MAIZE CROPPING GUIDE

4R NUTRIENT MANAGEMENT AND BEST AGRONOMIC PRACTICES

NORTHERN GHANA

4 Solution

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COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR GHANA

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4R NUTRIENT MANAGEMENT AND BEST AGRONOMIC PRACTICES

NORTHERN GHANA

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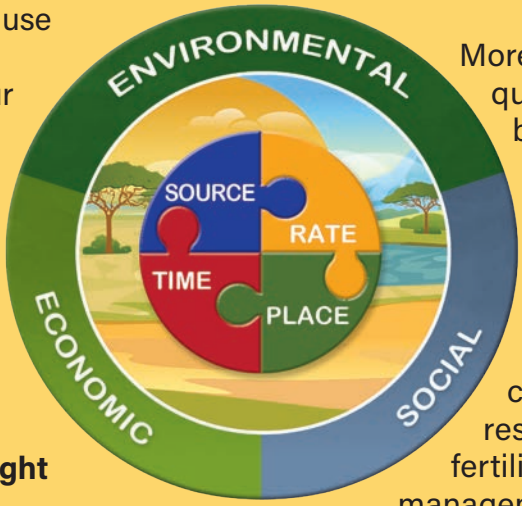
THE 4R NUTRIENT STEWARDSHIP CONCEPT

4R NUTRIENT STEWARDSHIP - is a framework developed to communicate the **Right way** to ensure sustainable and efficient use of fertilizer based on four principles namely: applying the **Right Source** of fertilizers, at the **Right Rate**, at the **Right Time**, and in the **Right Place**.



Effective fertilizer use, as guided by 4R Nutrient Stewardship, is important for developing sustainable cropping systems that support improved food production, increased income for farmers, and enhancement and maintenance of soil fertility.

More and better-quality maize can be produced with fertilizers. The fertility of soils, which has been largely over-exploited, can also be restored with fertilizers. Correct management of fertilizers based on the 4Rs can therefore result in better social, economic and environmental outcomes for farms, villages, communities, and entire countries in Africa.

RIGHT SOURCE:

refers to applying the correct fertilizer that provides crops with the nutrients required for good growth and high yields.

Different crops have different nutrient requirements. Different fertilizers also provide nutrients in different proportions. Matching a crop's nutrient uptake requirements with the fertilizer that supplies the right mix and proportions of required nutrients ensures that the Right source is achieved.

RIGHT RATE:

refers to supplying growing plants with the right amount of nutrients for healthy growth and development.

Different crops require different quantities of nutrients for healthy growth and development. The quantity of nutrients required by a particular crop also depends on soil fertility status and the crop yield target. Nutrient requirements will increase as soil fertility decreases. Similarly, as crop yield targets increase, the quantity of nutrients required to achieve those targets also increases.

RIGHT TIME:

refers to matching nutrient application with the timing of plant nutrient uptake.

Most crops take up nutrients slowly during the early stages of growth, but the rate of nutrient uptake increases as crops develop. Fertilizer applications timed to match periods of high plant nutrient uptake ensure efficient uptake of applied nutrients.

RIGHT PLACE:

refers to adding nutrients to the soil at a place where plants can easily access them.

Different crops have different rooting characteristics and this influences their ability to efficiently access and take up applied nutrients. The right placement of fertilizer for a particular crop should be selected to match a crop's rooting characteristics, and other aspects such as the planting density and tillage system. The right placement method will ensure reduced nutrient losses.

LAND PREPARATION

- Start field preparation 2 to 3 weeks before the start of the rainy season (from mid-May to early June).
- Before ploughing and harrowing, first clear any overgrown weeds, shrubs and stumps.
- After the field is cleared of shrubs and stumps, plough the field uniformly to a depth of 20 to 30 cm.
- Ploughing should be done when the soil moisture level is low to minimize soil compaction.
- After ploughing, harrow the field uniformly by breaking up any large soil clods that may be present.
- Good ploughing and harrowing practices helps to control weeds, kill some insect pests, and also makes it easier to incorporate manure, apply fertilizer, and plant.

