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Research Paper :

Low cost solar technology for safe storage of gram

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ABSTRACT

A low cost solar bed was developed and tested for safe storage of gram. Low cost solar bed was prepared by spreading insulated mattress of wheat husk, approx. 2.5cm in thickness on the bare surface to avoid losses to the ground. A Ix2m sheet of transparent polyethylene plastic was laid directly over the insulated mattress. The effectiveness of the solar bed as protectant of stored gram *(Cicer arietinum)* against infestation of pulse beetle *i.e. Dhora, C. chiilensis* was tested. Two types of experiments were conducted to test the efficiency of this solar bed *viz*., gram spread over the solar bed was covered with transparent polyethylene sheet and in the another case, gram was not covered with the transparent sheet. Results indicated that there was no significant increase in infestation level of gram samples, which were exposed on solar bed with transparent covering and on solar bed without transparent covering. Level of infestation was higher for gram stored on bare floor as compared to those gram grains which were exposed on solar beds (with and without transparent covering). Percentage of infestation increased significantly in control groups after 3 months of storage. The findings reflect that the difference between ambient and solar bed temperatures did not allow the pulse beetle to multiply and it also helped to check any further increase in infestation levels of gram grains. These findings on the whole have strong implications for researchers and field level functionaries.

Key words : Deterioration, Solar bed, Infestation level

Foodgrains are stored in different types of storage structures, which vary from region to region. The selection of storage structure depends upon quantity of grains to be stored. Survey conducted by Chaudhary *et al.* (1998) has revealed that 82 per cent of the grains are stored in traditional storage structures. Large amount of foodgrains are lost every year for want of scientific storage facilities. The losses occur mainly due to spillage, contamination, attack by insects, birds and rodents, and deterioration in storage. Pulses form the major constituent of diet for masses in India where the consumption of animal protein, except milk, is still considered a religious and social taboo. Presently, the availability of pulses is below the stipulated requirement of 80g per day per person. In 1971, this availability dropped to 51.2g per capita per day and it further declined to 36.6g in 1993 (Lal and Brahm, 1996). Therefore, efforts are required to prevent the post¬harvest and storage losses so as to increase its availability per person. Drying of grains to safe moisture limits before storage is the most commonly adopted practice as it increases the storage life of the grains. The drying system currently in use for drying small crop volume involves spreading the material on the ground and exposing it to the sun and wind. This traditional method to dehydrate the material under direct sunshine is a slow process and requires a considerable amount of handling. Sometimes, it also damages the materials because of exposure to adverse conditions. This leads to handling and storage losses. Under such circumstances and due to limited availability of other control methods, use of low cost solar technology has considerable potential for minimizing the losses in storage. It will help in prevention of infestation, besides reducing the need for using insecticides and pesticides. *Chickpea* (gram) saved in this way, will add to family's income and also provide a form of saving to cover future cash needs. It is in this context that the present study was conducted with the specific objective to develop and test a low cost solar bed for safe storage of gram.

METHODOLOGY

Locale :

The effectiveness of solar bed as protectant of stored gram (*Cicer arietinum*) against infestation of pulse beetle *i.e.* Dhora, *Callosobruchus chinensis* (L.) was tested in open area of the laboratory of Department of Family Resource Management, College of Home Science, CCS HAU, Hisar.

Preparation of solar bed :

Low cost solar bed was prepared by spreading insulated mattress of wheat husk, approximately 2-5 cm in thickness, on the bare floor, to avoid losses to the ground. A 1 x2 m sheet of transparent polyethylene plastic was laid directly over the insulated mattress.

Treatments:

Twenty four samples of gram grains, each sample weighing 2 kg, were prepared for the 8 treatments as mentioned below:

T_1 Gram with 20% level of infestation and exposed on solar bed with covering of

transparent sheet for 1 hr.

T_2 Gram with 20% level of infestation and exposed on solar bed without covering of transparent sheet for 1 hr.

