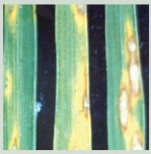
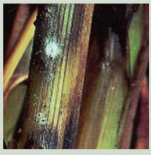




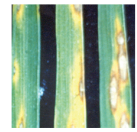
Field Guide on Major Disorders of the Rice Plant

DISEASES AND NUTRITIONAL DEFICIENCIES

REVISED EDITION (2021)

DEPARTMENT OF AGRICULTURE 1898 PHILRICE

RICE COMPETITIVENESS RCEF ENHANCEMENT FUND EXTENSION PROGRAM



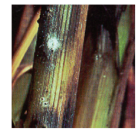


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Table of Contents

Preface

Most rice farmers and extension workers have difficulty in identifying the important diseases of the rice plant. More so on how the diseases develop and spread in the field. The main reason is the lack of easily understood instructional materials that cover these topics.

This field guide is intended for extension agents and farmers. It highlights information on at what age of the crop the disease occurs, the characteristic symptoms and where to see them, and the practical management measures applicable at a particular growth stage of the crop. Since some symptoms manifested by plants are not always caused by pathological agents, a section on nutrient deficiencies that are often misdiagnosed as pathogenic diseases is included. Information on soil tests to determine the needed nutrient is also presented. The authors and subject matter specialists believe that through this guide, the rice disorders, both pathological and nutritional, could easily be understood and appreciated. Likewise, the appropriate measures of prevention and management can be applied.

This field guide describes and illustrates in the simplest manner possible the important information on diseases that infect the rice plant and how they are managed. It complements the "Field Guide on Harmful and Useful Organisms in Philippine Ricefields," which is also published by the DA-Philippine Rice Research Institute (DA-PhilRice) that deals largely on insects. It directs and informs the farmers and field technicians in identifying the yield-reducing factors so that they can intelligently formulate sound and practical disease management decisions in the field.

JOHN C. DE LEON
Executive Director

How to Identify a Disease and its Cause

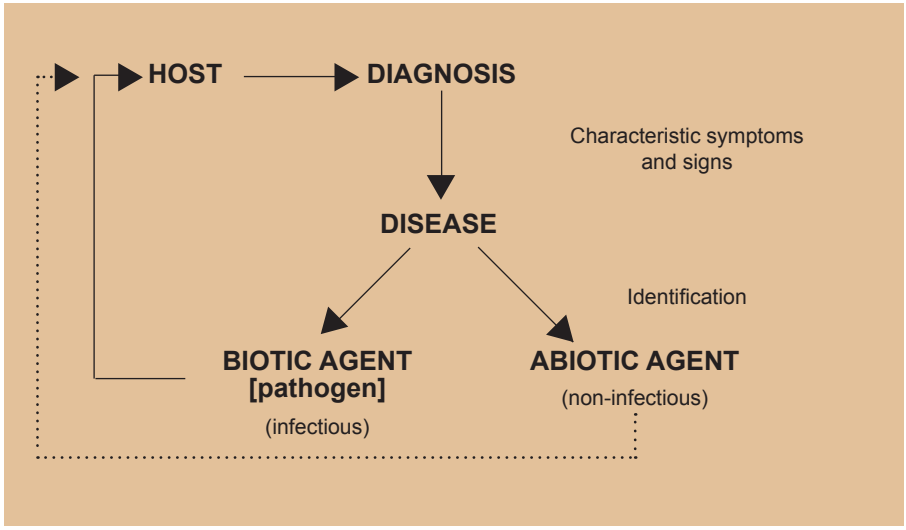
Any disturbance that interferes with the normal structure (e.g., height, tillers, leaves), function (e.g., reduced vigor, early death), and economic value (e.g., reduced yield, poor quality produce) of the plant (HOST) is a DISEASE.

A plant disease can be identified (DIAGNOSE) through the characteristic manifestation of diseased conditions (SYMPTOMS) and the presence of visible structures (SIGNS) produced by the pathogen.

The causal agent may be either a living (BIOTIC) or nonliving (ABIOTIC) agent. Biotic agents (PATHOGEN) have the ability to enter and colonize plant parts and other plants (INFECTIOUS).

When a disease increases rapidly in a large plant population over time, a serious outbreak occurs (EPIDEMIC).

By following the diagram below, one can identify a disease and its likely cause.

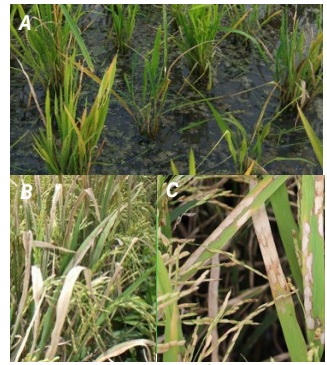


How to Diagnose a Plant Disease

A. Look for symptoms. *The symptoms may be visible on the entire plant or any of its parts such as roots, stems, leaves, leaf sheaths, panicles, and grains.*

The symptoms can be grouped as:

1. **Stunting** – reduction in plant height
2. **Yellowing or chlorosis** – deviation from the green color
3. **Necrosis** – death of tissues (spots, streaks)
4. **Wilting** – drying of the plant owing to interference in water movement
5. **Transformation of organs** – abnormal development of plant parts (false smut)
6. **Formation of galls** – swelling of veins



(A) Chlorosis and stunting of plants.
(B) Drying and wilting of infected leaves.
(C) Necrosis on affected plant parts.

B. Compare the growth development and appearance with a healthy plant of the same variety and age – *they should be of the same height, color, and appearance.*

In diagnosing a disease in a crop, the following points should be considered:

- **Disease distribution** – Does the disease affect the whole field, in clusters, or individual plants?
- **Disease spread** – Does it spread to neighboring plants over time? How fast?


Uneven distribution of diseased plants.

- **Disease occurrence** – At what stage of the crop growth is the problem common? Did it affect all or most plants in a very short period?
- **Condition of the field** – Was the field properly prepared and fertilized? How is the drainage condition?
- **Close and thorough examination of the diseased plants** – Note the symptoms in detail and look for signs of the disease. What plant part is affected: whole plant or localized? Were there any different responses among varieties?
- **Look for the presence of other organisms** – Is the problem associated with insects, weeds, and other plants or animals?
- **Note for the presence of toxic substances** – Are there pesticide burns and chemical compounds in the field and in the surrounding areas?
- **Consult with the farmer** – Consider the farm practices including farm inputs, farm management, and disease history of previous and present crops.

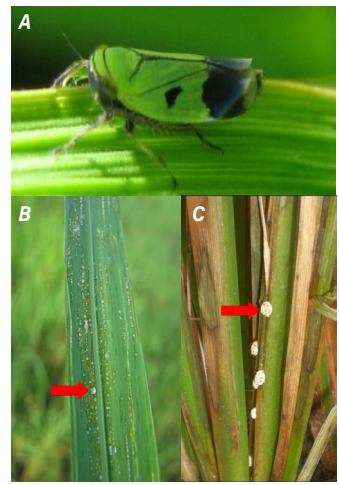
Common Causes of Plant Disease

Nonliving (abiotic) factors

- Not spread from diseased to healthy plants
- Can be recognized only by symptoms
  Ex. Drying of leaves – lack of moisture or chemical burn
  Yellowing of leaves – nutrient deficiency
- Can be avoided by providing the lacking factor
- More often, it affects a large area within a brief period

Living (biotic) factors

- Caused by organisms that spread from diseased to healthy plants
- The organisms are very small and are measured as:
  - micron (μ) equivalent to 1/1000 mm
  - nanometer (η) equivalent to 1/1000 μ
- Can be recognized by symptoms and signs
- Can be managed by destroying or removing the parasitic agent and reducing the number of pathogens and infection rate



(A) Presence of insect vector.
(B) Bacterial ooze coming out from lesions.
(C) Formation of sclerotia bodies from the lesions.

Major Organisms Causing Plant Disease

Fungi

- Tiny, simple plants called molds, generally measured in microns
- No chlorophyll; depends on other organisms or plant tissues for food
- Multiply by spores that produce threadlike filaments, which enter the host directly or through natural openings
- Spores are spread by wind, water, insects, seeds, plant debris, soil, or tools
- Get support from the host by extracting its nutrients
- Can survive in adverse conditions through special structures (sclerotia) and infects again when favorable condition prevails

Bacteria

- Small, one-celled organism, measured in microns
- Lack chlorophyll; cannot produce its own food
- Reproduced by cell division every 15-20 minutes
- Need wounds or entry points to enter the host
- Survive in seeds, plant debris, soil, tools
- Spread by wind, water, insects, tools, or soil
- Generally cause rotting of host tissues

Viruses

- Smaller than fungi and bacteria, measured in nanometer
- Can be seen only under an electron microscope
- Strictly dependent on living organisms for food and reproduction
- Their presence is generally recognized by the symptoms manifested by the host
- Generally spread by insects, seeds, soil, nematodes, fungi, or mechanical means

Occurrence of Plant Disease

A disease can occur only when the following factors are present at the same time:

- Pathogen, the causal agent, is virulent.
- Host is susceptible.
- Favorable environmental conditions exist.
    - **Temperature** – Bacteria grow rapidly at high temperature. Most insects are also active and multiply fast in warm temperature.
    - **Moisture** – High moisture content enhances high germination rate of fungal spores, affects bacteria in entering into plant tissue cells, and increases insect number.
    - **Wind** – It disperses fungal spores over distance. Strong wind damages plant tissues; thus, creating entry points for bacteria. Light wind current is favorable for insect's movement.

