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# Damage and Weight Loss Due to *Callosobruchus chinensis* Infestation in Arhar and Their Effect on Germination during Storage of Most Susceptible Months

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**Abstract:**
India is at the top in the area of cultivation as well as production of pulses which is about 35% of global acreage and 25% of the world's production. Large group of the population is still vegetarian and pulses are part of their staple diet. The low fat and high fiber content in addition to small amounts of essential amino acids enhance the nutritional value of pulses. PEM is a type of malnutrition which occurs due lack of adequate amount of protein in diet. The production and consumption gap of 3.8 million tons of pulses culminated into import of not less than 4 million tons. Pulses are attacked by insect pests; *Callosobruchus sp*p is most serious pest. Infestation starts in the agricultural field even prior to harvesting and continues during storage causing significant loss of grains. Present work has been done to assess the damage caused by *Callosobruchus* spp. and their effect on germination of various high yielding varieties of Arhar during storage of most susceptible period. Two varieties of Arhar grains were infested during the rainy season having a min. and max. Temperature range of 23.6$^0$c -33.7$^0$c and percentage RH 63-69. Eggs appeared on the surface of grains. Larva developed inside the grains; fed on the cotyledon and moulted into adults. The adults emerged out of the grains by making holes causing substantial damage and weight loss. The data obtained from the present work indicates severe damage of 61.34 % and 61.59 % grain content loss and weight loss of 50.26% and 49.8 % in both varieties of pulse grains. All of the damaged grains were not unviable from germination point of view. But a significant loss of germination was also recorded.

**Keywords:** PEM, Nutritional Value, Damage, Weight Loss, Unviable, Germination, Essential Amino Acids

## INTRODUCTION

Pulses are vegan protein source, produced by leguminous plants. In India a large group of population is still vegetarian and pulses are part of their staple diet. The low fat and high fiber content add to the nutritional value of pulses and make it the most popular food item now a days. Besides, cheapest source of protein available to rural and weaker section of society is the pulse grains.PEM is a type of malnutrition which occurs due lack of adequate amount of protein in diet. RDA (recommended daily allowance) for protein is 0.8 g/kg of body weight; it is recommended for adult male and female as 60 g/day and 55 g / day respectively. To combat PEM is a great challenge for agriculture. However India is largest producer and consumer of pulses in world. As per the Data gathered from Govt. of

India, Directorate of Pulse development Ministry of Agriculture & FW, (DAC & FW), Bhopal M.P.; Globally pulses are grown in an area of about 81 million ha with 73 million tons production. India is at the top for both, the area of cultivation as well as production of pulses; which is about 35% of global acreage and 25% of the world's production. In past few years the pulse yields has reduced and number of consumers increased. Thus current scenario spotlighted India as a largest producer as well consumer of pulses and manifestation of gap in demand and supply leading to not less than 4 million tons of pulses import to fulfill the current requirement. India is agriculture based country. Economy of India largely depends on agriculture. Pulses are grown in almost all parts of country. Less production of pulses may cause an economic loss to the country. The leguminous plants of these pulse grains are important from agriculture point of view as they increase the soil nitrogen content by fixing atmospheric nitrogen into the soil.

