BAYER

EverGol® Prime

Technical Guide

A new standard in fungicidal seed treatments for the suppression of rhizoctonia and the control of smut diseases* in wheat and barley.

Bayer CropScience

Bayer SeedGrowth™

seedgrowth.bayer.com

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INTRODUCTION

EverGol® Prime 240 FS is a new fungicidal seed treatment that offers outstanding suppression of rhizoctonia root rot and the control of smut diseases in wheat and barley*. Through its high levels of activity on key diseases and favourable crop safety profile, EverGol Prime will set a new standard in plant health leading to healthier, higher yielding wheat and barley crops.

Rhizoctonia root rot is the most yield depleting root disease in the southern and western GRDC cereal cropping zones and is on the increase due to the increasing adoption of minimum tillage cropping systems. EverGol Prime gives growers a new weapon to help suppress this devastating disease.

This Technical Guide summarises the results of extensive trial work throughout Australian cereal cropping areas and provides detailed technical and disease information to agronomists, consultants, advisors and researchers so that they can understand how to get the best results from this unique seed treatment.

*Suppression of soil-borne flag smut.

DIRECTIONS FOR USE

EverGol Prime is registered for use as a fungicidal seed treatment in wheat and barley.

EverGol Prime is registered for the suppression of rhizoctonia root rot at a range of application rates as well as the control of smut diseases*, including bunt, in wheat. The approved product label can be viewed in table 1.1.

Table 1.1: EverGol Prime directions for use.

CROP	DISEASE	RATE	CRITICAL COMMENTS
Wheat	**Bunt** (*Tilletia* spp.) **Flag smut** (seed and soil-borne) (*Urocystis agropyri*) **Loose smut** (*Ustilago tritici*) **Rhizoctonia root rot** (*Rhizoctonia solani*)	40 to 80 mL/ 100 kg seed	EverGol Prime is applied to seed prior to sowing. Ensure even coverage of seed. EverGol Prime will suppress rhizoctonia root rot and its symptoms. Suppression of rhizoctonia root rot by EverGol Prime is characterised by a reduction in root damage, an increase in root growth and an increase in above ground biomass. Use the higher label rates in situations conducive to greater risk of rhizoctonia root rot damage and/or higher yielding situations. EverGol Prime will provide suppression of soil-borne flag smut.
Barley	**Covered smut** (*Ustilago segetum*) **Loose smut** (*Ustilago nuda var. hordei*) **Rhizoctonia root rot** (*Rhizoctonia solani*)		

APPLICATION GUIDELINES

EverGol Prime should be applied to clean good quality wheat and barley seed at between 40 and 80 mL/100 kg of seed. To ensure adequate coverage of the seed treatment on the seed, the product should be diluted with clean water to a total slurry volume of 400 - 600 mL/100 kg of seed.

The addition of water is important to ensure EverGol Prime, is spread evenly over each and every seed. Well-treated seed will appear red in colour and will have an even colour with no patchiness.

Safety precautions should be followed when using EverGol Prime. These can be found in the product profile section of this Technical Guide.

Images 1.1 and 1.2 demonstrate a well-treated wheat sample compared to a poorly treated wheat sample. The only difference between the application of these two samples was the amount of water added to the total slurry.

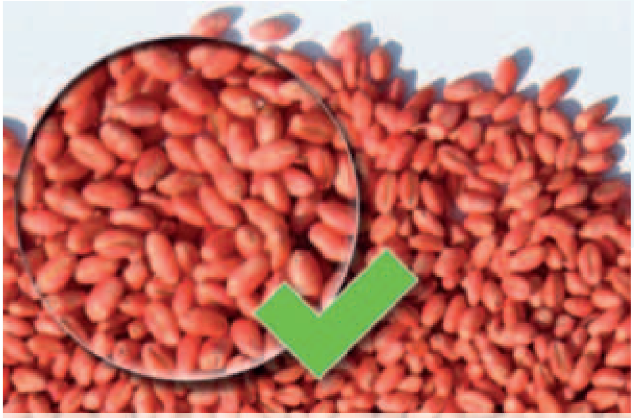


Image 1.1: EverGol Prime at 80 mL/100 kg seed + water at 420 mL/100 kg. Total slurry volume of 500 mL/100 kg.

Image 1.2: EverGol Prime at 80 mL/100 kg seed + water at 100 mL/100 kg seed. Total slurry volume of 180 mL/ 100 kg seed^.

^Not recommended total slurry volume.

KEY PRODUCT FEATURES

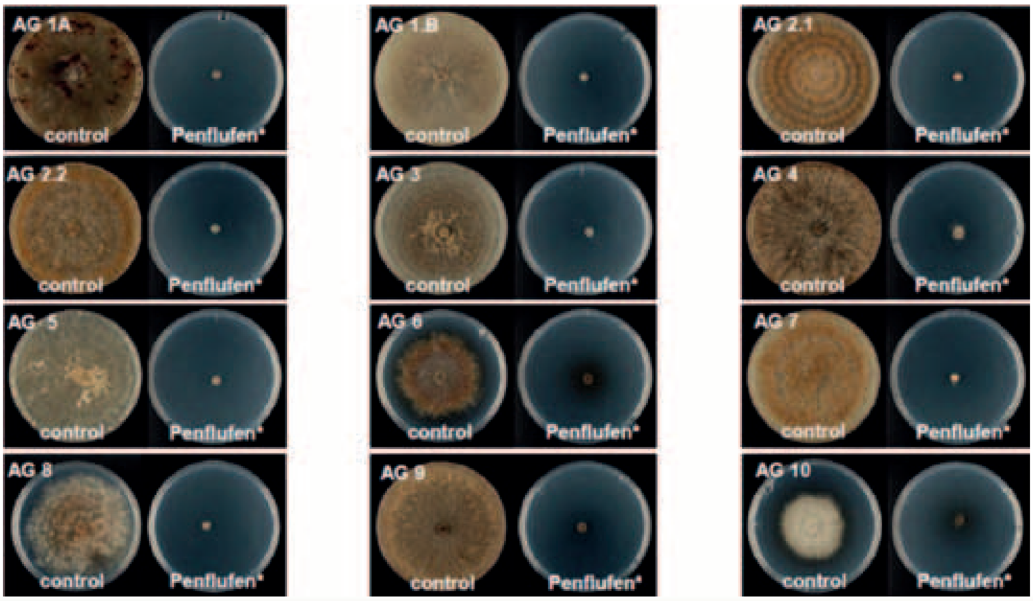
Through effective disease protection EverGol Prime will set a new standard in plant health leading to healthier, higher yielding wheat and barley crops.

Information contained in this Technical Guide supports several key features of this new seed treatment fungicide.

Market-leading suppression of rhizoctonia root rot

EverGol Prime offers outstanding suppression of rhizoctonia root rot in wheat and barley. The powerful active ingredient penflufen offers excellent efficacy on all recognised anastomosis groups (AG) of the disease (figure 1.1). Section 2 of this Technical Guide focuses specifically on EverGol Prime's action on root health and rhizoctonia disease.

Figure 1.1: Petri dish demonstration of penflufen's efficacy on different rhizoctonia AG groups.



Penflufen tested at 20 ppm representing 2 g a.i/100 kg seeds.

Improved grain yields

EverGol Prime significantly improves crop yields in wheat and barley in rhizoctonia infested sites over untreated crops delivering positive return on investment (ROI) for growers. Yield losses from rhizoctonia for cereal crops are generally in the range of 5 - 20% however in situations which are conducive to severe infection, losses may be as high as 50%. Section 3 of this Technical Guide covers EverGol Prime's impact on grain yields and ROI.

Control of smut diseases

For many years seed treatments were viewed by growers as an insurance policy against unforeseen smut diseases that only present when a crop comes to head. While today's seed treatments offer a significant step-up in disease protection and plant health benefits, the protection of cereals from smut diseases is still a vital part of a seed treatment fungicide. EverGol Prime offers excellent control of smut diseases* including outstanding performance on loose smut in barley which is poorly controlled by some other seed treatments. Section 4 of this Technical Guide focuses on smut disease protection.

Improved root development

The importance of a well-developed root system is vital to the health and vigour of a good crop. Penflufen, the active ingredient in EverGol Prime, helps to promote stronger more-established root systems by suppressing rhizoctonia infections in the plant's roots leading to improved access to water and nutrients which supports a healthier plant. Section 2 of this Technical Guide focuses specifically on EverGol Prime's action on root health and rhizoctonia disease.

Improved plant biomass

Through the improved root system and access to nutrients and water, EverGol Prime helps to improve above ground biomass and plant weights. Stronger, fitter plants lead to higher yielding crops and improved returns for farmers. Section 3 of this Technical Guide demonstrates the plant health benefits associated with EverGol Prime including crop biomass.

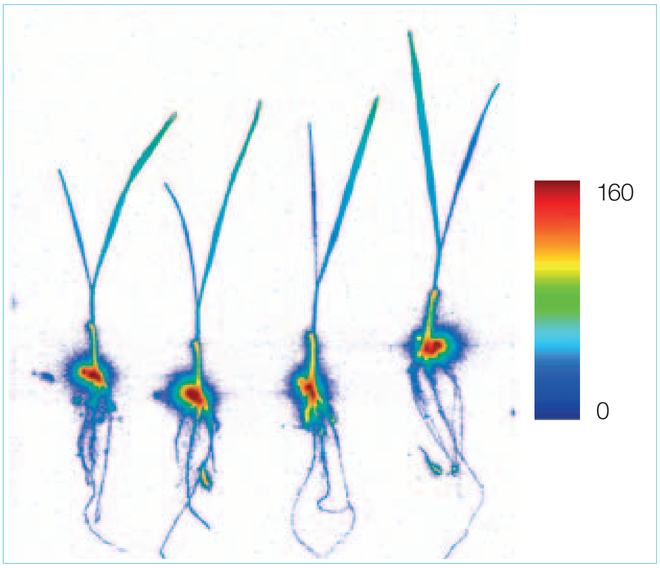
Excellent seed safety

EverGol Prime contains a single active ingredient formulation with no triazoles. It has been well-documented that triazoles can have an effect on coleoptile length of cereals and also delay emergence. EverGol Prime contains penflufen which has no impact on coleoptile length or emergence. Section 5 of this Technical Guide reviews crop safety and germination data.

Limited systemicity

The new proprietary active ingredient, penflufen, has limited systemicity and low water solubility as seen in figure 1.2 and 1.3. This means that the active ingredient penetrates the seed and stays in and around the seed and root zone where it is required.

Figure 1.2: Penflufen mobility within a wheat plant, C14 study.



Excellent residual activity

Penflufen also has excellent persistence in the soil for extended disease protection. Figure 1.3 demonstrates a 3D time lapse simulation of penflufen around treated barley seed. This simulation was modelled on climate and soil data representative of conditions conducive to rhizoctonia in Australia (Dubbo, NSW; sandy loam, 0.6% organic carbon). During the time interval studied (0 - 80 days), the total soil concentration of penflufen around the treated seed is well above the EC_{50} of penflufen (0.01 ppm) which controls the rhizoctonia fungus. The *in vitro* study shown in figure 1.4 demonstrates the potency of penflufen against *Rhizoctonia solani* (AG8). The study showed that penflufen is 300 times more active on the fungus than difenoconazole.

*Suppression of flag smut.

Figure 1.3: Time lapse simulation of penflufen around treated seed.

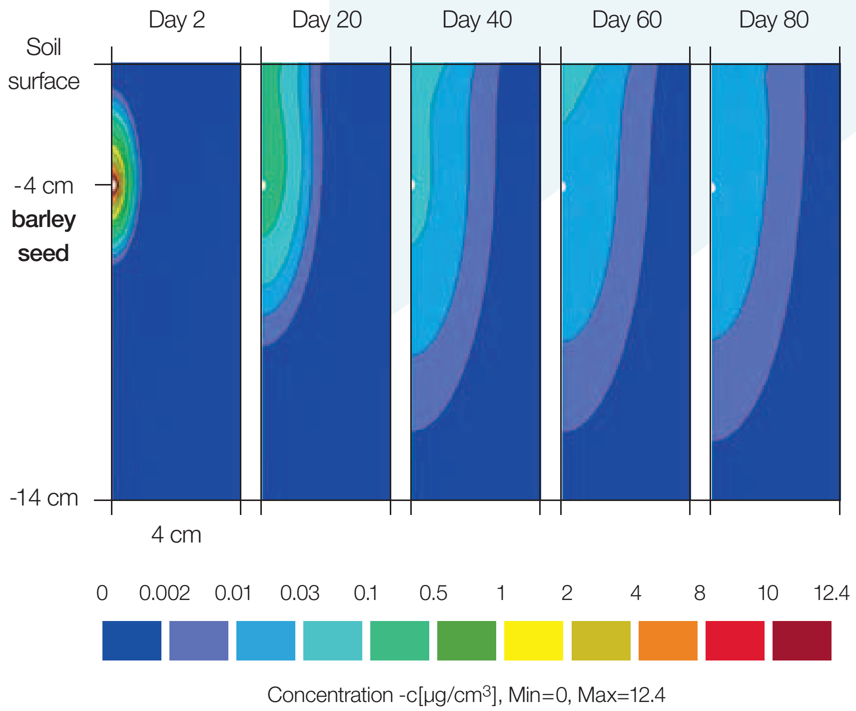
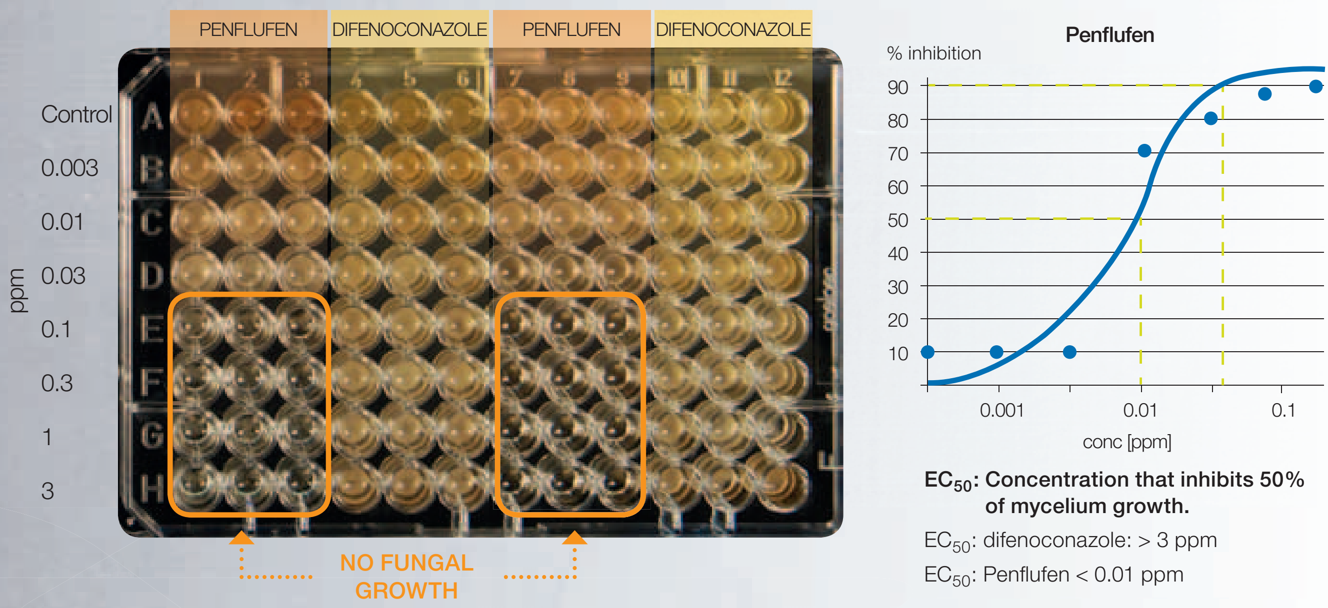


Figure 1.4: Biological activity of penflufen based on mycelium growth.



EC_{50}: Concentration that inhibits 50% of mycelium growth.

EC_{50}: difenoconazole: > 3 ppm

EC_{50}: Penflufen < 0.01 ppm

The *in vitro* potential of penflufen is at least 300 fold higher than that of difenoconazole against *Rhizoctonia solani* AG8.

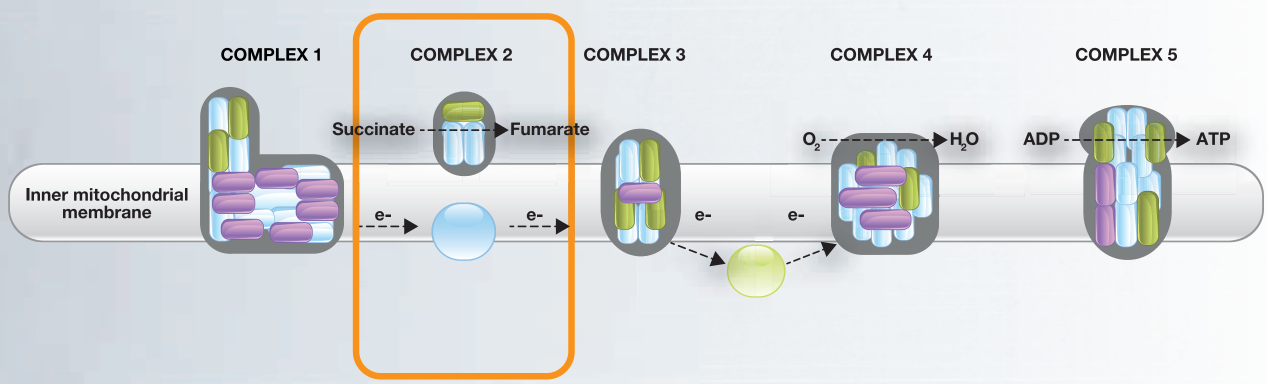
MODE OF ACTION

The active ingredient of EverGol Prime is penflufen, a locosystemic Group 7 fungicide. Penflufen is an alkylamide fungicide belonging to the succinate dehydrogenase inhibitor (SDHI) class of fungicides. Unlike many other fungicidal seed treatments, EverGol Prime does not contain a triazole active ingredient.

Penflufen works by interfering with fungal respiration. The penflufen molecule binds to the succinate dehydrogenase enzyme, consequently inhibiting the transformation of succinate to fumarate and the corresponding electron transport (figure 1.5). This action disrupts cellular respiration and energy generation, causing the fungal cell to die.