Principles of Disease Management

Crop production practices influence disease development. Therefore, it is important that management be considered in all stages of crop production. Disease management is primarily based on the following principles:

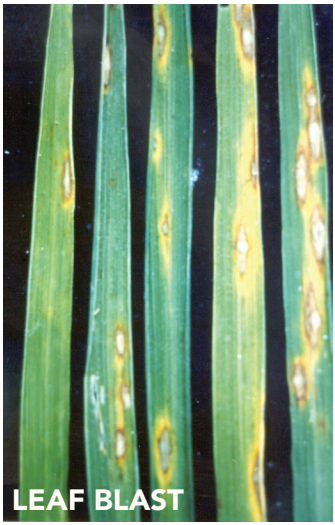
1. **Avoidance of the pathogen.** Many diseases are prevented by choice of planting time and variety. Resistant variety planted in synchrony in a wide area results in very low incidence of insect-transmitted disease. The host also escapes infection when planted at the time the pathogen or insect vector populations are in their lowest level.
2. **Exclusion of inoculum.** Preventing the entry into a place where the disease does not exist through seed certification, quarantine, and crop inspection will control the spread of pathogens to new areas.
3. **Eradication of the pathogen.** Reducing or eliminating diseased host by biological control agents, crop rotation, and roguing at the early stage of disease development help reduce the rate of disease spread.
4. **Protection.** The fast spread of the disease by biotic (insect) or abiotic (wind factors) necessitates the inactivation or destruction of the inoculum and insect vector by pesticide application and modification of the plant environment or host nutrition.
5. **Disease resistance.** Preventing infection or reducing the effects of infection through improved plant resistance by genetic manipulation is the most widely used control strategy. The resistance may also be induced by modification of genes through biotechnology.
6. **Therapy.** This is a curative procedure (e.g., hot water treatment) applied to the host to reduce disease severity. However, there is no known cure yet for virus-infected rice plants.

Reliance on one management option will be inadequate or inefficient. Disease management will be most successful if integrated into the crop production system and employs diverse approaches.

MAJOR DISEASES

Fungal Diseases

BLAST


LEAF BLAST

LOCAL NAME:

- mata-mata (Bisaya)
- agupaw (Waray)
- taya-taya (Cebuano in Mindanao)

CAUSAL ORGANISM:

- *Magnaporthe oryzae*
- Anamorph: *Pyricularia oryzae*

WHERE TO FIND:

- **On leaves** *(leaf blast)*

  SYMPTOMS: small to spindle-shaped spots with brown border and gray center; spots join resulting in drying and death of leaves

  SUSCEPTIBLE STAGE: seedling to tillering


PANICLE BLAST

- **On nodes of tillers** *(node blast)*

  SYMPTOMS: black, rotten node that later breaks

  SUSCEPTIBLE STAGE: tillering

- **On base of panicle** *(panicle blast)*

  SYMPTOMS: black-node panicle that later breaks; unfilled grains

  SUSCEPTIBLE STAGE: booting to heading

- **On seeds** *(usually found at the basal portion of the grain); has very low seed transmission rate*

  SYMPTOMS: sterile lemma and a rachilla discolored with fungal growth

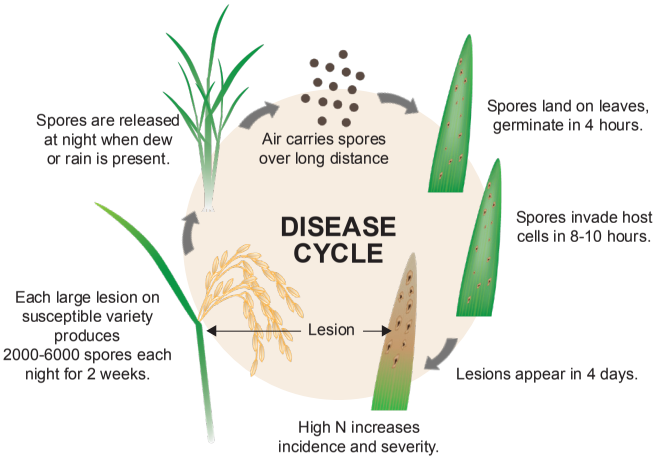
  SUSCEPTIBLE STAGE: maturity

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

High nitrogen fertilizer

- Overcast sky
- Light rain

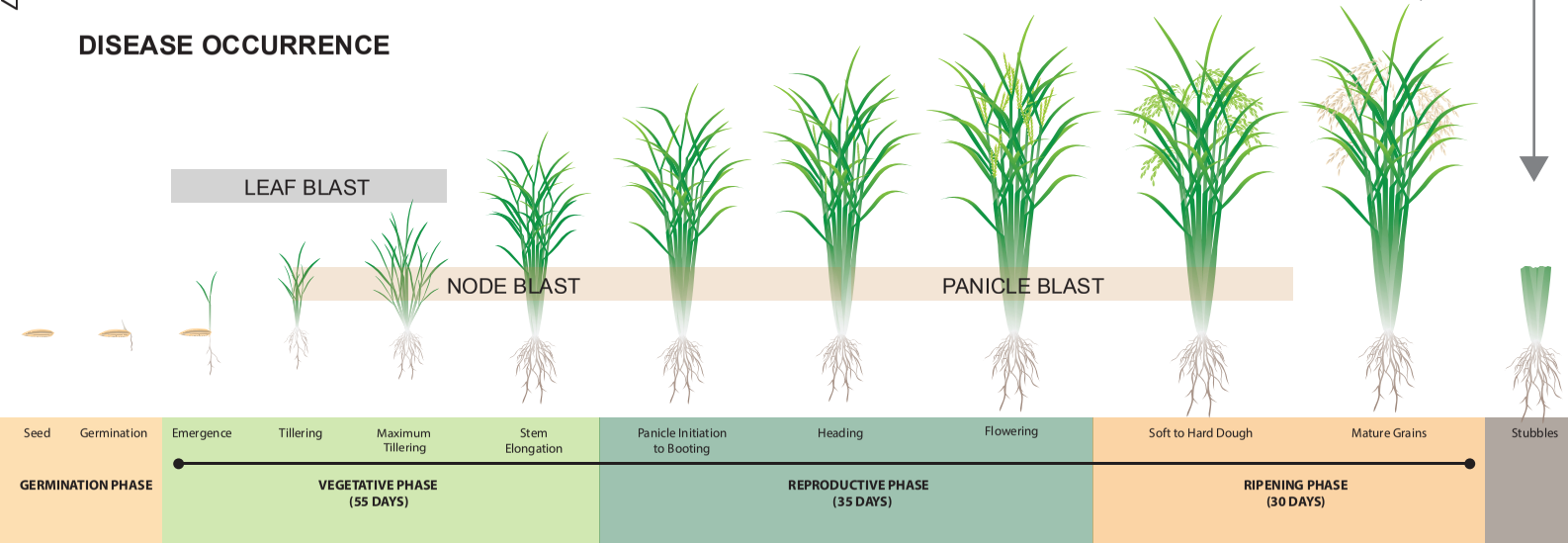
- Long dew period
- Water scarcity with high night humidity and low night temperature



DISEASE MANAGEMENT

- Plant resistant variety.
- Raise seedlings on wet bed.
- Avoid water stress.
- Avoid high N-fertilization.
- Destroy infected crop residues.

DISEASE OCCURRENCE



SHEATH BLIGHT

LOCAL NAME:

- labhag sa pal-ak (Cebuano)
- masot (Pangasinan)

CAUSAL ORGANISM:

- *Thanatephorus cucumeris* (Frank) Donk
- Anamorph: *Rhizoctonia solani* AG1-1A Kuhn

WHERE TO FIND:

- **On leaf sheath**

  leaf sheaths above the water line (sclerotia may be present on affected areas)

  SYMPTOMS: oval gray spots that later enlarge; with black brown margins and gray center

  SUSCEPTIBLE STAGE: tillering to heading

- **On leaves**

  basal portion of the leaves

  SYMPTOMS: lesions are irregular, banded with green-brown coloration; center is grayish white; leaf withers; panicle exsertion affected when flag leaf is infected

  SUSCEPTIBLE STAGE: heading and maturity

Typical symptoms of sheath blight disease on leaf sheath.

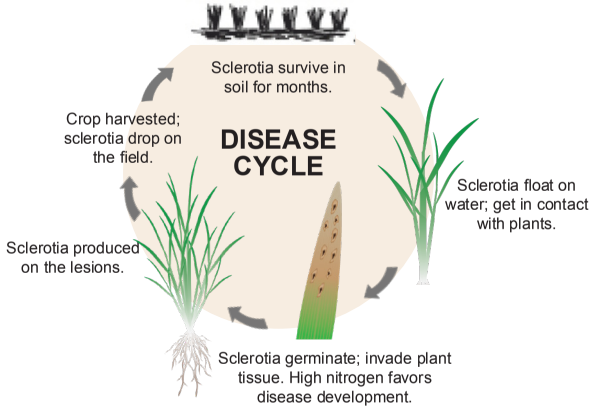
Severe infection of sheath blight disease on the flag leaf and panicle.

