



What organism is responsible for the losses of canola seedlings at establishment in the southern Cape?

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Introduction: The benefits of conservation farming are well recognized by the farming community, but the change over to conservation farming has also brought problems which had not been experienced in the past. One such problem is the loss of a substantial percentage of canola seedlings during the early establishment phase, often requiring a field to be replanted. Seedlings disappear just before or soon after they emerge on the soil surface. The loss of seedlings may be widespread over the entire field, or else bare patches form within a field and steadily enlarge over a period of weeks.

Although various diseases and organisms such as slugs and isopods (“krimpvarkies”) have been observed to be responsible for damage to and loss of canola seedlings, no direct cause and effect has been established to explain these widespread losses. The story is further confused by conflicting data. For example, the number of isopods in a field that was destroyed and had to be replanted, was the same as the number in the replanted field which experienced no damage. How then could isopods be the culprits? The burning of stubble prior to planting resulted in no damage one year, but the following year the burning did not prevent the field from being destroyed. And why is canola of all the rotational crops the worst hit by whatever is causing the damage?

The aim of the trial that was conducted in 2006 was to establish the best practice at planting in order to minimize the losses regularly experienced in the Overberg district. The variables used were the application of slug pellets, herbicide and insecticide. The situation within the canola fields was also compared with an undisturbed site in an adjacent pasture where various weather data were compared with the numbers of slugs and isopods present.

Experimental procedure: There were four experimental sites laid out in the Caledon district in fields that had been planted with barley the previous season and where problems with the planting of canola had been experienced in the past. Each site was divided into 8 treatment plots of 30 x 30 m with a 3m interval between plots i.e. a total of 32 plots.

The mortality rate of seedlings was determined by counting the number of seedlings within 4 blocks of 1 x 0.5m each which were demarcated by means of 4 pegs linked with string. The seedlings were counted every fourth day for the first two weeks and then at weekly intervals thereafter for eight weeks. A total of 128 blocks were therefore counted at each interval.

The number of slugs and isopods within each plot was determined by placing 5 melthoid traps in a row at about a meter apart, starting three weeks prior to planting and

continuing again after planting. These traps, consisting of 2mm thick squares (30 x 30 cm) of melthoid held to the ground by two metal pegs, were merely lifted and the number of slugs, isopods and other insects under the traps were counted before being replaced. These counts were done at the same intervals as counts for the seedling survival rate.

The 8 treatments consisted of combinations of slug pellets, herbicide, insecticide and appropriate untreated control plots. The planting date was 2 May 2006 and seed was planted at a rate of 5 kg/ha. The seeds were treated with the fungicide Cruiser so that pathogens could be eliminated as a cause of seedling mortality. The insecticide was applied at the rate of 200ml cypermethrin/ha; atrazine was applied on 29 May 2006 at 2 l/ha with a fixer wenfinex at a rate of 500 ml/ha; and glyphosate applied on 27 April 2006 at a rate of 1.25 l/ha. Kombat slug pellets were applied on 4 May 2006 at a rate of 8 – 10 kg/ha and again on 19 June 2006.

Ten melthoid traps which had been in place in an adjacent pasture at Roodebloem for about a year were inspected at the same time as the traps in the canola field. The fluctuating numbers of slugs and isopods under these traps were compared with corresponding weather data in order to ascertain whether they could be linked.

Results:

- The number of **isopods** under the melthoid traps was significantly higher in the canola fields prior to planting than after planting. There were significantly more isopods under the traps in the undisturbed pasture (mean = 375) than in the canola field (mean = 7.4). Disturbance of the soil resulted in fewer isopods being present.

- Spraying with **insecticide** at planting almost doubled the isopod population. Presumably this is because their predators are highly susceptible to the insecticide. Predators present in low numbers were spiders, assassin bugs, and ants. The mean number of isopods that were present in the insecticide treated plots was almost twice that of the control plots, whereas the number of slugs was the same because they were unaffected by the insecticide:

	Isopods/trap	Slugs/trap
Control	3.3	0.13
Insecticide	6.2	0.13

- The application of **herbicide** had no significant affect on the numbers of isopods, slugs or seedlings.

