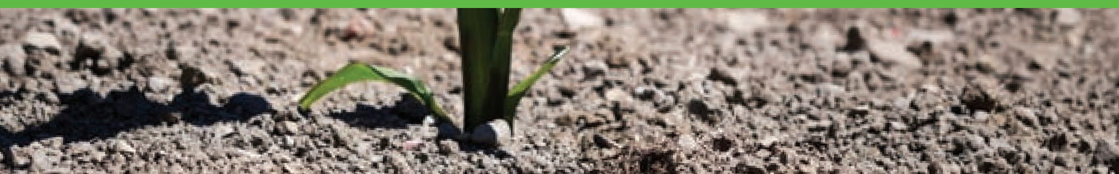
CORSON MAIZE®

CROP SCOUTING GUIDE



1.0 INTRODUCTION

This Corson Maize Crop Scouting Guide is aimed at providing growers and industry personnel with information on crop agronomy, husbandry, scouting and diagnosis of problems commonly encountered in the field.

While every effort has been made to cover most situations; given the diversity of our climate, soils, machinery and indeed farmers who work the land there will inevitably be some omissions. Nevertheless, by applying the principles and methodology described it should be possible to avoid, mitigate and/or diagnose problems commonly found in maize fields, including many of the less frequent problems.

Symptoms are commonly the result of an interaction between two or more factors. For example, Nitrogen (N) deficiency symptoms may be a result of several management, biotic and abiotic factors including N application rate, timing, rainfall, drainage, root health/architecture (depth, pest/mechanical damage) and/or soil compaction etc.

Astute agronomists and growers study the whole plant and the soil while considering pests, diseases and interactions with the climate to understand the cause(s) of the symptoms rather than just observing or trying to treat them. Taking the time to gain a better understanding of the problem will help to determine the best course of action, therefore enabling better management practices in future to avoid recurrence or reduce the frequency/ severity of the same problem.

There will be situations where remedial action will be warranted and there will likely be just as many if not more situations where no immediate action will be necessary, typically because doing so will not provide an economic return. But only by fully understanding the factors causing the problem will you be able to take steps to avoid the same problem reoccurring in the future.

In terms of crop nutrition, soil tests are only indicative of plant nutrient availability, plant tissue is a much better indicator. All agronomists should know the difference between N, P, K, S and Mg deficiency symptoms (see pg 62 for specific details). N deficiency is easy to address early in-season with urea but what, if anything can be done to address P, K, S or Mg deficiency?

In terms of pests and diseases a common approach to minimise damage while maximising the benefit of remedial action is to assess the extent and severity of symptoms and only employ remedial action if threshold values are exceeded.

In New Zealand threshold levels exist for some of the more common pests and diseases of maize. If in doubt, contact your regional sales agronomist.

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2.0 HOW TO GUIDE

2.1 Effective scouting

Just like a cub scout is always prepared, the same should apply for a crop scout. Having some idea of what you expect to find in the field and preparing for it is a good start, but being prepared for any scenario that might crop up is even better.

The growth stage of the crop will determine what you will likely find and need for a proper diagnosis. If you find you do not have the necessary tools or materials to accurately diagnose the problem, it will pay to record and return to the precise location(s) in the field at a later date either with the missing tools/ materials or with some expert help. It is better to do this than to perhaps incorrectly assume what caused the problem. Only by learning the exact causes or eliminating potential causes will you make progress towards a better understanding of your system in order to make improvements.

Be careful when making comparisons between fields or areas within fields. Many factors can affect the appearance of the crop including your position relative to the position of the sun, topography/ slope, row orientation, as well as cultural/ management factors, seed treatments, hybrids and even different seed lots of the same hybrid, particularly in the early stages of development.

Be aware that hybrid differences observed early on may not necessarily translate into differences later in their lifecycles. For example, other things being equal, differences between hybrids in early vigour or growth rarely correlate with final yield but may affect weed pressure during the season.

Record dates, times and locations of each scouting trip and record everything that is noteworthy.

Here is a list of handy tools and materials that will help you to identify and solve problems in the field.

2.2 Tool kit

- [x] This guide
- [ ] Tape measure
- [ ] Pocket knife
- [ ] Small trowel
- [ ] Magnifying glass
- [ ] Notebook and pen
- [ ] GPS
- [ ] Camera
- [ ] Calculator
- [ ] Field markers (flags)
- [ ] Small plastic bags
- [ ] Paper towels
- [ ] Water bottle
- [ ] Spade
- [ ] Buckets

2.3 Collecting samples

Occasionally you may find that you cannot make an accurate diagnosis in the field and you will need to collect samples for laboratory analysis, whether for nutritional deficiencies, pests or diseases.

In all instances handling of the sample in the field and during transit is critical for a successful diagnosis. Plants tend to sweat in plastic bags so it is usually helpful to wrap plant material in a paper towel before placing in the plastic bag. In mid-summer it may be beneficial to lightly dampen the paper towel to help reduce water loss from the plants. If it is very hot, consider putting the samples in a cool-pack while in transit.

Here are the names of a few of the leading plant and soil diagnostic laboratories currently operating in New Zealand:

- Hill Laboratories (plant and soil testing)
- Analytical Research Laboratories (plant and soil testing)
- Eurofins (plant testing)
- Plant Diagnostics Ltd (plant and disease testing)

3.0 CROP SCOUTING BY GROWTH STAGE

The following diagnostic guide is separated into four subsections covering the four main stages of maize crop development from emergence to grain harvest.

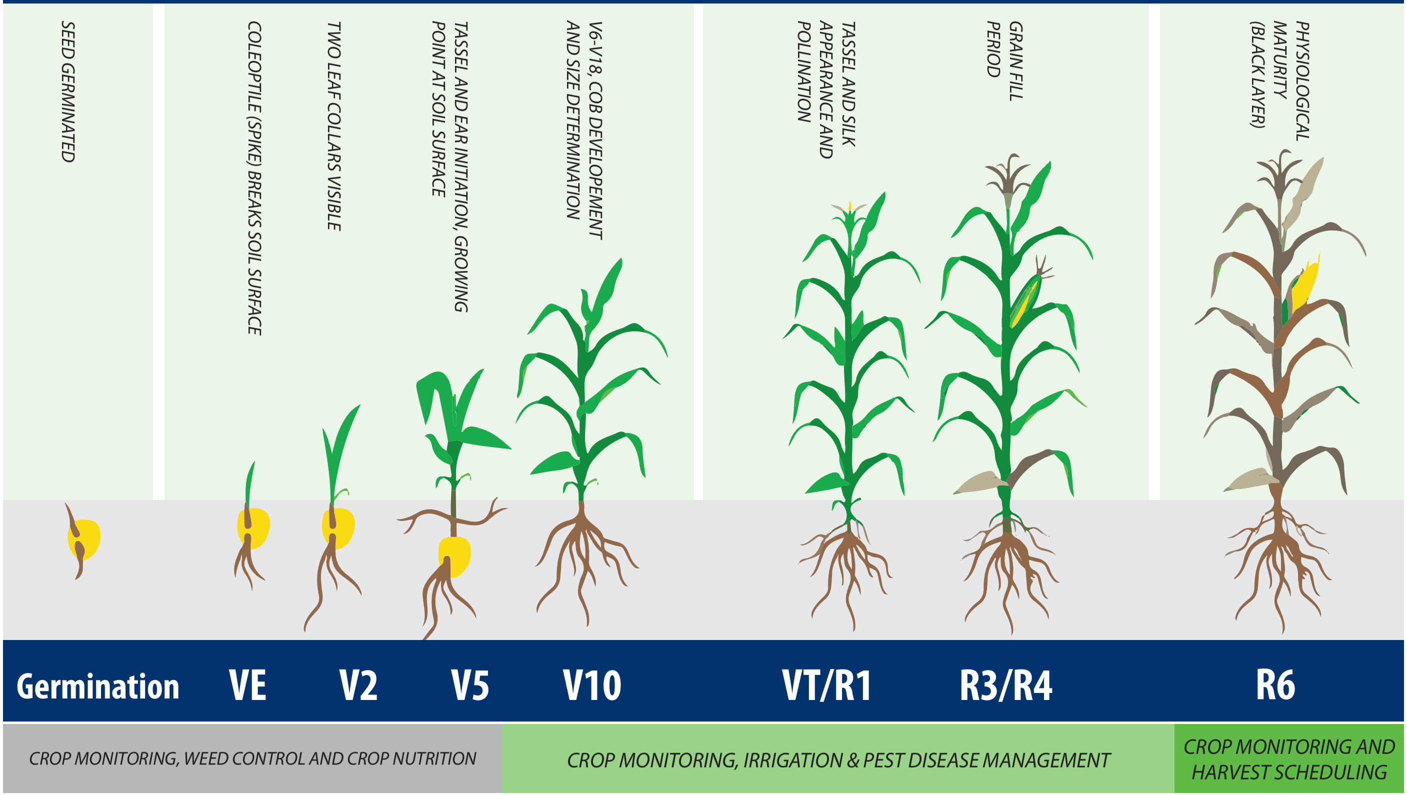
- Stage 1: VE to V6 (establishment phase)
- Stage 2: V6 to VT (vegetative growth phase)
- Stage 3: VT to R6 (reproductive phase)
- Stage 4: R6 to grain harvest (drydown)

MAIZE GROWTH STAGE	DEFINITION
V	Vegetative
Vn	n= number of true leaves
VT	Tassel
R	Reproductive - cob development
R1	Silking/pollination
R2	Blister stage of kernels
R3	Milk stage of kernels
R4	Dough
R5	Dent
R6	Maturity achieved

It is often said that the best thing a grower can see in their field is their shadow. For only by being present in the paddock is it possible to observe the crop in the detail that is necessary to fully understand what is happening and whether action is required. As a general rule, it takes about ten minutes to effectively scout 1 hectare of crop by walking. Once a problem is identified it will take time to properly assess it before continuing. During the early stage of development, it is easy to zigzag across and up/down a field without getting lost, and it is much easier to identify problem areas to focus attention, such as around fence lines, gate ways, humps and hollows etc. During the later stages of development this becomes much more difficult and more often than not most scouting is done by jumping the fence or opening a gate at a convenient spot and walking a few meters into the crop. We are all guilty of it and it is far from ideal.

With the affordability of unmanned aerial devices (drones) with HD cameras increasing, a growing service-industry is developing offering aerial scouting services to identify areas within fields for inspecting on foot.

Maize growth stages



3.1 STAGE 1 - VE TO V6 (ESTABLISHMENT PHASE)

Problems at this stage can be caused by any number of interacting factors.

First, determine the extent and severity of any problems as this will help eliminate some of the possible causes. Is the problem confined, patchy, localised or widespread?

Is there a problem with emergence? If so, have a dig where there are gaps to find out what proportion of missing seedlings are due to skips and what proportion of seeds are dead or just slow to germinate.

