

Effect of solarization against bruchid infestation and seed quality in Greengram (*Vigna radiata* L. Wildzek) during storage

Abstract: The Pulse beetle, *Callosobruchus chinensis* is an important storage pest of green gram which infests during both pre and post-harvest stages. The ovipositional potential, adult emergence, seed damage decreased at above 35°C. To maintain the quality of seeds during storage, it is better to store the seeds in moisture vapour proof containers like polythene bags having 700 gauge. To know the effect of solarization cum packaging in a clear polyethylene (700 gauge) packets on the storability of seeds and bruchid management in greengram. A laboratory study was conducted during June 2018 to April 2019 at the Seed Research and Technology Centre, PJTSAU. The experiment was conducted with eight treatments with three replications. The data on seed germination percentage, seed moisture content, adult emergence and insect infestation were recorded at every three months upto nine months of storage and statistically analyzed by using completely randomized block design (CRD). Solarization of fresh seeds in clear polyethylene (700 gauge) packet for 4 h for 6 days was able to maintain per cent insect infestation (0.49%) below permissible limit and maintained germination percentage (90.67)>IMSCS upto six months of storage as compared with 4.22 per cent seed damage and 83.33 per cent germination in untreated control (Fresh seeds). Seeds packed in a clear polyethylene (700 gauge) packet serves as a moisture vapour proof containers and able to reduce moisture by 22.16 per cent over the untreated control.

Keywords: Solarization treatment, polythene (700 gauge) packaging material, Bruchid management, Seed Quality

1. INTRODUCTION: In India, greengram production contributes more than 70 per cent. The predominant greengram growing districts of Telangana are Mahabubabad, Sangareddy, Suryapet, Khammam, Vikarabad and Kamareddy. In storage, it is infested with *C. chinensis* (L.). This was first recorded on mungbean in 1957. Later, it was observed infesting cowpea in Pakistan [1].

Though, it is mainly considered as a storage pest, its infestation starts in the field itself. The adult beetle lays eggs on matured and dried green gram pod. The grubs feed through the pod cover and remain concealed with in the developing seed [2]. When such seeds are harvested and stored, larvae continue to feed. Larval feeding on the cotyledons causes significant losses in seed weight and viability. As the grub attacks the whole seed by remaining inside the seed, it is very difficult to observe the damage until the adult emerges by breaking the seed coat. This adoptive feature of the insect poses a challenging threat for its management. It causes 33 per cent infestation to legume seeds. [3] reported seed weight loss 55-60 per cent and 45.50- 66.30 per cent losses in protein

content due to bruchid infestation in storage. Pesticides are the most powerful tool available for pest control, despite these credentials, the long and indiscriminate use of pesticides has been found ecologically unsound. Solar heating for the management of bruchid is less hazardous and safe method to control bruchids. Eggs deposited on the surface of the seeds exposed to high temperature and low humidity will desiccate. Therefore, bruchids living within seed are excellent targets for management using elevated temperature. Farmers in many parts of the tropics are already using solar heat as a means of driving out insects from infested seeds and perhaps, in an attempt to kill any larvae which may be inside the seeds. The effectiveness of the technique depends upon spreading the seeds in thin layer and exposing them to the sun for a long period. Solar disinfestations technology is an effective, low cost, non- toxic pest control process, which does not alter seed quality and other desirable properties of the seed [4].

1. MATERIALS AND METHODS

A laboratory experiment was conducted to know the effect of solarization against bruchid infestation in freshly harvested greengram seeds cv. of MGG 295. This was procured from Agricultural research station, Warangal. Seeds were cleaned and disinfested. One kilogram of freshly harvested certified seed with very high percentage of germination and low moisture content (< 10 %) was taken for each treatment. For artificial inoculation pulse seed, the seeds were inoculated with bruchids (5 pairs / kg seed) and kept under ambient condition in the room for two weeks. Later adult insects were removed from seeds. Solarization was done at noon and same schedule was maintained in every treatment. During solarization, 5 cm thickness of seed layer inside seed packet was kept. The temperature outside/inside of packets were recorded each day before and after the solarization. After treatment, the seeds were kept under ambient condition. This experiment was carried out with eight treatments, replicated thrice and data on insect infestation, seed germination and moisture content of seed were recorded at every three months interval upto nine of storage and analyzed by using completely randomized block design (CRD) as suggested by [5]