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

High nitrogen fertilizer

Close plant spacing

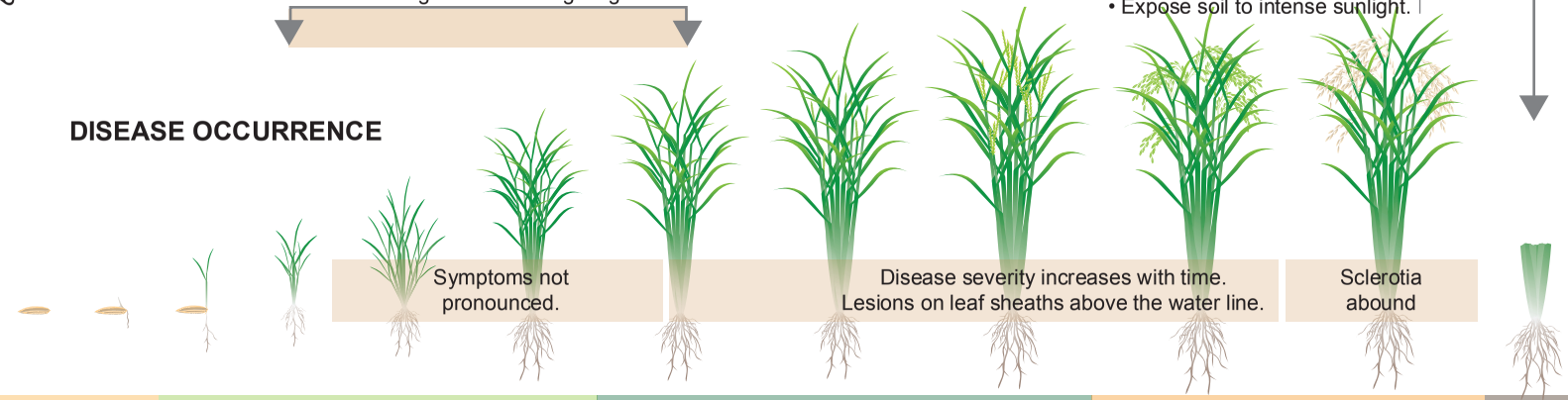
High temperature and humidity



DISEASE MANAGEMENT

- Plant resistant variety.
- Avoid high N fertilization. Split the application.
- Reduce seeding rate or provide wider spacing.
- Drain the field at maximum tillering for few days.
- K fertilizer reduces disease incidence.
- If fungicide is to be used, apply it at the leaf sheath at stem elongation to booting stage.
- Plow deeply to bury infected stubble and weeds.
- Expose soil to intense sunlight.

DISEASE OCCURRENCE



BROWN SPOT

LOCAL NAME:

- butik-butik, taguntom (Waray)
- tawonton (Cebuano)
- puntik-puntik (Cebuano in Mindanao)
- putak-putak (Bicolano)

CAUSAL ORGANISM:

- *Cochliobolus miyabeanus* (Ito et Kuribayashi) Drecheler ex Dastur
- Anamorph: *Bipolaris oryzae*

WHERE TO FIND:

- **On leaves**

  leaves (common in plants in the shaded area, in potash-deficient and saline fields)

  SYMPTOMS: small, circular, oval spots fairly scattered on the leaves with gray center; spots fuse and leaf withers

  SUSCEPTIBLE STAGE: tillering

- **On seedlings**

  leaf coleoptile and roots (seedborne; seedling infection arises from infected seeds)

  SYMPTOMS: brown spots on leaf coleoptile; roots with black lesions

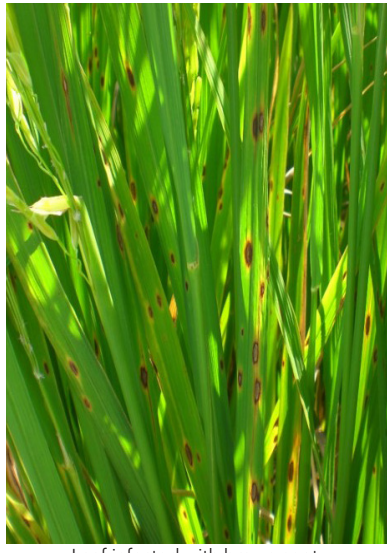
  SUSCEPTIBLE STAGE: seedlings on seedbed

- **On grains**

  fungus enters the glume and infects the seed

  SYMPTOMS: black spots on glumes and covered with dark brown velvety mat of fungal spores; seeds become discolored and shriveled

  SUSCEPTIBLE STAGE: maturity



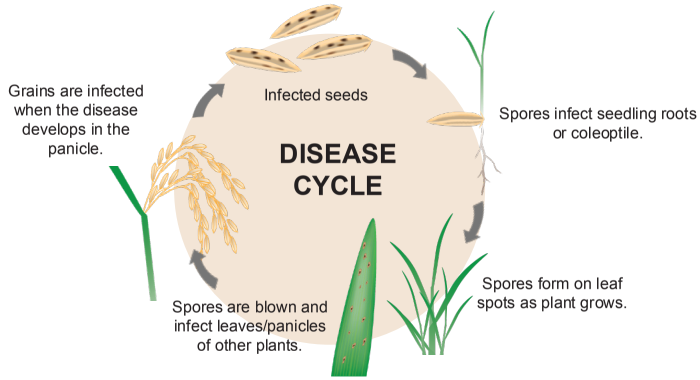
Leaf infected with brown spot.

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

Deficiency in potassium

Cloudy, light rain, heavy dew, 20°-29°C temperature

Planting infected seeds



DISEASE MANAGEMENT

- Plant certified seeds
- Proper agronomic practices:
  - Balanced fertilization
  - Field sanitation
  - Good water management
  - Soil amendments

- Apply muriate of potash to correct K deficiency.

- Destroy stubble and weeds acting as inoculum sources.

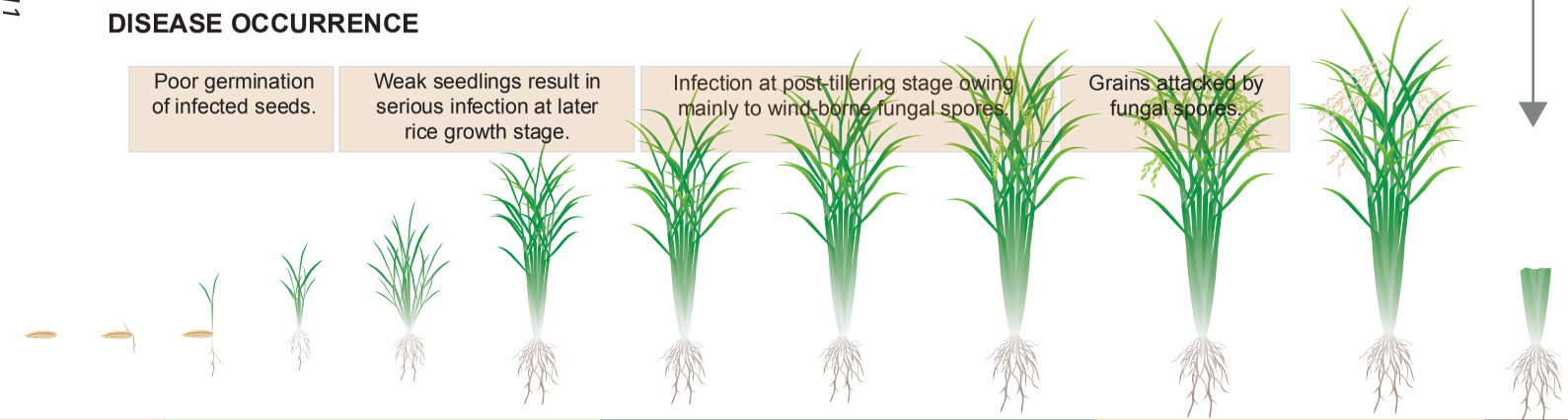
DISEASE OCCURRENCE

Poor germination of infected seeds.

Weak seedlings result in serious infection at later rice growth stage.

Infection at post-tillering stage owing mainly to wind-borne fungal spores.

Grains attacked by fungal spores.