Check for small/weak plants. Are there any problems with abnormal development of slow-germinating seedlings? Try to find out what has caused them to lag behind. Other than size is there anything abnormal about them? Were they late emergers? If so why? Check seed-soil contact and their roots. Have they been affected by some pest, disease or other factor(s) or were they simply weaker plants/seeds?

If you are concerned about the level of establishment, undertake plant counts to assess stand establishment, including abnormal and chewed seedlings, skips, doubles and dead seeds. Do this in at least 10 representative locations across each field. If emergence is variable across the field split it into zones. Look closely for signs of root burning (fertiliser placement) in emerged plants, and insect or disease damage in abnormal, emerging or dead seeds/seedlings. Try to understand what is going on. Remember that seed is a living organism and there may be differences not only between hybrids but also different seed lots of the same hybrid. Despite strict quality control measures implemented by all leading seed companies there are natural differences in germination % and vigour between seed lots and just like seed companies, growers must accept that there will be differences between seed lots and hybrids. Furthermore, some treatments are tougher on the seed than others. It is recommended that seed be sown in the same season of purchase to mitigate any issues that may arise from carryover seed.

One of the biggest and often overlooked causes of poor emergence is waterlogging. The process of imbibition (seed rehydration) causes trauma to the embryo and the rate at which this happens can have a marked effect on the embryo's ability to overcome the cellular damage that occurs. If conditions are near optimal during the imbibing and germination period, then emergence will be close to the germ % (germ test result) on all but the lowest vigour seed lots. High-vigour seed lots are less likely to have problems in cold and/or wet conditions than lower-vigour seed lots. At present, there is no standard seed vigour test for maize which makes it impossible to compare vigour test results from different seed companies.

The following section details what to look out for during the crop establishment phase.

3.1.1 Germination & emergence problems

3.1.1.1 SKIPS (NO SEED OR SEEDLING)

Planter error	Dig for seed where there are skips to determine if seed is present or not. If there is no seed, check planter settings and maintenance prior to next planting.
Rodents or birds	Check for damaged and/or partly eaten kernels. If the problem is severe and widespread, consider replanting worst affected areas. In future consider preventative measures including seed treatments, baiting and/or population control.

3.1.1.2 SEED LOOKS NORMAL BUT HAS NOT IMBIBED (SWOLLEN)

Cold, dry	In the future either "plant to moisture" if the soil is dry, ensure adequate moisture is present before planting or irrigate after planting.
Poor seed-soil contact, cloddy soil	In the future check seed-soil contact when planting, adjust down force, press wheels and/or residue managers if necessary. Revise tillage practices or soil conditions at cultivation if the soil is cloddy.
Dead seed	If suspected dead seed is greater than 10% request an inspection from your seed supplier.

3.1.1.3 SEED HAS IMBIBED (SWOLLEN) BUT NOT GERMINATED

Unfavourable soil conditions	Cold, wet soil.
Fertiliser or pesticide injury	Residual herbicide damage or excessive fertiliser too close to seed.
Dead seed	If suspected dead seed is greater than 10% request an inspection from your seed supplier.

3.1.1.4 SEED GERMINATED BUT DIED BEFORE EMERGING

Seed rot	Check seed treatment used, this should include fungicide; but several species of bacteria may also be involved. Seed rot tends to be prevalent in cold or very warm, wet soils, and/or where high rates of raw manure have been applied.
Fertiliser injury	Seed may have germinated but roots appear stunted or burnt. In-furrow (pop-up) fertilisers with high salt indexes are the most risky; it is safer to apply these fertilisers 5 cm below and 5 cm to the side of the seed.
Pests	Slugs and black beetles can chew the growing point (shoot meristem) beneath the soil. Closely inspect the damaged seedlings for signs of chewing.

3.1.1.5 SEEDLING TWISTED/TANGLED UNDERGROUND

Unfavourable soil conditions	Crusted, cold or cloddy soil. A cloddy soil can allow light to penetrate the soil disrupting normal "spike" emergence.
Seed planted too deep	Aim for 4-5 cm planting depth with good seed-soil contact; only plant shallower if the soil is already damp and rain is forecast in the first few days after planting. Do not plant shallower than 3 cm as there is an increased risk of nodal root development problems during the establishment phase.
Chemical injury (tatters)	Can be caused by pre-emergent herbicides including acetachlor and metolachlor especially in very light, or cold/wet soils where seedling emergence is delayed; pre-plant incorporation of these herbicides may increase risk in some situations (e.g. light and/or cold/wet soils).

3.1.1.6 SLOW, UNEVEN EMERGENCE

Unfavourable soil conditions	Cold, dry, wet, cloddy or crusted soil.
Seed planted too deep or too shallow	In the future pay attention to seed depth placement in different areas of the field while planting, especially where soil conditions change.
Variable planting depth	Usually caused by excessive planter speed and/or uneven soil surface. In the future check seed depth uniformity during planting and adjust planter/speed as required.
Poor seed-soil contact	In the future check seed-soil contact while planting when soil conditions are changeable and adjust planter set-up if necessary.
Low seed vigour	Talk to your seed supplier if you are concerned and other causes are unlikely.

3.1.2 Seedling problems from VE to V6

By now the crop has emerged and the transition from seed reserves to photosynthesis progresses as rapidly as development of the nodal root system allows. A delay in the development of the nodal root system will cause a corresponding delay in the transition from seed reserves to soil nutrient uptake. During the early part of this transition the seedling is particularly vulnerable to attack from soil borne pests and diseases. Various pests and diseases can affect the mesocotyl (the thin "stalk" between the seed and the growing point) which can have a marked effect on the rate of nodal root and seedling growth and development. Seed fungicide treatments or in-furrow applications help to protect the seed and young seedling from fungal attack but in some conditions and for some pathogens, this protection may be inadequate. Furthermore, bacteria are not deterred by fungicides and chewing insects or birds do damage before they are controlled or deterred by some seed treatments. This highlights the importance of ensuring your crop protection plan is well thought out prior to ordering the seed.

3.1.2.1 SEEDLINGS UPROOTED

Birds/rodents	Common culprits are pheasants, pigeons, pukekos and rats. If the problem is severe and widespread, consider replanting. In the future consider preventative measures including seed treatments, baiting and/or population control.

3.1.2.2 SLOW, UNEVEN PLANT GROWTH

Unfavourable growing conditions	Cold, dry, wet or compacted soil.
Starter fertiliser placement problems	Check for patterns in row vigour/growth across the field. Are they systematic and related to planter passes? Is the fertiliser blocked, placed too close or distant from the seed furrow? Starter fertiliser should be placed 5 cm below and 5 cm to the side of the seed furrow. In the future check fertiliser placement during planting, focusing on headland/turning exits to help identify issues.
Herbicide injury	Check for patterns across the field, focus on sprayer overlaps around headlands and uneven contour. Check the chemicals used, label application rates and timing.
Nutrient deficiency	Usually associated with other symptoms including discoloured leaves (see page 16). If a deficiency is suspected, collect plant tissue samples to determine the nutrient balance.
Insects, slugs	Check for insect and/or slug damage. Apply remedial action if necessary.
Variable planting depth	Check uniformity of seed depth and root development. Planting too shallow can affect nodal root development especially in dry, loose, cloddy soil and/or windy conditions. In the future ensure a correct and even planting depth is achieved and adjust speed and downforce if necessary.
Low seed vigour	Talk to your seed supplier if you are concerned and other causes are unlikely.

3.1.2.3 DISCOLOURED LEAVES

Nutrient deficiency	The most common nutrient deficiencies are N, P, K, S, Mg and Zn at this stage (see page 62 for specfic symtoms). Usually, N, P, K, S and Mg availability can be adequately forecast in soil tests. Collect plant tissue samples from affected and normal areas to analyse for a deficiency. Apply remedial action if the deficiency is widespread and necessary.
Frost and cold temperature stress	This includes frost and near frost events. Frosted plants will appear burnt, pale and weak. Check the growing point (below the ground) for damage. Usually worse in low-lying areas. Plants usually recover providing the frost is not too severe or late. Widespread, severe frost at V4 or greater may require replanting. Quantify the affected area and severity and seek advice before making the decision to replant.
Large temperature variations	Cool nights and warm days promote shoot growth over root growth which can limit nutrient uptake, making shoots appear pale and/or unthrifty.

High rainfall and wet soils	Perfect conditions for nutrient losses (leaching and denitrification). Collect tissue samples to determine any deficient nutrient(s) and try to correct any deficiencies if it is economically viable and possible.
Compaction	Affects root growth and nutrient uptake. In the future reduce and alleviate compaction with deep ripping and limit wheel traffic before and after planting. There are a multitude of crop management systems that can minimise the risk or severity of compaction.
Disease	Diseases such as anthracnose can cause yellowing and blotchy patches (lesions) on the leaves of young plants. Most prevalent in wet conditions, particularly ponded areas. Plants will usually recover but may be prone to stalk rot during the grain drydown period. Monitor affected areas during this period.
Insects and slugs	Chewing may be accompanied with chlorosis (yellowing) or other pigmentation (e.g. purpling) and general unthriftiness. Apply control measures if damage is widespread. In the future consider the merits of preventative control measures.
Herbicide injury	Leaves may appear pale, bleached and/or scorched. Symptoms are usually worse in overlap areas so focus on headland and contoured areas. Always check chemicals, the compatibility of mixtures used and application rates/calibration before spraying. Some herbicides can interact with some insecticides including seed treatments so again, check compatibility before spraying.
Fertiliser injury	Leaves can appear pale, bleached and/or scorched. Check roots for signs of damage as well as starter fertiliser placement and application rate.
Mechanical injury	Includes tyre damage and machinery. Check roots and shoots for damage. If the damage is significant or widespread ask the question "how do we avoid the same problem in future?".
Hybrid differences	Some hybrids are naturally darker or lighter in colour than others. Providing the crop looks uniform with healthy roots and shoots, subtle differences in colour should not be of concern. Take notes on differences in colour between hybrids for future reference.
Drought	In dry conditions plants may take on a pale and/or greyish tinge, which is usually accompanied with leaf rolling; particularly during the heat of the day (see page 18).

3.1.2.4 LEAVES ROLLED (PINEAPPLED)

Drought	Leaf rolling can occur in very hot conditions, even in seemingly moist soil. More often leaf rolling will occur when the soil is approaching the critical soil moisture deficit where water uptake cannot service transpiration requirements. If possible, apply irrigation before this point to avoid reducing nodal root development which may affect yield.
Insects	Insects feeding on roots reduces water uptake causing leaves to wilt. Check roots for damage.
Mechanical root damage	By side dressing or weeding implements. Check roots for damage.