Figure 1.5: Mode of action of penflufen.

Respiratory chain



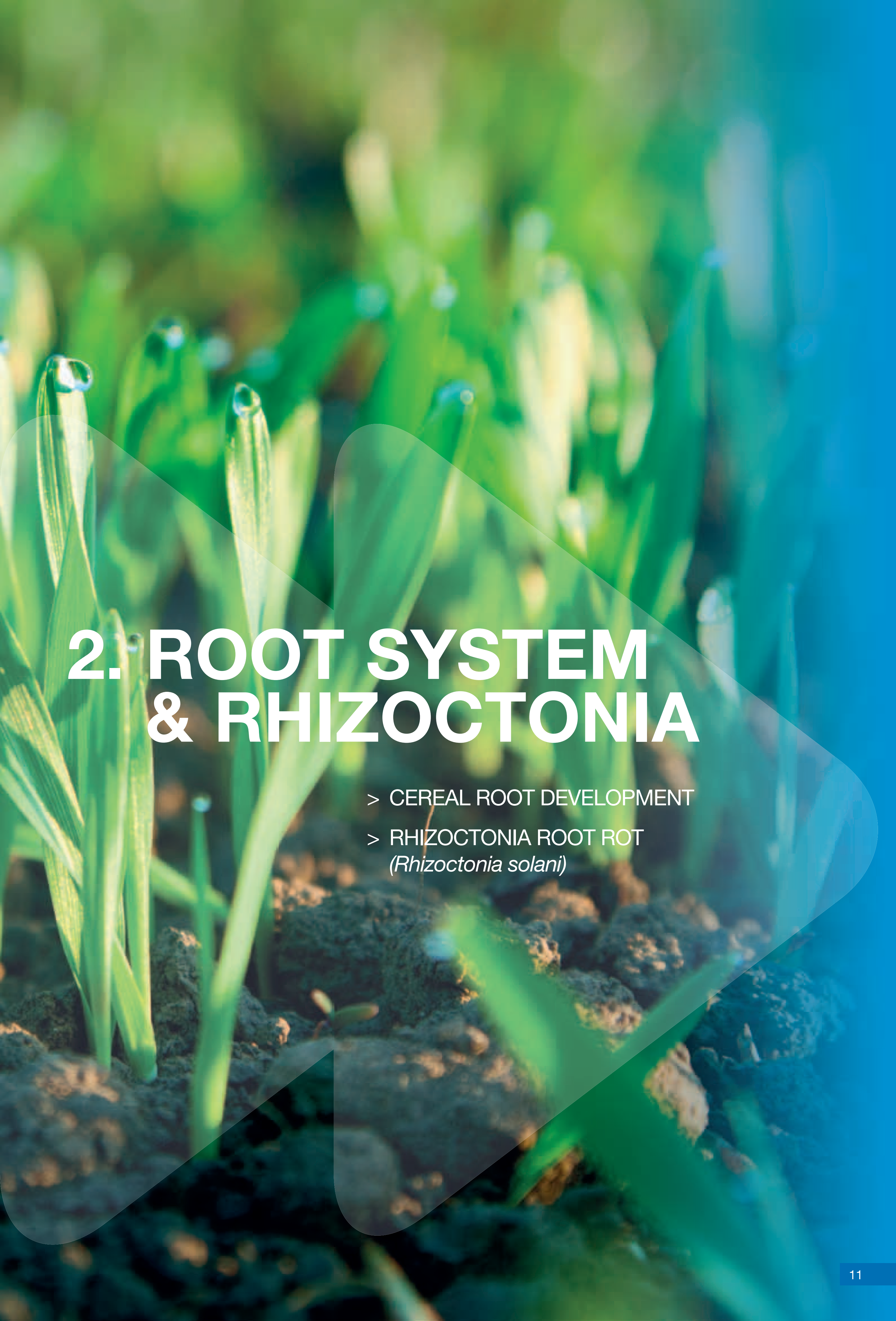
The respiratory chain is a sequence of enzymatic biochemical reactions leading to the production of energy in the form of ATP.

Penflufen binds to the succinate dehyrogenase enzyme, consequently inhibiting the transformation of succinate to fumarate and the corresponding electron transport.

The following enzymatic reactions of the respiratory chain are blocked so no energy is produced.

FUNGAL CELL DIES

NOTES



2. ROOT SYSTEM & RHIZOCTONIA

> CEREAL ROOT DEVELOPMENT

> RHIZOCTONIA ROOT ROT *(Rhizoctonia solani)*

ROOT SYSTEM AND RHIZOCTONIA

CEREAL ROOT DEVELOPMENT

Like all plants, a strong and well-developed root system is vital for a strong, healthy, high yielding plant because this improves a plant's ability to access necessary nutrients and moisture in the soil.

Cereals such as wheat and barley have two types of roots; seminal roots and crown roots, which can be seen in figure 2.1. Seminal roots are produced from the base of the main stem at the seed shortly after germination. The crown roots (also known as nodal roots) commence growing from the base of the crown around the 4-leaf stage when tillers begin to form. As they are the uppermost roots in the root system, they form a 'crown' in the early stages of growth.

Root development

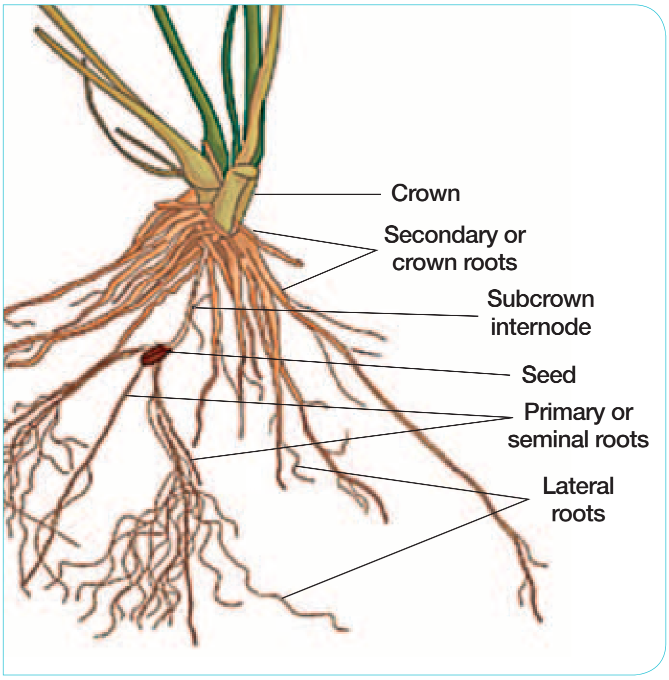
The primary root or radicle, which is the first visible sign of germination, generally grows straight down.

About the same time that the coleoptile or main shoot begins to emerge from the seed, a pair of seminal roots form on each side of the primary root. This is the lower of two pairs of seminal roots that occur in wheat.

From the 1 to 2 leaf stage of the crop the second pair of seminal roots develops above the lower pair. A third single root may develop at the level of the upper pair of seminal roots with up to six or more seminal roots generally developing in cereals.

The crown roots start to develop after the main stem has four leaves and the first tiller becomes visible. Crown roots develop in a pattern similar to that of the upper pair of seminal roots. They grow almost horizontally for the first 3 - 5 cm then turn downward. Additional crown roots develop on the main stem with the emergence of around three leaves on each new tiller. The crown roots eventually comprise the bulk of the plants roots and can extend to depths of 1 - 2 m or more.

Figure 2.1: Cereal root system.



Source: Root disease under intensive cereal production systems; Western Australian Agriculture Authority, 2008.

Importance of seminal roots

Seminal roots are very important in crop establishment as they are the structures that ensure that the seedling can access nutrients and moisture prior to tillering. The length of the seminal roots and their branches depends upon soil conditions.

Root diseases such as rhizoctonia that attack and shorten the roots and root hairs limit the plant's access to nutrients and moisture, making it more vulnerable to abiotic stresses like drought, and biotic stresses such as fungal diseases or insect pests. If the plant is stressed by low nutrient levels, root diseases, or other environmental factors when tillering commences, then some of the earliest, most productive tillers may not develop or may be aborted.

Importance of crown roots

Crown roots explore the soil between furrows and above the seed depth once tillering begins. Poor colonisation of this area by the crown roots may result in reduced weed competition and greater emergence of weeds in the crop.

The crown roots become increasingly important as the plant grows, and eventually make up the bulk of the plant's root system. The crown roots ensure that multiple tillers can be supported and deliver access to moisture and nutrition in order to achieve grain fill.

Damage to crown roots from rhizoctonia root rot results in shortened 'spear-tipped' roots. Above the ground, this can be seen as highly visible weak or bare patches in a crop, however damage can also be seen as reduced evenness of the crop and can result in poor grain fill with high screenings.

RHIZOCTONIA ROOT ROT (*Rhizoctonia solani*)

With the widespread adoption of minimum tillage agriculture there has been an increase in the distribution and frequency of rhizoctonia root disease across Australia. Once confined to sandy poor quality soils and low-rainfall areas, a reduction in tillage has enabled the pathogen to colonise a wider variety of soil profiles and rainfall zones to encompass most cereal growing regions across Australia. In fact, rhizoctonia is estimated to cost the wheat and barley industry $77 million per year in lost revenue. It is the most yield depleting root disease in the western and southern GRDC regions, costing the industry close to eight times as much as pythium/damping-off (table 2.1).

Table 2.1: The costs of root and crown fungi to wheat and barley in Australia by GRDC region ($AUD millions).

	SOUTHERN		WESTERN		NORTHERN		TOTAL	
Root and Crown Fungi	Potential	Present	Potential	Present	Potential	Present	Potential	Present
Crown rot	261	46	36	7	216	44	513	97
Rhizoctonia root rot	112	50	118	27	0	0	230	77
Common root rot	111	35	0	0	35	9	146	44
Take-all	89	11	33	4	0	0	122	15
Pythium root rot/Damping Off	29	8	7	1	1	1	37	10
Total	602	150	194	39	252	54	1048	243

Sources: Brennan & Murray: *The Current and Potential Costs from Diseases of Barley in Australia* and *The Current and Potential Costs from Diseases of Wheat in Australia,* GRDC, 2009.

Rhizoctonia is not just a disease that affects seedlings, it is active across all growth stages of a cereal crop. While seedlings are highly susceptible to the disease due to their developing root systems, often the highest levels of disease activity occurs in spring at crop maturity, severely impacting crop yields.

Rhizoctonia disease activity will vary across regions, however it is important to consider the farm/paddock history, surrounding environment and soil conditions, as all these factors contribute heavily to the threat posed by the disease and overall disease pressure.

Due to the powerful activity of EverGol Prime's active ingredient penflufen, EverGol Prime has activity on all rhizoctonia anastomosis groups including *Rhizoctonia solani* AG8 which causes crop damage by pruning newly emerged and existing roots (image 2.1). Trial results suggest that EverGol Prime is the benchmark in terms of rhizoctonia suppression in cereals.

Image 2.1: Protection of seminal roots by seed treatments in Gairdner barley (38 days after planting).

Symptoms

Rhizoctonia can cause several highly visual symptoms which characterise the disease. These include; delayed emergence; pruned or trimmed roots giving the roots a 'spear-tipped' and significantly shortened appearance; uneven crop growth in a paddock ranging from undulations in crop height (image 2.2) to large bare and weak patches. Crop yields are also affected, as is root and above ground biomass as the plant struggles to access nutrients and water from its damaged root system. Plants will fail to thrive and may appear severely stunted in situations of higher disease pressure.

Yield losses for cereal crops are generally in the range of 5 - 20% however in situations which are conducive to severe infection and high disease pressure, losses may be much higher.

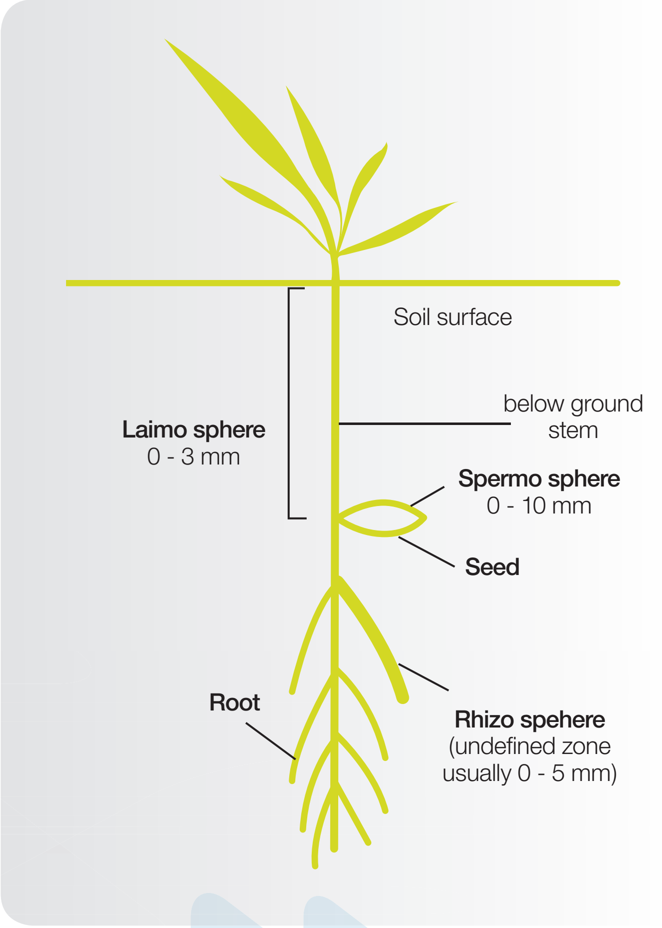
Image 2.2: Uneven cereal crop affected by rhizoctonia, Weetulta, SA, 2012.

Disease location in the soil

The *Rhizoctonia solani* fungus is predominantly distributed in the uppermost part of the soil profile with 80% of inoculum found in the top 2.5 cm. The inoculum is therefore most pronounced in the laimosphere and rhizosphere zones of the subterranean organs of the plant (figure 2.2).

There are, however, differences in rhizoctonia pressure across regions, a low level in one region may result in increased effects due to environmental or soil conditions.

Figure 2.2: The location of the subterranean organs of a plant.



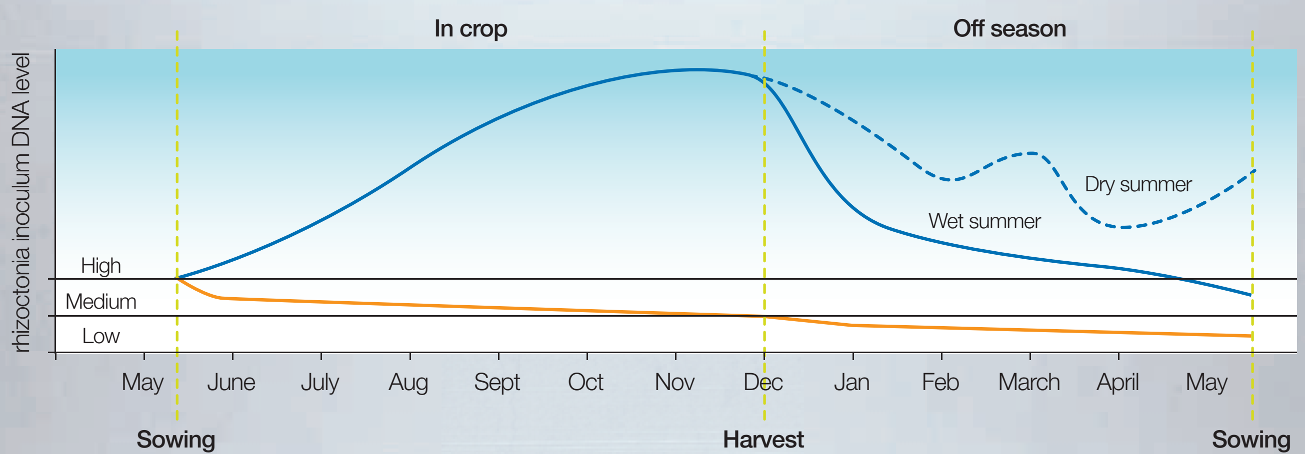
Disease lifecycle

The rhizoctonia fungus can survive in the soil for many years and lives as an underground network of hyphae which is similar to a cobweb-like structure under the soil surface.

Predominantly, the fungus lives in the soil rhizoshpere with other microorganisms but it has a unique ability to out-compete other fungi when conditions are favourable, totally dominating the subsoil space.

The fungus is attracted to the plant by chemical stimuli which are released by growing or decaying plant material. The fungus then penetrates the plant root system to gain nutrients and will eventually colonize the root system of the plant (both living and dead plant material).

Figure 2.3: Rhizoctonia inoculum level in soil.



Wet summer = multiple rainfall events throughout summer. Dry summer = long dry periods (~4 wks) between rainfall events. Note that wet summer can reduce inoculum risk from high to medium.

Source: GRDC Rhizoctonia Fact Sheet, March 2012.

Wheat Canola

Factors influencing the disease

Tillage system

Soil cultivation helps to break up the rhizoctonia hyphae structure in the soil which assists in reducing the disease pressure. No or minimal tillage systems therefore can contribute to an increase in rhizoctonia.

Using narrow points that disturb the soil below the seeding zone will help reduce rhizoctonia inoculum levels in minimum tillage systems however as the inter-row zone is not disturbed this will only provide short term benefit as the pathogen will recolonise the seeded furrow over the growing season.

Using disc seeders and shallow sowing can heighten exposure to the disease and result in increased root damage. Using disc seeders can cause significant problems with establishment in rhizoctonia-prone areas.

Soil conditions

Warm, moist soils can reduce rhizoctonia levels as other soil flora can compete better with rhizoctonia in these conditions however when the soil gets drier conditions favour rhizoctonia fungus and the fungus is able to outcompete the other fungi in the soil profile.

For this reason drought followed by a dry summer is conducive to very high inoculum levels. Controlling summer weeds is crucial to help minimise soil inoculum, as a high proportion of summer weeds will take moisture from the soil, drying it out and making the soil profile more conducive to the rhizoctonia fungus.

Soil compaction and high mineral nitrogen levels over summer can also lead to an increase in soil rhizoctonia inoculum levels. High mineral nitrogen reduces the effectiveness of suppressive organisms present allowing the rhizoctonia to grow more freely.

