Active ingredients and Trademark acknowledgments

Betanal maxxPro contains desmedipham, ethofumesate, phenmedipham and lenacil.
Betanal maxxim contains desmedipham and phenmedipham.
Cruiser SB contains thiamethoxam.
Force ST contains tefluthrin.
Draza forte contains methiocarb.
Escolta contains cyproconazole and trifloxystrobin.
Gaucho contains imidacloprid.
Nuprid contains imidacloprid.
Poncho Beta contains beta-cyfluthrin and clothianidin.
Punch C contains carbendazim and flusilazole.

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Punch C is a registered trademark of DuPont.
Cruiser SB and Force ST are registered trademarks of Syngenta.
Nuprid is a registered trademark of Nufarm UK.
XBeet is a registered trademark of Germains Seed Technology.

Always read the label: Use pesticides safely.

Betanal® maxxPro®

ESCOLTA®

PONCHO® BETA

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Bayer CropScience

Expert Guide: Sugar Beet

BackingBritishBeet

Contents

1. Introduction

Bayer CropScience takes a keen interest in sugar producing crops throughout the world and leads the way in sugar beet crop protection to support British growers.

Our product portfolio tackles the full range of disease, pest and weed pressures encountered in sugar beet production today and we continue to invest in innovation to tackle future challenges. The Expert Guide to Sugar Beet, first published in 2009 as part of our commitment to 'Backing British Beet', has become an essential reference for growers and advisers wanting to make best use of these products and pursue the crop's full potential.

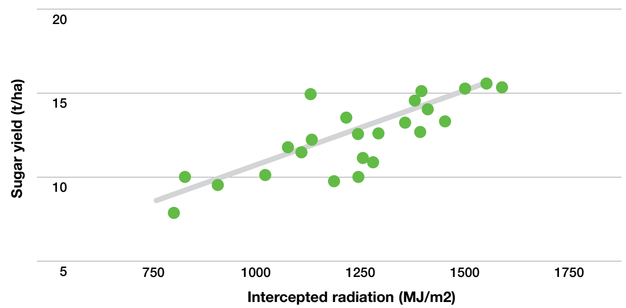
In this new edition, the weed control section has been updated with guidance on how to use the next generation herbicide, Betanal maxxPro, as the foundation of the Flexible strategy for weed control. The foliar disease section has been extended with new research into the value of Escolta-based fungicide programmes and throughout the guide you will find new illustrations and information bringing it fully up to date.

We hope you will find it helpful with the ongoing challenge of removing hindrances to crop growth to maximise sugar beet yields and profitability.

Dr Bill Lankford
Campaign manager root crops

2. Yield potential

Sugar beet is a biennial crop so yield is determined by the amount of radiation captured in the first year of growth (Graph 1). In parts of the world where there is adequate rainfall or irrigation available to prevent drought stress, and the crop has a long growing season before winter, yields in excess of 200 adjusted tonnes per hectare (32 t sugar/ha) have been recorded. The UK's growing season limits potential to around 140 to 150 t/ha.



Graph 1: Radiation interception vs sugar yield.

Source: Broom's Barn.

The fact that this is not achieved is due to the weather, crop management, pests, diseases and weeds. Whilst growers cannot control the weather and irrigation is not an economic option for most, all the other major factors are in their hands; crop protection has a vital role to play in maximising yield.

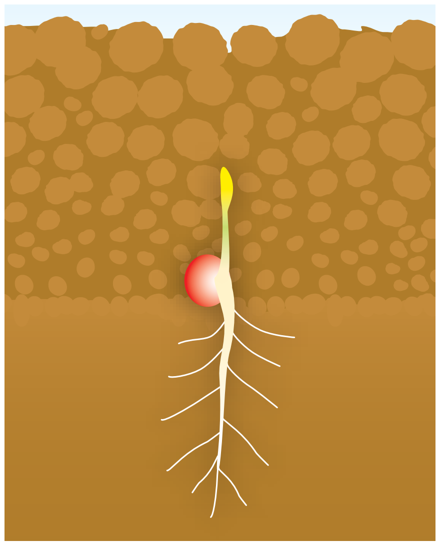
A quality seedbed is the foundation of a high yielding crop. Attention to detail and optimum timing of primary cultivations are essential to ensure good soil structure and to facilitate seedbed preparation. Cultivation under wet conditions produces poor soil structure that does not allow water to permeate properly leading to poor aeration and slow growth of the following beet crop.

Picture 1: Crop protection has a vital role to play in maximising yield.

Recent changes in climate mean that British crops now have to cope with more heavy rainfall events than previously. Primary cultivations carried out under good conditions (Picture 2) produce good soil structure that allows free drainage and proper root growth and also reduce the work involved in preparing the final seedbed.

Picture 2: Optimum timing of cultivation is essential to prepare a good seed bed.

It is worth releasing time from other tasks in the autumn and early spring to ensure that the soil is prepared under the best conditions possible. The ideal seedbed allows the drill to operate smoothly and sow all seed at the correct depth with good seed to soil contact for optimum germination (Picture 3).

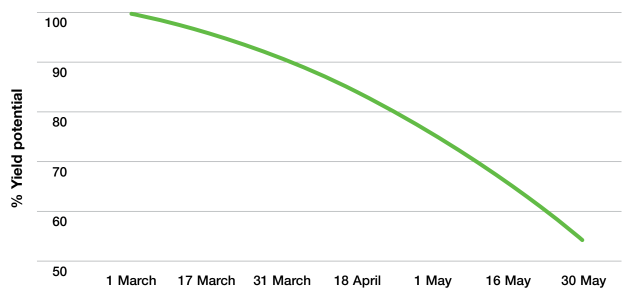


Picture 3: The ideal seedbed.

Crops can be drilled earlier too where the soil has been well prepared. Early drilling is essential if the crop is to make the most of the season's radiation; the yield potential of a crop drilled on 1st March is approximately 10% higher than one drilled on 1st April (Graph 2). The decision on when to drill should be based on soil conditions, soil temperatures - which should be 5°C or more and likely to rise as beet will not germinate below 3°C - and forecasts of good weather. If drilling in early March it is advisable to choose bolting-tolerant varieties.

Picture 4: Drilling beet in the first week of March.

As there are likely to be five or more passes of the sprayer or fertiliser spreader through the crop between drilling and late summer, it is well worth considering the use of tramlines. They allow use of wider tyres early in the season for application of nitrogen and herbicides, and also reduce damage by tyres to the sides of beet crowns when applying fungicides in summer; damaged crowns can be susceptible to secondary infections causing root rots. The seed saved by not sowing beet in tramlines should more than compensate for any lost yield.



Graph 2: Yield potential vs drilling date.

Effect of delayed sowing beyond 1st March.

Apart from fungicides that give the crop a physiological boost (see section 6), it is drilling date, the weather and unhindered crop growth that determine yield potential. Anything that reduces the time taken to reach full canopy and enables the crop to fully exploit the sun's energy will increase yield. So it is the role of crop protection – with insecticidal seed treatments, herbicides and fungicides – to remove hindrances to growth and thereby help growers maximise the yield and profitability of their sugar beet crops.

3. Establishment pests

3.1 Introduction

For profitable beet production every seed should count towards yield. Whilst today's seeds are high quality with good germination, beet seedlings are still susceptible to pests and diseases. Seed treatments protect young beet against them so crops can achieve target plant populations with good, even establishment.

All UK sugar beet seed is treated with tachigaren and thiram to protect against seed-borne diseases and blackleg and there are three options for insecticidal protection; imidacloprid (Nuprid), thiamethoxam + tefluthrin (Cruiser Force) and clothianidin + beta-cyfluthrin (Poncho Beta).

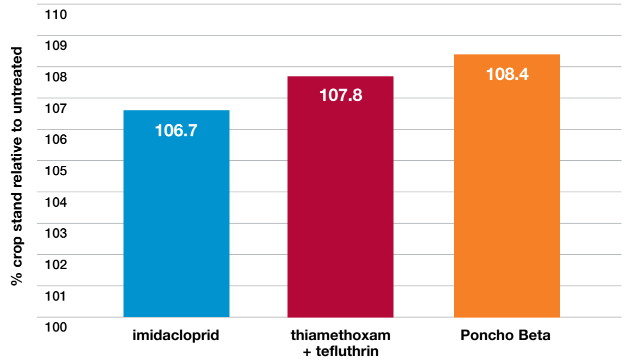
Imidacloprid was the first neonicotinoid to be developed and became available as Gaucho in 1994. The other two are new generation treatments combining more advanced neonicotinoids with pyrethroids for more persistent, robust and reliable control of soil and foliar pests to establish higher yield potential crops.

Picture 5: Poncho Beta treated seed.

Seed treatments are used at very low dose compared to overall spraying. For example a unit of Poncho Beta treated seed contains 60 g of the neonicotinoid clothianidin and 8 g of the pyrethroid beta-cyfluthrin. Treatments are sealed onto the pellet, which is placed into the soil, to greatly reduce any potential risk to wildlife.

Combining a pyrethroid and a neonicotinoid in a seed treatment brings two different modes of action to pest control. This is important when planning long-term resistance strategies, as reliance on only one mode of action can increase the chances of target pests developing resistance.

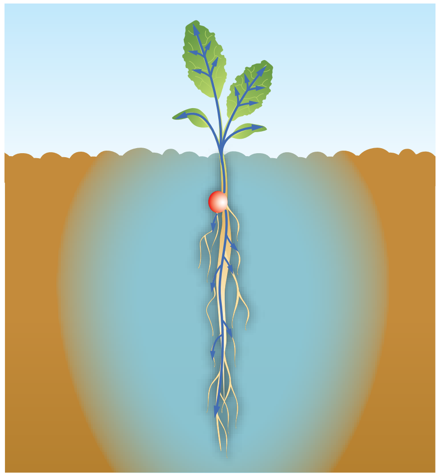
It is essential that seed treatments do not adversely affect crop growth. Graph 3 summarises the levels of crop establishment achieved over three years of trials with the three treatment options under low pest pressure.



Graph 3: Crop establishment under low pest pressure.

Source: Broom's Barn 2004-06, mean of 6 trials.

With Poncho Beta, the plant does not take up beta-cyfluthrin to any great extent but its vapour action forms a protective zone in the soil around the growing plant (Picture 6). Clothianidin also provides protection in the soil but, more importantly, is taken up by the plant roots and shoots so its systemic action protects the plant from pest attack, both below and above ground.



Picture 6: Poncho Beta protection of beet plant.

The dose is also designed to bring the persistence needed to control foliar pests and aphids until the risk of yield loss from attack has passed. Once sugar beet reaches the 12- to 14-leaf stage it protects itself against green aphids by producing a black sticky substance that blocks their gut so that they starve to death. Poncho Beta gives good persistence to this stage, even through periods of slow growth.

