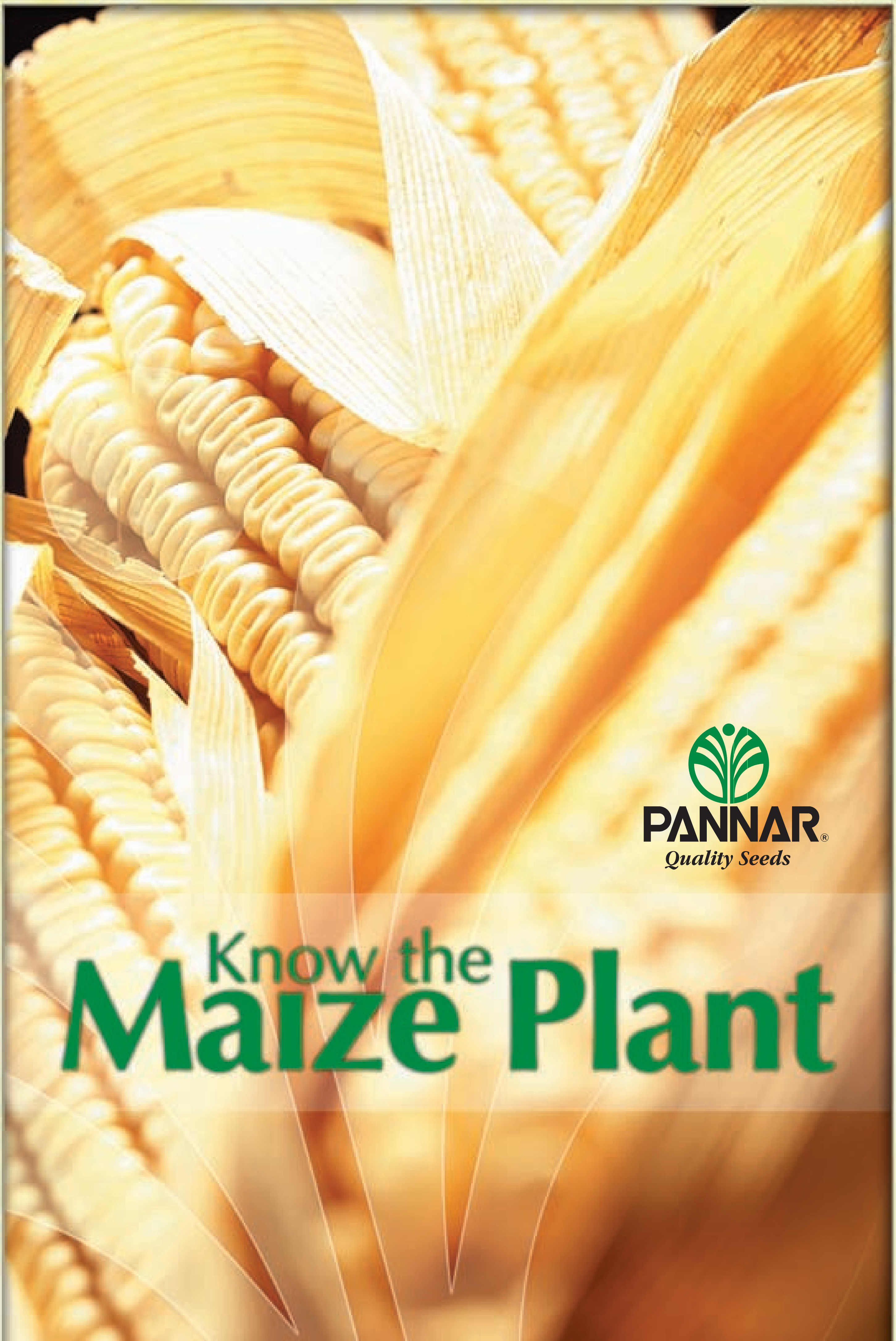
Know the Maize Plant



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Know the Maize Plant

Mechanics of the Maize Plant

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1 FROM PLANT TO EMERGENCE

SEEDBED

The value of a well prepared seedbed cannot be over emphasized. It creates the ideal base for vigorous and uniform plants at the required population. This forms the foundation of a good grain crop.

SEED

The yield expectation starts with the seed. Seed is the final result of a lengthy, expensive breeding and production programme. The seed contains the yield potential as well as certain attributes that will bring the best out of the climatic and soil conditions.

REQUIREMENTS FOR A GOOD PLANT POPULATION

There are three conditions of utmost importance:

- Moisture must be favourable. Rainfall of 25mm should normally ensure that there is sufficient moisture in the soil to commence planting, if the sub-soil is moist.
- Enough oxygen
- The minimum soil temperature is important.

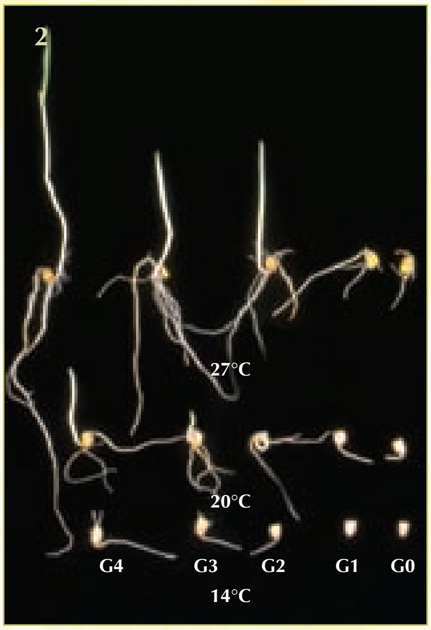
The temperature for planting must be adequate. Maize seed will not germinate below 10°C. Ideal temperatures should be 18°C and higher. A shortage or, in some instances, too much (like excess water) of the above elements can have a negative influence on the final plant population as well as the uniformity of the plants.

MANAGEMENT HINTS

- Early planting must be as shallow as possible within certain limits. Deep planting means lower soil temperatures with slower germination and an uneven stand.
- Place fertilizer in bands at least 5cm deeper as well as 5cm away from the seed to prevent chemical burn. This is crucial especially on sandy soils.
- Do not apply more than 60 - 70 kg nitrogen (N) plus potassium (K) in the band, as this can lead to chemical burn.
- Prevent the soil from forming a crust, or rectify the problem immediately. Treat with registered insecticides to reduce soil insect damage.
- A weedfree seedbed after emergence gives the seedling the best chance for good establishment. Evenly emerged seedlings form the basis of a good crop.

THE EFFECT OF SOIL TEMPERATURE AND PLANTING DEPTH ON DEVELOPMENT

PIC 1: Effect of different planting depth on seedling development. Note the difference in seedling development, from seed planted too deep on the right to an optimum depth on the left. The deeper you plant the lower are the soil temperatures, resulting in lower and uneven plant population. Note the seed with the coleoptile curling round it, typical symptoms of seed planted too deep.



PIC 2: Difference in development tempo at 14˚C, 20˚C and 27˚C in the soil over a period of 5 days.

ROOT DEVELOPMENT THE FOUNDATION FOR A PROMISING CROP

Root development can have an important influence on the yield potential of the crop.

When looking at a stand of maize the general appearance, plant population and the colour of the crop will impress the most. Few people are aware that what is visible of the crop is a manifestation of what is happening in the soil.

THE FIRST ROOT SYSTEM

The primary root system of the maize plant starts functioning before emergence and plays a crucial part in determining the potential of the plant, up to the last stage of grain-filling.

A radicle starts developing 2-3 days after planting, and the primary roots are almost fully developed at emergence. These radicles feed on the endosperm of the seed and develop rapidly to form the main root system of the young plant up to the five leaf stage. It keeps on functioning until late in the growing season of the plant.

The above information shows that the correct management at planting can be a major contribution factor on good root development of the plant. An example is to plant shallow with early planting as the soil temperature decreases with an increase in depth. The importance of this is emphasized in the fact that planting too deep can delay emergence with up to two weeks. Primary roots show a poor reaction to soil fertility levels but react very well to fertilization in the row.

Early root development can therefore be enhanced by placing small quantities of phosphoric fertilizer very close to, or on the seed, at planting (popup). Beware of placing fertilizer with a high percentage of nitrogen or potassium close to the seed. This can burn the seedling or even kill it.

PIC 3: A healthy root system forms the basis for a successful crop. The seedling in the middle has been damaged by ground Insects and will result in a weak plant.

PIC 4: Excellent root development in the single leaf stage. Primary roots can clearly be seen on the picture.

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Another valuable management tool is to treat the seed with a registered chemical to protect it from soil insects. This will assist in obtaining a uniform plant stand as well as healthy seedlings.

With later plantings and higher soil temperatures, deeper planting can be done to ensure the seed is placed close to the available moisture. Take care not to plant too deep, especially in soils that form a crust or compact easily.

THE MAIN ROOT SYSTEM

From the six leaf stage until late into grain filling, it is the secondary or nodal roots that supply most of the nutrients required by the plant. These roots develop at a soil depth of 25mm-35mm, irrespective of planting depth, and are concentrated at 300mm around and under the plant. They can develop to a depth of 1.5m to 2m. These roots react well to general soil fertility as well as band placed fertilizer. Hair roots that develop actively from these roots can die due to drought stress but will develop again as soon as moisture becomes available.

GIVE THE ROOT SYSTEM THE BEST CHANCE FOR OPTIMUM DEVELOPMENT

From a management perspective, it is easier to break up compaction layers during the primary land preparation before planting. When the compaction is broken up at a later stage of the plants development, a shallow cultivation needs to be performed to avoid damage to the plant's root system. Mechanical damage can increase the possibility of stem and root rot. This will in turn lead to poor moisture uptake by the plant, especially during grain filling. Lodging also becomes a bigger problem. Where the aluminium content in the soil is high, as in the high rainfall areas, lime must be incorporated into the soil as deeply as possible, to ensure good root development. A profile pit, of around 1.5m to 2m must be dug across the rows to establish how well and how deep the roots have developed.

PIC 5: The first secondary roots start to develop from the first node.

PIC 6: From each node below the soil surface a set of secondary roots will develop.

THE LAST ROOT SYSTEM

During the last phase of the vegetative growth, brace roots (also known as aerial nodal roots) develop from the nodes just above the soil. These roots can penetrate the top soil layers. Their primary function is to support the plant but they can also scavenge the top layers of the soil for water and nutrients during the reproductive stage. Brace roots can play an important role if water-logging conditions occur when secondary roots will start to die off. Lands that tend to get waterlogged later in the season should be planted first as more mature plants handle wet conditions better than younger plants. If a hormonal herbicide is used during the development of brace roots they will develop abnormally.

