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# Integrated Management of Pulse Beetle, *Callosobruchus chinensis* L. (Coleoptera: Chrysomelidae) on Stored Pigeonpea Seeds

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**ABSTRACT: The experiment conducted on management of pulse beetle, *Callosobruchus chinensis* Linn. (Coleoptera: Chrysomelidae) during 2020 to 2021. Pulse beetle is a major constraint in production which inflicts severe losses both in the field and storage. The study revealed that the pigeonpea plants sprayed with emamectinbenzoate 5 SG @0.3g / l at the time of pod maturity has recorded the minimum seed damage of 0.25% at 8 weeks after storage of pigeonpea seeds. The seeds exposed for sun light in clear polythene bags for 4 hours for 6 days registered least seed damage of 10.66%. In storage pigeonpea seeds treated with insecticide spinetoram 11.7% SC @ 6.50 ml/kg seeds azadirachtin 10,000ppm @ 6.50 ml/kg seed and deltamethrin 2.8EC @ 0.04 ml/kg seed were effective in suppressing the bruchid, *C.chinensis*. Whereas, maximum seed damage of 21.33 per cent and minimum seed quality parameters were observed in untreated control. The beetle population can be suppressed by adopting integrated pest management approaches.**

**Keywords:** *Callosobruchus chinensis*, *Cajanus cajan*, Azadirachtin, Solarization, Insecticides.

## INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) is an second most important pulse crop in India. It is the main source of protein for vegetarians. Pigeonpea pods are longer and contain 4 to 5 seeds, which are important source of energy as they are rich in several essential amino acids, minerals, vitamins and protein. In India, pigeonpea is grown in an area of about 4.42 million hectares with a production of 3.57 million tons and productivity of around 760.33 kg per hectare (Anonymous, 2019). Pigeonpea is stored in the form of seed and these seeds are prone to several insect pests during storage. The bruchids have been observed as most important insect pest in pigeonpea seeds during storage (Sharma *et al.,* 2010).

The pulse beetle *C. chinensis* damage the seed up to 30 per cent in a short period of time (Keita *et al.,* 2000). Therefore, it is necessary to minimize the losses caused by this bruchid under storage. In recent years, the pigeonpea seeds storage insect pests are managed by the insecticides, but it lead to development of resistance in bruchids and causes environmental hazards. With these background a study was under take to develop integrated management strategies against *C. chinensis* infesting pieonpea seeds.

## MATERIAL AND METHODS

The field and laboratory investigations were conducted at the National Seed Project, University of Agricultural Sciences, Bangalore (12°58′N and 77°35′E, 930 m AMSL) during 2020 to 2021. Pigeonpea crop variety BRG-5 was sown in a Randomized Block Design with 3 replications and 5 treatments.

**Pre-harvest spraying against *C. chinensis*:** Treatments comprising of neem formulations and insecticide were imposed at the time of pod maturity. After threshing, one kg each of seeds from each treatment was kept in gunny bagllets of two kg capacity. Observations were recorded on per cent seed damage by *C. chinensis* at 7 days interval up to 2 months.

**Effect of solarization of pigeonpea seeds against *C. chinensis*:** One kg of freshly harvested certified pigeonpea seed with high percentage of germination and low moisture content (<10%) was taken in 2kg capacity of clear polythene bags of 700 gauge and were inoculated with bruchids (5 pair/kg seed) and kept under ambient condition in the room for 2 weeks. The adult insects were removed from the seed lots before transferring them into the polythene packets. Solarization was done for 4 hours each day for 2, 4 and 6 successive days from 10 AM to 2 PM for both fresh and inoculated seeds. The observations were recorded on per cent seed damage, live and dead adults of bruchids, per cent seed germination, per cent seed moisture content and seed viability at monthly interval upto six months of storage.

**Effect of neem formulation and insecticides on pigeonpea seed against *C. chinensis*:** One kg of freshly harvested and untreated pigeon pea seed with high percentage of germination and low moisture content of (<10%) was taken for each treatment. The seeds were treated different dosages of azadirachtin 10000 ppm and insecticides. Treated seeds were shade dried, packed in gunny bagllets and kept stored under ambient conditions. An untreated control was maintained without any seed protectants. Observations were recorded on per cent seed damage, number of adult live and dead bruchids, seed germination (%) and seed moisture content (%).