STEM ROT

LOCAL NAME:

- lata na puno (Cebuano)
- dunnot nga puno hin humay (Waray)
- bulalaw, kusim (Ilonggo)

CAUSAL ORGANISM:

- *Magnaporthe salvinii* (Cattaneo) Krause et Webster
- Anamorph: *Sclerotium oryzae* Cattaneo

WHERE TO FIND:

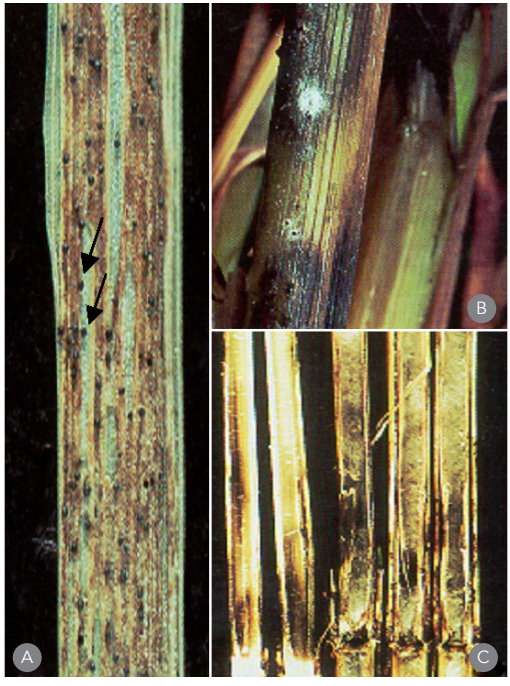
- **Leaf sheaths**

  near water line; split open an affected stem to see fungal mycelium and black sclerotia inside

  SYMPTOMS: small, black irregular lesions on outer leaf sheaths near the water line; lesions enlarge and infect inner leaf sheaths and stem; leaf sheaths rot and many sclerotia are embedded in decaying tissues

  SUSCEPTIBLE STAGE: late tillering to maturity

  NOTE: serious in field where the lower plant parts remain under water most of the growing period; sclerotia spread the disease



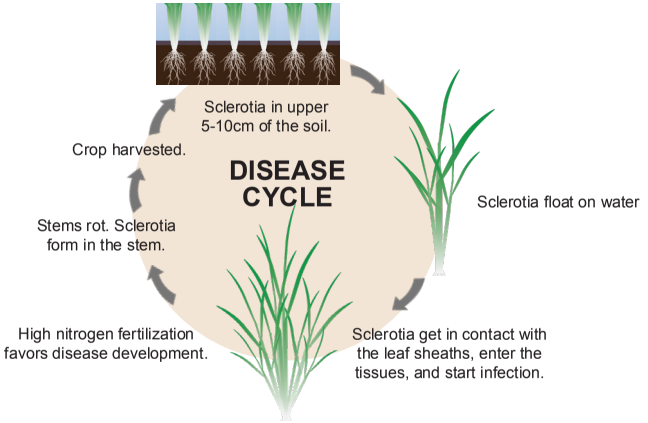
(A) Infected rice stem split open showing sclerotia inside; (B) Stem rot lesions on leaf sheath with fungal mycelial growth; and (C) infected rice stems split open showing the black discoloration.

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

High nitrogen and phosphorus fertilization

Poor drainage system

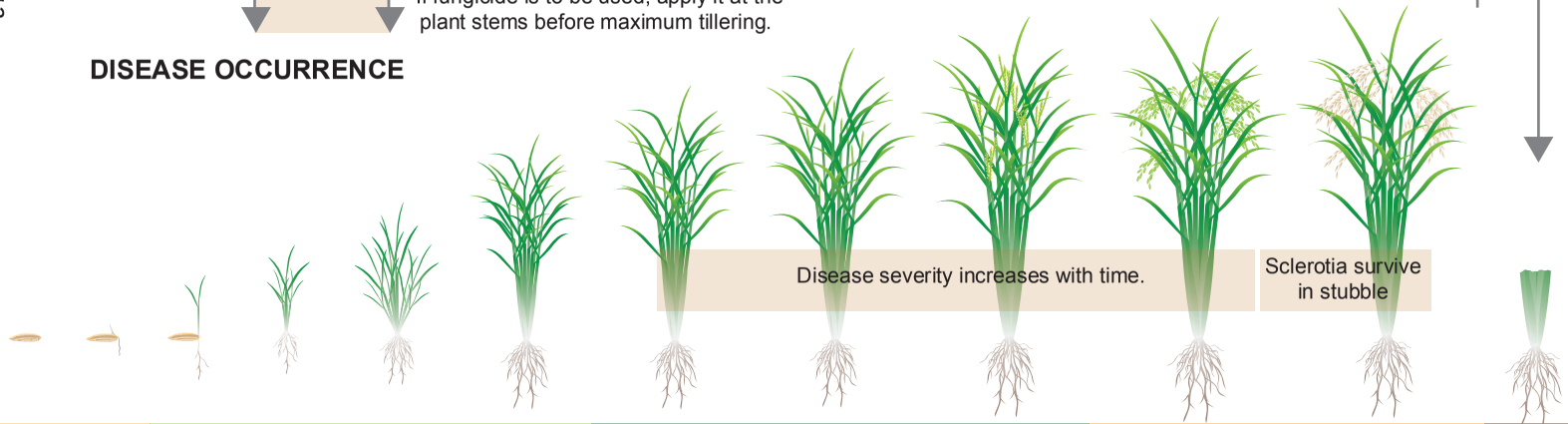
Plants lodge at early growth stage



DISEASE MANAGEMENT

- Plant lodging-resistant variety.
- Avoid excessive N and P fertilizers.
- Add potash and sodium silicate.
- Good water management.
- If fungicide is to be used, apply it at the plant stems before maximum tillering.
- Drain and dry the field.
- Destroy stubble and crop residues.

DISEASE OCCURRENCE



SHEATH ROT

LOCAL NAME:

- nalata nga pal-ak nga naggunit sa bunga (Cebuano)
- nadudunot nga pal-ak han humay (Waray)

CAUSAL ORGANISM:

- *Acrocylindrium oryzae* Sawada
- Anamorph: *Sarocladium oryzae* [Sawada] W. Gams et d. Hawksworth

WHERE TO FIND:

- **At the uppermost leaf sheath that encloses emerging panicle** (white powdery fungal mass inside infected sheath)

  SYMPTOMS: irregular lesions with gray center and brown margins; on the sheath, panicle emerged partially; and mostly unfilled grains

  SUSCEPTIBLE STAGE: from tillering to panicle initiation

- **On grains**

  SYMPTOMS: brown discoloration, chaffy, and covered with white to light pink fungal growth

  SUSCEPTIBLE STAGE: maturity (the pathogen can survive for 10 months on seeds while in storage)

Sheath rot lesion on leaf sheath clasping the panicle resulting in partially emerged panicle and empty grains.

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

High nitrogen fertilization

Dense plant population

Cool, moist weather
High humidity

DISEASE CYCLE: LITTLE IS KNOWN ABOUT ITS EPIDEMIOLOGY

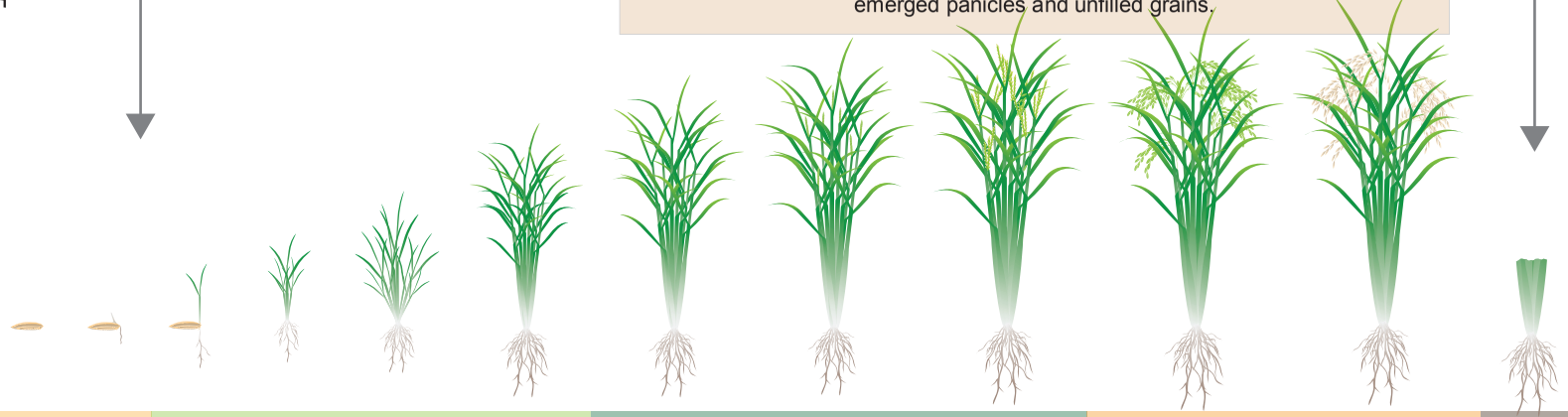
- Externally and internally seed-borne
- Wound facilitates infection
- Infects weeds
- Survives in stored seeds up to 10 months
- Mostly affects plants injured by insects
- Wind-borne; enters through wounds

DISEASE MANAGEMENT

- Use certified seeds
- Avoid dense planting.
- Do not apply excessive N-fertilizer.
- Plow dry diseased plants and weeds.

DISEASE OCCURRENCE

Infection at panicle initiation results in partially emerged panicles and unfilled grains.



