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Evaluation of best exposure period of phosphine against insect complex in stored maize

Muhammad Ameen[1], [2]Muhammad Latif, [3]Mazher Farid Iqbal, [4]Farooq Ahmad, [5]Jawahar Ali, [6]Irfan Yaqoob, [4]Maznsoor ul Hasan, [4]Mohammad Sagheer, [3]Maqsood Ahmed and [7]Zahid Iqbal

Pest Warning and Quality Control of Pesticides, [1]Sialkot, [2]Gujranwala
[3]Ph.D Scholar, Shenyang Agricultural University, Liaoning Province, P.R. China
[4]Department of Entomology, University of Agriculture, Faisalabad
[6]Regional Agricultural Economic Development Centre, Vehari
Department of Agriculture (Extension) [5]Pasrur, [7]Sialkot

Abstract

The study was carried out to identify the best exposure period of phosphine (200 ppm) against insect pest complex of stored maize grain with complete randomized design (CRD) analysis of variance. Three insects types were used i.e. *Rhizopertha dominica* (Rd); *Tribolium castaneum* (Tc) and *Trogoderma granarium* (Tg). After one day the data showed significant result ($P<0.05$) in mortality (%) Rd (73.33%) compared to the other insects but non-significant results ($P>0.05$) was recorded by Tc (56%) and Tg (46%). The data showed non-significant result ($P>0.05$) in mortality (%) of Tc and Tg (58% and 50.67%) and showed significant result of Rd (76.67%) after three days. The data showed highly significant result ($P<0.05$) in mortality of Rd (100%) but showed non-significant result ($P>0.05$) of Tc and Tg (55.33% and 56%) after five days. Significant result ($P<0.05$) in mortality was recorded by Rd (100%) compared with Tc (66%; 68%) after 7 days. However 100% mortality was recorded by Rd compared to Tc (76.67%) and (74.67%) after 10 days.

Keywords: Period; Phosphine; *Rhizopertha dominica*; *Tribolium castaneum* and *Trogoderma granarium*, Faisalabad, Punjab-Pakistan

Introduction

Maize (*Zea mays* L.) belongs to family gramineae is one of the 2nd most important cereal grain after wheat and rice. It is a staple food in Sub-Saharan Africa and a major source of daily intake. Insect infestation is a key reason of storage losses. Kaminski et al., (2014) reported that the loss was estimated due to stored grain insect-pests between 1.4-5.9% during storage. Alavi et al. (2012) recorded 23% losses in the maize with maximum losses upto 9% during drying. Maize plays a significant role in the economy of country because it is used as food, feed for livestock and provide raw material for industries. Maize contributes 2.2% to the value addition in agriculture and 0.4% in GDP. The cultivated area of maize was 1144 thousand hectare with annual production of 4.92 million tons (Anonymous, 2015). Postharvest losses are maximum after harvesting of crop until its consumption (Aulakh et al., 2013). Weight losses are increased due to fungal diseases, quality disturbance, seed viability and commercial loss (Boxall, 2001). *Tribolium castanum* is an important stored pest (Shafiq et al., 2006) however *Trogoderma grainrium* is the most destructive pest of grains (Burges, 2008; Szito, 2006). The larvae of khapra beetle damage the grains resulting reduction nutritional quality (Ahmedani, et al., 2009). *Sitophilus* spp. and *Rhyzopertha dominica* L. are major pests, they cause severe losses in rice, maize, barley, wheat, and other crops (Neupane, 2002). The damage caused by this was 16.25%, 8.50%, and 6.25%, in wheat, barley, and maize. After harvesting the loss reduces its quality, economics and makes it unsuitable for human consumption (Subedi, et al., 2009). In severe damage these losses can be up to 80% (Fox, 2013).

The present study was carried out to evaluate the best exposure period of phosphine (200 ppm) against insect pest complex of stored maize grain in University of Agriculture, Faisalabad.

Materials and Methods

The study was carried out to evaluate the best exposure period of phosphine (200 ppm) against insect pest complex of stored maize grain. Three insects types were used i.e. lesser grain borer technically known as *Rhizopertha dominica*; *Tribolium castaneum* and *Trogoderma granarium*.

Insect collection

Insects collected from infested godowns of Punjab Food Department located in Faisalabad.

Rearing

Adults of *Rhizopertha dominica* (Rd); *Tribolium castaneum* (Tc) and *Trogoderma granarium* (Tg) reared in one liter capacity glass jars on maize in an incubator maintained at 30±2 °C and 60±5% relative humidity to get homogenous population. For this purpose, 50 pairs of adult insects were placed in glass jars with sterilized maize in an incubator at above said temperature and humidity. After 4 days all the adults were separated from jars by sieving and the remaining maize jars with eggs were covered with muslin cloth. The insects hatched out from those eggs were in equal age and size.

Phosphine generation

A funnel fixed with thread hanged over a cylinder with 5% H_2SO_4 solution. A pellet of Aluminium phosphide wrapped in muslin cloth dropped in solution under the funnel. Open burette was taken in the solution. The air in the burette was sucked out with the help of syringe through rubber septum, until the solution raised into the burette upto the mark (Anonymous, 1975).

Phosphine liberated and accumulated in the burette over acidified water. The burette filled with gas the level of the solution went down. After filled, 5ml gas was sucked out with the help of an air tight syringe; injected into the sealed glass jar then injected into the Harris conductivity meter for measurement of gas concentration (Harris, 1986).

