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Ovipositional behaviour of *Callosobruchus chinensis* (L) in different pulses: A review

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Abstract

Pulse beetle, *Callosobruchus chinensis* is one of the major stored pests of pulses. There were various factors that influence the ovipositional behaviour of *C. chinensis*. The preference of host specificity for oviposition by the female pest is very important to lay maximum number of eggs and also for the survival of a species. Bigger size, smooth surface, deep coat and coloured seeds are the most suitable for oviposition. The combination of temperature and humidity also play important role in ovipositional behaviour of the pest. The numbers of egg deposition vary within the period of oviposition and the maximum eggs laid on the first day of oviposition decreases with the enhancement of period. Plant extracts may alter the ovipositional behaviour and could be one of best practical ability to control the destructive stored pest.

Keywords: *Callosobruchus chinensis,* pulse beetle, ovipositional behaviour and host preference

Introduction

Insects have been causing tremendous losses not only to the crops growing in fields but also to post-harvest commodities during storage. The pulse beetle, *Callosobruchus* species (Coleoptera: Bruchidae), is a major destructive pest of economically important leguminous grains such as cowpeas, lentils, green gram, and black gram, widely distributed around the world. (Talukder and Howse, 1994; Park, *et. al.* 2003; Srinivasan and Durairaj 2008) [57, 38, 53]. Insect oviposition is a complex but critical activity in the life cycle of an insect. Egg-laying behaviour is one of the most important aspects of female behaviour, and has a profound impact on the fitness of a species (Cury, *et.al.* 2019) [15]. Various factors that influence both physiology & subsequent behaviour, that lead to egg deposition by an insect which tries to ensure safety to their progeny. Many females succeed but few may fail in their attempt to start new life. Pre-oviposition incorporates all the behaviours and factors involved in the selection of, or attraction to, an oviposition site and oviposition itself. The adult pulse beetle female lays eggs, which are glued to the seed surface. The larvae bore into the pulse grain, where the entire development takes place and the adults emerge out leaving behind holed grains. The grains, therefore, become unsuitable for human consumption, viability for replanting, or for the production of sprouts (Raja *et. al.* 2001) [40].

Ovipositional behaviour of *Callosobruchus chinensis* (L.)

Ovipositional behaviour comprises one of the final steps in insect reproduction. It involves the deposition of the mature egg outside the body of the female and includes a series of behavioural and physiological events that begin with the movement of the egg through the oviduct and end with the placement of the egg on a substrate that will support the development of the larva. Specialized behaviours and structures on the female allow her to place the eggs within a protected environment during oviposition. Ovipositing females perceive cues on the host surface through a variety of sensory receptors such as gustatory, olfactory, and mechanical receptors located on different parts of the insect body such as antennae, tarsi, proboscis, labial palpi, and ovipositor (Stadler, 1974; Stadler, 1984; Ramaswamy, *et. al.* 1987 and Hansson, 1995) [55, 54, 42, 22]. In contact with various oviposition substrates, females of phytophagous insects perceived with their tactile and gustatory receptors the difference in the texture and chemical composition of the plant-host (Huignard, 1984 and Parr *et. al.* 1996) [23, 39].

Factors influencing ovipositional behaviour of *C. chinensis*

An understanding of the physiological, behavioural, ecological, or evolutionary interactions between these insects and their hosts requires precise representation of the events and factors influencing oviposition (Singer, 1986) [48]. Several investigations have shown that the progeny develops best on host chosen by their mother insect. Visual and mechanical properties can influence the oviposition behaviour, but chemicals of the environment seem in almost all insects to be of paramount importance. Since nutritional and allelochemical compounds determine successful development, it is not surprising that chemoreceptors plays crucial role during oviposition.

Preference for egg deposition

Based on the pulse and cereal seeds

Ovipositional preference and development of *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae) on five different leguminous seeds such as cowpea, white kidney bean, soybean, mung bean and azuki bean was studied both choice and no-choice tests revealed cowpea seed as the most preferred oviposition substrate (Mainali, 2015) [32]. Highest eggs deposition occurred on chickpea and the lowest eggs deposition was found in black gram among the pulse species. The egg deposition on mung bean and lentil were intermediate (Ahmed, *et. al*. 2018) [3]. The findings were in conformity with Singh, (1976) [51] who reported that *C. chinensis* preferred oviposition to chickpea followed by mung bean, lentil, black gram and bean in order of decreasing suitability. Bhaduria and Jakhmola (2006) [7] reported that the ovipositional preference and survival of the pulse beetles on black gram which were less preferred for oviposition. Yunus *et. al.* (2015) [59] observed significant differences among the oviposition rate on five different pulses (kidney beans, black gram, chickpea, Mung beans and cowpea and five different cereals (wheat, maize, pearl millet, barley and oat. The highest preference of oviposition was recorded on kidney beans (147.67±0.58), mung beans (132.00±2), whereas in the case of cereals on maize (13.67±1.53) and wheat (7.67±1.15).

