Influence of solarization on seed quality of bruchid infested and fresh cowpea (*Vigna unguiculata* (L.) Walp.) seeds during storage.

Abstract

During July 2018 and April 2019, the laboratory study was conducted at the Department of Seed Science and Technology and National Seed Project, University of Agricultural Sciences, Bengaluru, to investigate theinfluence of solarization on the seed quality of both bruchid-infested and fresh cowpea seeds (cv. IT38956-1). The findings indicated that subjecting fresh seeds to solarization in clear polyethylene packets (700 gauge) for 3 hours daily over 6 days resulted in the lowest seed moisture content (11.03%), highest germination rate (70.67%), longest mean seedling length (21.80 cm), highest mean seedling dry weight (46.10 mg), enhanced seedling vigour indices I and II (1541 and 3258), improved field emergence (68.33%), elevated TDH activity (1.43), higher protein content (19.73%), and reduced electrical conductivity of leachate (927 µS cm^{-1}) after nine months of storage, compared to the control.

Keywords: Solarization, Germination, Bruchids and Field emergence

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) plays a vital role in providing essential dietary protein and calories for humans. It is grown for multiple uses such as seed production, fodder, consumption of green pods, as well as for its benefits as green manure and a cover crop. It stands out as a highly adaptable, versatile, and nutritious grain legume, renowned for its rich protein content ranging from 22% to 27%, as well as its abundance in carbohydrates, fats, vitamins, and phosphorus, making it a valuable source of essential nutrients. Cowpea is globally cultivated across an expansion of 14.50 million hectares, yielding a total production of 6.50 million tons. Notably, Nigeria contributes to over 70% of this production (Fatokun*et al.,* 2014). In India, it spans across 3.1 million hectares, with a production output of 1.92 million tons (Anon., 2016).

Pulses, due to their poor storage qualities, are prone to infestation by bruchids like *Callosobruchus maculatus.* Infestation by these bruchids commonly initiates in the field and may continue even during storage. Bruchids, typically seen as minor pest in the field, these can become notably troublesome during seed storage.Adebayo and Anjorin (2018) observed that cowpea seeds stored under conventional storage conditions are prone to complete infestation by bruchids within 3 to 5 months.

In the recent past, insect and other storage pests were primarily controlled using chemical methods, which involved fumigating stored commodities with substances like carbon disulfide, phosphine, or applying dusts containing malathion, carbaryl, pirimiphos-methyl. In the search for alternatives to chemical insecticides, current research endeavours are directed towards eco-friendly control methods including irradiation, heat treatment, bio pesticides, integrated pest management, and the utilization of insect hormones. (Adebayo and Anjorin, 2018).

Solarization of pulse seeds is a safer and less hazardous alternative method for controlling *C. maculatus*. Eggs laid on the seed surface exposed to high temperatures and low humidity they get desiccate and resulting in deformities.The efficacy of this technique relies on evenly spreading of the seeds in a thin layer and subjecting them to prolonged sun exposure. Solar disinfestation technology emerges as an efficient, cost-effective, non-toxic method for pest control. It also preserves the physical, cooking, nutritional, and other desirable qualities of cowpea grains (Adebayo and Anjorin,2018).In the view of above facts to increase the storage life of the cowpea seed this research investigation was carried out to know the efficacy of solarization on seed quality during storage.

Material and Methods

Freshly harvested cowpea seeds of cv. IT38956-1 were obtained from the Seed Processing Unit of the National Seed Project, GKVK, Bengaluru. Subsequently, the seeds were thoroughly cleaned and dried to ensure the absence of any insect damage or live insects. After that cowpea seeds were inoculated with five pairs of pulse bruchids per kilogram and left for a period of fifteen days. Finally, one kilogram of seeds was packed into 700-gauge polythene packets and then subjected to solarization.

