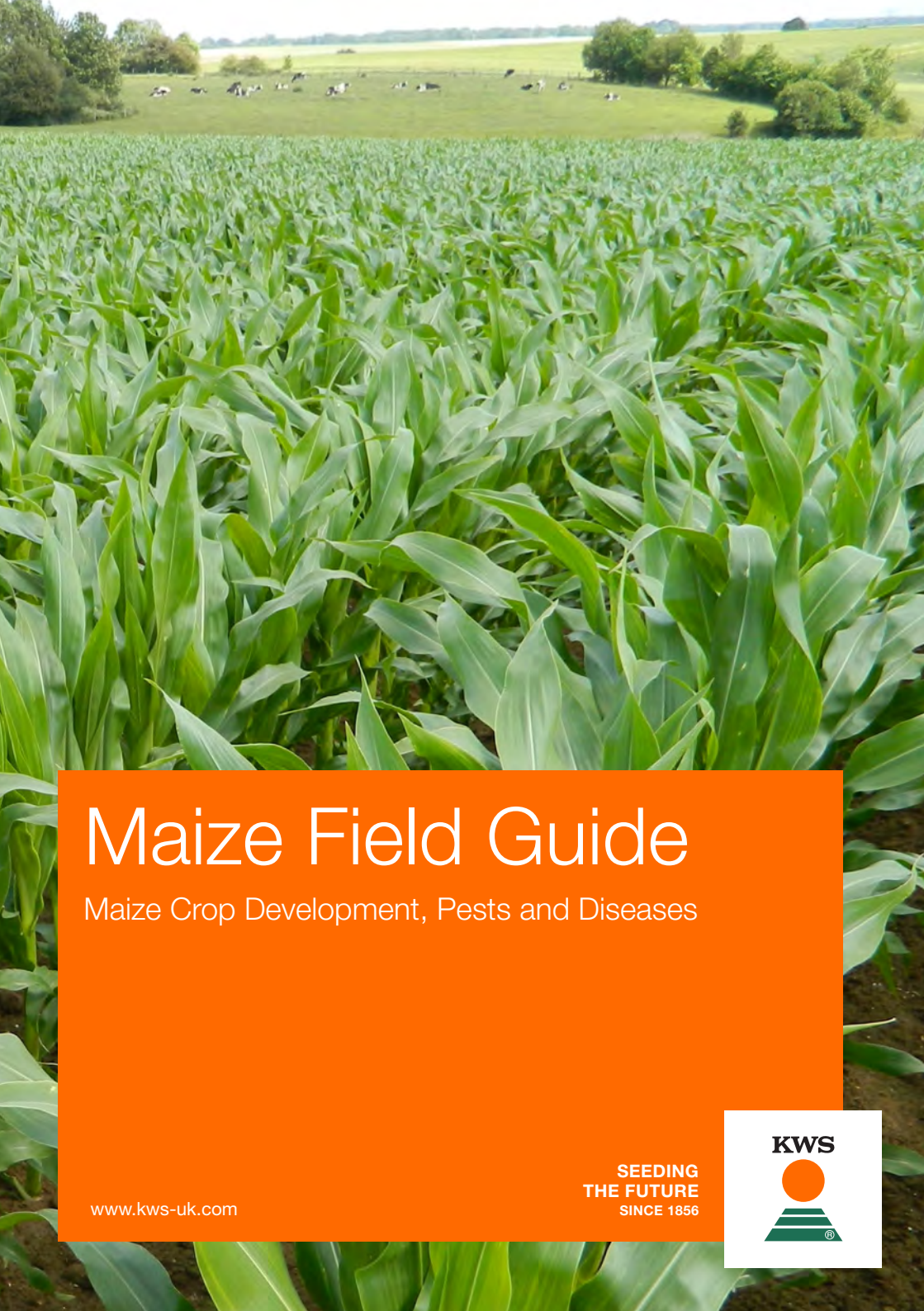


# Maize Field Guide

## Maize Crop Development, Pests and Diseases

www.kws-uk.com

SEEDING
THE FUTURE
SINCE 1856

KWS

# KWS Demonstration Site

**If you would like to visit the KWS Office and Demonstration Site at Lydney in Gloucestershire please contact your local merchant.**

KWS UK Maize, Demonstration Field and Office, Lydney, Gloucestershire GL15 6PN

# Contents

# CROP DEVELOPMENT

# Crop development

## Maize hybrids – From breeding to registration

| Year 1 | Year 2 | Year 3 | Year 4 |
|---|---|---|---|
| ▪ Maize populations from different genetic origins are crossed<br>▪ Plants are selfpollinated over seven generations to produce inbred lines<br>▪ The most promising lines are tested against a known control | ▪ New, elite lines are produced and the best components are identified | ▪ The hybrids are compared to key varieties already on the market<br>▪ Application is made for entry into official trials | ▪ National List application is made plus VCU and DUS tests<br>▪ The hybrid enters the commercial market |

## Haploid Lines – Speeding up Breeding

| Year 1 | Year 2 |
|---|---|
| ▪ Inbred line produced within only two generations instead of seven | ▪ Initial seed production and launch of commercial seed is fast tracked along with registration and pre-national listing |