T_3 Gram with 20% level of infestation and exposed on bare floor for 1 hr.

T_4 Gram with 20% level of infestation and directly stored in cloth bag and served as untreated control-I

T_5 Gram with zero level of infestation and exposed on solar bed with covering of transparent sheet for 1 hr.

T_6 Gram with zero level of infestation and exposed on solar bed without covering of transparent sheet for 1 hr.

T_7 Gram with zero level of infestation and exposed on bare floor for 1 hr.

T_8 Gram with zero level of infestation and directly stored in cloth bag and served as untreated control-II

Each of the above treatments was replicated thrice.

Collection of data :

Average ambient temperature, average temperature on solar bed and sun shine intensity were also recorded simultaneously. Recordings started at 11:00 am and continued at 20 minutes interval until 12:00 noon. After treatments, the gram samples were packed individually in cloth bags and kept at room temperature for 3 months. Data were collected by observing moisture content and percentage level of infestation both before and after the treatments. Data pertaining to moisture content and infestation level were collected by observing stored gram after every month for successive 3 months.

Analysis of data :

The experimental data for infestation levels and moisture content were tabulated and statistically analysed by 'Analysis of variance' technique. Critical difference (C.D.) at 5 per cent level was worked out to judge the significance of differences. Correlation coefficients between moisture content and infestation level were also computed.

FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Effectiveness of the solar bed for checking infestation due to pulse beetle, *C. chinensis* in gram with 20 per cent level of infestation for safe storage:

Data in Table 1 revealed that there was a significant increase in moisture content of gram grains from 8.1 to 13.1 per cent after one month of storage. This increase in moisture content was observed to be more or less similar in all treatments the, T_1, T_2, T_3 and T_4. Thereafter, moisture content increased only slightly *i.e.* from 13.0 to a maximum of 13.6 per cent after 3 months of storage.

Results further indicated that there was a significant increase in infestation level of gram grains after 3 months of storage from 20 to 79.3 per cent where these were not subjected to any treatment *i.e.* stored as such and served as untreated control I (T_4). There was no further increase in initial infestation level of gram grains exposed on solar bed with transparent sheet (T_1). However, in other two treatments *i.e.* T_2 and T_3, the infestation level increased from 20 to 23 per cent and from 20 to 31.6 per cent, respectively after 3 months of storage. The level of infestation was recorded to be higher for grains exposed on bare floor (T_3) *i.e.* from 20 to 31.6 per cent as compared to those gram grains which were exposed on solar bed without transparent covering (T_2) where no significant increase in initial infestation level of 20 per cent was found.

Though the increase in moisture content (from 8.0 to 13.6%) was found in all the treatments T_1, T_2, T_3 and T_4 after 3 months of storage but there was no significant increase in initial infestation level of treatment T_1 and T_2 after 3 months of storage. Thus, the treatments in which the gram grains were exposed on solar bed with transparent covering for 1 hour before storage, proved to be the most effective, followed by treatments in which gram grains were exposed on solar bed without covering, against increase in level of pulse beetle infestation.

During exposure, average ambient temperature, average solar bed temperature with transparent covering and solar bed temperature without transparent covering were 43^0C, 64^0C and 56^0C, respectively. Average sunshine intensity recorded was 271 lux meter. The temperature difference between ambient and solar bed with transparent covering varied from 20^0C-24^0C. The temperature difference between ambient and solar bed

Table 1: Effectiveness of solar bed for checking infestation due to pulse bettle, *C. chinensis* in gram with 20% level of infestation for safe storage

