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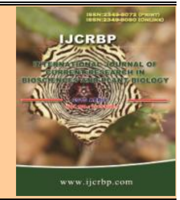

Original Research Article

Effects of Selected Pesticides on Seedling Vigour and Viability of Corn (*Zea mays*) and Wheat Grass (*Triticum aestivum*)

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A b s t r a c t

Pesticide use is widespread in agriculture, though problems in misuse still exist. This study aimed to determine the effects of pesticides, Kilabot® and Malathione®on seed vigour and viability of two crop species, corn (*Zea mays*) and wheat grass (*Triticum aestivum*). No significant differences were observed in germination rates of corn and wheat grass seeds among treatments. Generally, there was no significant increase in weight measurements observed for the rapid imbibition test for corn and wheat grass except at t=50 h for wheat grass seeds. Under laboratory conditions, none of the pesticides negatively affected standard germination; percent emergence of pesticide-treated seeds equalled or was greater than that of control seeds.

K e y w o r d s

Pesticides
Seedling vigour
Seedling viability
Triticum aestivum
Zea mays

Introduction

The use of pesticides in agriculture is applied worldwide. In the Philippines, $2,400 million worth of agrochemicals was used in 1988 for rice alone (Rola and Prabhu, 1993). In 2004, the Philippines imported 24,801,192 kg of formulated pesticides. Despite the good pesticide management system in the Philippines, misuse of pesticides in agriculture is still observed. The problem lies in the lack of information regarding the risks and hazards of pesticide use (Austria, 2005). The use of pesticides may affect the quality of the seeds of important crop species.

Seed viability and vigour are some of the important qualities used in evaluating the planting value of seeds. A standard method to assess seed viability is through germination testing, whereby the ability of seeds to produce normal seedlings are tested (International Seed Testing Association, 2011). It is important that the pesticides that are used to protect seeds do not interfere with the viability or vigour of the seeds, no matter under what stress conditions the seeds are grown.

Seed vigour can be evaluated through the different plant properties that determine the activity and performance of seed (Ellis, 1992). The process of seed imbibition is a crucial stage in the development of plant and is critical for successful crop establishment, hence the imbibition test is appropriate (McDonald et al., 1988).

Two pesticides were used in this study: Kilabot® is mainly composed of the compound profenofos while Malathione® is composed of malathion (iFarm, 2010; NPIC, 2010). This study aims to evaluate the effects of commercial pesticides Kilabot® and Malathione® on the seed viability and vigor of corn and commercial wheat.

Materials and methods

Treatment of the seeds

The methodology of Aveling et al. (2013) for testing the physiological effects of pesticides on plants was used in this experiment. A total of 180 seeds, 90 from *Zea mays* and 90 from *Triticum aestivum* were submerged in a solution containing water and recommended amount of selected pesticides. The seeds were mixed thoroughly with the pesticide for five minutes until the whole surface of the seeds were covered with the pesticide solution. The seeds were treated with water only for the control treatment. After treatment, the seeds were dried using paper towels.

Vigour test (rapid imbibition)

Seeds treated with selected pesticides were subjected to rapid imbibition. Seeds were weighed individually before imbibition. Three trials of 10 seeds (10 replicates) were used for each treatment. The seeds were soaked individually in 4mL distilled water for 6, 24 and 50 h. After that, they were removed, blot-dried and reweighed individually. The 50 h treatment was subjected to the seed germination test at standard room temperature and pressure.

Seed germination test

Three replicates, with 10 seeds per replicate, were set up for each of the three treatments and two species. A total of 180 seeds (90 each per species, and 10 seeds per plate), were placed on moistened cotton in Petri plates sealed with parafilm. The seeds were allowed to germinate for seven days. The germination percentage was determined as the percentage of seed that produced normal seedlings after seven days of germination. Seeds were visually assessed based on the ISTA rules (International Seed Testing Association, 2011)

Statistical analysis

One Way Analysis of Variance (ANOVA) was performed to determine any significant differences between the pesticide treatments and the control, distilled water. Differences with $p<0.05$ values were considered as significantly different. Tukey HSD multiple comparison was thereafter performed.