3.1.2.5 LEAVES COILED, TWISTED, LADDERED OR WHIP-LIKE

Herbicide injury	Certain pre and post-emergence herbicides can cause leaves to curl or twist. Sometimes this is a temporary phenomenon, whereas at other times the problem can last for weeks, reducing the yield potential of affected plants.
Temperature variation	Alternating hot and cold weather induces alternating periods of fast and slow growth, this can cause developing/emerging leaves to become entangled.
Mechanical damage	This is often caused by crushing of the leaf whorl from tractor tyres etc.
Hail or frost damage	Damage to the leaf whorl can cause leaves to become entangled.
Nutrient imbalance	Calcium deficiency can cause leaves to entangle and become laddered. It is rare but collect tissue samples if there is no other logical explanation.

3.1.2.6 LEAVES CHEWED, SHREDDED OR MISSING

Slug/insect damage	Slugs, Argentine stem weevil (ASW), or cutworm.
Animal grazing	Common culprits are hares, stock and birds.
Wind or hail damage	Wind causes abrasion of leaves on the soil surface. Hail damage is usually accompanied with ponding and/or soil splashing onto leaves and into whorls.

3.1.2.7 LEAVES PALE, SCORCHED, SPOTTED, STRIPED OR DEAD

Wind damage	Most common on exposed lighter textured (sandy) soils in high wind-run areas.
Nutrient deficiency	Most commonly N, P, K, S, Mg and Zn. Collect plant tissue and soil samples from affected and normal areas for analysis. If the deficiency or imbalance is widespread seek advice on remedial action.
Disease	Anthracnose (prevalent in ponded areas) or bacterial wilt (prevalent in cool, wet soils).
Herbicide injury	Spray drift from neighbouring crops or overlaps (check headlands and contoured areas).
Hybrid differences	Some hybrids are more susceptible to the possible causes of leaf scorching, spotting or striping; and because one hybrid doesn't show any symptoms this doesn't mean that another hybrid will be unaffected by a potential causal agent.

3.1.2.8 PLANTS WILT, FALL OR DIE SUDDENLY

Insect damage	Argentine stem weevil (ASW) larvae, cutworm or black beetle. Check for signs of insect chewing above and below ground.
Disease	*Phythium* seedling blight (damping off) or bacterial wilt.

3.1.2.9 PLANTS BROKEN, LEANING OVER OR SNAPPED OFF

Uneven planting depth	Shallow planted seed may not develop a strong nodal root system and may be prone to falling/leaning. If the problem is widespread consider mounding the soil around the base of the plants to provide an opportunity for nodal roots to develop (effective before V4).
Insect damage	Common culprits are cutworm (plants chopped off) and Argentine stem weevil (ASW) larvae (plants wilt from the growing point with an accompanying hole in the stem at or just below ground level). Cutworm can be controlled by spraying a synthetic pyrethroid while ASW can be controlled by seed applied insecticide Poncho®.
Herbicide injury	Especially caused by 2,4-D or similar (auxin-type) products followed by a strong wind event. These products can make plants brittle and susceptible to lodging and green snap.
Wind damage	Severe winds can cause plants to fall or snap. If nodal roots have properly developed it is unlikely that plants will fall at this stage unless the soil is very loose and/or wet. More common is green snap where plants snap off above ground level once the stems start to elongate.

3.1.2.10 PLANTS ABNORMAL WITH MULTIPLE TILLERS AND/OR STUNTED MAIN SHOOT

Insect damage	Most common culprit is Argentine stem weevil (ASW) larvae but other insects cannot be discounted.

3.1.2.11 DAMAGED, CHEWED OR ABNORMAL ROOTS

Herbicide injury	Particularly phenoxy-type products such as dicamba can affect nodal and brace root development. Typically, this is only a problem if applied too late (after V6) or at higher rates. Some hybrids are more susceptible to these herbicides so check tolerance to phenoxy herbicides before application. If concerned ask your seed supplier.
Insects	Particularly black beetle.
Mechanical injury	Commonly caused during side dressing or other post-planting tillage operations.
Compaction	Planting or field operations when too wet can cause sidewall compaction. Check for horizontally restricted root systems.
Fungal Damage	Crazy top - occasionally occurs in the Waikato and Northland but is generally rare and control measures are unnecessary.

3.2 STAGE 2 - V6 TO VT (VEGETATIVE GROWTH PHASE)

This is the period of cob size determination and rapid vegetative growth. To maximise the yield potential of crops growers should aim to have them strong and vigorous as they enter this growth phase.

This is because the number of kernels around each cob is determined around V6. This can be achieved by ensuring adequate nitrogen (N) and moisture is available before the crop reaches V6.

During the early stages of this growth phase (V7 to V10) the number of kernels along each cob is being determined. So strong vigorous growth throughout this period will also maximise yield potential.

One key to maximising yield potential is to ensure N is not limited at any point during this rapid growth and ear size determination period. In other words, ensure that the bulk of your N is effectively applied prior to V6.

Applying side dressed N into dry soil is not as effective as if it is applied into moist soil. Likewise, knifing-in will reduce losses

particularly in dry conditions. Getting side dressing N on before V6 also reduces crop damage caused by tractor tyres or leaf scorching.

Cobs are initiated on several leaf axis' on the main stalks of each plant. The number of cobs that develop is also determined during this period. If conditions are good and the plants feedback mechanisms indicate it can support two (or more) cobs, then it will direct any surplus resources to the second or third cobs in that order. The primary (top) cob will always have priority over other cobs, unless the top cob fails to develop, is unfertilised, is damaged or is unable to receive resources due to insect attack (e.g. corn stalk borer, which fortunately, we don't have here in NZ at present).

Liebig's Law of the Minimum states that growth is determined by the availability of the resource that is most limiting at that time. Any deficiencies that occur during this growth stage will limit the yield potential of the crop.

Over the whole crop growth cycle, final yield is reduced by the sum of the daily effects of the most limiting factor on crop growth and development. This sum of effects creates the difference between the actual and potential yield, often referred to as the yield gap.

During the establishment phase the most common limiting factors are temperature, root oxygenation and available soil water. From V4 onwards it is more likely to be water, sunlight, and/or nutrient availability. If it's water, there is no benefit to putting on extra fertiliser unless you can irrigate or it is likely that significant rainfall will occur.

Astute growers work hard to understand what is limiting their system. The key objective is to balance the resources and inputs so that none are applied more than needed, so that the limiting resource is one that is set by the environment, usually water (e.g. rainfall), sunlight, or the ability of the crop to take up water and nutrients (think root architecture and soil structure).

When scouting crops at this stage keep a keen eye out for any signs of stress, leaf disease and problem weeds. Consider the scale of any symptoms; is the issue widespread (macro scale), more localised or patchy (meso-scale) or confined to individual plants (micro-scale).

Collect tissue samples from any plants showing deficiency symptoms for nutrient analysis. Collect and submit samples from healthy plants nearby at the same time. Soil samples from the same locations will help with interpretation. Record the exact location of any potentially serious threats (e.g. noxious weeds). Study the crop; try and understand what it needs to overcome the present limiting factor. Overcoming that factor may have to be done indirectly. For example, implementing strategies to enhance soil structure and health to increase root growth, development and health to enhance water and nutrient uptake.

Be mindful to assess the likelihood of an economic return to fix a problem before implementing a plan. Also consider the longer term consequences if nothing is done. In the case of potentially serious threats (e.g. noxious weeds) consider future revenue losses against the costs of control and/or eradication. Note any differences between fields and/or hybrids for future reference.

3.2.1 Leaf problems from V6 to VT

3.2.1.1 LEAVES DISCOLOURED OR DEAD

Heat/drought	Leaves exhibit a greyish sheen, curl/roll up and die under drought conditions and will scorch when excessively hot.
Nutrient deficiency	See page 62 for details of specific symptoms.

3.2.1.2 WHORL LEAVES DEAD

Disease	Bacterial stalk rot can occur in hot, wet conditions.
Herbicide injury	Caused by late application of some herbicides directed over the whorl of the plant.
Excessive heat	Uncommon in NZ.

3.2.1.3 LEAVES SPOTTED OR STRIPED

Disease	Refer to section 5.1 (page 65) for symptoms and details.
Nutrient deficiency	Macro/meso-scale symptomology. Particularly N, K, Mg, S, Mn, Fe and B.
Hybrid genetics	Macro/meso and micro-scale symptomology. Some hybrids are more prone to striping and/or physiological spotting than others.
Sunscald	Banded scorching on the upper leaves, tips and margins.
Low soil pH	Beaded streaking of leaves which turn reddish-purple and may die.

3.2.1.4 LEAVES SHREDDED OR CHEWED

Wind damage	Macro-scale loss of leaf area, often with mid-rib broken. Some hybrids are more susceptible to wind damage than others.
Insects	Including armyworm and other insect larvae (i.e. caterpillars).
Animals	Check for signs of tracks and droppings.
Hail damage	Even light hail is usually accompanied with strong winds which can combine to cause significant damage to leaves.

3.2.1.5 LEAVES ROLLED (PINEAPPLED)

Drought/heat stress	Usually on a macro/meso-scale. Plant leaves will appear rolled and upward pointing (like a pineapple) often with a greyish colour/tinge. Symptoms may appear first on lighter (sandy) ridges/seams and/or fields with a north-westerly aspect.
Poor soil conditions/root development	Often seen in areas where poor soil conditions restrict root growth/health and/or available water capacity (e.g. sub soil acidity, high salt index or compaction).
Root injury	Occasionally results from side dressing implements too close to plant rows.

3.2.2 Plant and stalk problems from V6 to VT

3.2.2.1 PLANTS WITH VARIABLE HEIGHT

Variable growing conditions	Variability in plant height at the macro/meso-scale caused by widely different growing conditions (e.g. ponding, soil texture, water/nutrient availability, salt index, compaction, or shading/ competition from trees).
Uneven emergence	Uneven planting depth, seed/soil contact and/or soil moisture.
Previous injury/ stress	Caused by any "checking" during the previous growth stage (VE to V6) including pest, disease, chemical and/or mechanical injury.

3.2.2.2 PLANTS WITH MULTIPLE TILLERS

Growing point injury	Injury caused during previous growth stage (VE-V6) by pests or mechanical injury (e.g. Argentine stem weevil (ASW) or crushing).
Favourable growing conditions	Expressed at the macro/meso-scales.
Low plant population density	Widespread tillering suggests the plant population could have been increased whereas more localised tillering is more indicative of variation in local conditions (e.g. high fertility/water availability or pest pressure).
Hybrid differences	Some hybrids are more prone to tillering than others.

3.2.2.3 PLANTS STUNTED WITH NO OR VERY SHORT INTERNODES; LEAVES MOTTLED, STREAKED OR DISCOLOURED

Virus or virus-like disease	Maize dwarf mosaic virus or maize leaf fleck virus.

3.2.2.4 PLANTS GOOSE-NECKED

Recovery from earlier root damage/lodging	Likely causes include, pests (birds and insects), compaction, poor fertiliser placement, mechanical injury, herbicide injury (e.g. phenoxy types) and wet/windy conditions.

