Correlation between rice weevil infestation *Sitophilus oryzae* (Linnaeus) and seed quality parameters of maize (*Zea mays*. L) seed

ABSTRACT

The experiment was conducted at the Seed Research and Technology Centre, PJTSAU, Rajendranagar, Hyderabad, to investigate the impact of *Sitophilus oryzae* on the seed quality parameters of maize. Samples weighing 500g of maize variety DHM-117 were placed in plastic jars in three replications *S. oryzae* adults of 0, 5, 10, 15, and 20 pairs were separately released into each replicate of the maize seeds then these jars were placed in an incubator set at 25°C and 75% humidity. These jars were covered with lids equipped with aeration facilities. The adult emergence, germination percentage and moisture content were evaluated for every two months for a period of six months. An inverse correlation was observed between adult emergence with germination percentage and seedling vigour index while, adult emergence had showed positive correlation with moisture content.

Keywords: Rice weevil, *S. oryzae*, Seed quality, Correlation, DHM-117.

1. INTRODUCTION

Globally, Maize is known as queen of cereals. Maize plant parts has high economic value and are used to produce a large variety of food and non-food products. It is the most important crop grown in more than 166 countries across the globe including tropical, subtropical and temperate regions. It is cultivated in nearly 193.7 Mha with a production of 1147.7 MT and productivity of 5754.7 $kgha^{-1}$ all over the world. (3). Among the maize-growing countries, India ranks fourth in area and seventh in production representing around four per cent of the world maize area and two per cent of total production (2).

During storage maize seeds are damaged by many insects and pests which causes both qualitative and quantitative losses in tropical zones this damage is about 20-30% (4). Among the various stored product insects infesting maize, *S. oryzae* is one of maize's most critical, internal feeding

pests and one of the most important stored product pests. The management of quality should consider insect population fluctuation to establish an appropriate control (10).

This present research was aimed to measure the effect of different infestation levels of *S. oryzae* on quality of stored maize, considering adult emergence, germination percentage seedling vigour index and moisture content.

2. MATERIAL AND METHODS

The present research work was carried out at Seed Research and Technology Centre, PJTSAU, Rajendranagar, Hyderabad. Freshly harvested certified maize hybrid DHM 117 seed having high germination percentage and low moisture content were procured for the present investigation. After procurement, maize seeds were thoroughly cleaned by removing physical impurities. The seeds were incubated at a temperature of 55ºC for four hours to kill the immature stages of insects without affecting the viability of the seeds (8). After disinfestation, test insects of five, ten, fifteen, and twenty pairs were released into the plastic jars containing five hundred grams of maize seeds. Similarly, an untreated control was maintained [13,14]. To provide good aeration tiny punctures were made on the lids of plastic jars. After artificial infestation, plastic jars were labelled accordingly and placed in a BOD incubator maintained at temperature of 25±1ºC and humidity of 75%. The weevils were allowed to oviposit on the seeds for seven days and then removed. The effect of rice weevil infestation on seed quality parameters were assessed based on following observations (Adult emergence, germination percentage, seedling vigour index and moisture content). Correlation between adult emergence of *S. oryzae* with seed quality parameters were carried out at every two months for a period of six months. The statistical method described by Snedecor and Cochran (9) was adopted for the present investigation. The data was subjected to square root and angular transformation values wherever necessary and analysed by adopting Completely Randomized Design (CRD)

2.1 Methodology to record observations

2.1.1 Adult emergence (Per five hundred grams of seed)

The adult emergence was recorded by counting total number of adults emerged in each replication for every two months interval for a period of six months.

2.1.2 Germination percentage

Germination percentage of seed was calculated by using paper towel method (5). One hundred maize seeds were kept in moist paper towel and allowed to germinate in walkin germinator. Percentage of germination was calculated by using the formula.

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds}} \text{ x } 100$$

2.1.3 Seedling vigour index

To determine seedling vigour index, ten healthy germinated seedlings were taken on seventh day from each replication. The shoot and root length of each seedling was measured (cm) and average seedling length (cm) was calculated. The seedling vigour index was recorded by multiplying germination percentage with seedling length as per the guidelines given by Baki and Anderson (1973).

Seedling length = Shoot length (cm) + Root length (cm)

Seedling vigour index (SVI) = Seed germination percentage x Seedling length (cm).

2.1.4 Moisture content of seed (per cent)

Moisture content of seed was determined by using standard Dickyn John moisture metre.

4. RESULTS AND DISCUSSION

At the end of storage period, it was observed that with increase in initial population density of *S. oryzae* mean adult emergence was increased in all the treatments except control. Subsequently, germination percentage, seedling vigour were decreased while, moisture content was increased (Table 1). Final mean number of adult emergence for 5 pairs and 10 pairs of initial parental population density was 69.50 and 86.00, respectively while for 15 pairs and 20 pairs it was 148.75 and 169.00, respectively and no adult emergence was observed in control.