Based on the physical and morphological characters of seeds

The variation of egg deposition on different pulse species associated with the physical and morphological characteristics of the seeds. The shape, colour and size of pulse seeds, curvature, texture and thickness of the seed-coat affected egg-laying (Nwanze *et. al.* 1975). Ahmed, *et al*. (2018) [33, 3] revealed that he seeds of chickpea were large in size having larger surface area which favoured larger egg deposition. Bhattacharya and Banerjee (2012) [8] found that eggs deposited on a garden pea seed were significantly greater than those deposited on a chickpea or a lentil seed. Chakraborty and Mondal (2016) [11] reported that pulse beetle laid maximum number of eggs in larger surface area of seed in kidney bean. This was in conformity with the observation of Teotia and Singh (1968) [58] who found that the fecundity of *C. chinensis* depended upon the size and quality of seeds with seed coat. The fecundity of the weevil increased when smooth and well-filled seeds were provided for oviposition. In general, the bigger the size of the seed, the greater was the number of eggs laid per seed (Seddiqi, 1972). Lema (1994) [46, 31] observed the variety with high rough and wrinkled and thick seed coat prove to be tolerant to choice for egg laying when compared with those having smooth, thin seed coat varieties could be the most preferred for egg laying. *C. chinensis* distributed eggs uniformly on grains of different 70 cowpea lines and oviposited a small number of eggs/grain having rough seed surfaces were less preferred. Brown, black, grey and red coloured seeds were more preferred than white coloured seeds. (Chavan, 1997) [13].

Based on the nutritional characters

Chakraborty and Mondal (2016) [11] investigated that relative preference of *C. chinensis* to different pulses varied widely depending upon their physical and chemical characteristics of seeds. Ovipositional preference was dependent on the seed color, seed texture, seed weight, thickness of seed coat, seed moisture and various chemical parameters. These findings were in accordance with the observation of Schoonhoven (1972) [45] and found the variations in influence on the oviposition of the pulse beetle attributed to the odour emanating from the seed. The varieties with high protein content were most susceptible to pulse beetle (*C. chinensis* L.) than the varieties of low protein content. Ashfaque, *et. al.* (2001) [6] also reported that the varieties with high protein content are highly preferred for oviposition by *C. chinensis* L. while varieties with low protein content are least preferred for oviposition (Kamble, *et. al.* 2016) [24]. Higher egg laying preference and shorter developmental time with longer adult longevity of the beetle on cowpea probably signifies importance of physical as well as chemical attributes of the seed as an oviposition substrate other than evolutionary history of the insect (Mainali, *et. al*. 2015) [32].

Period of oviposition

Bhattacharrya and Banerjee (2012) [8] assessed the factors affecting egg laying behavior and fecundity of *C. chinensis* L infesting stored pulses. They found that mated female deposited more eggs than the unmated ones. A female lay 50-100 eggs on smooth legume pods (Smith 2015) [52]. The pre oviposition and oviposition period of *C. cheninesis* L was lasted for 4 to 14 hours and 6 to 8 days respectively. Pandey and Singh (1997) observed that maximum daily egg laying occurred in the first 24 hours, the number gradually dropped till the last day of oviposition. The fecundity of a single female of *C. chinensis* had been 30 – 110 eggs at the rate of 1 – 35 per day. Prabha and Sehgal (1990) observed that aging has profound effects on fecundity and fertility of *C. chinensis*. Singh and Rina (2000) [49] studied the biology of *C. chinensis* infesting the stored pulses like mung and lobia has proved that maximum egg output was observed on the first day of oviposition.