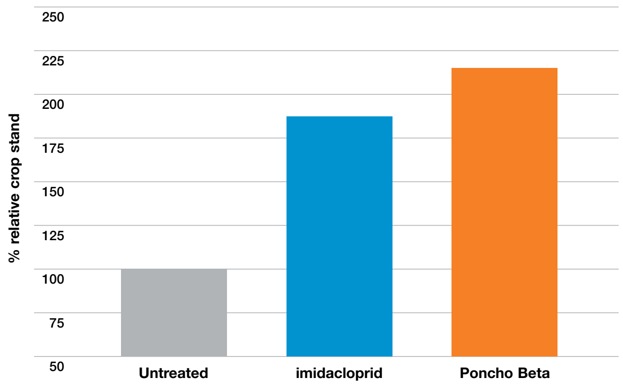
All sugar beet is now primed using the XBeet process to accelerate emergence. When priming was first introduced as Advantage it was of particular importance in overcoming the slower emergence of imidacloprid treated seed. The new generation insecticidal seed treatments do not have any adverse effect on germination so allow maximum benefit from this germination advancing process.

Millepedes, symphylids and springtails make up what is commonly referred to as the soil pest complex of sugar beet and, along with a range of other problems such as pygmy beetles, wireworms, leatherjackets and slugs are the main pests to attack beet as it emerges.

3.2 The soil pest complex


Picture 7: Millepede.

Millepedes *(Blaniulus* spp.) feed on the roots or stem below soil level causing the damaged area to turn brown or black. If the attack is severe the plant will die. Damage is usually worse when the soil is cold and wet and seedling growth is slow. Millepede damage, which is often associated with damage from other soil pests such as symphylids, springtails or pygmy beetles, is well controlled by Poncho Beta (Graph 4).



Graph 4: Millepede control.

Source: Mean of 4 Bayer CropScience trials, 2 in 2002 and 2 in 2004.


Picture 8: Springtail.

Springtail *(Onychiurus* spp.*)* feeding damage is usually noted as small bites out of the stem or, in some cases where surface-living springtails are present, the hypocotyls and cotyledons. There are both surface and soil-inhabiting springtails, but the latter are most significant in beet as they cause the greatest amount of damage.


Picture 9: Symphylid.

Symphylids *(Scutigerella immaculata)* occasionally attack germinating seeds but more usually they damage seedlings. Symphylids feed on the root, stem and root hairs. Damage is related to pest density and populations can be very high, particularly on silt or chalky soils.

A neonicotinoid insecticide alone gives useful control of the soil pest complex but, because the active ingredient is mostly in the beet plant, pests have to attack it to gain a lethal dose. Addition of a pyrethroid gives better protection against high pest populations as many are killed on entering the protection zone around the roots. It also reduces the amount of sub-lethal damage that can weaken beet plants and reduce their yield potential. Therefore, a combination treatment such as Poncho Beta is able to deliver better control of the soil pest complex (Picture 10).

Picture 10: Impact of soil pests on sugar beet. Bayer CropScience soil pests trial, Yorkshire 2004.

i For more information on these and other pests visit: **www.pestspotter.co.uk**

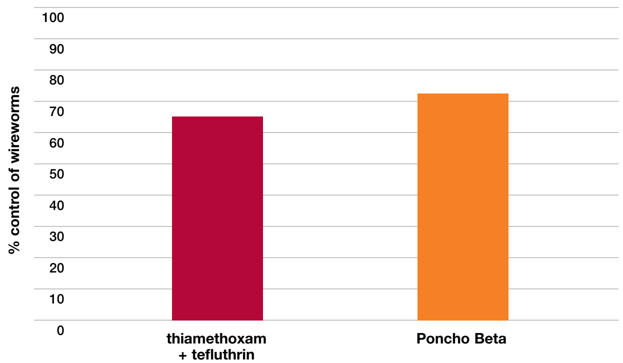
3.3 Other soil pests

Picture 11: Pygmy beetle.

Pygmy beetle *(Atomaria linearis)* damage takes the form of black pits on the radicle and hypocotyls of beet but sometimes the beetles also attack the cotyledons and even the first true leaves. Damage tends to be greatest where beet follows beet, as the beetles have to fly from their previous beet host to the new crop.

Picture 12: Wireworm.

Wireworms *(Agriotes* spp.*)* are larvae of the click beetle and generally damage beet by eating through the main tap root or severing the hypocotyl between the seed and the soil surface. Damage is often severe where beet is grown after grass, set-aside or a long run of cereals. Whilst wireworms were once a very severe problem in beet, damage can now be significantly reduced by insecticidal seed treatment and in trials Poncho Beta has been seen to offer greater activity (Graph 5).



Graph 5: Wireworm control.

Source: Bayer CropScience, 7 trials in Europe, 2003-06.

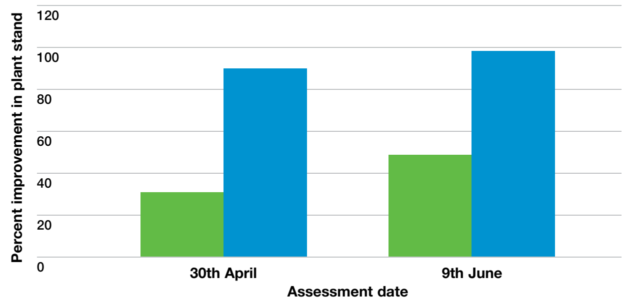
3.4 Slugs and leatherjackets

Picture 13: Leatherjacket.

Leatherjackets *(Tipula paludosa)* are usually the larvae of the crane fly or 'Daddy Long Legs', although the larvae of the spotted crane fly (*Nephrotoma appendiculata*) caused serious damage in 2005. Adults lay eggs in the soil during late summer and larvae hatch in approximately 14 days. They are very susceptible to dry conditions so tend to be less of a problem on sandy soils and to cause most damage in springs that follow wet autumns.

Larvae overwinter in the soil and become particularly active in the spring feeding both above and below ground on young seedlings. When fully grown they are around 40 mm long with a leathery skin.

Risk of leatherjacket damage is highest when beet follows grass or set-aside, especially long-term set-aside, although the spotted crane fly may cause damage after cereals. Control is best achieved by treating grass with chlorpyrifos before ploughing up in the previous year, and then using Poncho Beta treated seed for the following beet crop. If populations are high the use of methiocarb slug pellets will optimise control (Graph 6).



Graph 6. Leatherjacket control.

methiocarb slug pellets
insecticide treated seed + methiocarb slug pellets

Source: ITB France, 2004.

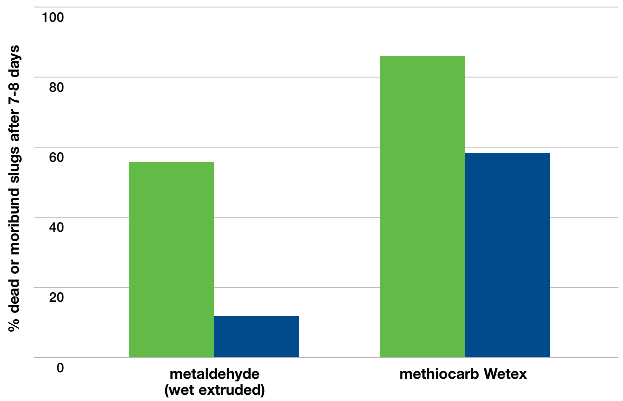
Picture 14: Slugs.

Slug damage on roots and hypocotyls is normally visible as irregular notches and on leaves they also cause irregular holes. Beet crops at greatest risk are those grown on medium or heavy soil following a brassica crop or where green foliage has been present during the winter and/or early spring. Slugs cause most damage to beet when feeding below the soil surface but, if conditions are damp, they will feed at or above the soil surface on stems and leaves of the crop.

Slugs are normally most active at night and are seldom seen during the day so bait traps need to be used to check for activity. If monitoring indicates the crop to be at risk or if slugs are already starting to cause damage, treat with a slug pellet broadcast onto the soil surface.

Slug damage is generally worse in cool and moist conditions that also put slug pellets at risk of dissolving and moving into water. Methiocarb, as in Draza forte, is less soluble than metaldehyde and therefore less likely to indirectly contaminate watercourses. However, care should be taken with all pellet types to ensure they are not broadcast onto or in the vicinity of watercourses.

Baits give best control when slugs are active on the soil surface; it is difficult to control slugs when they remain underground. Methiocarb is more effective than metaldehyde (Graph 7) when broadcast, because the Wetex technology used in its bait formulation has greater attractant properties than metaldehyde products. The pellets are also more durable so that repeat applications should not be necessary even if slugs do not emerge for several days after treatment.



Graph 7: Molluscicide performance.

Grey field slug *(Deroceras reticulatum)*
Round-backed slugs *(Arion spp.)*

16°C and 80% RH.

Controlled climate tests 2000.

Mean of 2 trials Nov/Dec 2000; 10 reps of 5 pellets and 5 slugs.

Tests by ITCF (Arvalis) France.

i For more information on slugs and bait trapping to assess risk, visit **www.bayercropscience.co.uk** and download the **Expert Guide: Slugs**

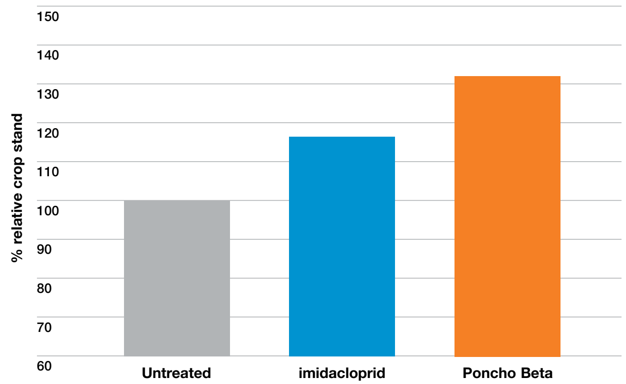
3.5 Foliar pests

Pygmy beetles, slugs and surface-living springtails are not the only pests to damage young beet plants above the surface. Flea beetles, thrips, capsid bugs and leaf miners are some of the most commonly found pests in the UK that attack young beet. These can all cause severe damage but are well controlled by Poncho Beta.

Picture 15: Flea beetle.

Flea beetles *(Chaetocnema concinna)* attack cotyledons and leaves. They do not eat all the way through but leave small pits on both sides which develop into holes as the leaves expand. Severe attacks significantly reduce the green leaf area of young foliage and make it more susceptible to herbicide damage.

Flea beetles cause most damage in cold, dry and sunny weather when plant growth is slow. Their damage exacerbates this slow crop growth and can reduce establishment. Poncho Beta offers enhanced control of flea beetles compared with imidacloprid (Graph 8).



Graph 8: Flea beetle control.

Source: Bayer CropScience 2002, mean of 2 UK trials.

Picture 16: Thrip.

Thrips *(Thrips* spp.*)* are very small insects - approximately 1 mm long - but can cause severe damage to young beet. They tend to feed on the heartleaves as they form and before they unfurl by sucking the contents. This leads to silvery brown or even red colouring of the centre of the beet. The effect on crop growth can be severe as the damaged leaves are unable to expand properly. As with flea beetles, damage is greatest in cold, dry weather when plant growth is slow.