PIC 7: Good brace root development. The separate roots below are the secondary or nodal root system.

PIC 8: Dying off of secondary roots due to very wet conditions. See how the brace roots compensated.

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PIC 9: Tillage too near and deep can result in root and stem rot. The photo illustrates the difference between a diseased and healthy plant.


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2 THE FACTORY OF THE MAIZE PLANT - VEGETATIVE GROWTH

LEAF AND STEM DEVELOPMENT

Each stage of the development of the maize plant needs specific management. By attending to the correct management at a specific time, optimum yields can be obtained with more ease. With the above in mind, we will divide the leaf and stem development of the maize plant into four stages;

Emergence to five leaf stage, six to eight leaf stage, nine to twelve leaf stage and thirteen leaf stage to flowering.

THE SEEDLING STAGE

The characteristic of the first leaf is that it has an oval point that differs from all the other leaves. At this stage of the vegetative growth of the plant, the leaves develop the slowest, with a new leaf emerging every ± four days. These leaves develop from the nodes under the ground.

PIC 1: The first leaf stage - note the oval point of the first leaf. The first five leaves disappear as the plant gets older.

At emergence a good uniform plant stand will lay the foundation for an excellent yield potential, while an uneven stand will increase competition between the plants. The weaker plants will not be able to compete and will produce very little grain or no yield at all - especially under high plant population conditions.

PIC 2: The two leaf stage. Notice collar on second leaf.

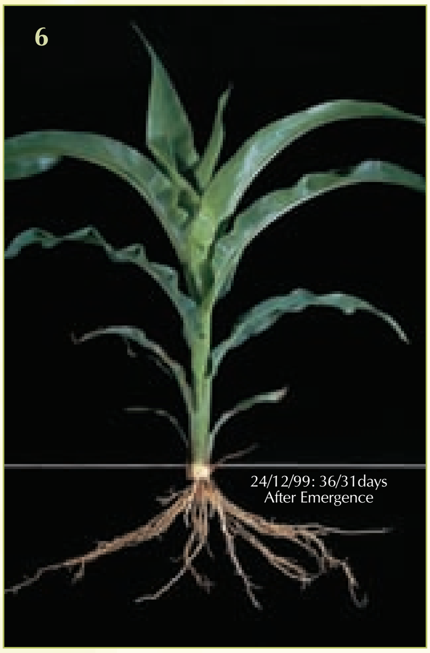
An important point to remember is that the theoretical yield potential is established at the five leaf stage when the cob and tassel are initiated at the growth point. At this stage the growth point is still under the ground. It can clearly be seen when a plant is cut vertically in half, on the part of the stem that is still under the ground.

PIC 3: At the two leaf stage the growth point is still below the soil surface.

Any nutritional deficiencies must be corrected immediately at this stage. Weed control is very important to ensure that the small slow-growing plant can establish itself well. With the growth point under the ground very

PIC 4: At the five leaf stage the growth point is just below the surface.

PIC 5: In the five leaf stage the lower leaves break loose because of root and stem development.



PIC 6: At the seven leaf stage the plant begins to develop quickly and lower leaves disappear.

PIC 7: At the eight leaf stage the growth point is above the surface and internodes are easily recognised.

PIC 8: A maize land in the eight to nine leaf stage.

wet conditions can lead to extreme yield loss, but hail or cold damage will not have a major influence on the yield at this stage. Low temperatures and hail damage may however lead to slower development of the plant, and delay growth by a few days.

THE BEGINNING OF THE ACTIVE GROWING STAGE

At the six to eight leaf stage the growth point is above the ground. The plant develops quicker with new leaves emerging approximate every three days, with an increase in moisture and nutrient requirements. The secondary roots are well established and form the main root system of the plant. Tillers will form and leaves on the lower nodes start to break off the stem and can disappear. Because the main leaves of the plant have not appeared, hail damage may not be very critical, except in the case where the total plant is destroyed. To determine the leave stage after 9 to 10 leaf stage, add 5 to the number as the first five leaves would have disappeared.

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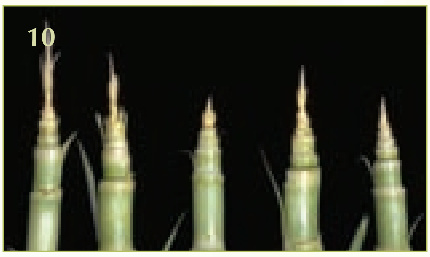
PIC 9: A plant in the nine leaf stage. Most of the leaves originated below the soil surface will have disappeared.



PIC 10: Plants in the nine to ten leaf stage. It demonstrates tassel growing point at different stages of early development. Early cob development is visible on nodes.

NITROGEN APPLICATION BEFORE THE EIGHT LEAF STAGE

This is the ideal time to apply a nitrogen top dressing. All nutritional deficiencies must now be rectified to ensure that the final yield potential determined, during the twelve leaf stage, is not influenced negatively. Where the surface of the soil has compacted a light tillage cultivation can be done to aerate the soil. Cultivation must be very shallow and away from the roots to avoid any root damage.

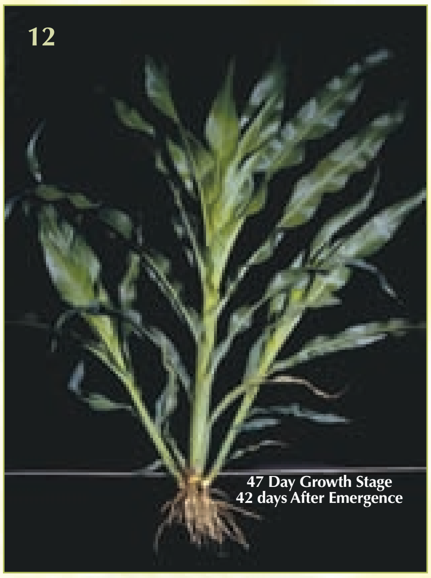
A drought at this stage will cause shorter plants, the effect on yield loss on dry land productions will be relatively small. In early planted crops first generation stalkborer can become visible. This can easily be controlled by spraying.

NINE TO TWELVE LEAF STAGE

At the nine to twelve leaf stage things start happening. Cob development quickens and starts to show if the plant is dissected. Stem development also speeds up due to the lengthening of the nodes. A new leaf will appear every two to three days and the final cob size is determined - this means the number of rows on the cob as well as the egg-cells in the cob row, thus the total yield potential. The stem also starts to develop quicker with the internodes getting longer from the bottom to the top.

On an irrigated crop it is essential that the plants do not suffer any moisture shortages at this stage of the growth cycle. Care must also be taken that all nutrient deficiencies were corrected beforehand.

PIC 11: A plant in the ten leaf stage. Note the start of the tassel development.



PIC 12: A plant in the ten to twelve leaf stage with two well developed suckers.

ACTIVE GROWING STAGE

From the thirteen leaf stage to flowering the stem and leaf development keeps accelerating. The last few leaves appear every one to two days. As with the leaves, cob development also speeds up, this especially applies to the top cobs. With prolific hybrids the top 2 - 3 cobs will develop to almost the same size, while single eared hybrids will give preference to the development of the top cob.

At a low plant population, tillers will develop prolifically during favourable conditions, while in high plant stands tiller development will come to a standstill or even die off due to an energy shortage.

PIC 14: Cob development in the final stages of vegetative development showing the difference in size of the upper cobs and those below.

PIC 13: Fourteen leaf stage. The start of the critical two week before tasseling. The two weeks before and after tasseling is the most critical period in the life cycle of the maize plant.

PIC 15: The difference in development between quick, medium and medium late cultivars planted on the same date.

Tassel development will be complete at around 3 - 4 days before the silk appears and pollen is released. This is when the vegetative growth of the plant terminates.

MANAGEMENT TIPS

From a management point of view, with maize under irrigation it is of vital importance to prevent any moisture stress two weeks before and two weeks after tasseling. Hail damage at this stage, especially during tasseling can mean a total crop failure. The factory of the plant, which is the leaves, is now fully developed. The plant cannot recover from any form of damage. In maize lands especially lands planted late in the growing season, second generation stalk borer can appear. This is normally a severe infestation and leads to big yield losses and poor grain quality due to *Fusarium* cob-rots. An aerial application of the correct chemical will be needed to solve this problem.

The moisture as well as fertilizer requirement of the plant is very high at this stage. Strong root development will assist the plant to withstand very wet conditions. Deep tilling operations must be avoided as this will enhance stem and root rot infection.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3 THE REPRODUCTIVE STAGE OF THE MAIZE PLANT

POLLINATION

A typical characteristic of the first stages of reproductive growth is when the silk appears at the tip of the ear. The silk usually grows for three to four days while pollen shedding takes place mainly in the mornings for a period of about seven days. Drought stress at this stage will reduce the time of pollen shedding and delay silk development, while cool, moist conditions will prolong this period. Tillers will shed pollen seven to ten days later than the main plant, which could be advantageous in some dry seasons.

PIC 1: Difference in cob development on the same stem. The large cob is the primary and main ear on the plant and a few days from emergence.

