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Effect of Seed Moisture on Incidence of Pulse Beetle, *Callosobruchus chinensis* (L.) infestation in Popular Pigeonpea Cultivars Grown in Telangana

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ABSTRACT: The most important factors influencing seed quality and longevity during its storage are temperature, seed moisture content and relative humidity. Among them the seed moisture content plays a key role. High seed moisture is detrimental to seed quality that causes predisposing the seeds to pest infestation and pathogen attack, that results in rapid deterioration of seeds and ultimately poor crop stand in field. So, an experiment was conducted to evaluate the effect of seed moisture content on pulse beetle, *Callosobruchus chinensis* (L.) infestation in two popular pigeonpea cultivars grown in Telangana, PRG 176 and TDRG 4. These varieties were tested in hermatic bags (Super grain bags) at three different moisture regimes (9%, 11% and 13%) at Seed Entomology Laboratory, Seed Research and Technology Centre and Department of Seed Science and Technology, College of Agriculture Rajendranagar, PJTSAU, Hyderabad, Telangana during 2021-22. The experiment was laid out in two factor factorial experiment based on completely randomized design (CRD). Data on adult emergence, per cent seed damage and per cent weight loss was taken at two months interval for a period of six months. The results revealed that per cent seed damage observed in PRG 176 and TDRG 4 was 0.34% and 0.06%, respectively. With respect to seed moisture levels the highest (0.38%) pulse beetle infestation was recorded at 13% followed by 11% (0.22%) and least in 9% moisture level. These findings evidenced that seeds with low moisture content helps in reducing insect infestation and retaining seed quality of pigeonpea seed for long duration.

Keywords: Pigeonpea, Seed moisture content, *Callosobruchus chinensis* (L.), PRG 176, TDRG 4.

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) Millsp.) commonly known as redgram, tur or arhar is a very old well known crop of this country as its domestication in the Indian subcontinent is of 3500 years ago. After gram, arhar is the second most important pulse crop in country. In Telangana, pigeonpea is being cultivated in array of soils under erratic distribution of rainfall cultivation occupying area, production, and productivity of 2.95 lakh hectares, 2.07 lakh tones and 701 kg ha^{-1}, respectively (DES Telagana 2019-20). It is the major crop grown in Mahbubnagar, Adilabad, Rangareddy, Medak, Nalgonda, Warangal and Kammam districts of Telangana.

The important storage pest of pigeonpea is *Callosobruchus chinensis* (L.). In storage, adults are facultative aphagous and they depend entirely on resources acquired during larval stages for survival and reproduction (Stearns, 1992). In case of heavy infestation by *Callosobruchus chinensis*, the seeds lose their germination capacity and if exploited as grains, they become unfit for human consumption. In addition to quantitative losses, the *Callosobruchus chinensis* also causes qualitative losses (Khare and Johari 1984). In most cases pest infestation pre-dispose the stored grains to secondary attack by disease causing pathogens.

The most important factors influencing seed quality and longevity during its storage are temperature, seed moisture content and relative humidity. Among them the seed moisture content plays a key role. Since seeds are hygroscopic in nature and the moisture content of the seed changes in accordance to the relative humidity of the surrounding environment in which they are stored. In tropical climate, high temperature and humidity cause rapid deterioration of seed in open storage resulting predisposing to pest infestation and pathogen attack, further which leads to loss in vigour, viability and germination percentage which results in poor plant stand in main field.

Generally, the moisture content of the pigeonpea seeds harvested at physiological maturity is high. For safe

seed storage the moisture content need to be brought down to 9-10%, since these are orthodox seeds their moisture content can be further reduced so as to improve their storage life. Hence the present experiment was taken up to determine the effect of seed moisture content on incidence of pulse beetle, *Callosobruchus chinensis* infestation on two majorly grown pigeonpea cultivars (PRG 176 and TDRG 4) in Telangana.