*Screening Trials*

# Crop development

## Hybrid Types

| | |
|---|---|
| **Single hybrid** | ▪ Crossing of two inbred lines |
| **Three-way hybrid** | ▪ Crossing of a single hybrid (serving as the female line) with a male line |
| **Double hybrid** | ▪ Crossing of two existing single cross hybrids |

## Seed Production

- Line used as female parent is planted at end of April
- Line used as pollinator (male) is sown two weeks later
- Silks of 'female' line are pollinated with pollen of 'male' line
- Ears of 'female' line are harvested, dried, shelled and graded – these kernals are the seeds of the commercial hybrid
- Seed is dried, shelled, cleaned, bagged and shipped to the customer

# MAIZE GROWTH STAGES

# Germination and emergence

*A germinated seed*

*The first leaf appears*

## Germination

Three factors are needed for successful germination:

- Water – the soil surrounding the seed has to be sufficiently crumbly and moist
- Warm temperatures – 8°C and rising for 3-4 consecutive days
- Oxygen – the soil is not compacted

During germination, which generally lasts 36 hours depending upon temperature, the seed uses its energy reserves to grow. At the end of the germination stage, the radicle (root embryo) breaks through the seed coat.

## Emergence

Following germination the coleoptile (a protective leaf enclosing the first leaves and growing point) breaks through the surface. The first leaf then appears and unrolls.

## Comments

- The radicles growing out of the seed are the undeveloped root system
- The grain is connected to subsequent roots by an embryo axis. Its size and length varies depending on the sowing depth
- Deep drilling (up to 12 cm) will result in an elongated root system
- For leaves to develop properly, the soil surface must have a minimum temperature of at least 13°C

# 3-6 Leaf Stage

*Plants at the 3 leaf stage (the latest ideal timing for post-emergence herbicide application)*

## What is happening?

- The plant moves from heterotrophic nutrition (living on the energy reserves contained in the seed) to autotrophic nutrition (starting to live on organic compounds from the soil)
- The developing root system starts to nourish the plant
- Nodes and leaves begin to grow rapidly

## What it means

- This is a critical stage for the young maize plant. It is easily affected by phosphorus deficiency, particularly if the root system is badly developed or environmental conditions are detrimental (cold soil, excessive water)
- The density of the final population is now fixed
- The number of grain sites is fixed by the 6 leaf stage
- Large temperature fluctuations up to the 6 leaf stage can cause ‘double cobbing’. This can also be exacerbated by premature drilling

*Plants at the 5 leaf stage*

# 8-10 Leaf Stage

## What is happening?

- The growing point rises above the soil surface
- Rapid apical leaf development allows the crop to grow at up to 5 cm per day

## What it means

- The plant is now particularly sensitive to poor weather conditions, e.g. temperatures of less than 8°C and late herbicide applications

## Comments

- The plant initiates between 4-5 ear shoots, however, only one assumes priority and becomes a harvestable ear
- The highest ear is normally located at the 6th stalk node counting from top to bottom

# Stem Elongation

## What is happening?

- Rapid stem elongation begins
- The upper leaves unfurl and the tassel becomes visible at the top of the stem
- Formation of buttress roots

## What it means

- The number of ears per plant and the number of ovules per row are determined
- During this stage, the plant is very sensitive to water stress (one hectare of maize may have a daily peak uptake of 80 litres of water)
- Bad weather conditions may cause lodging or ‘green snap’

*Stem elongation and development of buttress roots*

# Flowering

*(Male) Tasseling and pollen shed*

*(Female) Silk emergence*

## What is happening?

- The first anthers start to shed pollen
- Pollen shedding starts at the upper third of the main spike of the tassel and then spreads out over the whole tassel down to the lower branches
- Each spike of the tassel sheds pollen for about eight days – up to 6 million pollen grains per tassel

## Female inflorescence (flowering)

- The first silks emerge at the ear tip
- The silks do not appear all at the same time; the silks from near the base of the ear emerge two to three days earlier than the ones of the ear tip
- It takes between one and three days until all of the silks have emerged

## What it means

- Female inflorescence gives the main indicator of a likely harvest date (this applies to grain as well as to silage varieties)
- This is the stage where Fusarium may first intercept the ear structure

## Comments

- Usually, the tassel starts to shed pollen the day before the first silks emerge
- The heat unit requirements from sowing to full grain maturity, directly determine the maturity of a hybrid (FAO number)
- The exact heat units for your farm can be found by entering your postcode in KWS' Live Maize Heat Unit Service, at www.kws-uk.com

# Pollination

*Pollen shed on the upper leaves*

*Full silking*

## What is happening?

- A pollen grain starts germinating within minutes of coming into contact with a silk
- A pollen tube forms, and grows down the silk channel until it reaches the ovule

## What it means

- The number of fertilised kernels is determined
- Incomplete pollination/kernel set may occur at this time
- Water supply plays a key role as it influences the receptivity of the silks
- Stress after silk emergence may cause premature ageing of the silks leading to pollination failure
- Both the pollen and silks

## Comments

- It is possible for several pollen grains to germinate on a silk, however, only one pollen tube will reach the ovule
- Under normal conditions, an ear

# Grain development

## What is happening?

- Cell division starts a few hours after pollination
- The silks begin to dry down
- The kernels begin ‘blistering’ after pollination