Experiment

Glass Jar of 1150 ml capacity was used in exposure chamber. 200 grams of maize grains taken for each treatment. 100 grubs of *Rhizopertha dominica*, *Tribolium castaneum* and *Trogoderma granarium* were placed in each glass jar. These insects were exposed to 200-ppm concentration of phosphine. The amount of phosphine gas required was calculated using formula as under.

Phosphine required=Concentration x Volume of glass jar x 836.81

A 5ml syringe was used to inject phosphine concentration into the air tight jars. Exposure periods for each treatment were 1, 3, 5, 7 and 10 days.

Mortality determination

At the end of exposure period, the jars were opened and each insect's mortality (%) was recorded by counting.

Statistical analysis

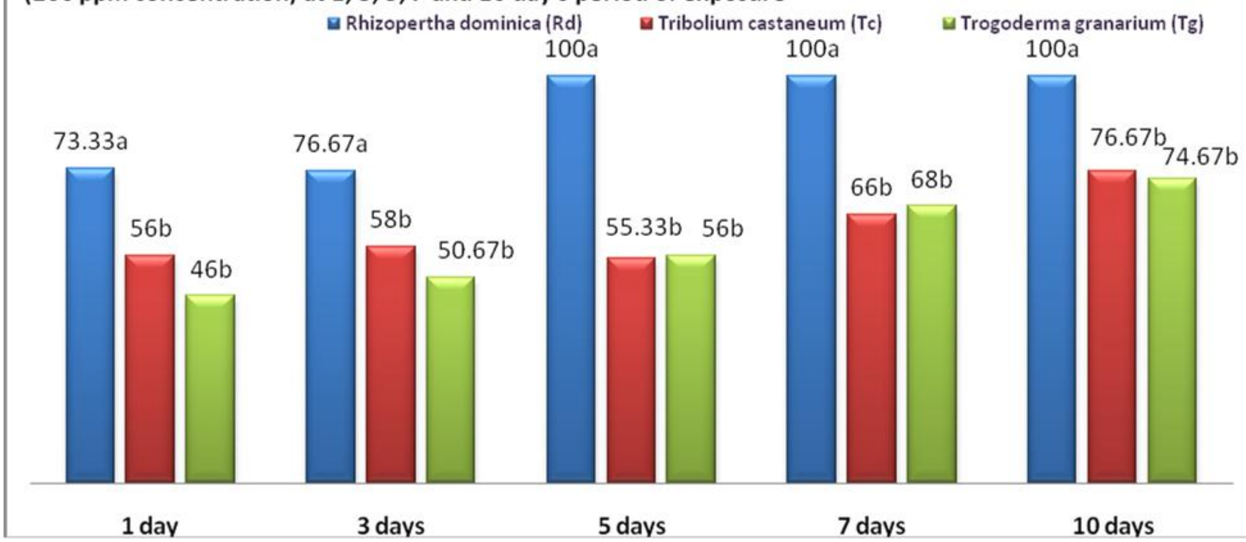
The effect of treatment was computed following (CRD) analysis of variance with three replications. The treatments means were computed by DMR Test at P=0.05 (Steel and Torrie, 1997).

Results and Discussion

After one day the data showed significant result (P<0.05) in mortality (%) Rd (73.33%) compared to the other insects but non-significant results (P>0.05) was recorded by Tc (56%) and Tg (46) by the exposure of phosphine. The data showed non-significant result (P>0.05) in mortality (%) of Tc and Tg (58% and 50.67%) and showed significant result of

Rd (76.67%) after three days of exposure. The data showed highly significant result ($P<0.05$) in mortality of Rd (100%) but showed non-significant result ($P>0.05$) of Tc and Tg (55.33% and 56%) after five days of phosphine application. Significant result ($P<0.05$) in mortality was recorded by Rd (100%) compared with Tc (66%; 68%) after 7 days. However 100% mortality was recorded by Rd compared to Tc (76.67%) and (74.67%) after 10 days. These results were in line with Rajendran (1994) who reported that at lower Ct product, concentration of phosphine reduced insect mortality after 12-72 hours. He also reported that it was necessary to maintain sufficiently high concentration of phosphine till the end of fumigation period. These results were contradictory to Daglish et al (2003) who studied to evaluate the prospect of predicting insect mortality under different phosphine concentrations. These results were partially in line with Yadav et al (2002) who reported that the mortality of adult *Rhizopertha dominica* increased with the increase phosphine rates and exposure periods. Maximum mortalities (92.75% and 100%) were recorded after 7 and 15 days of exposure. Our results were contradictory to Rajendran et al (1994) and in line with Ciobanu (2001); Wukang et al (1999) who reported the efficacy of phosphine gas in steel silos and recorded 100% control of stored grain pests and Gursharan, et. al., (1994) who reported the mortalities against these three insects at six days exposure was 98-100% and 84.33% in PVC and metal bins respectively.

Figure-1 showing mortality (%) of different stored grain insect pests against phosphine (200 ppm concentration) at 1, 3, 5, 7 and 10 day's period of exposure



Conclusion

At the end it was concluded that with the increasing exposure period the entire insect showed high mortality of insect pest. However phosphine concentration at 1 day exposure period gave poor results of mortality. It means that exposure period act as a key factor for controlling stored grain insect pests when we keep concentration constant, the results showed that at exposure period of 10 days, these three insects are controlled effectively recording 100%; 76.67% and 74.67% mortalities of *Rhizopertha dominica*; *Tribolium castaneuam* (Hbst.) and *Trogoderma granarium* (Everts) respectively.

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