SEED SELECTION & SEED RATE

- For best maize yields, plant newly purchased certified seeds instead of recycling old grain.
- Certified seeds usually contain a green tag with details on variety name, maturity period, germination percentage, and expiry date.
- Carefully read the instructions on the green tag to ensure that purchased seeds are suitable for your region and are not expired. **Table 1** shows some of the recommended maize varieties for northern Ghana.
- Certified seeds can be obtained from agro-input dealers such as Wumpini Agrochemicals, Garnoma, Vansado, SASSEC, Antika, and Simple Prince.
- Using high quality seeds that are adapted to the local environment is crucial for good germination and high yields.
- Where farmers have no access to new certified seeds, farmers can recycle available open pollinated varieties (OPV) from their fields such as Obantapa, Omankwa, and Abontem. However, recycled OPV seeds should not be used for more than two years.
- Hybrid seed varieties such as Sika Aburoo, Pan 53 and Pan 12 should not be recycled and new seeds should be obtained each year.
- The recommended seed rate for good maize yields is about 20 to 25 kg per hectare.
- Based on the size of your farm and the recommended seed rate, acquire the right quantities of seeds in consultation with your agrodealer.

Table 1: Maize varieties recommended for Northern Ghana.

				Attainable yield	
Variety	**Variety Type**	**Grain Color**	**Maturity period, days**	**t/ha**	**Bags/ha**
Bihilifa	OPV*	Yellow	110	4 - 5	40 - 50
Ewul-Boyu	OPV	White	90	5 - 6	50 - 60
Obatanpa	OPV	White	110	4 - 5	40 - 50
Okamasa	OPV	White	120	5 - 6	50 - 60
Sika Aburoo	Hybrid	White	105 - 110	5 - 6	50 - 60
Sanzal Sima	OPV	White	110	5 - 6	50 - 60
Wang Dataa	OPV	White	90	4 - 5	40 - 50
Pan 12	Hybrid	Yellow	110	6	60
Pan 53	Hybrid	Yellow	120	6 - 7	60 - 70

*OPV = open pollinated variety.

PLANTING

- Maize planting in the northern region should be done between early June and July 10th based on the onset of rains. Better yields are achieved with early planting with the first rains.
- Early maturing varieties such as Ewul-Boyu and Wang Dataa can be planted up to end of July.
- For good growth and yields, plant maize in rows using planting lines.
- The spacing between rows will depend on the maize variety to be planted.
- For early and medium maturing varieties, row-to-row spacing of 75 cm and 40 cm spacing between plants in a row is recommended.
- For late maturity varieties, row-to-row spacing of 80 cm and 40 cm spacing between plants in a row is recommended.
- Prepared planting holes should be about 5 cm deep, with two seeds planted per hole.
- Planted maize seeds should be lightly covered with soil.

Table 2: Recommended spacing for the available improved maize varieties.

Planting distance	Late maturity (110-120 days)	Medium maturity (100-110 days)	Early maturity (90-95 days	Extra early (75-90 days)
Spacing between rows (cm)	80	75	75	75
Spacing within row (cm)	40	40	40	40
Plant population per ha (2 seeds/hill)	62,500	66,667	66,667	66,667

FERTILIZER APPLICATION

For good maize yields, fertilizer application should be based on the 4Rs of fertilizer management to ensure that the maize crop is supplied with the **Right Source** of fertilizer, applied at the **Right Rate**, at the **Right Time** in the growing season, and at the **Right Place** where growing plants can easily assess nutrients supplied.

To understand the best 4R fertilizer management practices for good maize yields, it is important to understand the nutrients required in large quantities and their role in maize crop growth.

There are three essential nutrients that are required by maize plants in large quantities for good growth and yields.

Nitrogen – promotes strong and healthy maize crop growth, and helps maize plants produce large cobs full of grain. Nitrogen is required both during early crop growth and at mid-crop growth when maize plants are preparing to develop grains. Nitrogen should be supplied at planting or soon after germination, and also during mid-crop growth as a top dressing. Supplying all maize nitrogen requirements at planting should be avoided as nitrogen is easily lost from the soil.