## What it means

- If stress occurs, kernel development may fail, especially the kernels at the ear tip. This is typically caused by high rainfall, nitrogen deficiency and lack of sunshine

# Grain filling and maturity

*Silage maturity*

*Grain maturity*

## What is happening?

- Vegetative growth is complete; dry matter produced by the leaves is transferred to the kernels
- The vessels, the link between the kernel and the cob, are closed down and a 'black layer' appears at the tip signifying full maturity of the kernel
- The kernel achieves its maximum dry matter weight

## Comments

- At the end of the grain filling stage, sugars and proteins have completely migrated to the ear; the plant is completely dry
- N.B. For silage harvesting this stage is rarely achieved

# PROBLEMS

# Field Emergence Problems

## Poor emergence

**Why?**

- Soil problems (water logging, compaction, tramlines)
- Strong temperature variations on light and dry soils (typically between day and night)
- Irregular water supply, or poor soil structure
- Bird damage
- Wireworm damage

*Ideal uniform field emergence: Check plants at random points in each field*

# Field Emergence Problems

## Large-scale emergence problems

Poor emergence is typically judged as a percentage of total crop emergence, usually where 90% of the crop is uniformly established and 10% of the field has failed. This may be explained by various reasons:

**a) Seed cannot be found**

- Wrong sowing disk (very large seed)
- Wrong air pressure
- Drill depth set excessively deep (beyond 12 cm)

**b) Seedlings seem to miss the selected row width**

- Uneven seed placement caused by incorrectly adjusted drill coulters (together with other factors like bird damage, drought), damage after mechanical weeding (too deep, wrong time)
- Compaction (tramlines)
- Poor coverage of the kernels (often due to drilling depth set too shallow or drilling too fast)

**c) Irregular emergence, very unevenly developed population**

- Excessively loose seedbed (bad water supply during germination)
- Poorly consolidated soil around the seed
- Excessively cloddy seedbed (bad water supply)
- Drilling depth too deep
- Suffocation in very wet soils
- Pest damage to the kernel (wireworms, symphalids, slugs)
- Fungal diseases like Fusarium, Pythium, Rhizoctonia (often in the case of a prolonged emergence time after early seeding)
- Ungerminated or germinated kernels remain too long in cold, wet soil
- Many doubles or misses from the drill (sown too fast, worn coulters)

**d) Ungerminated kernels, abnormal seedlings**

- Poor emergence conditions (drought, cold, excess water)
- Cloddy seedbed, poor preparation
- Interruption of germination due to cold temperatures

# Early Season Pests

## FRIT FLY

### When and why?

- 1-4 leaf stage
- Slow growth (e.g. cold spring) after an initially warm period favouring oviposition (egg laying)
- Clearly visible damage after emergence

### What to look for

- Fly: 3-4 mm, shining black – oviposition on the plant
- Larva: about 4 mm, without legs, pale yellow
- Damage across the leaf veins
- Leaves turn yellow
- Twisted leaves
- Damaged growing point (stunted, poor growth, tillering, twisted leaves, complete loss of the plant)
- Favours co-infestation with maize smut and soil-bourne spores

### What to do and when

- Use insecticidal seed treatments e.g. Mesurol®
- Take preventive measures to enhance early growth development such as careful seedbed preparation, choice of variety etc.
- Dependant on the degree of infestation and the plants' ability to produce an ear later on

### Comments

- Frit flies have 3-4 generations per year. The first generation affects maize in the young development stages

## CEREAL FLY

### When and why?

- 1-4 leaf stage
- Slow growth (e.g.; cold spring) favours cereal fly attacks

### What to look for

- Fly: Oviposition begins in the leaf whorl until around the 3-leaf stage
- Larva: Around 6 mm, attacks the leading shoot after hatching
- The first leaves are green, but new leaves turn red and wilt
- The stem base becomes narrow
- Plant death

### What to do and when

- Use insecticidal seed treatments e.g. Mesurol®
- Take preventive measures to enhance early growth development such as careful seedbed preparation, choice of variety etc.

### Comments

- There are two generations per year. The second generation uses rye grass as a host plant in the autumn

# Early Season Pests

## WIREWORMS

### When and why?

- Up to the 5-6 leaf stage

### What to look for

- Bug: Around 10 mm, dark brown
- Larva: 7-35 mm, legless, yellow-brown, round, feeds on root debris
- Affected patches in the field
- Heart leaves and young leaves turn reddish/brown
- Entrance holes at the root collar
- Tillering is possible, but shoots will fail to form an ear

### What to do and when

- Use insecticidal seed treatments e.g. Mesurol®
- Use micro granules
- Take preventive measures to enhance early growth development such as careful seedbed preparation, choice of variety etc.

### Comments

- Wireworms have a life cycle of up to 5 years, therefore, larvae of different sizes and development stages may be found in the soil
- Most damage occurs if the spring is humid and maize is grown within the first three years after grassland
- When to act 1-2 wireworms/$m^2$

## CUTWORMS

### When and why?

- Oviposition (egg laying) occurs in springtime.
- At the third larva stage, the larva stays in the topsoil layers during daytime and damages plants at the stalk and the roots.