3.2.2.5 PLANTS TWISTED OR GROWING HORIZONTALLY

Mechanical injury	More prevalent at the meso/micro-scale. Usually other symptoms such as crushing/foliar damage are also apparent.
Herbicide injury	Particularly around headlands or overlap areas. Commonly seen following late applications of Dicamba or other Auxin-type herbicides.

3.2.2.6 PLANTS LEANING OR BROKEN OFF

Mechanical injury	Typically at the meso/micro-scale. May be systematic, check for patterns across paddock.
Herbicide injury	Particularly around headlands or overlap areas. May be systematic. Commonly seen following late applications of Dicamba or other Auxin-type herbicides.
Wind	Severe wind can cause root lodging when conditions are wet and/or soil lose; green snap can occur in otherwise dry conditions or firm seedbeds.
Soil conditions	Macro/meso-scale variations in soil conditions that affect root growth and health.
Poor nodal root development	Macro/meso-scale variations in soil conditions that affect root growth and health. Shallow planting. Dry loose, rubbly soils.
Hybrid differences	Some hybrids are more prone to root lodging and/or green snap than others.

Animal tramping/ feeding	Look for tracks and droppings.

3.2.2.7 PLANTS WILTED OR DEAD

Disease	Bacterial stalk rot.
Drought	Common at the macro/meso-scale particularly on sandy ridges/seams.
Herbicide damage	Macro/meso-scale damage. Check for misapplication of herbicides or spray drift from neighbouring crops.
Frost	Symptoms are likely to be worse in low-lying areas.

3.2.2.8 STALKS SPINDLY

Nutrient deficiencies	Likely to be caused by a Mn deficiency, but several other nutrient deficiencies can result in poor stalk development.
Excessively wet or dry soils	Affects root growth and health, resulting in reduced water and nutrient uptake.
Root damage	Affects effective root zone and root health, resulting in reduced water and nutrient uptake.
Excessive population density	Symptoms will be worse in more challenged areas of fields where resource availability (water, nutrients or light) is lower.

3.2.2.9 CURLED/STUBBY BRACE ROOTS

Herbicide injury	Macro/meso-scale symptoms. Usually late applications of phenoxy-type herbicides are responsible. Most prevalent around headlands and overlap areas.
Soil conditions	Macro/meso-scale symptoms. Excessively wet, dry or hot soil conditions.
Windy conditions	Macro/meso-scale symptoms.

3.2.3 Tasseling problems (VT)

3.2.3.1 GREY OR BLACK GALLS ON PLANT REPRODUCTIVE PARTS

Disease	Common smut.

3.2.3.2 TASSELS MALFORMED WITH A SOOTY, BLACK, STRINGY APPEARANCE

Disease	Head smut.

3.2.3.3 EMERGING TASSELS CHEWED

Insects	Corn earworm or cosmopolitan armyworm.

3.2.3.4 TASSELS MALFORMED INTO GREEN ROPEY CLUSTERS OFTEN COMBINED WITH EXCESSIVE TILLERING & MALFORMED LEAVES

Disease	Crazy top.

3.3 STAGE 3 - VT TO R6 (REPRODUCTIVE PHASE)

This period coincides with two of the most critical periods in the crop cycle; pollination and kernel set.

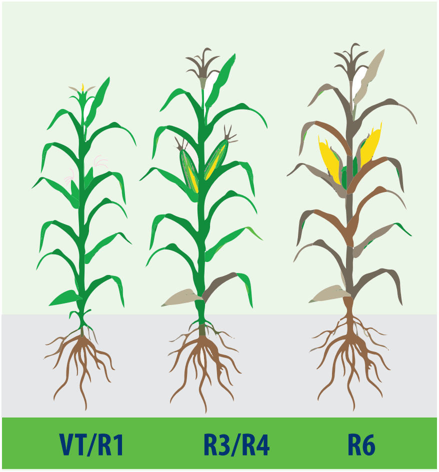
Despite potential ear size already being determined during the previous growth phase, what happens during this period determines the plants ability to express this potential.

Stress that occurs during pollination can affect the number of ovules (kernels) that get fertilised. Stress that occurs during and soon after successful fertilisation can affect the number of kernels that "set" and go on to develop into grain.

Maize has the ability to compensate to some extent for lower than optimal kernel set by increasing grain weight during the grain fillling period. Stress that occurs during grain fill will limit grain size. Significant stress during early grain fill will result in kernels aborting at the cob tips, commonly called "tipping".

During this period scout the crop for signs of stress including firing (dying off) of lower leaves, or changes in colour in the upper canopy. Keep an eye out for signs of pests and diseases. Check timing or synchronisation of silking and anthesis (pollen shed). Silking should commence no later than two days after anthesis. Pollen shed occurs only once the first anthers appear on the developing tassels. Ideally, for each plant these two events would take place on the same day, but in reality silking is often delayed one or two days after anthesis. Dry conditions tend to delay the appearance of silks. If everything has gone well prior to these events, the

entire crop should commence pollinating within one or two days of the first silks appearing. Initiation of tassel or silk emergence on individual plants spanning several days or more is indicative of prior and/or present stress and may occur throughout and across fields or in localised areas within fields.



The timing of flowering is closely correlated to the maturity of the hybrid and accumulated thermal time after germination. Given that accumulation of thermal time in early spring is much slower than it is in late spring, relatively big differences in planting date often result in relatively small differences in flowering date. Later planting dates, up to a point, often result in taller crops; but this does not mean that later planted crops are higher yielding. New Zealand research has shown that in ideal conditions the highest yields will be achieved for most hybrids if flowering commences on or soon after the longest day (22 December).

Monitor the crop for pests and diseases regularly during this period. If it is dry and there are grass weeds in your crop keep a close eye out for signs of armyworm. Refer to section 6.2 (page 71) for more information on this insect pest. Armyworm tends to start causing problems midway through the grain fill period and can result in severe leaf stripping if left unchecked. Weak plants tend to be stripped by the caterpillars before larger healthy plants. Damage can be very localised or widespread. If you identify it early enough you will be able to monitor its progression and make a timely decision on whether or not you need to spray. It takes a trained eye and experience to accurately assess the risks of an impending or invasive armyworm attack, so it would be wise to seek advice from an expert if in any doubt.

In terms of diseases, the big three; Northern corn leaf blight (NCLB or NLB), common rust (rust), and eyespot; are common during this growth phase. Growers should be more alarmed if they start to see these diseases entering the crop prior to, during, or soon after flowering. If an infection commences or takes hold in the middle to upper canopy during any of these periods, growers should implement a course of action. This could involve regular (e.g. daily) monitoring, or getting straight in with a fungicide spray. Both options would work but the first option would be the best if the short to medium-range weather forecast was for fine weather (although common rust loves cool dewy nights and mornings, so keep this in mind), but if forecast weather conditions were conducive to another infection cycle(s), then the last option (to spray) would likely be the best course of action. If in doubt talk to an expert.

3.3.1 Leaf problems from VT to R6

3.3.1.1 LEAVES CHEWED OR EATEN

Insects	Armyworm or grasshoppers. If the problem is severe consider insecticide application. In the case of armyworm, a parasitic wasp *(Apanteles ruficrus)* often keeps the population under control, but if damage is severe and unstung caterpillar numbers are above 3-4 caterpillars per plant, then it may be worthwhile spraying. Refer to section 6.2 (page 71) for more information on this insect pest.
Stock/animals	Check for tracks and droppings, usually accompanied with pushed over/leaning plants.

3.3.1.2 LEAVES SHREDDED

Wind	Strong winds in exposed places will often result in leaf shredding which can range from <5% to >50% loss of leaf area. In severe cases leaves are usually snapped off either at the base or somewhere up the midvein, with accompanying leaf blade loss.
Hail	Even light hail is usually accompanied with strong winds which can combine to cause significant damage to leaves.
Hybrid differences	Some hybrids have strong leaves which are more resistant to leaf shredding than others.

3.3.1.3 LEAVES SPOTTED, DISEASED OR DYING

Disease	Various pathogenic microorganisms including common rust, northern leaf blight and eyespot cause spots or disease lesions on leaves, and in severe cases these lesions can coalesce resulting in total leaf senescence/death.
Insects	Mites can give the appearance of tiny yellow-brown spots on both the upper and underside of leaves. Close inspection may reveal the presence of mites which will be accompanied by the presence of a fine web-like film on the underside of leaves. More common in sheltered areas. This is unlikely to be of economic concern unless there is widespread infestation.
Chemical damage	Spray drift from neighbouring crops.
Nutrient deficiency	Lower leaves will "fire-off" in cases of N or K deficiency. This can be induced by dry topsoil where these nutrients are often in their highest concentrations.

3.3.1.4 LEAVES DISCOLOURED

Nutrient deficiency	Lower leaves will yellow and start to fire off in cases of N or K deficiency. This can be induced by dry topsoil where these nutrients are often in their highest concentrations. See page 62 for specific details.
Barren plants	If pollination or kernel set is unsuccessful entire plants may slowly turn purple during this growth phase.
Insects	Mites or aphids. Leaves infected with mites display thousands of fine spots with a fine web and tiny light-coloured mites on the underside of leaves.

3.3.1.5 DISCOLOURED LEAF SHEATH

Disease	Dark blotches caused by saprophytic fungi colonising pollen trapped between the stalk and leaf sheath. Eyespot can also affect leaf sheaths.
Insects	Aphids.
Hybrid differences	Purpling due to anthocynanin deposition.

3.3.2 Stalk and whole-plant problems from VT to R6

3.3.2.1 STALKS ZIGZAGGED

Hybrid differences	Each hybrid has characteristically straight or zigzagged internodes. Expression of the zigzag trait can be influenced by environmental conditions with some hybrids sometimes expressing both straight and zigzagged internodes to varying degrees within the same field.

3.3.2.2 STALKS SNAPPED OFF

Wind	At this growth stage plants will more usually lodge from the roots but if they are well anchored into firm soil, stalks can snap; but only in severe or turbulent wind events in exposed areas, on ridgetops or downwind of some form of shelter or obstacle. Snapping can occur above or below the ear but occurs more typically at or just above the ear.
Disease	Uncommon at this stage but can become an issue in crops that have experienced or are experiencing significant stress which has allowed disease to take hold and weaken the stalks. Often the pathogenic organism(s) will come up from the roots. Check the stalks and roots of affected plants for signs of rot by cutting open some stalks and digging up some plants.
Animals	Check for tracks and droppings of stock or wild animals. Determine if stock is still present in the crop. Remove the stock if warranted. Fence off entry points to avoid this occurring again.
Mechanical damage	In-season field operations can result in stalk injury. Check for signs of mechanical injury on stalks of affected and unaffected plants.

Excessive plant population	High populations can reduce stalk diameter, stem strength and can increase crop and ear height, which interact to increase the risk of stalk snapping/lodging. Scout and check these characteristics on plants in the outside and inside rows, and in overlap areas around headlands to help understand the problem.
Nutrient imbalance	N-K imbalance (excessive N, insufficient K) can predispose plants to stalk lodging by increasing plant and ear height, and reducing stem diameter and strength.