In India pulse grains are cultivated in all parts , but the major Arhar producing states are Maharashtra, Karnataka, Madhya Pradesh, Uttar Pradesh, Gujarat and Andhra Pradesh which contribute 33.6%, 15% 10.5%, 10.1 %, 8.8%, 7.8% respectively of total Arhar production. These six states contribute about 86% of Arhar. Net daily availability for Indians has increased slightly from 35.5 g per capita in 2007 to 41.9 g per capita in 2013. The production gap of 3.8 million tons culminated into import of 4 million tons of pulses from Myanmar, Tanzania, Australia, Russia, USA, Canada, Ukraine, Uzbekistan etc. The major import share belongs to peas 39% followed by urad / mung bean 16%, pigeon pea 13 % and chickpea 12% To promote the pulse production Govt. of India has implemented NFSM which include various developmental interventions like improved technology, quality seeds, integrated pest management. Besides number of factors like unfavorable monsoon, poor quality of seeds and lack of advanced techniques in agriculture insect pests of storage are the one of major causes of lesser yields of pulses. Insect pests cause damage of crop grains in field as well as storage condition. Insect pest attack is one of the major curtailments in productivity of pulses. Substantial destruction of pulse grains in storage condition as well as in field was found by (Sherma, 1989). (Aslam et. al., 2002) observed *Callosobruchus chinensis* as a notorious pest of chickpea, mung, pea, cowpea, lentil and Arhar. In last 4 decades only marginal increase in pulse production and astronomical losses during post harvest storage is attributable to the pulse beetle (PB) *Callosobruchus chinensis* L (Coleoptera : Bruchidae) (Mendki et. al., 1999). On getting suitable temperature and humidity pest population grows rapidly in the stored pulse grains. The eggs appeared on the surface of grains can be observed easily. Larva develops inside the grains and so they are not visible apparently. They feed on the cotyledon and moult into adult. Adults emerge out of the grains by making holes. The larval feeding on the nutritional contents of the grains cause damage which leads to weight loss, inferior quality and quantity properties (Atwal, 1976), and potential loss of germination of the infested grains (Booker, 1967).

Study also shows that larva and adult both are found inside the grains usually and cause a potential loss of legume by feeding on the protein content of the grains and their damage ranges from 12-30% (FAO 1994). A potential loss in legume is caused by the pest bruchid; about 55-69% loss in seed weight and 45.6-66.3% loss in content of chickpea (Gugar and Yadav1978) and up to 100% loss in susceptible grain legumes (Borikar and Puri 1985);(Magagula and Maina 2012).With the increased duration of the infestation and emergence of new adults number of holes increases on the grain surface. Weight loss in the grains is due to the exit holes of the insects. Due to feeding activities of larvae seed grains may be completely hollowed .When adults come out of the seed grains their emergence holes may be evident (Giga et. al., 1978). (Gosh and Durbey, 2003) found 40-50% losses of pulse grains during storage due to insect pest *Callosobruchus chinensis*; a major economically important pest of stored grains. The quantitative and qualitative losses due insect pest bruchid make the seeds not suitable for planting and consumption (Ali et. al., 2004). Aslam (2004) accounted *C. chinensis* as a major pest of pulses he also noticed 10 % damage of Chickpea which make the grain not suitable for consumption. Result was also in accordance with Tun (1979). Germination loss due to the attack of storage pests on cereals and pulse grains ranges from 3-37 and 4-88% respectively. The weight loss of these grains also ranges from 4.4-14 and 9-29.7% for cereals and pulse respectively (Adugna et. al., 2003). Present work has been done to assess the damage caused by Callosobruchus spp. and their effect on germination of two high yielding varieties of Arhar during storage of most susceptible period.

## MATERIAL AND METHOD

To assess the damage, weight loss and germination loss due to infestation of Callosobruchus spp in pulse grains of arhar of two varieties; the experiments were conducted in following steps: procurement of pulse grain varieties, procurement of insect pest .preparation of main culture and preparation of experimental sets and control set.

**Preparation of main culture:** After procuring the healthy pulse grain seeds from authentic seed center first it was cleaned and sun dried to check and ensure any infestation from procurement site. Infested grains of experimental materials; pulse grains were also fetched to grow the insect pest population. 500 g of both varieties of pulse grains were taken into a cleaned and sun dried plastic jars. After identification of male and female the 5 pairs of insect pests were introduced into the jars from the infested grains. Careful observation was made to notice the appearance of eggs and the emergence of new adults in the jars. A fresh culture was maintained by segregating freshly emerged adults and introducing them into new sets of jars..

**Preparation of experimental sets:** 50 g of cleaned and sun dried grains of both types were taken into different plastic jars. Jars were covered by thin cloths with the help of rubber bands .Freshly emerged one day old adult male and female pests were introduced into all experimental sets. Experimental sets were replicated for each grain.