Phosphorus – supports good crop establishment by helping maize plants grow healthy roots, and also ensuring uniform and early growth. Phosphorus is mostly required during early crop growth stages and should be supplied at planting or soon after germination to support good root growth. Good root growth is crucial for crops to take up nutrients and water.

Potassium – ensures healthy maize plants with strong stems, supports plants to withstand drought periods, and also helps plants resist attack by pests and diseases. Potassium is required both during early crop growth and also during later growth stages. The entire potassium requirement should be supplied at planting or soon after germination since applied potassium is not easily lost from the soil.

Right Source At Planting

During planting or shortly after planting, the Right source of fertilizer for maize are compound fertilizers that supply all primary macronutrients namely nitrogen (N), phosphorus (P) and potassium (K). Good examples are NPK 15:15:15 and NPK 25:10:10.

Multinutrient fertilizers that supply secondary macronutrients such as sulphur (S), calcium (Ca) and magnesium (Mg), and micronutrients such as zinc (Zn) and boron (B), in addition to NPK, are also a good source at planting or shortly after planting. An example is NPK 11:22:21 + 5 S, 0.72 Zn, 0.5 B which additionally supplies crops with S, Zn, and B. Application of multinutrient fertilizers that additionally supply secondary and micronutrients has been shown to give the best maize yields in Northern Ghana.

4R TIP - *To determine the number and quantity of nutrients supplied by a particular fertilizer check the nutrient content as labeled on the fertilizer bag.*

The nutrient content of any fertilizer is usually indicated on the bag's label as a series of numbers. The first three numbers always refer to the primary nutrients (N, P and K). If any other nutrients are present, additional numbers are given followed by their chemical symbols.

Example: a fertilizer bag labeled 15-20-20-5S-0.5B contains 15% Nitrogen, 20% Phosphorus as P_2O_5, 20% Potassium as K_2O, 5% Sulphur, and 0.5% Boron.

Right Source At Topdressing

During topdressing, maize plants require to take up nitrogen in large quantities for good growth and grain development. The Right source of fertilizers for top dressing are therefore straight fertilizers that are rich in nitrogen, such as urea. Urea fertilizer has round granules that are white in colour. Urea contains the highest content of nitrogen (46% N).

In addition to urea, different fertilizer companies have developed special multinutrient fertilizers for top dressing applications in maize that are rich in nitrogen. Consult your local extension officer, agrodealer or fertilizer company agronomist for advice on other multinutrient fertilizers available in your local market for top dressing.

Right Rate

In northern Ghana, the recommended rate of nitrogen for maize is 60 to 120 kg/ha, while the recommended rates for both phosphorus (P_2O_5) and potassium (K_2O) range from 30 to 60 kg/ha. These recommendations provide the range of nutrient application that should be applied depending on specific characteristics of the field where maize is to be grown, and on the farmer's target yield.

- Fields that have been cultivated for a long time with minimal application of fertilizer or manure are often less fertile and require higher nutrient applications.
- Fields that have only recently been converted to farmland, or that usually have large quantities of manure applied are often more fertile and may require lower nutrient applications.
- Recommended nutrient applications can also be adjusted based on the expected or target maize yield.
- Higher maize yield targets require more nutrients to be supplied hence higher fertilizer application rates. **Table 3** presents estimated nutrient (N, P, and K) and fertilizer product application rates required to achieve various target maize yields.

- To ensure the application of equal quantities of fertilizer at each planting stand, farmers can use locally available soda bottle tops to measure and apply equal quantities of fertilizer. Generally, one full level soda bottle top contains about 5 grams of fertilizer, while a half full soda bottle top contains about 2.5 grams of fertilizer.
- To uniformly apply one bag of fertilizer in a one hectare field, farmers can apply half a soda bottle top at each planting hole. To uniformly apply two bags of fertilizer, one full level soda bottle top of fertilizer should be applied per planting stand. Further guidelines for larger quantities of fertilizer are provided in **Table 3**.