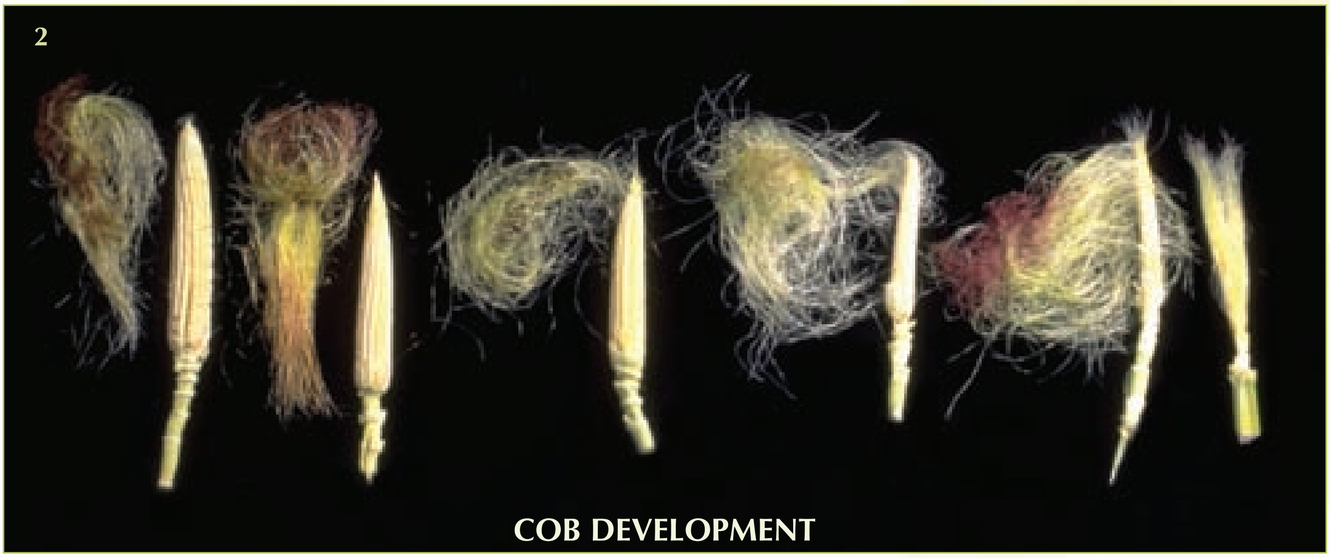
DRYLAND PRODUCTION AND POLLINATION PERIOD

The growth stage of the maize plant at the time of pollen shedding and silk development in dryland production is of utmost importance. In the western production areas of the country it is the determining factor for the best planting time for the biggest portion of the crop.

During pollination the pollen falls on the sticky silks, germinates and grows down to the egg nucleus on the cob where fertilization takes place. The whole process takes about 24 hours which makes it one of the quickest growth processes in nature.

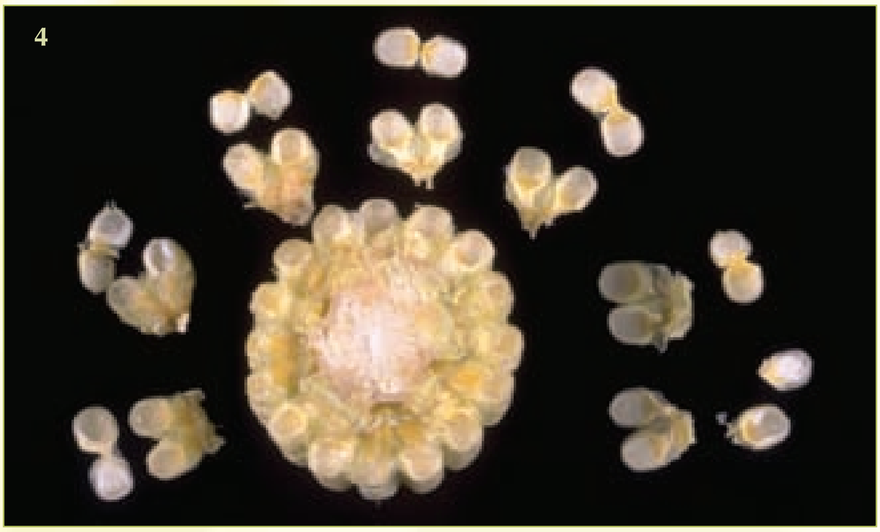
MANAGEMENT HINTS

The most important management tools are the choice of planting date and plant populations under dryland production, especially in the western production areas of South Africa. These choices are linked to the long-term climatic conditions of the area. This is the most critical time in the



PIC 2: Different stages of silk development and fertilization. The cob on the left is fully fertilized and silk has already abscinded. Second from the right is a unfertilized cob with the silk still attached to the cob.

development of the maize plant, as the moisture requirement of the plant is at its highest level and damage, due to drought stress, the most severe. From the above it is imperative that long-term rainfall records are studied carefully to determine the peak rainfall periods as well as the obvious midsummer drought periods (if applicable) that need to be avoided to ensure a good crop. From the above information it has been proved that the peak planting date for the Western production regions are after 20 November for the best results. Cultivar choice is another tool that can assist in reducing risk. Hybrids that have proved themselves over the years under dryland conditions as well as at low plant populations during good and bad seasons must receive first choice. Prolific hybrids play a vital role in hybrid choice in the Western production regions.



PIC 4: The first stage of grain development is the blister stage. The kernels are still transparent and the contents jelly like.

In the Eastern Highveld the primary factor determining plant date is the number of heat units required by the crop, which means that the bulk of the planting should take place in October for best results.

With an irrigated crop it is especially important to take note of the critical time, two weeks before and two weeks after silk development when enough moisture should be available to the plant.

GRAIN FILLING

Blister Stage

The first stage of grain filling is known as the blister stage, and is the start of grain development. Immediately after pollination, the silk separates from the core (cob), and the developing kernels look like a blister. The content of the kernel is clear, and jellylike. White and yellow maize look the same at this stage.

This stage takes 10-15 days depending on cultivar type and heat-units. The kernels at the base of the cob develop first and the kernels at the tip of the

PIC 3: A plant with two cobs. The top cob has been fertilized and the grain is in the blister stage. The brown silk indicates fertilisation is complete.

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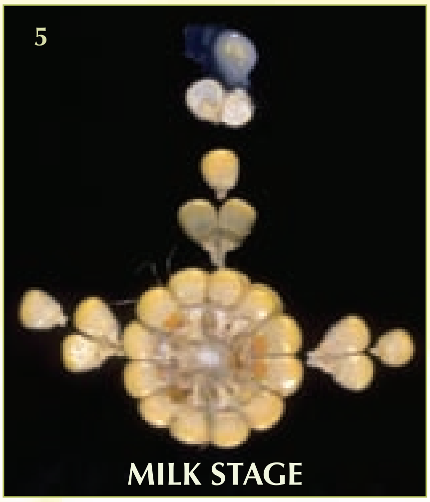


PIC 5: The milk stage is the second stage of grain development. This is the start of starch build up.

PIC 6: During the dough stage starch is deposited and the contents are a paste.

cob last. In the drying phase of the grain, this process is reversed with the kernels at the tip of the cob drying off first.

Although abscission of the silk takes place after pollination, bollworm can be found on the silk and front kernels. This normally does not cause too much damage. Hail damage, frost and drought can lead to huge crop losses and poor quality grain. The moisture requirements of the plants are still very high and of utmost importance under irrigation.

Soft Dough Stage

The next seven to ten days are the milk stage. The kernel content is soft and sweet, and the kernels of yellow maize start to change colour. The end of this stage is the ideal time for picking green maize.

At this stage there is a reduction in the moisture requirement of the plant, although it is still relatively high. Drought, hail and frost will have a big influence on yield and grain quality. The farmer must be on the look out for insect damage to the grain. This can induce *Fusarium* cob rots.

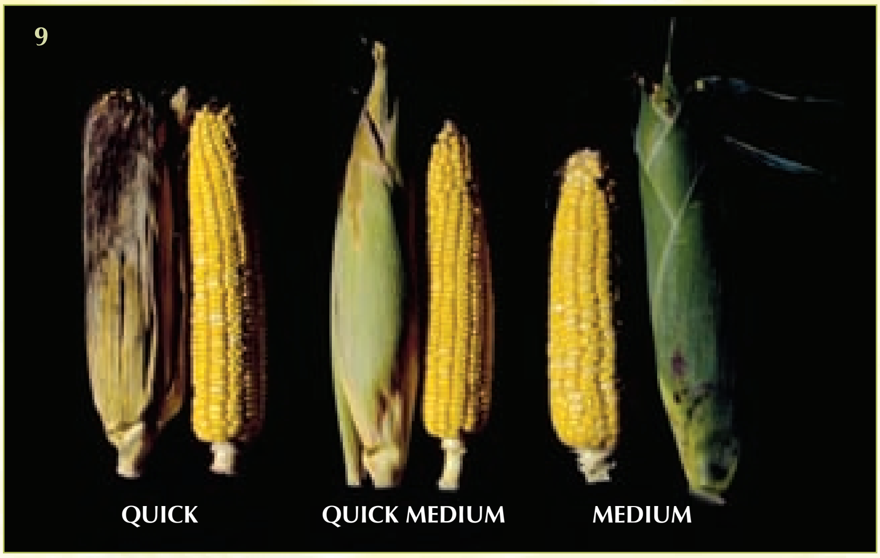
PIC 7: The full dent stage. This is the ideal stage to ensile the crop.

Hard Dough Stage

The dough stage follows and also takes seven to ten days. The moisture content of the grain drops rapidly and the kernel content changes to a paste. The formation of starch increases and the weight of the grain is about half the actual yield.

Drought stress at this stage still has a big influence on yield and grain quality. Although the moisture requirement is less, it is still reasonably high. A drought during this stage will cause cobs to hang prematurely, and/or wean off the kernels at the tip of the cob.

PIC 8: Characteristic of mature grain is the black layer at the base of the kernels.



PIC 9: Different stages of grain development. Quick cultivar on left is physiologically mature, the medium quick in the full dent stage and the medium cultivar on the right in the dough stage. When 80% of the husk leaves are brown the crop is physiologically mature.

Full Dent Stage

The dent stage of development - the correct time to cut silage - lasts 12 to 15 days and is complete when all the kernels have formed a dent on the crown. The moisture content of the grain decreases quickly, and should be around 50%.

Enough moisture is still important, but not crucial. Drought and frost can still reduce yield and grain quality.

Physiological Maturity

Physiological maturity is the last stage of the grain filling period and takes 15 to 20 days while the moisture content of the grain decreases from 50% to below 40%. There are no soft portions of grain at the tip of the kernel (this is where the kernels are joined to the cob) and the hard starch line, also known as the milk line, has moved through the kernel from the crown of the kernel to the attachment on the cob. A black layer will develop at the tip of the kernels.

The colour of the husk leaves that cover the cob are 70% to 80% light brown. In contrast to grain filling, the kernels at the tip of the cob will mature before the kernels at the base.

The moisture requirement of the plant is now very low, but drought will still influence the yield and grain quality. With an irrigated crop, irrigation can cease when 80% of the husk leaves have turned brown.

Characteristic of the final stage of the maize plant's existence starts with the husk leaves changing to a light brown colour. The bottom leaves on the stem have dried down and a light brown colour replaces the last green in the top leaves. A black layer at the tip of the kernel where it is joined to the cob is distinct when threshed. Moisture content of the grain is around 35%.

After physiological maturity the drying period up to harvesting is determined by the grain type. The flint types will dry slower than the dent types. The humidity of the environment also plays a role in the rate of drying-down.