3.3.2.3 STALKS/PLANTS LEANING OR LODGED FROM THE ROOTS

Wet windy conditions	Commonly occurs in soft, saturated peat soils or heavy or poorly drained soils.
Mechanical injury to roots	Commonly occurs in fields that have been side dressed with N using knives or discs during an earlier growth stage. Check lodged plants for signs of root cutting.
Poor root development	Usually caused by compaction and/or ponding either before or after planting, but pests (insects or nematodes) or diseases (*fusarium* etc.) should not be ruled out. Subsoil acidity or compaction may also be involved.
Herbicide damage	Late applied phenoxy herbicides such as Dicamba and 2-4D can cause damage to brace roots making plants more susceptible to root lodging. Check for signs of malformed brace roots if these herbicides have been applied, focussing on overlap areas around headlands etc.
Excessive plant population	High populations can increase crop and ear height and reduce root strength, which interact to increase the risk of root lodging. Scout and check these characteristics on plants in the outside and inside rows, and in overlap areas around headlands to help understand the problem.
Nutrient imbalance	N-K imbalance (excessive N, insufficient K) can predispose plants to root lodging by increasing plant and ear height.

3.3.2.4 PLANTS DEAD OR DYING PREMATURELY

Premature plant death	Usually caused by pathogenic fungi killing stressed plants from the roots. May start to occur two or more weeks before R6 (black layer), particularly under high plant populations and/or stressed conditions.

3.3.2.5 STALKS DISCOLOURED

Disease	Splotches, marks or discolouration from within the stalk may indicate developing stalk rot. Cut a few affected plants stalks open to investigate. Refer to section 5.2 (page 66) for stalk rot identification.
Hybrid differences and/or field spatial variability in growing conditions	Some hybrids naturally produce red to purple coloured stalks, but stalks for any given hybrid within a field or localised area should be similar in colour. Significant variation in stalk colour may be indicative of an underlying problem and/or differences in local field conditions.
Barren plant	Check ear development of affected plants. Poor kernel set usually results in anthocyanin accumulation in leaves and stalks, giving them a marked red/purple colouration.

3.3.2.6 HOLES APPEAR IN THE STALKS

Corn borer	Currently not present in NZ but something all growers should be aware of in case of a future biosecurity incursion. This pest is also responsible for mid-grain fill stalk lodging and chewing holes in the ear peduncle/shank causing premature ear drop.

3.3.3 Flowering problems from VT to R1

3.3.3.1 PLANTS FLOWER EARLY

Drought stress	Drought-like conditions can cause plants to flower early while the crop is relatively short; in extreme cases flowering can occur when crops are below waist height.

3.3.3.2 DELAYED SILKING

Drought stress	Drought-like conditions can cause a delay in silk emergence relative to tassel emergence. If this phenomenon occurs in an otherwise healthy looking crop, it is almost certainly indicative of a recent critical soil-moisture deficit developing. Irrigate immediately if possible.

3.3.3.3 POOR ANTHESIS AND/OR POLLEN SHED

Drought stress	Drought-like conditions can result in poor anthesis or pollen shed. Usually occurs in conjunction with delayed silking. If these phenomena occur in an otherwise healthy looking crop, it is almost certainly indicative of a recent or critical soil-moisture deficit developing.

3.3.3.4 SILKS CHEWED

Insect damage	A variety of caterpillars can be found feeding on maize silks. Refer to section 6.2 (page 71) for more information on these insects.

3.3.3.5 SILKS SCRAMBLED OR BALLED UP INSIDE HUSKS

Temperature variation	The cause of this phenomenon is a topic of some debate but anecdotal evidence suggests that large diurnal (night/day) temperature differences can impede normal silk development in some hybrids, typically those with long and naturally tight husks.

3.3.3.6 MULTIPLE COBS SILKING ON EACH PLANT

Exceptionally good growing conditions leading into flowering	This is perfectly normal in any decent growing season. Unless plant populations are very low, most secondary cobs will abort soon after pollination and/or kernel set on these lower order cobs will be severely limited.

3.3.3.7 NAKED/TASSEL COB DEVELOPS ON THE TOP OF PLANTS

Genotype/hybrid by environment interaction	Usually occurs on tillers on the outside rows of the crop. Perfectly normal and nothing to be concerned about.

3.3.3.8 MALE TASSEL-LIKE APPENDAGES EMERGE FROM TIPS OF COBS

Genotype/hybrid by environment interaction	Occurs rarely, certainly less frequently than naked/tassel cobs, but again, nothing to be concerned about.

3.3.3.9 MULTIPLE EARS EMERGE FROM THE BASE OF MAIN COBS

Genotype/hybrid by environment interaction	Commonly called parasitic ears, which die off as grain fill progresses.

3.3.3.10 POOR POLLINATION AT THE COB TIPS

Drought conditions	Often resulting from a combination of delayed silking and poor anthesis/pollen shed as described earlier.
Low light conditions and/ or high plant population density	Cloudy or short days during or soon after flowering period (e.g. late planting date) and/or high plant population density can result in poor pollination at the cob tips.

3.3.3.11 TASSELS MALFORMED WITH A SOOTY, BLACK, STRINGY APPEARANCE

Disease	Head smut.

3.3.4 Ear problems from R2 to R6

3.3.4.1 COB TIPS CHEWED

Insects	Corn earworm or cosmopolitan armyworm. See section 6.2 (page 71) for more details on these insects.
Birds or rodents	A variety of birds and rodents are fond of feeding on cob tips. Common symptoms are chewing of the husks and developing grain. Rodents tend to concentrate on outside rows near shelter, whereas damage from birds tends to be more random and widespread, often accompanied by droppings on affected cobs.

3.3.4.2 HUSKS CHEWED OR PIERCED

Insects	Corn earworm or green vegetable bug (GVB) which pierce husks causing damage/discolouration to underlying kernels. Refer to section 6.2 (page 72) for more information on these insect pests.

3.3.4.3 HUSKS DISCOLOURED, SPOTTED OR STRIPED

Disease	Particularly eyespot. See section 5.1 (page 65) for more details.
Saprophytic fungi	Harmless fungi feed on pollen trapped between husk leaves causing pale to dark drown splotches on the first few layers of husk leaves.

3.3.4.4 POOR KERNEL SET OR TIP FILL

Drought conditions	Often resulting from a combination of delayed silking and poor anthesis/pollen shed.
Low light conditions and/or excessive plant population density	Low light levels during pollination can result in poor pollination at the cob tips which may not be apparent until the R2 stage.

3.3.4.5 TIPPING BACK OF THE COB TIPS

Drought conditions	Chaffy, shrivelled kernels at the cob tip can be indicative of developing or previous (post R1) drought conditions and/or excessive plant population density.
Insufficient sunshine or excessive plant population	In the absence of drought conditions chaffy, shrivelled kernels at the cob tip can be indicative of low solar radiation levels (e.g. cloudy days) post R1 and/or excessive plant population density.

3.3.4.6 RANDOM ABORTED KERNELS

R1 near-frost chilling injury	The occurrence of a near-frost event during or soon after pollination can result in the abortion of random kernels in some sensitive hybrids. Even moderate symptoms do not seem to affect yield.

3.3.4.7 RANDOM DAMAGED OR DISCOLOURED KERNELS

Insect damage	The proboscis of the green vegetable bug (GVB) is capable of piercing the husks of some hybrids creating off-coloured (splotchy brownish-grey) tips on random kernels on affected cobs. Refer to section 6.2 (page 72) for more information on this insect pest.
Disease	Certain diseases including *Fusarium* (white/salmon discolouration) or *Cladosporium* (black discolouration) can be isolated to specific kernels ranging from several to many on a cob.

3.3.4.8 PREMATURE EAR DROP

Corn borer	Currently not present in NZ but something all growers should be aware of in case of a future biosecurity incursion. This pest is also responsible for mid-grain fill stalk lodging and holes chewed in the ear peduncle/shank causing premature ear drop.
Premature plant death	Ears falling off plants during silage operations. See section 3.3.2.4 (page 46) for more information.

3.4 STAGE 4 - R6 TO GRAIN HARVEST (DRYDOWN)

This is the phase during the maize crop cycle where each hybrid's strengths and weaknesses start to become apparent.

Crops that have looked magnificent throughout the season can quickly disappoint, and crops that have looked average can end up surprising.

What is often seen to be desirable for silage crops (e.g. height and bulk) may be undesirable for grain crops. The ideal grain hybrid is medium to medium-tall in height, with a reasonably low ear placement, preferably not much higher than half the height of the plant.

Strong roots and a solid stem add to a crop's resilience during this phase as does good husk cover, ear rot profile and the speed at which the cob peduncles (shanks) succumb to gravity and allow the cob to point downwards, reducing the risk of grain spoilage due to moisture/rainfall and disease that follows if the grain gets wet.

The target grain moisture at harvest will depend on the market/end use, and can range from 28% to 18% with moisture above 20% often increasing drying costs significantly. Lower values increase the risk of losses both in-field and at the driers through disease etc. A safe medium is around 22% moisture where plant integrity is good, shelling is easy, handling characteristics are good, disease level is low, drier throughput is near optimal and losses are minimal.

Scouting during this growth phase is really about monitoring the integrity of the plant and forecasting any problems that might occur either due to pests, disease and climate related factors. If it looks as though a problem may be starting to occur, it probably is. The best thing to do is take stock, assess the situation, and if the risk is too high, seek advice and consider harvesting.

It's also a good time to check for problem weeds at this time because they usually stand out among the dying maize plants. For problem or noxious weeds record the location of any hotspots not least as a reminder to scout these locations next season, but also to be armed with the knowledge of where to look for which weeds and to formulate strategies to tackle the weeds if/when they appear.

3.4.1 Leaf problems from R6 to grain harvest

Green leaf area (GLA) at the start of this growth phase can range from 10% to 80% depending on the hybrid and the local/field conditions. In ideal conditions, hybrids with excellent staygreen characteristics and leaf and root disease resistance may see this GLA hold through until grain harvest (25% to 22% grain moisture). In other hybrids or fields, GLA at harvest may be non-existent. This is not a concern providing stalk and root strength is adequate. Persistence of GLA during drydown is indicative of healthy stalks and roots and should provide growers with confidence to delay harvest to reduce drying costs.

3.4.1.1 LEAVES GRADUALLY BROWN AND DIE

Natural senescence	In good growing conditions this often commences some time before R6 at the top and bottom of the plant and slowly progresses towards the primary/top cob leaf. The cob leaf should be the last to senesce and may occur any time after R6 depending on the staygreen characteristics of the plant and its late season plant health in general.

3.4.1.2 WHOLE PLANT RAPIDLY WILTS AND DIES

Root disease	May occur a short time after black layer (R6) while the plant still has marked green leaf area. Monitor root strength in affected plants, assess frequency of symptoms. Factor this into future decisions.