Table 3: Estimated N, P, K, and fertilizer product application rates required to achieve various target maize yields.

Target yield (t/ha)	Nutrient rates (kg/ha)			Basal fertilizer 11:22:21 (NPK) + 5 S: 0.7 Zn: 0.5 B		Top dressing (Urea)	
	N	P_2O_5	K_2O	Bags per ha	Bottle tops per hole	Bags per ha	Bottle tops per hole
2	30	15	15	2	1	1	½
3	60	30	30	3.5	2	1.5	1
4	90	45	45	5.5	3	2.5	1½
5	120	60	60	7	4	3	2

Notes: In this table, attainable yield without fertilizer application is assumed to be 1 tonne per hectare. These estimates are based on a maize planting spacing of 80 cm between rows (intra-row) and 40 cm along rows (inter-row), equivalent to 31,250 planting holes per hectare, with 2 plants per hole. Fertilizer application for an acre for the same plant spacing can be calculated by dividing the values presented in the Table by 2.47 (1 hectare = 2.47 acres).

Right Time

- The first fertilizer application (basal application) should be applied shortly after germination at about two weeks after planting.
- The Right time for application of top-dressing fertilizer is at 6 weeks after planting.
- Top dressing should be done when the soil is moist, to enhance the dissolving of applied nutrients in the soil as this allows for faster uptake of nutrients. If at 6 weeks after planting maize the soil is very dry, delay the topdress fertilizer application until some rains are received.
- Top dressing should also be conducted when the field is well weeded as weeds compete with the maize plants for nutrients.

4R TIP - *Basal fertilizer should be procured a few weeks before the planting period so as to ensure timely application when planting starts.*

In cases where the nutrient source is a bulk blended multinutrient fertilizer, the blend should be mixed thoroughly to ensure proper distribution of the granules in every fertilizer scoop.

Fertilizer applications should be avoided during periods of very heavy rainfall to avoid washing away of applied nutrients.

Right Place Basal application

- To ensure Right placement of basal fertilizer, create small holes about 5 cm from the plant using a stick.
- Use a bottle top or other small container to apply equal amounts of the basal fertilizer next to each plant based on the guidelines provided in **Table 3**.
- Cover the applied fertilizer with soil to avoid nutrient losses.
- Applying fertilizer 5 cm away from the plant prevents the fertilizer from coming into direct contact with the plant as this may cause damage to the plant as the fertilizer dissolves.

Right Place Topdressing

- To ensure Right placement of fertilizer at topdressing, make small holes about 5 cm from the plant using a stick.
- Use a bottle top, or other small container, to apply equal amounts of fertilizer next to each plant based on the guidelines provided in **Table 3**, and then cover it with soil.
- Applying equal amounts of the top-dressing fertilizer at each planting hill ensures uniform crop growth.
- Covering top-dressing fertilizer with soil helps to avoid loss of applied nitrogen to the air or washing by runoff water.

MAIZE CROP MANAGEMENT

4R Tips for management of maize plants

- *At 10 days after planting, check for gaps along the rows and plant additional seeds to fill any gaps.*
- *After germination, protect young plants from attack by rodents and birds using local methods.*
- *Regularly scout for pest and disease infestations by walking through the farm in a zig zag pattern every week. Perforated leaves, presence of larvae, egg clusters or insects on maize leaves are all indicators of pest infestation.*
- *Discoloured leaves and small, stunted plants may be indicators of nutrient deficiency or disease infestation. Farmers should consult local AEA's for assistance with interpreting any signs observed.*

Management of Weeds

- Weeds reduce the growth and yield of maize by competing for nutrients, water and light. For best yields, maize fields should be kept weed-free by conducting timely weeding at regular intervals.
- If weeds are actively growing in the field at planting, spray non-selective herbicides such as glyphosate or paraquat.
- If there are no weeds growing in the field at planting, apply pre-emergence weed control herbicides such as Atrazine and Pendimethalin 2 to 3 days after planting.
- Before applying any herbicide, carefully read and follow instructions provided by the manufacturer or consult your local AEA.
- To manage parasitic weeds such as striga, it is recommended to use an integrated approach that includes growing rotation trap crops such as cotton and soybean; hand pulling of striga weeds; and planting of striga tolerant maize varieties such as Omankwa and Aburohemaa.
- Improvement of soil fertility through the application of fertilizers or manure also helps to reduce striga infestation.