MATERIALS AND METHODS

The experiment was conducted in the Seed Entomology Laboratory, Seed Research and Technology Centre and Department of Seed Science and Technology, College of Agriculture Rajendranagar, PJTSAU, Hyderabad, Telangana during 2021-22. The experiment was conducted in Two Factorial Completely Randomized Design (FCRD) with three different seed moisture levels and two popular pigeonpea cultivars as two factors and with three replications. The two popular pigeonpea cultivars grown in Telangana *i.e* TDRG 4 and PRG 176 were procured from Agricultural Research Station Tandur and Agricultural Research Station Palem, respectively later these were disinfested by sundrying for four days.

V1 : PRG 176
V2 : TDRG 4

The moisture content of each variety were maintained at 9%, 11% and 13% moisture level by adding predetermined quantity of water to the seeds according to the formulae given by El-Rafie 1958. Later the seeds were kept in hermetic bags.

S1 : 9%
S2 : 11%
S3 : 13%

Seeds of each cultivar TDRG 4 and PRG 176 were stored in moisture and vapour proof bags (GrainPro bags) at three different moisture levels (9%, 11% and 13%) by adapting standard procedure. For each replication of the treatment, twenty five pairs of newly emerged adult pulse beetle were released into GrainPro bags containing five Kg seed and allowed to copulate. The bags were labelled accordingly and kept in laboratory at ambient room condition. The influence of seed moisture content on incidence of pulse beetle was assessed based on data recorded at bimonthly intervals upto six months of storage period on parameters like adult emergence, per cent seed damage and per cent weight loss due to pulse beetle, *Callosobruchus chinensis* (L.) infestation.

Adult emergence. The number of adult emerged was counted at two months interval for a period of six months.

Per cent seed damage. The seed damage was calculated by taking a random sample of 400 seeds and counting the number of seeds with bored holes made by pulse beetle and converted to percentage.

$$\text{Seed damage (\%)} = \frac{\text{Number of damaged seeds}}{\text{Total no. of seeds}} \times 100$$

Per cent weight loss. The count and weight method was used to determine seed weight loss using the formula:

$$W(\%) = \frac{(Wu \times Nd) - (Wd \times Nu)}{Wu \times (Nd + Nu)} \times 100$$

Where,
W → Weight loss (%)
Wu → Weight of undamaged seed(grams)
Nu → Number of undamaged seed,
Wd → Weight of damaged seed (grams)
Nd → Number of damaged seed.

RESULT AND DISCUSSION

Effect of seed moisture on adult emergence from pigeon seeds. The results obtained from the studies on the effect of seed moisture levels (9%, 11% and 13%) on number of adults emerged from pigeonpea seeds of two popular cultivars which were artificially inoculated with *C. chinensis* (L.) are presented in Table 1.

At two months of storage, as observed from data mean number of adult emerged showed significant difference between the varieties, the highest mean number of adult emerged (9.89) was recorded in PRG 176 and the lowest (7.67) in TDRG 4. The number of adult emerged showed increasing trend with increase in moisture level as the mean number of adult emerged were 3.50, 8.83 and 14.00 at 9%, 11% and 13% moisture level, respectively irrespective of varieties. The interaction effect between two cultivars and different moisture levels revealed that PRG 176 showed maximum number of adults emerged (15.00) at 13% moisture level and minimum (2.00) in TDRG 4, at 9% moisture level. Similar trend was observed in four and six months after storage. From the perusal of data on six months after storage, the population buildup of pulse beetle showed further decreasing trend compared to two and four months after storage.

At each moisture levels significant higher insect population was found in PRG 176 than TDRG 4, inferred that PRG 176 was most susceptible than TDRG 4. During the experimental period noticeable insect population was observed at two months after storage but along the storage period the adult emergence showed decreasing trend, the population buildup was low at hermetic storage condition. The reduction could be attributed to high carbon dioxide concentration generated within the containers throughout the storage period and also due to high temperature (42°C) and lower relative humidity (65%) encountered during storage period, that accelerated the carbon dioxide toxicity.

The present findings are in accordance with Navarro (2012) who reported that the lower the grain moisture content and the low intergranular humidity, higher will be the mortality due to the desiccation effect on insects caused by low O_2 or elevated CO_2 concentrations further, atmospheres with 60 % CO_2 and 8 % O_2 are very effective against internal seed-feeding insects. (Banks and Annis 1990).

