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Short communication

Evaluation of thiamethoxam insecticide (Cruiser®) efficiency using seed treatment to control wheat ground beetle *Zabrus tenebrioides* (Coleoptera: Carabidae)

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Abstract

Wheat ground beetle *Zabrus tenebrioides* (Goeze) (Coleoptera: Carabidae) is an important wheat pest in Iran and some regions of the world. This pest causes damage to wheat by feeding on the root, stalk, and leaves. Farmers try to control this pest by the foliar application of different insecticides, but this method causes damage to the environment. To find an effective method to control this pest, the thiamethoxam insecticide (Cruiser®) efficiency was evaluated using seed treatment in this study. An experiment based on a randomized complete block design with four treatments and four replications was conducted in a field in Ramhormoz city, Khuzestan province (Iran). The treatments were 150 and 200 ml of thiamethoxam plus 2350 ml of water for seed treatment, 2,000 ppm of diazinon by field spraying at the wheat tillering stage, and a control. The results indicated that the average plant density in 150 and 200 ml of thiamethoxam (333.58 and 333.28 plant/m^2, respectively) was more than those of diazinon (258.28 plant/m^2) and the control (182.12 plant/m^2). The average ear density in 150 and 200 ml of thiamethoxam (513.78 and 506.12 plant/m^2, respectively) was more than those of diazinon (321.22 plant/m^2) and the control (260.86 plant/m^2). According to the present results, farmers can use 150 ml of thiamethoxam plus 2350 ml of water for 100 kg of seeds to control this pest by seed treatment.

Keywords: wheat,* Zabrus tenebrioides*, thiamethoxam, seed treatment, pest control

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Introduction

Wheat (*Triticum aestivum* L.) is a major crop worldwide (FAO, 2011), which has a major contribution to energy and protein needed by society (AWNRC, 2018). Wheat ground beetle *Zabrus tenebrioides* (Goeze) (Coleoptera: Carabidae) is a factor limiting wheat production in some regions of Iran, including Khuzestan province (Jozeyan, 1996). This pest is observed in some regions of the world, such as Western and Central Asia, Eastern and Western Europe, particularly Germany, Russia, Ukraine, Georgia, Turkey, and North Africa (Miller & Pike, 2002). The main damage of this pest is related to larval stages that cause damage by feeding on the root, stalk, and leaves (Manolache et al., 1963; Hulea et al., 1975; Kryazheva et al., 1989; Walczak, 2007). At a high population density, larval and mature stages can completely destroy wheat fields (Georgescu et al., 2017). Wheat monoculture causes more activity of this pest and increases its density from year to year (Popov et al., 1983, 2004). However, crop rotation alone is not enough to control this pest (Popov et al., 2008).

Farmers have tried to control this pest by spraying fields with insecticides, such as diazinon, carbaryl, phosalone, and chlorpyrifos (Anonymous, 2010). In addition to its indefinite control, this method increases production costs and causes damage to the environment. Some synthetic insecticides, which are currently used to control this pest, may shortly be excluded from the market because of harmful effects on non-target organisms and increasing the evolution of resistance (Siegwart et al., 2015).

Neonicotinoid insecticides, such as thiamethoxam and imidacloprid, provide effective control of a wide range of pests by disrupting the functions of nicotinic acetylcholine receptors in the central nervous system of insects (Casida, 2011). The primary usage pattern of neonicotinoids (neonics) is as seed treatment for many crops. Since neonics are water-soluble, seed neonics are transferred to plant tissues, distributed systematically in plants, and thereby enter the body of pests while feeding (Lanka et al., 2017). To find an effective and practical method to control *Z. tenebrioides*, thiamethoxam (Cruiser®) efficiency was evaluated using seed treatment in this study.

Materials and methods

The current research was conducted in December 2021 on the Sarang cultivar in a wheat field with a history of severe *Z. tenebrioides* damage using identical planting, growing, and harvesting gears. The study area is located in Cheragh Shahryari village (Ramhormoz city, Khuzestan province, Iran) with the geographic coordinates of 49.57 E and 31.23 N. In a 2 ha plot of land, an experiment was conducted based on a randomized complete block design with four treatments and four replications. The treatments were 150 ml of thiamethoxam (Cruiser® FS 350, Syngenta Co., Switzerland) for 100 kg of seeds by seed treatment, 200 ml of thiamethoxam plus 2350 ml of water by seed treatment, 2,000 ppm of diazinon (Arya Chimi Co.) by field spraying at the wheat tillering stage, and a control. Seed treatments were mixed with thiamethoxam manually, and diazinon was sprayed by a 400 L tractor-mounted sprayer. To evaluate the efficiency of the insecticides (Khajehzadeh et al., 2012), 10 replications (plots) were selected randomly for inventory. Five 1 m^2 quadrates were selected randomly for inventory per plot, and plant density (m^2), ear density (m^2), and wheat yield (ha) at the harvest time were compared after quadrat sampling.

