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EFFECTS OF HOST GRAINS ON THE RICE WEEVIL *SITOPHILUS ORYZAE* (L.)

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ABSTRACT

The present study observed the effect of host grains on oviposition, emergence, body length, longevity and sex ratio of adults of *Sitophilus oryzae* (L.), an important storage pest of cereals. Grains of maize, rice, pearl millet and chickpea were evaluated in primary culture under laboratory conditions. The results revealed variations in the developmental period (from egg to adult)- the least was on maize (32.5 days) and maximum with pearl millet (43 days). The body length of the male and female also varied- females were longer than males in all the evaluated grains. Maximum fecundity and longevity were found in maize with 453 adults in the lifespan of 184 days. The female: male ratio was not affected in a significant manner with cereals (maize- 2.36:1, rice- 2.35:1 and millet- 2.21:1), but decreased to 1.98:1 with chickpea. A linear relationship with a significant correlation between grain loss and adult emergence was observed. These results reveal that S. *oryzae* exhibits host preference as its fecundity and longevity are significantly affected with various host grains.

Key words: *Sitophilus oryzae*, mass culture, maize, rice, pearl millet, chick pea, oviposition, developmental period, emergence, fecundity, longevity, adult length

Minimization of the post-harvest loss is one of the major concerns for the farmers. Sometimes the yield loss by insects in storage reaches as high as 60-70% (Dhaliwal et al., 2007; Derera et al., 2014). About 12-20% of weight loss in grains is common due to weevil infestation, which might reach up to 80% under favourable conditions (Pingali and Pandey, 2001; Tefera et al., 2013). Gujarat is one of the leading states of India in terms of agricultural production and post-harvest losses are serious. Storage insects not only reduce the weight in food grains, but also affect the quality, commercial value and seed viability (Reichmuth et al., 2007). About 500 species of insects are associated with stored products. Nearly 100 of these cause economic losses (Jain and Bhargava, 2007).

The rice weevil *Sitophilus oryzae* (L.) is internal feeder, lays eggs in or on the surface of grains, spend a part or entire larval and pupal life inside the grains and emerge as adults. Significant loss of germination is observed in many stored grains due to these. Farmers mainly depend on chemical control against such insect pests, but misuse and overuse of insecticides cause resistance and increase the survival rate of insect pests. To overcome this insect-specific control needs to be developed. For such control, one should have a better understanding of dynamics of insect life cycle. For mass rearing of such insect pests, pure primary culture is needed (Merville et al., 2014). Earlier studies evaluate the host preference of rice weevil on rice or modified diet (Danho et al., 2002; Ojo and Omoloye, 2012). There is a paucity of information on preference of food grains other than rice (Ojo and Omoloye, 2012; 2015; 2016). The present study evaluates maize, rice, millet and chick pea as host grains with *S. oryzae* in terms of biology- oviposition, emergence, fecundity, longevity, sex ratio etc. under laboratory conditions.

MATERIALS AND METHODS

Stock culture of *S. oryzae* was obtained from the stored grain warehouse at Vadodara, Gujarat. The culture was acclimatised to the laboratory conditions, the dead and live were separated, and then identity of species confirmed using taxonomic key (Halstead et al., 1969). From this stock, 25 pairs of adults were introduced into 200g grains of rice in 1 kg capacity plastic jars covered with mesh lids and were allowed to feed, mate, and oviposit. The cultures were kept under 25-28°C and 60-70% RH, and 12-hour photo phase. Cultures were observed daily until new progenies emerged, with the whole set up replicated four times. The pure culture from the fifth generation was removed and used in all further experiments after sexing with morphological characters described by Halstead et al. (1969).

Development and morphometrics of *S. oryzae* was studied in the samples from the stock culture described above. Egg period, fecundity, longevity, male: female ratio and body length were observed along with grain loss. Ten pairs of one-week-old male and female were introduced in 200 g grains of maize (*Zea mays*), rice (*Oryza sativa*), pearl millet (*Pennisetum glaucum*) and chickpea (*Cicer arietinum*) kept in 4.5 kg capacity plastic jars covered with mesh lids. These jars were maintained at 25-28°C, 60-70% RH and 12-hour photo phase, and weevils allowed to feed, mate, and oviposit for 7 days. The grains were observed for infestation, which was identified by the plug formation on the grains. Once the infestation was observed, the live adult weevils were removed, and the culture monitored until all adults emerged for a period of 60 days with recording of the number of adults emerged.