Picture 17: Capsid bug.

Capsid bugs *(Lygus rugulipennis)* as both adults and young, damage beet by sucking the sap and at the same time injecting saliva into the plant, which causes distortion of the foliage. Although capsids can kill beet at the seedling stage, in most situations in the UK damage occurs too late for this, but causes multi-crowning or distortion of the growing point that makes beet susceptible to herbicide damage.

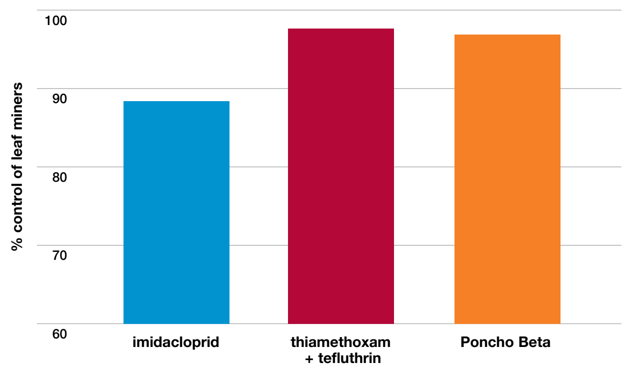
The tarnished plant bug is a common capsid found in the UK. Adults over-winter in hedges and other sheltered places, so attacks are usually most severe on headlands where damage is seen as yellowing of leaf ends.

Picture 18: Beet leaf miners.

Beet leaf miners *(Pegomya hyoscyami)* are named because the larvae tunnel under the surface of leaves. The first signs of attack are groups of white eggs on the underside of leaves or even the cotyledons. These white, elongated eggs are approximately 1 mm long and usually found in groups of two to ten placed side by side.

After hatching the larvae burrow into the leaves and live between the upper and lower surfaces. Damage appears as blisters and makes beet very susceptible to herbicide damage and also slows plant development. Heavy infestations can kill plants.

The first leaf miners usually fly in April and early May so they are at their most numerous and active when herbicides are being applied. The new generation insecticidal seed treatments give more effective and reliable protection against leaf miner damage than imidacloprid (Graph 9).



Graph 9: Leaf miner control.

Source: Bayer CropScience, 10 trials Europe, 2003-06.

For more information on these and other pests visit **www.pestspotter.co.uk**

3.6 Requirements from a seed treatment

As well as working when conditions are ideal for beet growth, insecticidal seed treatments have to work when the weather deteriorates and crop growth slows. Slow growing beet are most susceptible to pest damage, because they cannot grow away quickly from attack.

Recent years have seen wide variations in spring weather. In wet seasons, like 2008, there was a risk that some insecticides could leach away from the root zone. However, the low water solubility of clothianidin in Poncho Beta makes it the least likely of the seed treatments to leach. This is complimented by the high lipophilicity required to ensure good uptake into and up through the plant even in very dry conditions as in recent seasons.

Crop safety is another important consideration, and of the three treatment options it is only Poncho Beta that does not interact with other plant protection products, such as the herbicide lenacil. Crops drilled with imidacloprid or thiamethoxam treated seed can suffer severe reductions in emergence and establishment if subsequently treated with lenacil before crop emergence (Picture 19).

Picture 19: Herbicide / seed treatment interaction.

Venzar (lenacil) applied pre crop emergence. Bayer CropScience crop safety trial 2004.

In summary, the main requirements of an insecticidal seed treatment are that it **must**:

- Control the soil pest complex and other important soil pests
- Perform consistently regardless of soil conditions
- Have dual modes of action to prevent grazing by pests that slow growth
- Help control of leatherjackets
- Control early foliar pests
- Control virus-spreading aphids (see section 5)

In addition, it **must not**:

- Slow crop growth
- Adversely interact with herbicides

The combination of clothianidin + beta-cyfluthrin in Poncho Beta is the only insecticidal seed treatment for sugar beet that meets **all** these requirements to ensure good, even establishment.

Picture 20: Good, even establishment.

4. Weeds

4.1 Introduction

Weeds compete with beet for nutrients, water and light, but in most UK crops it is their competition for light that is most important. Yield losses from weed competition depend on their competitive ability, density (Picture 21) and how long they are present. Weeds that emerge early and grow taller than the crop are the most competitive and, if present in large numbers, can cause complete yield loss.

Picture 21: Weed densities and yield loss.

Picture 22: One tall weed per square metre.

Experiments under UK conditions have shown that just one tall weed per square metre can reduce yield by 10% or more (Picture 22). In the past growers might leave a few weeds in the crop but this is no longer acceptable for those now pushing for the high yields required for profitable production.

Weeds in beet can produce a large number of viable seeds ranging from around 150 per plant from species such as scarlet pimpernel to over 70,000 per plant from fat-hen. When growing spring break crops in rotation with sugar beet, minimising seed return can be a very important consideration, especially if there is a limited range of herbicides for use in those other crops.

When beet is grown in rotation with winter cereals seed return is usually less of an issue but, for some species such as cleavers, good control can help reduce pressure in winter crops. So when planning weed control it is important to consider implications for other parts of the rotation and vice versa. If black-grass (*Alopecurus myosuroides*) is a problem in the rotation, the beet crop is an opportunity to use herbicides with different modes of action to those available in cereals to help manage resistant black-grass.

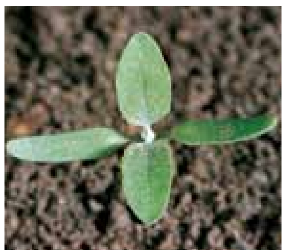
The weed species found in sugar beet present a range of challenges to the weed control programme. Examples include;


Picture 23: Black bindweed.

Black bindweed (*Fallopia convolvulus*) appears to have changed its response to herbicides. It used to be controlled easily by phenmedipham plus lenacil or chloridazon but in recent years appears to have developed a waxy cuticle that reduces penetration by older herbicide formulations. The main method of improving control has been to include ethofumesate in the treatment mixture.


Picture 24: Small nettle.

Small nettle (*Urtica urens*) has a hairy covering on the leaves making it difficult for herbicides to reach and spread on the leaf surface. The reduction in the number of herbicides registered in Europe for use in other crops has meant that this weed is becoming more common, especially on farms where rotations include a number of spring crops.


Picture 25: Fat-hen.

Fat-hen (*Chenopodium album*) has always been a difficult weed to control in sugar beet and not just because, being a member of the *Amaranthaceae* family, it is closely related to sugar beet. The main problem with this species is that it germinates over a long period of time and, when conditions are warm and moist, grows rapidly. Each post-emergence herbicide treatment must therefore be able to control fat-hen at a range of growth stages.


Picture 26: Common orache.

Common orache (*Atriplex patula*) is often confused with fat-hen so clear identification is important. At the early cotyledon stage it will be controlled by herbicides that also control fat-hen but, once the true leaves start to show, it is harder to kill and previously a herbicide mix containing metamitron and ethofumesate has been necessary for good control.


Picture 27: Cleavers.

Cleavers (*Galium aparine*) prefers moist conditions and can be more of a problem on heavier beet-growing soils. It usually emerges at the same time as other weeds but traditionally is best controlled slightly later, at the first whorl stage. This is because conventional, non-sulfonylurea herbicides, generally burn the cotyledons off but leave the growing point intact to grow on.


Picture 28: Knotgrass.

Knotgrass (*Polygonum aviculare*) has always been a difficult weed to control as it is often one of the first to emerge in spring so by the time herbicides are applied the first true leaves are starting to develop. These tend to shield the growing shoot from herbicides. Like small nettle, this weed is particularly troublesome where the rotations include other spring crops, especially peas.

All these weeds have the potential to be very competitive but a good understanding of these characteristics will enable construction of an effective control strategy.

Despite the difficulty of identifying good selective herbicides for use against weeds closely related to the crop, there are 19 active ingredients registered for use in UK beet crops and these are marketed alone or in combination in around 170 products. In the future, sugar beet herbicides are likely to become more important for rotational weed control as the number of plant protection products registered in Europe for other crops decreases.

A further concern is that 75% of herbicide use worldwide relies on just six modes of action. This suggests that resistance of weeds to herbicides is likely to rise even higher up the agenda in the future. The range of herbicides available in sugar beet means that beet crops could well play an increasing role in preventing the build-up of herbicide resistant weeds in rotations. Indeed sugar beet could once again become the cleaning crop of the rotation as the availability of control options in other crops diminishes.

4.2 Weed control strategies

The first principle of weed control in sugar beet is to start clean. Seedbed cultivations usually kill small cotyledon weeds but larger ones tend to survive, often partially buried, and thus difficult to control by non-selective herbicides applied between drilling and crop emergence. These weeds continue to grow and become too large for control by selective herbicides within the crop.

Non-selective herbicides should therefore be used to kill large weeds present before drilling. If they are applied after drilling, care must be taken to ensure that the crop is not close to emergence or beet will be killed too.

The use of pre-emergence herbicides has declined in recent years and it is best to consider them as part of the overall strategy rather than as a separate control option; their role is described where relevant below.

Hoeing is still important for weed beet control, because there is no selective herbicide for use against them, but is no longer considered part of the main weed control strategy.

Post-emergence weed control (Picture 29) is the backbone of modern weed control strategies in sugar beet. Which strategy to adopt should be based on the desire for good weed control and on the spray days available; these are likely to be determined by the spraying capacity available and the ability to travel on fields when required.

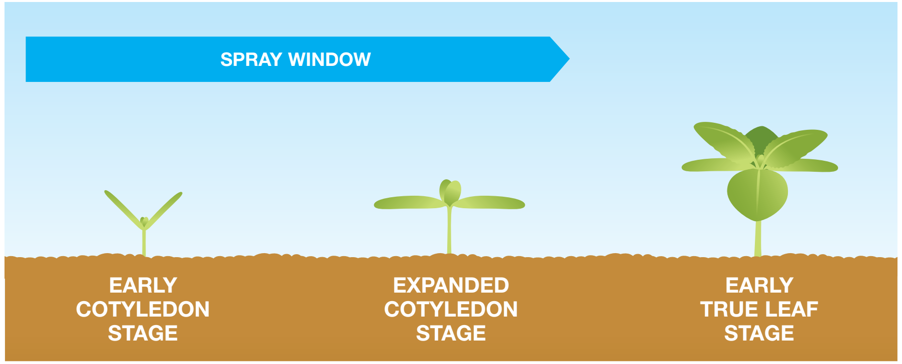
Picture 29: Timely application of beet herbicides requires efficient sprayers.

Selective herbicides cannot control large weeds so, whichever strategy is chosen, a key principle is to control small weeds as each flush emerges. Consequently UK beet crops currently receive an average of four herbicide applications each year, including treatments applied before drilling.

Today there are three main approaches to weed control in UK beet, which are referred to as Basic, FAR and Flexible.

The Basic method

This method began in the 1970s and was initially referred to as the repeat low dose system. It utilises herbicide mixtures centred on straight phenmedipham plus residual herbicides that are applied to weeds when they reach the expanded cotyledon stage (Picture 30).



