

Effect of hot and cold treatments for the management of Pulse beetle *Callosobruchus maculatus* (Fab) in pulses

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Abstract: The pulse beetle *C. maculatus* (Fab.) is a major pest of economically important leguminous grains, such as cow peas, lentils, green gram, and black gram. Effect of sun drying on oviposition of pulse beetle, *C. maculatus* showed 100 per cent egg mortality during the second, third and fourth months. It was observed that there is no significant difference among the exposure periods. Effect of sun drying on adult emergence of pulse beetle, *C. maculatus*, indicated that 100 per cent adult mortality was recorded during the second, third and fourth months and significant difference was not observed among the exposure periods. Effect of cold treatment on oviposition of the pulse beetle, *C. maculatus* recorded with 100 per cent mortality and no significant difference was noticed among the exposure periods in which was observed. Effect of cold treatment on adult emergence of the pulse beetle, *C. maculatus* revealed 100 per cent adult mortality was observed in all the exposure period during the second, third and fourth months.

Key words: Adult beetles, Bruchids, Black Gram, Cold treatment, Oviposition, Sun drying

I. Introduction

Pulses, also called grain legumes, which are extensively grown in tropical regions of the world for centuries as a major protein rich crop bringing considerable improvement in human diet [1]. India is one of the major pulse growing countries in the world with a total area of 23.31 million hectares and a total production of 14.50 million tonnes [2]. Among the different pulses, black gram is a rich source of protein which is one of the essential nutrients of human diet. Black gram (*Vigna mungo* L.) contributes 10 per cent to the national pulse production from an area of 13 per cent. This crop is grown in 3 million hectares area producing 1.37 million tonnes of grains. It is grown in part of Asia and South Africa. In India it is mostly cultivated in Madhya Pradesh, Maharashtra, Andhra Pradesh, Uttar Pradesh, Karnataka, Tamil Nadu and West Bengal.

Pulses are rich sources of protein as they contain about 20-30 per cent protein, which is almost three times higher than that found in cereals but these are more difficult to store than cereals as they suffer great damage during storage due to insect-pests and microorganisms [3]. Insect pests have been a threat to food and seed since man has started growing crops. Almost all stored food stuffs and seeds are liable to insect injury [4]. Among the insect-pests, bruchids are well known to inflict post-harvest loss to stored legumes, primarily through consumption of the resource, and secondarily through the qualitative deterioration of the commodity or reduced seed stock viability [5]. They are the important pests of pulse crops in Asia and Africa under storage conditions [6,7,8].

The pulse beetle *C. maculatus* is a major pest of economically important leguminous grains, such as cow pea, lentil, green gram, and black gram [9,10,11]. During storage, black gram is damaged to a great extent by pulse beetle, *C. maculatus*. The pest being an internal feeder lays eggs on the seed surface in the field as well as during threshing which hatch during storage. As and when the congenial conditions become available and the insect multiplies. The infested seeds are unfit for planting or for human consumption [12].

In order to preserve the seed material several measures have been employed from time to time. To manage this storage pest, different strategies are tried by the scientists. But still it continued to be a threatening pest in storage. The use of pesticides has been employed by the farmers. Though these pesticides have positive effect on the pests, they continued to remain hazardous to man and the environment. With the objective of providing quality food for general public the interest of this research has been directed towards finding alternative to pesticide that are environmentally friendly and does not pose dangers to man.

II. Materials And Methods

2.1 Effect of sun drying on pulse beetle, *Callosobruchus maculatus* (Fab.)

The experiment was set up to study the management of pulse beetle through solar energy in stored black gram seeds. Six treatments were maintained and the experiment was replicated thrice. Ten pairs of newly

emerged adults were released in each replication and allowed the adults to lay eggs for 3 days after which the adults were removed from all the treatments. All the treatments were exposed to sun light, bimonthly at the maximum of 4h/day from 8 AM to 12 PM, i.e. 4h (1st day), 8h (1st and 2nd day), 12h (1st, 2nd and 3rd day), 16h (1st, 2nd, 3rd, and 4th day), 20h (1st, 2nd, 3rd, 4th and 5th day) and 24h (1st, 2nd, 3rd, 4th, 5th and 6th day). Similarly all the treatments were exposed to refrigerated condition (4 °C) bimonthly for 4, 8, 12, 16, 20 and 24h. The number of eggs and adult insect were recorded every month and the observations were continued till four months.

2.2 Effect of cold treatment on pulse beetle, *Callosobruchus maculatus* (Fab.)

One hundred grams of disinfested seeds were taken in plastic container and ten pairs of newly emerged uniform aged adults were released for egg laying. Adults were removed after 3 days of egg laying and number of eggs were counted. Seeds with three day aged eggs were kept in plastic containers and each treatment was replicated thrice and was exposed to cold temperature regimes for different exposure periods (4, 8, 12, 16, 20 and 24h) and a control was maintained at room temperature. Later the seeds along with eggs were taken out and kept at ambient condition (27±2 °C) for adult emergence. Observations were made on the adult emergence after twenty five days of egg laying. The effect of various exposure periods of cold treatments on larvae of pulse beetle was studied following the same procedure as outlined above, except that the stage of exposure of insects to cold treatments was larval stage (6 days after egg laying). Observations were made on the adult emergence after twenty five days of oviposition.

