	> Banana	> Orange
(80.40)	(5.82)	(0.99)	(0.90)	(0.60)	(zero)	(zero)	(zero)

Above results revealed that predatory wasps had the maximum attractancy towards chikku (5.82 per cent), whereas, guava, banana, orange bait proved to be the least attractive (zero per cent).

2. Fermented

Comparative attractancy towards fermented fruit bait showed the following sequence:

Bees	> Chikku	> Apple	> Grapes	> Banana	> Guava	> Orange	> Pear
(80.40)	(4.99)	(0.99)	(0.90)	(0.60)	(zero)	(zero)	(zero)

Above results suggest that among the six fermented fruit baits used, chikku attracted the maximum number (4.99 per cent) of predatory wasps, whereas, no predatory wasps were attracted towards guava, orange and pear baits (zero per cent) respectively.

b. Meat, Fish and Egg bait

1. Fresh

Comparative attractancy data on wasps in relation to fresh meat, fish and egg baits revealed the following pattern:

Mutton	> Fish	> Bees	> Chicken	> Pork	> Egg
(35.29)	(29.43)	(24.83)	(8.57)	(0.33)	(0.28)

Above results indicated that predatory wasps had the maximum attraction towards mutton bait (35.29 per cent), whereas, egg bait (0.28 per cent) proved to be least attractive

2. Rotten

Comparative attractancy data on wasps in relation to rotten meat, fish and egg baits revealed the following sequence:

Fish	> Mutton	> Bees	> Pork	> Chicken	> Egg
(37.65)	(25.05)	(24.83)	(2.10)	(0.56)	(0.42)

Above results indicated that among the different baits used, fish bait attracted the maximum number (37.65 per cent) of predatory wasps, whereas, minimum number of wasps were attracted towards rotten egg bait (0.42 per cent).

c. Juices and Extracts

Comparative attractancy of predatory wasps towards juices of brass, pineapple, plum and orange and extracts of candy, gur and whey revealed the following trend:

Bees	> Pineapple	> Orange	> Candy syrup	> Gur	> Plum	> Brass	> Whey
(69.47)	(1.21)	(1.21)	(1.21)	(1.21)	(zero)	(zero)	(zero)

These results showed that among different extracts and juices used, pineapple, orange, candy syrup and gur baits were more attractive than plum, brass and whey baits, however, it was seen that predatory wasps got more attracted towards the adult bees than different juices and extracts used.

Insecticidal Baits

1. Dichlorvos and methyl parathion

The relative attractancy of wasps to fresh mutton treated with varying concentration of dichlorvos showed that predatory wasps were attracted towards dichlorvos baits of 0.1 per cent concentration. Similarly, comparative attractancy of wasps to rotten fish baits mixed with different concentrations of this insecticide revealed that wasps were attracted towards dichlorvos baits of 0.1 per cent concentration. In case of methyl parathion, the relative attractancy of predatory wasps to fresh mutton treated with varying concentrations of this insecticide revealed that wasps were attracted towards methyl parathion baits treated with 0.02 per cent concentration. Similarly rotten fish bait treated with 0.02 per cent concentration of Methyl parathion showed optimum attractancy to predatory wasps.

2. Carbaryl and B.H.C.

Comparative attractancy of wasps to mutton baits treated with different concentration of carbaryl showed that predatory wasps were attracted towards baits treated with 0.01 per cent of carbaryl. Similar concentration of this insecticide with rotten fish showed optimum attractancy for the predatory wasps. In case of B.H.C. the relative attractancy of predatory wasps to fresh mutton and rotten fish bait treated with 0.2 per cent of the insecticide had maximum attractancy. However, at other concentrations of B.H.C. almost negligible number of wasps was trapped.

Based on present studies, it is suggested that following measures can be used for control of predatory wasps in different apiaries of Himachal Pradesh:

1. Killing the wasps in the apiary with the help of light long wooden planks or leather belts
2. Locating the nests of wasps and destroying them either by burning or by using pesticides.
3. Wasp population can also be controlled by reducing the entrance of bee hives, especially in case of giant hornets like *V. mandarina*.
4. Use of queen gates, wire guage gates and removal of alighting boards can also be useful.
5. By trapping the wasps in specially prepared wasp traps.
6. By using the insecticidal baits which will be carried by wasps to their nests to feed the brood and thus resulting in their mortality.

Discussion

Comparative attractancy data on predatory wasps in relation to different fruits baits revealed that fresh and fermented chikku bait attracted the maximum number of wasps (5.82 and 4.99 per cent) followed by pear, apple, grape, guava, banana and orange baits. This may be due to the fact that chikku had maximum sugar contents and carbohydrates as compared to other fruit baits (Free, 1993; Spurr, 1996; Sharma, 1996) [5, 20] which might have helped in attracting the predatory wasps (Spradbery, 1990). After fermentation chikku retains its sweet taste, while other fruit baits turn sour and emanates foul smell. These results are in accordance with the finding of Mishra *et al* (1989) [11], Sharma, (1996) and Dovark and Landolt, (2006) [4] who reported pear baits to be more attractive than plum, mango and peach fruit baits. They also observed *Vespa auraria* catching bees in presence of fruit baits as and when the chance arose. However, *Vespa auraria* caught bees preferentially in the presence of fruit baits, which may be due to their requirement of bees for feeding their larvae (Spradbery, 1990; Spurr, 1995) [19].