Sr. No.	Treatments	Moisture content of gram (%) Before storage (Initial)	After storage interval 1 mth	2 mth	3 mth	C.D. (P=0.05)	Level of infestation of gram (%) Before storage (Initial)	After storage interval 1 mth	2 mth	3 mth	C.D. (P=0.05)	Ambient temperature (^{0}C)	Temperature on solar bed (^{0}C)	Coefficient correlation between M.C. and infestation
1	T_1.Gram with 20% level of infestation and exposed on solar bed with covering of transparent sheet for 1 hr.	8.1 (16.53)	13.0 (21.16)	13.4 (21.53)	13.1 (21.19)	0.17^{s}	20.0 (26.56)	19.0 (26.08)	19.0 (26.32)	20.0 (26.8)	-	43	64	-0.2655
2.	T_2.Gram with 20% level of infestation and exposed on solar bed without covering of transparent sheet for 1 hr.	8.2 (16.61)	13.06 (21.16)	13.4 (21.5)	13.5 (21.5)	0.14^{s}	20.0 (26.56)	20.6 (27.17)	23.7 (29.75)	20.0 (25.61)	NS	43	56	0.7212
3.	T_3.Gram with 20% level of infestation and exposed on bare floor for 1 hr.	8.2 (16.60)	13.1 (21.21)	13.5 (21.56)	13.6 (21.9)	0.17^{s}	20 (26.56)	25.6 (30.49)	29.3 (32.76)	23.0 (34.22)	2.47^{s}	43	-	0.9182
4.	T_4.Gram with 20% level of infestation and directly stored in cloth bag and served as untreated control-1	8.1 (16.60)	13.1 (21.19)	13.5 (21.53)	13.6 (21.9)	0.13^{s}	20 (24.89)	42.3 (40.57)	44 (41.34	79.3 (63.25)	5.28^{s}	-	-	0.7817

Figures in parentheses are angular transformed values: S=Significant; NS = Non-significant; Average sun shine intensity – 271 lux meter M.C. – Moisture content

without transparent covering varied from 13^{0}C – 15^{0}C (Table 1).

This temperature differences in solar beds (with and without covering of transparent sheet) did not allow the pulse beetle to multiply and checked any further increase in 20 per cent level of infested gram grains. Therefore, this is an additional advantage of using transparent sheet covering on the solar bed. The findings are in agreement with the study of Fields (1992) who reported that insect pests survived and multiplied over a narrow range of temperature.

The correlation coefficients were worked out to study the relationship between the moisture content and infestation level of each treatment after 3 months of storage. The correlation coefficient analysis (Table 1) indicated that for treatment T_1, there was negative correlation between moisture content and infestation level whereas for treatments T_2. (r=0.7212), T_3(r=0.9182) and T_4 (r=0.7817), there was positive correlation between moisture content and infestation level. However, for all the treatments correlation coefficient between the moisture content and infestation level of gram grains after 3 months of the storage was not significant.

Effectiveness of solar bed for checking infestation due to pulse beetle, *C. chinensis* in gram with zero level of infestation:

Data in Table 2 revealed that there was a significant increase in moisture content of gram grains after one month of storage. Rate of increase of moisture content was found more or less similar in all treatments the, T_5, T_6, T_7 and T_8. The increase in moisture content was very little after 3 months of storage *i.e.* only up to 13.6 per cent.

It was further revealed that there was a significant increase in infestation level of gram grains from 0 to 13 per cent after 3 months of storage, where gram grains were not subjected to any treatment and served as untreated control II (T_8). There was no increase over initial infestation levels of gram grains after 3 months of storage, where solar bed was covered with transparent sheet (T_5) and where it was not covered with transparent sheet T_6.

Though the increase in moisture content (from 8.0 to 13.6%) was recorded in all the treatments the T_5 ,T_6, T_7 and T_8 after 3 months of storage, yet there was no significant increase in infestation level in treatments T_5 and T_6. Therefore, it could be concluded that solar bed treatments, with or without covering, proved to be effective in checking the

Table 2: Effectiveness of solar bed for checking infestation due to pulse beetle, C. chinesis in gram with zero level of infestation for safe storage