Management of Pests and Diseases

Major maize insect pests include stem borers and fall army worm. These pests can cause considerable damage to maize plants, and when detected, control measures should be put in place. Maize diseases such as maize streak virus, maize lethal necrosis and cob rot are some of the major diseases that can severely reduce yields and grain quality.

For effective management of pest and diseases, make regular visits to the maize field and scout for any signs of pest or disease infestation. It is recommended to have a walk through the maize field at least once a week.

When scouting, walk through the field and look out for unusual patterns such as insect damage on leaves, cobs or stems, presence of insect larvae or eggs on maize leaves, abnormal leaf colour, and stunted slow growing plants.

Where signs of pest or disease infestation are noted, further checks can be conducted by splitting up the stems of a few infested plants, and digging out of some infested plants to inspect the roots.

Pest - Stalk borer

Stalk borers will tunnel into the stem of maize, feed on the internal tissues, and cause the plant to wither and die. Heavy stem borer infestation can cause considerable damage to maize plants and result in reduced yields.

Prevention measures

- Intercrop maize with non-host plants such as groundnut to reduce infestations.
- Where maize is grown as a mono-crop, rotate maize with non-host plants such as groundnut to reduce stalk borer infestations.
- Remove maize residues from the field after harvest to reduce stalk borer populations and limit infestation in the following season. Leaving maize residues exposed to the sun's heat for about one month also helps to kill the stalk borer larvae and pupae.

Control

- Chemical control can be used early in the season by applying appropriate pesticides according to manufacturer's recommendations. For example Lamda Cyhalothrin applied at 3L per hectare, 2 weeks after planting, and every 2 weeks till tasseling can help to control stem borers where infestations are high.

Pest - Fall Army Worm

Fall army worm feed on maize leaves and can cause considerable damage to maize plants that results in reduced yields. They mostly spread as moths from other infested maize fields.

Prevention measures

- Rotate maize with non-host plants such as groundnut to help reduce Fall Army worm infestations.
- Deep ploughing and burial, or burning of infested maize residues helps to reduce populations in the following season.
- Proper weeding of maize fields also helps to reduce infestations.

Control

- Application of recommended pesticides can help to control infestations once they occur. Consult your local AEA for advice on the recommended fall army worm control pesticide in your area.

Disease – Maize Streak Virus

Maize streak virus is the most serious disease affecting maize in Northern Ghana. The disease is transmitted by the white fly, and is more prevalent in late planted maize.

Signs

- First signs appear as minute pale, circular spots on the lowest exposed portion of the youngest leaves.
- Symptoms can also appear as broad yellow stripes or yellowing of entire leaves.
- The only leaves that develop symptoms are those formed after infection, with older leaves remaining healthy.

Prevention measures

- Use certified seeds from varieties recommended by local extension services and national research centers.
- Rotate maize with non-cereal crops such as groundnut to reduce disease infestation.

HARVESTING & STORAGE

- Harvesting should be done as soon as the maize crop is mature and dry.
- At harvesting, maize grains are usually not fully dry and have a moisture content of about 15 to 20%.
- Immediately after harvesting, cobs should be dried so as to reduce the grain moisture content to about 10 to 12% in readiness for storage.
- Maize should be stored after removal of maize husks and shelling. Storing unhusked maize is not recommended as it is very difficult to detect insect infestations.
- Well dried and shelled maize should be treated with recommended storage chemicals and stored in jute sacks lined with polythene bags. Common storage chemicals include Actellic 25 E.C. or aluminum phosphide (e.g., Phostoxin and Gastoxin).