Crop sensitivity and rotation

Cereals and grass pastures are readily infected by rhizoctonia and provide an excellent host crop for the disease. Often rhizoctonia inoculum is highest in the soil after these crops have been in a paddock, so crop rotation is very important as there can be a compounding effect of cereal following cereal or grass pasture. Canola can be infected by rhizoctonia but it is not a good host crop so inoculum levels are likely to decline as per figure 2.3.

Barley is the most sensitive cereal to the effects of rhizoctonia due to the higher amount of crown roots that support the plant's tillers. Additionally, barley often follows a wheat rotation so soil inoculum levels are likely to be higher anyway. Like all cereals, oats are also affected by rhizoctonia and are an excellent host crop for the disease. Plant health will be impacted which may manifest uneven crop growth but large bare patches are less likely to be seen in oats.

Sensitivity to rhizoctonia in cereals, from highest to lowest is; barley, wheat, triticale, oats.

Canola and grass free pastures (pasture legumes) are excellent break crops and can help to significantly reduce disease inoculum levels. Lupins are not a good break crop and can be severely affected by rhizoctonia as well as increase rhizoctonia inoculum levels in a paddock.

Time of sowing

The timing of the rhizoctonia infection can impact the severity of the crop symptoms and the resulting yields. Late sowing, especially into cooler soils, is particularly conducive to higher rhizoctonia disease expression. Seminal and crown root pruning together with a reduction in biomass in this situation will often result in the stereotypical 'bare patches' being observed in crops (image 2.3 and 2.4).

Early sowing into warmer moist soils is generally beneficial for cereal crops as the rhizoctonia fungus is less active in these conditions, allowing seedlings to establish. Later infection is still possible however and while the seminal roots may have established in the soil without significant impact, later infection tends to affect the crown roots. Damage to the crown roots results in an unevenness or undulation of the crop and will result in a failure of the crop to achieve its yield potential.

Other factors influencing disease expression

There doesn't need to be high levels of rhizoctonia inoculum in the soil to see crop damage. Low levels combined with cold, slow growing conditions or poor nutrition can facilitate rhizoctonia colonising and causing severe root pruning effects.

The overuse of sulfonylurea (Group B) herbicides can also affect the soil biology and crop health which may exacerbate the ability of rhizoctonia to colonise the soil and impact the crop.

Image 2.3 and 2.4: Damage to seminal roots in late sown Baudin barley near Badgingarra, WA 2012 resulting in a bare patch.

NOTES

3. PLANT HEALTH BENEFITS

- > SPEED OF PLANT EMERGENCE
- > CROP ESTABLISHMENT
- > ROOT HEALTH
- > PLANT DEVELOPMENT AND CROP BIOMASS
- > YIELD DATA
- > RETURN ON INVESTMENT (ROI)

PLANT HEALTH BENEFITS

Trial work carried out by Bayer and independent researchers over a number of seasons suggests that EverGol Prime is a leading seed treatment that provides significant benefits beyond disease control in wheat and barley crops.

Speed of emergence, crop establishment, root health, above and below ground biomass, and yield have all been assessed in a variety of conditions to demonstrate the benefits of EverGol Prime.

To fully demonstrate the plant health benefits of EverGol Prime, trial work has consisted of natural infection rhizoctonia sites as well as inoculated sites where the rhizoctonia pathogen has been introduced artificially via infected millet.

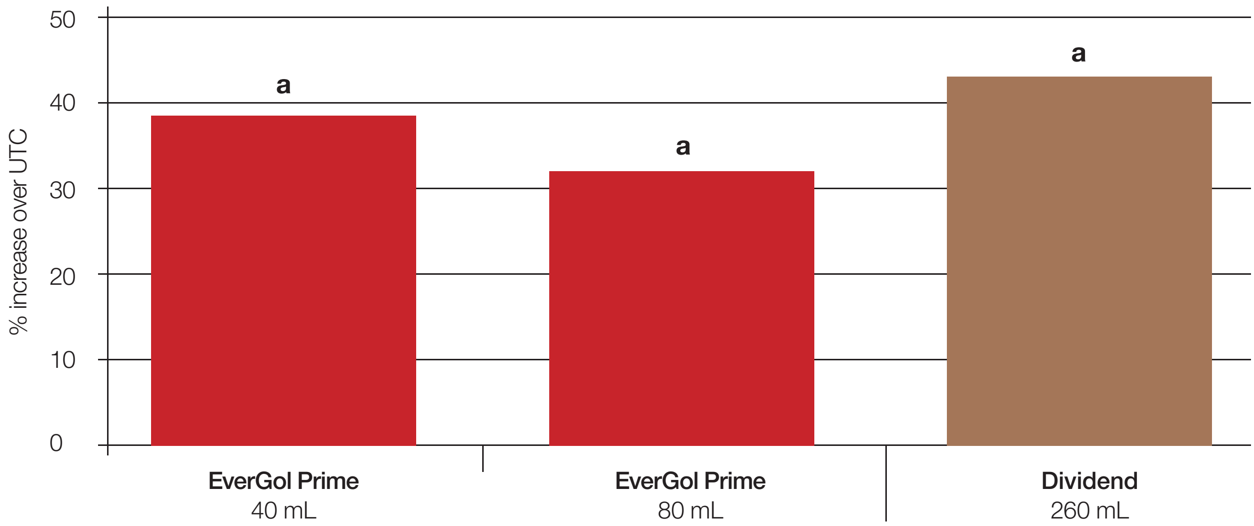
SPEED OF PLANT EMERGENCE

A common symptom of rhizoctonia infection is delayed seedling emergence. These plants generally display poor vigour which results in a reduction of tillers and yield compared to plants where the disease has been suppressed from the time of seed germination.

The rhizoctonia fungus is attracted to the cereal seed by chemical stimuli released by the germinating plant. Hyphae will come in contact with the emerging coleoptile and roots, penetrate the plant cells and begin to obtain nutrients and release enzymes that break down plant cell walls. This process slows and weakens the growing seedling. EverGol Prime protects the germinating seedling by preventing the pathogen from invading and colonising the plant.

Trial results in graphs 3.1 and 3.2 demonstrate how EverGol Prime is effective at increasing speed of emergence in rhizoctonia infected soils compared to untreated crops. Results at both high and low EverGol Prime rates are statistically significant in both wheat and barley when compared to the untreated.

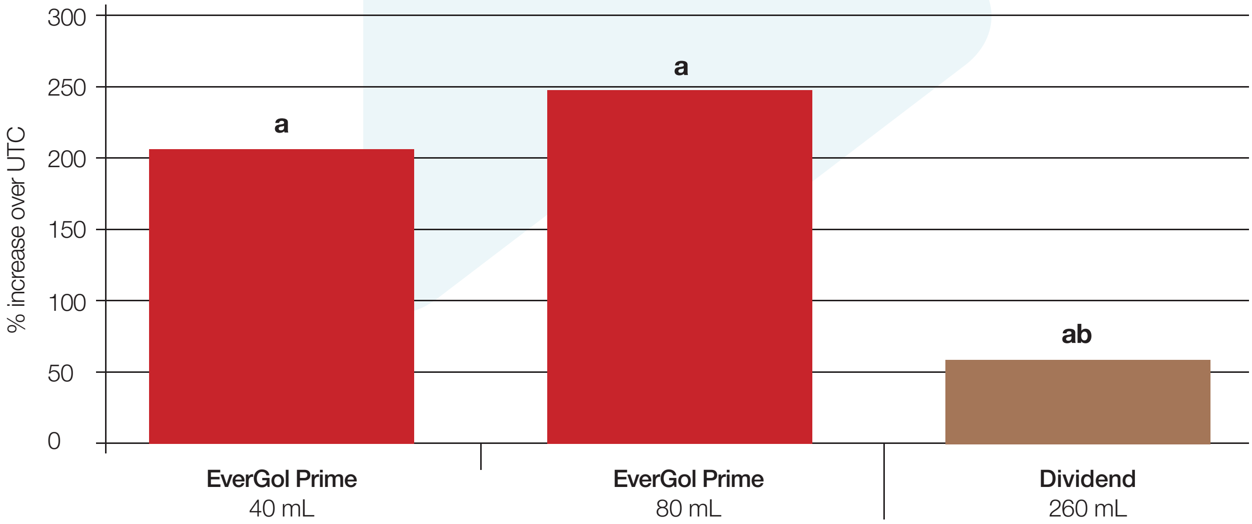
Graph 3.1: Speed of emergence (% increase in emerged plants) in rhizoctonia infected wheat trials (average 16 days after planting).



Trial ID: 07DC26, 09NW13, 09VA08, 10ND01, 10WA11 All rates per 100 kg of seed.

Treatments marked by the same letter do not significantly differ. P = 0.05, Untreated = 0 (b).

Graph 3.2: Speed of emergence (% increase in emerged plants) in rhizoctonia infected barley trials (average 12 days after planting).



Trial ID: 08WA19, 09ND21, 09ND22, 10SA11, 10NW01 All rates per 100 kg of seed.
Treatments marked by the same letter do not significantly differ. P = 0.10, Untreated = 0 (b).

Image 3.1: Rhizoctonia bare patches in Weetulta, SA, 2012.

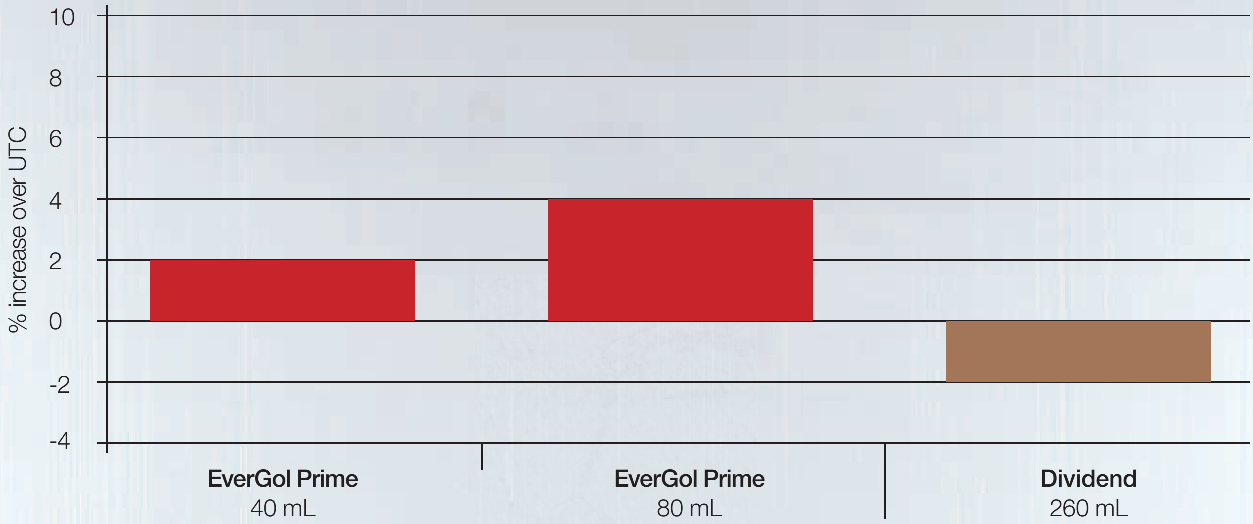
CROP ESTABLISHMENT

As can be seen in image 3.1, large 'bare' patches of poor growth occur when rhizoctonia infection is severe. However, even in these bare patches, actual surviving plant numbers are often similar to the surrounding areas where the crop is less affected.

The patches may be described as bare however, as can be seen in the image, plants are still present in similar numbers but their relative size is small as they lack the vigour of the less affected parts of the crop. Plant numbers in the untreated plots of barley trials averaged a respectable 125 plants/m^2 (graph 3.3), similar to the EverGol Prime plots which highlights this point. Differences in crop biomass become more pronounced as the season progresses. Rhizoctonia damaged roots will result in loss of plant development due to insufficient root mass available to support plants, particularly in the drier and warmer conditions of spring.

Graph 3.3 shows average crop establishment data for EverGol Prime in barley trials.

Graph 3.3: Crop establishment (% increase) in rhizoctonia infected barley trials (average 31 days after planting).



Trial ID: 08WA19, 09ND21, 09ND22, 09WA17, 10SA11, 10NW01, 10ND02, SED1098, 11WE01

No significant differences. P = 0.05, Untreated = 0.

All rates per 100 kg of seed.

ROOT HEALTH

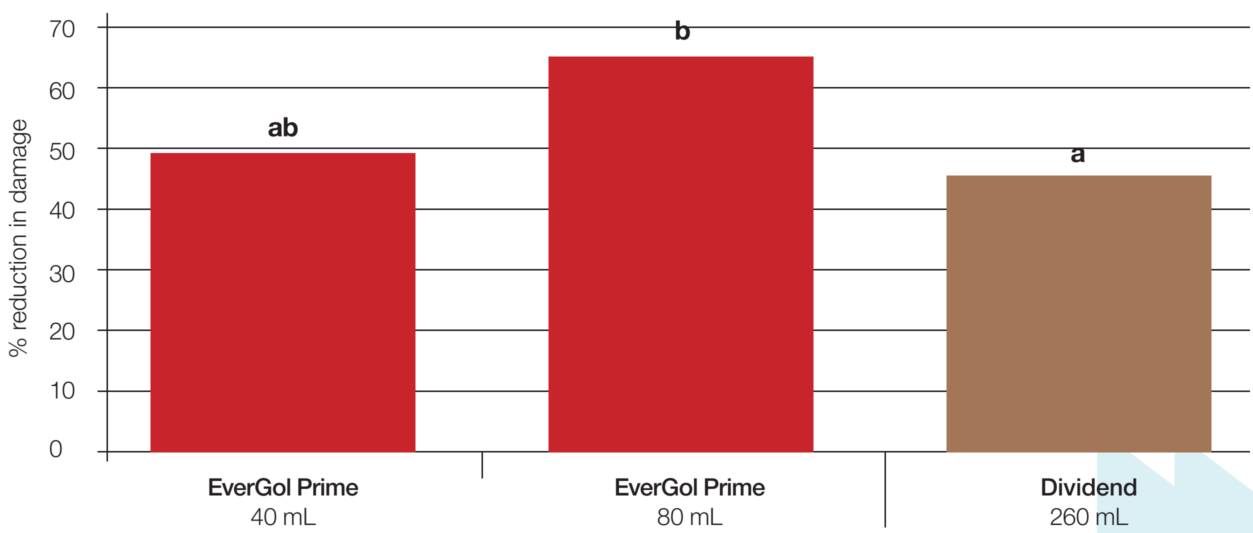
Rhizoctonia causes significant crop injury by pruning the root system which results in water and nutrient stress to infected plants. It is not possible to completely control rhizoctonia with currently available broadacre products, but the severity of the pathogen can be suppressed. Trial results in graphs 3.4 and 3.5 suggest that EverGol Prime is the leading product for suppression of rhizoctonia infection in wheat and barley at both the high and low application rates.

The severity of root damage can be significantly reduced by treating wheat and barley seed with EverGol Prime (image 3.2, graphs 3.4 and 3.5).

Trial ID: 09ND22

Image 3.2: Protection of the seminal roots by seed treatments in Gairdner barley (38 days after planting).

Graph 3.4: Reduction (%) in damage of seminal roots in rhizoctonia infected wheat trials.

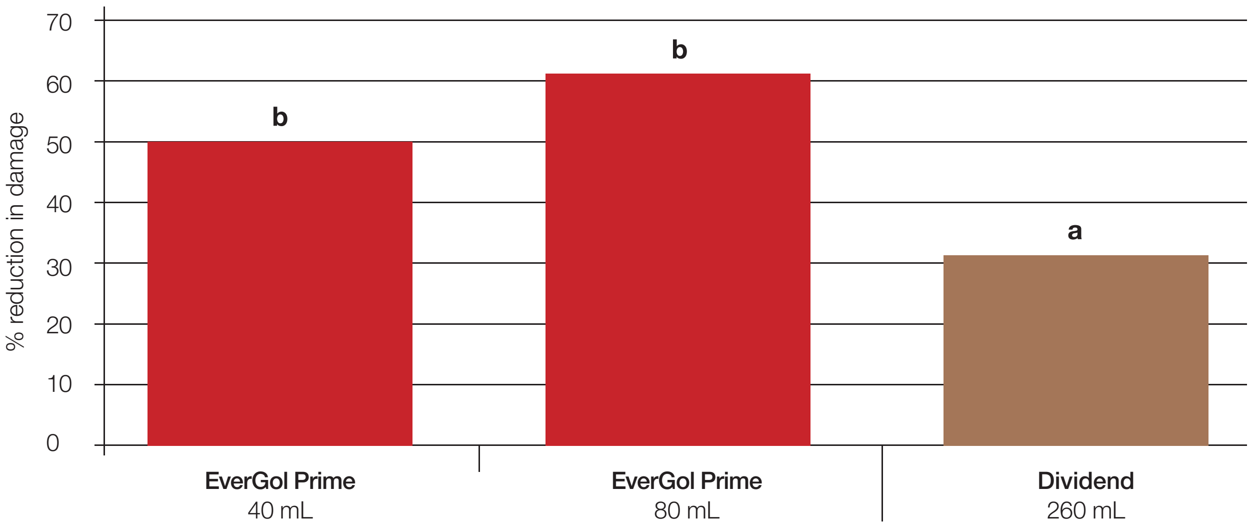


Trial ID: 08ND12, 09NW13, 09VA08, 10ND01, 10WA11, 10WE22

All rates per 100 kg of seed.

Treatments marked by the same letter do not significantly differ. P = 0.05.

Graph 3.5: Reduction (%) in damage of seminal roots in rhizoctonia infected barley trials.



Trial ID: 08ND12, 09NW13, 09VA08, 10ND01, 10WA11, 10WE22

Treatments marked by the same letter do not significantly differ. P = 0.05.

All rates per 100 kg of seed.