Germination percentage at end of storage period was in the range of 66.00 to 99.00% with highest in control (99.00%) where no parental population was released and lowest (66.00%) in treatment with highest initial parental population of 20pairs (Table 1).

Moisture content at the end of storage period was in the range of 11.63% to 16.58% with highest (16.58%) in treatment where highest initial parental population was released and lowest was observed in control (11.63) (Table 1).

At two months of storage during correlation studies between adult emergence with seed quality parameters, adult emergence had shown negative correlation with germination percentage (-0.96^{**}) and seedling vigour index (-0.95^{*}) and positive correlation with moisture content (0.97^{**}). (Table 2)

After four months of storage during correlation studies between adult emerge with seed quality parameters, adult emergence had shown negative correlation with both germination percentage (-0.98^{**}) and seedling vigour index (-0.94^{*}) and positive correlation with moisture content (0.97^{**}). (Table 2)

Similarly, at the end of storage period during correlation studies between adult emergence with seed quality parameters, adult emergence had shown negative correlation with germination percentage (-0.98^{**}) and seedling vigour index (-0.96^{*}) and positive correlation with moisture content (0.98^{**}). (Table 2)

The above findings were also in accordance with Canappele *et al*. (1) who observed positive correlation of insect infestation with adult emergence, weight loss and moisture content while, negative correlation was observed between insect infestation and germination percentage after 150 days of storage.

Zunjare *et al.* (12) reported that germination percentage of infected seeds was negatively correlated with adult emergence and seed damage.

These results corroborated with Kandalkard *et al*. (6), who found that after nine months of storage, insect infestation caused the increase in moisture content of sorghum seeds from 9.4 to 12.30%.

Okpile *et al*. (7) reported that seedling vigour index was decreased due to attack of seeds by *S. oryzae* and fungi.

5. CONCLUSION

From the results it was observed that with increase in initial parental population quality parameters of maize seed were decreased. Increase in initial parental population had lead to increase in adult emergence and moisture content while, germination percentage and seedling vigour index were decreased. During correlation analysis it was observed that adult emergence had shown negative correlation with germination percentage and seedling vigour index while positive correlation was observed with moisture content.

Table -1 Effect of *S. oryzae* initial parental population of adult emergence, germination percentage, seedlingvigour index and moisture content of maize seed

No . of insects	Adult emergence			Germination percentage			Seedling vigour index			Moisture content		
	2 MAS	4 MAS	6 MAS	2 MAS	4 MAS	6 MAS	2 MAS	4 MAS	6 MAS	2 MAS	4 MAS	6 MAS
5 pairs	13.00^{b} (3.67)	54.50^{b} (7.42)	69.50^{b} (8.36)	97.00^{b} (80.10)	89.50^{b} (71.12)	87.25^{b} (69.10)	3541^{b}	2926^{b}	2858^{b}	12.63^{b} (20.81)	13.08^{b} (21.19)	13.50^{b} (21.56)

10 pairs	17.25[c] (4.21)	72.50[c] (8.54)	86.00[c] (9.30)	95.25[c] (77.50)	78.25[c] (62.22)	77.50[c] (61.70)	2897[c]	2555[c]	2418[c]	13.65[c] (21.68)	14.68[c] (22.52)	14.88[c] (22.69)
15 pairs	22.00[d] (4.74)	134.50[d] (11.62)	148.75[d] (12.22)	92.75[d] (74.46)	70.50[d] (57.11)	68.75[d] (56.02)	2657[d]	2145[d]	2045[d]	14.73[d] (22.56)	15.75[d] (23.38)	15.95[d] (23.54)
20 pairs	32.00[e] (5.70)	162.25[e] (12.76)	169.00[e] (13.02)	86.50[e] (68.46)	64.00[e] (53.13)	63.00[e] (52.64)	2371[e]	1997[e]	1956[e]	15.73[e] (23.36)	16.23[e] (23.75)	16.58[e] (24.02)
Control	0.00[a] (0.71)	0.00[a] (0.71)	0.00[a] (0.71)	100[a] (90.00)	100[a] (90.00)	99.00[a] (84.26)	3806[a]	3804[a]	3801[a]	11.58[a] (19.88)	11.63[a] (19.93)	11.63[a] (19.93)
Grand mean	16.85	84.75	94.65	94.30	80.45	79.77	3055	2685	2615	13.66	14.27	14.51
CD (P= 0.05)	0.040	0.231	0.291	2.143	1.485	1.288	97.196	72.295	65.745	0.146	0.156	0.319
SE (m)±	0.013	0.076	0.096	0.710	0.492	0.427	32.244	23.983	21.811	0.048	0.052	0.036
CV (%)	0.692	1.867	2.211	1.820	1.477	1.313	2.111	1.786	1.668	0.447	0.467	0.107