Picture 30: Basic method spray window.

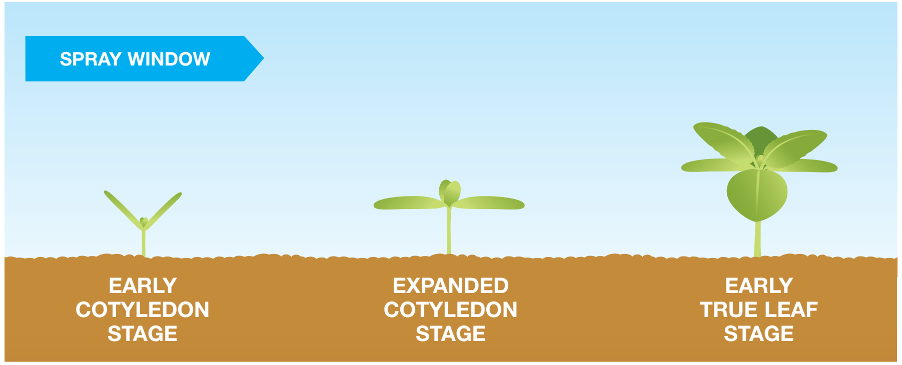
The Basic method requires good knowledge of herbicides' activities to select the correct mixtures and this can be very complex when there is a wide range of weed species present. Weed stage is critical as the size of the largest weeds dictates spray timing and assessment of this can also be very difficult when weed emergence is protracted. Spray windows can be narrow so Basic programmes often start with a pre-emergence residual herbicide, usually chloridazon, to provide some control of weeds and to sensitise survivors to post-emergence sprays.

Chloridazon is not suitable for organic soils where it is too strongly absorbed on the soil particles to be effective. In most situations two or three post-emergence sprays are required following a pre-emergence herbicide treatment, or three or four if no pre-emergence is used.

The number of spray-day options limits the effectiveness of this method and crop damage can occur when treatments are applied under less than optimum conditions. Herbicide damage can result in yield losses up to 20% or more and, even when symptoms do not look severe, it is very easy to lose 5% of yield by applying treatments on the wrong day.

The FAR system

FAR was developed on the continent in the late 1990s, as a method of simplifying decision making, and is based around phenmedipham (the F), ethofumesate as an activator (A) and a residual herbicide (R), which in the UK is usually metamitron, lenacil or chloridazon. Doses are approximately half those used for the basic method but have to be applied earlier, at the early cotyledon stage of weeds (Picture 31).



Picture 31: FAR system spray window.

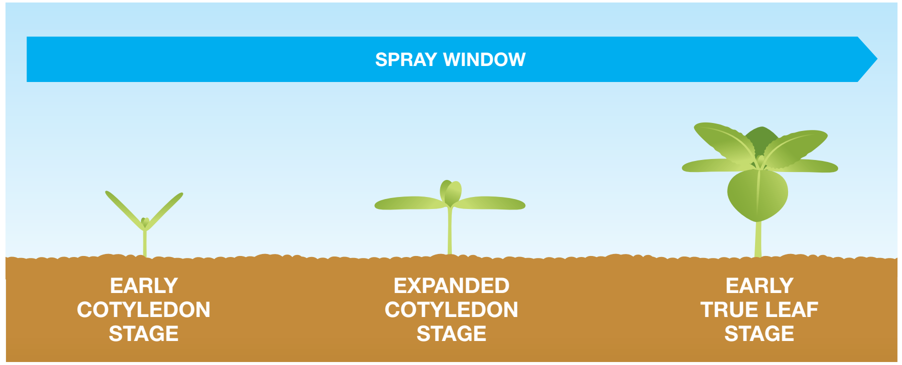
The first spray must be applied when the first weeds of the first flush are at this stage followed by weekly sprays until the weed flushes cease. Adjuvant oil is usually included to improve wetting of the leaves and this is especially important with modern-day formulations of phenmedipham that no longer contain isophorone as a solvent.

With ample spraying capacity and meticulous timing the FAR system can achieve good control from four to five post-emergence sprays and pre-emergence treatment should not be necessary. Although low doses are used, some crop damage and yield loss can still occur if treatments are applied under adverse conditions (see section 4.5).

If the weather delays spraying and weeds advance beyond the early cotyledon stage users have to change to the Basic method or Flexible strategy. One problem for users of the FAR system is how to determine when to end the programme.

The Flexible strategy

This approach has been developed by Broom's Barn since 2005 to bring greater flexibility in weed control and increase spraying capacity across the farm as a whole. It widens the spraying window for weed control by enabling the application of robust, broad-spectrum treatments to weeds at the early true leaves stage (Picture 32). It also provides the opportunity to deploy the same tank-mix across a number of fields and allows selection of spray days with optimum conditions for herbicide activity to avoid the risk of crop damage.



Picture 32: Flexible strategy spray window.

Initially the Flexible strategy was based on using Betanal Expert – the former three-way co-formulation of desmedipham, phenmedipham and ethofumesate – mixed with an appropriate residual herbicide, usually metamitron or lenacil. Following introduction of Betanal maxxPro – the new generation three-way co-formulation – in 2011, this or the tank-mix of Betanal maxxim and ethofumesate, are now the foundations for the Flexible strategy.

The combination of advanced formulation technology and their desmedipham component makes these products the most robust on the market. Not only do they give good, broad-spectrum weed control under good growing conditions – warm and moist – but equally when conditions are highly challenging to herbicide activity – dry and/or cool – which has been a common feature of recent weed control seasons in the UK.

As a result, the flexible strategy enables growers to achieve effective broad-spectrum control from two to three post-emergence applications.

Consideration of strategy

The scale of arable farming in general is increasing and many beet growers are expanding their beet enterprise too, whilst trying to do so with less labour to achieve economies of scale. In addition growers are having to work around the more challenging spring weather that climate change is bringing.

In the past it was normal to select a different combination of herbicides for each field. Nowadays the pressures on labour and sprayer use and other time constraints on farms demand use of high capacity sprayers to treat a number of fields from one fill of the tank.

The use of a second sprayer (Picture 33) for sugar beet is no longer economic, especially as many of these were 'hand-me-downs' and not as efficient as the main farm sprayer(s), so spray wash-out occasions are also a consideration.

Picture 33: Second, small sprayers kept solely for use in beet are seldom efficient.

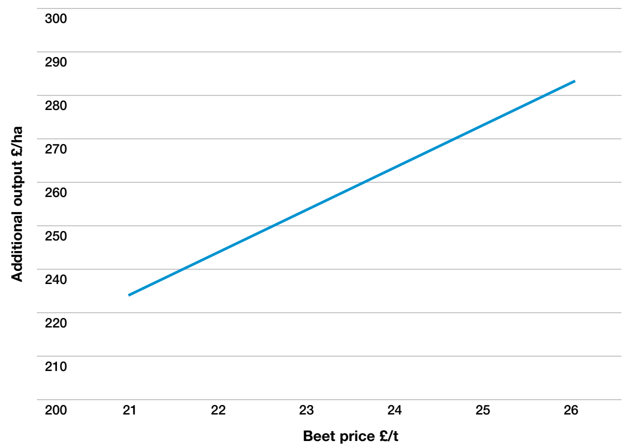
A further complication is that in most sugar beet fields the weed population normally comprises five or six main species with many others present at lower densities. The major weeds are naturally the main target for herbicide selection but, it is always worth ensuring that low populations of other species are controlled too. For optimum yield, herbicide treatments in sugar beet need to give broad-spectrum control.

For these reasons the best weed control strategy for many will be the one that brings the flexibility to balance spraying capacity with workload. This is why the current trend is away from the FAR system and towards the Flexible strategy. This is not just down to the need to reduce workload but also to access the added flexibility it brings over the Basic method, to work around the weather and maintain good weed control even when delayed.

Since 2004 Broom's Barn have done trials every year to compare the Flexible strategy against the Basic method. The results up to 2010, across seven widely differing weed control seasons, show the Flexible strategy consistently delivering higher yields from better weed control and greater resilience to delays.

Based on Betanal Expert up to 2007 and thereafter on Betanal maxxPro, the Flexible strategy has delivered a mean increase in yield over the Basic method of 10.8 t/ha. Graph 10 illustrates the value of this extra yield to growers in relation to the prevailing beet price.

On a like for like basis the difference in cost between three-spray programmes of the two approaches has been around £35/ha and the results show how growers can expect this to be paid back a number of times over.



Graph 10: Additional output from Flexible strategy.

Source: Broom's Barn trials 2004-10. Mean yield increase from Flexible strategy compared to Basic method: 10.8 t/ha.

The difference between weed control performance from the two approaches has often been visibly dramatic too (Picture 34), particularly when treatment has been intentionally delayed to simulate the difficulties often faced in practice.

Picture 34: Broom's Barn trials 2010

Photographs of trials plots taken on 7th August 2010 following three-spray programmes.

T1: 10th May (delayed 5 days), T2: 21st May (delayed 3 days), T3: 2nd June (on time).

Untreated

Basic method

phenmedipham + metamitron (T1) / lenacil (T2) / metamitron (T3).

Flexible strategy

Betanal maxxPro + metamitron (T1) / lenacil (T2) / metamitron (T3).

4.3 Herbicide selection

In 1968 introduction of the first Betanal herbicide revolutionised the production of sugar beet. Since then the requirements for weed control in beet have changed but Bayer CropScience have innovated the Betanal range of herbicides beyond recognition with advances in formulation technology.

Today the new generation Betanal herbicides – Betanal maxxPro and Betanal maxxim – are the foundation of the Flexible strategy. Their broad spectrum of control and flexibility provide the basis for complete weed management solutions. Excellent compatibility with the full range of other herbicidal active ingredients also allows growers to select tank-mix partners for control of locally problematic weeds when required.

The Betanal range of herbicides

Product	Betanal maxxPro	Betanal maxxim
Formulation	Oil dispersion (OD)	Emulsifiable concentrate (EC)
Active ingredients	60 g/L phenmedipham 47 g/L desmedipham 75 g/L ethofumesate 27 g/L lenacil	160 g/L phenmedipham 160 g/L desmedipham
Dose rate	1.0 – 1.5 L/ha alone or 0.75 – 1.5 L/ha in mixture, rate depending on weed and crop stage	0.75 – 1.0 L/ha alone or 0.5 – 1.0 L/ha in mixture, rate depending on weed and crop stage
Maximum individual dose	1.5 L/ha	1.0 L/ha
Maximum total dose	4.5 L/ha	3.0 L/ha
Latest time of application	Before crop leaves meet between the rows	Before crop leaves meet between the rows
Water volume	80 – 200 L/ha	80 – 100 L/ha
LERAP	None	B

Tank-mix partners

The main tank-mix partners for phenmedipham products are the residual herbicides ethofumesate, metamitron, chloridazon and lenacil and the foliar-acting herbicides triflusulfuron-methyl and clopyralid. These can be selected to add some extra residual activity and/or control of certain species.

