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

Abstract

A laboratory study was conducted to know the effect of solarization on seed quality of bruchid infested and fresh cowpea seeds (cv. IT38956-1) during July 2018 to April 2019 in the Department of Seed Science and Technology, and National Seed Project, University of Agricultural Sciences, Bengaluru. The results revealed that the solarization of fresh seeds in clear polyethylene (700 gauge) packet for 3h for 6 days recorded lowest seed moisture content (11.03 %), highest germination (70.67 %), mean seedling length (21.80 cm), mean seedling dry weight (46.10 mg), seedling vigour index I and II (1541 and 3258), field emergence (68.33 %), TDH activity (1.43), protein content (19.73 %), lowest electrical conductivity of leachate (927 µS cm^{1}) of seeds after nine months of storage when compared with control.

Keywords: Solarization, Germination, Bruchids and Field emergence

Introduction

Cowpea [*Vigna unguiculata* (L.) Walp.] is an important source of human dietary protein and calories cultivated for seed, fodder, green pods, green manure and cover crop. It is one of the most widely adapted, versatile and nutritious grain legume. It's a good source of protein (22 - 27 %), carbohydrate, fat, vitamins and phosphorus. Cowpea is cultivated in an area of 14.50 million hectares worldwide with a production of 6.50 million tons, of which more than 70 per cent contribution is from Nigeria (Fatokun *et al*., 2014). In India, it is cultivated in an area of 3.1 m. ha. with a production of 1.92 m.t. (Anon., 2016). Karnataka accounts for 12 per cent of area under pulses in the country and among all pulses in Karnataka, cowpea stands on fourth position with an area of 0.81 lakh hectare and production of 0.32 lakh tones (Anon., 2016a). In Karnataka, productivity of cowpea is as low as 3.68 q/ha as compared to national productivity of 5.7 q/ha. In India, major cowpea growing states are Rajasthan, Gujarat, Karnataka, Tamil Nadu, Kerala and Andhra Pradesh (Anand *et al*., 2016).

Solar heating of cowpea is one of the alternatives, non hazardous and safe method to control *C. maculatus*. Eggs deposited on the surface of the seeds exposed to high temperature and low humidity will desiccate as a result leads to deformed seeds. 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 uniform 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 the physical, cooking, nutritive, and other desirable properties of the cowpea grain (Adebayo and Anjorin, 2018).

Material and Methods

A laboratory experiment was conducted to know the effect of solarization on seed quality against bruchid infested and fresh seeds of cowpea. Freshly harvested cowpea seeds of cv. IT38956-1 were procured from Seed Processing Unit, National Seed Project, GKVK, Bengaluru. Later, the seeds were thoroughly cleaned and dried, ensuring the absence of any insect damage or live insects. Further, the cowpea seeds were inoculated with five pairs of pulse bruchids per kg and kept for fifteen days. One kilogram of seed was packed in 700-gauge polythene packets and solarization was taken up as per recommendations.

There were eight treatments replicated thrice in completely randomized block design (CRD). Treatments were **T_1:** Solarization of fresh seeds in clear polyethylene (700 gauge) packet at 3h for 2 days, **T_2:** Solarization of fresh seeds in clear polyethylene (700 gauge) packet at 3h for 4 days, **T_3:** Solarization of fresh seeds in clear polyethylene (700 gauge) packet at 3h for 6 days, **T_4:** Solarization of inoculated-seeds in clear polyethylene (700 gauge) packet at 3h for 2 days, **T_5:** Solarization of inoculated-seeds in clear polyethylene (700 gauge) packet at 3h for 4 days, **T_6:** Solarization of inoculated-seeds in clear polyethylene (700 gauge) packet at 3h for 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 four hundred seeds from each 700-gauge 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.

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

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 between paper method as prescribed by ISTA (2010). Randomly selected ten normal 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 (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, noticeable variations 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 clear polyethylene (700 gauge) packet at 3 hours for 6 days (T3). Conversely, the highest seed moisture content (12.58%) was observed in the control group (inoculated seed, T8). This increase in the moisture content was due to increase in the seed infestation by the 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.

After nine months of 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 (700 gauge) packet for 3h for 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 decreased the seed germinability by making holes and consumption of seed reserve. These holes were also responsible for the entering of a harmful micro-organisms and also interfere with the water intake which retards the seed germination (Sonali *et al*., 2018) and ultimately 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, Manisha *et al*. (2017) and 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 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 (700 gauge) packet at 3h for 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 variables due 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

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