- Three of the sites were situated within **larger fields** which had had canola seeds planted before the winter rains i.e. about three weeks prior. Of these, two fields had to be replanted, while the trial plots planted three weeks later experienced almost no losses.

- Only the **Roodebloem** site experienced severe losses of seedlings (50.1%) and had corresponding large numbers of both slugs and isopods. The mean numbers of isopods and slugs under 40 melthoid traps in each of the four sites:

	Isopods	Slugs
Roodebloem	7.42	0.42
Heuningneskloof 2.	5.25	0.06

Heuningneskloof 1.	4.11	0.01
Heuningneskloof 3.	2.21	0.03

- The effect of the slugs and isopods in the different experimental sites may be seen by comparing the mean number of seedlings per site:

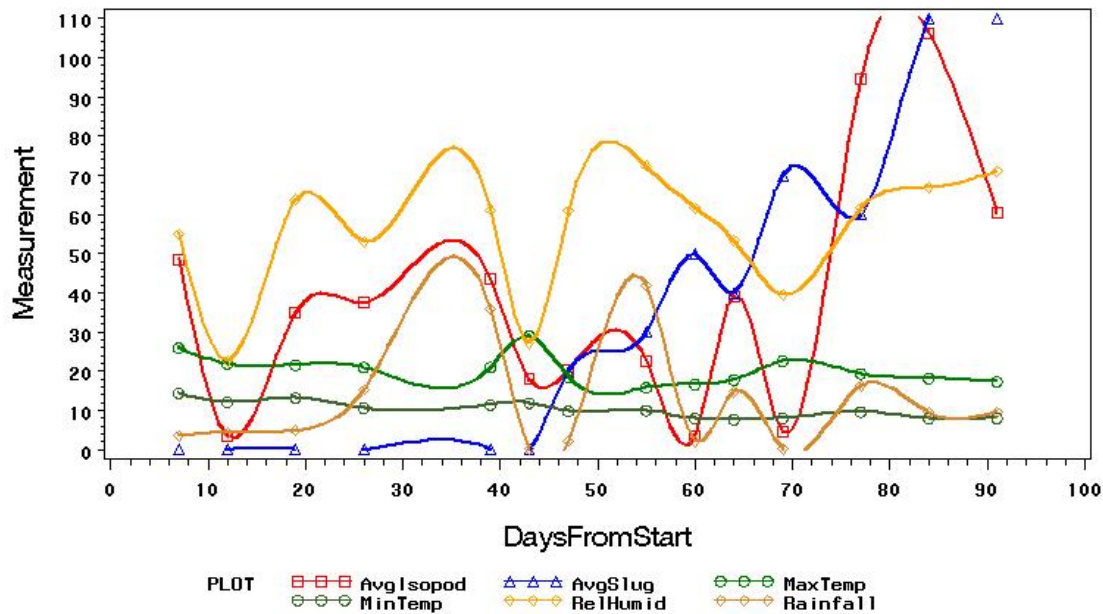
Mean number of seedlings

Roodebloem	35.7
Heuningneskloof 2.	74.9
Heuningneskloof 1.	84.3
Heuningneskloof 3.	87.0

- Correlations with **weather** aspects were much as expected and are presented in the graph below. There was a strong correlation between minimum temperature and slug activity where more slugs were active during the coldest period. A moderate negative correlation was recorded for maximum temperature indicating that slugs avoid high temperatures. A weak positive correlation with minimum relative humidity indicates that high humidity is favourable for slugs to be active. The only correlation with isopods was a weak positive correlation with minimum relative humidity, whereby they require higher levels of moisture in the air in order to be active. Although there is undoubtedly a correlation between rainfall and the activity of both slugs and isopods, this was not able to be shown statistically by comparing rainfall in millimeters. More likely, accumulative soil moisture would be a more accurate measure of the effect of rainfall on the activity of slugs and isopods.