Plant extracts on ovipositional behaviour

Plant materials has an important role in insect pest control, including ash (Ofuya,1986 and Ajayi, *et.al.*1987) [34, 4], vegetable oils (Schoohoven, 1978 and Kazi, *et. al.* 1999) [44, 25] plant extracts (Chiasson, *et. al*. 2004 and Devanand and Usha 2008) [14, 16] and botanical powders (Abdullahi and Muhammad 2004 and Gupta and Srivastava 2008) [1, 21]. Kazi *et.al.* (2001) [26] worked on effects of neem oil on mating and oviposition behaviour of azuki bean weevil, *Callosobruchus chinensis* and observed fecundity and emergence rate were always lower in oil-treated conditions. Similar findings were also reported by Khaire, *et. al.* (1993) and Pandey, *et al*. (1986). Singal and Chauhan (1997) [27, 36, 47] tested the effect of neem seed oil and neem seed kernel powder individually prevented egglaying for up to 8 months of storage and a negligible adult population developed after this period. Subramanya, *et. al.* (1994) [56] reported that the extracts of *Eucalyptus citrodora* gave a better reduction in the number of eggs oviposited and emerging adults. Rani, *et. al.* (2000) [43] carried out a research using different vegetable oils such as cottonseed, neem, palm, rice, bean and soybean oils as surface protectants against *C.chinensis* on chickpea grains and reported the lowest fecundity. Singh (2003) [50] checked the effect of some oils against *C.chinensis* infesting pigeonpea. Edible oils of coconut, mustard, sunflower, sesame and mahua and non-edible oils like neem, karanj, castor, tarpin and noorani as well as hair oil of arnica, himtaj, amla, banthol and navratan were used as surface protectants against *C.chinensis* at 8 ml/Kg. seeds. All the oils proved highly effective in protecting the seed upto 9 months storage in terms of seed damage and weight loss. Rajak and Pandey (1964) [41] reported the oils prevented egg laying and controlled the population buildup of the beetle. The oils of taramira, coconut, sunflower, safflower and castor were found more effective in reducing the egg laying at 1 ml and 3 Page 16 ml/Kg. seed as compared to other oils. Bushra and Devi 2020 [10] studied on effect of edible oils on different stages of pulse beetle (*Callosobruchus chinensis* L.) on chickpea grains. Among the five edible oils *viz*. olive oil (*Olea europaea* L), coconut oil (*Cocos nucifera* L.), groundnut oil (*Arachis hypogaea* L.), mustard oil (*Brassica* spp L.) and sesame oil (*Sesamum indicum* L.), coconut oil at 9 ml kg^{-1} grains was found to be most effective in inhibiting the oviposition (26.43 eggs). Akter, *et.al.* (2019) [5] informed soybean oil was the best to decrease the rate of oviposition than the black seed oil and sesame oil.

Effect of temperature on ovipositional behaviour

Temperature plays a major role in growth and development of insects. The optimal temperature for egg laying and development of stored product insects was between 25 °C and 35 °C while temperature between 13 °C and 25 °C made the development of insects (metabolic activity) slower. Most of the stored product insects stopped their development at 20°C (Ghosh and Durbey 2003). Khalil and Ali 1999, Bursell, 1974; Kim and Choi, 1987, Graeme and Zalucki, 1991, and Ahmad, *et. al.* 1993) [19, 28, 9, 29, 20, 2] observed that fecundity and longevity were found to be significantly less at higher temp. Flinn and Hagstrum (1990) and Evans, 1983) [18, 17] revealed that fecundity was reduced and development of insect was slow at low temperature between 20 ° C to 10 °C. Temperature selection might be affected by humidity or state of hydration of the insects (Chapman, 1965) [12], they might together affect fecundity and longevity markedly Lale and Vidal (2003) [30] evaluated four temperatures (25 °C, 30 °C, 35 °C and 40 °C) and three humid levels (30%, 60% and 90% R.H) for their effect on oviposition and development of stored beetles in pure and mixed populations on groundnut, where temperature influenced oviposition significantly more than humidity. Omar and Mahmoud (2020) [35] found egg-laying was optimal at temperature range of 30-35 °C. The study showed the temperature had significant effect on the pre-oviposition, oviposition and post-oviposition periods.

Conclusion

The pulse beetle, *Collosobruchus chinensis* L. has a great tendency to deposit maximum number of eggs in the seeds having larger surface area, smooth and deep coat. The number of laid eggs varied according to the surface area and chemical composition of seed where they feed and also has significant influencing the egg deposition and damage of seed. The plant extracts are safe, cheap, residue free and eco- friendly materials that can inhibit the egg deposition and fit into the IPM package of stored grain pests. The current research paves the way to provide awareness to the farmers not to store seeds in the same place or at the same time to avoid cross infestation because of their high susceptibility to *C. chinensis.*

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