**Observation:** Regular and careful observations were taken and it was noticed that after emergence of adults, the grains were damaged. The adults emerged out by making holes on the seed surface. Successive generations appeared in the experimental sets and after one month and eight days the grains were found to be damaged to different extent. The infested grains were with one to many holes. The infested grains were segregated into four different categories. The dirty physical appearance and foul smell of grains were remarkable during observation. Experimental sets were replicated. A mean of the Data thus obtained was presented in tables and analyzed.

## RESULT AND DISCUSSION

Data obtained after 38 days of most susceptible months for infestation shows that the grains damaged to different extent and were categorized into 4 types; grains with one hole, two holes, three holes, and four holes. Numbers of damaged grains of all these types were counted. These were found 160, 41, 14 and 4 grains and 114, 31, 11, and 6 grains with one hole, two holes, three holes, and four holes in smaller and larger varieties respectively. Total no of damaged grains were 219 and 162 in both types of grains. Altogether 138 and 99 grains were not damaged at all in both types of grains. Damage caused apparent content loss .Weight loss (%) and content loss (%) was calculated. The total number of undamaged grains was subtracted from the sum total of different categories of damaged grains. Percent damage was calculated which was recorded as grain content loss of 61.34% in smaller variety and 61.59 % in larger variety.

Weight loss of different categories of damaged grains ranges from 0.22 g - 03.2 g in smaller variety and 0.36g - 3.2 g in larger variety .The total weight of damaged grains (Weight of all the categories of damaged grains) was taken it was subtracted from the same no of healthy seed grains. Percent loss of weight was calculated. Total weight of damaged grains was 24.9 g. Weight of same number of grain was 30.47g. Weight loss in this case is 5.57 g and percent weight loss is 18.2%. Whereas considering the total weight of experimental material; larger variety which is 50 g the weight loss is 25.1 g and percent loss is 50.2%. For smaller variety total weight of damaged grains is 25.105 .Weight of same no of undamaged grains is 30.66 g. Weight loss in this is 5.55 g and percent loss is 18.1%. Considering the total weight of experimental material i.e. smaller variety grains which is 50 g the weight loss is 24.89g and percent loss is 49.89%. Data of both content loss and weight loss percent of the present work has some similarity with the finding of Gugar and Yadav 1978. They recorded 45.6-66.6 % content loss and 55-69 % weight loss in a legume due to bruchid infestation.

Calculation of germination loss due to damage: For Germination loss Total 24 Petri dishes were taken. These were cleaned and sterilized. All damaged seeds were divided into number of samples having minimum number of 6 grains to maximum number of 15 grains .Only one category of damaged seeds were taken in one. Grains of one sample were soaked overnight in one Petri dish and covered with another one. Healthy grains were also soaked into water in two sets of Petri dishes. All the soaked grains were taken into fine cloths and tied. All these were kept in separate Petri dishes and covered with other Petri dishes. These were allowed to germinate at normal room temperature and atmospheric moisture. All sets were monitored to ensure the moisten state of the seed grains. Germination data was collected from all sets and a mean percent value is presented in table 2. Loss of germination % was also calculated and presented in table 2.Percent germination of damaged seed grains in both varieties has been recorded as 66, 48, 18 and 0 in smaller variety with grains having one hole, two holes, three holes and four holes and 68, 50, 18, 0, in larger variety with grains having one hole, two holes, three holes, four holes. Thus grains with one hole, two holes, and three holes show a percent loss germination of 34%, 52%, 82% and 100% and 36%, 50%, 82%, 100% in smaller and larger variety respectively. Sharma and Bhalla (1988) reported that the percent loss of germination due to one hole, two holes, three holes and four holes grubs developing in pea seeds is 39.9, 79.5, 94.5 and 100%. Jotwani et al. (1967) recorded 49 %, 27 %, and 4 % germination from the seeds of cowpea in which bruchids develop and complete their development .Normal development expected in gram after 10 and 15 days of infestation but after completion of development it may be 54%, 36% and 18 % and in mung it may be 71 %, 2% and 0 % respectively supported by present studies .