Graph showing the average number of slugs and isopods recorded under 10 melthoid traps at Roodebloem in relation to the average minimum and maximum temperatures, relative humidity, and rainfall over time from the start of planting:

Trends over days



It is important to note that the slugs start from a low base after the first rains and increase rapidly after the heavy winter rains have set in. The isopods in contrast start from a high base and fluctuate considerably due to the influence of weather conditions. Because a direct link with various weather factors was not clearly shown, it is likely that the micro-climate is all important to the isopods and is indirectly influenced by prevailing weather conditions.

Conclusions: The evidence obtained from this trial, field observations, and discussions with the farming community, indicate that isopods and slugs are responsible for the deaths of seedlings. Not every field is affected in exactly the same way because of differences in position, soil qualities, aspect and rotational history. Slugs and isopods may act separately or at the same time in one field, but their damage can be distinguished from one another. By and large the following scenario appears to take place:

Plants resulting from canola seeds planted before or just after the first winter rains in April are vulnerable to both slugs and isopods. The isopods become active before the majority of the slugs and the early damage, which often requires complete replanting, is due to the damage they cause. The isopods are indigenous and desiccate easily and this is why they are always found in damp places. The first winter rains bring the isopods to the surface where they feed on the accumulated detritus which is their natural food. However, the first winter rains are invariably followed by a hot dry spell which lasts for two to three weeks before the real winter rains begin. It is during this period that the isopods, desperate for moisture but now active on the soil surface, feed at the base of the water-filled stems of the canola seedlings. Once this dry period is broken by rains and a drop in temperature which lowers the evaporation rate, there is no longer a necessity for the isopods to feed on the seedlings because moisture is now plentiful. But it is at this stage that the slugs emerge in large numbers and feed on all green matter within

proximity of their holes in the ground. Bare patches begin to form and steadily increase in size as the season progresses until a limit is reached and they cease to expand. This occurs when there is so much foliage on the plants surrounding the bare patches that the damage becomes negligible or warmer temperatures cause the slugs to become less active.

The following evidence also appears to agree with this scenario:

Replanting: Isopods are usually responsible for the early loss of seedlings which often require complete replanting of the field. Negligible losses occur after replanting even though the same number of isopods is present in the field, because by the time that the seeds germinate, the winter rains have set in and moisture is available everywhere.

Late planting: Canola fields planted at the time of the true winter rains rarely experience losses due to isopods. The experimental trials planted three weeks later than the surrounding fields in the three Heuningneskloof sites were largely unaffected by isopods while two of the fields had to be replanted.

Not maturation feeding: Organisms usually undergo a 'maturation feeding' in which nitrogen is required for the manufacture of amino acids to form the protein necessary for the production of eggs. The highest concentration of nitrogen is found in the apical growing point of the canola plant but instead the isopods are feeding on the water-filled cells in the base of the stem of the plant. Water, not protein is what the isopods required.

Lupin, barley and wheat stems: Only the canola stems are succulent and soft enough to be fed on by isopods. Fields of lupins, wheat and barley are rarely destroyed by isopods because their stems are drier and tougher.

Desiccation: Isopods are prone to desiccation and need moisture when active. This can easily be demonstrated by having two Petri-dishes with blotting paper floors placed under a lamp, and to one is added a drop of water. If 10 isopods are added to each of the dishes, within a short while all the isopods in the one dish will be concentrated on the moist spot, while those in the other dish will move randomly before they eventually die.

Burning of stubble: The conflicting reports of the advantage of burning stubble to reduce losses of seedlings appears to be linked to when the seeds were planted - before or after the heavy winter rains - and not to the burning.

Isopod damage: Isopods feed either on the seedling as it emerges from the soil or on the water-filled stem. Crush a canola seedling's stem in your fingers to see the amount of water present. Because the plant grows from the top, the 'ring-barking' of the stem at its base results in the death of the plant. The characteristic damage by isopods is that they feed at the base of the stem and never higher up. An 'hour-glass' constriction results at the base of the stem, the plant withers, falls over and shrivels up.