PLANT DEVELOPMENT AND CROP BIOMASS

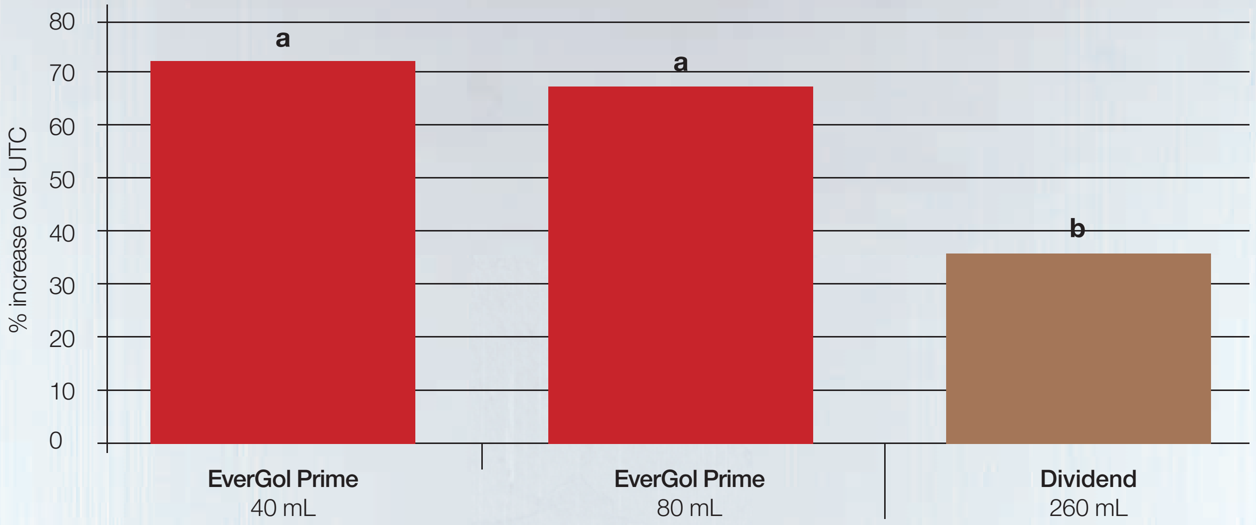
Stronger more developed root systems lead to greater access to nutrients and water by the plant and subsequently improved overall biomass. Due to the strong suppression of rhizoctonia by EverGol Prime, root health is significantly improved leading to impressive increases in overall plant weights and crop biomass.

Trials represented in graphs 3.6 - 3.9 were undertaken in a variety of soil types throughout Australia over several seasons. Root damage from rhizoctonia will result in reduced crop development and yield in lighter soils with lower water holding capacity and fertility, especially when seasonal conditions are adverse such as in image 3.3. In these situations, EverGol Prime, through its superior protection of the plant's root system, will provide the greatest benefit to crop growth compared to other seed treatments.

Image 3.3: Gairdner barley (128 days after planting) in a sandy loam soil at Gilgandra, NSW, following almost no rainfall for three months, plants from 3 m of row.

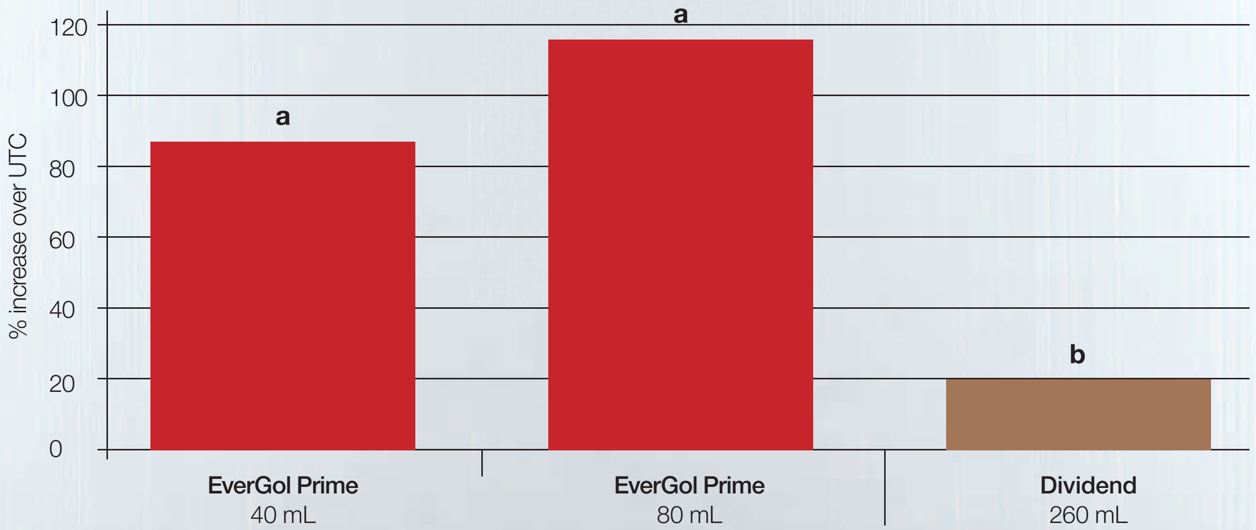
Trial ID: 09ND22

Graph 3.6: Increase (%) in plant weights in rhizoctonia infected wheat trials (average 44 days after planting).



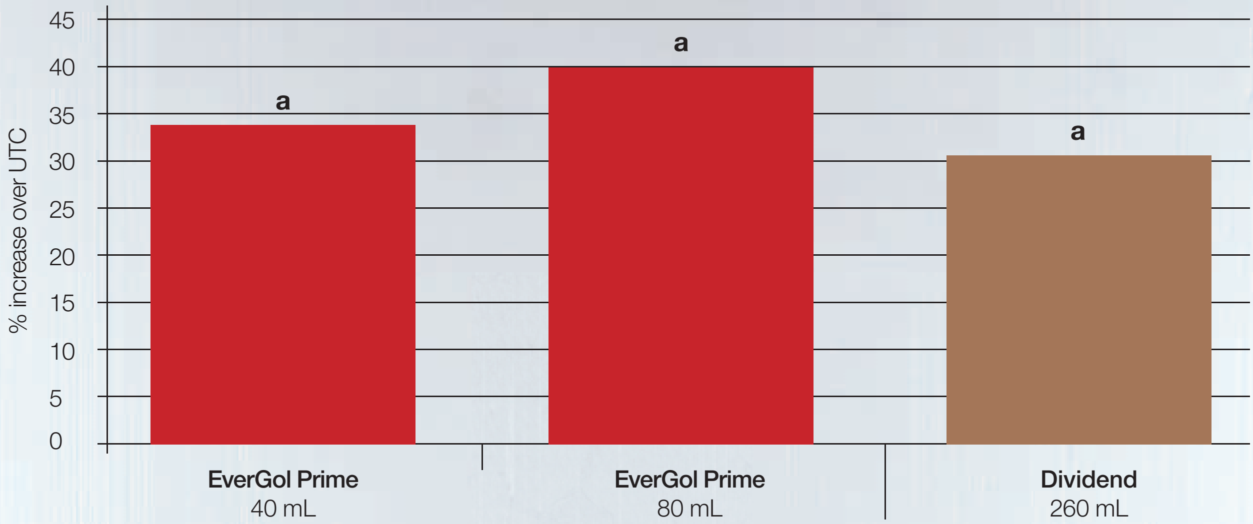
Trial ID: 08ND12, 09NW13, 09VA08, 10ND01, 10WA11 All rates per 100 kg of seed.
Treatments marked by the same letter do not significantly differ. P = 0.10, Untreated = 0.

Graph 3.7: Increase (%) in plant weights in rhizoctonia infected barley trials (average 49 days after planting).



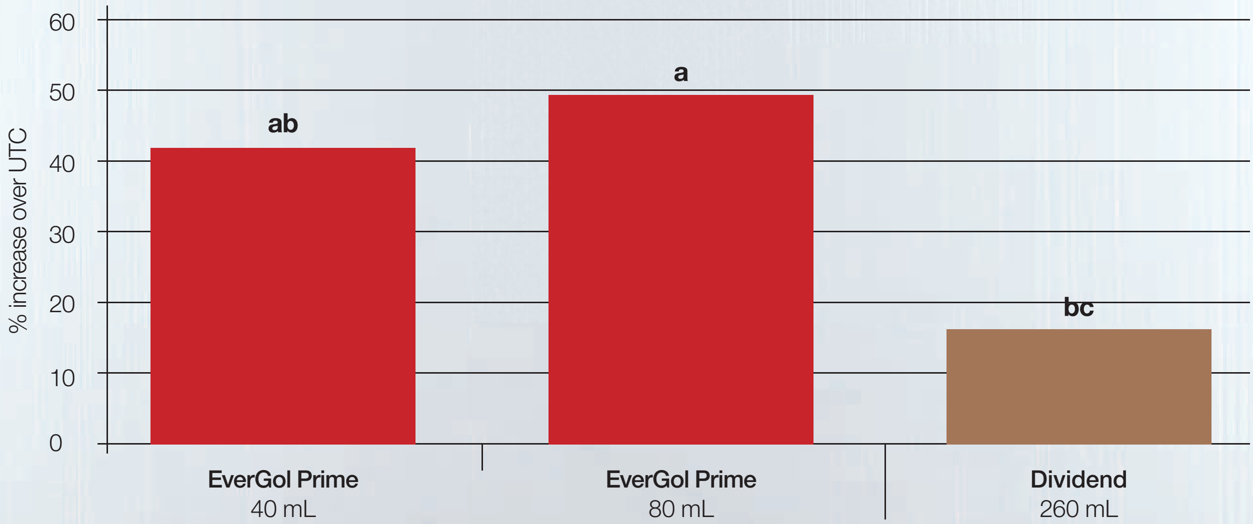
Trial ID: 08WA19, 09ND21, 09ND22, 09WA17, 10SA11, 10NW01, 10ND02, SED1098 All rates per 100 kg of seed.
Treatments marked by the same letter do not significantly differ. P = 0.05, Untreated = 0.

Graph 3.8: Increase (%) in crop biomass in rhizoctonia infected wheat trials (average 43 days after planting).



Trial ID: 07DC26, 08ND12, 09NW13, 09VA08, 10ND01, 10WA11, 10WE22 All rates per 100 kg seed.
Treatments marked by the same letter do not significantly differ. P = 0.05, Untreated = 0 (b).

Graph 3.9: Increase (%) in crop biomass in rhizoctonia infected barley trials (average 55 days after planting).



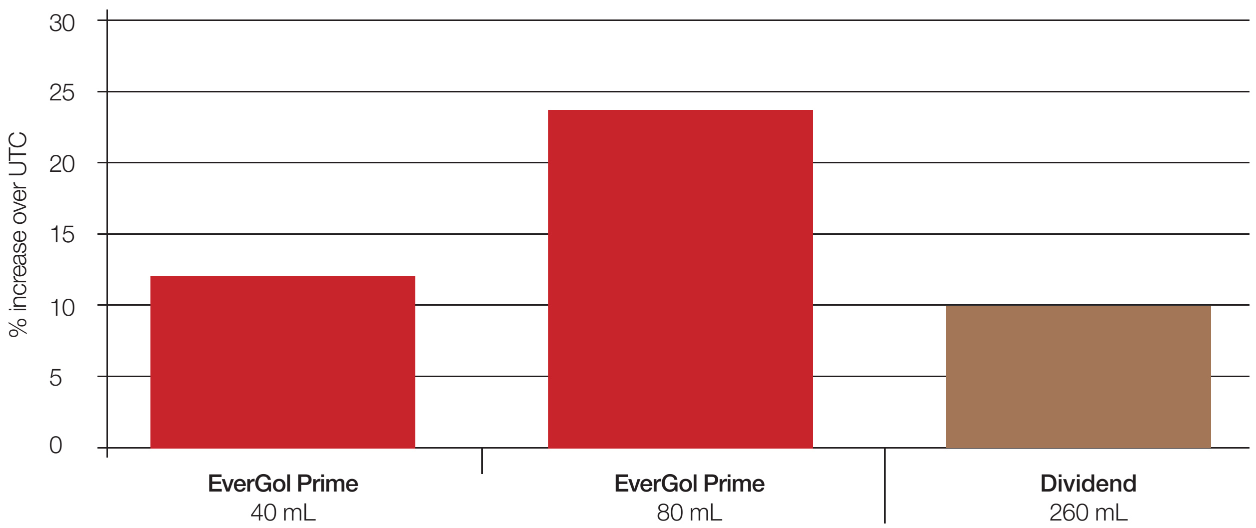
Trial ID: 08WA19, 09ND21, 09ND22, 09WA17, 10SA11, 10NW01, 10ND02, SED1098, 11WA06, 11WA07, 11WE01, 12VD14, 12VD07 All rates per 100 kg seed.
Treatments marked by the same letter do not significantly differ. P = 0.05, Untreated = 0 (c).

YIELD DATA

The overall impact of rhizoctonia is loss in grain yield and quality due to poor plant health. Yield losses from rhizoctonia for cereal crops are generally in the range of 5 - 20% however in situations which are conducive to severe infection losses may be as high as 50%. Rhizoctonia affected crops may also produce higher levels of screenings, resulting in lower grain prices or increased processing costs.

Seed treated with EverGol Prime will suppress rhizoctonia and its symptoms at both the high and low label rates. The impressive suppression of rhizoctonia translates directly into significant yield increases for the grower. Trials in graphs 3.10 and 3.11 were taken to yield in a variety of rhizoctonia infestations and demonstrate the percentage yield increases of EverGol Prime over untreated and Dividend treated seed.

Graph 3.10: Grain yield (% increase) in rhizoctonia infected wheat trials.

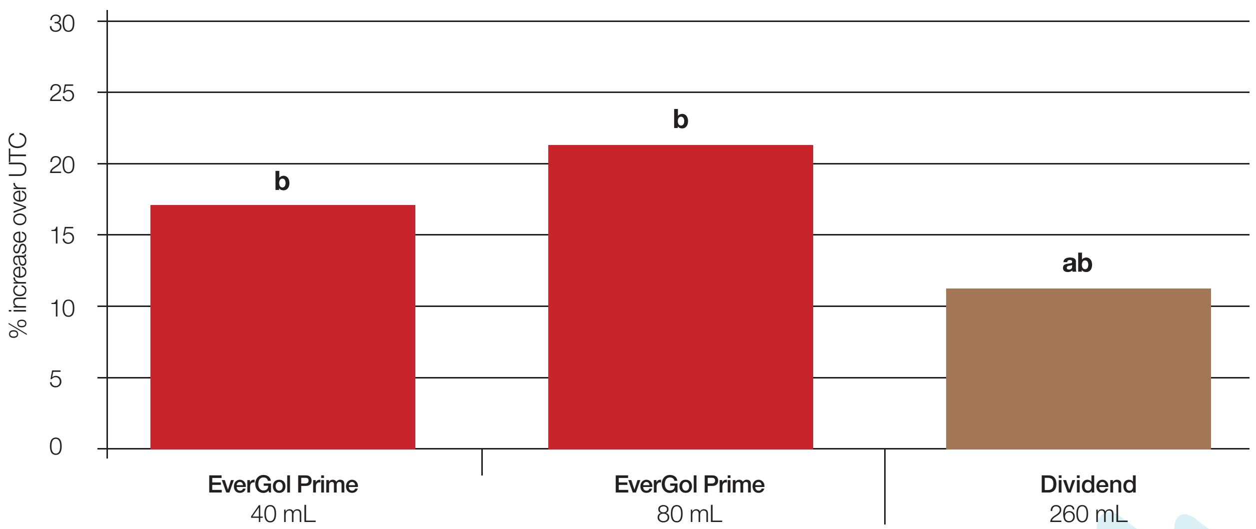


Trial ID: 10WA11, 10WE22, 11SB05, 12NA09, 12VD15

All rates per 100 kg of seed.

No significant differences. Average yield of untreated = 0.

Graph 3.11: Grain yield (% increase) in rhizoctonia infected barley trials.



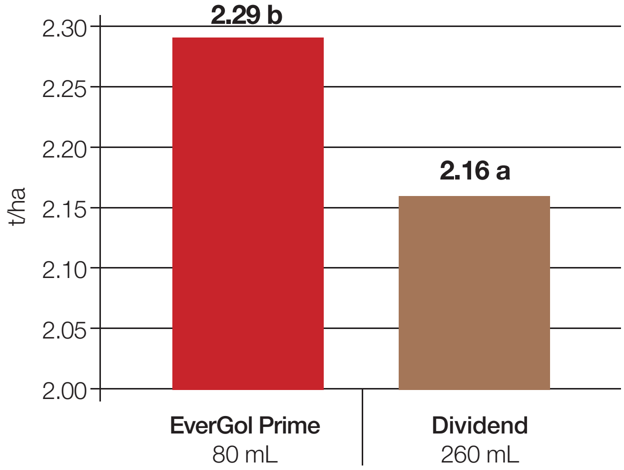
Trial ID: 10SA11, 11WE01, 11VD06, 11NA02, 11SB06, 12VD14, 12VD15

All rates per 100 kg of seed.

Treatments marked by the same letter do not significantly differ. P = 0.05, Average yield of untreated = 0 (a).

A larger set of trials compared EverGol Prime at only the higher rate of 80 mL/100 kg with the current industry standard Dividend Fungicide Seed Treatment at its registered rate of 260 mL/100 kg. EverGol Prime showed yield increases over Dividend in both wheat and barley. When EverGol Prime was applied to wheat it gave a 130 kg/ha (statistically significant) increase in yield compared to Dividend (graph 3.12), and when applied to barley it showed a 260 kg/ha (statistically significant) increase in yield (graph 3.13).

Graph 3.12: Grain yield (t/ha) in rhizoctonia infected wheat trials.

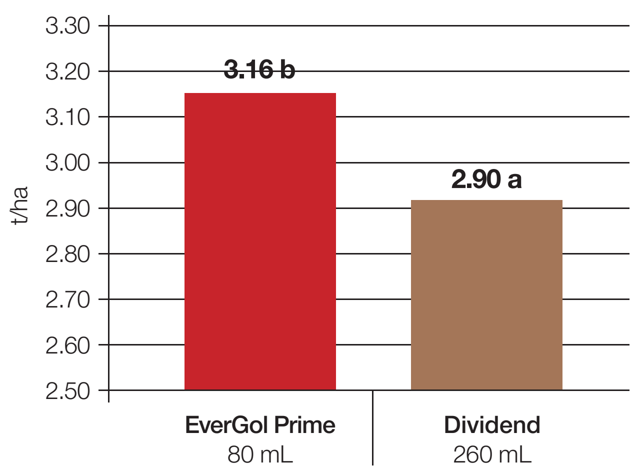


Trial ID: 10WA11, 10WE22, 11SB05, 12NA10, 12WE02, 12WE04, 12NA09, 12VD15

All rates per 100 kg of seed.