Treatments:

- T1:** Solarization of fresh seeds in clear polyethylene (700gauge) packet for 3h for 2 days
- T2:** Solarization of fresh seeds in clear polyethylene (700 gauge) packet for 3h for 4 days
- T3:** Solarization of fresh seeds in clear polyethylene (700 gauge) packet for 3h for 6 days
- T4:** Solarization of inoculated-seeds in clear polyethylene (700 gauge) packet for 3h for 2 days
- T5:** Solarization of inoculated-seeds in clear polyethylene (700 gauge) packet for 3h for 4 days
- T6:** Solarization of inoculated-seeds in clear polyethylene (700 gauge) packet for 3h for 6 days
- T7:** Control (fresh seed)
- T8:** Control (inoculated seed)

2.1 Seed damage (per cent)

The seed damage was calculated by taking a random sample of 100 seeds and counting the number of seeds with bored holes by pulse beetle and converted to percentage.

$$\text{Percentage seed damage} = \frac{\text{Number of damaged seeds}}{\text{Total number of seeds}} \times 100$$

2.2 Adult emergence (Number)

The number of adults emerged per kg seeds was counted at three months interval upto nine months of storage.

2.3 Per cent seed germination at different periods

Germination of the seeds was determined by paper towel method by maintaining three replications of each treatment. 100 seeds were kept in moist paper towel and allowed to germinate in walk in germinator for seven days and the percentage of germination was calculated by using the formula

$$\text{Seed germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Total Number of seeds}}$$

2.4 Seed moisture content at different periods

Moisture content of the seed was estimated by using Dickyjohn moisture meter

3. RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads

3.1 Seed damage (%) : At three months of storage, solarization of fresh seed for 3 hours for 2, 4 and 6 days and solarization of inoculated seed for 3 hours for 4 and 6 days maintained insect damage below permissible limit (<1.00%). At six months of the storage none of the solarization treatments restricted insect damage below permissible limit except solarization of fresh seed for 3 hours for 6 days in which insect damage (0.49%) was recorded. Maximum insect damage 8.17% was observed in untreated inoculated seeds. At nine months of storage, though none of the treatments restricted insect damage below permissible limit but lowest per cent insect damage (2.87%) was observed in solarization of fresh seed for 3 hours for 6 days. Per cent reduction in insect damage over the control recorded was 73.74%. While, in case of solarization of inoculated seed for 3 hours for 6 days, the

per cent reduction of insect damage over the untreated control was 26.19%. As the storage duration increased per cent insect damage increased from two months to nine months in all the treatments due to increase in insect population. Minimum seed infestation was found in solarization of fresh seeds in clear polyethylene (700 gauge) packet for 3h for 6 days after nine months of storage. Bruchid-infested seeds exposed to sunlight at 40 to 50⁰ C reduces the seed infestation [6]. [7] reported that when seeds are kept under sun radiations it significantly inhibits the development of *Callosobruchus maculatus*. These results were in accordance with [8]and[9].

3.2 Adult emergence: The lowest average insect population (1.00) was observed in solarization of fresh seed for 3 hours for 6 days at three months of storage as compared with the highest population build up in untreated inoculated seed (10.00). While insect population in the rest of the treatments ranged from 2.33-8.33. Similar trend was observed at six and nine months of storage. The results revealed that solar heating inhibits egg hatching which in turn reduces the insect population buildup. The present results are in accordance to [10] [11]who reported that Solar heating of seeds was effective in eliminating eggs of bruchids and then protecting seeds from bruchid damage in pigeon pea seeds. Sun exposure of bruchid infested seeds at 40 to 50⁰ C, which reduces the developmental stages of bruchids [6].) observed no emergence of progenies in neem seed oil treated seeds with 4 hours exposure to sun radiations [11] in cowpea seeds. Exposure of cowpea seeds to 50⁰ C for 2 hours leads to complete disinfection of bruchids [12]. [13] also reported that the developmental stage at 42⁰ C get seized in bruchids. These recorded results were in accordance with [9].