**Table 1: Damage % and weight loss % of Arhar grains (larger) due to infestation of *Callosobruchus* Data of 50 g of Seed grains total (no of seed grains =263; Data of one month eight days)**

| S. No. | Grains Category of Damage | No. Seed grains | % Damage | Weight of Healthy Grains (g) | Weight of Damaged Grains(g) | Loss in wt (g) | % Loss in Weight |
|---|---|---|---|---|---|---|---|
| **1.** | Healthy Grains | 99 | …… | 18.8 | ----- | ----- | ----- |
| **2.** | Grains with one hole | 114 | 43.3 | 21.66 | 18.463 | 3.2 | 14.7 |
| **3.** | Grains with two holes | 31 | 11.78 | 5.73 | 4.402 | 1.39 | 24.3 |
| **4.** | Grains with three holes | 11 | 4.18 | 2 | 1.342 | 0.68 | 32.5 |
| **5.** | Grains with four Holes | 6 | 2.28 | 1.08 | 0.72 | .36 | 33.3 |

Total damage %=61.54

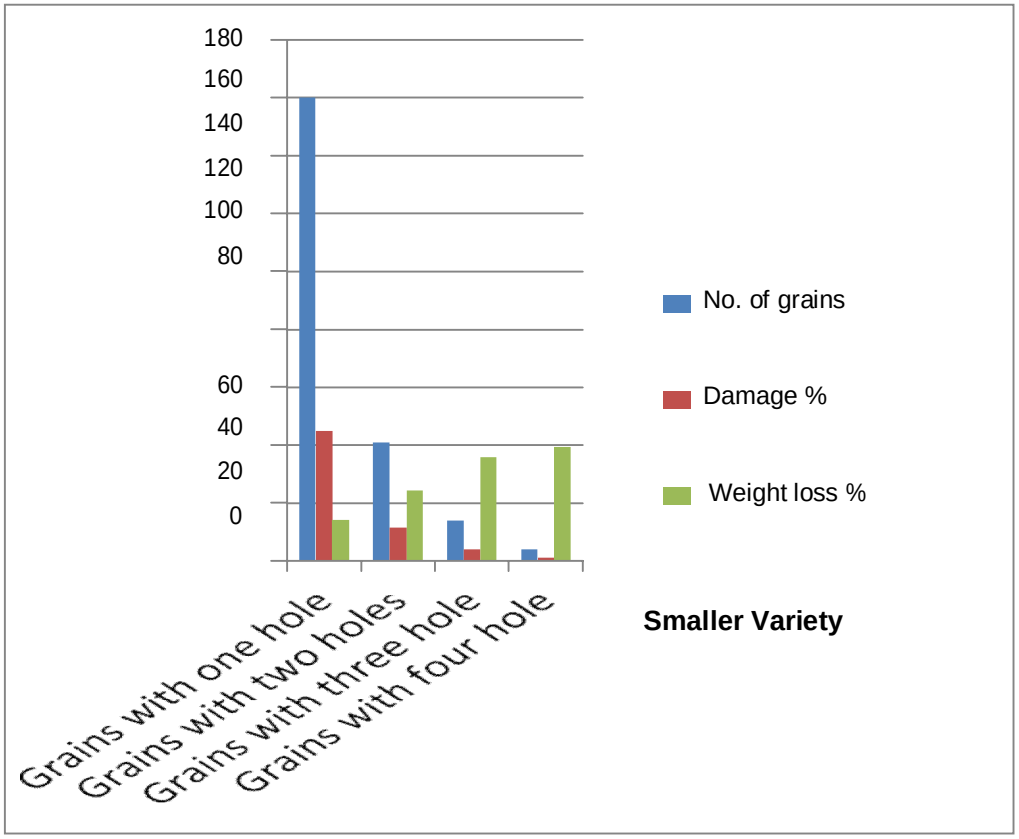
**Table 2: Damage % and weight loss % of Arhar grains (Smaller) due to infestation of *Callosobruchus***
**Data of 50 g of Seed grains total (no of seed grains =357; Data of one month eight days)**