BACTERIAL LEAF BLIGHT

LOCAL NAME:

- nauga nga dahon, nalata nga tanum (Cebuano)
- nadurot nga tanum (Waray); naggapula (Ilonggo)

CAUSAL ORGANISM:

- *Xanthomonas oryzae p.v. oryzae* (Ishiyama) Swing et al.

WHERE TO FIND:

- **Kresek**

  usually found in seedbed and newly planted seedlings

  SYMPTOMS: tiny water-soaked spots on lower leaves; spots enlarge, turn yellow and dry rapidly; seedling wilts

  SUSCEPTIBLE STAGE: seedling

- **On leaf (leaf blight)**

  leaves (presence of opaque dew drops on the surface of lesions in the morning)

  SYMPTOMS: water-soaked stripes that later cover a large area of the leaf blade; lesions are grayish white with wavy light brown margin

  SUSCEPTIBLE STAGE: reproductive to maturity

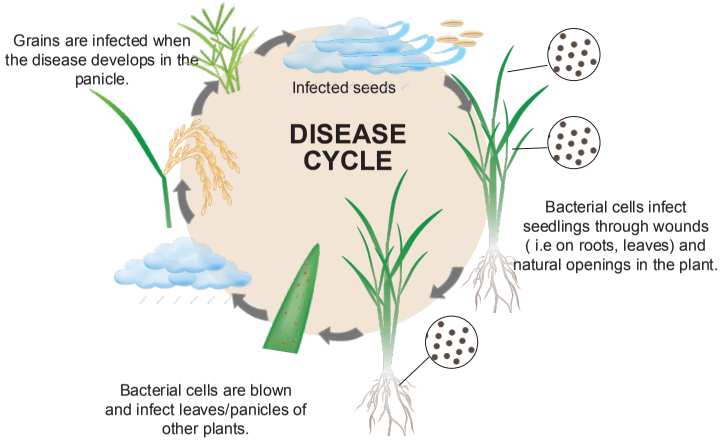
(A) Plants infected with bacterial leaf blight.
(B) Bacterial blight-infected leaf showing yellow-brown lesion.

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

Excessive nitrogen, magnesium silicate fertilization; Deficiency in P and K

Highly susceptible variety

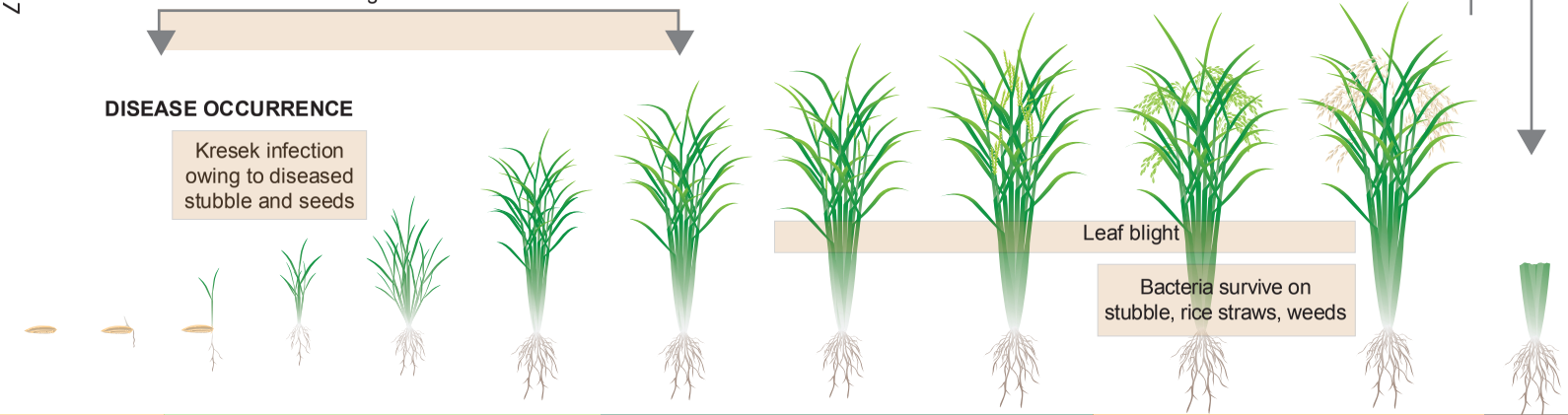
Strong wind
Heavy rain
25-35°C temp



DISEASE MANAGEMENT

- Plant resistant variety.
- Reduce plant injury during transplanting.
- Treat seeds or use seeds from healthy plants.
- Avoid excessive nitrogen fertilization.
- Destroy plant residues.

DISEASE OCCURRENCE



BACTERIAL LEAF STREAK

LOCAL NAME:

- naggapula (Ilonggo)

CAUSAL ORGANISM:

- *Xanthomonas oryzae p.v. oryzicola* (Fang et al.) Swings et al.

Where to find:

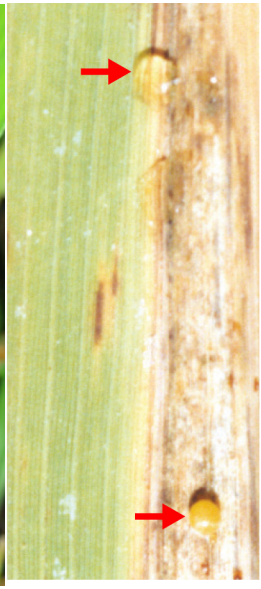
- **On leaves**

  SYMPTOMS: fine translucent streaks that enlarge lengthwise; coalesce (merging lesions), form large brown affected leaves; at later stage, entire leaf turns brown and withers

  SUSCEPTIBLE STAGE: tillering to maturity

  NOTE: wind-borne, present in lowland and upland fields

Narrow brown streaks along the leaf veins of bacterial leaf streak-infected rice plant.



Close-up of bacterial oozes (arrows) on infected leaf tissues.

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

Excessive nitrogen fertilization

Injured rice leaves

High humidity, rain

DISEASE CYCLE

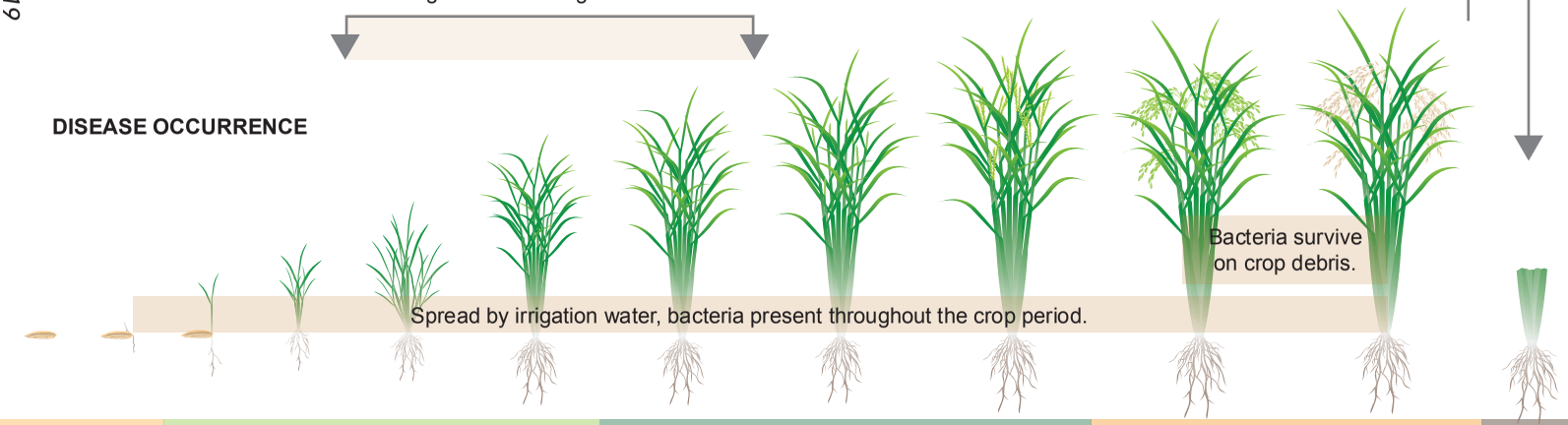
Little is known except:

- Bacteria enter leaves through stomata and wounds
- Bacterial cells are discharged on leaf surface at night
- Disease is spread by irrigation water and seeds

DISEASE MANAGEMENT

- Plant certified seeds.
- Avoid high dose of nitrogen.
- Destroy infected crop residue.

DISEASE OCCURRENCE



TUNGRO

LOCAL NAME:

- tungro (in most local languages)

NOTICE CHANGES ON:

- **Plant height and leaves**

  SYMPTOMS: mottled young leaves; older leaves are yellow to yellow-orange; stunted with slight reduction in tiller number

  SUSCEPTIBLE STAGE: seedling to tillering

  NOTE: spread only by the green leafhopper (GLH); widespread occurrence

(A) A tungro-infected field. Note the yellow plants in clusters; (B) Green leafhopper, the insect that spreads the tungro virus; and (C) infected plant is stunted and has yellow-orange leaves.

