Effect of large seed size, post-sowing compaction and chemical seed dressings on the survival of canola seedlings in the presence of the earth mite damage

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Abstract

The effect of post-sowing compaction, seed size, and four chemical treatments (endosulfan (175 g/ha) as ground spray, fipronil (100 g/100 kg) and imidacloprid (240 g/100 kg) both as seed dressings and untreated control) on seedling survival of canola (cv. Charlton) in the presence of redlegged earth mites and blue oat mites was compared in a randomised complete-block split plot with 2 x 4 x 2 factorial field trial carried out at Horsham, Victoria. Earth mite numbers in the compacted treatment 21 days after planting were significantly less than those in the no-compaction treatment. Soil compaction may indirectly reduce earth mite numbers by preventing mites reaching shelter away from direct light and/or influencing access to microfauna used as food by the mites. Post-sowing compaction significantly increased seedling density without the use of chemicals. Both fipronil and imidacloprid seed dressings significantly ($P<0.05$) increased seedling survival without the need for compaction. Endosulfan increased seedling survival only with compaction. With compaction there was no significant difference in seedling survival between the compacted control and the chemical seed dressing treatments. Large seed size (mean diameter 1.86 mm) significantly ($P<0.001$) increased seedling survival compared to small seed size (mean diameter 1.52 mm) by 25%. Results indicated that the post-sowing compaction and increased seed size may benefit seedling survival and help reduce the need for chemical use in controlling redlegged earth mite in canola.

Key Words

Brassica napus, redlegged earth mite, blue oat mite, seed size, compaction, chemical control

Introduction

Red-legged earth mites (*Halotydeus destructor*) and the blue oat mites (*Penthaleus falcatus in particular*.) can prevent the successful establishment of canola seedlings in southern Australian (1,2). Integrated control methods include management of host weeds, better crop rotations and targeted chemical application (1,3,4). Increased seedling vigour and the use of systemic seed dressing chemicals at low dosages (5) may provide useful environmentally acceptable ways of controlling the mite damage in the current year's crop. Increased seedling vigour could be a key process to avoid insect damage to crops (6,7). The ability for the seed to produce a healthy and vigourous seedling is of highest importance in establishing a canola crop (8). Often the farmer retained seeds lacked seed vigour reflected in the seedling emergence, seedling vigour and seedling biomass (8). Other factors having a direct impact on seeding performance are genetic factors and improved varieties (9), larger seed size (10), post-sowing compaction (11,12) and soil nutritional status especially of Zn and Ca (13). A combination of these factors will have advantages in modern pest management.

This study reports results of a mite management experiment incorporating two tactics for increasing seedling vigour (post-sowing compaction and large seed size) and precision delivery of insecticides by seed dressings in winter-grown canola.

Methods

The effect of the two canola seed sizes (largest 10% and smallest 10% fractions of a seedlot cv. Charlton), four insecticidal treatments and two post-sowing compaction treatments (with and without compaction) were compared in a 2x4x2 factorial field trial with a split plot design arranged in randomised complete blocks. The insecticide treatments were endosulfan (175 g/ha) as blanket spray (applied post sowing); fipronil (100 g/100 kg seed) and imidacloprid (240 g/100 kg seed) as seed dressings, and a no-chemical control. Percentage seed germination of the treated and sized seeds was compared in the laboratory with 5 replicates. Post-sowing compaction was carried out by pulling a 2 m wide tyre-roller with a wide-wheeled four-wheeled motor cycle along a randomly selected split plot per replicate. Endosulfan was applied with a shrouded spray boom in 65 L/ha water. Seed dressing were done by the relevant chemical companies. The trial was carried out in Horsham (36? 50'S, 142? 17'E) in a paddock of self mulching grey cracking clay with a history of grass pastures managed for hay. Plot size was 5.5 m x 1.92 m with 160 mm between seed rows. Urea was predrilled at 100 kg/ha (50 mm deep). Seeds were sown at two cm depth with superphosphate (85 kg/ha). The trial was sown in four replicates on 2 August 2000 with a cone seeder. Seed size treatments were sown at equivalent plant densities of 108 plants/m^2 (4 kg/ha of Charlton).

At 21 days after planting, five samples/plot of earth mites in a 12 cm diameter area around the plants were taken with a suction sampler and mite numbers determined microscopically. Seedling density per plot was assessed at 35 days after planting (DAP). Results were analysed using analysis of variance. Mite numbers (x) were transformed to Sqrt (x) prior to analysis of variance.

Results

Laboratory germination percentage (mean 97.5%) did not differ significantly between different seed sizes or chemical treatments. The overall ratio of redlegged earth mite to blue oat mite in the plots was 1:0.23. Total mite numbers at 21 DAP did not differ between chemical treatments but were significantly lower in compacted compared to uncompacted plots ($P<0.01$) (Table 1a). Large seed had 24 % fewer mites than small seed ($P<0.05$) (Table 1b).