3.3 Seed germination percentage

At three months of storage, The highest germination (97.33) was observed in Solarization of fresh seeds in clear polythene (700 gauge) packet for 3 h for 6 days. However, it was on par with Solarization of inoculated seeds in clear polythene (700 gauge) packet for 3 h for 6 days (95.33). Similar trend was observed at six months and nine months of storage, Solarization of fresh seeds in clear polythene (700 gauge) packet for 3 h for 6 days maintained significantly highest germination 90.67 and 84.00 per cent, respectively. While, untreated control recorded lowest germination percentage 81.33 and 72.00 at six and nine months of storage, respectively. The germination percentage upto three months gradually reduced with increase in storage period. This shows natural ageing of greengram seeds and level of bruchid infestation. There is drastic decrease in seed germination after six months of treatment imposition, which is due to insect infestation. The seed germinability of seed is reduced as pulse beetle bores into the seed and consume of seed reserve. These holes are also responsible for the entering of harmful microorganisms and interfere with the water intake, which retards the seed germination [13]. The results of this study were in line with the findings of [14] in horse gram seeds, [9]and [8] in cowpea.

3.4 Seed moisture: Minimum seed moisture 9.93, 9.83 and 10.57 per cent were observed in T₃ (solarization of fresh seeds in clear polyethylene (700 gauge) packet for 3h for 6 days at three, six and nine months of storage, respectively. While, maximum seed moisture 12.67, 13.67 and 15.40 were recorded in untreated control (inoculated seed) at three, six and nine months of storage

respectively. Packaging material made with 700 gauge polyethylene will serve as moisture vapour proof containers and further sealing it create hermetic conditions thereby insect is killed due to hyper-carbic and hypoxic conditions and seeds will retain its natural properties and thus increases shelf life. The present results are in consonance with [15] who investigated the effects of low input drying procedures on seed quality of maize, cowpea, and bambara groundnut by using four drying regimes (sun, shade, silica gel and conventional drying room). They reported that seeds stored with silica gel showed the lowest moisture content in all three species viz., maize (7%), cowpea (3%) and bambara groundnut (8%) followed by sun drying which reduced the initial seed moisture content from 10% to 7.8%, 5.1%, and 8.4% in maize, cowpea and bambara groundnut, respectively.

4. CONCLUSION

Solar disinfestation is a cost effective, nontoxic technology for bruchid management in greengram. As the seed is hygroscopic in nature, seed quality is affected by fluctuation in moisture content, relative humidity and temperature. Packaging material made with 700 gauge polyethylene will serve as moisture vapour proof containers and further sealing it create hermetic conditions thereby insect is killed due to hypercarbic and hypoxic conditions. Seeds will retain its natural properties and thus increases shelf life. From the present study, it is concluded that the treatment with solarization of fresh seeds in clear polyethylene (700 gauge) packet for 4 h for 6 days was able to maintain per cent insect infestation (**0.49%**) below permissible limit and maintained germination percentage (**90.67**)>IMSCS upto six months of storage as compared with 4.22 per cent seed damage and 83.33 per cent germination in untreated control (Fresh seeds).

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Table 1. Effect of solarization on adult emergence and seed damage (per cent) in greengram