Data were subjected to suitable transformation before subjecting to statistical analysis and the data analyzed through one way ANOVA technique by using Statistical web tool (WASP-Web Agri Stat Package 2.0). The means of significant parameters were compared by using Duncan's Multiple Range Test (DMRT) post hoc test.

## RESULTS AND DISCUSSION

**Pre-harvest spraying against *C. chinensis*:** In pre-harvest spraying of azadirachtin 10,000 ppm and insecticide against pulse beetlehe pigeonpea seed damage varied from 0.00 to 17.66 per cent at eighth week after storage. The maximum pigeonpea seed damage of (17.66 %) was recorded in untreated control at eight weeks after storage (Table 1). Minimum seed damage of (0.25 %) was recorded in emamectin benzoate 5 SG @ 0.3 g/l at eighth weeks after storage. These results are in confirmation with the observations of Dhobi and Borad (2019) they have observed the effectiveness of emamectin benzoate 5 SG against *C. chinenesis* in greengram seeds. Ashok *et al.* (2020) reported the similar observations in case of chickpea seeds.

**Effect of solarization of pigeonpea seeds against *C. chinensis*:** Effect of solarization of pigeonpea seeds against *C. chinensis* revealed that the pigeonpea seed damage was varied from 1.50 to 32.91 per cent at six month after storage. Maximum seed damage of (32.91 %) was recorded in untreated control (inoculated seed) at six months after treatment (Table 2). Least pigeonpea seed damage of (1.50 %) was observed in fresh pigeonpea seeds solarized in clear polyethylene (700 gauge) packet for 4 h for 6 days at six month after treatment. Minimum number of live adults of *C. chinensis* (4.33) were recorded in fresh pigeonpea seeds solarized in clear polyethylene packets of 700 gauge for 4 h for 6 days. Whereas, the maximum number of live adult of *C. chinensis* (50.33) was recorded in untreated control (inoculated seeds).

Minimum number of dead *C. chinensis* adults of (10.66) were recorded in fresh pigeonpea seeds solarized in clear polyethylene packet of 700 gauge for 4 h for 6 days. Whereas, the maximum number of dead *C. chinensis* adults of (58.33) were recorded in untreated control (inoculated seeds).

The initial germination of pigeonpea seeds was 93.00 per cent. However, pigeonpea seed germination at six months after treatment varied from 55.00 to 86.33 per cent. Maximum seed germination of (86.33 %) was recorded in fresh pigeonpea seeds solarized for 4 h for 6 days in clear polyethylene packet of 700 gauge and the significantly least germination of (55.00 %) was recorded in untreated control (inoculated seeds) at six month after treatment (Table 2).

The seeds infested by *C. chinensis* decreased the seed viability by damaging the seed embryo and consumption of seed reserve. The least seed moisture content of (9.10 %) was recorded in fresh pigeonpea seeds solarised for 4 h for 6 days in clear polyethylene packet of 700 gauge. Maximum seed moisture content of (13.66 %) was registered in untreated control (inoculated seeds) at six month after storage (Table 2). Gradual increase in the seed moisture content was observed in pigeonpea seeds stored from one month to six months in ambient condition, present findings are in conformity with the observations of Lale and Vidal (2003).

The seeds exposed for solarization was, significantly inhibited the egg laying, embryonic development and postembryonic development of *C. maculates* which resulted in inhibition of emergence of off springs. Moumouni *et al.* (2014) observed similar effect in pigeonpea seeds and observations made by Tabu *et al.* (2012); Ashok *et al.* (2020) in chickpea seeds supported the present findings. Moumouni *et al.* (2014) opined that, pigeonpea seeds exposed for sun radiations significantly inhibits the development of *C. maculatus*. Pigeonpea seeds exposed for solarization were effective in desiccating the eggs of *C. chinensis* and protected the pigeonpea seeds from bruchid damage (Chauhan and Ghaffar 2002).