To determine the fecundity and longevity, single pair was introduced into 20 g of the four selected grains, replicated thrice, and kept in plastic jars covered with mesh lids at 25-28°C, 60-70% and 12-hour photo phase. After 7 days these pairs were shifted to fresh batch of heat sterilized grains and again kept for 7 days, and this repeated for 27 weeks. Fresh grains were given on every 7th day until the end of the experiment. The infested grains were separated in jars and observed for emergence. The total number of adults emerged were recorded along with their longevity. The weight of the grain before and after the exposure was used for computing grain loss. Means of emerged adults, grain loss, body length and sex ratios obtained were subjected to analysis of variance (ANOVA) with Minitab software package. Significance was observed at $p<0.05$ with the means compared using post-hoc Tukey's HSD test at $p\geq0.05$.

RESULTS AND DISCUSSION

The results revealed that the host grains evaluated viz., maize, rice, pearl millet and chick pea exhibited variations in the host preference of *S. oryzae*. Loss in grain weight, number of F_1 progeny and % grain damage differed significantly.

Table 1 provides the developmental period, number of adults emerged, grain loss and variation in male and female body length. The developmental period showed a significant difference ($p<0.001$). The least development period (from egg to emergence of adult) was observed with maize (32.5 days) followed by chick pea, rice and millet (35, 39 and 42 days, respectively). The progeny size (emergence) was also found to be significantly different- it was found to be maximum ($p<0.001$) in maize (226 adults) and the least (126 adults) with pearl millet. The grain loss was the maximum in maize (29.88%) and minimum with pearl millet (16.10%). This significant variation indicates the host preference and on which to lay more eggs for a maximum F_1 progeny.

Earlier estimates reveal the annual loss in stored grain by these pests from 15% to 57% with preference of different grains (Shivakoti and Manandhar, 2000; Upadhyay et al., 2001; Bhandari et al., 2015). In the present study, *S. oryzae* larvae reared on stored grains resulted in loss of 1.12 g/day in maize, while in other three grains it varied from 0.6 to 1.0 g/day. These observations corroborate with those of Ansari et al. (2003) on varieties of wheat and maize. The weight loss had also been correlated with the susceptibility and resistance in host grains (Dari et al., 2010; Derera et al., 2014; Garcia-Lara et al., 2014; Masasa et al., 2013; Zunjare et al., 2016). Due to the difficulty in visualizing the eggs and larvae, the number of larvae that emerged as adults in the respective cultures was observed. These observations revealed that the least time taken from an egg to adult was 32.5 days with maize, followed by chickpea, rice and millet (35, 39 and 43 days, respectively). These results are in accordance with earlier ones (Ojo and Omoloye, 2016; Subedi et al., 2009; Danho et al., 2002).

Grain hardness has been identified as an important mechanism of resistance against the maize weevil (Garcia-Lara et al., 2014), and according to Kelvin (2002) the snout penetration by the weevils into the grain depends on the hardness of the kernel. In the present study, peal millet being the hardest of the grains, there was reduced adult emergence. F_1 progeny size was observed to be large with maize, followed by chick pea, rice and pearl millet. The reduction in emergence might be due to low hatchability of eggs (Padmasri et al., 2017).