PIC 10: Healthy mature maize plants ready for harvest.

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4 GRAIN QUALITY AND HARVESTABILITY

The final yield has been established when the maize plant has reached physiological maturity. The moisture content of the grain is now about 35%. The mature grain needs to dry down before it can be combined and stored. Moisture content should be below 15%. The time needed to dry down will be influenced by the relative humidity, temperature, maturity class of the cultivar, grain type and husk cover. This period can range from 50 to 100 days depending on the interaction of the above factors.

Grain quality can still be influenced in the dry down period by low temperatures, relative humidity, insect damage and certain cob diseases. A farmer can reduce this risk by drying the grain artificially, but it is normally a costly exercise and in some cases impractical.

COB DISEASES

a) Diplodia

Two types of cob rot can damage the crop at this stage. Diplodia cob rot can come into the crop during grain filling or after physiological maturity, thus also in the drying stages. The infection during the drying stages is commonly known as "skelm" Diplodia (not visible) due to the grain on the cob not showing any signs of the disease as will be the case with an early infection. Only after the grain is shelled do the brown stains become visible on the grain. This fungus can develop on grain with a moisture content of >15%.

There are some management tools that can reduce the risk of Diplodia cob rot of which "clean" lands are the most important. Infested crop residue needs to be destroyed as best as possible and/or deeply incorporated into the soil. A drastic measure would be to burn the residue and incorporate the residue deep into the soil. Crop rotation with unrelated crops like soybeans, groundnuts or dry beans will also have a good sanitation effect.

Tolerant hybrids can also be considered. Diplodia cob rot is a complex disease, and no hybrid is immune to the disease. There are in fact vast differences in tolerance to the disease and farmers can choose hybrids with an excellent tolerance. Artificial drying is another method of reducing the risk of poor quality due to "skelm" Diplodia. This can reduce or prevent infection.

PIC 1: Diplodia cob rot.

b) Fusarium Cob Rot

In contrast to this, Fusarium cob rot will infect ears before physiological maturity. It is more often a secondary infection that occurs where pysical damage have been caused by hail or second generation stalk borer. The effect of the disease is only noticed after harvest and is sometimes mistaken for Diplodia cob rot.

PIC 2: Fusarium cob rot.

Due to the fact that second generation stalk borer infestation increases Fusarium cob rot, it is important that stalk borer is controlled, especially in later planted crops.

COLD DAMAGE

Other problems that can still be experienced at this stage of the crop production are cold damage due to subzero temperatures. This normally happens in late plantings and in very cold areas. Distinctive of cold damage are kernels that look pale, and the crop dries off much more slowly than normal. The kernel contents are soft and light.

In areas where cold damage is common, hybrids with a short growing season need to be used for later planting dates. Low-lying lands must be planted first.

PRE-GERMINATION

PIC 3: Pre-germination of grain - due to a molybdenum deficiency in the soil.

An exceptional phenomenon is pre-germination of grain, which has been observed in certain seasons in Kwazulu-Natal and Mpumalanga. Seasons with low sunlight hours, lots of overcast weather and low heat units normally leads to this phenomenon. It happens during the latter part of grain filling, and is normally only noticed at harvesting when it is mistaken for cob diseases.

Molybdenum deficiencies are responsible for the above. To treat the seed at planting will not stop pre-germination. The only way to prevent this is to spray the young plants when knee high till tasseling with a solution of 100g/ha of Sodium Molybdate.

STEM AND ROOT ROT

The ability to combine-harvest the crop can also be influenced at this stage by stem and root rot. Typical symptoms are the lodging of plants that reduce the ability to combine. This disease is a complex infestation made up of Fusarium, Diplodia and Gibberella and other fungi. Plants are normally infected during the later growth stages of grain filling. As plants get older, the immunity of the plant decreases and heavy infestations are possible.

At high plant populations care must be taken to ensure that the correct nitrogen and potassium fertilizer has been applied. High nitrogen and low potassium levels will increase lodging. Root damage in wide row spacing - especially during the later stages of growth - can lead to this disease. Hybrids differ in tolerance. Those that have stalks that stay green longer will tolerate the disease better. Crop rotation as well as incorporating the residue into the soil on a rotational basis will reduce lodging. Good stalk-borer control will increase standability. Early harvesting and artificial drying are the last resort, but costly.

PIC 4: The primary cause of lodging is stem and root rot.

DRY DOWN OF GRAIN

The last aspect that influences the time of harvest is the relative humidity and the hybrid type planted (short-, medium or long growing seasons). Late rains during dry down of grain can delay the harvest process for a couple of weeks.

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The type of grain and maturity of hybrids also plays a important role, for instance a hybrid with a short growing season and a dent type of grain, will be ready for reaping a couple of weeks ahead of a later maturing hybrid with a flinty type of grain.

HYBRID CHOICE

If a farmer would like to harvest early, he must plant as early as possible at the most reliable planting time for his area and ensure that a hybrid with a short growing season is part of his package.

The Tables clearly indicate the vast differences in plant development at the same planting date (1 November), but in different areas. These tables compare the interaction between the growing season of the different production areas, heat-units and stage of plant development. It shows the projected days to tasselling, physiological maturity and harvest ability of three different maturity classes.

In the same region the differences between hybrids gets bigger as the plants develop further. At Potchefstroom the difference in days to tasseling between the ultra quick hybrid and the medium season hybrid is only 3 days, but to harvest it widens to 22 days. Although this information is only a guideline, the most important concept is that of planting date for different climatic regions.

COOL REGIONS:
In the cooler areas this will have a large influence on yield potential due to the shortage of heat-units. Late planted crops will not only have reduced heat-units, but a portion of the grain-filling period takes place beyond the peak rainfall period.

WARM REGIONS:
In the warmer Western production regions heat units are less of a limitation. Here it is more important to choose a planting time where grain production coincides with the months of the best rainfall for instance the end of January to mid February. In these areas it is all about risk evasion and the best chance

Table: A comparison of three maturity classes with the same planting date of 1 November at four areas. Ranging from a warm area to a cool locality.

Ultra - short	Development Stages					
	Flowering		Mature		Reap	
Locality	Date	Days	Date	Days	Date	Days
Hoopstad	27 Dec.	57	11 Feb.	103	12 April	163
Potchefstroom	1 Jan.	62	20 Feb.	112	21 April	172
Babsfontein	13 Jan.	74	17 March	137	26 May	207
Ermelo	25 Jan.	86	17 April	168	16 Jun.	228

Medium	Development Stages					
	Flowering		Mature		Reap	
Locality	Date	Days	Date	Days	Date	Days
Hoopstad	29 Dec.	59	17 Feb.	109	3 May	184
Potchefstroom	4 Jan.	65	27 Feb.	119	13 May	194
Babsfontein	16 Jan.	77	27 March	147	10 Jun.	222
Ermelo	29 Jan.	90	25 April	176	9 July	251

Long	Development Stages					
	Flowering		Mature		Reap	
Locality	Date	Days	Date	Days	Date	Days
Hoopstad	31 Dec.	62	20 Feb.	120	16 May	205
Potchefstroom	6 Jan.	67	2 March	122	26 May	207
Babsfontein	19 Jan.	80	1 April	152	6 July	237
Ermelo	1 Feb.	93	2 May	183	26 July	268


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MOISTURE UTILIZATION

The mechanics of the maize plant are best illustrated when maize is compared with other grain crops. Grain crops are divided into two main groups i.e. C4 and C3 plants. They differ as follows:

The C4 plants are more economical in their use of water compared to C3 plants. The maize plant is a C4 plant and needs 350 to 500 liters of water to produce 1kg of grain (depending on the climate and nutrient status of the soil). Sunflower, on the other hand, a C3 type plant, needs twice as much water (700 - 800 litres) to produce 1kg of grain.

• Yield potential

The C4 crops have a much higher yield potential than the C3 crops. Compare maize with sunflower. Maize yields of 12 to 15 ton/ha are not unusual under irrigation, whereas 3 to 3.5 ton/ha yields are an exception for sunflower.

• The difference between C3 and C4

The C4 crops produce less complicated nutrients e.g. sugar and starch, whereas the C3 crops produce more complex and higher quality nutrients like oil and protein.

• Classification of C3 and C4 crops

C4 crops - sugarcane, maize and grain sorghum

C3 crops - dry beans, soya beans, ground nuts, sunflower and wheat.

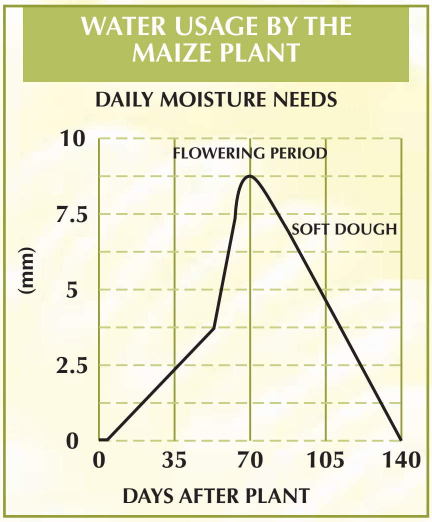
MOISTURE UTILIZATION AND THE MAIZE PLANT

When cultivating maize it is important to understand the critical role of water during the different growth stages. In the following well known graphs the daily water requirements as well as the effects of drought stress on the final yield are illustrated.

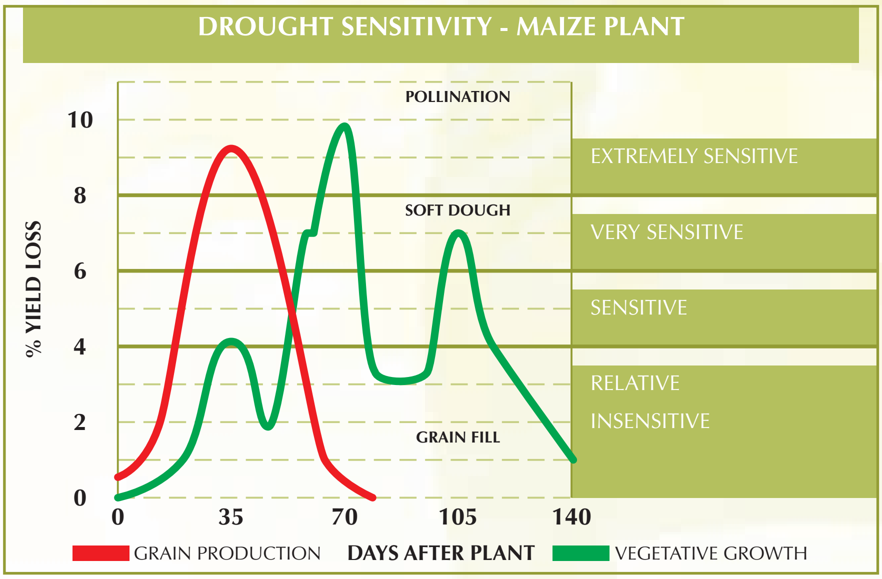
WATER REQUIREMENT OF MAIZE

Initially the moisture requirement is low and builds up to a maximum during the flowering period of the maize plant. Thereafter the moisture requirement progressively decreases until the plants are physiologically mature. In practice it is important to remember that the moisture requirement is at its highest approximately two weeks before and two weeks after pollination. During this period all the leaves will have unfolded and the first critical stages of grain development will take place.