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

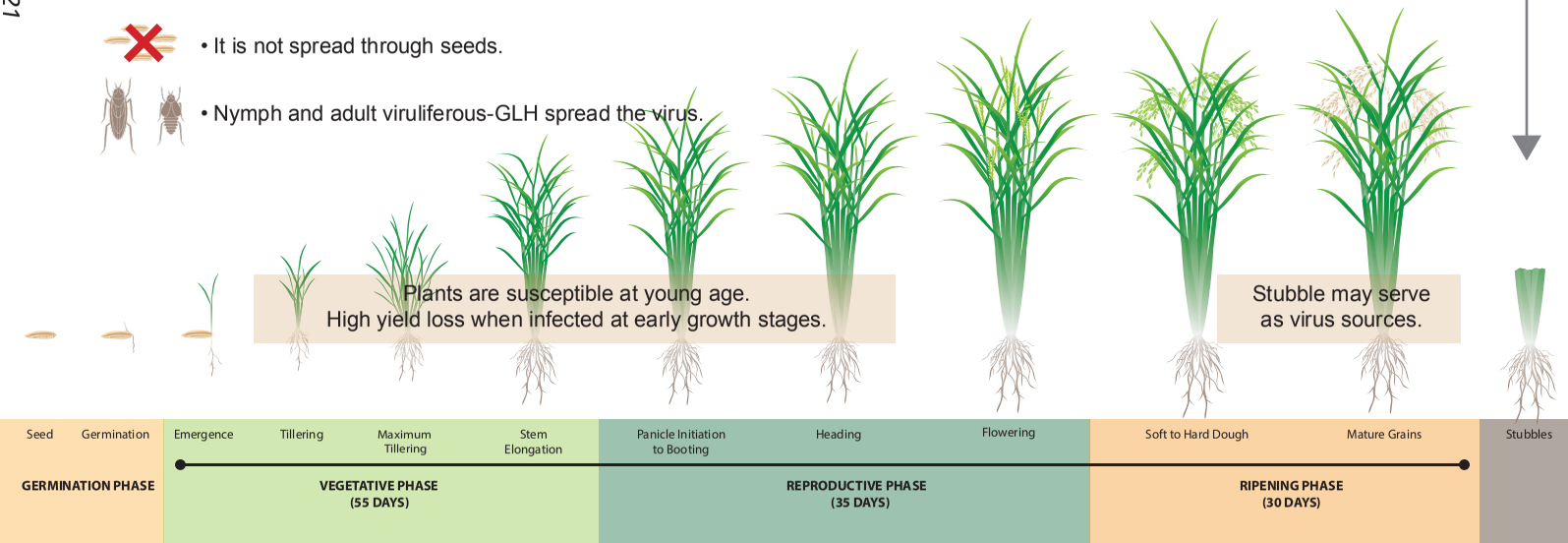
Susceptible variety	Late planting time	Overlapping crops	High number of GLH and diseased plants

DISEASE MANAGEMENT

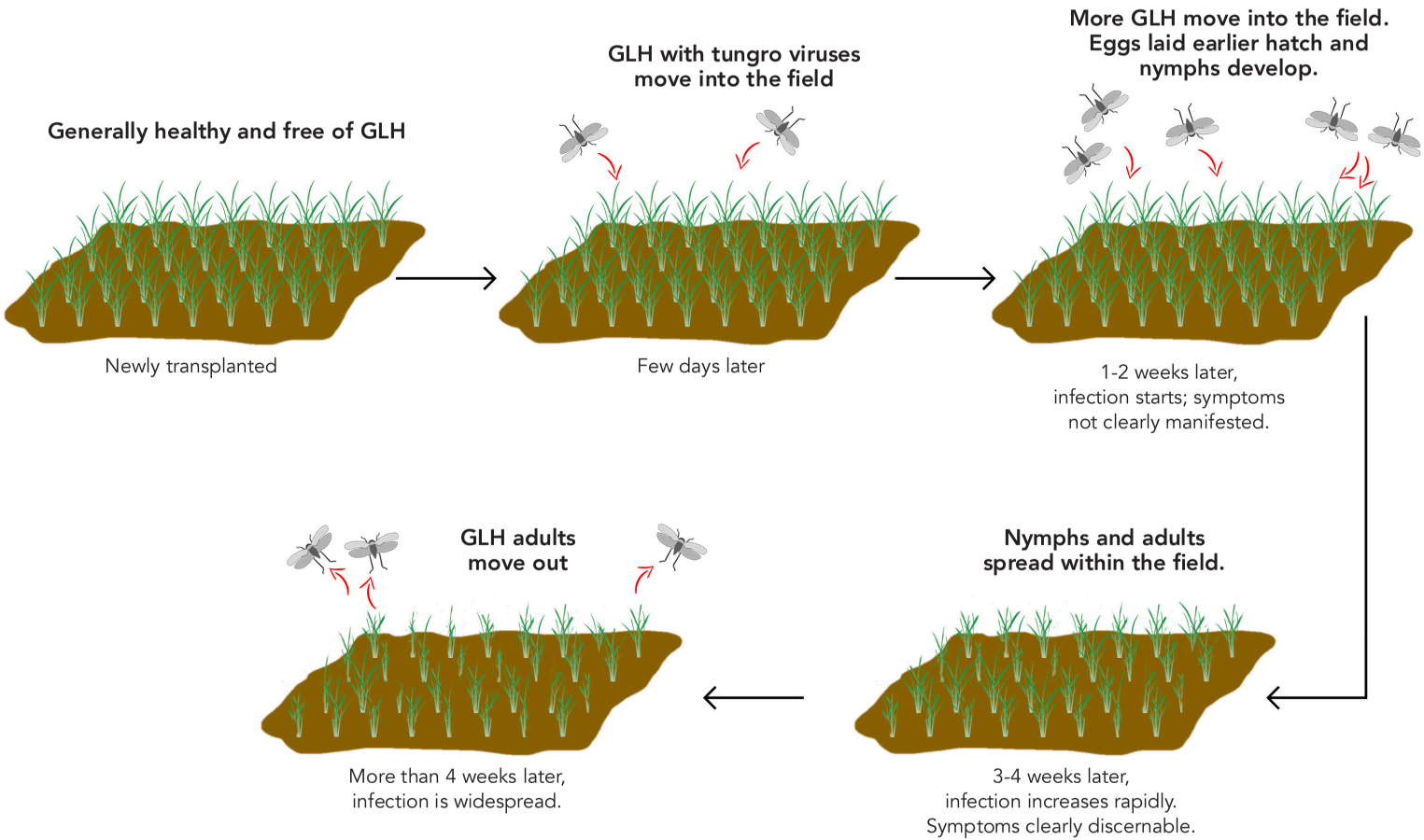
- Plant resistant variety.
- Plant in synchrony with neighboring farmers.
- Remove diseased plants.
- Insect control is important at this point, if threat exists. Do not apply insecticide indiscriminately.
- Rice-free period for at least one month.
- Dry the field to destroy weeds and stubble.

DISEASE OCCURRENCE

- It is not spread through seeds.
- Nymph and adult viruliferous-GLH spread the virus.



TUNGRO DISEASE CYCLE



GRASSY AND RAGGED STUNT

LOCAL NAME:

burit (Tagalog)

- **Grassy stunt**

  Notice changes on: plant height and leaves

  SYMPTOMS: severe stunting; profuse tillering; erect growth habit; leaves are short, narrow, pale green to yellow with numerous small dark brown spots

  SUSCEPTIBLE STAGE: from seedling to tillering

- **Ragged stunt**

  Notice changes on: plant height and leaves

  SYMPTOMS: stunted plant; torn or ragged leaves with twisted tip; vein swellings on leaves and near leaf collar; plant remains green

  SUSCEPTIBLE STAGE: from seedling to tillering

(A) Grassy stunt-infected plants are severely stunted and with erect light green leaves; (B) Ragged stunt-infected plant is green but stunted and with ragged leaves; and (C) Brown planthopper, the insect that spreads both viruses.