The body length of female was observed to be significantly more compared to male in the adults reared on the four food grains, and those reared on maize were larger in both male and females. Likewise, maximum fecundity and longevity were observed with maize (453 adults), followed by chickpea (299 adults), rice (214 adults) and pearl millet (142 adults). Campbell (2002) observed that seed size and competition among larvae can impact offspring survival and fecundity, which explain the present observations with maize. About male and female ratio, the female ratio in all the

Table 1. Biology and morphometrics of and grain loss by *S. oryzae* in four host grains

Host Grain	Incubation period	(F1 progeny) ±SE	Grain Loss ±SE (in g)	Body length (mm)		Fecundity	Female: Male	Longevity	Grain loss g/day	Grain consumed-1 larva/ day (mg)
				Male	Female					
Maize	32.5**	226±5.77** (202-241)	59.77±3.02** (29.88%) (49-65)	4.28±0.76** (4.17-4.31)	4.6±0.41** (4.51-4.87)	453±2.37** (422-494)	2.36:1**	184±1.52 (179-198)	1.12 ±1.53**	4.95±2.75*
Rice	39**	139±3.98** (122-158)	44.04±2.53** (22.02%) (41-49)	3.18±0.26** (3.02-3.28)	3.43±0.17** (3.37-3.49)	214±1.52** (201-236)	2.35:1**	175±2.01 (167-183)	0.83±2.43*	5.97±2.96*
Chickpea	35**	176±4.43** (163-186)	53.08±2.94 ** (26.54%) (51-68)	4.02±0.54** (3.82-4.07)	4.14±0.24** (4.10-4.26)	299±1.75** (271-315)	1.98:1**	180±2.57 (169-192)	1.0±1.09**	5.68±1.53**
Millet	42**	126±3.07** (116-132)	32.21±1.83 ** (16.10%) (27-39)	2.67±0.06** (2.64-2.69)	2.84±0.03** (2.79-2.91)	142±1.13** (135-152)	2.21:1**	157±2.01** (145-169)	0.6±3.12^{ns}	4.76±3.24^{ns}

**Significant at p=0.01; *at p=0.05

four host grains was found to be more (in maize the females were 1.36x fold as male). These results agree with those of Thakare et al. (2009) and Ojo and Omoloye (2016). Irrespective of the host grains, females were observed to be larger than males, and maximum body length was in those reared on maize, as observed by Flay (2010).

Thus, the present observations reveal that maize is the best and effective host grain for the mass rearing of the *S. oryzae*. Hence, for mass rearing and primary culture under laboratory condition maize could be preferred.

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REFERENCES

Ansari, A. 2003. Host preference, varietal screening and management of the rice weevil, *S. oryzae* (Coleoptera: Curculionidae). M.Sc. Thesis (unpublished). Faculty of Agriculture. Maharana Pratap University of Agriculture and Technology, Udaipur.

Bhandari, G., Achhami, B. B., Karki, T. B., Bhandari, B. and Bhandari, G. 2015. Survey on maize post-harvest losses and its management practices in the western hills of Nepal. *Journal of Maize Research and Development,* 1(1): 98-105.

Campbell, J. F. 2012. Influence of seed size on exploitation by the rice weevil, *Sitophilus oryzae*. *Journal of Insect Behaviour,* 15: 429-445.

Danho, M., Gaspar, C. and Haubruge, E. 2002. The impact of grain quantity on the biology of *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae): Oviposition, distribution of eggs, adult emergence, body weight and sex ratio. *Journal of Stored Products Research,* 38 (3): 259-266.

Dari, S., Pixley, K. V. and Setimela, P. 2010. Resistance of early generation maize inbred lines and their hybrids to maize weevil. *Crop Science,* 50: 1310-1317.

Derera, J., Pixley, K. V., Giga, D. P. and Makanda, I. 2014. Resistance of maize to the maize weevil: III. Grain weight loss assessment and implications for breeding. *Journal of Stored Products Research,* 59: 24-35.

Dhaliwal, G. S., Dhawan, A. K. and Singh, R. 2007. Biodiversity and ecological agriculture: Issues and perspectives. *Indian Journal of Ecology,* 34 (2): 100- 109.

Dhaliwal, G. S., Vikas Jindal and Dhawan, A. K. 2010. Insect Pest problems and crop losses: changing trends. *Indian Journal of Ecology,* 37 (1): 1-7.

Flay, C. 2010. Multiple mating and mate choice in *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). A thesis submitted to Massey University, Palmerston north, New Zealand.