Graph 1



Graph 2



VEGETATIVE STAGE

Dryland:

In short in graph 2 shows that the young plant is very sensitive to drought stress during its vegetative development. A period of drought stress during this stage will result in a smaller plant. This normally has a relatively small implication on the potential yield under dryland cultivation.

Irrigation:

Under irrigation it is important that the plant experiences no stress during this period as one strives for the optimum "starch factory" to ensure the maximum yield potential.

The definition of a stress day is when the plant starts to wilt early in the morning. In other words it did not recover from the previous day's drought stress.

REPRODUCTIVE STAGE

The most sensitive period is during pollination when millions of pollen grains are produced (graph 2). Pollen is pure protein and thus requires a lot of energy for its production. In this period the moisture requirements are at a peak. Under high plant populations the requirement can be 10mm or more per day. This is determined by the prevailing temperatures, humidity and air flow.

MANAGEMENT HINTS

a) Dryland

Planting date: The choice of planting date can make a big contribution to minimize risk. In the cooler eastern production regions, heat units are the principal factor to consider when planting maize. As one moves to the western production areas, the midsummer drought plays an increasing role in the choice of planting date. It is important that pollination should not take place in this period. Planting date should be such that the bulk of the maize production flowers after the traditional midsummer drought. Under normal conditions the bulk of the planting should take place from 20 November to 15 December in the Western production regions. Should one start the season with a wet profile, a part of the planting could be done earlier.

Plant Population: In the drier regions a relatively low plant population is recommended. Choose multi cobbing (prolific) hybrids to plant at lower plant populations. This will ensure the best chance for a crop in a dry season. More important, the plant must compensate with more cobs to ensure an above average yield under favourable conditions. This could be especially important in an El Niño season, where a dry midyear is more likely.

Choice of growing season: It has been proved over many seasons that medium growers should comprise the bulk of the planting. To minimize risk it is also important to plant a package of hybrids of different growth classes over an extended period.

Stability: The majority of the planting should comprise hybrids that have proven their worth over seasons. Phase in new hybrids on a small scale, to provide for improved cultivars for the future.

Cultivation: Cultivation practices should be directed at conserving moisture and optimum land preparation for maximum root penetration.

b) Irrigation

Success under irrigation starts with the best adapted cultivars and plant population. However it is of equal importance to apply sound management practices. Any weak link may limit the yield potential. Avoid drought stress as far as possible. Good moisture management is improved by the ploughing in of organic matter, breaking up of any compaction layer and correct scheduling of irrigation. It is important to note that during the period before and after flowering, the moisture demand could be so high that many irrigation systems can't keep up with the demand. This can be overcome and minimized, to a great extent, by entering this period with a wet profile.

Irrigation should continue until 80 percent of all the outer cob leaves have turned brown. At this stage all cobs will be physiologically mature and no more moisture is required for grainfilling. Do not stop irrigation to soon as this can affect the yield and grain quality.

2 THE NUTRITIONAL REQUIREMENT OF THE MAIZE PLANT

The maize plant should be regarded and managed as a "starch factory". The efficiency of the factory and its production potential is determined by a few important factors of which the most important are water, nutrition and heat units. Fertilisation is also essential to ensure that the factory produces at it's full capacity. The factory is powered by the leaf area per plant and the unit soil area. It is important that each land must be managed and fertilised according to its nutritional status and yield potential.

Soil Medium and Fertilisation

The creation of a soil medium that allows optimum root development forms the basis of a promising maize yield.

Maize Hybrids and Soil Acidity

The neutralization of soil acidity plays an important role in determining the full yield potential. Hybrids that can tolerate acid soils exist although no hybrid is resistant to soil acidity. There is no hybrid that can replace a liming program. In a successful maize production system liming is essential. Except for better root development and nutrient uptake, it also supplies the essential elements of calcium (Ca) and magnesium (Mg).

FERTILISATION

The following tables and graphs have been taken from the 1994 FSSA Fertilisation Manual. These guidelines give a broad background to the nutritional requirements for the main nutrients of nitrogen (N), phosphorus (P) and potassium (K). These nutrients are essential for grain production and do not usually occur in sufficient quantities in the soil.

Table 1 indicates the amount of N, P and K that are removed by 1 tons of maize grain.

PLANT	N	P	K
GRAIN	15	3	3.5
WHOLE PLANT	27	4.5	20

The table is a broad guideline and does not take into account aspects like denitrification and phosphate fixation. It is not meant for a fertiliser programme. Consult a expert in this respect.

NITROGEN

Nitrogen plays a very important role in the yield. Application guidelines are based on yield potential. Table 2 gives an indication of the nitrogen guidelines for different yields.

These are broad guidelines that can be refined to each situation. The higher the yield target the more nitrogen per ton of grain is required. Nitrogen plays an utmost important role where maize is cultivated under irrigation, and the yield target exceeds 10 tons per hectare.

Table 2 Nitrogen Fertilisation Guidelines for different yield potentials.

	Ton/ha								
Yield Potential	2	3	4	5	6	7	8	9	10
	kg/ha								
Nitrogen Application	20	45	70	95	120	145	170	195	220

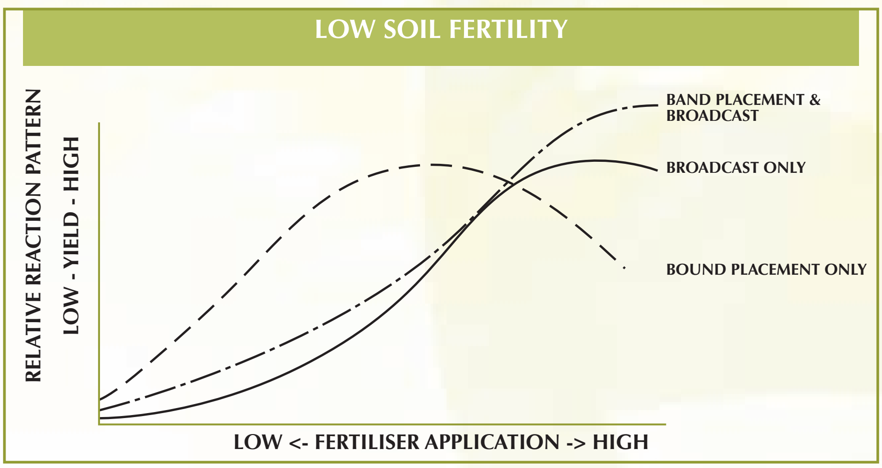


Fig. 1 - Response to fertilisation in a low fertility soil

Fig. 1 RESPONSE TO FERTILISATION IN A LOW FERTILITY SOIL

Important Deductions

a) Dryland with low fertility. The most economical and efficient way of fertilisation is band placement.

b) Band placement is economical and the most efficient way to limit fixation of nutrients.

c) Broadcast fertiliser is only efficient at high fertility levels and is not an economically sound practice for low fertility and low yield potential.

Fig. 2 REACTION TO FERTILISATION AT HIGH SOIL FERTILITY

At high fertility the reaction to band placement is substantially less than at low fertility levels. It is a practice to band place some of the fertiliser as it acts as a pop-up, stimulating early growth especially where the soil temperature is still low at planting. Under high potential and irrigation conditions, high soil fertility is essential to meet high yield expectations.

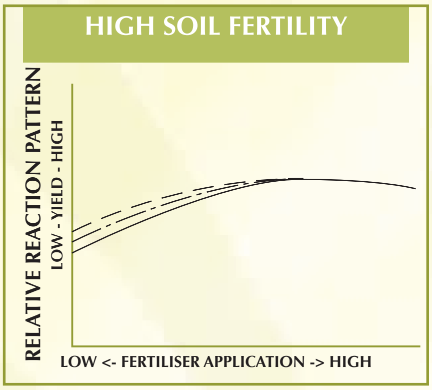


Fig. 2 - Reaction to fertilisation at high soil fertility.

Fig. 3 TEMPO OF N, P AND K UPTAKE

The uptake of the three nutrients accelerates with the highest percentage of the total requirement before and after flowering.