### What to look for

- Moth: about 2 cm, grey, brown, black
- Caterpillar: up to 5 cm long, hairless, greyish brown, nocturnal. They curl up when disturbed, distinct from leatherjackets, which remain straight
- Damaged leaves in the whorl
- The plant is cut off at ground level then dries and perishes
- Incidence in patches
- Damage often looks worse than it is

### What to do and when

- Deep soil cultivation
- 2-3 larvae/$m^2$

# Early Season Pests

## NEMATODES

***(Ditylenchus dipsaci, Pratylenchus sp., Heteroda avenae)***

### When and why?

- Widespread in the soil prior to seeding; symptoms appear immediately after emergence
- High rainfall, cold weather
- Light soils
- Low pH-value

### What to look for

- Incidence in patches as soon as the plants are 1-5 cm high
- Root system is destroyed
- Strongly stunted growth
- Yellowing
- Lodging in grown plants

### What to do and when

- Take preventive measures to enhance early growth development such as careful seedbed preparation, choice of variety etc.
- Soil cultivation after harvest

## SYMPHALIDS

### When and why?

- From drilling to the 6-7 leaf stage

### What to look for

- Small millipede with 12 pairs of legs, starts laying eggs in spring
- Adults and larvae feed on germinating seeds and developing roots
- Weakened plants, yellow leaves
- Damaged root system

### What to do and when

- Take preventive measures to enhance early growth development such as careful seedbed preparation, choice of variety etc.
- Crop rotation

# Early Season Pests

## SLUGS

### When and why?

- From emergence to the 6-7 leaf stage
- Rainfall/excessive humidity
- Crop residues at the surface
- Cloddy soils
- Proximity of retreats (e.g. hedges)

### What to look for

- On young leaves, eaten leaf blades
- Entire plant is destroyed in the case of strong incidence (cut at the base)

### What to do and when

- Strategic use of molluscicides
- Careful seedbed preparation e.g. fine soil cultivation, avoiding crop residues on the ground, rolling

# Late Season Pests

## APHIDS

### When and why?

- June/July with a peak during cereal (wheat, barley) harvest

### What to look for

- Rose grain aphid (Metopolophium dirhodum)
  – 2 mm, green
  – Often to be found on maize during the 3 to 10 leaf stage
  – Aphids may have a strongly poisonous effect on plants if the attack happens early
- Grain aphid (Sitobion avenae)
  – 2 mm, olive green, brownish with black cornicles
  – Often to be found on maize during the 3-10 leaf stage
  – Deposits honeydew on the silks, but rarely causes pollination problems
- Bird cherry–oat aphid (Rhopalosiphum padi)
  – < 2 mm, olive green, with rusty red coloured parts
  – To be found on maize at the 5-6 leaf stage
  – Especially on tassels and uppermost leaves
  – Honeydew deposits can inhibit photosynthesis
  – After spraying liquid pyrethroids against the European corn borer, recurrence of aphid populations often occurs as spraying also kills useful predators

### When and why?

- Use insecticidal seed treatments e.g. Mesurol®
- Use natural predators e.g. ladybirds

### When and why?

- Barley yellow dwarf virus (BYDV): Leaf tips turn red
- Maize dwarf mosaic virus (MDMV) (very rare): Chlorotic (pale green) and dark green stripes on the leaves; retarded growth

*Aphids*

## LEAFHOPPERS

### *(Zyginidia scutellaris)*

### When and why?

- During the entire vegetation period
- Larvae and adults feed on the contents of the cell walls

### What to look for

- Small white spots on the leaves (lower part of the plant)
- Infestation moves upward
- The lower leaf withers (similar to natural maturation/senescence)

### What to do and when

- Spray with insecticide when white spots appear
- Use insecticidal seed treatments e.g. Mesurol®

### What to do and when

- Losses may reach 15% if the ear leaf pales (photosynthesis activity decreases)
- Other plant hoppers (Laodelphax striatellus) are vectors of the maize rough dwarf virus (MRDV)

# Late Season Pests

## EUROPEAN CORN BORER

### *(Ostrinia nubilalis)*

#### When and why?

- Moth activity and transit depends on adequate temperature with a peak in June/July
- Larvae start to be active from July
- Life cycle:
  – The frost-resistant larva remains in maize stubble (stalk/cob residue)
  – Hatch out starts in late May
  – The moth lays clusters of eggs in an overlapping configuration of 15-20 eggs underneath the lower leaves in early/mid June
  – The larvae hatch after ten days. They perforate the leaf and chew tunnels inside the stalks. When the maize develops further, the larvae may be found inside the cob or at the stalk base, which are the softest parts of the plant.

#### What to look for

- Moth: About 3 cm, yellowish brown with dark irregular wavy bands across the wings
- Larva: About 3 cm, yellowish brown, black head
- Eggs on the underside of the leaves
- Holes alongside the leaves as soon as they grow out of the whorl (early infestation). After hatching, the larva tries to get into the whorl
- Perforated stalks (around the nodes), sawdust may be found in the axilla
- Broken tassels
- Broken stalks
- Tunnels chewed through cobs, ears, at the ear base
- Infestations with Fusarium at the affected sites on the stalk
- Broken stalks and ears

#### What to do and when

- Cultural practices (chopping and incorporation of crop residues, as larvae hibernate in them until the spring). This practice eliminates roughly 75% of the larvae.
- Use an insecticide programme
- Chemical and biological control of the European corn borer is indicated in cases of at least 30 larvae per 100 plants in the previous year.