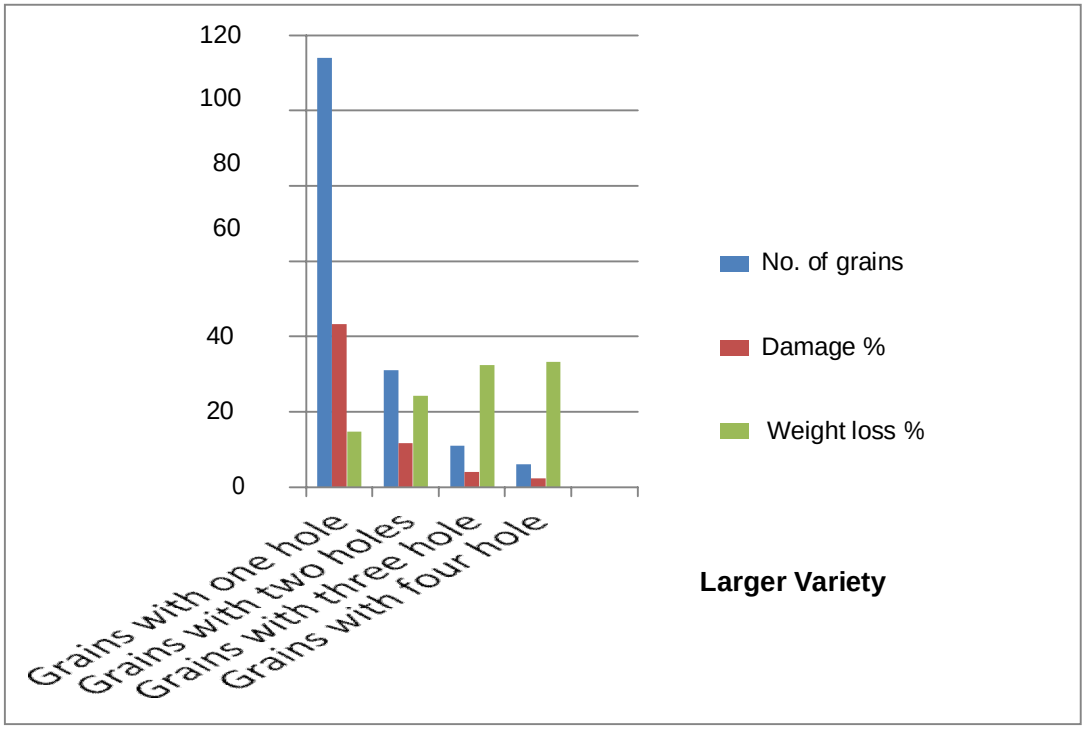
| S. No. | Grains Category of Damage | No. of Seed grains | % Damage | Weight Healthy Grains (g) | Weight of Damaged Grains (g) | Loss in wt (g) | % Loss in Weight |
|---|---|---|---|---|---|---|---|
| **1.** | Healthy Grains | 138 | …… | 19.3 | ----- | ----- | ----- |
| **2.** | Grains with one hole | 160 | 44.81 | 22.4 | 19.2 | 3.2 | 14.2 |
| **3.** | Grains with two holes | 41 | 11.48 | 5.74 | 4.305 | 1.4 | 24.3 |
| **4.** | Grains with three holes | 14 | 3.92 | 1.96 | 1.26 | 0.7 | 35.7 |
| **5.** | Grains with four holes | 4 | 1.12 | 0.56 | 0.34 | 0.22 | 39.2 |