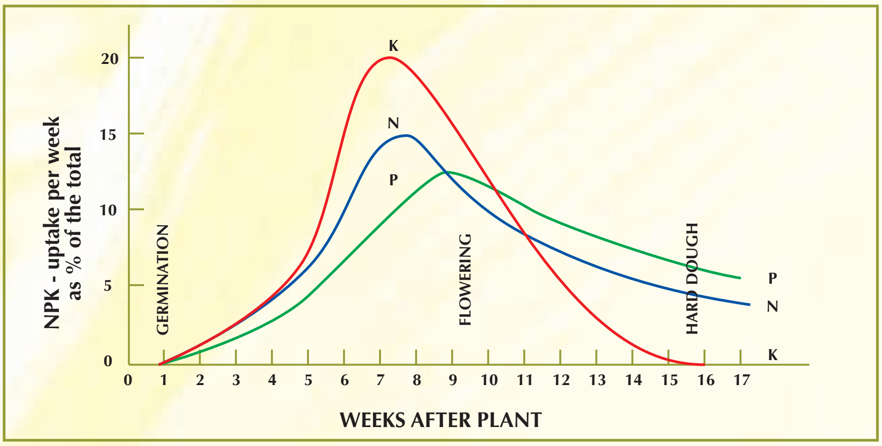
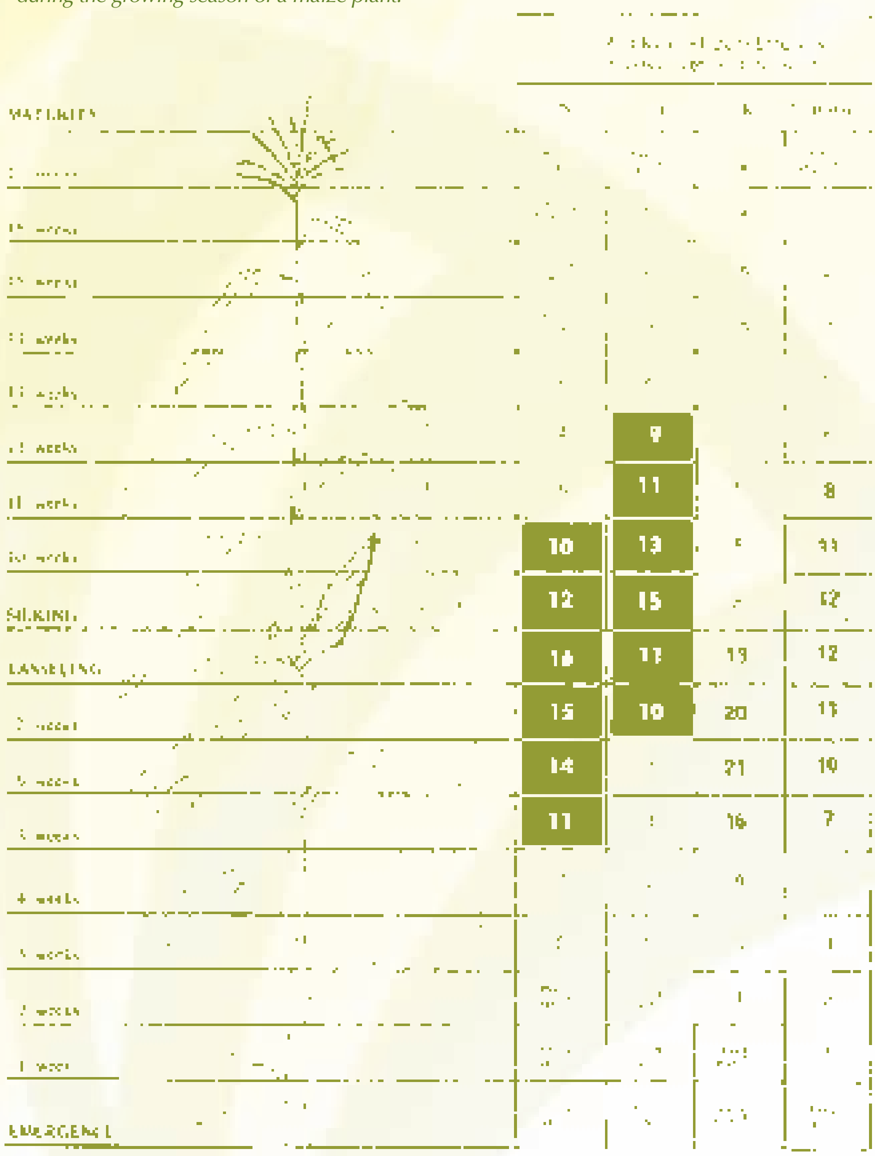


Fig. 3 - The tempo of N, P and K uptake during the growing season of a maize plant.



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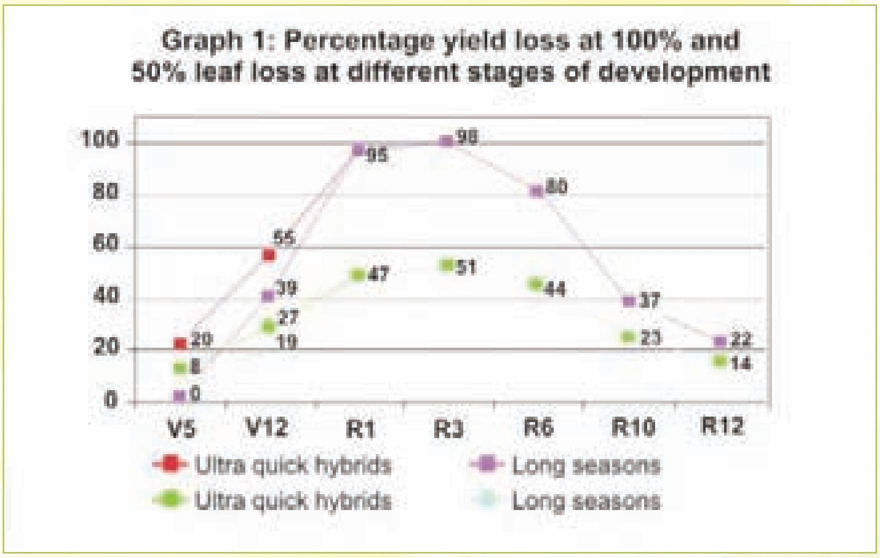
3 THE MAIZE PLANT AND HAIL DAMAGE

Hail causes millions of rands damage every year. It is a phenomenon that is endemic to all the maize production regions. This article focuses on the vulnerability of the maize plant to hail damage at different growth stages. The percentage yield loss at the different growth stages is based on research done by Kobie de Beer of the ARC.

In the study a comparison was made between the ultra quick and longer season hybrids. The yield loss as a result of 100% and 50% leaf loss at the different growth stages was also compared and is shown in Graph 1.



The detrimental effect of leaf loss on grain development

The photo's below demonstrate the influence of leaf loss (evidence of hail damage) on cob development is illustrated. This demonstration work was done by Heinz Oellermann of the Agronomic Services at Greytown.

83 days after plant ***90 days after plant*** ***103 days after plant*** ***126 days after plant***

For the purpose of the discussion, hail damage is discussed at the following easily recognised growth stages.

GROWTH STAGES

1. Five leaf stage (V5)
2. Twelve leaf stage (V12)
3. Pollination period (R3)
4. Grain filling period:

- Blister stage (R6)
- Soft dough stage (R10)
- Hard dough stage (R12)
- Full dent stage (R13)
- Physiologically mature stage (R14)

FIVE LEAF STAGE (V5)

The young maize plant was cut off ±1cm above ground. The plants produced almost a full yield. The only difference between this and the control was that it flowered one week later. A comparison between hybrids by the ARS found that the ultra quick hybrid types showed a yield loss of ±20%, whereas the long season hybrids had almost none *(see graph 1)*. This results from more leaves being produced by the long season hybrids. Ultra quick hybrids produce ±19-20 leaves compared to the 20-23 leaves of the longer growing season hybrids.

Environmental stress such as hail damage, drought stress, nutrient or moisture stress may lengthen the vegetative stage but will shorten the reproductive stage.

TWELVE LEAF STAGE (V12)

At this stage the plants showed considerably higher yield loss. Again the longer season hybrids exhibited a smaller yield loss than the short season hybrids.

This is also due to the increased number of leaves of the longer season hybrids. The yield loss at this stage was about 40% for the long season and 55% for the short season hybrids. With 50% of the leaves removed the yield loss was 19% (long season) and 27% (short season) respectively.

POLLINATION PERIOD (R1-R3)

At this stage ±50% of the silks of the maize plants are visible and the maize plant is at it's greatest risk due to hail damage for the following reasons:

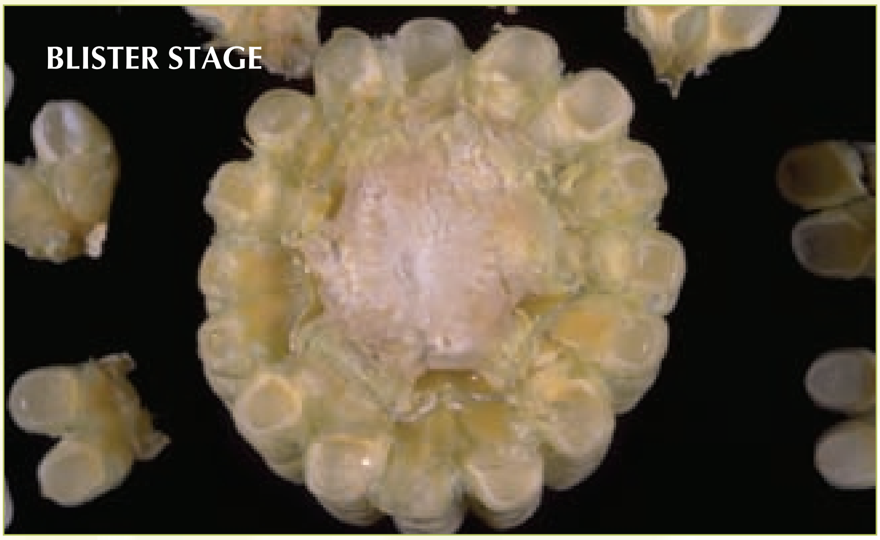
- Most of the nutrients (N, P & K) have been taken up by the plant.
- None of the photosynthates (sugars) have been translocated to the cobs.
- The "factory" of the plant is fully developed.

A 100% leaf loss due to hail will result in about a 100% yield loss. The leaves are the starch factory of the plant and without leaves the factory cannot function.

The most critical time for hail damage, as with drought stress, are the two weeks before and after pollination.

GRAIN FILLING

During the first stages of grain filling i.e. the blister and soft dough stages, yield loss is at it's highest. Yield loss progressively lessens until the plant is physiologically mature. The photo below and graph 1 illustrate the expected yield loss at the different stages of cob development.



INDIRECT YIELD LOSS

Damage to the stalk, such as bruising, is the ideal source for stem infection by stem and root rot organisms. Heavy infestation can occur after hail damage. This reduces the period of grain filling which leads to huge yield losses and problems with grain quality. It is illustrated by the hanging cobs 126 days after planting, where leaf damage occurred at blister stage.
(Photo on the previous page).

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SYMPTOMS OF COB AND STEM ROT

- Typically, cobs start to drop prematurely.
- Grain on the cob is loosely packed (inadequate starch accumulation).
- Colour of the grain has a pale matt appearance with poor hectolitre mass (bushel weight).
- The endosperm is soft and powdery.
- Some plants die overnight.
- Fusarium is the dominant organism that causes the problem.

THE RESULT OF DAMAGE DUE TO DROUGHT, HAIL OR DISEASE ON COB DEVELOPMENT DURING THE DIFFERENT GROWTH STAGES


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4 HEAT UNITS - FUEL FOR THE MAIZE PLANT

Heat units are the most important environmental factor, making the largest contribution to the growth rate of the maize plant. This includes the development of the roots, stem and leaves. The plant cannot develop from one stage to the next advanced stage without receiving the necessary heat units.