Table 1. Mean earth mite density after 21 days in plots with postsowing compaction (a) seed size (b) treatments.

a– Effect of postsowing compaction

Treatment	Mite density (transformed)[1]
With compaction	1.69 (54)
Without compaction	2.06 (75)
LSD (P=.05)	0.17

b– Effect of seed size

Treatment	Mite density (transformed)[1]
Large seed	1.62 (46)

Small seed	2.14 (81)
LSD (P=.05)	0.48

[1] back transformed mean density per sq m in parentheses

In the absence of any chemical treatment, compaction significantly improved seedling density by 82% (P<0.05) (Table 2). Compaction had no significant effect on the seedling density when fipronil or imidacloprid were used. Both fipronil and imidacloprid seed dressings gave significantly (112%) higher seedling density, over the uncompacted no chemical control (P<0.01). Without compaction, there was no significant difference between endosulfan and no chemical control. Compaction however, significantly improved (58 %) the seedling density with endosulfan over the uncompacted endosulfan treatment (P<0.05). This increase was 124% higher than the uncompacted no chemical control (P<0.01). Compacted no chemical control, seed dressings and compacted endosulfan treatments were not significantly different.

Table 2. Effect of postsowing compaction and chemical tratemet interactions on the mean seedling density/m^2 35 days after planting.

Treatment	Mean seedling density / sq m			
	Control	Endosulfan[1]	Fipronil[2]	Imidacloprid[2]
with compaction	49.5	61.0	57.7	57.1
without compaction	27.2	38.6	55.7	59.8
LSD (P=0.05)	19.13[3]			

[1] Blanket application postsowing
[2]Applied as a seed dressing
[3] valid for comparing all means shown

Discussion

The density of mites in the trial was relatively low, but treatment effects were nevertheless evident. An effect of the compaction treatment was seen at 21 DAP. Chemical effects on the mite population may have diminished over the 21 days and possibly as a result there were no significant differences between the chemicals. Post-sowing compaction may impose indirect mortality on earth mites. Compacted soil had fewer and shallower cracks on the soil surface compared to the uncompacted soil. Earth mites avoid the direct heat of the day by hiding in cracks on the soil surface (14) and they are known to feed on microflora that grow in soil cavities (15). These factors may have resulted in mortality in the compacted treatment due to desiccation or starvation. Agronomic benefits of compaction on seedlings have been inconsistent in the literature (16). These benefits and impacts on mite control need to be further investigated in different soil types and conditions.

Mite numbers around the seedlings were significantly higher in seedlings developing from small seeds. Perhaps there is an association between source seed size and defensive chemical(s) produced by seedlings, which is related to an increase in vigour in the seedlings from larger seeds. Higher seedling density and smaller mite numbers were significantly associated with the larger seeds. Seedling density in the larger seed treatment (65/m^2) was 25.4 % greater than with the small seeds. The increased seedling vigour in large seeds may be due to higher amounts of reserve polypeptides such as 11-12S globulin that are widely present among higher plants (17). Globulins are broken down during germination and used by the geminating seedlings as an initial food source by the radicle (18). Possible influence of chemicals formed during the germination process having any antibiosis (19) properties against mite feeding in canola would be of interest.

In the uncompacted treatment, endosulfan did not significantly increase seedling density. Endosulfan can evaporate (20) more easily from the uncompacted, porous and exposed surface losing the desired activity. Repellent action of endosulfan on insects and mites has been reported in the literature (21). On uncompacted ground, endosulfan may thus repel mites into underground spaces in soil and may even encourage mites to feed on the seedlings under low rainfall conditions during the critical period. Compacted ground on the other hand has less surface area and chemical loss from evaporation was probably less. Fipronil and imidacloprid seed dressings increased seedling density without compaction. The seed dressings may have had a beneficial action on the seedlings perhaps via increased vigour or seedlings were better protected from mite damage by the seed dressings than by endosulfan. With fipronil, increased root development has been reported in rice (5), but this has not been investigated in Brassicaceae [Cruciferae]. There is no information on interactions of seedling physiology and imidacloprid. Compaction significantly improved seedling density in untreated seeds. This may also reflect increased vigour of the seedling or altered levels of mite damage.

Conclusion

Post-sowing compaction and larger seed size may provide protection to canola seedlings under mite attack. Insecticidal seed dressings such as fipronil and imidacloprid active at low chemical doses can increase seedling density with no compaction. Mite numbers can be affected by post-sowing compaction possibly by altering the availability of shelter in the soil. The use of seed vigour characteristics for the management of pests during seedling establishment needs to be further investigated.

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