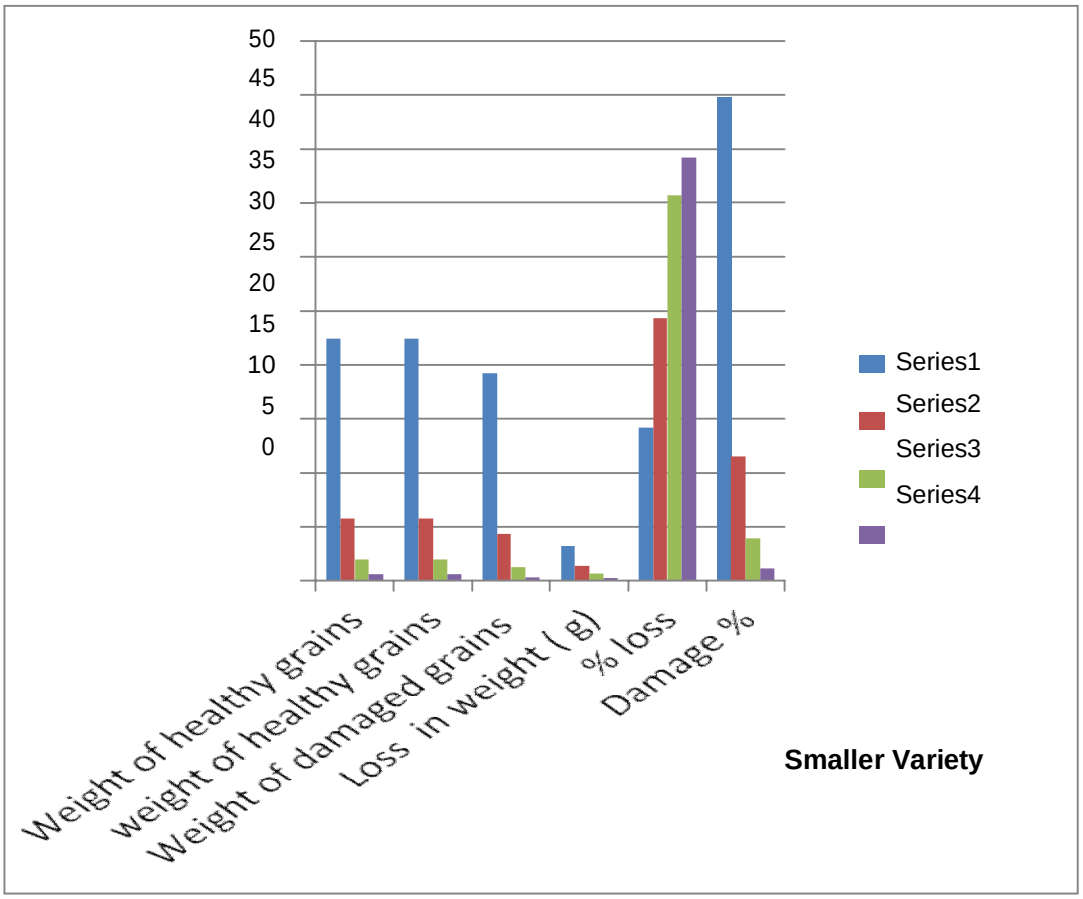
Total damage %=61.33

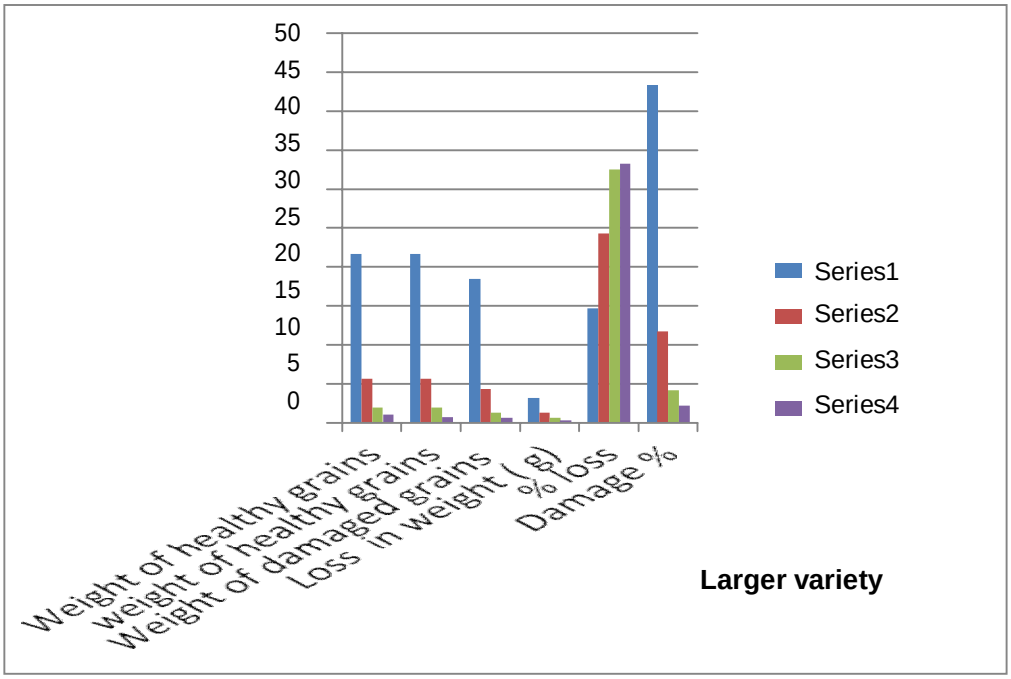
**Table 3: Germination percent of Control (healthy) and damaged grains**