Analysis of data

The normality of data was confirmed using the Anderson-Darling test, and there was no need for data transformation. Data obtained from this experiment based on a randomized complete block design were analyzed by Tukey's test at a 5% statistical probability using SAS 9.1 software (SAS Institute, 2003).

Results

At the wheat tillering stage, a more uniform green surface was observed in thiamethoxam-treated plots than in the diazinon and control plots, which were damaged by the pest (Fig 1).

According to ANOVA results, the average plant density in 150 and 200 ml of thiamethoxam (333.58 ± 2.24 and 333.28 ± 2.36 plant/m^2, respectively) was significantly more than the plots of diazinon (258.04 ± 2.28 plant/m^2) and the control (182.12 ± 5.58 plant/m^2). The diazinon treatment was significantly different from the control ($F_{7,\ 192}$ = 129.27; *P*<0.0001; C.V.= 10.66%) (Fig. 2).

Figure 1. A: Plots treated with 150 ml of thiamethoxam for 100 kg of seeds; B: damage to wheat caused by *Z. tenebrioides* in control plots.

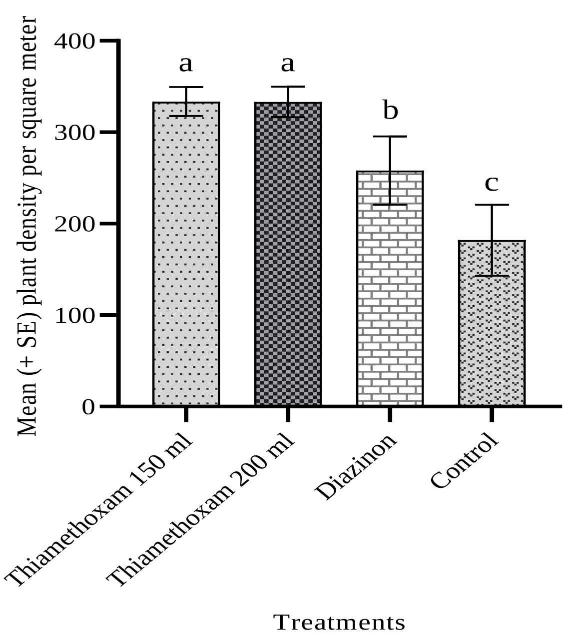

Figure 2. Mean (± standard error) of plants/m^2 in different treatments. Different letters indicate significant differences based on Tukey's test at the 1% probability level.

The average ear density in 150 and 200 ml of thiamethoxam (513.78 ± 3.3 and 506.12 ± 4.03 plant/m^2, respectively) was significantly more than the plots of diazinon (321.22 ± 4.58 plant/m^2) and the control (260.86 ± 4.31 plant/m^2). There was a significant difference between the diazinon treatment and the control ($F_{7,\ 192}$ = 405.67; P<0.0001; C.V. = 7.39%) (Fig. 3).

Wheat yields were higher in 150 and 200 ml of thiamethoxam (4615 and 4592 kg/ha, respectively) than in diazinon (2876 kg/ha) and control (2461 kg/ha) treatments (Fig. 4).

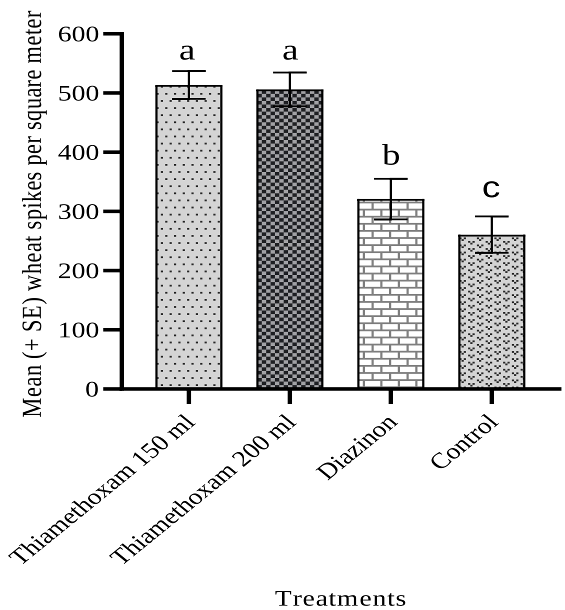

Figure 3. Mean (± standard error) ears/m^2 in different treatments. Different letters indicate significant differences based on Tukey's test at the 1% probability level.