Low moisture content in grains caused a dehydrating effect on the immature stages of insect development, since insects require the moisture within the grain in order to mature and reproduce (Oxley and Wickenden (1963) and Calderon and Navarro (1980)).

The results are also supported by findings of Mudrock (2012) who reported that under hermatic storage, low oxygen (hypoxia) and elevated levels of carbon dioxide (hypercarbia) leads to cessation of larval feeding, that arrests the growth and development and thus reproduction rate is also affected.

Effect of seed moisture on per cent seed damage caused by pulse beetle, *Callosobruchus chinensis* (L.). The results obtained from the effect of seed moisture levels (9%, 11% and 13%) on per cent seed damage caused by *C. chinensis* (L.) in pigeonpea seeds of two popular cultivars are presented in Table 2.

After two months of storage, the mean per cent seed damage showed significant difference between two varieties, as mean per cent seed damage of 1.69%, and 1.33% was recorded in PRG 176 and TDRG 4, respectively. It was observed that per cent seed damage was positively related with seed moisture level. Mean seed damage recorded was 0.75%, 1.50% and 2.29% at 9%, 11% and 13% moisture level, respectively irrespective of varieties. The interaction effect between the two cultivars and different moisture levels revealed that PRG 176 had maximum seed damage (2.33%) at 13% moisture level, whereas minimum seed damage (0.41%) was recorded in TDRG 4 at 9% moisture level.

From the perusal of data at four months after storage, the interaction effect between the two cultivars and different moisture levels revealed that PRG 176 showed maximum seed damage (1.00%) at 13% moisture level and no seed damage in TDRG 4, at 9% moisture level. Along the storage period seed damage showed decreasing trend in both the varieties as adult emergence is reduced along the storage period compared to two months after storage.

After six months of storage, it was observed that seed damage caused by pulse beetle showed further decreasing trend compared to four and two months after storage. A significant difference was observed between the varieties for mean per cent seed damage, the highest mean seed damage (0.34%) was recorded in PRG 176 and lowest (0.06%) in TDRG 4. The mean per cent seed damage with respect to seed moisture levels showed increasing trend as the per cent seed damage was zero, 0.22% and 0.38% at 9%, 11% and 13% moisture level, respectively irrespective of varieties. The interaction effect between two cultivars and different moisture levels (9%, 11% & 13%) revealed that PRG 176 showed maximum seed damage (0.58%) at 13% moisture level and no seed damage in TDRG 4, at both 9% and 11% moisture level and at 9% moisture level in PRG 176. The reduction in per cent seed damage along storage period was observed due to decline in adult emergence, as influenced by storage container (Hermetic bag). Among the two cultivars PRG 176 showed maximum seed damage at each moisture levels compared to TDRG 4.

Among the different moisture levels (9%, 11% and 13%) irrespective of varieties along the storage period seeds stored at 9% moisture level remained mostly free from damage, indicate that less seed moisture is usually unfavorable for insect infestation. This results are in accordance with Oxley and Wickenden (1963) and Calderon and Navarro (1980), who reported that that the low moisture content in grains causes a dehydrating effect on the immature stages of insects, since insects need moisture to complete their life cycle.

The results are in accordance with findings of Aryal *et al.* (2019) who reported that, highest weevil infestation (19%) was found in maize seed stored at moisture content of 11% and least (12%) in seed with moisture content of 9% for a storage period of two years under hermatic condition, further they concluded that high moisture content resulted in increased insect activity.

Effect of seed moisture on per cent weight loss caused by pulse beetle, *Callosobruchus chinensis* (L.) in pigeonpea seeds. The results obtained from the effect of seed moisture levels (9%, 11% and 13%) on per cent weight loss caused by *C. chinensis* (L.) in pigeonpea seeds of two popular cultivars are presented in Table 3.

After two months of storage, the results on mean weight loss showed significant difference between the varieties. The highest mean weight loss of (0.397%) was recorded in PRG 176. While, lowest (0.267%) in TDRG 4. The results at different moisture levels revealed that weight loss increased with increase in moisture level. Mean weight loss of 0.195%, 0.324% and 0.475% was recorded at 9%, 11% and 13% moisture level, respectively. The interaction effect between the two cultivars and different moisture levels it was observed that, among the two cultivars PRG 176 showed maximum weight loss (0.590%) at 13% moisture level and minimum weight loss (0.160%) in TDRG 4 at 9% moisture level.