Ethofumesate is absorbed by weeds' foliage and roots. It bolsters control of a wide range of weeds, especially those more difficult to control such as cleavers, knotgrass, black bindweed and grass weeds.

Metamitron is absorbed by both the roots and leaves of weeds. It is especially effective on mayweed species, knotgrass and nettles and will also control annual meadow-grass.

Chloridazon is a soil-acting herbicide that is absorbed by the weeds' roots during or shortly after emergence. Organic matter can severely reduce its activity so it is not recommended for use on fen peat and moss soils or where organic matter is high. Chloridazon is especially effective on mayweeds and black bindweed.

Lenacil is a relatively persistent, soil-acting, residual herbicide absorbed by the weeds' roots during or shortly after emergence. It is particularly effective against brassica species such as charlock and volunteer oilseed rape.

Triflusulfuron-methyl is the only sulfonylurea herbicide approved for use in UK sugar beet. It is foliar acting, should normally only be used in tank-mix with other herbicides and is particularly effective against volunteer oilseed rape and other brassicas as well as fool's parsley, mayweeds and cleavers.

Clopyralid is a systemic herbicide that is absorbed predominately through weeds' leaves. It is normally recommended in tank-mix with other products and is particularly effective against mayweed species, thistles and volunteer potatoes. Inclusion of ethofumesate in the mixture will enhance the control of volunteer potatoes.

Picture 35: Volunteer potato in sugar beet showing symptoms of clopyralid treatment.

Adjuvant oils have long been used in attempts to boost the performance of foliar-acting herbicides by improving coverage of weeds' leaves and speed of uptake. They can improve the activity of some phenmedipham formulations but care is needed as they can do so on both weeds and the crop and reduce the selectivity of treatments. However, the advanced formulations of Betanal maxxPro and Betanal maxxim usually make the addition of further adjuvant oil unnecessary.

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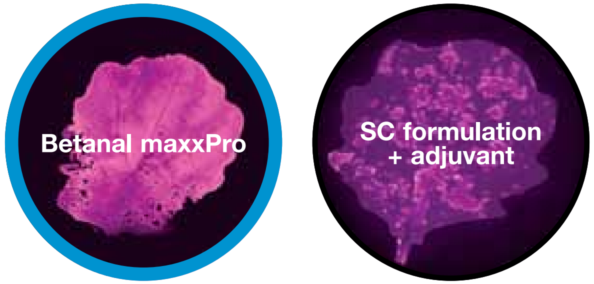
For information on Bayer CropScience recommended tank-mixes consult the sugar beet section at www.bayercropscience.co.uk
For help with weed identification visit www.weedspotter.co.uk

4.4 Double-A technology

Betanal maxxPro is the next generation three-way co-formulation and the first to incorporate Bayer CropScience's Double-A technology. Combining advanced formulation and unique activation technologies, it sets the new benchmark in sugar beet weed control.

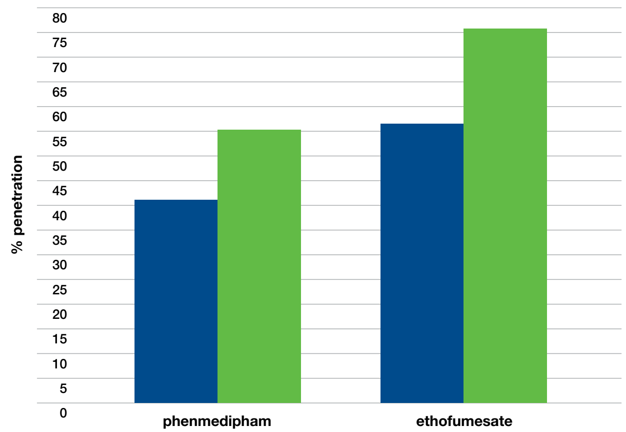
The advanced formulation technology combines state-of-the-art solvents, emulsifiers and wetting agents in an OD (oil dispersion) formulation. As illustrated by the fluorescence photographs below (Picture 36) this ensures even distribution of the active ingredients to optimise spreading and coverage of weeds' leaf surfaces. By comparison the spray distribution from a generic SC formulation with adjuvant is clearly patchy.



Picture 36: Spreading and distribution over the leaf

Leaves of volunteer oilseed rape (*Brassica napus*) 30 minutes after herbicide application.

The result is faster and more reliable uptake of the active ingredients by weeds compared to a standard 3-way EC formulation without Double-A Technology (Graph 11).



Graph 11: Uptake of active ingredients.

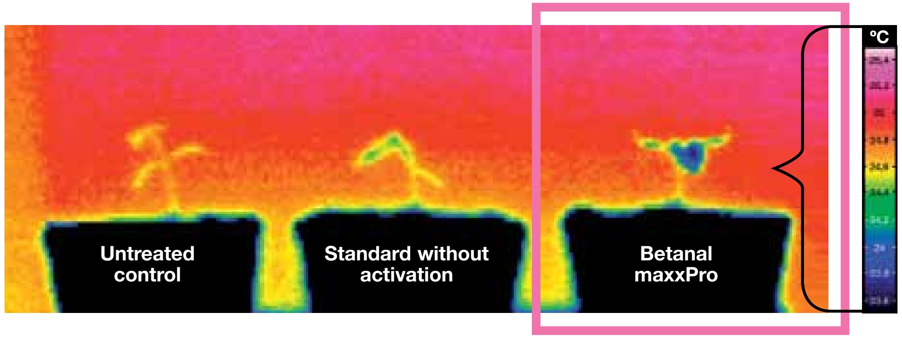
Penetration of active ingredients through the plant surface 48 hours after application.

Standard product

Betanal maxxPro

The other half of the Double-A Technology breakthrough is an **activation technology** based on a micro-rate of lenacil that significantly enhances the herbicidal performance of the active ingredients desmedipham, phenmedipham and ethofumesate.

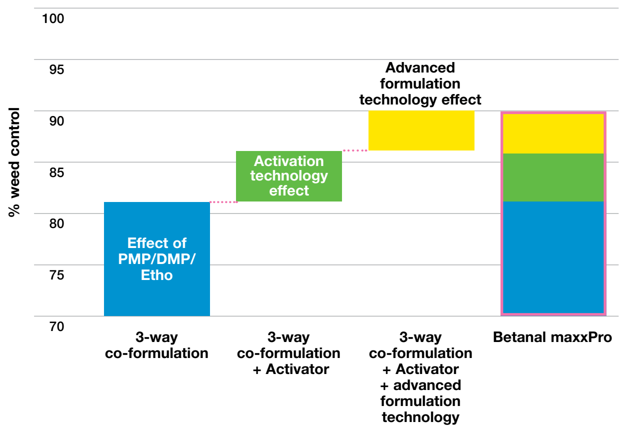
The weed plant's stomata regulation is blocked shortly after the herbicide is applied. This has a two-fold effect – increased transpiration and a higher electron transport rate – which can be seen by the resulting reduction in leaf surface temperature from Betanal maxxPro (Picture 37). The impact of both effects is faster and more powerful weed control.



Picture 37: Impact of activation on surface temperature of weed leaves

Black bindweed two days after herbicide application.

Working together, the advanced formulation and activation technologies drive Betanal maxxPro's weed control performance, delivering broader spectrum control (Graph 12) and a faster kill of more difficult weeds such as annual mercury, knotgrass, common orache and polygonums (Picture 38).

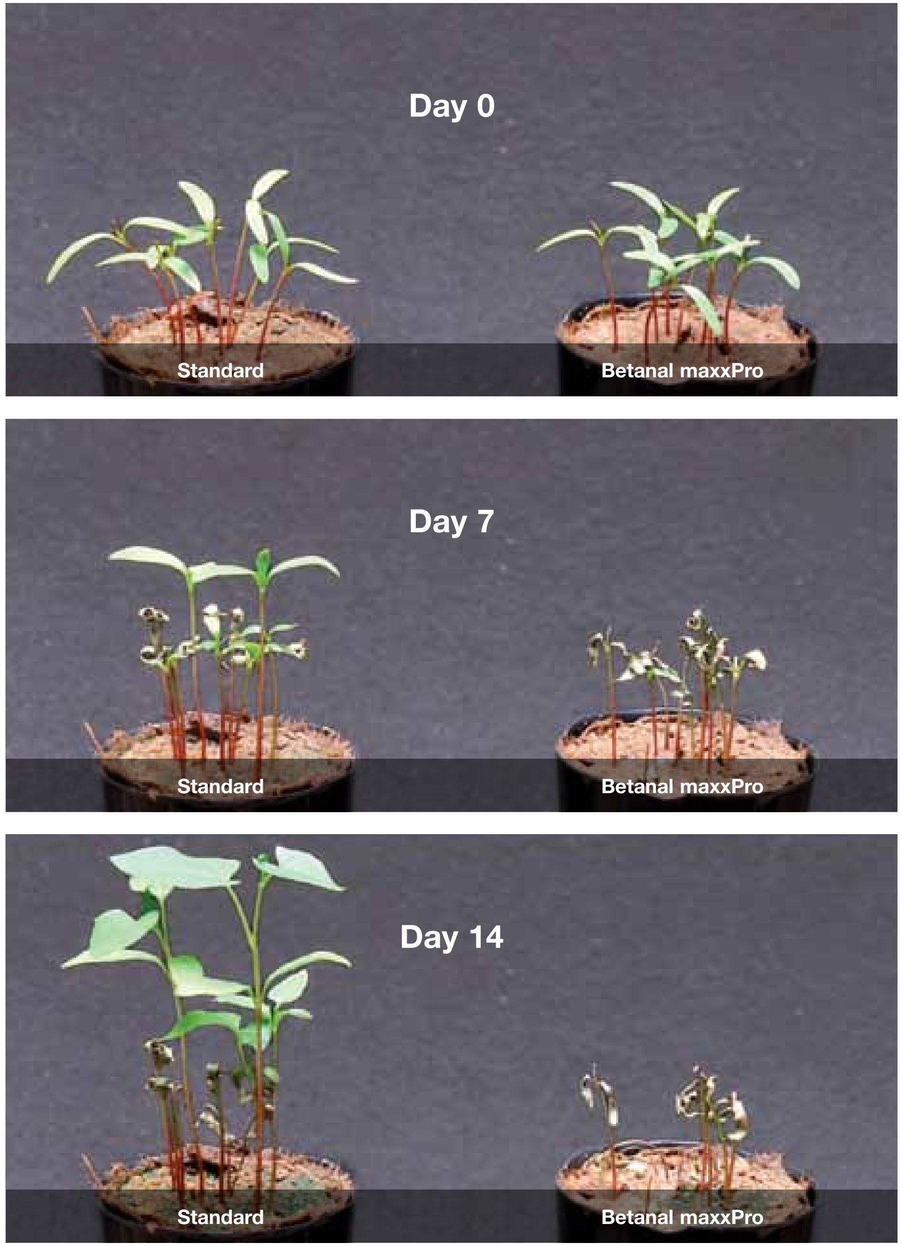


Graph 12: Impact of Double-A technology on weed control performance.