Treatments marked by the same letter do not significantly differ. P = 0.10.

Graph 3.13: Grain yield (t/ha) in rhizoctonia infected barley trials.



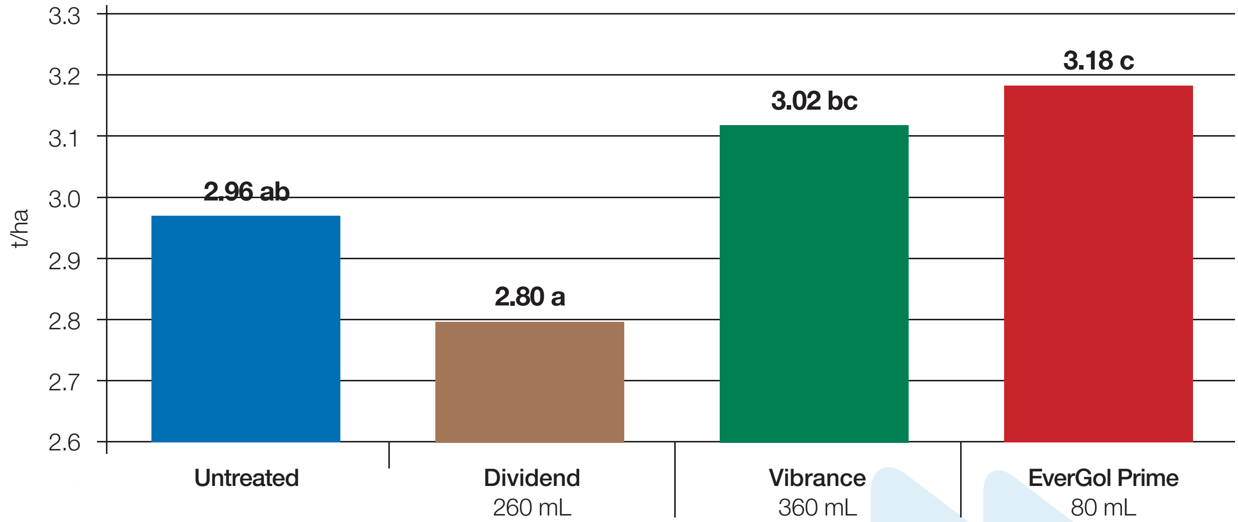
Trial ID: 10SA11, 11WE01, 11NA02, 11WA07, 12WE01, 12WE03, 12WE41*, 12WC01, 12VD15, 10VD06, 11VD04, 11VD06, 11SA25, 12SB06**, 12SB13, 12SB17, 12SB18, 12SB19, 12SB20, 12SB21, 12SB22, 12VD14

All rates per 100 kg of seed.

Treatments marked by the same letter do not significantly differ. P = 0.05.

Two trials in barely also compared EverGol Prime at the higher rate of 80 mL/100 kg with Dividend at 260 mL/100 kg and Vibrance® Fungicide Seed Treatment at 360 mL/100 kg. Trial results show that in barley, EverGol Prime gave a 160 kg/ha increase in yield compared to Vibrance (graph 3.14) and a statistically significant increase in yield over untreated and Dividend treated crops.

Graph 3.14: Grain yield (t/ha) in rhizoctonia infected barley trials.



Trial ID: 12WE418, 12SB06**

All rates per 100 kg of seed.

Treatments marked by the same letter do not significantly differ. P = 0.05.

Graph 3.13 and 3.14 - Trial data courtesy of * Landmark, Narrogin, WA, ** Cummins Ag Services, SA.

RETURN ON INVESTMENT (ROI)

To evaluate the economic benefit for growers from using EverGol Prime seed treatment compared to Dividend or Vibrance seed treatments, calculations have been made based on the trial data presented in graphs 3.12 - 3.14. Simplifying assumptions have been made for the purpose of this Technical Guide. Assumptions are clearly stated below to demonstrate how the ROI data has been generated.

ROI data should not be looked at in isolation, in addition to yield data, disease protection and grain quality data should also be considered.

Wheat ROI

For treated wheat seed, table 3.1 indicates that EverGol Prime gives an average yield increase of 6.0% over Dividend when comparing its registered rate with the highest registered rate of EverGol Prime. This translates into an incremental return of $33.80 per ha or $33,800 per 1,000 ha treated.

Table 3.1: EverGol Prime return on investment in wheat.

Product	APPLICATION RATE (mL/100 kg)	PRODUCT COST ($/ha)	GRAIN PRICE ($/t)	GRAIN YIELD (t/ha)	RETURN ($/ha)	INCREASE(%) IN RETURN	INCREMENTAL RETURN ($/ha)
Dividend	260 mL/100 kg	$7.80	$266.00	2.16	$566.76	-	-
EverGol Prime	80 mL/100 kg	$8.58	$266.00	2.29	$600.56	6.0%	$33.80

Barley ROI

For treated barley seed, table 3.2 indicates that EverGol Prime gives an average yield increase of 9.0% over Dividend when comparing its registered rate with the highest registered rate of EverGol Prime. This translates into an incremental return of $64.22 per ha or $64,220 per 1,000 ha treated.

Table 3.2: EverGol Prime return on investment in barley.

Product	APPLICATION RATE (mL/100 kg)	PRODUCT COST ($/ha)	GRAIN PRICE ($/t)	GRAIN YIELD (t/ha)	RETURN ($/ha)	INCREASE(%) IN RETURN	INCREMENTAL RETURN ($/ha)
Dividend	260 mL/100 kg	$7.80	$250.00	2.90	$717.20	-	-
EverGol Prime	80 mL/100 kg	$8.58	$250.00	3.16	$781.42	9.0%	$64.22

When EverGol Prime is compared against Vibrance (highest EverGol Prime application rate versus registered application rate) in barley, table 3.3 indicates that EverGol Prime gives a 5.3% yield increase over Vibrance. This translates into an incremental return of $39.52 per ha or $39,520 per 1,000 ha treated.

Table 3.3: EverGol Prime return on investment versus Vibrance in barley.

Product	APPLICATION RATE (mL/100 kg)	PRODUCT COST ($/ha)	GRAIN PRICE ($/t)	GRAIN YIELD (t/ha)	RETURN ($/ha)	INCREASE(%) IN RETURN	INCREMENTAL RETURN ($/ha)
Vibrance	360 mL/100 kg	$8.10	$250.00	3.02	$746.90	-	-
EverGol Prime	80 mL/100 kg	$8.58	$250.00	3.18	$786.42	5.3%	$39.52

ROI assumptions

- Average end-user pricing has been used based on market pricing January 2013. EverGol Prime $143/L, Dividend $40/L, Vibrance $30/L.
- Average seeding rate of 75 kg/ha.
- Yield data has been taken from trials shown in graphs 3.12 - 3.14.
- Grain pricing is based on 20 year average grain prices* ex-farm. Wheat ASW $266 ($/t), barley malt $250 ($/t).

*Data courtesy of Neil Clark & Associates.

4. SMUT DISEASES

> EXTERNALLY SEED-BORNE DISEASES
> INTERNALLY SEED-BORNE DISEASES

SMUT DISEASES

Smut diseases, including bunt in wheat, have the potential to devastate a grower's income by rendering their harvested grain unsaleable. It is therefore best practice to treat cereal seed with a seed treatment that controls smut diseases to avoid yield loss, improve grain quality and to maintain a clean seed source for the future.

Many growers and agronomists view seed treatments that control smut diseases (commonly called a smuticide) as insurance against a loss of grain production or producing grain that is unsaleable. Smut diseases can only be treated by applying a seed treatment to the seed. Foliar-applied fungicides will not have any activity on smut diseases. Additionally, often growers will not know they have a problem until the crop starts to head but by then it is too late for action.

Harvesting or handling equipment contaminated by spores from an infected crop serve to introduce the pathogen into seed lots harvested in the following season which continues the smut disease cycle.

EverGol Prime has exceptional activity on smut diseases (including bunt in wheat) and is a leading product in terms of its activity on smut diseases including the difficult to control loose smut in barley.

Smut diseases have one of two distinct lifecycles; externally seed-borne (outside the seed) and internally seed-borne (inside the seed).

EXTERNALLY SEED-BORNE DISEASES

Covered smut in barley and wheat (also known as bunt) can occur at low or trace levels however in the absence of a seed treatment have the potential to increase rapidly in growing crops. There is a nil acceptance level for bunt in wheat according to the Grain Trade Australia wheat trading standards 2009 - 2010.

Covered smut (barley) - *Ustilago hordei*

Symptoms

There are no symptoms of the disease prior to ear emergence. At ear emergence the head looks like it is covered by a thin membrane with the grains replaced by masses of black spores. The membrane is easily ruptured which releases the spores.

Lifecycle

After ear emergence some spores may be released on to the rest of the crop and carried by the wind to neighbouring plants (similar to loose smut). However, most of the infected heads remain intact until harvesting when they break up in the threshing process and contaminate the surrounding grain. These spores remain dormant on the outside of the seed until it is sown. When the contaminated seed germinates the spore will infect the developing seedling and the fungus then develops with the growing point of the plant until eventually it colonises the developing ear.

Diagram 4.1: Lifecycle of covered smut in barley.

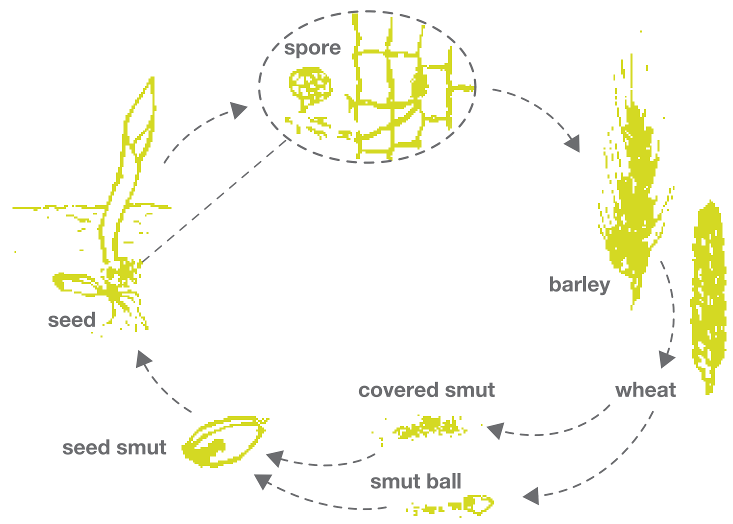


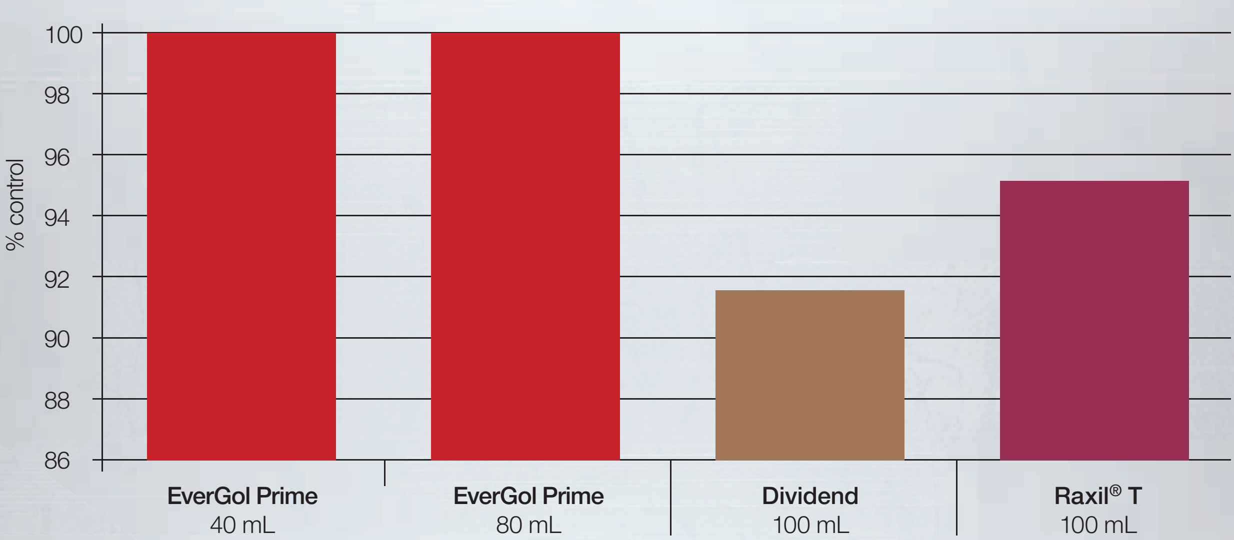
Image 4.1: Covered smut.

Source: Lifecycle adapted from McMullen and Lamey (2000). *Seed Treatment for Disease Control*, NDSU.

Disease control

EverGol Prime provides exceptional control of covered smut in barley as can be seen in graph 4.1.

Graph 4.1: Average covered smut control in barley trials.



Trial ID: 09ND27, 09NW29, 09NW30, 09QA05

All rates per 100 kg of seed.

Note: Trials were conducted using high inoculum levels and were not typical of commercial disease pressure.

Common bunt (wheat) - *Tilletia tritici* and *Tilletia laevis*

Symptoms

Symtoms are similar to covered smut in barley with no symptoms observed prior to ear emergence. In infected ears, grain is replaced by seed-like 'bunt balls' each containing millions of greasy, black foul smelling spores. In severe cases, the whole field may smell of rotting fish. For this reason the disease is sometimes known as 'stinking bunt'.

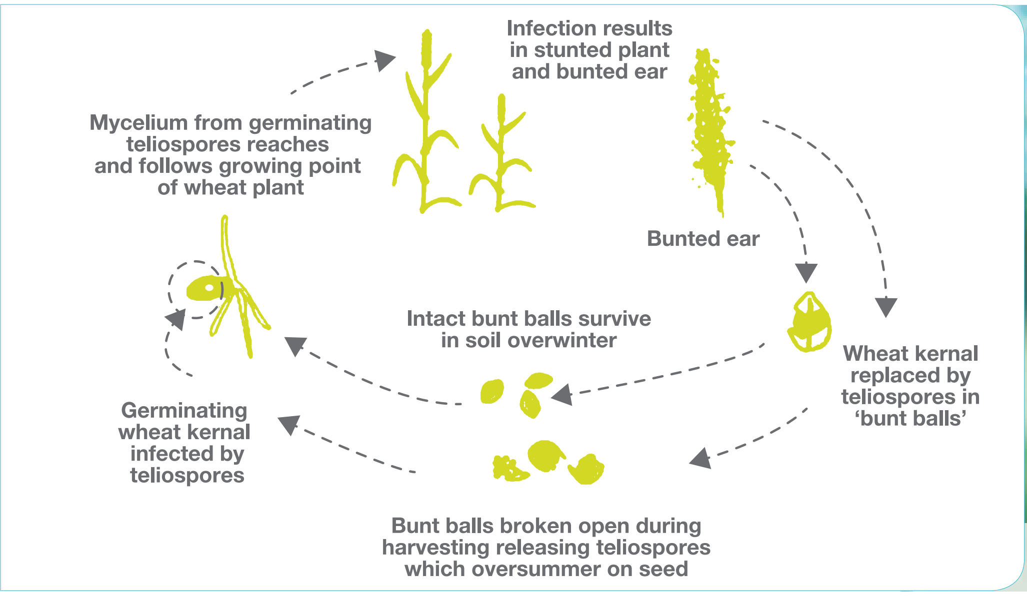
In wet weather conditions the ears may appear to be covered in a black ink-like substance as the spores are released and run out of the protective glumes onto the ear and stem.

Lifecycle

The spores on the seed surface germinate along with the seed. These spores infect the coleoptile of the young seedlings before emergence of the first true leaves. The mycelium grows internally within the shoot infecting the developing ear. Affected plants appear to develop normally until the ear emerges when it becomes clear that individual grains have been replaced by bunt balls.

In damp soil, spores usually germinate and then, in the absence of the host plant, die. However, in dry seasons, they may survive in the soil (especially if they are protected within the glumes of shed ears) from the harvesting of one crop to the sowing of the next. Windblown spores, can also contaminate neighbouring paddocks.

Diagram 4.2: Lifecycle of common bunt in wheat.

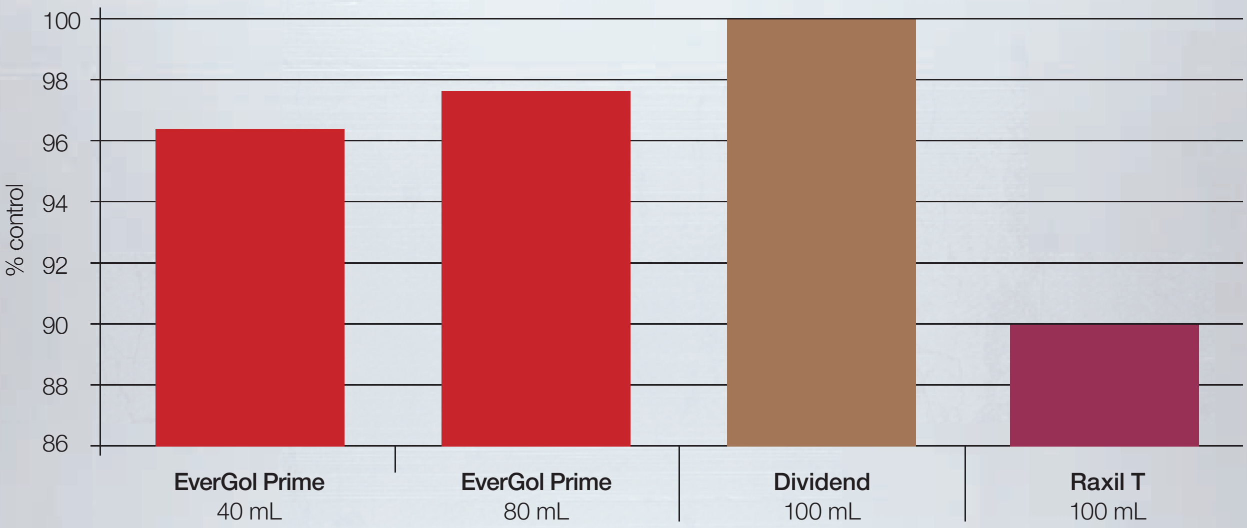


Source: Lifecycle adapted from McMullen and Lamey (2000). *Seed Treatment for Disease Control*, NDSU.