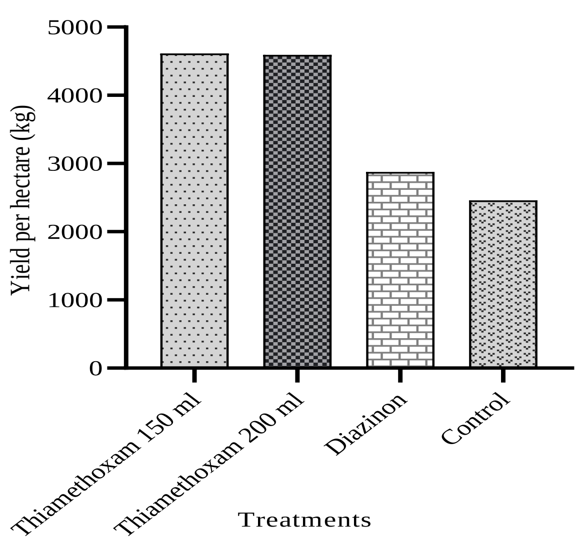

Figure 4. Comparison of wheat yields (kg/ha) in different treatments

Discussion

The results of this investigation demonstrated that the activity of *Z. tenebrioides* was significantly prevented by thiamethoxam. Plant density, ear density (m^2), and crop yield were significantly higher in thiamethoxam treatments than in diazinon and control treatments, suggesting that this insecticide can appropriately control this pest. The use of thiamethoxam (Cruiser® FS 350) at 10 ml per kg seed and imidacloprid (Gaucho 70% WS) at 14 g per kg rapeseed seeds by seed treatment could effectively control rapeseed flea beetles (Barari, 2016). Imidacloprid at 1.05 and 0.7 g per kg seeds by seed treatment could control *Melanaphis maidis* in maize and *Schizaphis graminum* in wheat 6-8 weeks after cultivation (Ahmed et al., 2001). In a study on the efficiencies of insecticides imidacloprid (Cropstar®), thiamethoxam (Cruiser®), chlorantraniliprole (Dermacor®), cyantraniliprole (Fortenza®), and fipronil + pyraclostrobin + thiophanate methyl (Standak Top®) at 500, 200, 100, 200, and 200 ml, respectively, for 100 kg of soy seeds by seed treatment, chlorantraniliprole and cyantraniliprole could more efficiently control fall armyworm (*Spodoptera frugiperda*) (Triboni et al., 2019).

Maize seed treatment with thiamethoxam (Cruiser 30% FS), at 1 and 2 g of the active ingredient for 1 kg of seeds, clothianidin (Poncho 600 g/l FS) at 1 g of the active ingredient for 1 kg of seeds, and imidacloprid (Gaucho 600 g/l FS) at 2 g of the active ingredient for 1 kg of seeds could better protect against early-season thrips and reduced damage to the field relative to nitenpyram (50% SG), dinotefuran (20% SG), thiacloprid (48% SC), and acetamiprid (20% SG) insecticides (Ding et al., 2018).

The use of thiamethoxam (Cruiser®) and imidacloprid (Gaucho) with seed treatment could effectively control European corn borer (*Ostrinia nubilalis*) and Indian meal moth (*Plodia interpunctella* Hübner) larvae (Yue et al., 2003). Carcamo et al., (2012) concluded that seed treatment with thiamethoxam could potentially be used as an integrated management method for pea leaf weevil, *Sitona lineatus* L., particularly in combination with other methods, such as biological control and trap products. Netam et al., (2013) reported that seed treatments of thiamethoxam WS 70 and imidacloprid FS 600 were effective against sucking pests of soybean (*Glycine max* L.) up to 4 weeks after seed germination. The effectiveness of thiamethoxam with seed treatment was investigated in the control of rice pests, such as water weevil *Lissorhoptrus oryzophilus* Kuschel (Lanka et al., 2013) and rice thrips *C. oryzae* (Porras, 2009; Tang et al., 2014).