S.No	Treatments	Storage duration					
		Adult emergence			Seed Damage (%)		
		3 M	6 M	9 M	3 M	6 M	9 M
T ₁	Solarization of fresh seeds in clear polythene (700 guage) packet for 3 h for 2 days.	2.33 (1.82)	10.09 (3.31)	23.67 (4.96)	0.83 (5.23)	3.34 (10.50)	7.54 (15.93)
T ₂	Solarization of fresh seeds in clear polythene (700 guage) packet for 3 h for 4 days.	1.00 (1.38)	5.3 (2.51)	15.00 (3.99)	0.47 (3.87)	2.23 (8.57)	3.91 (11.38)
T ₃	Solarization of fresh seeds in clear polythene (700 guage) packet for 3 h for 6 days.	1.00 (1.41)	3.0 (1.98)	12.33 (3.65)	0.13 (2.06)	0.49 (3.87)	2.87 (9.67)
T ₄	Solarization of inoculated seeds in clear polythene (700 guage) packet for 3 h for 2 days.	7.33 (2.87)	53.3 (7.34)	189.33 (13.79)	1.34 (6.60)	5.41 (13.4)	13.37 (21.43)
T ₅	Solarization of inoculated seeds in clear polythene (700 guage) packet for 3 h for 4 days.	8.33 (3.04)	34.3 (5.94)	116.00 (10.81)	0.78 (5.07)	4.41 (12.1)	11.70 (19.99)
T ₆	Solarization of inoculated seeds in clear polythene (700 guage) packet for 3 h for 6 days.	6.67 (2.75)	31.0 (5.65)	64.00 (7.99)	0.55 (4.22)	2.12 (8.37)	10.79 (19.16)
T ₇	Control (Fresh seed)	3.00 (2.00)	13.3 (3.78)	35.33 (6.02)	1.14 (6.17)	4.22 (11.86)	10.93 (19.29)
T ₈	Control (Inoculated seed)	10.00 (3.31)	75.0 (8.71)	254.00 (15.96)	4.23 (11.87)	8.17 (16.02)	14.62 (22.47)
	CD 0.01	0.415	0.586	0.825	0.96	1.14	1.223

Figures in the parentheses are square root and angular transformed values for adult emergence and seed damage, respectively.

Table 2. Effect of solarization on per cent seed germination and seed moisture

S.No	Treatment	Storage duration					
		Germination percentage			Seed Moisture content (%)		
		3 M	6 M	9 M	3 M	6 M	9 M
T ₁	Solarization of fresh seeds in clear polythene (700 gauge) packet for 3 h for 2 days	93.00 (74.65)	86.00 (68.05)	81.00 (64.13)	10.6 (18.99)	10.5 (18.90)	12.50 (20.69)
T ₂	Solarization of fresh seeds in clear polythene (700 gauge) packet for 3 h for 4 days	95.67 (78.30)	86.67 (68.57)	81.67 (64.64)	10.47 (18.87)	10.33 (18.7)	12.43 (20.63)
T ₃	Solarization of fresh seeds in clear polythene (700 gauge) packet for 3 h for 6 days	97.33 (80.70)	90.67 (72.20)	84.00 (66.50)	9.93 (18.36)	9.83 (18.27)	10.57 (18.95)
T ₄	Solarization of inoculated-seeds in clear polythene (700 gauge) packet for 3 h for 2 days	91.67 (73.22)	85.67 (67.73)	77.33 (61.63)	11.43 (19.75)	12.40 (20.61)	14.67 (22.50)
T ₅	Solarization of inoculated-seeds in clear polythene(700 gauge) packet for 3 h for 4 days	92.33 (73.90)	86.67 (68.56)	81.00 (64.13)	10.9 (19.27)	10.43 (18.84)	12.67 (20.84)
T ₆	Solarization of inoculated-seeds in clear polyethylene (700 gauge) packet for 3 h for 6 days	95.33 (77.55)	87.67 (69.43)	82.00 (64.80)	10.07 (18.49)	10.20 (18.61)	13.43 (21.49)
T ₇	Control (Fresh seed)	90.33 (71.88)	83.33 (65.89)	80.00 (63.42)	11.93 (20.20)	12.63 (20.81)	14.73 (22.55)
T ₈	Control (inoculated seed)	83.00 (65.67)	81.33 (64.38)	72.00 (58.03)	12.67 (20.84)	13.67 (21.69)	15.40 (23.09)
	CD 0.01	3.25	2.13	3.48	0.372	0.84	0.72

Figures in the parentheses are angular transformed values

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