3.4.1.3 TOP LEAVES RAPIDLY WILT AND DIE OR APPEAR SCORCHED

Disease	Various pathogens can cause this reaction including anthracnose and nonspecific top dieback.

3.4.1.4 GREEN LEAVES RAPIDLY SUCCUMB TO DISEASE LESIONS

Disease	Most often caused by NLB at this late stage. As plant defences shut down this previously supressed disease takes over.

3.4.2 Stalk problems from R6 to grain harvest

Stalk integrity is one of the main concerns during this phase. Growers should scout their crops regularly once GLA falls below 20%, focusing on those plants that have lost all GLA first as well as overlap areas around headlands etc. The most important part of the stalk is below the cob. Integrity of this part of the stalk is crucial to a hassle-free harvest. Although it's not impossible to pick up stalk lodged plants, it certainly slows down the harvesting operation and increases the risk of grain quality issues caused by disease and sprouting etc.

There are often differences in stalk strength between different hybrids and even the same hybrid in different fields or different areas in the same field. Check stalk strength by pushing laterally on the main stalk 1 or 2 nodes below the node of cob insertion. Failure of the stalks with less than moderate pressure in more than 20% of plants should be treated as a concern.

To understand what is causing the problem it will be necessary to assess the stalks using a combination of external and internal visual assessments.

3.4.2.1 STALKS DISCOLOUR AND SOFTEN

Natural senescence	As the drydown period progresses the stalks of most crops will gradually change from green through shades of red to straw before drying off completely.
Disease	Usually accompanied with a complete loss of GLA as well as changes in stalk colour and strength. This can be the result of specific pathogens or combinations of pathogens.

3.4.2.2 STALKS SNAP BELOW THE EAR

Disease	Usually accompanied with complete loss of GLA as well as changes in stalk colour and strength. This can be the result of specific pathogens or combinations of pathogens.

Extreme weather	Even the healthiest of stalks can break in extreme weather conditions. With stalk integrity naturally lower now than in previous growth phases, weather conditions capable of causing stalk lodging may be relatively moderate.

3.4.2.3 STALKS SNAP ABOVE THE EAR

Natural senescence	Often significant hybrid differences in plant integrity during drydown. Providing stalk strength below the ear is not overly compromised, upper canopy stalk breakage during this phase is not a major concern.
Extreme weather	Even the healthiest of stalks can break in extreme weather conditions. With stalk integrity naturally lower now than in previous growth phases, weather conditions capable of causing stalk lodging may be relatively moderate. Upper canopy stalk breakage during this phase is not a major concern.

3.4.2.4 HOLES APPEAR IN THE STALKS

Corn borer	Currently not present in NZ but something all growers should be aware of in case of a future biosecurity incursion. This pest is also responsible for chewing holes in the ear peduncle/shank causing premature ear drop.

3.4.2.5 STALKS TURN RED

Natural senescence	Stalks often redden during the drydown period caused by anthocyanin deposition, indicative of a surplus of photosynthates. Red stalks are an indicator of good stalk strength.

3.4.3 Root problems from R6 to grain harvest

Another concern during this phase is root strength. Like stalk strength, growers should start regular monitoring of each crops root strength once GLA falls below 20%, focussing on those plants with no GLA and those in overlap areas around headlands etc. There are often differences in root strength between different hybrids and even the same hybrid in different fields or different areas in the same field. Root strength can be checked by pulling vertically on the stalk below the point of ear insertion and/or by pressing the toe of your boot against the base of the stalk. A strong root system will offer a decent amount of resistance to these tests whereas a weak root system will offer little resistance.

Failure of the roots with less than moderate force in more than 20% of plants should be treated as a concern.

Taking this a step further, dig up the root balls on a few weak and a few strong plants to check for differences in root health and/or disease. Dry, dead roots are indicative of disease, whereas roots that still have some integrity should offer growers confidence that root lodging should not be a major concern.

3.4.3.1 BRACE ROOTS DIE AND BECOME BRITTLE

Natural senescence	As the crop dries down plants naturally go through a period of senescence leading to plant death and natural reduction of plant integrity and ultimately, the collapse of the above ground vegetative parts. This process is sped up when saprophytic fungi move from the roots up the stems.
Disease	A rapid change in colour of the brace roots, relative to neighbouring plants is indicative of root rot. Test the root strength or resistance to root lodging by following the method described above.

3.4.3.2 PLANTS FALLEN, EASILY PUSHED OVER OR PULLED OUT BY THE ROOTS

Natural senescence	As the crop dries down plants naturally go through a period of senescence leading to plant death and natural reduction of plant integrity and ultimately, the collapse of the above ground vegetative parts.
Disease	Test the root strength or resistance to root lodging by following the method described on page 58. If weak, dig up a few plants to examine the roots. Compare the roots of these to a few of the stronger plants. Drought conditions during the previous growth phase predisposes crops to root rot.
Extreme weather conditions/ hybrid differences	Some hybrids tend to have stronger roots and/or stalks than others and are more capable of withstanding moderate to extreme weather events. If adverse weather events during this growth phase are common in your area, consider stalk and root strength as key factors in the hybrid decision making process. Also, planting at moderate populations of 95,000 seeds/ha or less will help reduce risk.

3.4.4 Ear problems from R6 to grain harvest

There's nothing more disheartening to a maize grower than seeing the fruits of their labour literally disintegrate before their eyes. Certain cob rots are a major concern as they produce mycotoxins that reduce the quality and/or feed value of the grain which may result in it being rejected. Damage to cob tips and individual kernels by pests, short husks and/or upwards pointing cobs during drydown often result in some degree of cob or kernel rots. If conditions are conducive, some fungi are capable of creating a lot of damage very quickly. If you are concerned about the level of infected cobs/kernels it will be wise to seek advice from your grain processing plant and contractor to see if you can jump the queue and harvest early before more damage is done.

3.4.4.1 GRAIN AT COB TIPS CHEWED

Insects	Corn earworm and cosmopolitan armyworm. Refer to section 6.2 (page 71) for more details on these insect pests.
Birds and rodents	Rodents often congregate in sheltered areas neighbouring crops so most damage is confined to the outside few rows. Bird damage is usually more widespread and can range from subtle to severe. Usually worse in years where alternative food sources are low.

3.4.4.2 GRAIN AT COB BASE WET OR SPROUTING

Erect ears and poor husk cover	Upward pointing ears, particularly with open husks, can result in rain water running down and soaking into the base of the cob which causes sprouting. Particularly bad in hybrids with poor tip cover and tight husks, which allow water to come in but not to drain away.

3.4.4.3 GRAIN AT COB TIPS SOFT OR DISCOLOURED

Disease	Various fungi including *Gibberella* (white/pink discolouration), *Penicillium* (blue-green) and *Aspergillus* (black). See section 5.3 (page 67) for more details on these cob diseases.

3.4.4.4 GRAIN IN MIDDLE OR BASE OF COB SOFT OR DISCOLOURED

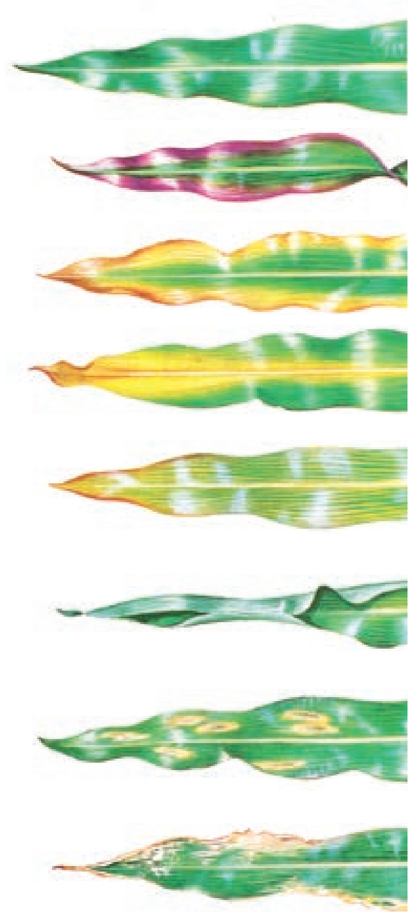
Disease	Various fungi including *Diplodia* (white discolouration), *Fusarium* (white/salmon), *Penicillium* (blue-green) and *Cladosporium* (black).
Insects	Green vegetable bug (GVB) use their proboscis to penetrate the husks and pierce the kernels creating browny-grey discoloured marks on the kernel surface. Refer to section 6.2 (page 72) for more information on this insect pest.

3.4.4.5 HUSK AT TIP CHEWED OR OPEN

Birds/rodents	Husks at cob tips appear shredded rather than chewed.
Insects	Corn earworm or cosmopolitan armyworm. Husks at tips appear more chewed than shredded, usually associated with caterpillar droppings. See section 6.2 (page 71) for more details on these insect pests.
Hybrid differences	Some hybrids have relatively short husks compared to others.
Genotype x environment interactions	In some seasons, hybrids with usually decent husk cover can produce relatively short husks leaving the cob tips exposed. If this is a concern, and/or weather conditions favour certain cob rots, regularly scout your crop during the late-grain fill and drydown periods.

4.0 VISUAL GUIDE TO LEAF, ROOT AND COB ABNORMALITIES

4.1 Leaf abnormalities



Healthy
Leaves shine with a rich dark green colour when adequately fed.

Phosphate shortage
Leaves marked with a reddish-purple colour, particularly on young plants.

Potash deficiency
Appears as a firing or drying along the tips and edges of the lowest leaves.

Nitrogen hunger
Signs of yellowing that starts at the tip and moves along the middle of the leaf.

Magnesium deficiency
Whitish strips along the veins and often a purplish colour on the underside of the lower leaves.

Drought
Causes the maize to have a grayish-green colour and the leaves roll up nearly to the size of a pencil.

Disease
Helminthosporium blight, starts in small spots and gradually spreads across the leaf.

Chemicals
May sometimes burn the tips, edges of leaves and other contacts. Tissue dies and the leaf becomes whitecap.

*All images in section 4 sourced from "Compendium or Corn Diseases" (Third Edition), Donald G. White.

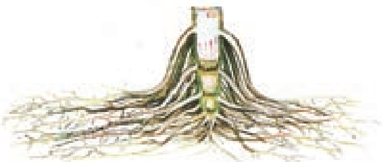
4.2 Root abnormalities

Deep, spreading roots
A healthy, high-yielding plant will crowd a 20 litre bucket.

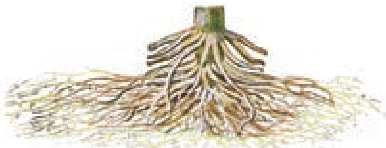
Phosphate shortage
A shortage during the early weeks causes a shallow root system with little spread.

Rootworms
Prune heavily as they eat small roots and tunnel in larger ones.

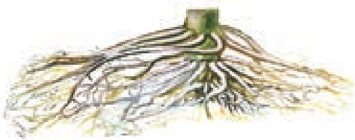
Poor drainage and hardpan
Causes a flat shallow root system. Maize with poor roots cannot stand drought and is easily blown over by high winds.