Image 4.2: Common bunt.

Source: Hugh Wallwork, SARDI.

Graph 4.2: Average common bunt control in wheat trials.



Trial ID: 09QA04, 09NW27, 09ND26

All rates per 100 kg of seed.

Note: Trials were conducted using high inoculum levels and were not typical of commercial disease pressure.

Flag smut (wheat) - *Urocystis agropyri*

Symptoms

Affected plants are often stunted and excessive tillering is common with the ears failing to emerge and remaining within the boot. The leaf blades and sheaths of infected plants will have dark streaks on them and a reduced ability to photosynthesize. These streaks eventually burst exposing the black teliospores which disperse and may give the plant a sooty appearance. The infection will reduce grain fill. There is a nil tolerance for infected grain at grain receival points.

Lifecycle

The teliospores released from the dark streaks may be blown onto and contaminate other grain. Alternatively, they can be blown to rest in the soil where they can persist for many years. If the soil becomes contaminated or if seed infected with the pathogen is sown they infect the emerging plant's coleoptile and the cycle restarts.

Diagram 4.3: Lifecycle of flag smut in wheat.

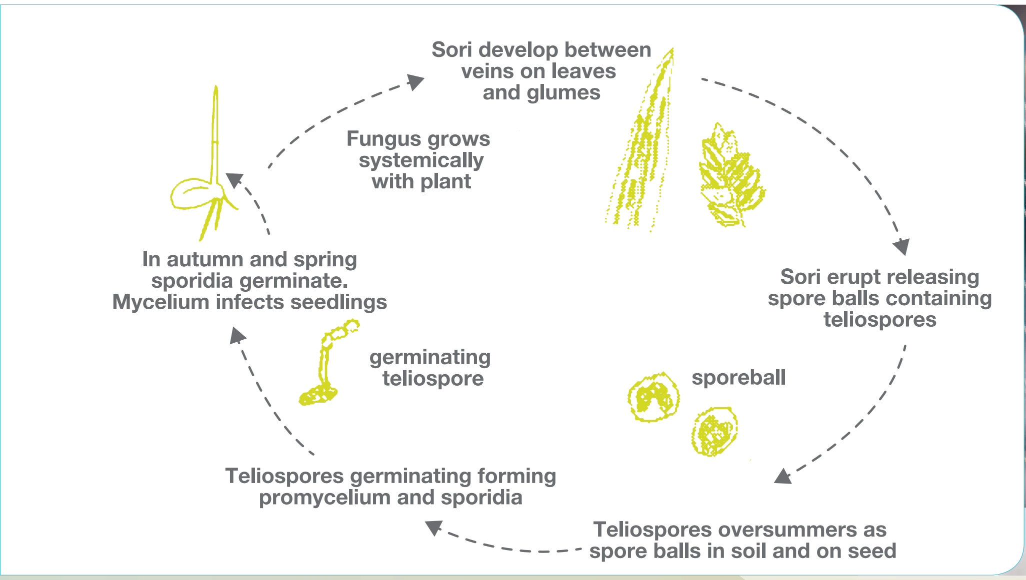


Image 4.3: Flag smut.

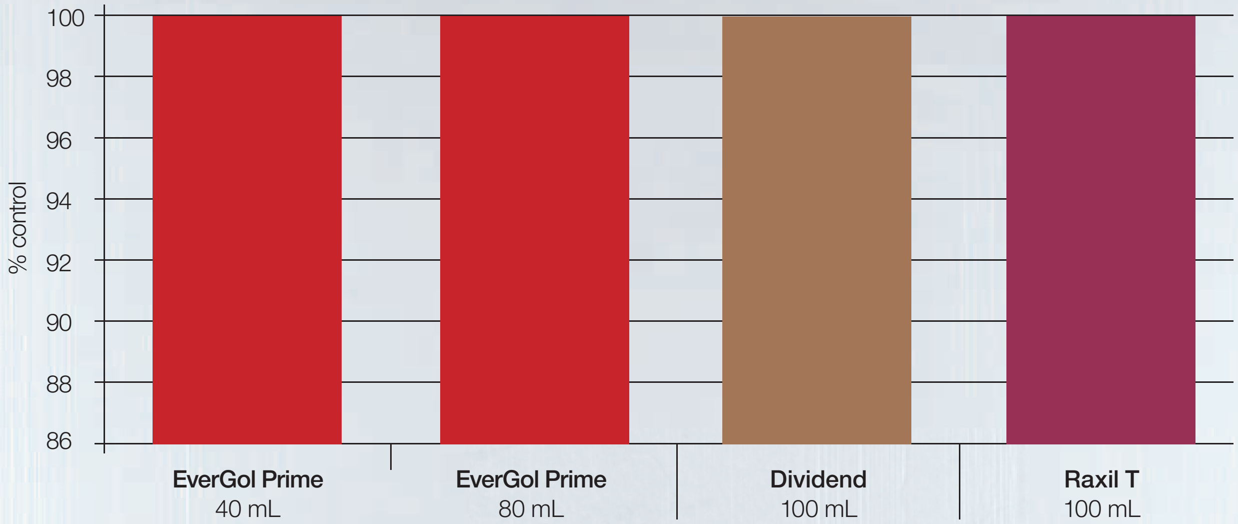
Source: Lifecycle adapted from McMullen and Lamey (2000). *Seed Treatment for Disease Control*, NDSU.

Source: Hugh Wallwork, SARDI.

Disease control

EverGol Prime provides good protection from both seed and soil-borne flag smut in wheat as can be seen in graphs 4.3 and 4.4. In trial 09WA33 (soil-borne flag smut) which was taken to yield, there was no significant differences in yield between the various seed treatments.

Graph 4.3: Average flag smut (seed-borne) control in wheat trials.

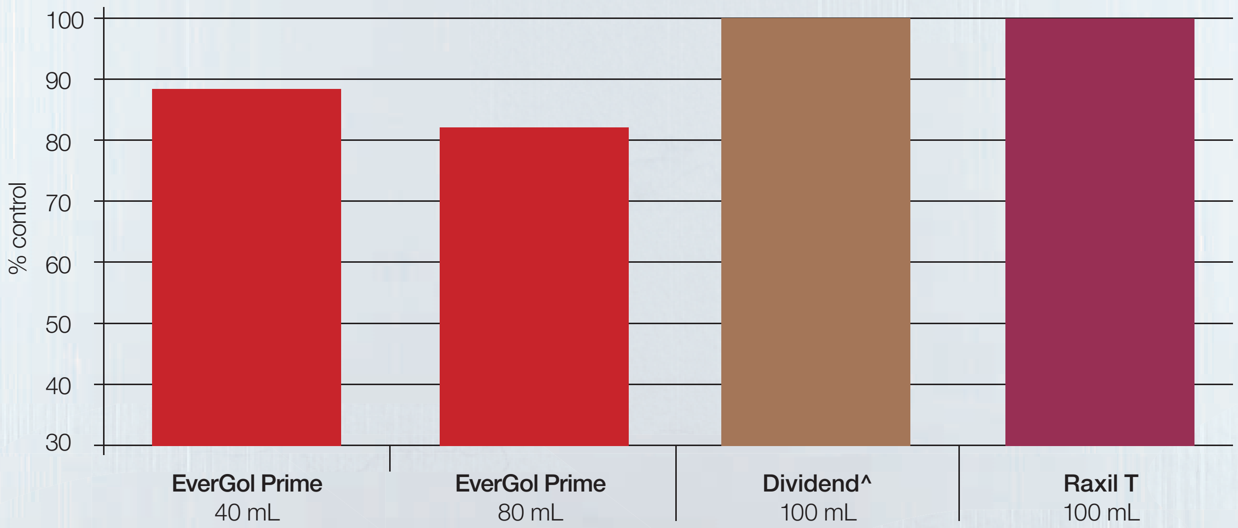


Trial ID: 09QA03, 09QA19

All rates per 100 kg of seed.

Note: Trials were conducted using high inoculum levels and were not typical of commercial disease pressure.

Graph 4.4: Average flag smut (soil-borne) control in wheat trials.



Trial ID: 08WB19, 09WA33

All rates per 100 kg of seed.

^Dividend was only in one trial (09WA33).

Note: Trials were conducted using high inoculum levels and were not typical of commercial disease pressure.

INTERNALY SEED-BORNE DISEASES

Loose smut (barley) - *Ustilago nuda* f.sp. *hordei*
(wheat) - *Ustilago nuda* f.sp. *tritici*

Symptoms

Loose smut infection in wheat and barley results in the florets being replaced by a mass of black spores resulting in a loss of grain production. When high levels of infection occur, it is best to purchase new clean seed for the next season. At maturity the spores will rupture and be spread by wind infecting neighbouring wheat or barley crops.

Infected seed appears normal however the fungus is contained inside the embryo. If an infected seed is sown, the fungus grows inside the plant and replaces the developing head with a mass of spores.

When grain is delivered to receival points, it is assessed for loose smut spores. According to Grain Trade Australia wheat trading standards 2009 - 2010, if the level of spores per half litre of grain is high, the whole grain load may be rejected.

Lifecycle

Loose smut in barley is the hardest of the smut diseases to control. Barley crops infected with loose smut will have the characteristic dark spore filled heads within the crop but this is actually the appearance of infection from the previous season which has been within the seed. These spores will infect other neighbouring crops at flowering time leaving the infected grain looking completely normal. Moist conditions at flowering combined with mild temperatures will favour infection. When the seed is sown and germination occurs the following season, the fungus will begin to grow within the plant with a mass of spores replacing the head and continuing the disease cycle.

Diagram 4.4: Lifecycle of loose smut in barley and wheat.

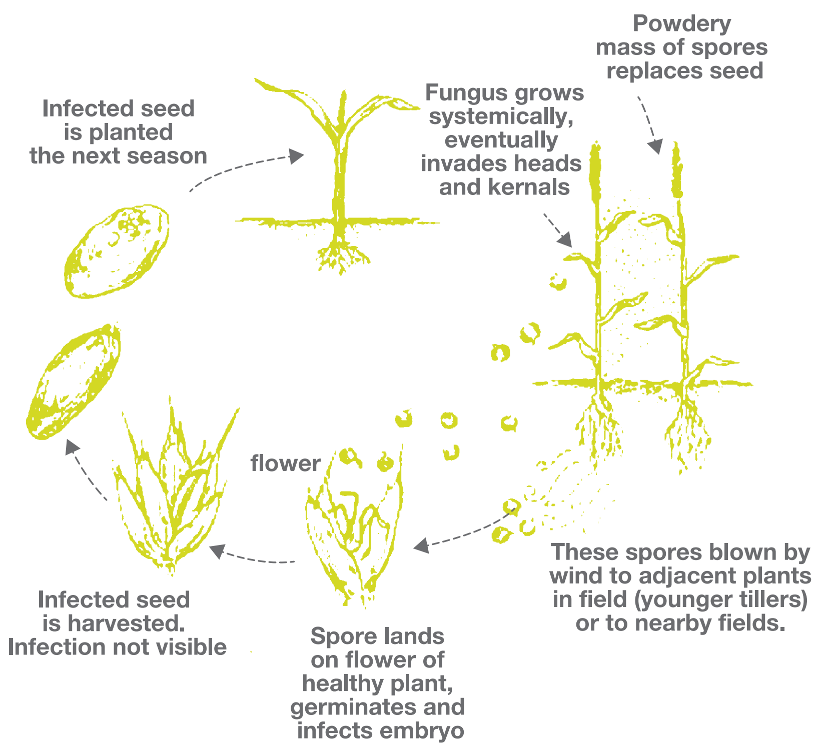


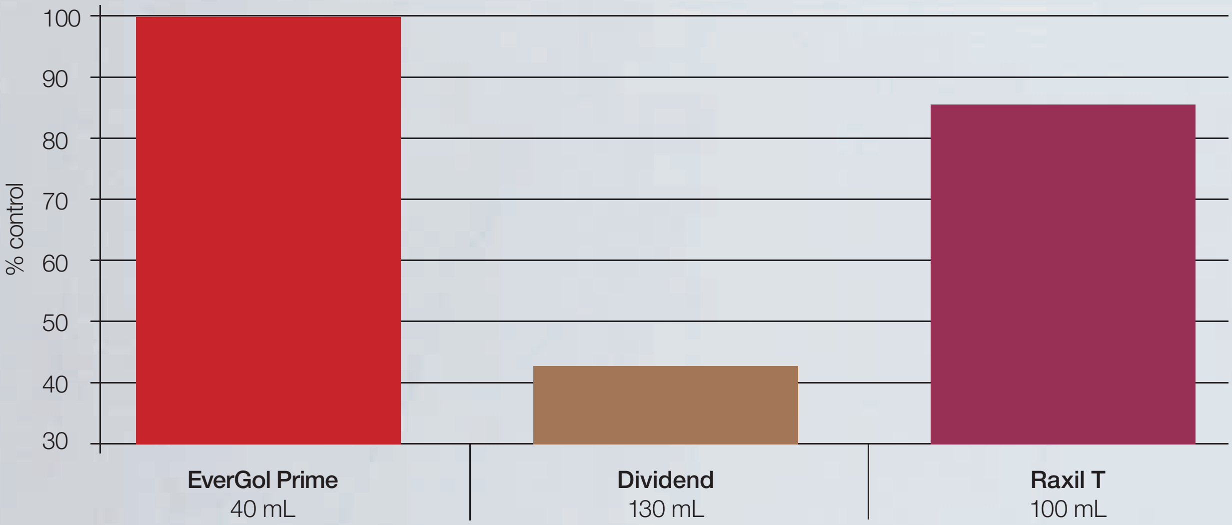
Image 4.4: Loose smut.

Source: Lifecycle adapted from McMullen and Lamey (2000). *Seed Treatment for Disease Control*, NDSU.

Disease control

Due to the lifecycle of loose smut, a fungicidal seed treatment that penetrates the seed at germination is required to control the disease. Most smut diseases can be controlled by a seed treatment that sterilises the surface of the seed but this is not the case for loose smut as the fungus is within the seed. Due to EverGol Prime's ability to penetrate the seed at germination, it offers exceptional control of this disease. Even at the low rate (40 mL/100 kg seed), EverGol Prime demonstrates outstanding loose smut control in barley when compared with the registered rate of Dividend (130 mL/100 kg seed) in graph 4.5.

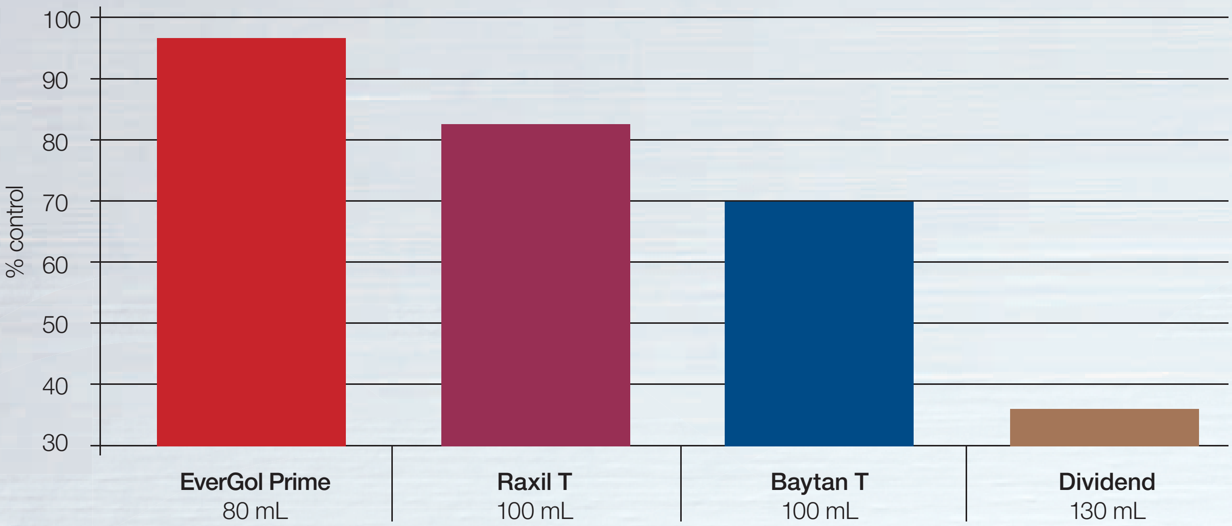
Graph 4.5: Average loose smut control in barley.



Trial ID: 05NW20, 05VA04, 05WB21, 05WB22

All rates per 100 kg of seed.

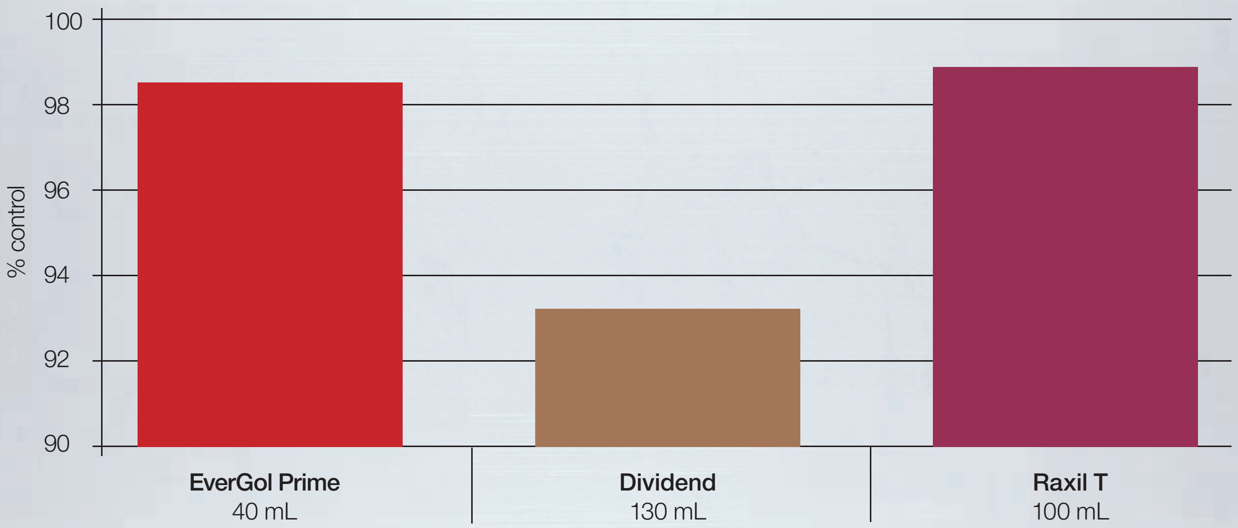
Graph 4.6: Average loose smut control in barley.