GRASSY STUNT and RAGGED STUNT

DISEASE DEVELOPMENT AND SEVERITY FAVORED BY:

Susceptible variety	Overlapping crops	High number of BPH and diseased plants

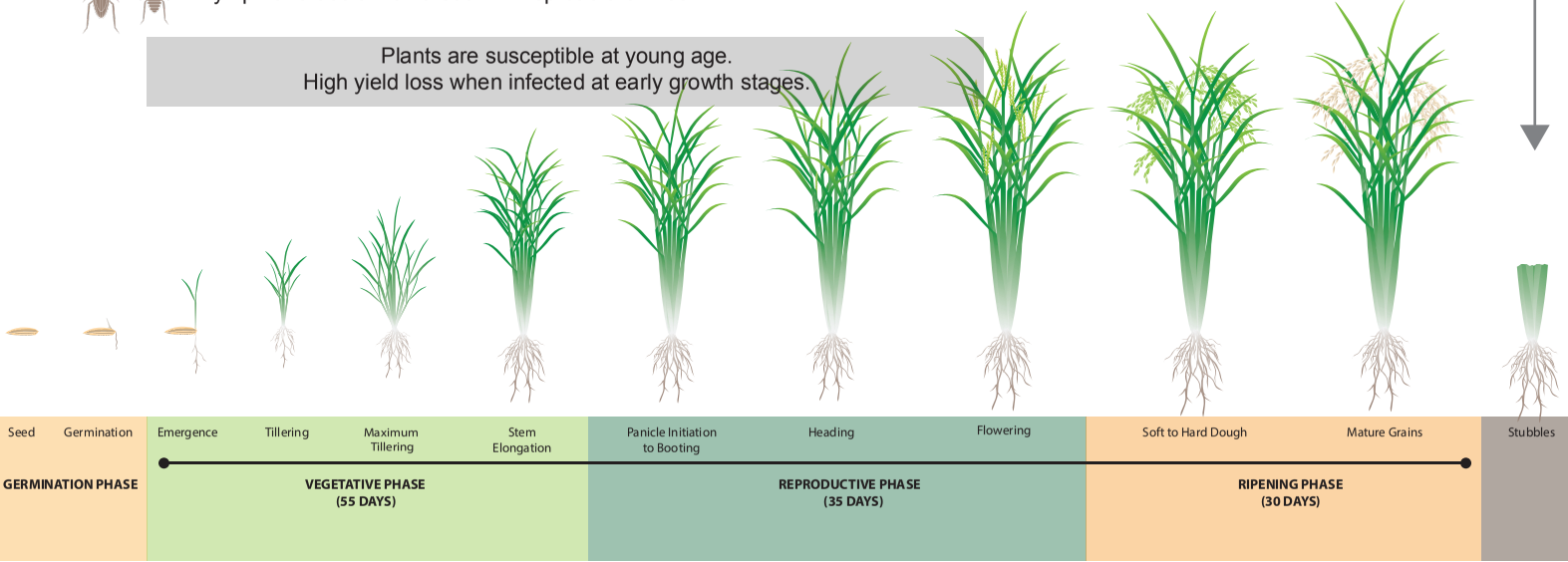
DISEASE MANAGEMENT

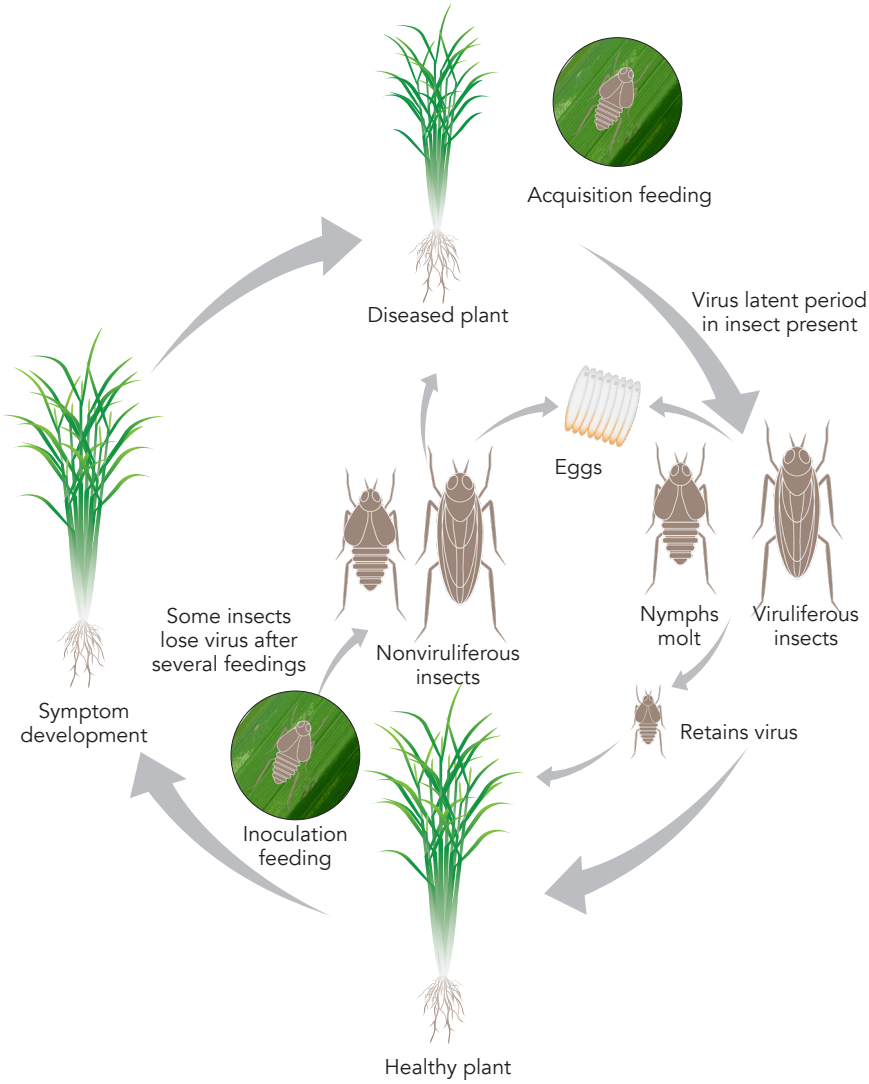
- Plant resistant variety.
- Insect control is important at this point, if threat exists. Do not apply insecticide indiscriminately.
- Dry the field to destroy weeds and stubble.

DISEASE OCCURRENCE

- It is not spread through seeds.
- Nymph and adult viruliferous-BPH spread the virus.

Plants are susceptible at young age.
High yield loss when infected at early growth stages.





Schematic diagram of the spread of rice grassy stunt and rice ragged stunt diseases in the rice paddy field (Modified after Ling, 1972).

Nutrient Deficiencies

(often misdiagnosed as pathogenic diseases)

NITROGEN DEFICIENCY

SYMPTOMS:

- stunted plant
- less tillers
- small, narrow, erect leaves that turn yellowish-red and brown
- old leaves become light straw-colored and wither


PHOTO CREDIT: IRRI.ORG

CORRECTIVE MEASURES:

- Apply nitrogen fertilizer as needed, based on the leaf color chart (LCC).
- Split application of nitrogen to increase efficiency.

PHOSPHORUS DEFICIENCY

SYMPTOMS:

- stunted plant
- less tillers
- erect stem with small, narrow, erect leaves
- young leaves look normal but old ones turn brown and wither


PHOTO CREDIT: IRRI.ORG

CORRECTIVE MEASURES:

- Upon introduction of irrigation water or flooding, symptoms disappear and ferric phosphate is reduced.
- Apply phosphorus fertilizer basally or at early tillering stage.

POTASSIUM DEFICIENCY

SYMPTOMS:

- stunted plant
- slightly reduced tillering
- yellowing of interveinal areas of lower leaves starting from the tip then later leaves turn brown and wither
- old leaves with brown spots


PHOTO CREDIT: IRRI.ORG

CORRECTIVE MEASURES:

- Apply potassium fertilizer.

ZINC DEFICIENCY

SYMPTOMS:

- stunted plant
- less tillers
- base and midrib of young leaves are yellowish, while old leaves are rusty brown
- smaller leaf blades
- uneven growth of the plants
- delayed maturity

CORRECTIVE MEASURES:

- Drain the field.
- Soil or foliar application of zinc fertilizer.

IRON DEFICIENCY

SYMPTOMS:

- stunted plant
- less tillers
- leaves, especially the youngest, become yellow-whitish and brown

CORRECTIVE MEASURES:

- Apply sulfur or diluted sulfuric acid.

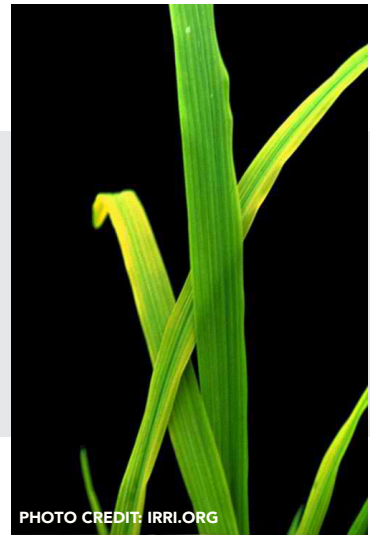


PHOTO CREDIT: IRRI.ORG

Determining the Plant's Nutrient Needs

The following protocol may be used to fully characterize the fertilizer requirement of the crop. This avoids over-fertilization that predisposes the plant to fungal and bacterial diseases, reduces cost of inputs, and enhances the physical and chemical properties of the soil.

1. Visual diagnosis should be done early as the symptoms appear. Compare the unusual symptoms with healthy plants.
2. Verify the visual diagnosis through soil test or biological technique (e.g., Minus-One Element Technique: Nutrient Deficiency Test Made Easy, Rice Technology Bulletin no. 30).
3. Fertilization can be done on a trial analysis basis, in small plots or over the entire field, using the required nutrient. Likewise, maintain an unfertilized area for comparison.
4. Confirm by taking leaf samples for tissue analysis.This should be done after irrigation or rainfall to ensure that the fertilizer added was absorbed and the deficiency was corrected.
5. Prevent by making a planned soil and plant analysis program of the farm.

Collection and Preparation of Soil Sample for Analysis

Pointers in Soil Sampling

- Collect soil samples after harvest when the field is dry, and away from outlying areas of the field.
- Collect one composite sample from each field having the same color, texture, slope, class, depth, drainage, and cropping history.