The values in parentheses are angular transformed values except for adult emergence where they are square root transformed

MAS- Months after storage

Mean values followed by the same letter do not differ significantly (p=0.05)

Table 2. Correlation studies between biological parameters of *S.oryzae* and seed quality parameters of maize at different storage periods

Storage period	Two months of storage			Four months of storage			Six months of storage		
Seed quality parameters / Biological parameters	Germination percentage	Seedling vigour index	Moisture content	Germination percentage	Seedling vigour index	Moisture content	Germination percentage	Seedling vigour index	Moisture content
Adult emergence	-0.96**	-0.95*	0.97**	-0.98**	-0.94*	0.97**	-0.98**	-0.96**	0.98**

1. * Indicates correlation is significant at 5% (p=0.05)
2. **Indicates correlation is significant at 1% (p=0.01)

REFERENCES

1) Caneppele, M.A.B., Canappele, C., Lazzari, F.A and Lazzari, S.M.N. (2003). Correlation between the infestation level of *Sitophilus zeamais* Motschulsky, 1855(Coleoptera, Curculionidae) and the quality factors of stored corn, *Zea mays* L. (Poaceae). *Revista Brasileira de Entomolgica*, 47, 625-630.

2) Directorate of Economics and Statistics. (2022). Agricultural Statistics at a Glance 2021. Directorate of Economics and Statistics. Department of Agriculture and Farmers Welfare.

3) FAO. (2022). World food and Agriculture- Statistical year book 2020, Rome, Italy.

4) Haque, M.A., Nakakita, H., Ikenga, H., Sota, N. (2000). Development inhibiting activity of some tropical plants against *Sitophilus zeamaiz* Motshulusky (Coleoptera; Curculionidae). *Journal of Stored Products Research*. 36(*3*), 281-287.

5) ISTA. (2013). International rules for seed testing. International Seed Testing Association, Bassersdorf, Switzerland.

6) Kandalkard, H.G., Wanjari, S.B., Indira, B and Thawari, S.B. (2003). Studies on the storability of sorghum grains in different storage structures. *Journal of Entomology Research.* 27(*2*), 127-130.

7) Okpile, C., Zakka, U. and Nwosu, L.C. (2021) Susceptibility of ten rice brands to weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae), and their influence on the insect and infestation rate. *Bulletein of Natural Research Centre*: 45(*2*)

8) Singh, R.K. (1989). Effect of different rice varieties on the growth and development of *S. oryzae* Linn. *Ph. D* (*Zoology*) *Thesis.* Kanpur University, Kanpur.

9) Snedecor, M.E & Cochran, T.S. (1967). Statistical methods. Oxford and IBH publishing company, Bombay. 135-197.

10) Subramanyam, B & Hagstrum, R. (2000). Alternatives to Pesticides in Stored-Product IPM. *Kluwer Academic Publishers*, Dordreecht. pp. 321–380.

11) UNEP. (1994). Montreal protocol on substances that deplete ozone layer: report of the methyl bromide technical options committee Assessment. In: Rep., Ozone Secr. U.N. Env. Prog., Nairobi, Kenya. https://nepis.epa.gov/Exe/ZyNET.exe/00000 NDE.txt.

12) Zunjare, R., Hossain, F., Muthusamy, V., Jha, S.K., Kumar, P, Sekhar, J.C, Thirunavukkarasu, N and Gupta, H.S. (2016). Genetic variability among exotic and indigenous maize inbreds for resistance to stored grain weevil (*Sitophilus oryzae*) infestation. *Cogent Food & Agriculture*. 2(1): 137-156.

13) Venkata Divya A., Prabhavathi K., Shashikala T., Jagan Mohan Rao P., (2023). Assessment of Influence of Seed Invigoration Treatments on Seed Germination, Seed Quality and Seedling Vigour in Fodder Maize (Zea mays L.). International Journal of Environment and Climate Change, 13(10), 1308–1317. https://doi.org/10.9734/ijecc/2023/v13i102783

14) Yeruva, R. R., Rai, P. K., & Nagar, S. (2022). Effect of Pre-Sowing Seed Treatment of Selected Organics and Botanical on Growth, Seed Yield and Yield Attributting Tarits of Maize (Zea mays L.) Var. VNR-4226. International Journal of Plant & Soil Science, 34(23), 1–11. https://doi.org/10.9734/ijpss/2022/v34i2331554