Trial ID: 10WA31, 10WA23

All rates per 100 kg of seed.

Graph 4.7: Average loose smut control in wheat.



Trial ID: 05VA03, 05WB20, 08WB20, 09WA32

All rates per 100 kg of seed.

NOTES

5. CROP SAFETY & COMPATIBILITY

> GERMINATION AND COLEOPTILE LENGTH

> CROP ESTABLISHMENT

> STORED SEED CROP SAFETY

> BIOLOGICAL COMPATIBILITY

> PHYSICAL COMPATIBILITY

CROP SAFETY & COMPATIBILITY

EverGol Prime shows excellent crop safety compared to some other seed treatment products. The product is also compatible with a broad range of seed treatments.

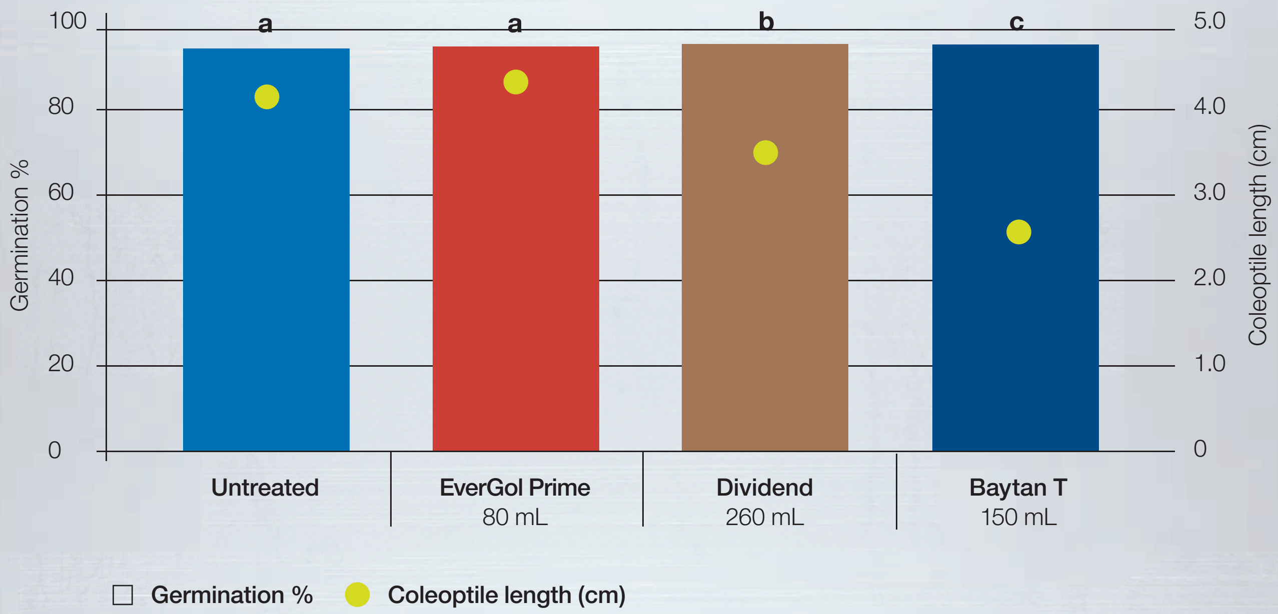
GERMINATION AND COLEOPTILE LENGTH

It has been recognised that seed treatments belonging to the triazole group (Group 3) of fungicides may reduce coleoptile length of emerging crops which can delay, and in some situations reduce, plant numbers. Triazole fungicides can cause problems particularly where short coleoptile varieties are planted, deep sowing or surface crusting occurs, or where some pre-emergent herbicides such as trifluralin are applied. EverGol Prime belongs to the SDHI family (Group 7) of fungicides and does not have this negative effect on coleoptile length.

The impact of seed treatments on germination and coleoptile length in two relatively short coleoptile varieties of wheat can be seen in graph 5.1.

Results show that there is no impact on germination from EverGol Prime, Dividend or Baytan® T, however Dividend and Baytan T have significantly reduced the coleoptile length of both wheat varieties due to the triazole influence. EverGol Prime shows no negative influence on the coleoptile length.

Graph 5.1: Average germination percentage and coleoptile length at 7 days after trial initiation in two wheat varieties (Gladius and Lincoln).



Trial ID: 11DC01 All rates per 100 kg of seed.

Treatments marked by the same letter do not significantly differ. P = 0.05.

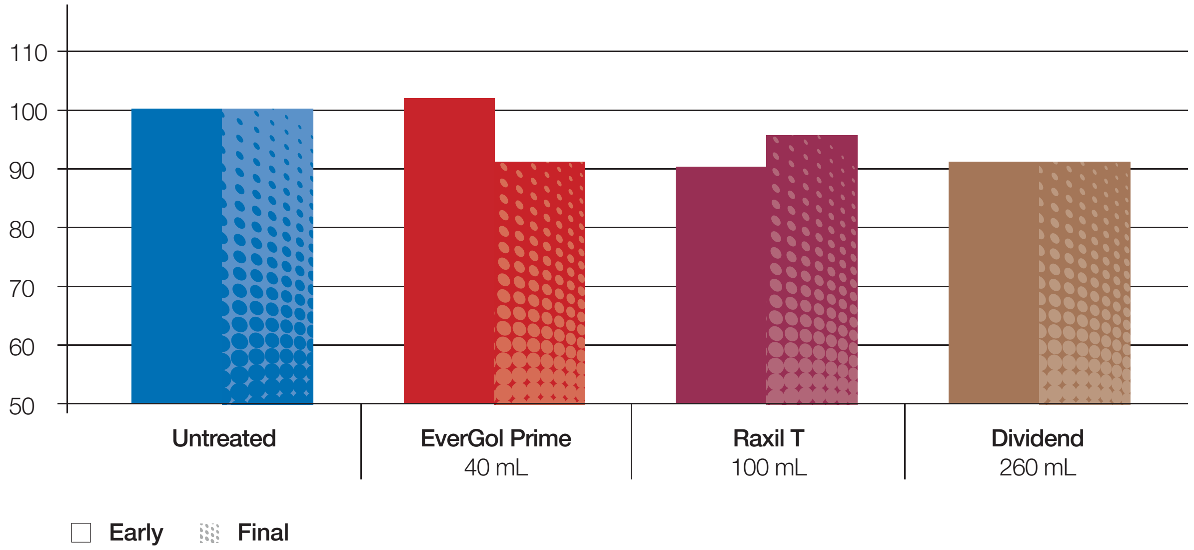
Statistical differences shown are for coleptille length.

CROP ESTABLISHMENT

Crop establishment can be affected by seed treatments particularly in situations where seed has low germination vigour or poor quality. Crop establishment data comparing different seed treatments to untreated seed has been collected in wheat and barley (smut disease) trials. The data from these trials is shown in graphs 5.2 and 5.3, in both graphs plant counts have been taken early and later across a number of trials.

The trials in graphs 5.2 and 5.3 have been selected because in each trial Raxil® T, a commonly used triazole fungicide treatment, demonstrated a reduction in plant numbers compared to the untreated plot in the earliest assessments undertaken. In all trials EverGol Prime at 40 mL/100 kg (graph 5.2) or 80 mL/100 kg (graph 5.3) produced a positive effect on plant numbers at early counts and similar numbers to other seed treatments at final plant counts.

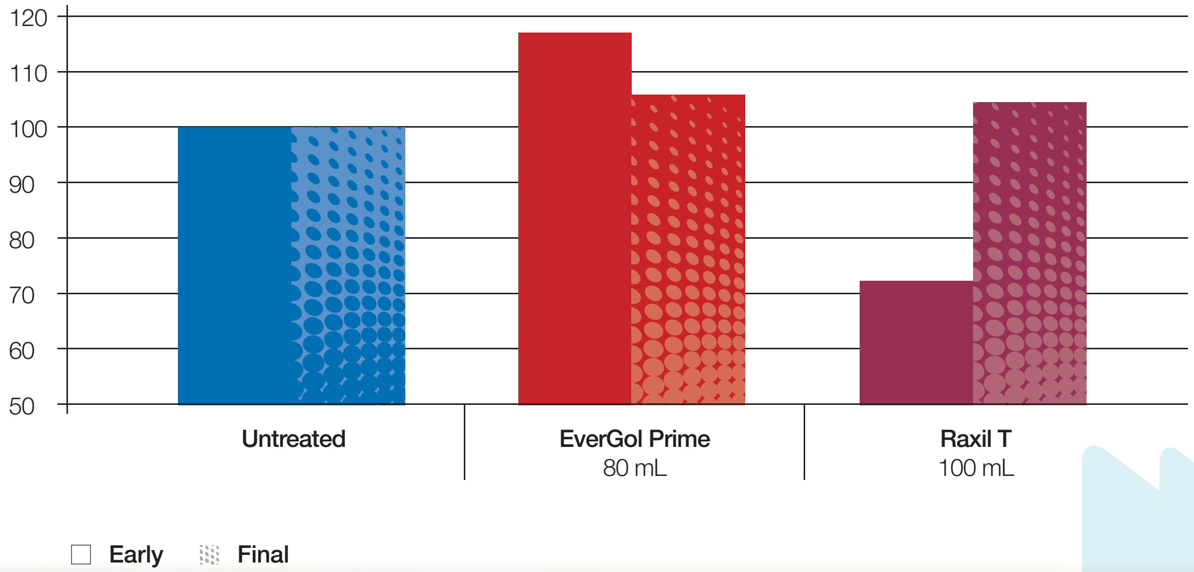
Graph 5.2: Average plant counts in wheat demonstrating crop establishment.
Early counts = 12 - 22 days after planting, final counts = 26 - 28 days after planting.



Trial ID: 05VA04, 05WB21, 05WB22

All rates per 100 kg of seed.

Graph 5.3: Average plant counts in wheat demonstrating crop establishment.
Early counts = 14 - 26 days after planting, final counts = 26 - 35 days after planting.



Trial ID: 08WB19, 08WB20, 09QA03, 09WA33, 09ND26, 09NW27

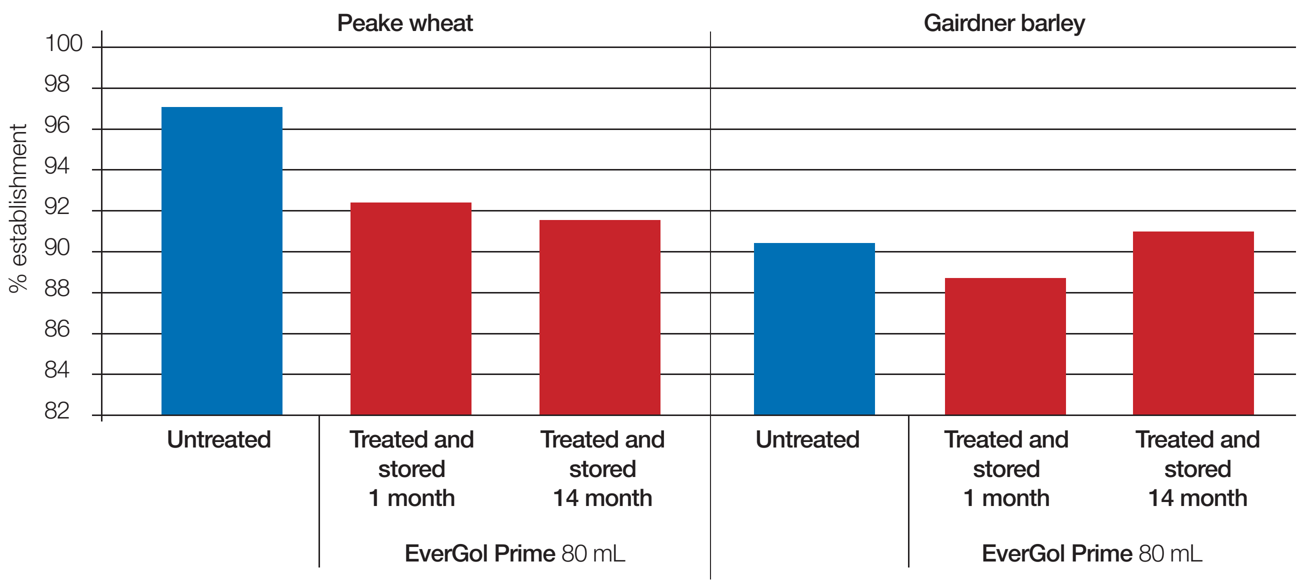
All rates per 100 kg of seed.

STORED SEED CROP SAFETY

Sometimes seed is not sown in the season it is treated due to environmental conditions, changes in recommendations and farm planning. In these situations, EverGol Prime treated seed may be stored and carried over to the following season for sowing.

EverGol Prime treated wheat and barley seed has been tested in laboratory trials for plant establishment, germination and coleoptile length (graphs 5.4 and 5.5). Seed was tested shortly after treatment and then again after more than 12 months. The trials demonstrate that EverGol Prime can be applied to wheat or barley seed and stored for one year without any effect on crop safety. However because seed quality can be adversely affected by insect pest damage and poor storage conditions such as high moisture and/or high temperatures, we recommend that treated seed always be sown in the year of treatment. If seed cannot be sown in year of treatment we recommend that a germination test is carried out prior to sowing.

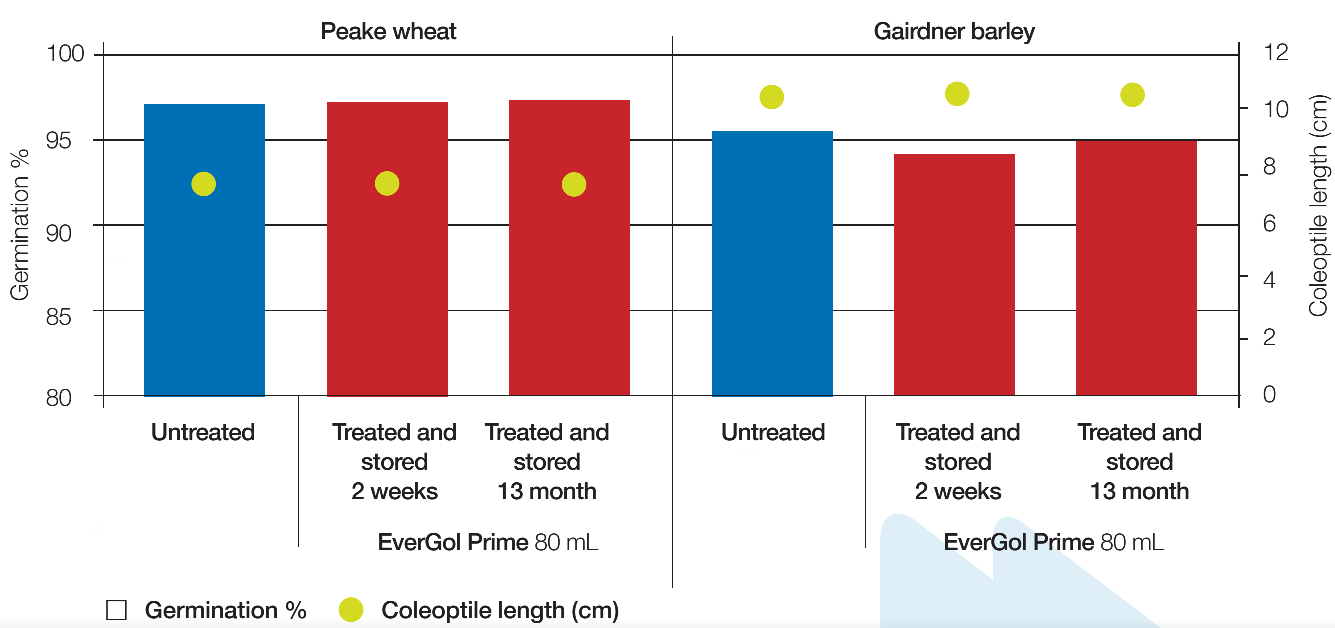
Graph 5.4: Average plant establishment (%) of stored wheat and barley seed.



Trial ID: 10WA27, 10VB10, 10WA28, 10VB11

All rates per 100 kg of seed.

Graph 5.5: Germination (%) and coleoptile length (cm)of stored wheat and barley seed.



Trial ID: 10DC27

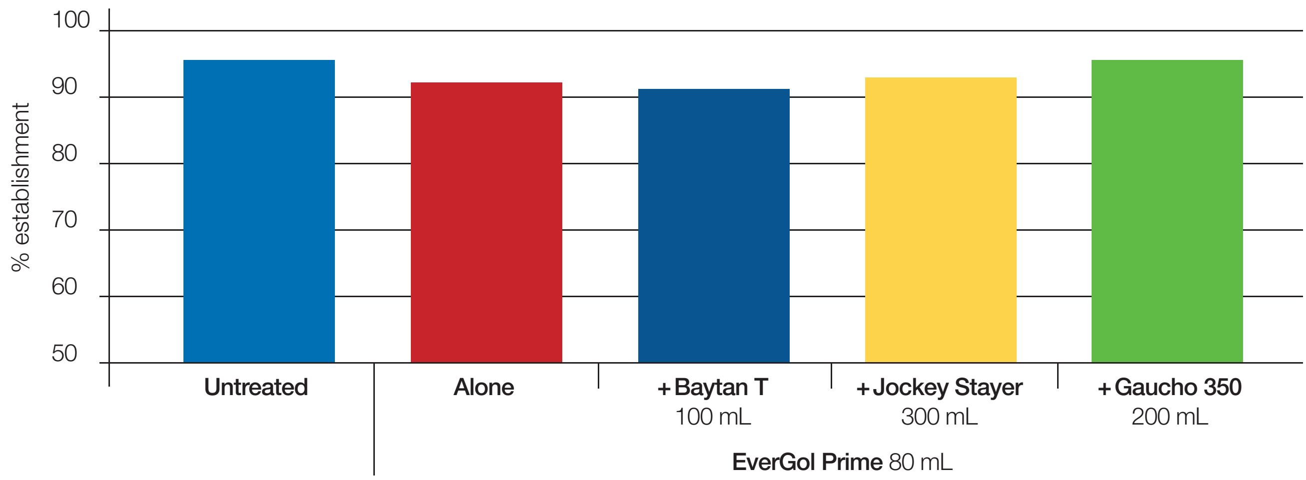
All rates per 100 kg of seed.