Example maize grain storage steps using aluminum phosphide:

1. Line the sack with a polythene bag.
2. Fill the sack half full and place one tablet wrapped in paper or cotton.
3. Fill the sack completely and add another tablet and sew the sack.
4. Store the packed maize on pallets in a clean and well-ventilated room.
5. Fumigate the room and keep doors locked until the produce is required.

MAIZE NUTRIENT DEFICIENCIES

Nitrogen Deficiency

Maize is highly susceptible to nitrogen (N) deficiency due to the high amounts of N required for good plant growth and grain yields. Key symptoms of N deficiency in maize include:

- Short and slow growing plants
- Pale green or yellow leaves
- Lower leaves turn yellow along the middle and start to turn brown
- Plants have small cobs with few grains

***4R TIP** - Rapidly growing maize takes up large amounts of N from the soil. After the maize is about knee-high, the N demand increases rapidly until tassels appear.*

- *Split applications of the required N application rates, based on local recommendations and target yields, are best since N is easily lost from the soil.*
- *The first N application should be basally applied at two weeks after planting, using available compound or multi-nutrient fertilizers. The second application should be topdressed 6 weeks after planting using high N content fertilizers such as urea.*

Phosphorus Deficiency

Maize plants are susceptible to phosphorus (P) deficiency when grown in low fertility soils with minimal or no application of P-supplying fertilizers. Even in situations where some P-supplying fertilizer is applied at planting, P deficiency may appear in young plants due to excessively wet or dry conditions that interfere with P uptake. Plants may be able to overcome this deficiency if the soil conditions improve. Key symptoms of P deficiency in maize include:

- Purple colour along leaf edges in young plants
- Symptoms first appear on older leaves
- Plants have weak stems and sparse short roots
- Delayed plant maturity
- Plants have small and twisted cobs with small grains

4R TIP - *Compound or multi-nutrient fertilizers that supply the required quantities of P based on local recommendations and yield targets should be basally applied close to the base of the plants at two weeks after planting.*

Potassium Deficiency

Maize plants are susceptible to potassium (K) deficiency when grown in light textured soils that have been cultivated for a long time with minimal or no application of K-supplying fertilizers or animal manure. Key symptoms of K deficiency in maize include:

- Edges of older leaves turn yellowish-brown
- Symptoms first appear as a yellowing along the edges of older, lower leaves.
- As the deficiency continues, the edges of lower leaves become brown and the yellowing and browning advances towards the younger, higher leaves on the plant
- Premature drying of leaves and plants
- Poor grain-filling at the tips of cobs
- The stalks of K-deficient maize tend to break late in the growing season due to poor stem strength.

***4R TIP** - Potassium is a major factor controlling plant water use, so the impact of drought on growth and yield of maize is greater for plants suffering from K deficiency.*

- *Compound or multi-nutrient fertilizers that supply the required quantities of K based on local recommendations and yield targets should be basally applied close to the base of the plant at two weeks after planting.*
- *Regular applications of large quantities of animal manure or maize residues can also help to enhance the K content of soils.*

Sulphur Deficiency

Sulphur (S) deficiency is most common in maize growing on sandy soils with low organic matter content. Key symptoms of S deficiency include:

- Entire leaves become uniformly pale green or yellow
- As S is not mobile in plants, symptoms first appear on younger leaves
- The entire maize plant may become pale green as the deficiency persists
- The entire plant becomes stunted and thin

***4R TIP** - Sulphur is taken up by the maize plant continually over the entire growing season.*

- *Apply S-containing fertilizer at two weeks after planting, as part of basal fertilization.*
- *Multi-nutrient fertilizers that supply S in addition to other essential nutrients are a good source of S for maize plants.*

Magnesium Deficiency

Magnesium (Mg) deficiency often occurs in maize growing on acid soils. Application of liming material that contains Mg (such as dolomite) is commonly recommended in these conditions. When Mg deficiency is present in non-acidic soil, Mg-supplying fertilizers can be applied to correct deficiencies.