**Table 1: Effect of pre-harvest spraying against *C. chinensis* during storage.**

| Treatment | Seed damage (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **1 WAS** | **2 WAS** | **3 WAS** | **4 WAS** | **5 WAS** | **6 WAS** | **7 WAS** | **8 WAS** |
| Emamectin benzoate 5SG @ 0.3g / l | 0.00 (0.14) | 0.00 ( 0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.25 (2.86) | 0.25 (2.86) |
| Azadirachtin 10,000 ppm @ 2 ml/ l | 0.00 (0.14) | 0.33 (3.26) | 0.25 (2.86) | 0.25 (2.86) | 0.25 (2.86) | 0.25 (2.86) | 0.50 (4.05) | 2.50 (9.07) |
| Azadirachtin 10,000 ppm @ 4 ml/ l | 0.00 (0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.25 (2.86) | 0.25 (2.86) | 0.33 (3.26) | 0.33 (3.26) |
| Azadirachtin 10,000 ppm @ 6 ml/ l | 0.00 (0.14) | 0.00 ( 0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.00 (0.14) | 0.25 (2.86) | 0.25 (2.86) |
| Untreated control | 1.33 (6.62) | 1.75 (7.60) | 4.66 (12.45) | 8.33 (16.76) | 13.00 (21.11) | 13.66 (21.68) | 17.33 (24.59) | 17.66 (24.84) |
| SEm ± | NS | 0.30 | 0.12 | 0.11 | 0.11 | 0.10 | 0.09 | 0.27 |
| CD at (P=0.05) | | 0.55 | 0.23 | 0.21 | 0.20 | 0.19 | 0.17 | 0.87 |
| CV (%) | | 13.50 | 5.53 | 4.61 | 3.52 | 3.29 | 2.00 | 5.52 |

Values given in parentheses are arc sine transformed values; NS: Non significant; WAS: Weeks After Storage

**Table 2: Effect of solarization on bruchids and seed quality on pigeonpea seeds.**

| Solarization period | Seed damage (%) | Bruchids | | Germination (%) | | | Seed moisture (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Live adult | Adult dead | Initial | 6 MAT | % reduction over initial | Initial | 6 MAT | % increase over initial |
| **Fresh seeds** | | | | | | | | | |
| 4 hrs for 2 days | 18.67 (25.60) | 13.33 (3.78) | 17.66 (4.32) | 93.00 | 61.33 (51.53) | 34.05 | 8.25 | 11.66 (20.00) | 41.41 |
| 4 hrs for 4 days | 14.67 (22.52) | 10.33 (3.69) | 14.66 (3.95) | 93.00 | 81.33 (64.37) | 12.54 | 8.25 | 10.33 (18.80) | 25.50 |
| 4 hrs for 6 days | 1.50 (6.88) | 4.33 (2.30) | 10.66 (3.41) | 93.00 | 86.33 (68.27) | 7.17 | 8.25 | 9.10 (17.55) | 10.30 |
| **Inoculated seeds** | | | | | | | | | |
| 4 hrs for 2 days | 22.67 (28.43) | 22.33 (4.83) | 21.00 (4.69) | 93.00 | 60.67 (51.13) | 34.77 | 8.25 | 12.33 (20.54) | 50.00 |
| 4 hrs for 4 days | 21.33 (27.51) | 11.33 (4.04) | 22.66 (4.86) | 93.00 | 69.33 (56.35) | 24.45 | 8.25 | 11.66 (20.00) | 41.41 |
| 4 hrs for 6 days | 1.75 (7.58) | 6.33 (2.70) | 14.33 (3.91) | 93.00 | 84.67 (66.92) | 8.96 | 8.25 | 9.40 (17.84) | 14.00 |
| Untreated (Fresh seed) | 26.67 (31.09) | 22.66 (5.00) | 43.66 (6.68) | 93.00 | 57.67 (49.40) | 38.00 | 8.25 | 12.66 (20.83) | 53.54 |
| Untreated (Inoculated seed) | 32.91 (40.41) | 50.33 (7.16) | 58.33 (7.70) | 93.00 | 55.00 (47.85) | 40.86 | 8.25 | 13.66 (21.70) | 65.66 |
| SEm± | 0.20 | 0.01 | 0.03 | - | 0.43 | - | - | 0.31 | - |
| CD at (P=0.05) | 0.34 | 0.91 | 0.56 | - | 1.30 | - | - | 0.94 | - |
| CV(%) | 3.09 | 2.6 | 1.22 | - | 1.31 | - | - | 2.75 | - |

Values given in parentheses are Arc sine transferred values for column I and square root transferred for II and III column; MAT-Months after treatment.

The change in seed moisture content indicated faster seed deterioration in the untreated control than the solarised seeds at different intervals Patro *et al.* (2007); Narayanaswamy *et al.* (2014), they observed the similar trend in per cent moisture content of solarised seed and untreated pulse seeds.