García-Lara, S. Bergvinson, D.J., Burt, A.J., Ramputh, A., Díaz Pontones, D.M. and Arnason, T. J. 2004. The role of pericarp cell wall components in maize weevil resistance. *Crop Science,* 44: 1560-1567.

Halstead, D. 1963. External sex differences in stored products Coleoptera. *Bulletin of Entomological Research,* 54: 119-134.

Kelvin, J. M. 2002. Maize kernel components and their roles in maize weevil resistance. Mexico City: International Center for Improvement of Wheat and Maize (CIMMYT).

Jain, P. and Bhargava, M. 2007. Entomology: novel approaches. New India Publishing Agency. pp. 1-18.

Masasa, R. T., Setimela, P.S., Setimela, P.S. and Chiteka, Z.A. 2013. Evaluation of open pollinated varieties of maize for resistance to the maize weevil in a controlled temperature and humidity laboratory in Zimbabwe. *Euphytica,* 193: 293-302.

Merville, A.,Vallier, A., Venner, S., Siberchicoti, A., Fouchet, D., Heddi, A., Bel-Venner, M.C. 2014. Determining the instar of a weevil larva (Coleoptera: Curculionidae) using a parsimonious method. *European Journal of Entomology,* 111 (4): 567-573.

Ojo, J. A. and Omoloye, A. A. 2016. Development and life history of *Sitophilus zeamais* (Coleoptera: Curculionidae) on cereal crops. *Advances in Agriculture,* 2016: 7836379.

Ojo, J. A. and Omoloye, A. A. 2015. Life history of the tamarind weevil, *Sitophilus linearis* (Herbst) (Coleoptera: Curculionidae), on tamarind seed. *Journal of Insects*, 2015: 429579.

Ojo, J. A. and Omoloye, A. A. 2012. Rearing the maize weevil, *Sitophilus zeamais*, on an artificial maize cassava diet. *Journal of Insect Science,* 12(69): 1-4.

Padmasri, A., Srinivas, C., Vijaya Lakshmi, K., Pradeep, T., Rameash, K., Anuradha, Ch. and Anil, B. 2017. Management of rice weevil (*Sitophilus oryzae* L.) in maize by botanical seed treatments. *International Journal of Current Microbiology and Applied Sciences,* 6 (12): 3543-3555.

Pingali, P., and Pandey, S. 2001. Meeting world maize needs: Technology opportunities and priorities for the public sector. P. L. Pingali (ed.) CIMMYT 1999–2000. World maize facts and trends (pp. 1-3). Mexico City: CIMMYT.

Reichmuth, C. H, Scholler, M., Ulrichs, C. 2007. Stored product pests in grain. Agro Concept Verlagsgesellschaft, Bonn, Germany. 8 pp.

Shivakoti, G. P. and Manandhar, D.N. 2000. An overview of post-harvest losses in maize in Nepal: Developing and disseminating technology to reduce post harvest losses in maize. Proceedings of a working group meeting of the hill maize research project. Kathmandu: NACR and CIMMYT.

Subedi, S. G. C., Thapa, R. B. and Rijal, J. P. 2009. Rice weevil (*Sitophilus oryzae* L.)- host preference of selected stored grains in chitwan Nepal. *Journal of the Institute of Agriculture and Animal Science,* 30: 151-158.

Tefera, T., Demissie, G., Mugo, S., Beyene, Y. 2013. Yield and agronomic performance of maize hybrids resistant to the maize weevil *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae). *Crop Protection,* 46: 94-99.

Thakare, S. M., Dhoble, B. and Thakare, A. S. 2009. Effect of different chemicals applied by seed or stem smearing technique on natural enemies of B.t cotton. *Crop Research* 38: 205-207.

Zunjare, R. H., Hossain, F., Muthusamy, V., Jha,S. K., Kumar, P., Sekhar, J. C., Thirunavukkarasu, N. and Gupta, H. G. 2016. Genetic variability among exotic and indigenous maize inbreds for resistance to stored grain weevil (*Sitophilus oryzae* L.) infestation. *Cogent Food and Agriculture*, 2: 1137156.

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