#### Comments

- There are different populations, some of which have one generation per year (e.g. Northern France, Northern Germany, Netherlands, Denmark, United Kingdom)
- In hotter parts of Europe (e.g. Southern Germany and Switzerland), two generations may be found and in Italy up to four
- The second generation onwards is mostly found directly on the ears
- Harvest is more time-consuming, yield losses

*Stem entry damage caused by European Corn Borer*

*European corn borer larva inside the ear*

# Late Season Pests

## PINK STALK BORER

### *(Sesamia nonagrioides)*

*Stalk borer damage*

#### When and why?

- During the entire vegetation period, with two separate generations
- Life cycle:
  – Larvae hibernate in crop residues
  – Hatching begins in April/May
  – Eggs are laid on the underside of the leaves
  – Larvae hatch and migrate into the whorls of the host plant and neighbouring plants
  – The new cycle leads to a second appearance of moths and oviposition (egg laying) in July

#### What to look for

- Moth: about 2 cm, greyish-white
- Larva: maximum 4 cm (larger than the European corn borer larvae), yellow-brown
- First Generation: appears at the 3 to 10 leaf stage
  – Leaf whorl damage
  – Plants wither in patches in the field
- Second Generation
  – Tunnelling in the stalks/broken stalks
  – Tunnelling at the ear base
  – Secondary infestations of the affected parts with Fusarium
- Reduced population density
- Broken stalks and ears: More time needed for harvest; harvest losses

#### What to do and when

- Cultural control – cutting crop residues and leaving them on the surface will enable frost to kill the larvae.
- Insecticide programmes – spraying the first generation will help to control a second generation which can be also be sprayed if needed

# Late Season Pests

## WESTERN CORN ROOTWORM

### *(Diabrotica virgifera)*

**When and why?**

- From June onwards, hatching in July/August
- Feeds on the roots

**What to look for**

- Beetle: 4-7 mm, lime green body, dark head, black stripes on the forewings
- Larva: 10-18 mm, whitish-yellow, brown head, 3 pairs of legs, found on maize roots
- Damage caused by larvae feeding on roots and root hairs which causes reduced water and nutrient supply
- Damage caused by beetles on leaves, silks which interferes with pollination and grain formation

**When to act**

- 0.6 individuals/plant

**What to do**

**Infested zone – within a radius of 1km around the infested field**

- Use an insecticide spray programme
- No maize cropping for two years. In individual cases, a three year crop rotation on individual fields may be possible, taking the previous crops of the two previous years into account.
- In the year of incidence, no transport of fresh maize plants or parts of plants (green or silage maize) from the infested zone to other zones before 1st October
- Maize not yet completely matured may not be harvested before 1st October
- Soil from infested areas may not be transported to other zones
- All machinery must be cleaned before leaving the infested zone

**As the Western Corn Rootworm is considered a quarantine pest within the EU, the following procedure must be followed:**

**Obligation to report**

- The incidence or suspected incidence of the pest must be reported without delay to the local plant protection service/authority

**Monitoring**

- The incidence of the pest is monitored with pheromone traps

**Pest control in case of first incidence**

- In case of incidence of a Western corn rootworm in an area previously free of the pest, an infested zone with a radius of at least 1 km around the infested field has to be declared, as well as a safety zone with a radius of at least 5 km around the infested zone

# Late Season Pests

**Safety zone – within a radius of 5 km around the infested zone**

- Two year crop rotation

**When to act**

- The infestation zone as well as the safety zone must be kept for three years
- The zones may be lifted once it is officially confirmed that no bugs/larvae have been found
- In case of increased incidence, the zones may be enlarged
- Special measures must be taken in regions where the pest cannot be controlled

# Late Season Pests

## BIRDS

### When and why?

- Mainly during emergence
- No more damage is seen after the 4-5 leaf stage

### What to look for

- Holes in the ground
- Grains lay bare or disappear
- Developing young seedlings are plucked out

### What to do and when

- Ensure seeds are drilled to the correct depth so no grains are left lying on the ground or insufficiently covered
- If possible, sow several fields at a time
- Use bird scaring devices
- Use appropriate seed treatments e.g. Mesurol®

# Nutrient Deficiency

## NITROGEN DEFICIENCY

### When and why?

- Starts with the autotrophic stage (when maize starts to take up nitrogen), but not during the first month of vegetation
- Insufficient fertilisation rate
- Organic manure is not mineralised (cold temperatures, high C:N ratio, manure with a high straw content)
- Drought (induced deficiency)
- Competing weeds
- Problems with root formation (compaction)

### What to look for

Temporary deficiency

- Weak plants of light green colour

### Strong deficiency

- Wedge-shaped, very typical chlorosis (pale green) beginning at the leaf tip moving towards the interior of the leaf along the midvein
- Poorly formed ears
- Leaves and/or entire plants perish

### What to do and when

- Apply fertiliser, if necessary (typically 100-130 kg /ha, NMAX 150 kg /ha)
- Apply herbicide treatments if the field has a high weed burden