Acid soil
Indicated when the lower part of the root is discoloured and decayed, particularly when brace roots shoot from the third or fourth node.

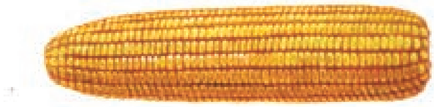


Pruned roots
Result of a cultivator. Shovels were too deep and too close.

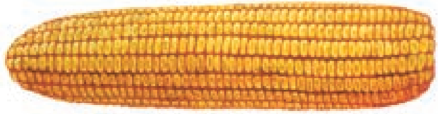


Chemical damage
Makes roots writhe and twist. Joined brace roots are another symptom.

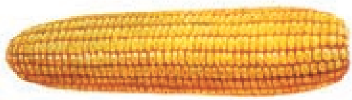
4.3 Cob abnormalities



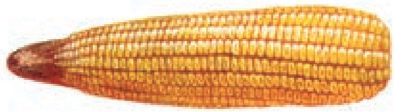
Normal ear
Well fertilised high producing maize cob weighs about 300 grams. It has well filled tips.



Big ears
Ears weighing up to 450 grams likely indicate that the plant population was too small for most profitable yields.

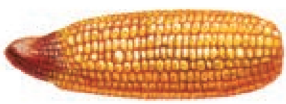


Small ears
Usually a sign of low fertility. For better yields, boost fertiliser application.



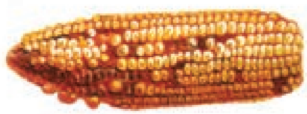
Potash shortage
A shortage shows up in ears with poorly filled tips and loose chaffy kernels.

Phosphate shortage
Interferes with pollination and kernel fill. Ears are small, often twisted and with undeveloped kernels.



Nitrogen
Essential throughout the growing season. If the plant runs out of nitrogen at a critical time, ears are small and protein content is low. Kernels at the tip do not fill.

Green silks at maturity
May be caused by too much nitrogen in relation to other elements.



Dry weather
Slows silking behind tasseling; kernels aren't pollinated.

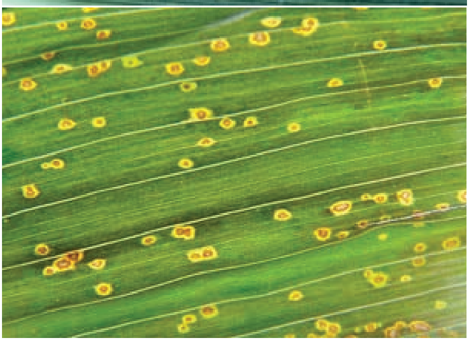
5.0 DISEASES

GUIDE TO COMMON DISEASES OF MAIZE IN NEW ZEALAND

5.1 Common leaf diseases of maize

Common rust
Raised, rust coloured pustules appear on both sides of the leaf blade. Chlorosis and leaf death may occur in severe infections on susceptible hybrids. The disease favours humid conditions and moderate temperatures (15 to 25°C), including dewy nights/mornings and overwinters on host oxalis species.

Northern leaf blight
Grey-green turning brown cigar shaped lesions 3 to 15 cm in length. May coalesce into large blighted areas on severely infected leaves. Infection usually spreads from the lower canopy upwards through successive favourable infection periods which consist of warm humid conditions (18 to 24°C) and accompanying rainfall.



Eyespot
Small (1 to 4 mm) translucent turning brown circular lesions with yellowish halos giving the appearance of an eyespot. Overwinters on maize crop residues so this is more prevalent/ severe in grain reduced-tillage maize monoculture systems.

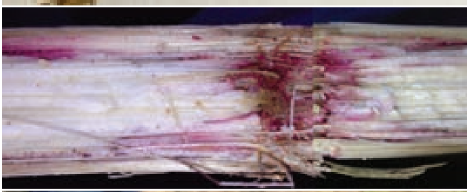
5.2 Common stalk diseases of maize

Anthracnose stalk rot
Shiny, black discoloration that cannot be scratched off the rind.

Charcoal rot
Tiny, black sclerotia produced inside the stalk gives the appearance of charcoal dust.

***Diplodia* stalk rot**
Tiny, raised black dots (*pycnidia*) on lower nodes are embedded in the stalk and cannot be scraped off.

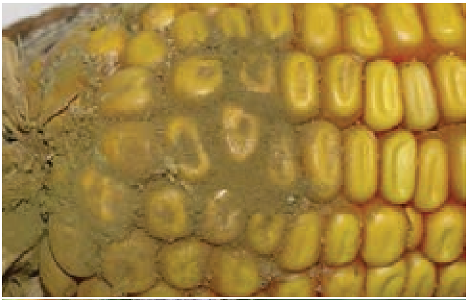
***Fusarium* stalk rot**
Pinkish-white fungal growth on outside of stalk, pink or salmon coloured discolouration on inside of stalk, lack of visible reproductive structures, crowns often are brown and rotted.



***Gibberella* stalk rot**
Bright pink to red discolouration at the nodes.

Bacterial stalk rot
Dark brown water soaked lesions at base of stem with soft, slimy stalk tissues accompanied by a strong odour.

5.3 Common ear/cob diseases of maize



***Aspergillus* ear rot**
Symptoms: Olive-green coloured powdery mould on the base or tip of infected ears.
Toxin type: Aflatoxin

***Diplodia* ear rot**
Symptoms: Grey to greyish-brown mould often starting at the base of the ear spreading to cover much of the infected ears. Infected ears appear mummified and weight is severely reduced.
Toxin type: N/A

***Fusarium* ear rot**
Symptoms: White, grey or pink coloured fungal growth on individual kernels or patches of kernels in infected ears.
Toxin type: Fumonisin

Common smut
Symptoms: Galls form on ears, leaves, stalks and/or tassels of infected plants.
Toxin type: N/A

Head smut
Symptoms: Cobs and tassels infected with a mass of sooty black fungal spores.
Toxin type: N/A

***Gibberella* ear rot**
Symptoms: White to salmon/pink mould starting at the tips of ears, with husks tightly adhering to infected ears.
Toxin type: Deoxynivalenol and Zearalenone

***Penicillium* ear rot**
Symptoms: Blue-green powdery mould on and between the kernels, usually near the tip of infected ears.
Toxin type: N/A

***Trichoderma* ear rot**
Symptoms: Dark-green fuzzy mould grows on and between the kernels of infected ears.
Toxin type: N/A

6.0 PESTS

MAJOR INSECT PESTS OF MAIZE IN NEW ZEALAND

6.1 VE to V6 (establishment phase)

Black beetle
Confined to the warmer (upper) regions of the North Island. Infestations are more severe following long term pasture, particularly paspalum or kikuyu. Damage is characterised by signs of chewing of the roots and stem at the base of plant. Damaged plants typically show signs of wilting and either die or tiller from the base of the plant and become stunted. Both Imidicloprid (Gaucho) and Clothianidin (Poncho®) seed treatments provide adequate levels of control of black bettle.

Argentine stem weevil (ASW) larvae
Present in all New Zealand maize growing regions. Damage is caused by the larvae, small white legless grubs (1 to 3 mm long) which transfer from decaying grass tillers before or soon after maize crop emergence. Damage includes emergence failure, wilting and death of plants up to V4. Death of emerged seedlings is characterised by a small hole of the base of the stem and subsequent wilting of the whorl leaves followed by either plant death or prolific tillering. Imidicloprid (Gaucho) provides some level of control and Clothianidin (Poncho®) usually provides an adequate control of ASW larvae, but in severe infestations significant damage may still occur. A grass free fallow period of 2 to 3 weeks should significantly reduce the infestation load.

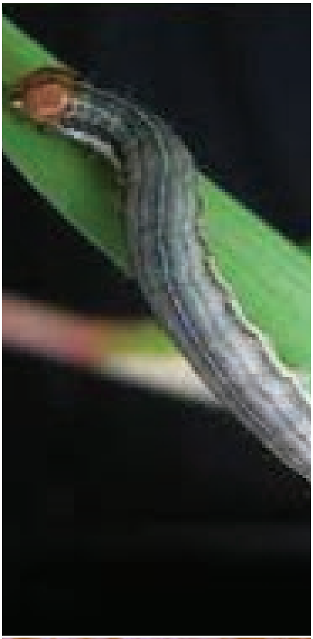
Wireworm

Wireworms are long (up to 30 mm), segmented, six legged insect larvae with yellowish to brown colouring. Several species of wireworm exist in NZ pastures. Damage to maize is similar to that caused by ASW larvae, in that they tunnel into the base of the plant causing the centre leaves to wilt and die. Currently there is no registered chemical to control wireworm in New Zealand. Intensive cultivation (disc and power harrow) may also help to reduce the infestation load by physically damaging the insect larvae and exposing them to predators (e.g. birds).

Greasy cutworm

Cutworm damage in maize is determined by the number and growth stage (instar) of the caterpillars in relation to crop growth stage. Cutworm moths tend to prefer laying eggs on the leeward side of shelterbelts once temperatures in spring reach 10.5°C. Thus, crops establishing in November are more likely to coincide with larger (cutting stage) caterpillars than those establishing in October. Clothianidin (Poncho®) usually provides good control of cutworm as does a synthetic pyrethroid spray either (or both) before emergence or at V2.

6.2 VT to R6 (reproductive phase)



Cosmopolitan armyworm

Present throughout the North Island and upper South Island, they typically show up in maize crops at or shortly before silking. In severe infestations complete defoliation of localised areas of maturing (R1 to R5) maize crops can occur over several days. Infestations are often more severe in crops with poor weed control and may commence as hotspots within the crop which spread rapidly as localised food reserves run out. Larger caterpillars consume considerably more than smaller caterpillars. Caterpillar numbers are usually controlled by a parasitic wasp (*Apanteles ruficrus*) which lay their eggs inside the developing caterpillars. Infected caterpillars can be identified by carefully squashing the caterpillar and observing the insides for tiny white wasp larvae. If more than 3 or 4 larger (>3 cm) uninfested caterpillars per plant are present prior to R5 (dent stage), and damage looks to be escalating or spreading rapidly, it may be worth applying a synthetic pyrethroid spray whilst being mindful of any withholding period(s).

Corn earworm

Also known as the tomato fruitworm can cause significant damage to developing cobs by feeding on silks (during pollination) and kernels throughout the grain fill period (R1 to R5) and subsequently by fungal attack of the grain during drydown (R6 onwards). Caterpillars are variable in colour ranging from pink to green or brown, with dark, bristley, raised bumps. Controlling corn earworm is difficult once the caterpillars have penetrated the ear, but prior to this they may be effectively controlled by application of a synthetic pyrethroid spray whilst being mindful that this will also reduce the numbers of beneficial insects present in the crop; this includes the parasitic wasps *Apanteles kazak* (moderately effective at controlling corn earworm) and *Apanteles rufricus* (controls cosmopolitan armyworm).