Slug damage: Slugs may consume almost the entire canola seedling, sometimes leaving only a fraction of the stem projecting above the soil before it withers away. The presence of slugs can be determined by the many perforations in the leaves and chunks removed from the sides of the leaves. Slugs will climb up the plant and damage is usually above the interface with the soil. Slugs usually leave characteristic trails if the soil is dry, but often do not leave trails in very damp conditions.

Emergence of slugs: Immature slugs are usually the first to emerge after the first rains and may be found together with the isopods causing damage. As the minimum temperature drops and the soil becomes saturated with moisture, the number and size of

the slugs increase and sustained damage by slugs becomes widespread in a field. This usually occurs after the isopod damage has ceased.

Limited movement of slugs: The slugs found under the melthoid traps are not representative of the population in the field because they are far less mobile than isopods. Slugs tend to congregate and feed on the plants nearest to where they have emerged from their burrows in the soil, and return to these burrows to hide during the day. Hence the steadily widening bare patches.

Elliptical shape of bare patches: The slugs tend to feed along the rows where the plants occur and where more water has accumulated. Thus the bare patches tend to stretch in the longitudinal direction of the rows and widen as they cross to adjacent rows. Their burrows from which they emerge each night are at the widest part of the oval-shaped bare patch. The bare patches thus tend to follow the contours.

Certain areas are more favourable to slugs: The distribution of slugs within a field is patchy and certain fields in turn may harbour more slugs than others. Slugs tend to aggregate within a field. Attractive fields appear to be associated with soils that are clay-like (and tend to retain more moisture), near streams or dams and adjacent to uncultivated vegetation.

Only slugs and isopods in sufficient numbers: Although a variety of organisms occurred under the melthoid traps, only slugs and isopods occurred in sufficient numbers to be able to account for the massive loss of seedlings.

Recommendations:

The present problems in the establishment of canola have come about with the change to conservation farming. This change has led to the relatively new crop of canola becoming attractive to isopods at a certain stage of development, and to an increase in the number of slugs.

Isopods: are indigenous and part of the natural system where they normally assist in the decomposition of detritus for inclusion in the humus layer. Their numbers were found to be lower in the canola fields than in undisturbed pastures, and part of the reason for this is that they react negatively to disturbance. The highest number of isopods under 10 melthoid traps in the pasture during weekly monitoring at Roodebloem was 1063, but in the nearby canola field 547 were present before planting and only 154 after planting. If possible, isopods should be incorporated into the conservation farming system. From these early results it appears that where isopods are known to be a problem, planting later, just before the heavy winter rains begin would prevent losses due to isopods. This in turn creates other problems such as a shorter growing season and the difficulty of planting in rain, but must be weighed against the replanting of the field in which the former two problems will in any case occur. Slug pellets do kill a certain number of adult isopods but are unlikely to reduce the population to below an acceptable threshold. A faster growing variety of canola may offset the delay in planting.

Slugs: Previously, deep ploughing destroyed the tunnels in the soil in which the slugs had passed the dry summer months and exposed them to the elements and predators. But with conservation farming, these tunnels and their occupants remain untouched, resulting in higher numbers of slugs. *Milax gagates* is originally from the Mediterranean region, is adapted to a winter rainfall climate, and has only a few generalist natural enemies in South Africa. Control of these slugs will have to be accomplished with the judicious use

of slug pellets. There has been a drastic reduction in slugs in the Caledon area compared with the epidemic experienced three years ago. Presumably this was brought about by the continual application of slug pellets following this outbreak. Fields surrounded by other fields and where slug pellets had been applied regularly, appeared to have fewer slugs. Thus it appears that it may be possible through the use of slug pellets to reduce the slug population to such levels that spot treatments only become necessary. Slugs are present and feeding on the seedlings soon after they appear above ground level and pellets would have to be broadcast at this stage in areas prone to slug damage. It is when the soil is saturated with water and the minimum temperature is below 8 °C that the slug population is at its maximum (approximately 34 days after planting on 6 May). This is when the bare patches have begun to form and when a second application of slug pellets will become necessary. This second application would target the larger slugs, and their deaths should result in fewer eggs being laid as the sexually mature slugs are removed from the population. However, the literature states that at every application of slug pellets, only about 50 % of the slugs are killed.

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