From perusal of data at four months after storage, among the two cultivars stored at different moisture levels PRG 176 showed maximum weight loss (0.213%) at 13% moisture level and TDRG 4 showed zero weight loss at 9% moisture level. After six months of storage similar trend was observed. The interaction effect between two cultivars and different moisture levels (9%, 11% & 13%) revealed that PRG 176 showed maximum weight loss (0.168%) at 13% moisture level and zero weight loss was recorded in TDRG 4, at both 9% and 11% moisture level and also at 9% moisture level in PRG 176.

Among the two cultivars PRG 176 showed maximum weight loss at each moisture levels compared to TDRG 4. Thus PRG 176 was found to be more susceptible to pulse beetle infestation than TDRG 4.

The results are in accordance with findings of Aryal *et al.* (2019) who reported that, highest weevil infestation and per cent weight loss was found in maize seed stored at moisture content of 11% (2.26 %) and least in seed with moisture content of 9% (1.43%), under hermatic condition and they concluded that the lower weight loss at 9% seed moisture content is due to lower number of weevil infestation in which biological activity of insect pest reduced at low seed moisture content.

Table 1: Effect of seed moisture content on number of adults emerged from pigeonpea seeds.

SMC / Variety	Adult emergence											
	2 MAS				4 MAS				6 MAS			
	S1 (9%)	S2 (11%)	S3 (13%)	Mean	S1 (9%)	S2 (11%)	S3 (13%)	Mean	S1 (9%)	S2 (11%)	S3 (13%)	Mean
V1	5.00 (2.45)	9.67 (3.26)	15.00 (4.00)	9.89 (3.33)	1.78 (1.67)	5.00 (2.45)	7.00 (2.83)	4.59 (2.32)	0.00 (1.00)	1.00 (1.41)	3.00 (2)	1.33 (1.47)
V2	2.00 (1.72)	8.00 (3.00)	13.00 (3.74)	7.67 (2.82)	0.67 (1.29)	2.00 (1.73)	5.00 (2.45)	2.56 (1.82)	0.00 (1.00)	0.00 (1.00)	1.63 (1.62)	0.55 (1.21)
Mean	3.50 (2.08)	8.83 (3.13)	14.00 (3.87)		1.22 (1.48)	3.50 (2.09)	6.00 (2.64)		0.00 (1.00)	0.50 (1.21)	2.32 (1.81)	
	C.D(P=0.05)		SE(m)±		C.D(P=0.05)		SE(m)±		C.D(P=0.05)		SE(m)±	
V	0.42		0.14		0.08		0.03		0.024		0.008	
S	0.52		0.17		0.10		0.03		0.03		0.01	
(VXS)	0.73		0.24		0.14		0.05		0.04		0.014	
CV (%)	4.65				2.19				2.63			

Figures in parentheses are square root transformed values MAS – Months after storage
V – Pigoenpea varieties (V1→ PRG 176, V2 → TDRG 4) S – Seed moisture content (S1→ 9%, S2→11%, S3→ 13%)

Table 2: Effect of seed moisture content on seed damage caused by *C. chinensis* in pigeonpea seeds.