Green vegetable bug (GVB)

Found throughout the North Island and warmer parts of the South Island the green vegetable bug (GVB) overwinters as adults and lay eggs in early spring. There are typically two or more generations per season and although they are not usually a major concern from a yield perspective in maize, they do cause damage when feeding on kernels by causing discolouration, shrinkage and potential entry points for infection by fungi associated with kernel rots. There are 3 parasitoids (all wasps) in New Zealand that are known to infect GVB, as well as a few predators (e.g. starlings and german wasps). There are no chemicals registered for use on GVB in maize.

Fall armyworm (FAW)

Fall armyworm (FAW) is a destructive insect pest that has recently arrived in New Zealand. The larvae can be identified with a number of external features, but specifically an inverted white 'Y' mark on the head between the eyes.

FAW is extremely invasive and feeds on a variety of crop species. It particularly favours corn (maize) with feeding damage to leaves, stems and ears. Early detection of its presence is key to minimising crop loss and failure.

FAW is known for its ability to disperse and migrate long distances (moths can travel up to 100 km in a night), which enables it to exploit new habitats and expand its range. FAW eggs are laid on the leaves in clustered masses up to 100 - 200 eggs. There can be up to 12 overlapping generations per year.

Corson Maize is working with industry bodies and international partners to explore the best options for identifying, controlling and minimising the risk of a likely FAW infestation.

GLOSSARY

TERM	DESCRIPTION
Anthocyanin	Water-soluble plant pigments that may appear red, purple, blue or black depending on their pH.
Anthesis	The time the first anther(s) appear on the maize tassel (see also anther and tassel).
Black layer	Physiological maturity of the maize plant classified as the point in time when discolouration at the point the kernel attaches to the ear occurs on 50% of the kernels.
Brace root	The thick roots that emerge from the first few above-ground nodes of a maize plant.
Chlorosis	Yellow discolouration of the leaf blade.
Coalesce	Joining together (of disease lesions/infections).
Cob development	The time and processes involved in formation of the maize cob, which typically starts at around V6 (6 fully emerged leaves) and continues through to physiological maturity.
Cob size determination	The time and processes involved in formation of kernels on the developing cob prior to pollination, which typically starts at around V6 (6 fully emerged leaves) and continues through to about 1 week prior to silking.
Coleoptile	The tightly wrapped leaf which appears as a spike at it emerges through the soil, and which protects the growing point (apical meristem) as it travels from the seed to just beneath the soil surface.
Compaction (soil)	Tightly packed soil with limited air spaces, and often low plant available water and oxygen levels.
Denitrification	A form of N (nitrogen) loss where plant available nitrate N is converted to unavailable gaseous N by soil bacteria in low oxygen (e.g. waterlogged and compacted) soil conditions.
Ear initiation	The point in time, around V6, when the maize plant starts initiating the primary ear/cob as a tiny structure (primordia) on a node (typically the 12 to 14th node) hidden away inside the whorl.
Ear placement/insertion	The height/point on the stem where the ear/cob attaches.
Emergence	The process and point in time when the maize spike/coleoptile breaks through the soil surface.
Establishment phase	The time period from planting until around V4 during which time the maize plants are changing from full dependance on seed reserves to reliance on photosynthesis and nutrient uptake from leaves and roots respectively.
Firing (leaf)	The loss of greenness from leaves resulting from reallocation of resources (i.e. nutrients) from the dying leaf to other parts of the plant.
Fungicide	A chemical or other treatment applied to the soil, seed or above ground parts of the plant aimed at killing or surpressing fungal growth.
In-furrow application	An application of some treatment (e.g. fertiliser, pesticide) into the groove in the soil where the seed is placed.
Germ test	A test performed by an accredited laboratory to assess and certify the viability of the seed.
Germination	The emergence of the root (radicle) shoot from the seed.
Grain fill	The period of time between kernel set and physiological maturity (see kernel set).
Green leaf area (GLA)	The amount of viable photosynthetic leaf area on the the plant, often expressed in terms of m^2 of green leaf area per m^2 of ground, but also as a percentage of the total leaf area (including non-green/scenescing leaves).
Green snap	Snapping of the plant stem while it is in the vegetative growth stage.
Growing point	Also called the apical meristem, is the location of the young, developing tissue hidden withing the whorl of the leaves. Following emergence and up until around V5 this is just beneath the soil surface. From then it rises as the internodes expand until the tassel emerges (VT).
Headland	The part of the crop (usually the first 18m or 24 rows) planted around the outside of the paddock.
Imbibition	The period of time that the seed is absorbing water prior to germination.
Infection period (disease)	A period of time longer than the minimum period of time that environmental conditions (typically moisture/ humidity and temperature) are right for a pathogen to infect a plant.

GLOSSARY

TERM	DESCRIPTION
Internode	The piece of stem between two nodes on the stalk.
Kernel set	The period between pollination/silking (R1) and early grain fill (R3) during which time the number of viable kernels is determined.
Leaching	The movement/loss of plant nutrients down through the soil profile.
Leaf axil	The point on the stem node(s) where the reproductive ears initiate and develop from.
Leaf collar	The junction between the leaf blade and the leaf sheath, near where the leaf blade touches the stem.
Leaf shredding	Damage to the leaf blades by physical force (e.g. wind, hail etc.).
Leaf whorl	The centre of the maize plant if viewed from above; or the point from which new maize leaves emerge.
Leaf blade	Or leaf lamina; is the main, typically flat part of the leaf with the main role of photosynthesis and gas exchange.
Lodging	The failure of a plant's integrity either from the roots or the stalks below the ear placement, potentially resulting in a loss of harvestable yield and/or quality.
Mechanical injury	Any injury to a plant or crop caused by mechanical means (e.g. root or leaf damage, stalk breakage etc.).
Meristem	Any active growing point on a plant. Note the apical meristem is the vertical growing point on the main stem; there are also root meristems and reproductive meristems.
Mesocotyl	The small stalk-like structure originating from the seed that projects the vegetative growing point up towards the soil surface.
Midvein (leaf)	Also called the mid-rib; the thickened rib that runs longitudinally down the centre of the leaf blade.
Monoculture	A cropping system that involves the growing of only one species of crop over several seasons.
Nodal roots	Cohorts/groups of roots originating from the nodes of the maize plant.
Noxious weed	Any weed that is deemed detrimental to agricultural ecosystems.
Nutrients (plant) (N, P, K, S, Mn, Fe, B)	N - Nitrogen; P - Phosphorus; K - Potassium; S - Sulphur; Mn - Manganese; Fe - Iron; B - Boron.
Overlaps	The areas, often around headlands or turning zones where management applications (e.g. seed, agrichemicals) pass over each other resulting in higher than intended application rates.
Over winter	A pest or disease that remains viable over the winter period.
Pathogen	Any biological agent (organism, virus etc) capable of causing infection.
Peduncle	The stalk-like structure that connects the maize cob to the stem.
pH	A measure of acidity in relation to the proportion of hydrogen ions in solution.
Photosynthesis	The process that plants and other organisms use to convert light energy into chemical energy to fuel cellular demands and growth.
Pigmentation	A natural colouring of biological tissues, often in response to changes in the environment, conditions or time.
Plant integrity	A characteristic relating a maize plant's ablity to maintain its form (particularly its stem) during the grain drydown period.
Planter skips	Gaps within a row of maize plants caused by failure of the planter mechanism to deliver a seed(s).
Pollination	The transfer of pollen from the male structures (anthers) to the female structures (silks) of a maize plant preceding fertilisation.
Pop-up (fertiliser)	Fertiliser placed in the immediate vicinity of the seed (see in-furrow).
Post-emergent herbicide	Any herbicide applied to the crop after crop emergence.
Pre-emergent herbicide	A herbicide applied to the crop prior to crop emergence, typically a residual herbicide, but may include glyphosate as well.

GLOSSARY

TERM	DESCRIPTION
Pre-plant incorporation	The mechanical incorporation of pre-emergent residual herbicides (e.g. acetochlor) into the top 5 cm or so of soil prior to planting.
Pycnidia	Tiny sack-like structures containing asexual spores that occur in ascomycetes and certain other fungi.
Residual herbicide	Any herbicide that is active after it has been applied to the soil. Note in most cases, in dry conditions such herbicides need "activating" by receiving a small amount (5 to 10 mm) of rainfall or irrigation.
Resilience	The ability to tolerate stress.
Root architecture	The physical structure of the root system within the soil profile including rooting depth and changes in root-length density both vertically and horizontally.
Salt index	A measure of the influence a fertiliser has on the osmotic pressure of the soil solution. Fertilisers with high salt indices tend to inhibit seed germination and root growth, and should therefore be kept away from the immediate vicinity of the seed.
Saprophytic	An adjective describing (micro) organisms that attain their nutritional requirements from dead or decaying organic matter.
Scale (Macro, Meso, Micro)	Macro-scale large or wide spread variation between different areas of a paddock; Meso-scale localised variation between groups of plants; Micro-scale variation between adjacent plants.
Sclerotia	A hardened and compacted mass of fungal hyphae containing nutrient stores, which remains dormant until favourable conditions return.
Seed lots	A unique batch of seed which may originate from one or more production fields and/or seasons.
Seed treatment	Any chemical or biological agent applied to the seed in order to enhance its viability or performance in the field.
Silking period	The period of time that the thread-like silks are actively appearing from the tips of the young maize ears.
Skips	See planter skips.
Soil moisture deficit (critical)	Soil Moisture Deficit (SMD) is the amount of precipitation or irrigation needed to bring the soil moisture content back to field (maximum available water) capacity. Beyond a critical SMD there will be a corresponding and proportional decrease in yield.
Spike	See coleoptile.
Symptomology	The expression or appearance of effects caused by one or more biotic, abiotic or management factors.
Synthetic pyrethroid	A class of synthetic insecticides chemically related to the plant based insecticide pyrethrum, and often considered much softer (user and environmetally friendly) options than organophosphate and/or carbamate based insecticides.
Tassel	The male flower projecting from the top of the maize plant.
Tipping	A barren area at the distal end of a maize cob caused by unsuccessful fertilisation or abortion of fertilised ovules or kernels during the kernel set and grain fill period due to stress, competition or a lack of resources (water, light, nutrients).
Transpiration	The process of water loss through stomata (pores) in plant leaves to facilitate cooling and other processes.
Unthriftiness	Slow growth, low vigour.
Vigour	A gauge of the relative growth and/or development rate of a crop.
Waterlogging	Soil moisture levels exceeding field capacity either as a result of excessive rain/irrigation, flooding or from surface-runoff of water to lower lying areas.
Whorl	See leaf whorl.
Yield potential	The yield that could be achieved in the absence of limiting and/or stress factors including water, nutrients, pests and diseases, lodging and competition from weeds or overcrowding/shading.
Yield gap	The difference between the maximum potential (i.e. simulated) yield of a crop and the actual yield achieved.

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