**Effect of neem formulation and insecticides on pigeonpea seed against *C. chinensis*.** Results revealed that the least pigeonpea seed damage of (0.67 %) was recorded in emamectin benzoate 5 SG @ 40 mg /kg of pigeonpea seeds at the end of six month after storage. Maximum pigeonpea seed damage of (21.33 %) was recorded in untreated control. Deltamethrin @ 0.04 ml/kg, spinetoram11.7 SC @ 6.50 ml /kg, azadirachtin 10,000 ppm @ 6.50 ml/kg of pigeonpea seeds were recorded 1.41, 1.16, 6.00 and 1.41 per cent damage, respectively (Table 3).

Least number live adult (1.00) *C. chinensis* /400 seeds was recorded in spinetoram @ 8.50 ml/kg and emamectin benzoate 5 SG @ 40 mg/kg treated pigeonpea seeds followed by azadirachtin 10,000 ppm @ 6.50 ml/kg and deltamethrin @ 0.04 ml/kg treated pigeonpea seeds. Maximum number of live adult of *C. chinensis* (24.33) was recorded in untreated control at six month after seed treatment (Table 3).

The number of dead *C. chinensis*/400 seeds varied from 2.33 to 47.66 at six month after storage. Maximum number of dead *C. chinensis* adult of (47.66) was recorded in spinetoram @ 8.5 ml/kg. Whereas, the minimum number of dead *C. chinensis* adult of (2.33) was recorded in untreated control. Reduction of *C. chinensis* number in azadirachtin 6.50 ml/kg treated pigeonpea seeds was due to antifeeding property and its ability to reduce fecundity (Table 3).

Maximum seed germination (92.66 %) was recorded in azadirachtin (neemazal®) @ 6.50 ml/kg seeds. It was significantly higher than untreated pigeonpea seeds (64.33 %). The drastic decrease in pigeonpea seed germination at six month after treatment was due to the pigeonpea seed damaged by *C. chinensis* (Table 3).

Azadirachtin 10,000 ppm @ 6.5 ml/kg recorded least seed moisture content of 8.90 per cent followed by (8.95 %) in deltamethrin @ 0.04 ml /kg, spinetoram @ 8.5 ml/kg and emamectin benzoate 5 SG @ 40 mg /kg treated pigeonpea seeds. Pigeonpea seeds damaged by *C. chinensis* acquired high moisture. This was due to the damaged pigeonpea seeds were broken and absorbed more moisture. Untreated pigeonpea seeds recorded maximum damage of 21.33 per cent by *C. chinensis* and high seed moisture content (Table 3).

The pre-harvest spraying of emamectin benzoate 5 SG @ 0.3 g/l and azadirachtin 10,000 ppm @ 6.00 ml/l were effective over control and recorded least pigeonpea seed damage of (0.25 %). The solarization of fresh pigeonpea seeds in clear polyethylene packet of 700 gauge for 4 h for 6 days was effective by recording higher pigeonpea seed germination of (86.33%), lower seed moisture content of (9.10 %), lower seed damage of (1.50%) and less number of live adult (4.33), respectively, as compared to other treatments.

The pigeonpea seeds treated with azadirachtin 10000 ppm @ 6.50 ml/kg, spinetoram @ 8.5 ml/kg and emamectin benzoate @ 40 mg/kg were recorded high pigeonpea seed germination percentage of (92.66, 92.00 and 92.00, respectively), lower seed moisture content of (8.90,8.95 and 8.94, respectively), least per cent seed damage of (1.41,1.16 and 0.67, respectively), less number of live adult (2.10, 1.00 and 1.00, respectively). The present observations on the effectiveness of azadirachtin 10000 ppm are similar to the findings of Gupta *et al.* (2015) they recorded the least developmental period of *C. maculates* in neem leaf powder treated seeds.

The effectiveness of molecules against tested against *C. chinensis* are in concurrent with the reports of Tabu *et al.* (2012); Khaire *et al.* (1993); Ashok *et al.* (2020) they observed similar effect of these molecules against *C. chinensis* on chickpea seeds. Zafar *et al.* (2018) they reported similar effect on *C. chinensis* in green gram seeds. Emamectinbenzoate 5 SG treated pigeonpea seeds recorded minimum number of live adult and dead adults of *C. chinensis*, at six month after treatment indicated the effectiveness of molecule on population buildup of *C. chinensis.* This is in confirmation with the reports of Kumari *et al.* (2014) and Sharma *et al.* (2016). The effect of azadirachtin 10,000 ppm @ 6.50 ml against *C. chinensis* on pigeonpea seeds are in agreement with the reports of Mishra (2015) in blackgram seeds and greengram seeds.