- Mg symptoms first appear as light striping along the lower leaves
- Since Mg is mobile in plants, it is easily transported from older leaves to the young leaves where deficiency symptoms may not be seen.
- As the deficiency progresses, the underside of leaves may develop a purplish colour. The leaf edges may also begin to turn yellow and die.

***4R TIP** - Application of liming material such as dolomite to prevent Mg deficiency in acidic soils should be done a few weeks before planting during the harrowing stage by uniformly applying the liming material across the field and incorporating it into the soil.*

- *Mg-supplying fertilizers should be applied at two weeks after planting as part of basal fertilization.*
- *Multi-nutrient fertilizers that supply Mg in addition to other essential nutrients are a good source of Mg for maize plants.*

Zinc Deficiency

Zinc (Zn) deficiency symptoms are frequently seen during the early growth period. Key deficiency symptoms include:

- Yellowing of younger leaves along the sides of the midrib extending from the stalk to the middle of the leaf. The leaf midrib and margins may continue to be green.
- While older leaves will appear healthy, emerging young leaves may be pale green.
- The stalk internodes become stunted, resulting in shorter plants and a bunching of the leaves at the top of the stalk.

4R TIP - *An adequate supply of Zn is important for healthy plant development and proper maturation for a timely harvest.*

- *Maize plants only require small quantities (less than 5 kg) of Zn for good growth and yields.*
- *Zn-supplying fertilizers should be applied at two weeks after planting as part of basal fertilization to address Zn deficiency in low fertility soils.*

Boron Deficiency

Boron (B) deficiency symptoms are mostly observed at the growing points and on the youngest leaves. Key symptoms include:

- Twisted leaves that develop yellow or white spots.
- In severe cases, B deficiency may result in barren cobs with only a few grains.

***4R TIP** - Maize plants only require small quantities (less than 1 kg/ha) of B for good growth and yields, and most soils contain enough B to meet the requirements for good maize growth and yields.*

- *In low fertility B-deficient soils, fertilization of maize plants with multi-nutrient fertilizers that contain B two weeks after planting as a basal application is recommended.*

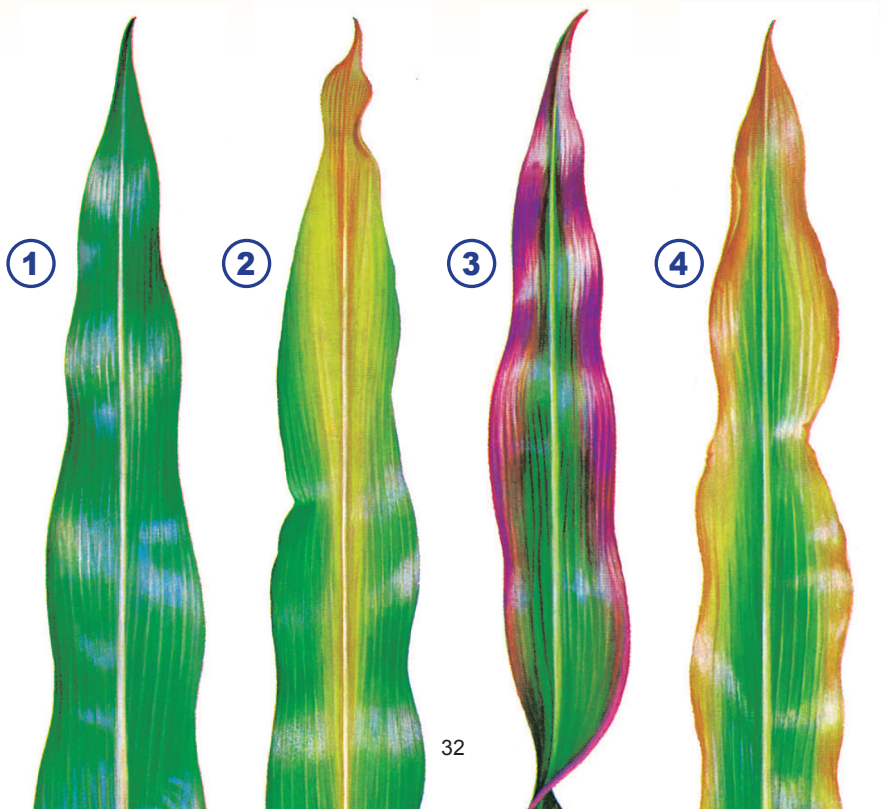
SYMPTOMS OF NUTRIENT DEFICIENCY & COMMON GROWTH DISORDERS - LEAVES

(1) Healthy leaves shine with a rich, dark green colour.