III. Results And Discussion

3.1 Effect of sun drying on oviposition of the pulse beetle, *Callosobruchus maculatus* (Fab.)

The data pertaining to the effect of sun drying on oviposition of pulse beetle, *C. maculatus* is given in TABLE 1. After one month of exposure to sun for different periods, the number of eggs laid per seed ranged from 0.02 to 0.65. Highest number of eggs laid per seed was observed in seeds exposed to 4h (0.65) duration. Lowest number of eggs per seed was recorded in seeds exposed to 24h (0.02) followed by 20h (0.06) and 16h (0.08) duration. After second, third, and fourth month of exposure 100 per cent of egg mortality of *C. maculatus* was observed in black gram seeds. Observations recorded on the effect of sun drying on adult emergence of pulse beetle, *C. maculatus* is given in TABLE 2. After one month of exposure to sun for different periods, the number of adult emergence ranged from 2.00 to 10.66. Maximum number of adults were recorded in seeds exposed to 4h (10.66) duration. Minimum number of adults were noticed in seeds exposed to 24h (2.00) duration which was at par with 20h, 16h and 12h followed by 8h (5.00). During second, third and fourth months of observation 100 per cent adult mortality was recorded. In the present study 100 per cent egg mortality of *C. maculatus* was observed in black gram seeds exposed to sun drying for different hours. There is no significant difference among the exposure periods. This in conformity with the findings of [13] reported that 100 per cent egg mortality of *C. maculatus* when exposed to sunlight for 2h in *Vigna subterranean* (L.). [14] summarised that the infestation of *C. chinensis* during egg stage can be eliminated by exposing the infested seeds to solar radiation for 8h. This could be due to the fact that eggs are deposited on the surface of the seed comes in direct contact with solar radiation. [15] registered the effect of sun light on the population build-up of *Bruchidius atrolineatus* (Pic.) and *Callosobruchus maculatus* (Fab.) This is in conformity with present investigation. [16] studied exposure temperature and time to attain 100% mortality of insects (*Callosobruchus chinensis* L.) and eggs in green gram. Time-mortality response of red flour beetle eggs, young larvae, old larvae, pupae and adult stages increased with increase in temperature and exposure time [1]. More specifically, eggs and young larvae are most susceptible at high temperature than old larvae. [18] reported that exposure of *C. maculatus* adults to solar heat at a temperature of 50°C for 2, 4, 6 h. decreased the oviposition, retarded egg development and 100 per cent adult mortality in *Vigna subterranean*. In the present study 100 per cent adult mortality was observed in black gram seeds when exposed to different exposure periods to sun light. These findings are in line with [19] who reported that sun drying of cow pea seeds at bimonthly intervals for 2 days consequently protected the seeds from bruchids attack up to 14 months while the untreated as well as fumigated cowpea seeds were completely destroyed by bruchids after a period of 10th and 12th month respectively. [20] reported that sun drying of seeds for 22 h destroyed the four stages of both *C. maculatus* and *C. chinensis*. [15] reported that with increasing the exposition time to sun light the number of bruchid adults decreased drastically. All the above findings are in agreement with the present investigation. It is evident from the present study that sun drying provided adequate protection of black gram seeds against infestation by *C. maculatus*. It offers a great prospect for successful protection of grain legumes against attack by bruchids for small and medium storage and does not require any extra financial investment.

3.2 Effect of cold treatment on oviposition of the pulse beetle, *Callosobruchus maculatus* (Fab.)

The data related to effect of cold treatment on oviposition of the pulse beetle, *C. maculatus* is given in TABLE 3. After one month of exposure the number of eggs laid per seed ranged from 0.02 to 0.51. Maximum

number of eggs per seed was observed in seeds exposed to 4h (0.51) duration. Minimum number of eggs laid per seed was recorded in seeds exposed to 24h (0.02) which was at par with 20h (0.08). Significant difference was not noticed during the different exposure periods in which 100 per cent mortality was observed in second, third and fourth months of observation. The mean adult emergence after an interval of one, two and three and four months of initial exposure is given in TABLE 4. After one month of exposure the number of adult emergence ranged from 2.66 to 11.33. Highest number of adults was recorded in seeds exposed to 4h (11.33) duration followed by both 8h and 12h (10.00) duration. Lowest number of eggs were noticed in seeds exposed to 24h (2.66) which was at par with 20h (5.33) duration. During subsequent observations, 100 per cent adult mortality was recorded. In the present investigation seeds exposed to 4°C for different exposure periods resulted in 100 per cent mortality. This is in conformity with the reports of earlier workers [21,22,23]. The present findings are also in line with [24] who reported that low temperature reduced insect development and killed large number of immature stages of stored grain insects. The insects became inactive and eventually dead at a temperature below 12 °C. [25] revealed that more than 99 per cent of the *C. maculatus* adults were died when pea seeds were exposed to -18°C for 6h. Similar trend was noticed in the present findings where 100 per cent adult mortality of *C. maculatus* was recorded in all the exposure periods from second month onwards.