**Table 3: Effect of seed treatments on seed damage, bruchid adults and seed quality on pigeonpea seeds.**

| Treatments with dosage | Seed damage (%) | Bruchids | | Germination (%) | | | Seed moisture (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Live adult | Adult dead | Initial | 6 MAT | % reduction over initial | Initial | 6 MAT | % increase over initial |
| Azadirachtin10,000 ppm @ 1.50 ml | 12.33 (20.54) | 13.33 (3.78) | 4.66 (2.37) | 93.00 | 79.33 (62.94) | 14.70 | 8.25 | 12.5 | 51.52 |
| Azadirachtin 10,000 ppm @ 2.50 ml | 12.00 (20.24) | 10.00 (3.32) | 7.66 (2.94) | 93.00 | 78.66 (62.46) | 15.41 | 8.25 | 12.67 | 53.54 |
| Azadirachtin 10,000 ppm) @ 3.50 ml | 6.00 (14.14) | 8.00 (3.00) | 15.00 (4.00) | 93.00 | 81.33 (64.38) | 12.54 | 8.25 | 10.75 | 30.30 |
| Azadirachtin 10,000 ppm) @ 4.50 ml | 4.33 (11.99) | 4.50 (2.24) | 11.66 (3.55) | 93.00 | 91.33 (72.85) | 1.79 | 8.25 | 11.16 | 35.35 |
| Azadirachtin10,000 ppm) @ 5.50ml | 4.33 (11.99) | 4.00 (2.24) | 8.33 (3.05) | 93.00 | 90.66 (72.18) | 2.51 | 8.25 | 8.90 | 7.80 |
| Azadirachtin 10,000 ppm @ 6.50ml | 1.42 (6.79) | 2.10 (1.73) | 5.50 (2.44) | 93.00 | 92.66 (74.26) | 0.36 | 8.25 | 8.90 | 7.64 |
| Deltamethrin @ 1 ppm (2.8 EC @ 0.04 ml) | 1.41 (6.79) | 2.00 (1.73) | 5.00 (2.44) | 93.00 | 92.33 (73.90) | 0.72 | 8.25 | 8.95 | 8.48 |
| Spinetoram 11.7% SC @ 6.50 ml | 1.16 (6.19) | 1.00 (1.41) | 47.66 (6.97) | 93.00 | 92.00 (73.56) | 1.08 | 8.25 | 8.95 | 8.48 |
| Emamectin benzoate 5 SG @ 40 mg | 0.67 (4.52) | 1.00 (1.41) | 4.66 (2.37) | 93.00 | 92.00 (73.56) | 1.08 | 8.25 | 8.94 | 8.44 |
| Untreated control | 21.33 (27.48) | 24.33 (5.03) | 2.33 (3.65) | 93.00 | 64.33 (53.32) | 30.82 | 8.25 | 13.66 | 65.67 |
| SEm± | 0.16 | 0.02 | 0.05 | - | 0.61 | - | - | 0.37 | - |
| CD at (P=0.05) | 0.48 | 0.56 | 0.51 | - | 1.80 | - | - | 1.10 | - |
| CV(%) | 2.14 | 1.15 | 2.65 | - | 1.53 | - | - | 3.43 | - |

*Seed treatment with various dosages per kg of seeds

## CONCLUSIONS

The study can be concluded that, the pigeonpea plants sprayed with emamectin benzoate 5 SG @0.3g / l at the time of pod maturity has recorded the minimum seed damage of 0.25% at 8 weeks after storage of pigeonpea seeds. The seeds exposed for sun light in clear polythene bags for 4 hours for 6 days registered least seed damage of 10.66%. In storage pigeonpea seeds treated with insecticide spinetoram 11.7% SC @ 6.50 ml/kg seeds azadirachtin 10,000ppm @ 6.50 ml/kg seed and deltamethrin2.8EC @ 0.04 ml/kg seed were effective in suppressing the bruchid, *C. chinensis*. Whereas, maximum seed damage of 21.33 per cent and minimum seed quality parameters were observed in untreated control. The bruchid population was suppressed by adopting integrated pest management approaches.

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**Conflict of interest**. Nil.

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