Tank-mixture and co-formulation effects, 6 field trial locations, Germany, France, 2008.

Picture 38: Control of black bindweed

Time-lapsed photography comparing efficacy of Betanal maxxPro and a standard 3-way EC formulation in a greenhouse trial.



4.5 Crop safety

Herbicide treatments can damage beet (Picture 39) if the crop is under stress or the wax protection on the leaves is inadequate.

Pest damage can stress crops and interact with herbicides to cause severe damage. Leaf damage caused by pests such as leaf miners also reduces herbicides' selectivity by allowing more to penetrate the foliage. Poncho Beta seed treatment provides a high level of pest control, so the crop is not stressed by pest attack and thus better able to withstand early herbicide sprays.

Picture 39: Herbicide damage to young beet.

Weather has a major influence on crop stress and herbicide safety:

- ***Hot weather*** (above 21°C) reduces the selectivity of all herbicides so during very hot periods, spraying in the evening may be a better option than in the morning
- ***High light intensity*** also reduces the selectivity of herbicides
- ***Frosts*** not only stress plants but also affect wax layers. There is a risk of severe damage and yield loss when herbicides are applied during or immediately after frost, particularly if it is the first one after a warm period
- ***Fluctuating temperatures*** are likely to cause crop damage if night and day temperatures fluctuate by around 18°C or more
- ***Windy / cool conditions*** can increase wax layers on beet leaves and reduce herbicide damage, but unfortunately have the same effect on weeds, so can reduce activity unless a selective herbicide with good foliar penetration is used such as Betanal maxxPro. On light soils strong winds move abrasive sandy particles and damage leaf surfaces resulting in an increased risk of herbicide damage
- ***Hail*** can also damage crop foliage and reduce herbicide selectivity

Nutrient deficiency and soil acidity can reduce the crop's tolerance of herbicides. Beet showing manganese deficiency symptoms are especially prone to herbicide damage and on manganese deficient soils (e.g. fen peats), manganese treatment should be included in the spray programme as routine.

Cultivations such as rolling and harrowing physically damage the crop and render it more susceptible to herbicide damage.

5. Aphids and virus yellows

5.1 Virus yellows and Beet mosaic virus

There are three main yellowing viruses transmitted by aphids (see section 5.2) that damage the UK beet crop; Beet yellows virus, Beet mild yellowing virus and Beet chlorosis virus; together they are commonly referred to as virus yellows. Beet mosaic virus can also cause damage in sugar beet but is not a true yellowing virus.

Picture 40: Beet crop infected with virus yellows.

Infections usually appear on individual plants or as small yellow patches in the field which expand as the season progresses and the disease spreads. Symptoms for all the viruses are yellowing between the veins followed by a thickening of the leaves which then become brittle. It can be difficult to tell which virus is present but laboratory and field diagnostic tests are available to differentiate them.


Picture 41: BYV.

Beet yellows virus (BYV) is the most damaging of the viruses, causing yield losses of 50% when it infects the crop by early June. Infection reduces the photosynthetic area of leaves reducing yield and sugar content. In recent seasons BYV appears to have become more common, especially in Norfolk and Suffolk.


Picture 42: BMYV.

Beet mild yellowing virus (BMYV) has been the most common yellows virus in recent years. It causes yield losses of around 28% when it appears in early June. BMYV generally causes leaves to turn an orange-yellow colour, which develops from the tip of the leaves, whilst BYV tends to cause lemon-yellow discolouration with initial vein-clearing of the youger leaves. The infected leaf tips then usually die as a result of attack by secondary fungal pathogens and this can sometimes be visually confused with nutrient deficiencies. However, virus infected leaves will be brittle.


Picture 43: BChV.

Beet chlorosis virus (BChV) was first reported in the UK in the early 1990s and produces very similar symptoms to BMYV. Early season infections cause slightly less damage than BMYV but BChV infections in late June are more damaging than BMYV.


Picture 44: BtMV.

Beet mosaic virus (BtMV), like the yellowing viruses, can be transmitted by the peach-potato aphid but can also be spread by machinery, people or animals passing through the crop. As would be expected, BtMV has quite different symptoms to the other three viruses. Yield losses, whilst significant at up to 10% or more, are lower than for the yellowing viruses.

5.2 Aphids – the virus vectors

The most important vector of the yellowing viruses is the peach-potato aphid (*Myzus persicae*) due to the large numbers that can invade UK beet crops. The potato aphid (*Macrosiphum euphorbiae*) is also significant in transmission of the yellowing viruses and the black bean aphid (*Aphis fabae*) can transmit BYV and BtMV. The black bean aphid normally appears in mid to late summer and is generally considered a much lower threat than the two green aphids. It is rare that direct feeding by aphids causes detectable yield losses; it is the viruses they carry that cause the damage.


Picture 45: Peach potato aphids.

Peach-potato aphids usually arrive in the crop in early summer as winged females. A small but significant proportion of them carry virus and infect the crop as they feed. These females give birth to young wingless forms that feed and move to adjacent plants, spreading the virus. Subsequent generations continue the spread of the virus and enlarge the symptomatic yellow patches.

Many peach-potato aphids over-winter in rape crops but few if any of these hold beet viruses overwinter. The main virus sources in spring and early summer are infected beet on cleaner loader clamps (Picture 46), weeds or sugar beet groundkeepers which females feed on before entering the crop. Essential hygiene precautions are to clear beet from cleaner-loader sites and spray off groundkeepers in set-aside before the new beet crop emerges. This also reduces the risk of downy mildew infection.


Picture 46: Infected beet on a cleaner-loader dump.

Picture 47: Potato aphid.

Potato aphids are usually less numerous than the peach-potato aphid, but because they generally fly into beet crops earlier can be the instigator of virus infection that is then spread further around the crop by peach-potato aphids.

Picture 48: Black bean aphids.

Black bean aphids are a serious threat in some central European and Scandinavian countries because of the feeding damage caused by large colonies. In the UK, even though large colonies can often be seen on odd plants in July, these are usually short lived due to rapid build-up of predators and pathogenic fungi. However, black aphid colonies building up before the middle of July can slow crop growth.

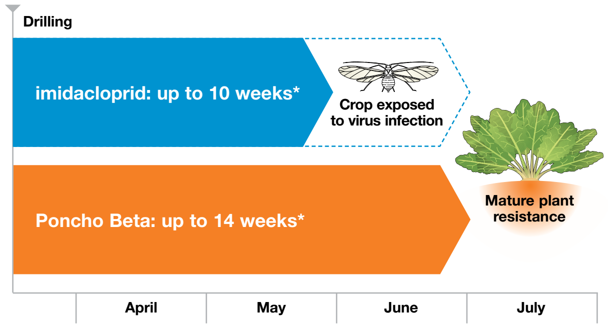
They normally infest the heartleaves of sugar beet causing them to pucker and roll. The aphids are found on the underside of leaves, which because of the leaf rolling can sometimes appear to be on top of the crop. They can carry both BYV and BtMV but are generally less efficient vectors than peach-potato aphids.

i For more information on these and other aphids visit **www.bayercropscience.co.uk** and download the **Expert Guide: Aphids**

5.3 Aphid & virus control

Control of aphids was once reliant on foliar spraying of aphicides such as pirimicarb. These insecticides are no longer viable options because there is widespread resistance to them in peach-potato aphid populations, the most common aphid found in beet. The carbamate granules currently available for control of free-living nematodes do not have sufficient activity to control aphids beyond the first true leaves stage of the crop. So drilling seed with insecticidal treatment is now the most effective way to control aphids and virus yellows in sugar beet.

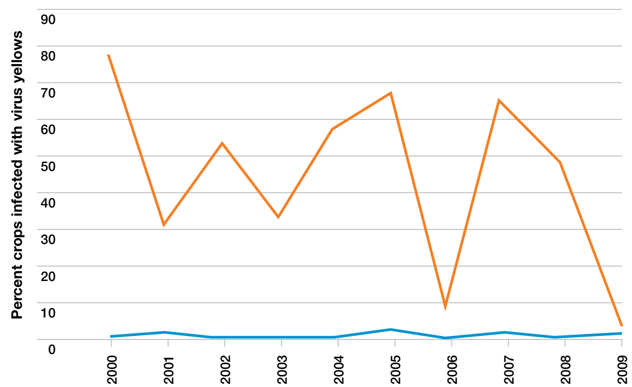
Whilst imidacloprid controls aphids arriving within eight to ten weeks of drilling, the new generation seed treatments provide greater persistence. This is important as the timing of aphid invasions carrying virus varies from year to year and it is essential to ensure that even late invasions are controlled because these can still cause serious economic losses. The best option is Poncho Beta which generally persists up to 14 weeks to keep crops protected through to the point of mature plant resistance (Graph 13).



Graph 13: Persistence of Poncho Beta versus imidacloprid.

***weeks from drilling in mid March.**

The virus yellows outbreaks of the mid 1970s caused severe yield losses and forced many growers to stop growing beet. In recent years the threat might appear to have diminished but, the records for aphid activity, their virus content and the weather in recent years suggests that without any protection from seed treatments or sprays, severe losses from virus infection would have occurred in eight out of the last ten years (Graph 14).



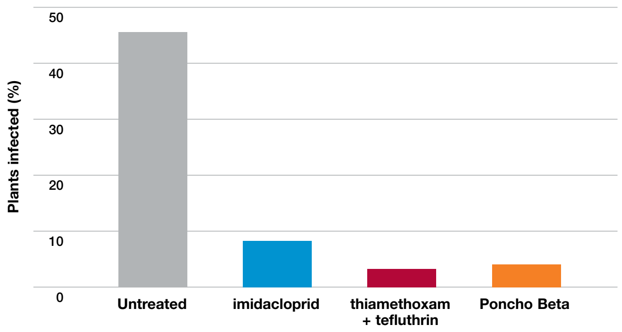
Graph 14: Comparison of UK virus yellows incidence against predictions.

Actual incidence

Predicted incidence if seed treatment not used

Source: Broom's Barn.

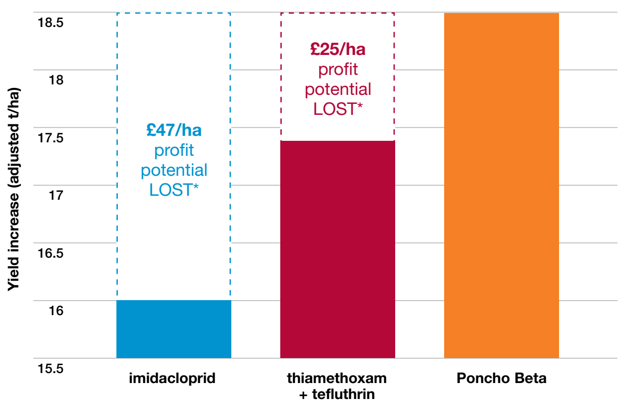
As foliar treatments are no longer an effective back up to imidacloprid seed treatment, the safest and most cost-effective option is to use Poncho Beta seed treatment. This will not only protect against virus yellows infection (Graph 15) but also meets all the requirements for soil and foliar pest control described in section 2.