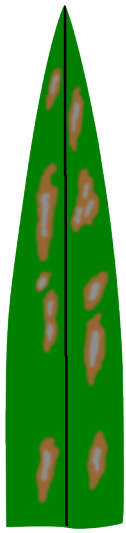
Materials

- Long-handled shovel
- Trowel
- Plastic bags
- Pentel pen

Steps in Sampling

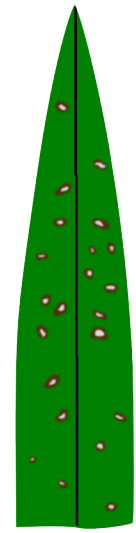
1. Remove plant residues in the soil surface.
2. Dig to about 20cm deep.
3. Slice about 5-cm-thick soil samples from the vertical side.
4. Collect about 10-cm wide of the middle part of the vertical slice and place in a container.
5. Take samples from three random points of each field to be tested.
6. Mix all samples thoroughly. Take 1kg from the composite sample and place in a plastic bag.
7. Put label (i.e., location, name, date of sampling, and cropping season) on the plastic bag.

Illustrated guide to the disease symptoms on leaves

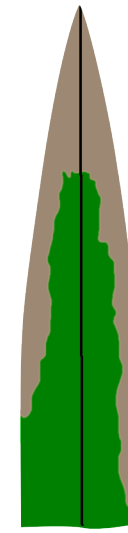


BLAST
Spindle-shaped lesions with brown margin and gray center

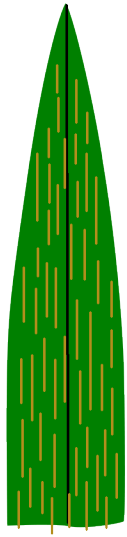
SHEATH BLIGHT
Large, irregular lesions with dark brown margin and gray center



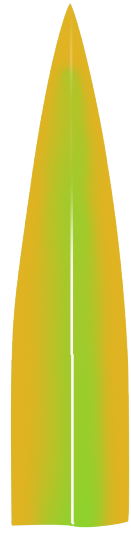
BROWN SPOT
Circular to oval dark brown spots with brown margins and light gray center



BACTERIAL LEAF BLIGHT
Gray to brown, uneven lesions progressing downwards



BACTERIAL LEAF STREAK
Linear, water-soaked, yellowish streaks between the veins



TUNGRO
Yellow to yellow orange leaves; mottled young leaf

GRASSY STUNT
Light green, narrow, and erect leaves with numerous dark spots

RAGGED STUNT
Leaves with ragged edge and twisted tip; whitish galls on veins

A quick guide to the appropriate control measures against major rice diseases.

Control Measure	Diseases							
	Blast	ShB	Brown Spot	Stem Rot	Sh Rot	BB/ BSt	Tungro	G/R Stunt
Resistant variety[1]	✓	✓	✓	✓	✓	✓	✓	✓
Plant certified seeds	✓	✓	✓	-	✓	✓	-	-
Synchronous planting[2]	-	-	-	-	-	-	✓	✓
Optimum fertilization	✓	✓	✓	✓	✓	✓	-	-
Destruction of plant residues/stubble[3]	✓	✓	✓	✓	✓	✓	✓	✓
Pesticide application[4]	✓	✓	✓	-	✓	✓	✓	✓
Field sanitation[5]	✓	✓	✓	✓	✓	✓	✓	✓
Avoid dense planting	✓	✓	✓	✓	✓	✓	-	✓
Good water management	✓	✓	✓	✓	✓	✓	✓	✓

[a] ShB means Sheath Blight, Sh Rot - Sheath Rot, BB - Bacterial Blight, BSt - Bacterial Streak, G/R - Grassy/Ragged Stunt.

[1] Highly recommended against rice blast, bacterial blight, tungro, grassy stunt, and ragged stunt.

[2] Within one month of the general planting time in a rice farming community.

[3] Dry or deep plowing after harvest.

[4] Correct timing and frequency of application are important to obtain positive results. The timing of pesticide application depends on the disease. An application usually happens when the disease is noticeable.

□Includes weeding and removal of diseased plants (roguing). For virus diseases, rogue at early disease development stage.

Types of soil tests.

Type of Test	Elements to Determine	Frequency	Cost*	Test Station
Routine analysis	N, P, K	Every 5 years	NPK = P130/sample (Qualitative test)	• Bureau of Soils and Water Management, (BSWM) Quezon City
	Soil pH		Soil pH = P100/sample	• BSWM
Special analysis	Fe, Zn	Every 7 years	P160.00 per element per sample	• BSWM

*prevailing rates (2021)

A practical guide in determining the plant's nutrient needs.

	Nitrogen deficiency	Phosphorus deficiency	Potassium deficiency	Sulfur deficiency	Zinc deficiency
Most susceptible stage of the plant	Vegetative	Vegetative	Vegetative	Vegetative	Vegetative
Plant parts showing symptoms	General yellowing of leaves Small, narrow, erect leaves that turn yellowish	Narrow, erect, dark green leaves Slender stems	Yellowish leaves with brown spots on old leaves	Yellowish to whitish leaves	Young leaves yellowish; old ones are rusty brown.
Indicators and signs reduced	Stunted plant; less tillers	Stunted plant; less tillers	Stunted plant; slightly reduced tillering	Stunted plant; less tillers Brown deposits on soil, water surface, and plant roots.	Stunted plant; less tillers Plants near the levees and at high position have better growth. Rust- or oil-like matters on water and soil. Water-logged areas.
Simple ways to correct the problem	Apply N	Apply P at early plant growth stage.	Apply K	Apply sulfur or diluted sulfuric acid.	Drain the field with standing water. Apply Zn.
Factors that aggravate the problem	Intensive cropping Low soil organic matter	Intensive cropping and cold weather.	Intensive cropping	High soil pH in upland	Intensive cropping Poor soil drainage

GLOSSARY OF TERMS

Abiotic - Pertains to nonliving condition.
Adverse condition (also abiotic factor) - Unfavorable weather factors (temperature, wind speed, temperature, sunshine, humidity), undesirable soil fertility, and limited or excessive water.
Bacterium (pl. bacteria) - Microscopic (tiny) and primitive one-celled organism that has no nuclear membrane and chlorophyll, lives as a parasite or saprophyte, and multiply by dividing from a mother cell into two daughter cells.
Biotic - Opposed to abiotic.
Brown planthopper - Mainly a pest of irrigated wetland rice, but can also become abundant in rainfed wetland environments; causes plants to wilt, and transmits grassy stunt and ragged stunt virus diseases *(Nilaparvata lugens stål).*
Chlorosis - An abnormal color of rice leaves and stems attributed to the lack or absence of green pigment caused by abiotic and biotic factors.
Coalesce - Joining of spots or lesions to form a larger affected area.
Diagnosis - A critical determination of identifying a plant disorder through symptoms and signs.

Electron microscope - A powerful microscopic instrument capable of greatly enlarging the image of a very tiny organism (virus) or subject.

Fungus (pl. fungi) - The nongreen-pigment microorganism whose somatic structure is stranded and branched; reproduces asexually and/or sexually.

Green leafhopper - Sucking insect pest of rice belonging to family Cicacellidae, the most important vector of rice tungro disease.

Growth stage - Process of growth over a period of time.
Host - The organism on which a parasite lives; plant on which a pest feeds.

Infectious - Capable of infection and spreading the disease from plant to plant.

Insect - An arthropod wherein the adult has six legs, a pair of wings, and three body divisions (head, thorax, and abdomen).
Kresek - A bacterial disease of rice that occurs at seedling stage.

Leaf sheath - The lower part of the leaf originating from a node and enclosing the stem (culm) above the node.

Lemma - The outer, lower bract enclosing the flower in a grass spikelet.

GLOSSARY OF TERMS

Micron - A unit of length equivalent to one per millionth of meter.

Mycelium (pl. mycelia) - Mass of interwoven strands that make up the somatic bodies of fungi.

Nanometer - A unit of length equivalent to one per billionth of meter.

Necrosis - Death of plant cells and tissues.

Nematode - An unsegmented worm-like organism parasitic in or on the plant or animal, or free-living in soil.

Panicle - The terminal shoot of the rice plant that produces grain.

Pathogen - A specific living agent that causes infectious disease.

Potash deficiency - Disease or disorder resulting from lack of essential potassium element.

Rachilla - Internal axis of a spikelet of grasses and sedges.

Saline - A natural deposit of soluble salt.

Sclerotium (pl. sclerotia) - Hard resting body of a fungus that remains dormant and germinates upon the return of favorable conditions.

Spore - A minute propagative unit of the fungi functioning as a seed but does not contain embryo.

Susceptibility - A condition wherein the host is infected at high level and spreads at a fast rate.

Susceptible stage - Growth stage of a plant most supportive to pest infestation.

Transmission rate -The rate of disease spread from infected to healthy plant.

Growth stage - Process of growth over a period of time.

Virus - An ultramicroscopic infectious agent (obligate parasite) that needs living host cells for survival.

Weed - Any unwanted plant.

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