Among meat, fish and egg baits, maximum attractancy of predatory wasps was towards fresh mutton baits (35.29 Per cent) as compared to fresh fish (29.43 Per cent), chicken (8.57 Per cent), pork (0.33 Per cent) and egg (0.28 Percent). This may be due to the reason that fresh mutton has better ratio of carbohydrates to proteins as compared to fish, chicken, pork and egg. However, when attratancy was observed with rotten meat, fish and egg baits, rotten fish was more preferred than others. Wasps also preferable fresh mutton to bees. This may be because it is soft and can be cut, fed and digested easily by the larvae of wasps.These results corroborate the earlier findings of Sharma *et al*. (1979) [16] who also found decaying fish bait to be more attractive than predatory wasps in the apiaries (Spradbery, 1991 Landolt & Zhang,2016) [7, 18].

Data on comparative attractancy of predatory wasps towards juices of brass, pineapple, plum and orange and extracts of candy, gur and milk (whey) showed that wasps got more attracted towards the adult bees than different juices and extracts used. This may be because of their requirement of feeding their larvae on proteineous diet. Present results are not in accordance with the findings of Ono *et al*.(1992); Wegner and Jordan (2005)and Libor & Landolt (2006) Devi, *et al*.,(2026) [3, 4, 15, 21] who also observed different species of wasps were traped in Czech Republic and Slovakia with syrup and fermented milk as bait.

Present data on the comparative attractancy of wasps towards fresh mutton and rotten fish baits treated with insecticides baits showed that Dichlorvos poisoned fresh mutton and rotten fish bait was most attractive at 0.01 per cent, while Methly parathion poisoned fresh mutton and rotten fish bait was effective at 0.01 per cent, while B.H.C. poisoned fresh mutton and rotten fish bait showed maximum attractancy at 0.20 per cent. These variations in the effective concentration of four insecticides may probably be due to their differences in LD 50 values. Sharma *et al*. (1979) [16] reported trichlorfom to be more effective than Chlordane and Lindane treated meat baits against predatory hornets at Solan. Wagner and Rierson (1969) [22] found fish flavoured baits poisoned with 1 per cent Mirex bait with 0.5 per cent heptyl Chlordane as an attractant for *Vespula pennsylvanica* in California.

Present results on non-insecticidal and insecticidal baits suggest that meat and fish baits should be preferred for the control of wasps in comparison to fruit baits, extracts and juices in the apiary. This may be because fruit baits ferment in the open air very quickly, thus can not be as attractive as meat and fish baits. Further, honeybees do not feed on meat baits in the apiaries while bees do sit and suck the fruit juices, extracts of gur and candy and juices of flowers. On the other hand insecticidal baits should be used judiciously because they can also cause pesticidal poisoning of honeybees.

Summary

In the present investigations, some methods were tried for the control of predatory wasps attacking *A.mellifera* colonies in Himachal Pradesh. For this, two types of baits were used. First type consisted of 'Non insecticidal baits' made from fruits, meat, fish, egg, juices of fruits and flower and extract of gur, candy and milk (whey). Second type of baits were made by mixing insecticides with some attractants and were named as 'Insecticidal baits'.

Comparative attractancy data revealed that among the different fruit baits (fresh and fermented), predatory wasps had the maximum attraction towards chikku bait as compared to pear, apple, grape, guava, banana and orange bait.

Relative attratancy data on fresh meat, fish and egg baits showed that predatory wasps had maximum attraction towards mutton as compared to fish, chicken and egg baits. Whereas, in case of rotten, fish baits attracted the maximum number of predatory wasps as compared to other baits.

Relative attractancy of juices and extracts showed that among different juices of fruits and other extracts tried, maximum predatory wasps got attracted to pineapple, orange and candy syrup. Moreover, it was seen that more wasps got attracted towards adult bees than different juices and extracts used.

Studies on attractancy of wasps to different insecticidal baits showed that baits with 0.1 percent concentration of Dichlorvos mixed with fresh mutton and rotten fish, 0.02 percent Methyl parathion mixed with fresh mutton and rotten fish, 0.01 percent Carbaryl with fresh mutton and rotten fish and 0.2 percent BHC mixed with these baits attracted the significant number of wasps. However, at other concentrations of these insecticides, only negligible numbers of wasps were trapped. From these studies, it was inferred that insecticidal baits did not prove as effective as non-insecticidal baits for attracting the predatory wasps in experimental apiaries.

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