In this study, better plant greenness and vegetative growth than the control were found in thiamethoxam-treated plots. Seed treatments with neonics can protect plants from environmental stresses, in addition to pest control (Casida, 2011). Seed treatments with thiamethoxam improved soy germination under drought stress (Cataneo et al., 2010), increased seed germination power in green peas *Pisum sativum* L. (Horii et al., 2007), and elevated root growth, cold tolerance, phenylalanine ammonia lyase, and ear weight in wheat (Macedo & Castro, 2011; Larsen & Falk, 2013), and increased maize germination (Afifi et al., 2015). Therefore, seed treatments with neonics can protect plants through insect control and may help plants by reducing stress, increasing plant growth, and elevating yield in special conditions.

Conclusion

According to our results, thiamethoxam (Cruiser® FS) at 150 ml with 2350 ml water for 100 kg of seeds by seed treatment can be recommended to control *Z. tenebrioides* in wheat.

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گیاه‌پزشکی (مجله علمی کشاورزی)

جلد ٤٦، شماره ١، بهار ١٤٠٢

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گزارش کوتاه

ارزیابی کارایی حشره‌کش تیامتوکسام (کروزر®) با روش تیمار بذر برای کنترل سوسک سیاه گندم *Zabrus tenebrioides* (Coleoptera: Carabidae)

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چکیده

سوسک سیاه گندم *Zabrus tenebrioides* (*Goeze*) (Coleoptera: Carabidae) یکی از آفات مهم گندم در برخی نقاط جهان و ایران است. این آفت با تغذیه از ریشه، ساقه و برگ باعث آسیب به گندم می‌شود. کشاورزان با محلول‌پاشی حشره‌کش‌های مختلف سعی در کنترل این آفت دارند، اما این روش باعث ایجاد اثرات زیان‌بار روی محیط زیست می‌شود.در این پژوهش با هدف پیدا کردن یک روش موثر برای کنترل این آفت کارایی حشره‌کش تیامتوکسام (*Cruiser® FS 350*) با روش تیمار بذر مورد بررسی قرار گرفت. آزمایش بر اساس طرح بلوک‌های کامل تصادفی با ٤ تیمار در ٤ تکرار در یک مزرعه در شهرستان رامهرمز استان خوزستان (ایران) اجرا شد. تیمارها شامل ۱۵۰ و ۲۰۰ میلی لیتر حشره‌کش تیامتوکسام به اضافه ۲۳۵۰ میلی‌لیتر آب برای ۱۰۰ کیلوگرم بذر با روش تیمار بذر، حشره‌کش دیازینون با غلظت ۲۰۰۰ پی پی ام با روش محلول پاشی مزرعه در مرحله‌ی پنجه زنی گندم و شاهد بودند. نتایج نشان داد میانگین تراکم بوته در تیامتوکسام ۱۵۰ میلی‌لیتر و تیامتوکسام ۲۰۰ میلی‌لیتر به ترتیب با ۳۳۳/۵۸ و ۳۳۳/۲۸ بوته در متر مربع بیشتر از دیازینون با میانگین تراکم ۲۵۸/۲۸ و شاهد با میانگین تراکم ۱۸۲/۱۲ بودند. میانگین تراکم خوشه در متر مربع در تیامتوکسام ۱۵۰ میلی‌لیتر و تیامتوکسام ۲۰۰ میلی‌لیتر به ترتیب با ۵۱۳/۷۸ و ۵۰٦/۱۲ بوته در متر مربع بیشتر از دیازینون با میانگین تراکم ۳۲۱/۲۲ و شاهد با میانگین تراکم ۲٦۰/۸٦ بودند. لذا با توجه نتایج این تحقیق کشاورازان می‌توانند حشره‌کش تیامتوکسام را با غلظت ۱۵۰ میلی‌لیتر به اضافه ۲۳۵۰ میلی‌لیتر آب برای ۱۰۰ کیلوگرم بذر با روش تیمار بذر برای کنترل این آفت استفاده کنند.

کلیدواژه‌ها: سوسک سیاه گندم، تیامتوکسام، تیمار بذر، کنترل آفت

دبیر تخصصی: دکتر معصومه ضیایی

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