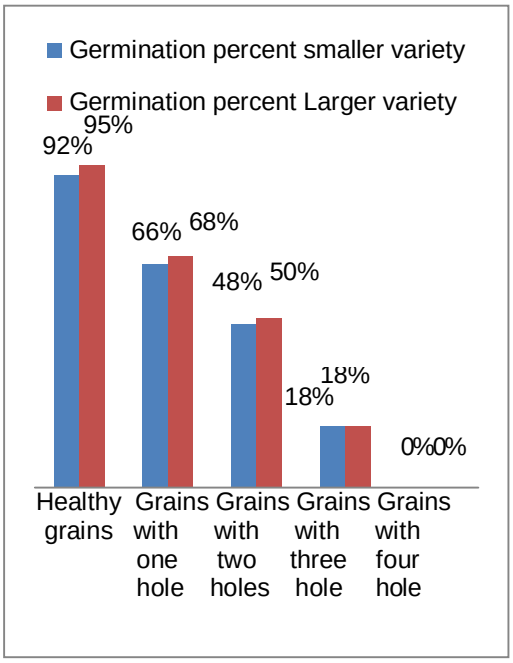
| S. No. | Seed grains status | Percent Germination of Smaller grains | Percent Germination of Larger grains | Loss of Germination (%) | |
|---|---|---|---|---|---|
| | | | | Smaller | Larger |
| **1.** | Control(Healthy grains) | 92 | 95 | ----- | ------ |
| **2.** | Grains with one hole | 66 | 68 | 34 | 36 |
| **3.** | Grains with two holes | 48 | 50 | 52 | 50 |
| **4.** | Grains with three holes | 18 | 18 | 82 | 82 |
| **5.** | Grains with four holes | ---- | 00 | 100 | 100 |
| **6.** | Mean % of germination loss | | | 42 | 33.6 |




120
100
80
60
40
20
0
No. of grains
Damage %
Weight loss %
Grains with one hole
Grains with two holes
Grains with three hole
Grains with four hole
Larger Variety


50
45
40
35
30
25
20
15
10
5
0
Series1
Series2
Series3
Series4
Weight of healthy grains
weight of healthy grains
Weight of damaged grains
Loss in weight (g)
% loss
Damage %
Smaller Variety




## CONCLUSION

Data obtained from the present work indicates that the damage to the pulse grains due to infestation ranges from moderate to severe depending upon the extent of damage of particular grain. But damage is apparent in all the infested grains. Existence of significant correlation between damage percent and weight loss percent and infestation can be justified .Loss of germination of damaged seed is also significant. A negative correlation of damage grains and weight loss and germination was

found. Apart from the weight loss and loss of germination one more remarkable observation of the experiment was the physical appearance and smell of infested grains. The dirty appearance due to large number of eggs on the surface of the grains and their foul smell make them unfit for consumption. This was also noticed by Aslam (2004) the report indicates 10% damage to chickpea by *C. chinensis* and making the grains not suitable for human consumption. So, the damaged seeds cannot be consumed. Nevertheless from germination point of view they may be used as data obtained from germination of all the categories indicates that all the seeds were not unviable. It is required to verify the germination of damaged grains productivity and quality of the grains obtained by sowing the seed grains into the soil.

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