SMC / Variety	Per cent seed damage											
	2 MAS				4 MAS				6 MAS			
	S1 (9%)	S2 (11%)	S3 (13%)	Mean	S1 (9%)	S2 (11%)	S3 (13%)	Mean	S1 (9%)	S2 (11%)	S3 (13%)	Mean
V1	1.08 (5.96)	1.67 (7.42)	2.33 (8.78)	1.69 (7.39)	0.17 (2.34)	0.75 (4.97)	1.00 (5.74)	0.64 (4.35)	0.00 (0)	0.44 (3.81)	0.58 (4.37)	0.34 (3.28)
V2	0.42 (3.7)	1.33 (6.63)	2.25 (8.62)	1.33 (6.32)	0.00 (0)	0.17 (2.34)	0.74 (4.94)	0.30 (2.43)	0.00 (0)	0.00 (0)	0.17 (2.33)	0.06 (0.78)
Mean	0.75 (4.83)	1.50 (7.02)	2.29 (8.70)		0.08 (1.17)	0.46 (3.65)	0.87 (5.34)		0.00 (0)	0.22 (1.90)	0.38 (3.35)	
	C.D(P=0.05)		SE(m)±		C.D(P=0.05)		SE(m)±		C.D(P=0.05)		SE(m)±	
V	0.0736		0.0239		0.0392		0.0135		0.0027		0.0008	
S	0.0902		0.0292		0.0487		0.0158		0.0033		0.0011	
(VXS)	0.1276		0.0414		0.0681		0.0226		0.0046		0.0015	
CV (%)	4.74				8.04				1.35			

Figures in parentheses are arsenic transformed values MAS – Months after storage
V – Pigoenpea varieties (V1→ PRG 176, V2 → TDRG 4) S – Seed moisture content (S1→ 9%, S2→11%, S3→13%)

Table 3: Effect of seed moisture content on weight loss caused by *C. chinensis* in pigeonpea seeds.

SMC / Variety	Per cent weight loss											
	2 MAS				4 MAS				6 MAS			
	S1 (9%)	S2 (11%)	S3 (13%)	Mean	S1 (9%)	S2 (11%)	S3 (13%)	Mean	S1 (9%)	S2 (11%)	S3 (13%)	Mean
V1	0.231 (2.752)	0.370 (3.482)	0.590 (4.404)	0.397 (3.546)	0.065 (1.458)	0.151 (2.226)	0.213 (2.64)	0.143 (2.108)	0.000 (0)	0.115 (1.94)	0.168 (2.32)	0.094 (1.78)
V2	0.160 (2.292)	0.283 (3.046)	0.359 (3.435)	0.267 (2.924)	0.000 (0)	0.022 (0.83)	0.184 (2.46)	0.069 (1.097)	0.000 (0)	0.000 (0)	0.022 (0.85)	0.007 (0.28)
Mean	0.195 (2.522)	0.324 (3.264)	0.475 (3.919)		0.032 (0.729)	0.087 (1.528)	0.199 (2.55)		0.000 (0)	0.058 (0.97)	0.095 (1.58)	
	C.D(P=0.05)		SE(m)±		C.D(P=0.05)		SE(m)±		C.D(P=0.05)		SE(m)±	
V	0.0169		0.0055		0.005		0.001		0.0024		0.0007	
S	0.0207		0.0067		0.006		0.002		0.0029		0.0009	
(VXS)	0.0293		0.0095		0.008		0.003		0.0042		0.0013	
CV (%)	4.97				4.24				4.59			

Figures in parentheses are arsenic transformed values MAS – Months after storage
V – Pigoenpea varieties (V1→ PRG 176, V2 → TDRG 4) S – Seed moisture content (S1→ 9%, S2→11%, S3→ 13%)

SUMMARY AND CONCLUSION

The study found that seeds stored at low moisture level *i.e.* 9% moisture showed lowest pulse beetle infestation and maintain the physical quality of pigeonpea seeds better than seeds stored at high moisture level (11% and 13%). Hence maintaining the low moisture content contributes in reduced pulse beetle infestation thus helps in maintaining better vigour and viability of seeds. In the present study it was observed that PRG 176 was most susceptible to pulse beetle infestation than TDRG 4. Since pigeonpea seeds are orthodox seeds their moisture content can be lowered further to safe moisture levels for better storage life, thus helps in maintaining good vigour and germinablity.

FUTURE SCOPE

Storage of seeds at high seed moisture level results in loss of vigour and germinability of seeds at a faster rate thus seeds should be dried to safe moisture level before storage which helps in preventing the insect pest infestation and maintaining better seed quality. Thus it

is necessary to come up with future research works on safe, environmental friendly and economical seed drying techniques (sundrying, desciccant beads, amorphous silica dusts etc.,) which could be accessible even under farmers level for safe storage of seeds.

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