TABLE 1. Effect of different exposure periods to sun drying on oviposition of the pulse beetle, *C. maculatus* (Fab.)

Exposure Period (4h/day)	Number of eggs (Mean of three replications)				Over all mean
	1 st Month	2 nd Month	3 rd Month	4 th Month	
4h (One day)	0.65 (0.83) ^c	0.00	0.00	0.00	0.162
8h (Two days)	0.14 (0.43) ^b	0.00	0.00	0.00	0.035
12h (Three days)	0.12 (0.41) ^b	0.00	0.00	0.00	0.03
16h (Four days)	0.08 (0.35) ^{ab}	0.00	0.00	0.00	0.02
20h (Five days)	0.06 (0.33) ^{ab}	0.00	0.00	0.00	0.015
24h (Six days)	0.02 (0.27) ^a	0.00	0.00	0.00	0.005
Over all mean	0.18	-	-	-	-
CD	0.10**	-	-	-	-
CV (%)	1.30	-	-	-	-

Values in parentheses are square root transformed values

In a column mean followed by a common letter are not significantly different by DMRT (P=0.05).

** - Significant at 1% level

TABLE 2. Effect of different exposure periods to sun drying on adult emergence of pulse beetle, *C. maculatus* (Fab.)

Exposure Period (4h/day)	Number of adults/100g seed (Mean of three replications)				Over all mean
	1 st Month	2 nd Month	3 rd Month	4 th Month	
4h (One day)	10.66 (3.26) ^c	0.00	0.00	0.00	2.66
8h (Two days)	5.00 (2.23) ^b	0.00	0.00	0.00	1.25
12h (Three days)	2.33 (1.48) ^a	0.00	0.00	0.00	0.58
16h (Four days)	2.33 (1.48) ^a	0.00	0.00	0.00	0.58
20h (Five days)	2.33 (1.48) ^a	0.00	0.00	0.00	0.58
24h (Six days)	2.00	0.00	0.00	0.00	0.50

	(1.40) ^a				
Over all mean	4.11	-	-	-	-
CD	0.63**	-	-	-	-
CV (%)	5.30	-	-	-	-

Values in parentheses are square root transformed values

In a column mean followed by a common letter are not significantly different by DMRT (P=0.05).

** - Significant at 1% level

TABLE 3. Effect of cold treatment on oviposition of the pulse beetle, *C. maculatus* (Fab.)

Exposure Period (4 ⁰ C)	Number of eggs (Mean of three replications)				Over all mean
	1 st Month	2 nd Month	3 rd Month	4 th Month	
4h	0.51 (0.74) ^c	0.00	0.00	0.00	0.12
8h	0.17 (0.46) ^b	0.00	0.00	0.00	0.04
12h	0.16 (0.46) ^b	0.00	0.00	0.00	0.04
16h	0.14 (0.43) ^b	0.00	0.00	0.00	0.03
20h	0.08 (0.36) ^{ab}	0.00	0.00	0.00	0.02
24h	0.02 (0.26) ^a	0.00	0.00	0.00	0.005
Over all mean	0.18	-	-	-	-
CD	0.10**	-	-	-	-
CV (%)	7.27	-	-	-	-

Values in parentheses are square root transformed values

In a column mean followed by a common letter are not significantly different by DMRT (P=0.05).

** - Significant at 1% level

TABLE 4. Effect of cold treatment on adult emergence of pulse beetle, *C. maculatus* (Fab.)

Exposure period (4 ⁰ C)	Number of adults/100g seed (Mean of three replications)				Over all mean
	1 st Month	2 nd Month	3 rd Month	4 th Month	
4h	11.33 (3.36) ^d	0.00	0.00	0.00	2.82
8h	10.00 (3.16) ^{cd}	0.00	0.00	0.00	2.50
12h	10.00 (3.16) ^{cd}	0.00	0.00	0.00	2.50
16h	6.66 (2.55) ^{bc}	0.00	0.00	0.00	1.66
20h	5.33 (2.25) ^{ab}	0.00	0.00	0.00	1.33
24h	2.66 (1.59) ^a	0.00	0.00	0.00	0.66
Over all mean	7.66	-	-	-	-
CD	0.74**	-	-	-	-
CV (%)	4.37	-	-	-	-

Values in parentheses are square root transformed values

In a column mean followed by a common letter are not significantly different by DMRT (P=0.05).

** - Significant at 1% level

IV. Conclusion

Bruchids *Callosobruchus maculatus* (Fab) are the most common and widespread insect pests during storage in pulses. Pods should be harvested as soon as they mature and the seeds are sun dried or stored in refrigerated conditions in an air tight beetle-proof containers. This way of physical control will ensure that the quality of the grain entering the storage facility does not deteriorate over time. These measures are eco friendly, environmentally safe and cost effective too.

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