What is the ideal temperature?

The optimum temperature for development of the maize plant is approximately 30°C. At temperatures below 6°C and above 45°C photosynthesis comes to a standstill.

How do we measure heat units?

The following formula was specifically developed for the maize plant.

$$\text{Heat units} = \frac{\text{Max} + \text{Min}}{2} - 10^\circ\text{C}$$

The maximum and minimum temperatures are recorded over a 24 hour period (per day). The reason for subtracting 10°C from the average temperature is that the maize plant stops developing below 10°C.

How does the maize factory work?

The maize plant can be regarded as a starch factory. The plant utilizes water and nutrients from the soil, CO_2 from the atmosphere and sunlight (heat units) as the energy source to manufacture plant food, of which starch is the main component. In this process heat units play an essential role in determining the final yield and quality of the grain.

MAIZE ARE SHORT DAY PLANTS

This means that as days shorten the quicker they mature. The shorter the days get, the less heat units are available per day and the quicker grain filling comes to an end. This is one of the reasons why late plantings tend to give disappointing yields. This can also result in poor quality grain. The growth period is shortened by insufficient heat units. This plays an important role in the cooler production regions. Typical symptoms seen in late plantings are purple leaves that indicate that the sugar translocation from the leaves to the cob is taking place at a reduced rate because of low temperatures. Sugar starts to accumulate in the leaves and causes the purple colour.

CULTIVAR TYPE, GRAIN PRODUCTION AND HEAT UNITS

When considering cultivars, the longer season types tend to have a greater leaf area that utilizes the available heat units better. These hybrids are usually prolific and have the ability to give higher yields under low plant population conditions. The short season types tend to have more upright leaves and a smaller leaf area. These hybrids can utilize sunlight better under high population conditions and thus produce high yields, ideal under irrigation.

Table A: The rate of development of the maize plant in different production regions

(Planting date 1 November)

Hybrid type and Locality		Development stages			
		Flowering		Physiologically mature	
		Date	Days	Date	Days
Ultra Short growers e.g.. PAN 6804	Hoopstad	27 December	57	11 February	103
	Potchefstroom	1 January	62	20 February	112
	Babsfontein	13 January	74	17 March	137
	Ermelo	25 January	86	17 April	168
Medium Growers e.g.. PAN 6479	Hoopstad	29 December	59	17 February	109
	Potchefstroom	4 January	65	27 February	119
	Babsfontein	16 January	77	27 March	147
	Ermelo	29 January	90	25 April	176

PRACTICAL IMPLICATIONS OF HEAT UNITS AND OPTIMUM PLANT DATE

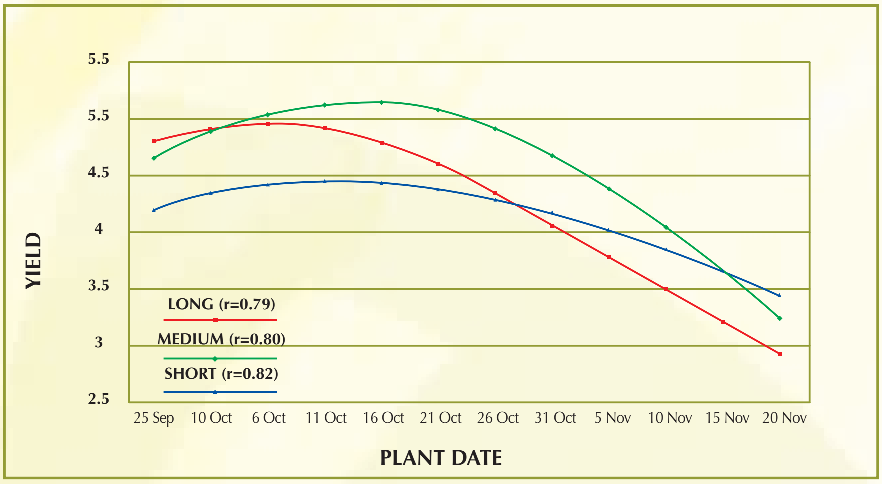
Optimum plant dates vary between production regions. The long term temperatures (heat units) play an extremely important role. When cultivating dryland maize it is also important to consider the long term rainfall and distribution.

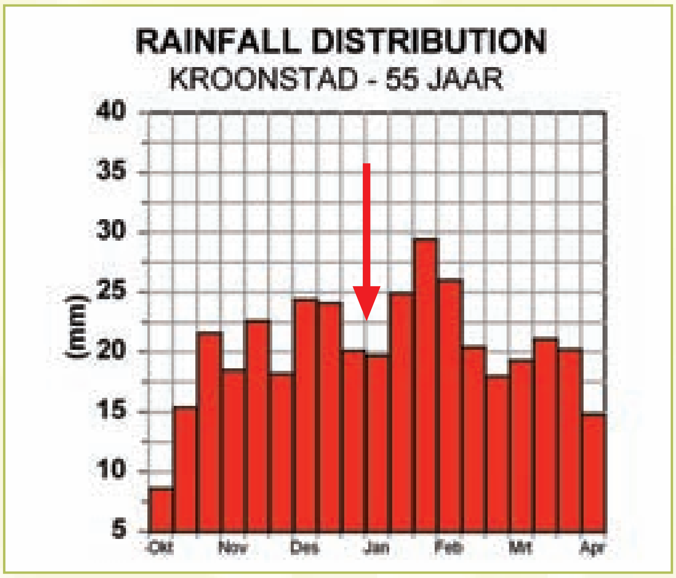
In Table A the difference in the tempo of development as influenced by heat units for different production regions is illustrated. As an example an ultra short hybrid planted on the 1st November in Hoopstad and Ermelo respectively, will flower one month apart. At physiological maturity the difference will be two months. Heat units thus play an important role in the determination of the optimum planting date and the choice of growth class. It is important to study long term rainfall data to get the best advantage from the available heat units, long term rainfall and hybrid type.

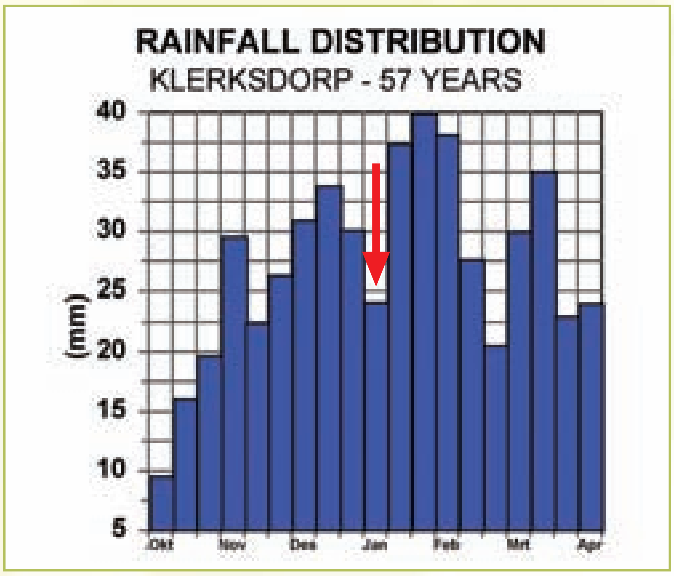
How is the growth class of hybrids determined?

Seed companies use the formula for heat units to calculate the approximate number of days to flower and physiological maturity for cool and warm production regions. Pannar classes its hybrids as ultra short, short, medium short, medium and medium late. These are broad guidelines to differentiate between different types of hybrids.

Figure 2: Yield as influenced by different planting dates, for maize hybrids of different growth classes over 22 years at Wildebeesfontein (Bethal). The optimum planting date as influenced by available heat-units for the eastern production region are demonstrated well.







Long term rainfall distribution for Klerksdorp and Kroonstad clearly shows the traditional midsummer drought at the end of December and first half of January. In the western production region adequate heat-units are available for an extended plant window. The best planting date for the least risk over many seasons however is where the largest portion of the maize planting, flowers after mid January.

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5 INFLUENCE OF DISEASES

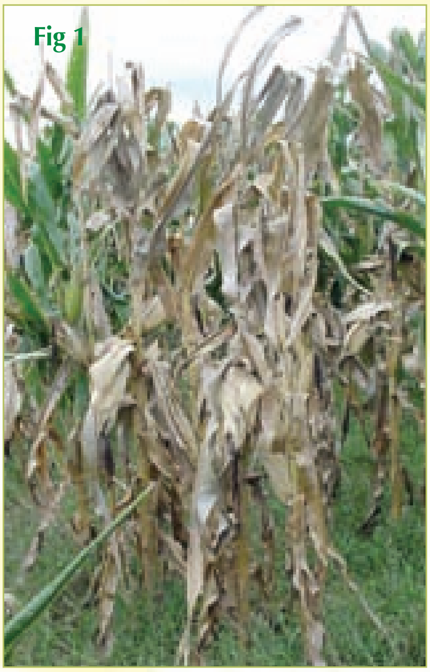


Fig 1

BASIC PLANT DISEASE CONCEPTS

A simple definition for a plant disease is: a disruption or continuous irritation by a disease-causing organism or an environmental influence that interferes with the plant's normal structure which causes plant cells and tissue not to function optimally. As the physiological processes in the plant are affected plant cells can die or whole sections of tissue can die off completely ***(Fig. 1)***. This is usually manifested as poor yields or inferior quality of products ***(Fig. 2 and 3)***.

Plant diseases can be divided in two groups:

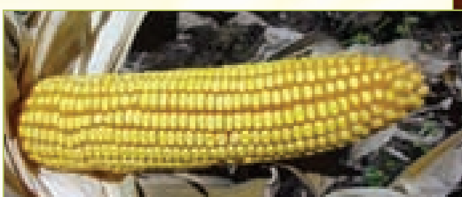
1. Those caused by parasitic micro-organisms or disease-causing infectious organisms known as pathogens (fungi, bacteria, viruses and nematodes) that attack the plant.

2. Non-parasitic (abiotic), non-infectious or physiological diseases. The symptoms are caused by various factors, including mineral toxicities, deficiencies or im-balances, wrong post-harvest storage practices, environmental influences like pollution and herbicide damage.

LOSSES DUE TO PLANT DISEASES

Plant diseases have always been with us. One of the most well known examples of the impact of a plant disease on man, was the late blight epidemic on potatoes in 1840. This disease caused by *Phytophthora infestant* caused wide spread famine and death in Ireland.