Graph 15: Control of virus with seed treatments.

Source: Bayer CropScience, 2005.

In three years of independent trials at Broom's Barn, Poncho Beta stood out as the leading insecticidal seed treatment to maximise crop potential – for yield and profit. It consistently delivered 2.5 t/ha more than imidacloprid, and a tonne more than thiamethoxam + tefluthrin (Graph 16).



Graph 16: Yield increases from seed treatments.

Untreated yield 64.4 t/ha.

*Profit potential calculated from average of 6 trials at Broom's Barn 2004-06 as: yield increase (adjusted t/ha) x £23.60/t less difference in treatment cost.

Source: Broom's Barn, average of 6 trials, 2004-06.

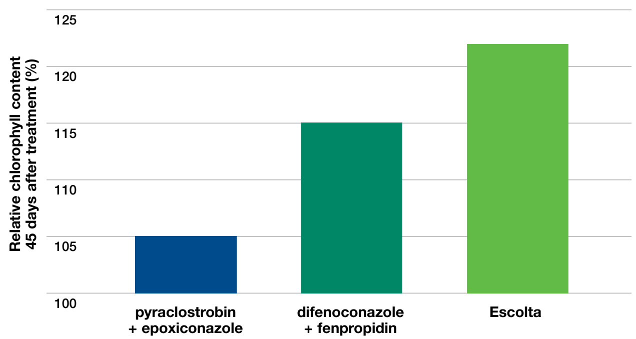
6. Foliar diseases

6.1 Introduction

In the UK we have gone from a situation where powdery mildew was the only really damaging disease to one where rust has become more important and *Cercospora* is starting to build up. Fortunately new fungicides have been introduced which contain a mix of both triazole and strobilurin actives to control all four foliar diseases that now affect UK beet crops, including *Ramularia*.

An important requirement of modern beet fungicides is to give a physiological boost to the crop. This is outwardly visible as a greening of the leaves and improved canopy retention. Yield increases from triazoles of around 5% are the norm even when disease is not present or is only at very low levels. Strobilurins such as trifloxystrobin tend to produce an even better physiological response than straight triazoles when disease levels are very low.

Escolta, which was developed specifically for the beet crop, contains both trifloxystrobin and cyproconazole, and in trials has shown a visibly dramatic leaf-greening effect compared with other fungicides (Graph 17). Increasingly this effect is being exploited by UK growers to continue building yield into early winter and to maintain healthy canopies for protection of roots and crowns against frost.



Graph 17: Escolta leaf greening response.

Source: Bayer CropScience, 2007.

Treatments applied 24th July.

There was a worry that relying solely on the use of triazole fungicides for disease control in sugar beet might encourage build up of resistance to those active ingredients and so the introduction of a second mode of action - strobilurin or QoI - is useful as a strategy to reduce the risk of resistance developing.

Most of the UK crop is now grown from rhizomania tolerant varieties which have a tendency to be more susceptible to rust than previous conventional varieties and range in their susceptibility to powdery mildew (Picture 49). Fortunately with fungicides such as Escolta, growers can chose varieties on important characteristics such as yield potential, establishment and susceptibility to bolting and not worry about disease ratings, as a fungicide will be economically beneficial even if disease does not develop.

Picture 49: Variety trials showing a range of susceptibilities to powdery mildew.

6.2 Foliar diseases

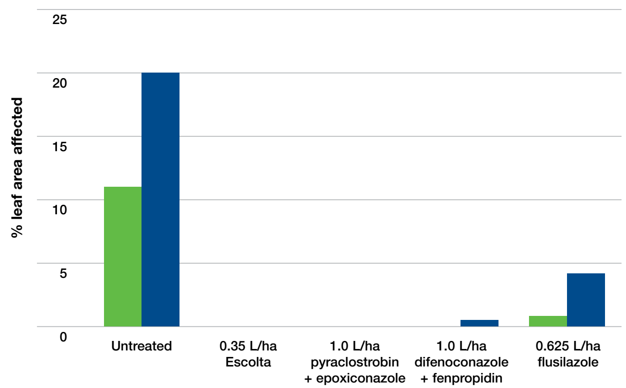
Picture 50: Powdery mildew.

Powdery mildew *(Erisyphe betae)* is currently the major foliar disease of sugar beet in the UK. Infection is characterised by the white powdery covering of leaves by mycelia and spores. Older leaves tend to be infected first and symptoms are more prevalent on the upper rather than lower leaf surfaces. After a while the leaves turn yellow and die.

Yield reductions from powdery mildew can be 20% or more as a result of reduced photosynthesis and early leaf senescence. Growth of the fungus is favoured by high temperatures - around 20°C - with dew at night.

The disease overwinters on host plants such as beet crowns and wild beet species such as sea beet, but the level of survival is very much dependent on the severity of the winter. Depending upon the weather, powdery mildew usually appears in late July or early August but can develop in early to mid July after a mild winter and with favourable summer conditions.

Sulphur used to be the main product for control of powdery mildew but, as it was difficult to mix and apply, and lacked physiological effect, it was rapidly replaced by flusilazole when this became available in products such as Punch C. For many years flusilazole was the product of choice but, as new fungicides have been developed with enhanced powdery mildew control capability, it has become out-classed (Graph 18). Applying Escolta at the onset of disease now provides four to six weeks robust protection even under high infection pressure.



Graph 18: Powdery mildew control.

Treatments applied 30th July and 29th August.

27th August
16th September

LSD = 0.37 (Aug)
LSD = 5.28 (Sept)

Source: Broom's Barn trial, 2008.

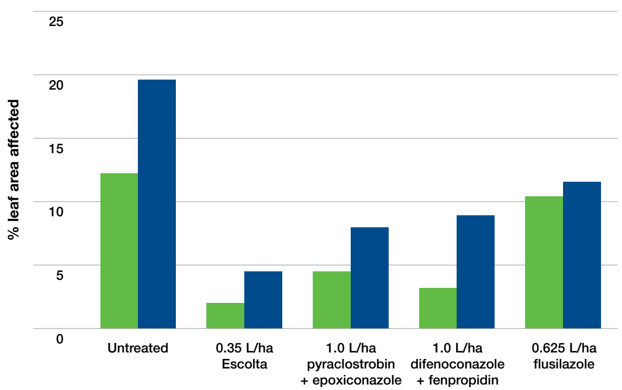
Picture 51: Rust.

Rust *(Uromyces betae)* infection appears on both sides of the leaves as small - *circa* 1 to 2 mm diameter - raised pustules that are red-orange or brown in colour. When infection is severe, spores will brush off onto animals, machinery and the clothing of people passing through the crop.

Disease spread occurs during periods of moist weather when temperatures are between 15 and 20°C and is most intense when dew persists for long periods. Development of the disease is halted by warm, dry weather leaving yellow sunken spots on the leaves. Rust over-winters on dead leaf tissue, crowns or wild relatives of sugar beet.

Yield reductions are much lower than for powdery mildew, usually in the region of 2 to 5%. However, heavy infections in mid to late August have been shown to reduce yields by 10% or more. In the UK rust usually develops in late August and early September but can continue to spread on leaves during early autumn.

Recent experiences suggest that frost is likely to cause greater damage when foliage is infected with rust than with powdery mildew. With the move to later harvesting in the UK, rust control in early autumn is therefore becoming even more important. Since its introduction, cyproconazole has always been an important component of fungicide programmes for the control of rust, so Escolta is also equipped to provide the strong and long-lasting control required (Graph 19).



Graph 19: Rust control.

Treatments applied 30th July and 29th August.

29th September
10th October

LSD = 3.19 (Sept)
LSD = 4.6 (Oct)

Source: Broom's Barn trial, 2008.

Picture 52: *Ramularia*.

Ramularia *(Ramularia beticola)* comes into many UK crops during the autumn, but usually at low levels. It appears first on older leaves as brownish-grey spots with dark edges. Under a microscope or powerful lens, small white spots can be seen emerging through the stomata.

Under humid conditions, similar looking spots occur on *Cercospora* infected leaves but are distinguished from *Ramularia* by their black colour. *Ramularia* prefers cooler conditions than powdery mildew - around 17˚C - and infection only occurs when relative humidity exceeds 95% so it is mainly observed from September onwards. It seldom causes significant yield losses in the UK unless it is so severe that leaves are lost and new ones grow using up accumulated energy from the root. It is thought to overwinter on crop debris.

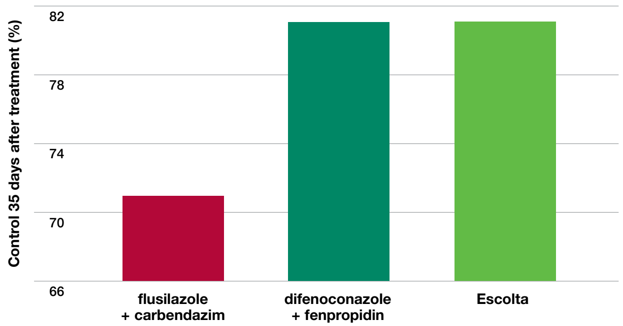
Picture 53: *Cercospora*.

Cercospora *(Cercospora beticola)* is a relatively new disease to the UK, but infections on odd beet plants have been recorded in the past. The disease appears as small round grey spots with reddish margins. Under humid conditions black spots can appear through the stomata, which help to distinguish the disease from *Ramularia*. It usually appears on odd plants and can spread if temperature and humidity are both high. Although *Cercospora* develops above 17°C, under UK conditions it requires daytime temperatures of 25°C or greater and high humidity for rapid spread.

In hot areas of the world where there are frequent storms or irrigation is used, *Cercospora* can cause severe damage resulting in 50% loss of yield or more. In the UK its development in the future will depend much on the summer weather. The rapid spread of *Cercospora* infections across the Netherlands within five years suggests its development in the UK needs to be monitored closely.

Fields where the disease occurs, even on odd plants, should be recorded as these will be at greatest risk in seasons when temperatures and humidity favour rapid spread. *Cercospora* usually over-winters as spores on old leaves and debris but, unlike powdery mildew, survival is not reduced by cold winters.

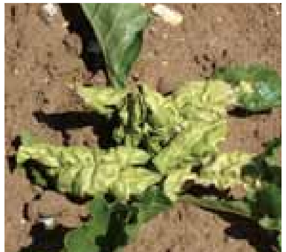
None of the triazoles originally used in sugar beet gave sufficient control of *Cercospora*, so a key requirement in the development of Escolta was to include this disease in its spectrum of control. Since its introduction Escolta has proved effective in continental European countries where *Cercospora* is now routinely the number one disease threat to beet crops (Graph 20).



Graph 20: *Cercospora* control.

Source:
Bayer CropScience, France.

Untreated = 13% infection.



Picture 54: *Downy mildew*.