*Nitrogen deficiency*

# Nutrient Deficiency

## PHOSPHORUS DEFICIENCY

### When and why?

- Mostly induced and appears during the months of May and June when weather is wet and cold and soils have a bad structure
- Phosphorus is absorbed by the plants during the entire vegetation cycle of maize, but is most critical in the initial growth stages

### Permanent deficiency

- Strongly acid soils (pH less than 5)
- Alkaline soils (pH greater than 7.5)

### Temporary deficiency

- Reduced absorption of phosphorus from the soil during development due to cold temperatures, wet conditions, drought or bad soil structure
- Underdeveloped root system due to cold, heavy soil

### What to look for

- Old leaves turn reddish-violet
- Growth is stunted and the efficiency of the root system is reduced
- When P deficiency persists, leaves dry up starting at the tip

### What to do

**Short-term**

- Warm weather and an increase in temperature will help

**Long-term**

- Apply fertiliser (typically 85-110 kg /ha)
- Help the soil structure by ensuring the seedbed is prepared properly

*Phosphorus deficiency*

# Nutrient Deficiency

## POTASSIUM DEFICIENCY

### When and why?

- Starts at the beginning of the autotrophic stage and lasts throughout the vegetation period
- Insufficient fertilisation
- Soil compaction (suffocating root system)
- Soils with strong potassium retention, especially clay soils
- Continuous nutrient removal e.g. silage maize monoculture and no replacement of potash or digestate

### What to look for

- Affects the oldest, lower leaves first
- Plant looks yellow-greenish
- Leaves turn yellow and brown margins appear at the leaf tips
- Distorted, curled, perished leaves
- Reduced resistance to lodging
- More susceptible to fungal diseases and bacteria

### What to do

- Distribute potassium before sowing (typically 260-300 kg /ha)
- Look to improve/restructure soil in case of clay soils

*Phosphorus deficiency*

# Nutrient Deficiency

## MAGNESIUM DEFICIENCY

### When and why?

- Starts at the beginning of the autotrophic stage and lasts throughout the vegetation period
- Acid soils
- Compacted soils, dry, heavy soils
- Light, sandy soils
- Insufficient organic manure

### What to look for

- White streaks between the green veins of the lower leaves
- Leaf tips and edges start to turn brown
- Leaves perish

### What to do

- Apply magnesium fertiliser
- Help availability of magnesium by increasing soil pH value
- Consider foliar application, however, symptoms are not visible until the plant has completed pollination

## MANGANESE DEFICIENCY

### When and why?

- Begins at the 4 leaf stage when the plant enters the autotrophic stage
- Soils with high pH values
- Soils rich in organic matter
- Sandy soils rich in humus

### What to look for

- White interveinal streaks
- Symptoms on the upper leaves
- Plant has a wavelike growth
- Impaired growth of new leaves

### What to do

- Foliar application of manganese

*Magnesium deficiency on the outer leaves of grown plants*

*Manganese deficiency*

# Nutrient Deficiency

## ZINC DEFICIENCY

### When and why?

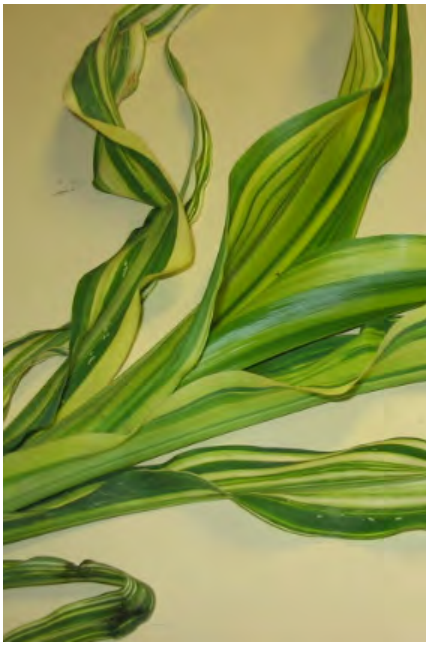
- Chlorosis on the leaves appears during the 5-12 leaf stages
- Starts to spread at flowering time
- Soils with pH values greater than 7
- Sandy soils with low organic matter
- Zinc deficiency is often found after periods of cold weather

### What to look for

- Streaks in new leaves around the central leaf vein on the lower part of the leaf
- Impaired growth
- Flowering is delayed with an impact on pollination

### What to do

- Apply a liquid fertiliser during the 4-6 leaves stage
- Look to reduce the soil's pH value



*Zinc deficiency*

*Iron deficiency (often mistaken)*

# Herbicide Deficiency

## PHYTOTOXICITY DURING PRE-EMERGENCE

### When and why?

- Herbicide damage may appear a few hours to a few days after application, depending on the weather conditions
- Excess rain after spraying
- Porous soils, especially sandy soils
- Sown too shallow
- Over dosing of herbicide e.g. spray overlaps

### What to look for

Chloroacetamide

- Leaves are curved, shortened, puckered and twisted

Dinitroanilines

- Strongly affects the root system

Isoxaflutole

- Burnt or twisted leaves

## PHYTOTOXICITY DURING POST EMERGENCE

### When and why?

- Herbicide damage may appear a few hours to a few days after application, depending on the weather conditions

### What to look for

Sulfonylureas

- Leaves fade to yellow until translucent
- Leaves curl up and inwards towards stem

# Diseases

## FUSARIUM GRAMINEARUM

### When and why?

- After pollination
- Infested maize debris left in the field
- Climate – cold and wet weather from flowering until autumn leading to high air humidity
- Other factors that weaken the ear e.g. insects, injuries etc.