In this study eight treatments were replicated three times in a completely randomized block design (CRD) i.e. **T_1:** Solarization of fresh seeds in clear polyethylene packet for 3 hour daily over a span of 2 days, **T_2:**Solarization of fresh seeds in clear polyethylene packet for 3 hour daily over a span of 4 days, **T_3:**Solarization of fresh seeds in clear polyethylene packet for 3 hour daily over a span of 6 days, **T_4:**Solarization of inoculated seeds in clear polyethylene packet for 3 hour daily over a span of 2 days, **T_5:**Solarization of inoculated seeds in clear polyethylene packet for 3 hour daily over a span of 4 days, **T_6:** Solarization of inoculated seeds in clear polyethylene packet for 3 hour daily over a span of 6 days, **T_7:** Control (fresh seed), **T_8:** Control (inoculated seed).

Observations were recorded bimonthly up to six months and monthly after six months up to nine months of cowpea seed storage (July, 2018 to April, 2019). These observations were recorded by sampling 400 seeds from each 700-gauge clear polyethylene packet and moisture content of cowpea seed was estimated by oven drying method by taking 5 grams of cowpea seeds from each replication and treatment. The cowpea seeds were ground and kept in oven for 17 hours and final weight was recorded. The moisture content of cowpea seed was calculated by using following formula.

$$\text{Seed moisture content (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W1: The weight of the container with its lid

W2: The weight of the container, with its lid and contents before drying

W3: The weight of the contents, container and lid after drying.

Along with the total dehydrogenase activity (TDH) (Perl *et al.*, 1978) and total soluble protein (Lowry *et al.*, 1951) of the seeds, germination test was also conducted by the paper method as prescribed by ISTA (2010). Ten randomly selected seedlings were taken from each replication for evaluating the mean seedling length and mean seedling dry weight after oven drying as prescribed by ISTA (2010). Seedling vigour index was calculated by using formula of Abdul -Baki and Anderson, (1973).

SVI-I = Germination (%) x Mean seedling length (cm)

SVI-II = Germination (%) x Mean seedling dry weight (mg/seedling)

Results and Discussion

After nine months of storage, a noticeable variation in seed moisture content was evident across the treatments. The lowest seed moisture content (11.03%) was registered in the group that employed solarization on fresh seeds enclosed in a Solarization of fresh seeds in clear polyethylene packet for 3 hour daily over a span of 6 days (T_3). Conversely, the highest seed moisture content (12.58%) was observed in the control group (inoculated seed, T_8). This increase in the moisture content was due to increase in the seed infestation by the bruchid insects. These results are inline with the findings of Raghavendra and Loganathan (2017) who recorded the higher moisture in pigeon pea seeds due to increased seed infestation by the insects.

Nine months after storage, the highest germination, mean seedling length, mean seedling dry weight, seedling vigour index I, seedling vigour index II and total dehydrogenase activity (A_{480}) of 70.67 %, 21.80 cm, 46.10 mg, 1541, 3258 and 1.43, respectively was found in Solarization of fresh seeds in clear polyethylene packet for 3 hour daily over a span of 6 days (T_3). Whereas, the lowest germination, mean seedling length, mean seedling dry weight, seedling vigour index I, seedling vigour index II and TDH of 52.33 %, 18.20 cm, 35.53 mg, 952, 1858 and 0.98, respectively was found in control (T_8). Insect infestation reduced the seed germination through hole creation and seed reserve consumption. These openings facilitated the entry of harmful microorganisms and disrupted water absorption, thereby impeding seed germination further (Sonali *et al*., 2018) andultimately leading to reduction in the total dehydrogenase activity, mean seedling length, mean seedling dry weight. These pertaining results of our study are confirmative with Divya *et al*. (2018) in horse gram seeds, Deshpande *et al*. (2011) in cowpea seeds, Patro *et al*. (2007), and Ghaffar and Chauhan (1999) in pigeon pea seeds and Narayanswamy*et al*. (2014) in soybean seeds. Raghavendra and Loganathan (2017) reported that bruchid infestation of pigeon pea seeds lead to seed deterioration, affecting germination and loss of seed vigour.