Downy mildew *(Peronospora farinose)* should not be confused with powdery mildew. Downy mildew affects the heart leaves, usually in early to mid summer, turning them light green and producing a thickened distorted rosette of leaves or multi-crowning if the main growing point is killed.

Whilst downy mildew infection can be serious in some countries, it has not been a major problem in the UK as damage is usually restricted to odd plants in fields. These are prone to infection by secondary pathogens such as *Fusarium* that rot the beet crown and root causing problems at harvest, especially if beet is to be clamped.

The most serious downy mildew infections occur near old cleaner loader sites or set-aside where it has over-wintered on beet. As there are no fungicides registered for control of downy mildew, cleaner loader sites should be cleared of beet after the last load has been delivered to the factory, and any beet in set-aside should be controlled before beet in neighbouring fields emerge.

6.3 Fungicide programmes

Selection of a fungicide programme is generally quite straightforward for beet growers requiring good yields and flexibility of fungicide application timings. The main requirements are;

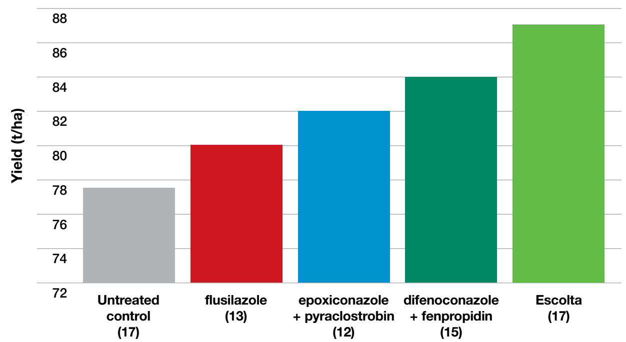
- Physiological boost to yields, even if little or no disease
- Control of all four diseases; powdery mildew, rust, *Cercospora and Ramularia*
- Maintaining a healthy canopy into winter for frost protection
- Flexibility of application timing to fit around cereal harvest
- Short harvest interval to keep beet lifting schedule flexible

The combination of strobilurin and triazole fungicides in Escolta fulfils all these requirements.

Escolta product profile

Formulation	Suspension concentrate
Active ingredients	cyproconazole 160 g/L trifloxystrobin 375 g/L
Dose rate	0.35 L/ha
Maximum number of treatments	2 per crop
Latest time of application	21 days before harvest
Water volume	200 – 400 L/ha
LERAP	None

Trials by Broom's Barn, British Sugar and Bayer CropScience have studied the effects of one and two fungicide sprays. In a series of trials from 2007 to 2009, where beet received one (T1) spray of Escolta it consistently outperformed all other products delivering an average yield benefit of 10 t/ha over untreated and 3.4 t/ha over the next best competitor (Graph 21).

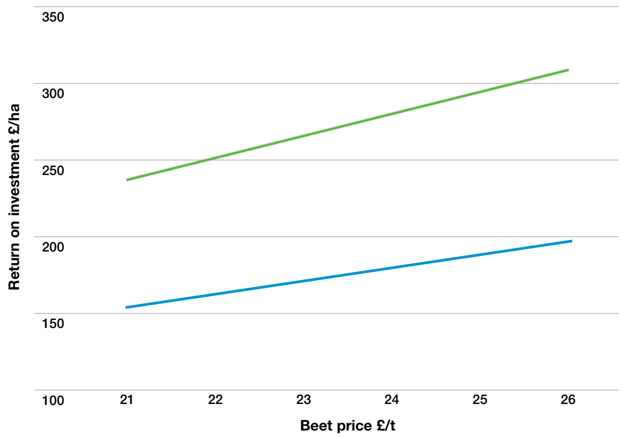


Graph 21: Yield response to one fungicide treatment.

Source: British Sugar, Broom's Barn and Bayer CropScience trials 2007-09.

Number of trials in brackets below treatments.

In the nine trials where one and two sprays were applied to beet lifted between October and January, the first Escolta spray (T1) increased yield by 8.7 t/ha and the second spray (T2) added a further 5.5 t/ha. In financial terms these yield benefits represent a significant contribution to overall beet enterprise profitability (Graph 22).



Graph 22: Return on investment from Escolta.

Source: British Sugar, Broom's Barn and Bayer CropScience. Nine trials lifted from October to January.

Return on investment = additional yield x beet price - treatment cost.

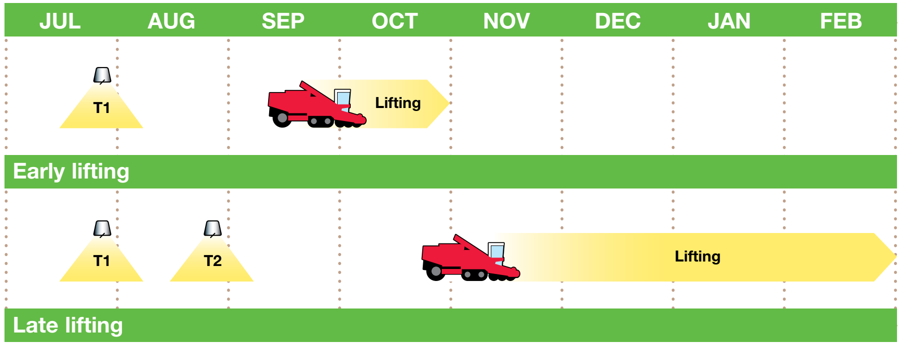
The main considerations in implementing effective fungicide programmes are the timing and development of disease pressure and planned lifting date. The following best use guidelines will help optimise returns from Escolta-based programmes (Picture 55).

The first spray (T1) should be applied at full rate prior to the onset of disease, usually in late July to early August. However, this frequently clashes with the start of cereal harvest so growers often need to apply their T1 in advance. Escolta persists up to six weeks so a well-timed T1 spray will keep the crop fully protected right through cereal harvest and into September.

The need for a second (T2) spray should be assessed in late August to early September based on disease pressure and planned lifting date.

If disease pressure is high, crops to be lifted during October will usually give an economic response to a T2 spray. Escolta's short harvest interval of 21 days provides the flexibility to take advantage of this.

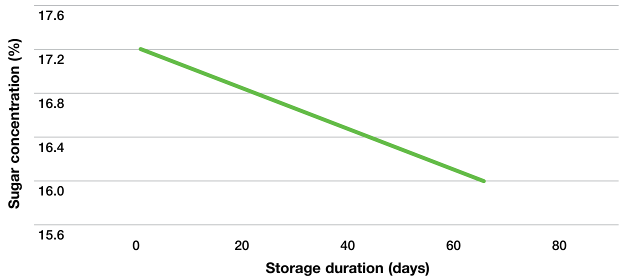
Crops destined for later lifting - beyond the end of October - may need longer protection so a T2 spray is often advisable. This will control any subsequent disease coming in - particularly from late rust - so crops can continue building yield into winter and maintain healthy canopies for protection of roots and crowns against frost.



Picture 55: Escolta programme options.

7. Harvest

It is essential to maintain a healthy crop canopy during the autumn because beet keep on growing right through until harvest. Although growth slows in late autumn, in October the crop is still gaining approximately 3 t/ha of yield per week. Additionally, lifted beet are still ‘alive’ and will respire and lose sugar yield during storage; in mid autumn storage losses are around 0.2% sugar content points every ten days (Graph 23).



Graph 23: Sugar loss in storage.

Source: Broom's Barn.

Good disease control helps maintain leaf cover to protect beet in the field against frost damage. Diseased leaves offer little protection as they are likely to be the first killed by frost. The use of a good quality fungicide such as Escolta ensures the crop has little or no disease present to restrict autumn growth, as well as giving the crop a physiological boost from its greening properties.

Quality of harvesting also affects yields (Picture 56). Modern harvester drivers are well versed in the complex settings of their machines to achieve an efficient harvest. However, there are many factors that can restrict their performance.

Picture 56: Beet harvesting.

Picture 57: Good, even plant stand.

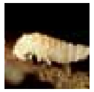
The main one is evenness of plant stand. Gappy stands tend to have a wide range of root sizes and crown heights making it impossible for the harvester to lift and top beet properly. Seed treatments such as Poncho Beta help ensure a regular plant stand (Picture 57) by controlling soil-inhabiting and foliar pests that can attack beet. As Poncho Beta does not interact with herbicides or affect seed germination it will help achieve uniform establishment leading to an even stand at harvest.

Weeds left behind by poor control programmes not only reduce yields through competition but also obstruct efficient harvesting. Even small patches of weeds left where a herbicide programme did not have a sufficiently broad spectrum of control will reduce yields. The beet in those patches will be small and uneven making it impossible for the harvester to lift and top them all properly. Robust broad-spectrum weed control from the Betanal maxxPro / Betanal maxxim based Flexible strategy will minimise the number of odd patches of uncontrolled weeds present at harvest.

The Bayer CropScience range of sugar beet crop protection products is designed to help growers remove hindrances to crop development from drilling to harvest to maximise yields and profitability.

8. Calendar of sugar beet crop protection

March	April	May	June	July	August	September	Harvest


Springtails

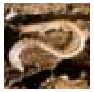

Wireworms


Symphylids


Flea beetles


Aphids


Pygmy beetles

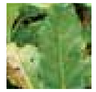

Millepedes

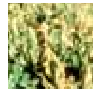

Leaf miners


Virus yellows

PONCHO BETA

Soil and foliar pests, aphids and virus control


Cercospora

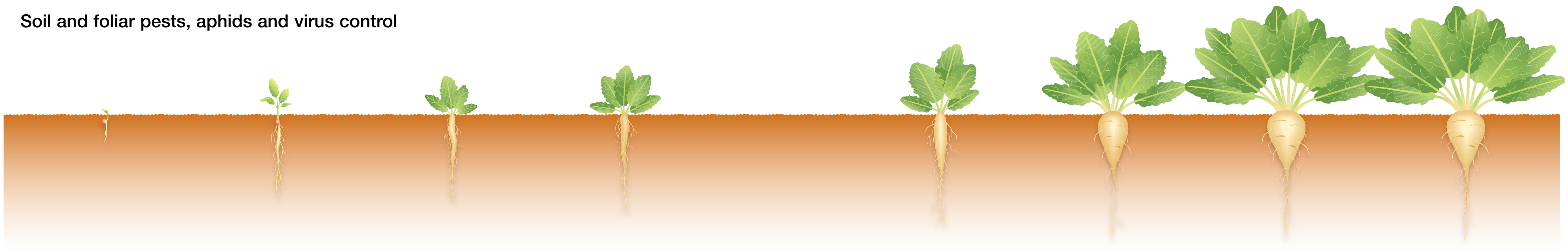

Powdery mildew


Rust


Ramularia

ESCOLTA

Foliar disease control and physiological enhancement



Season-long weed control with crop safety

DRAZA forte

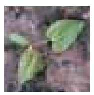
Betanal maxxPro

Betanal maxxim


Slugs


Leatherjackets


Chickweed


Black bindweed


Fat-hen


Knotgrass