### What to look for

- Silks and husks stick to the grains
- The tip of the ear is mainly affected including the spindle
- Grains break into the cob when the affected area is pressed
- Smell in the case of strong outbreaks

### What to do

- Harvest early
- Use cultural controls such as ploughing/ deep incorporation of stubble
- Choose varieties which are robust and suited to the region

*Fusarium graminearum on the maize ear*

# Diseases

## FUSARIUM MONILIFORME

### When and why?

- After flowering
- Infested maize debris left in the field
- Infestation begins through the silk channel. High rainfall during flowering is ideal for infestation
- Other factors that weaken the ear e.g. weather, birds, boring insects etc.

### What to look for

- Burst grains distributed unevenly over the ear
- White to pink mycelium (mould) which may be found all over the grain
- Cob stays intact

### What to do

- Insect control of corn borer and pink stalk borer is the very important
- Harvest early
- Choose varieties which are robust and suited to the region

### Comments

- Other than F. graminearum, F. moniliforme is a disease limited to maize
- The same fungus can attack the leaves
- 'Flaming maize' – when the entire plant turns red within a few days
- Strong differences of susceptibility between maize varieties

# Diseases

## FUSARIUM STALK ROT

### When and why?

- At the end of maize vegetation
- Caused by the fungus, Fusarium graminearum
- Stress
- Light soils
- High population density

### What to look for

- Emptied, weakened stalk, shredded pith, stalk breaks easily
- Base of the stalk is brown
- Brown and pink spots found inside the stalk
- Ears fall off
- Lodging of the crop

### What to do and when

- Choose varieties which are robust and suited to the region
- Ensure stubble is finely chopped and incorporated into soil
- Maintain good cropping techniques (fertilisation, population density)

## RHIZOCTONIA

### *(Rhizoctonia solani)*

### When and why?

- Beginning of the autotrophic stage until the end of the vegetation period
- Maize in a crop rotation with sugar beet or potatoes after three or more years
- Hot and humid climate
- Organic manure or high index soils

### What to look for

- Root necrosis which may destroy the entire root system
- Delayed vegetation
- Deficiencies in plant nutrition
- Crop lodging

### What to do and when

- Choose varieties with a high Rhizoctonia tolerance
- Avoid compacting the soil
- Keep an optimal pH-value of 6.5-7.0

# Diseases

## KABATIELLA ZEAE

### When and why?

- Early infestation (8 leaf stage onwards)
- Symptoms only appear at a more advanced vegetative stage
- Spores on contaminated leaves are spread by the wind
- Cold temperatures
- High air humidity

### What to look for

- Small, colourless, millimetre sized spots with brownish-red centre and yellow halos
- Leaf blade dries out starting at the bottom. By the end of the vegetation, the uppermost leaves and tips are the most affected

### What to do and when

- Choose varieties which are robust and suited to the region
- Ensure stubble is finely chopped and incorporated into soil

### Comments

- The damage is caused by reduced photosynthesis of the plant
- Can cause very significant losses

## COMMON RUST

### *(Puccinia sorghi)*

### When and why?

- Late summer
- Alternating heat and excessive water

### What to look for

- Pustules of 1-2 mm that spread over both sides of the leaves
- Release of brownish-black spores

### Comments

- Rare
- Affects yield only very rarely

# Diseases

## NORTHERN CORN LEAF BLIGHT

### *(Helminthosporium turcicum)*

#### When and why?

- In mild to warm and humid areas, generally after flowering
- Contaminated stubble of infested crops (resting spores, mycelia)
- Ambient temperatures between 18-27°C
- Humidity greater than 95% e.g. dew, mist

#### What to look for

- Spot-like lesions on lower leaves underneath the ear (primary infestation)
- Appearance of spindle-shaped, oblong lesions parallel with the leaf veins
- When lesions meet together, the leaf blade is destroyed (secondary infestation)
- The plant finally withers depending on the weather and the amount of infectious material
- Black dust on the stains = spores
- High incidence

#### What to do and when

- Ensure crop rotation on already infested fields
- Ensure stubble is finely chopped and incorporated into soil
- Select tolerant varieties especially late maturing hybrids – FAO 200+
- If the disease appears early and around 30% of the plants are affected, use a fungicide programme containing triazoles and/or strobilurins

#### What to do and when

- May lead to very high yield losses in case of early infestation (3-4 weeks before silage maturity), as the plant prematurely finishes starch synthesis
- Varieties with early maturity are usually more affected
- It is not possible to assess the situation with just one check. Effective control requires continuous monitoring of the disease

*Early symptoms of Helminthosporium*

# Diseases

## SMUT

### *(Ustilago maydis)*

#### When and why?

- First symptoms appear during the 8-10 leaf stage and during the entire vegetation period
- Soil infested with spores (which may survive for 10 years in the soil)
- Spread by wind, rainfall and insects
- Stress from damage caused by hail, strong rain, storms, drought, frit fly

#### What to look for

Early incidence

- Leaves with pearl-shaped deformations, torn leaves
- Often to be found after fly attacks