Decrease in the field emergence and protein content were observed from initial (83 % and 23.40 %, respectively) up to nine months after storage (45 % and 18.23 %, respectively) in control (T_8). However, maximum field emergence and protein content(68.33 % and 19.73%, respectively) was found in Solarization of fresh seeds in clear polyethylene packet for 3 hour daily over a span of 6 days (T_3). This revealed that the level of bruchid infestation and natural ageing of seeds, and these findings are in accordance with Raghavendra and Loganathan (2017) who reported that bruchid infestation of pigeon pea seeds lead to seed deterioration, affecting germination and loss of vigour. Whereas, decreased protein content along with the decreased seed weight and other variablesdue to *C. maculatus* infestation (Oke*et al*., 2015).

Table 1. Initial seed quality parameters of the cowpea seeds of cv. IT-38956-1 Before treatment and storage

Sl. No	Parameter	Observation
1	Seed moisture content (%)	**8.30**

2	Seed germination (%)	**88.00**
3	Mean seedling length (cm)	**34.80**
4	Seedling dry weight (mg/seedling)	**69.50**
5	Seedling vigour index - I	**3062**
6	Seedling vigour index - II	**6116**
7	Field emergence (%)	**83.0**
8	Total dehydrogenase activity (A_{480})	**2.12**
9	Total protein (%)	**23.40**
10	EC of seed leachates (μScm^{-1})	**605**

Table 2. Effect of solarization on seed quality against bruchid infested and fresh seeds of cowpea at nine months after storage.

Treatments	Seed moisture content (%)	Germination (%)	Mean seedling length (cm)	Mean seedling dry weight (mg)	Seedling vigour index I	Seedling vigour index II	Field emergence (%)	(Unit) TDH Activity A_{480}	Protein content (%)	Electrical conductivity (µS cm^{-1})
T_1	11.28	69.33	20.80	41.13	1443	2854	58.67	1.33	19.67	947
T_2	11.25	68.67	20.40	42.63	1401	2927	60.33	1.29	19.60	940
T_3	11.03	70.67	21.80	46.10	1541	3258	68.33	1.43	19.73	927
T_4	11.46	65.33	18.37	39.00	1200	2550	49.00	1.18	18.87	1097
T_5	11.53	66.33	19.67	41.80	1304	2772	54.67	1.20	18.97	1037
T_6	11.42	66.67	21.20	42.50	1413	2834	56.67	1.36	19.17	1024
T_7	12.37	60.67	18.67	39.20	1132	2378	60.40	1.03	19.13	1128
T_8	12.58	52.33	18.20	35.53	952	1858	45.00	0.98	18.23	1163
Mean	11.62	65.00	19.88	40.99	1298	2679	56.63	1.23	19.17	1033
S. Em ±	0.07	0.97	0.29	0.87	28.0	76.4	1.21	0.05	0.06	16.48
CD at 5%	0.19	2.91	0.88	2.61	84.0	228.9	3.64	0.14	0.17	49.4
CV (%)	0.96	2.59	2.56	3.68	3.74	4.94	3.71	6.54	0.50	2.76

Conclusion

Solarization, which harnesses solar energy, is an eco-friendly approach for pest management and preserving seed health. Prior comprehensive research has validated its effectiveness in managing insect infestations. From the present study, it is being concluded that the treatment with Solarization of fresh seeds in clear polyethylene packet for 3 hour daily over a span of 6 days (T_3) recorded significantly the highest germination, mean seedling length, mean seedling dry weight, seedling vigour index I, seedling vigour index II and total dehydrogenase activity (A_{480}) of 70.67 %, 21.80 cm, 46.10 mg, 1541, 3258 and 1.43, respectively as compared to control.

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