Results and discussion

Based on the results of seed germination test, there were no significant differences in germination of corn and wheat grass seeds among different treatments. None of the pesticides used in this experiment negatively affected the standard germination of corn and wheat grass seeds under laboratory conditions. In fact, treatment with pesticides equaled or increased the percent emergence with that of the control, distilled water as shown in Figs. 1 and 2. These results are consistent with a study conducted by Aveling et al. (2013), where the treatment of maize seeds with pesticides increased seed germination by 7 to 13%.

There was no significant increase in corn seed weight among treatments following rapid imbibition for 6, 24 or 50 h (Table 1). However, after rapid imbibition for 50h, the control set up containing distilled water showed a significantly higher increase in weight when compared with Kilabot® and Malathione®.

Kilabot® and Malathione® were tested for physiological effects on seeds in this study. The active ingredient of Kilabot® and Malathione® are profenofos and malathion, respectively (iFarm, 2010; NPIC, 2010). Both active ingredients are classified as organophosphates (da Silva et al., 2013; NPIC, 2010).

Organophosphates are a commonly used class of contact insecticides. It was used to replace organochlorine pesticides that were proven to be highly toxic (Jauregui et al., 2003).

Fig. 1: Standard germination test for treated and untreated maize seeds (Error bars indicate ± SD).

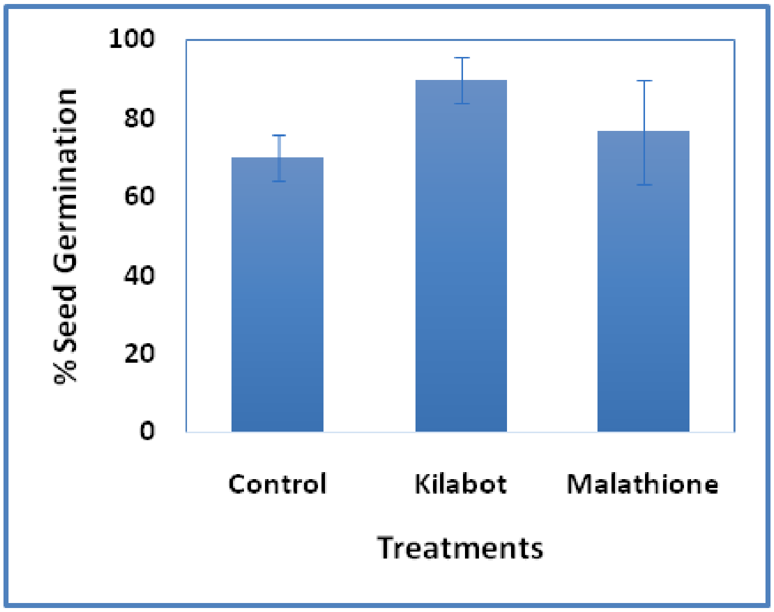
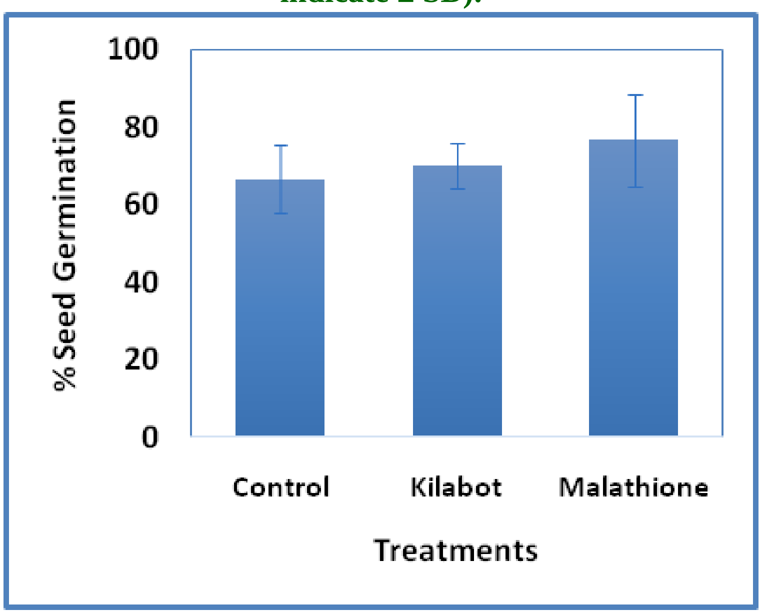


Fig. 2: Standard germination test for treated and untreated wheatgrass seeds (Error bars indicate ± SD).