Sr. No.	Treatments	Moisture content of gram (%) Before storage (Initial)	After storage interval 1 mth	2 mth	3 mth	C.D. (P=0.05)	Level of infestation of gram (%) Before storage (Initial)	After storage interval 1 mth	2 mth	3 mth	C.D. (P=0.05)	Ambient temperature (^{0}C)	Temperature on solar bed (^{0}C)	Coefficient correlation between M.C. and infestation
1.	T_5-Gram with 20% level of infestation and exposed on solar bed with covering of transparent sheet for 1 hr.	8.1 (16.53)	13.0 (21.24)	13.2 (21.27)	13.3 (21.44)	0.19^s	0 (1.81)	0 (1.81)	0 (1.81)	0 (1.81)	--	43	64	-
2.	T_6-Gram with 20% level of Infestation and exposed on solar bed without covering of transparent sheet for 1 hr.	8.0 (16.61)	13.0 (21.16)	13.5 (21.5)	13.6 (21.5)	0.15^s	20.0 (26.56)	0 (1.81)	0 (1.81)	0 (1.81)	0 (1.81)	43	56	0.3749
3..	T_7-Gram with 20% level of infestation and exposed on bare floor for 1 hr.	8.1 (16.60)	13.0 (21.17)	13.4 (21.53)	13.5 (21.56)	0.14^s	0 (1.81)	0 (1.81)	0 (1.81)	0 (1.81)	1.70^s	43	-	0.5096
4.	T_8-Gram with 20% level of infestation and directly stored in cloth bag and served as untreated control-II	8.1 (16.67)	13.1 (21.27)	13.2 (21.27)	13.4 (21.53)	0.15^s	0 (1.81)	0 (1.81)	0 (1.81)	0 (1.81)	1.71^s	-	-	0.5502

Figures in parentheses are angular transformed values: S=Significant; NS = Non-significant; Average sun shine intensity – 271 lux meter M.C. – Moisture content

infestation of gram grains due to pulse beetle, *C. chinensis*.

The temperature variations between both solar beds were same as in Table 1. Here too, the variations in temperature at which the storage was done, played an important role in checking the infestation of gram grains by pulse beetle, as in the previous case.

The findings are in conformation with the observations of Murdock and Shade (1997) who revealed that if cowpea seeds exposed on high temperatures (57^{0}C for 1 hour) killed all stages of cowpea bruchid, *C. maculatus.*

The correlation coefficients were worked out to study the relationship between the moisture content and infestation level of each treatment after 3 months of storage. The correlation coefficient analysis (Table 2) indicated that for treatment Ts there was no correlation between moisture content and infestation level, where as for treatments T_6 (r=0.3749), T_7 (r=0.5096), and T_8 (r=0.5502), positive correlation was found between moisture content and infestation level. For all the treatments, the correlation coefficient between the moisture content and infestation level of gram grains after 3 months of storage was found to be non-significant.

Conclusion:

Conclusively, there was no significant increase in infestation level of gram samples, which were exposed on solar bed with transparent covering and on solar bed without transparent covering. Level of infestation was higher for grains exposed on bare floor as compared to those gram grains, which were exposed on solar beds (with and without transparent covering). Percentage of infestation increased significantly in control group after 3 months of storage. The findings reflect that the difference between ambient and solar bed temperatures did not allow the pulse beetle, Dhora to multiply and it also helped to check any further increase in infestation level of gram grains. For all the treatments, correlation coefficient between the moisture content and infestation level of gram grains after 3 months of storage was found to be non-significant. Finally, the solar bed with transparent covering was proved to be most effective in checking increase in infestation level of gram due to pulse beetle, followed by effectiveness of solar bed without transparent covering, for safe storage of gram.

Implications of study:

The existing method of drying food grains under direct sunshine is a slow process and has usual problems like dust contamination, insect infestation and spoilage due to unexpected rains or weather conditions. Therefore, low cost solar bed can be effectively utilized for drying and safe storage of gram grains. Extension workers of Agricultural Universities and field functionaries of Agricultural Departments can play an important role in popularizing this low cost solar technology to reduce the post-harvest losses and drudgery of rural women.

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