(2) Nitrogen deficiency starts as yellowing at the tip of older leaves and moves along the middle of the leaf.

(3) Phosphorus deficiency marks leaves with reddish-purple tissue, particularly on young plants.

(4) Potassium deficiency appears as a yellowing or drying along the tips and edges of the lowest, older leaves.

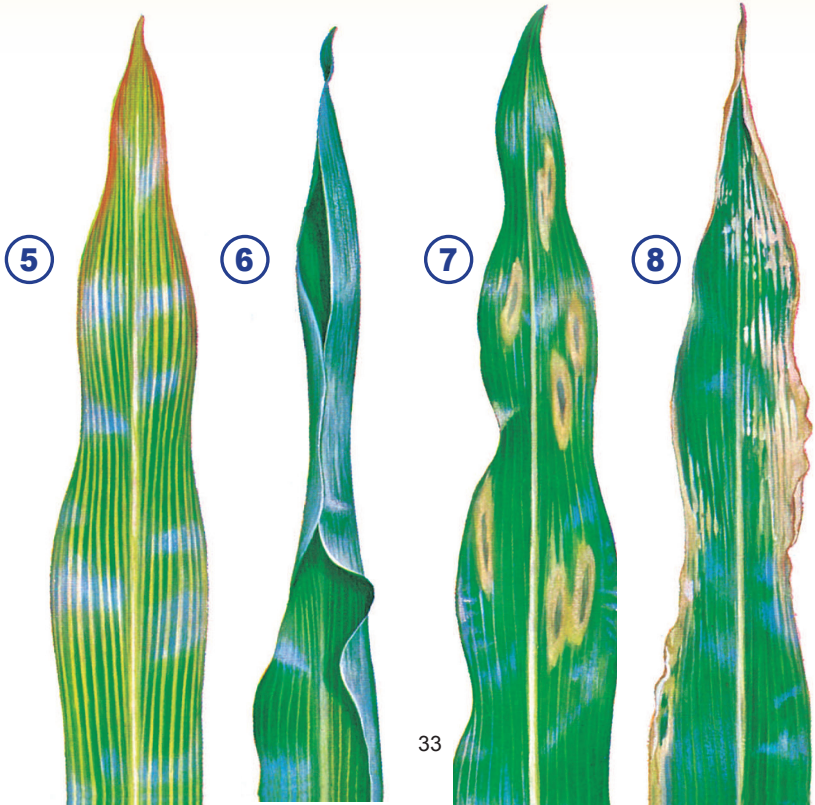


(5) Magnesium deficiency causes whitish stripes along the veins and often a purplish colour on the underside of the lower leaves.

(6) Drought causes maize plants to have a greyish-green colour; leaves may roll up to the size of a pencil.

(7) Disease infection starts in small spots (e.g., leaf blight shown), and gradually spreads across leaf.

(8) Chemical damage may sometimes burn tips of edges of leaves at the point of contact. Tissue dies, leaves becomes bleached.



Notes

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ABOUT **The 4R Solutions Project**

www.4rsolutions.org

The 4R Solutions Project is funded by Global Affairs Canada to improve the livelihoods of 80,000 smallholder farmers in Ethiopia, Ghana and Senegal by improving agricultural productivity and farm income through incorporation of 4R Nutrient Stewardship into local farming practices. 4R Nutrient Stewardship supports best management of plant nutrients based on four key practices: Right Source, Right Rate, Right Time, and Right Place.

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