Plant diseases caused great losses not long ago in the RSA. During August - October 1996 stripe (yellow) rust caused by *Puccinia striiformis f.sp. tritici*, was observed for the first time in the Western Cape. Losses of R30 million were caused. The following season the total loss over the whole



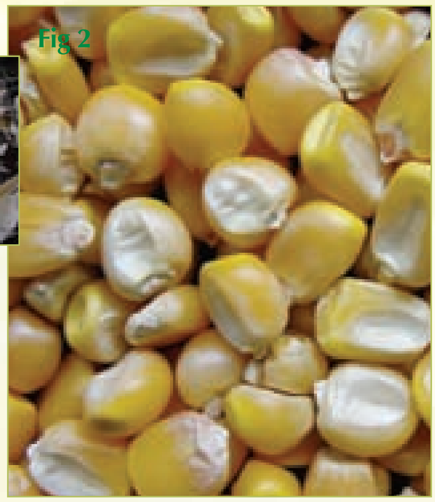
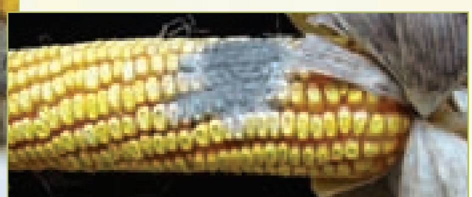


Fig 2

Fig 3

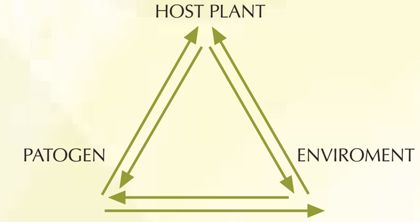


country was estimated at R70 million. Soybean rust and Karnal bunt on wheat first observed in 2001 in SA made great impact on their respective crops.

Indirect losses caused by hidden costs e.g. control measures, quarantine and import and export practices are aspects that are not always taken into consideration when losses due to diseases are calculated.

DISEASE DEVELOPMENT AND CONTROL

All diseases caused by pathogens, are the result of an interaction between the host plant, a pathogen and environmental factors like light, temperature and moisture. Environmental factors influence the development of both the host and pathogen. This interaction is commonly known as the disease triangle. When any of the components in this triangle are absent the disease will not develop. ***(Fig. 4)***.



DISEASE TRIANGLE

The development of an epidemic is basically dependent on 3 factors:

1. The initial quantity of disease causing organisms (inoculum) present.

2. The rate at which the disease can spread.

3. The time available for the disease to develop and spread.

The normal development of an epidemic, when plotted, follows a sigmoidal or the well known S-curve ***(Fig. 5A)***. Initially the development is slow. There is little inoculum and infection is slow. As soon as infections set in, new inoculum (e.g.. rust spores) multiplies quickly (exponential) ***(Fig. 5A)***. Later the disease slows down ***(Fig 5A)*** when no more plant material is available for infection (everything is diseased), and/or if environmental conditions become unfavourable for further infection or the growing season comes to an end for the host.

Disease control strategies are aimed at impacting on any, or all, of the above-mentioned, and optimizing the growth and development of the host plant, reducing the initial quantity of inoculum, slowing the rate at which the disease develops and reducing the time available for infection and therefore manipulating the disease development.

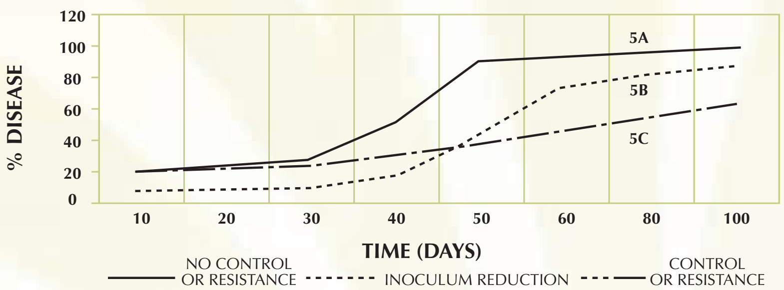
Quarantine measures that keep the disease out, or the use of disease free or clean certified quality seed can accomplish reduction of the initial inoculum. Crop rotation is also very effective as many diseases are host specific and can only infect one type of crop. Sanitation is based on agronomic practices and aimed at eliminating or reducing the quantity of inoculum present in a plant or field. This includes removal and destroying of plant residue in which the organism survives, including host weeds. Specific or total resistance in a crop reduces inoculum as infection cannot take place and infection structures cannot develop for repeated infection. Where inoculum is reduced the disease levels are lower at the start and thus take longer to reach high levels ***(Fig 5B)***. In this situation damage by disease can be evaded, as plant development reaches the stage where high disease levels would have little or no economic impact.

Disease development can also be retarded by using plant resistance / tolerance and/or the use of chemical control measures. In the case of high inoculum levels the use of disease tolerant cultivars and the effective application of fungicides can slow down the rate of disease development ***(Fig. 5C)***, giving the plant the opportunity to develop to its full potential.

The time available for infection can be manipulated by adjusting the planting date and by choosing cultivars with a specific growing season length to escape the period when probability for disease is high.

The effect of different control strategies on the percentage disease infection after a time period (e.g. 50 days) can clearly be seen in Fig. 5. The principle of modern disease control is, however based on a combination of practices (integrated disease control) which obtains effective, economically acceptable disease control, with minimum risk on the environment.

Fig. 5A; B; C



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6

MAIZE DISEASES IN SOUTHERN AFRICA

MAIZE DISEASES IN SOUTHERN AFRICA

Introduction

The loss in maize production worldwide because of disease is estimated at 10.9%. In certain seasons with climatic conditions favourable for disease development, diseases can develop into epidemics, resulting in even bigger yield losses.

The more common maize diseases in South Africa can be divided into root, stem and cob diseases, and leaf diseases. Extensive literature and information are available on most of these diseases. The most common diseases will thus only be listed here. Locally bred maize hybrids have the advantage that they were developed in the same environment as these diseases and generally have higher levels of natural resistance than hybrids introduced from abroad. Where possible all Pannar hybrids are subjected to heavy disease pressure under ideal conditions and rated for their resistance.

The information is made available as guidelines to the producer. This information can be used to make an informed decision where maize is grown under threat to a specific disease. Although hybrids are tested extensively over years and the information is reliable, it is important to remember that the biological environment is very

Fig 1

Common Rust

Fig 2

Northern Corn Leaf Blight

DISEASE	DISEASE CAUSING ORGANISM	IMPORTANCE AND CONTROL
Common rust	Fungus: Puccinia sorghi	Economically important in all maize production regions of SA. Hybrid choice and chemical control.
Grey leaf spot	Fungus: Cercospora zeae-maydis	Very destructive disease. Especially in KZN and eastern Highveld. Has been identified in Limpopo and the North West. Hybrid choice and chemical control.
Northern corn leaf blight	Fungus: Exserohilum tursicum	Was important the last season in all maize production regions. Destructive and spreads quickly. Hybrid choice and chemical control.
Phaeosphaeria leaf spot	Fungus: Phaeosphaeria maydis	Economic impact is not well documented. Occurs frequently especially in KZN and even the drier West. Hybrid choice.
Eyespot	Fungus: Kabatiella zeae	Occurs sporadically, especially in the cooler parts of KZN and the Eastern Free State. Hybrid choice.
Sorghum downy mildew	Fungus: Peronosclerospora sorghi	Especially under warm humid conditions and irrigation in the Limpopo province. Chemical control.
Bacterial leaf streak	Bacterium: Xanthomonas campestris pv zeae	In the west and Orange River irrigation areas. Little known about economic impact. No chemical control. Hybrid choice.
Maize streak disease	Virus: Maize streak virus	Occurs in KZN, Free State and parts of the North West lowveld. Can cause serious damage if infected early. Weed control to inhibit survival of leafhoppers.

Fig 3

Diplodia Cob Rot

dynamic. Disease organisms can adapt quickly to the limitations that resistance imposes on them. Therefore the guidelines cannot be regarded as guarantees.

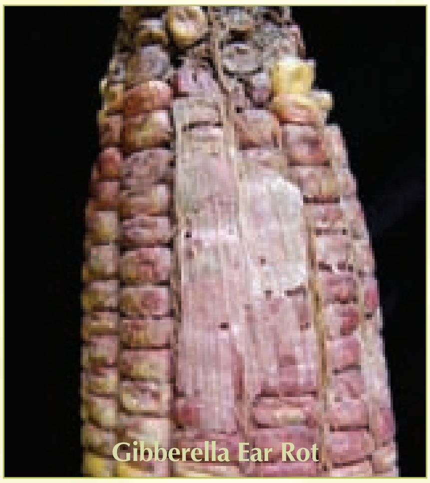
LEAF DISEASES

Most of the locally bred hybrids from the Pannar breeding program have good resistance against one or more of the leaf diseases. Information is available from local representatives and the Pannar product brochure. Leaf diseases are visually easily recognized and yield losses could be limited with an effective chemical spraying program.

STEM, ROOT AND EAR DISEASES

These diseases are not initially easily noticed and as visible as leaf diseases and the true impact is more often than not only realized at harvest. Damage can occur in many ways. Direct as stand or lodging problems, lighter or poor quality grain or more indirect in that contaminated grain is unfit for human or animal consumption. Hybrids with total resistance are not readily available and chemical control is not always cost effective.

Fig 4a/b



Gibberella Ear Rot

Gibberella Stem Rot

DISEASE	DISEASE CAUSING ORGANISM	IMPORTANCE AND CONTROL
Diplodia cob rot and stem rot	Fungus: Stenocarpella maydis	Can become an epidemic in favorable wet seasons and especially in the cooler eastern production regions. Some hybrids more tolerant than others.
Fusarium ear and stem rot	Fungus: Fusarium verticilliodes	Widespread but seldom becomes an epidemic. Stalk borer damage can lead to secondary infection.
Gibberella ear and stem rot	Fungus: Fusarium graminearum	Biggest cause of lodging, especially where insects like stalk borer create infection opportunities. Crop rotation with wheat and minimum tillage will increase disease pressure
Cob and tassel smut	Fungus: Sphacelotheca reiliana	Sporadic occurrence. Good genetic resistance in most hybrids.
Boil smut	Fungus: Ustilago maydis	Sporadic disease. Good genetic resistance in most hybrids.
Bacterial stalk rot	Erwinia chrysanthemi pv zeae	Single plants are affected. A characteristic rotten smell is present.

PANNAR® Quality Seeds

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NOTES