The effects of various organophosphates differ in potency and how well they are absorbed by the plants. As mentioned, Malathione® contains the active ingredient malathion, O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate. This ingredient is eventually metabolized by the plant to malaoxon, after which it is eliminated (NPIC, 2010). According to the National Pesticide Information Center, malathion and malaoxon are not toxic to plants since its target site is the nervous system. In the present study, results showed that the seeds treated with Malathione® did not show a significant difference in seed germination compared to that of the control, except in the case of wheatgrass seeds after 50 h (Tables 1 and 2). Previous study on *Oryza sativa*, showed that malathion inhibited germination as malathion concentration increased (Poovaragavan et al., 2012). The concentration of malathion used in the experiment may not be high enough to affect the germination rate, or it may be possible that aberrations only begin to show after a particular number of hours, which in this case is 50 h.

The active ingredient of Kilabot®, is profenofos, O-(4-bromo-2-chlorophenyl) O-ethyl S-propyl phosphorothioate. It is classified as moderately hazardous by WHO (Abass et al., 2007). The degradation of profenofos in plants occurs with the help of several enzymes to hydrolyze profenofos to 4-bromo-2-chlorophenol. It was also discovered that degradation of profenofos in plants is rapid in aerobic soil conditions.

Table 1. Weight increase after imbibition of treated and untreated maize seeds with pesticides.

Tests	Time	Treatments			
		Control	Kilabot®	Malathione®	*p*-value
Germination (%)*					
Rapid imbibition	50 h	63.33	63.33	56.67	0.865
Weight Increase (%)†					
Rapid imbibition	6 h	23.53	22.69	24.81	0.75
	24 h	39.88	39.64	38.55	0.966
	50 h	52.89	50.58	47.84	0.341

*Each value is a mean percentage of three replicates of 10 seeds.
†Each value is a mean response of three replicates of 10 seeds.

Table 2. Weight increase after imbibition of treated and untreated wheatgrass seeds with pesticides.

Tests	Time	Treatments			
		Control	Kilabot®	Malathione®	*p*-value
Germination (%)*					
Rapid imbibition	50 h	56.67	40.00	60.00	0.422
Weight Increase (%)†					
Rapid imbibition	6 h	33.34	29.92	27.98	0.350
	24 h	57.26	44.69	43.52	0.077
	50 h	76.91	53.28	55.38	0.014

*Each value is a mean percentage of three replicates of 10 seeds.
†Each value is a mean response of three replicates of 10 seeds.

In the present study, setups treated with Kilabot® did not show any differences in germination rate compared to control setups. However after 50 h, significant differences were noted in wheatgrass seeds treated with the pesticide. There was a significant reduction in the % weight increase of wheatgrass seedlings treated with Kilabot®. In the study of Mishra et al. (2014), the authors observed a significant reduction in the morphological traits (root length, shoot length, fresh weight and dry weights) and pigments (chlorophyll a, chlorophyll b, total chlorophyll, carotenoid and phaeophytin) of *Vigna radiata* seedlings upon treatment of profenofos. This phytotoxic effect of profenofos at high concentration might explain the observed reduction in percent weight change of wheatgrass seeds.

Conclusion

Based on the results obtained from this study, emergence and establishment of corn and wheatgrass seedlings were not affected by the treatment of Kilabot® and Malathione®. However, the vigour test for wheat grass indicated a significant difference between the treatments. The pesticides tested negatively affected seed imbibition of wheat grass. However, further studies are required to determine whether the seed treatments presently applied would continue to sustain viability and vigour of maize and wheatgrass seeds in the long run. It is also recommended to perform other morphological and physiological tests to confirm the safety of these pesticides for plant use.

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