Late incidence

- White tumours that later turn into a black mass (sporulation)

#### What to do and when

- Avoid mechanical damage to the crop
- Maintain good management of soil structure

#### Comments

- Not toxic for dairy cattle provided maize is fully ensiled
- The disease may promote Fusarium infection of the ear

# Other Crop Damage

## CHILLING AND FROST DAMAGE

### When and why?

- Occurs when temperatures are less than 8°C for several days – chlorotic discolouring
- Early frosts – when temperatures are below -3°C the growing point dies
- Late frosts – when temperatures are below 0°C leaf necrosis occurs

### What to look for

- Often to be found at field edges/ depressions
- Seedling looks corkscrew-like

### Young plants

- Striated whorl, leaf colour fades and becomes pale
- Leaf tips become frozen and brown
- Twisted leaves and stem
- Vegetative growth stops, plant dies

### Adult plants

- Pale, dry leaves
- Usually affects the upper leaves

### Comments

Frost on young plants

- During the 4-5-leaves stage, when the new, recently grown leaves are green, the growing point is not affected, as it is still below the soil and insulated
- During 8-10 leaf stage, cold temperatures are more detrimental

Frost on adult plants

- Harvest silage maize earlier to conserve quality
- Where frosts are strong, maize has to be ensiled within three days of the frost
- Use ensiling additives as sugars are lost due to frost

# Other Crop Damage

## FERTILISER INJURY

### When and why?

- Visible as soon as plants start absorption or after spraying during initial development

### Reduced growth when rows forms

- Problems with the uptake of starter fertilisers when rows form
- Plant soon recovers unless seedling damage is evident

### Entire rows with reduced development

- Placement fertiliser spread irregularly (clogged drill machine). Fertiliser must be side dressed underneath the seed furrow at a distance of 3-5 cm from the kernel

### Entire rows are burnt

- Placement fertiliser deposited too close to the row can result in burning

### Burnt leaves

- Nitrogen fertilisation after emergence
- Surface treatment with ammonium nitrate after 5-leaves stage (dew: burning on leaf whorl)

# Other Crop Damage

## PHYSIOLOGICAL LEAF CURLING

### When and why?

- From the 7 leaf stage until the 12-13 leaf stage
- Some varieties have problems producing leaves under stress e.g. temperature fluctuations, growing under plastic

### What to look for

- Curled leaves for several days which may last until the end of stem elongation
- Whitish or pale yellow leaves

### Comments

- The visual effect can be quite significant, however, as long as the affected plants unfurl their leaves later, there is unlikely to be an effect on yield
- Not to be mistaken for herbicide damage

# Other Crop Damage

## TILLERING

### When and why?

- Typically during the 4-5 leaf stage
- Early attacks of frit flies which lead to the destruction of the growing point
- Any kind of stress affecting the main shoot (low temperatures/frost)
- Strong growth – individual plants due to low population density, very fast growth in early summer
- Poor varietal stability

### What to look for

- Frit fly attacks – several shoots maybe attacked and in the case of strong attacks, the main shoot cannot be identified
- Tillering at the side of the main shoot
- More prolonged harvesting for silage due to lower leaf wrap around cutter bars

# Other Crop Damage

## LODGING/'GREEN SNAP'

### When and why?

- From the 8-10 leaf stage until harvest
- Strong winds, hail, excess rainfall etc.
- Very fast growth during the vegetative stage
- Fusarium stalk and ear rot (in grain stage)
- Others factors such as Rhizoctonia, nematodes etc.

### What to look for

- Lodging before flowering
- Green snapping before flowering
- Stalk breaks at the bottom
- Stalk breaks below the ear
- Lodged or broken plants due to strong winds and/or excess rainfall
- Severe yield loss
- Harvesting is more time-consuming

### What to do and when

- No efficient measures possible
- 'Responsible' cropping e.g. population density, fertilisation, pest control, etc.
- Choose varieties which have resistance to lodging

### Comments

- Plants lodged before flowering may recover easily, provided that lodging does not happen too close to flowering

# Other Crop Damage

## WATER DEFICIENCY

### When and why?

- As soon as the plants needs increase (10 leaf stage onwards)
- Reduced water availability in the soil
- Poor weed control
- Cultivation technique is not adapted to water availability e.g. excessive population density

### What to look for

- Leaves are pale green, as there is less water in the cells, and curl up
- Wilting foliage
- Inhibited plant growth

### Comments

- Water deficiency affects the plant before it becomes visible with curled leaves
- The plant regulates its water consumption by stomatic regulation. Very often leaves that have curled up during the daytime unroll during the night and the cells are filled with water
- The plant needs excessive water in case of a potassium (potash) deficiency. Potassium helps to regulate the opening and closing of the stomata
- Water deficiency also strongly affects the ear e.g. sterile, badly pollinated ears, bad ear growth etc.

*Early season drought*

*Late season drought*

# Other Crop Damage

## INCOMPLETE SEED SET

### When and why?

- Becomes apparent during the grain filling stage
- Silks are not receptive when pollen is shed (high rainfall at flowering)
- Excessive heat reduces pollen vitality
- Excessive cold in juvenile growth stages

### What to look for

- Uneven distribution of seeds on the cob (ovules not pollinated)

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