BIOLOGICAL COMPATIBILITY

A common and effective method of controlling foliar diseases or insect pests in wheat and barley is to apply a registered seed treatment. EverGol Prime does not provide protection from foliar diseases or insect pests. If foliar disease or insect pest control is required, EverGol Prime will need to be mixed with other seed treatments.

EverGol Prime is biologically compatible with a number of seed treatments including Baytan T, Jockey® Stayer® and Gaucho®, without any loss of crop safety in excess of what might be reasonably expected from using a triazole fungicide seed treatment alone. Data from several field and laboratory trials (graphs 5.6 and 5.7) demonstrate the biological compatibility of EverGol Prime with a number of seed treatments.

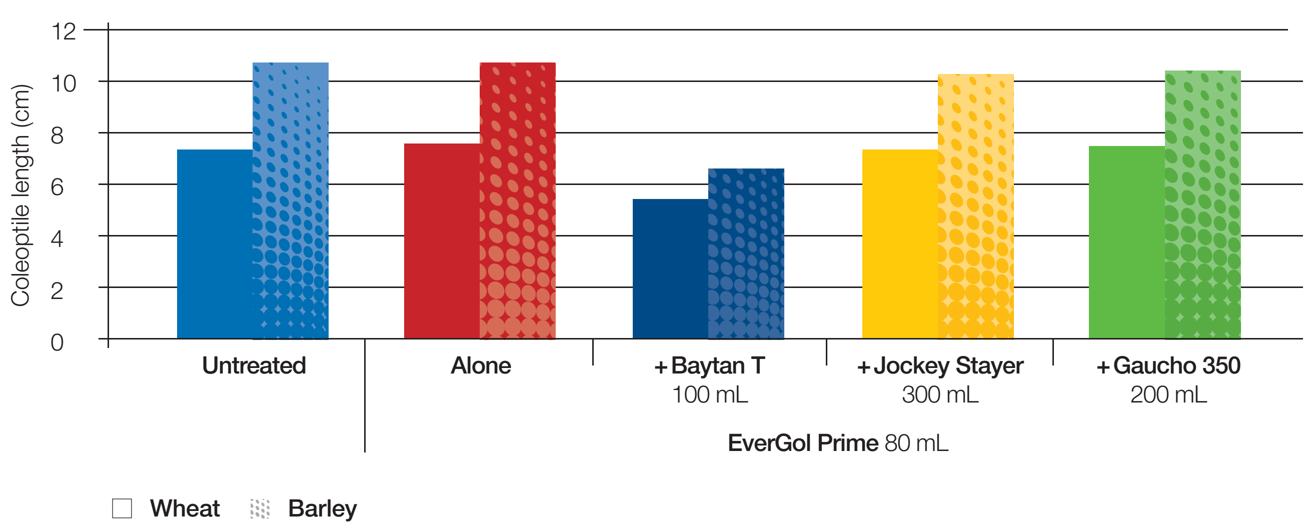
Graph 5.6: Plant establishment (%) for EverGol Prime with and without a tank-mix partner in wheat and barley trials.



Trial ID: 10WA28, 10VB11, 10NW23, 10WA31, 10WA27, 10VB10

All rates per 100 kg of seed.

Graph 5.7: Coleoptile length (cm) of Peake wheat and Gairdner barley treated with EverGol Prime alone and in tank mixes.



Trial ID: 10DC27

All rates per 100 kg of seed.

PHYSICAL COMPATIBILITY

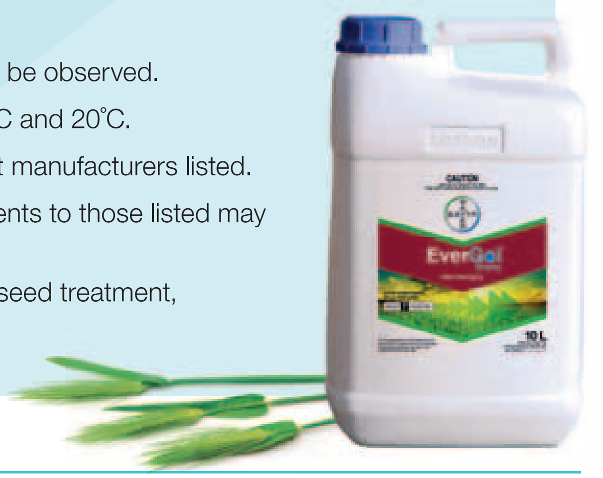
EverGol Prime is a fungicide, but does not provide protection from foliar diseases or insect pests, so it may be mixed with other seed treatments including stored grain insecticides and trace element products. It is important that these tank-mixes are physically compatible. Table 5.1 summarises physical compatibilities for EverGol Prime.

Table 5.1: Physical compatibility of EverGol Prime at 80mL/100 kg seed.

PRODUCT	FORMULATION TYPE	ACTIVE CONSTITUENTS	COMPANY	DOSAGE/ 100 KG SEED	SLURRY VOLUME	PHYSICALLY COMPATIBLE	COMMENTS
Baytan T	FS	150 g/L triadimenol 4 g/L triflumuron	Bayer CropScience	150 mL Baytan T	400 mL	Lab test - Yes	
Jockey Stayer	FS	167 g/L fluquinconazole	Bayer CropScience	450 mL Jockey Stayer	600 mL	Lab test - Yes	Mix slightly viscous
Gaucho 600 Red	FS	600 g/L imidacloprid	Bayer CropScience	120 mL Gaucho	400 mL	Lab test - Yes	
K-Obiol® Combi	SC	50 g/L deltamethrin 400 g/L piperonyl butoxide	Bayer CropScience	2 mL K-Obiol Combi	400 mL	Lab test - Yes	
Actellic® 900	EC	900 g/L pirimiphos-methyl	AgNova	0.45 mL Actellic 900	400 mL	Lab test - Yes	
Divap® 1140	EC	1140 g/L dichlorvos	UPL	1.05 mL Divap 1140	400 mL	Lab test - Yes	
Fenitrothion 1000	EC	1000 g/L fenitrothion	Nufarm	1.2 mL Fenitrothion 1000	400 mL	Lab test - Yes	
Reldan®	EC	500 g/L chlorpyrifos-methyl	Dow	2 mL Reldan	400 mL	Lab test - Yes	
Reldan Plus IGR	EC	30 g/L S-methoprene 500 g/L chlorpyrifos-methyl	Dow	2 mL Reldan Plus IGR	400 mL	Lab test - Yes	
Rizacon® S IGR	EC	300 g/L S-methoprene	Dow	0.2 mL Rizacon S IGR	400 mL	Lab test - Yes	
Activist Max Zinc	SC	70% zinc	Agrichem	200 mL Activist Max Zinc	500 mL	Lab test - Yes	
Flexi-N®	SL	422 g/L nitrogen	CSBP	520 mL Flexi-N	600 mL	Lab test - Yes	
Smartrace® Zinc	SL	100 g/L zinc 49 g/L sulphur	SprayGro	500 mL Smartrace Zinc	600 mL	Lab test - No	**Mix curdles**
Twin Zinc™	SC	700 g/L zinc 18 g/L nitrogen	Yara	400 mL Twin Zinc	500 mL	Lab test - Yes	Mix is quite viscous

Notes:

- All compatibility testing was conducted with EverGol Prime 80 mL/100 kg seed.
- **Only physical compatibility was determined. Effect on seed germination and seed viability was not determined and cannot be commented on.**
- pH varied between 5.12 - 8.94.
- In all mixtures label requirements of the mixing partner should be observed.
- Mixtures were compared using soft and hard water, and at 4°C and 20°C.
- Compatibility is limited to those specific products and product manufacturers listed.
- Products containing varying concentrations of active constituents to those listed may not be physically compatible with EverGol Prime.
- EC = emulsifiable concentrate, FS = flowable concentrate for seed treatment, SC = suspension concentrate, SL = soluble concentrate



6. PRODUCT PROFILE

> PRODUCT FORMULATION
> TOXICOLOGICAL PROPERTIES
> BEHAVIOUR IN THE ENVIRONMENT
> EFFECTS ON FLORA AND FAUNA
> PRECAUTIONS
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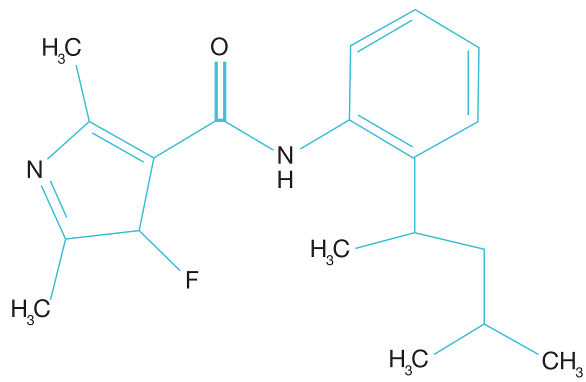
PRODUCT PROFILE

The powerful new active ingredient in EverGol Prime is penflufen, a SDHI Group 7 carboximide. Penflufen utilizes a new mode of action for rhizonctonia, and has new levels of activity against rhizoctonia root rot.

PRODUCT FORMULATION

Trade name:	EverGol Prime Seed Treatment
Active constituent:	240 g/L penflufen
Chemical name:	2'-[(RS)-1,3-dimethylbutyl]-5-fluoro-1,3-dimethylpyrazole-4-carboxanilide (IUPAC)

Structural formula - penflufen



Formulation type:	Flowable concentrate for seed treatment
Appearance:	Red liquid
Density:	1.07 g/mL - 1.13 g/mL
Odour:	Sweetish musty
Vapour pressure:	4.1×10^{-7} Pa at 20°C (for active ingredient)
Solubility:	10.9 mg/L at 20°C, pH 7 (for active ingredient)
Corrosiveness:	Not corrosive
Poison schedule:	Schedule 5
Hazchem code:	3Z
DG Class:	Class 9 - ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (penflufen solution).

According to AU01, Environmentally Hazardous Substances in packagings, IBC or any other receptacle not exceeding 500 kg or 500 L are not subject to the ADG code.

TOXICOLOGICAL PROPERTIES

Tests have been performed with EverGol Prime Seed Treatment on a number of different animal species using various routes of administration. EverGol Prime and penflufen are included in Schedule 5 of the SUSMP.

Results obtained include the following:

Acute toxicity

Oral LD_{50} (rat):	> 2000 mg/kg
Dermal LD_{50} (rat):	> 2000 mg/kg
Inhalation LC_{50} (rat) 4 h:	> 1.877 mg/L
Skin irritation (rabbit):	non irritant
Eye irritation (rabbit):	non irritant
Sensitisation (guinea pig):	not sensitising

BEHAVIOUR IN THE ENVIRONMENT

In crop

Penflufen is metabolized to a number of metabolites in crops. Based on the available data, the APVMA has approved parent penflufen as a suitable residue definition for commodities of both plant and animal origin and MRLs have been assigned. Following application to wheat and barley as per the product label, the withholding periods are:

Withholding periods

> Harvest: Not required when used as directed.

> Grazing: Do not graze plants grown from treated seed or cut for stock food within 5 weeks of sowing.

In soil

Penflufen is slightly to very slightly degradable under aerobic conditions with DT_{50} values between 117 - 432 days in a range of soils in the laboratory. In the field, biotic degradation was somewhat faster (2 - 340 days). Penflufen is very slightly degradable in anaerobic soil with a DT_{50} value of 866 days in total system. Based on the KOC values, penflufen is classified as moderately mobile in soils.

EFFECTS ON FLORA AND FAUNA

EverGol Prime formulation (testing conducted on a similar formulation):

LC_{50} Carp: 0.062 - 0.166 mg/L (96 h)
EC_{50} Daphnia: > 4.93 mg/L (48 h)
EC_{50} *Pseudokirchneriella subcapitata*: 24.8 mg/L (72 h)
Acute oral LD_{50} Bobwhite quail: > 456 mg/kg

Penflufen has been tested for the following:

LC_{50} Carp: 0.103 mg/L (96 h)
EC_{50} Daphnia: > 4.66 mg/L (48 h)
EC_{50} Duckweed: 4.7 mg/L (7 d)
EC_{50} *Pseudokirchneriella subcapitata*: > 5.1 mg/L (72 h)
Acute oral LD_{50} Bobwhite quail: > 4000 mg/kg
Acute LC_{50} *Eisenia fetida* (earthworm): >1000 mg/kg (14 d)
Acute oral LD_{50} *Apis melifera* (honey bee): >108.2 µg/bee

Penflufen has been tested on a range of fish, aquatic invertebrates, birds, and on beneficial animals such as earthworms and honey bees. Penflufen is highly acutely toxic to fish and moderately toxic to aquatic invertebrates. Penflufen shows slight toxicity to bees and earthworms and low toxicity to birds.

PRECAUTIONS

Do not use treated seed for human or animal consumption. Do not allow seed treated with this product to contaminate seed intended for human or animal consumption. If possible, use a separate auger for treated seed. If using the same auger for treated seed and moving grain for human consumption, remove all EverGol Prime residues from the auger to avoid contaminating untreated seed with seed treatment residues.

Re-handling

Do not allow re-handling of treated seed until dry unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

Protection of livestock

Seed treated with this product must not be used for animal consumption or poultry feed or mixed with animal feed. DO NOT allow seed treated with this product to contaminate seed intended for animal consumption.

Protection of wildlife, fish, crustaceans and environment

Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product, used containers or bags which have held treated seeds. DO NOT feed treated seed or otherwise expose to wild or domestic birds. Any spillages of treated seed, however minor, must be cleaned up immediately, preferably by recovery and re-use. If disposal is required, ensure treated seeds are thoroughly buried and not accessible to birds and other wildlife.

STORAGE AND DISPOSAL

Product and original container

Store in the closed, original container in a cool, well-ventilated area. Do not store for prolonged periods in direct sunlight. Do not store near foodstuffs or animal feed.

Triple rinse containers before disposal. Add rinsings to slurry in auger/mixer, or dispose of rinsings according to State/Territory legislative requirements. DO NOT dispose of undiluted chemicals on site. If not recycling, break, crush or puncture and deliver empty packaging to an approved waste management facility. If an approved waste management facility is not available, bury the empty packaging 500 mm below the surface in a disposal pit specifically marked and set up for this purpose clear of waterways, desirable vegetation and tree roots, in compliance with relevant Local, State or Territory government regulations. DO NOT burn empty containers or product. Do not re-use empty container for any other purpose.

Treated seed and containers of treated seed

When treated seed is stored it should be kept apart from other grain and the bags or containers should be clearly marked to indicate the contents have been treated with this product. DO NOT use treated seed for human consumption. Bags which have held treated seed are not to be used for any other purpose.

Application equipment

Rinse all equipment with clean water immediately after use and dispose of rinsings according to State/Territory legislative requirements.

FIRST AID

If poisoning occurs, contact a doctor or Poisons Information Centre. **Phone: 13 11 26.**

SAFETY DATA SHEET

Additional information is listed in the Safety Data Sheet, which can be obtained from:

www.bayercropscience.com.au

EXCLUSION OF LIABILITY

This product must be used strictly as directed, and in accordance with all instructions appearing on the label and in other reference material. So far as it is lawfully able to do so, Bayer CropScience Pty. Ltd. accepts no liability or responsibility for loss or damage arising from failure to follow such directions and instructions.

USEFUL INTERNET LINKS

More information about EverGol Prime and relevant to its can be found at these websites:

EverGol Prime product website

www.evergolprime.com.au

Grains Research & Development Corporation

www.grdc.com.au

South Australian Research & Development Institute

www.sardi.sa.gov.au

Department of Agriculture and Food, Western Australia

www.agric.wa.gov.au

NOTES

7. FAQS

FAQS

What is the active ingredient in EverGol Prime?

EverGol Prime contains the new active ingredient penflufen (240 g/L). Penflufen is a powerful SDHI Group 7 (carboximides) molecule with a new mode of action and superior levels of activity against rhizoctonia.

What are the key features of EverGol Prime?

EverGol Prime is registered for the suppression of rhizoctonia root rot and the control of smut diseases* and can increase yield by up to 20% in wheat and barley. Through effective disease management, EverGol Prime delivers a new standard in plant health with higher yielding, fitter crops and stronger root systems which improve water and nutrient uptake. EverGol Prime also has excellent crop safety, causing no delay of emergence when compared to untreated crops.

*Suppression of soil-borne flag smut.

What crops can EverGol Prime be used on?

EverGol Prime is registered for use in wheat and barley.

What is the application rate and water dilution rate of EverGol Prime?

EverGol Prime is registered for application at 40 - 80 mL/100 kg of seed. This should be diluted with clean water to a total slurry volume of 400 - 600 mL/100 kg seed (4 - 6 L per tonne). The addition of water helps to evenly spread EverGol Prime over each and every seed to provide effective coverage and disease protection.

What colour is EverGol Prime on treated seed?

EverGol Prime is red in colour when applied to seed.

What pack size is available for EverGol Prime?

EverGol Prime is available in a 10 L container. This will treat 25 t of seed at a 40 mL/100 kg application rate or 12.5 t of seed at a higher rate of 80 mL/100 kg seed.

Why doesn't EverGol Prime contain an insecticide?

Stored grain pests have developed resistance to many of the traditional insecticides used in grain storage protection. As part of any resistance management program, it is best to review what has been used in the past and alternate between different chemical groups. Synthetic pyrethroids, organophosphates and growth regulators should be rotated so that no one chemical group is used all the time.

What is rhizoctonia root disease (*Rhizoctonia solani*)?

Rhizoctonia is a fungal soil-borne disease that attacks the roots of plants and is often seen as uneven crop growth, weak or bare patches in paddocks. Its presence in the soil is strongly influenced by environmental conditions but is becoming more widespread due to the adoption of conservation farming and intense cereal rotations. The fungus damages the roots of the plant, limiting its access to water and nutrients, hampering growth.

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