# HIGHLAND POTATO

## ADAPTATION

Potato, a crop rich in minerals and other food nutrients, grows best in deep well drained, loamy or sandy loam soils with pH ranging from 5.5-6.0.

An average temperature of 15-18$^{o}$C is essential during its growth period.

A rainfall of about 2.5 cm per week evenly distributed through the growing season.

## CULTIVAR SELECTION

An ideal cultivar is adaptive, high yielding, resistant to common pests and diseases, stable and has low degeneration rate. These qualities, however, can seldom be found in one cultivar. A farmer has to select for the right cultivar that suits his own conditions and needs.

## SEEDPIECE SELECTION

Good seed quality enhances yield. Healthy plants usually come from healthy seeds. Select seed tubers which are free from insect pests and diseases, full in form, firm and with good sprouts. Choose seed tubers which are not stored for a long time.

The use of certified seeds is best but not always profitable because of their very high price. Farmers who often store tubers for planting from their previous crops should only choose those tubers from healthy plants.

Seed tubers come in different forms from different sources as certified seeds from importers and farmer-cooperators of the Potato Seedgrowers Association; or as clean seeds from other farmers.

## CULTURAL MANAGEMENT PRACTICES

### Land Preparation

Remove weeds and volunteer plants in the area before plowing. Do the second plowing. Do the second plowing immediately before planting. If the area is recently planted plow only once.

Raised beds are recommended during wet season planting to improve drainage. On the other hand, beds need not be raised during dry season planting.

### Fertilization

Just like other crops, proper nutrition is essential in potato production. Nitrogen (N), Phosphorus (P) and Potassium (K) perform vital tasks in the growth and development of the plant.

The required amount of Nitrogen for potato varies from 100-200 kg/ha depending on the purpose of the crop and the type of soil. Seed potatoes require a lower level of nitrogen to maintain a smaller tuber size. High nitrogen application is not desirable because it prolongs the maturity of the crop and mask mild viral symptoms.

Phosphorous contributes to the early development of the crop, early tuberization, and increase in the number of tubers produced per plant. Relatively high rates of P are applied in seed potato field to help reduce virus infection.

Potassium on the other hand, increases the crop's dry matter content, helps prevent black-spot damage and the blue discoloration after cooking. It also improves the storage quality of potato.

If available, use organic fertilizer to improve the water holding capacity of the soil, enhance aeration, make heavy soils lighter, bind lighter soils and serve as source of other nutrients.

**Fertilizer Rate**. The general NPK recommendations for table and seed potatoes are 140-140-140 and 120-120-120 kg nutrient/ha, respectively.

**Time of Application.** Apply organic fertilizers before planting. The crop uses fertilizer more efficiently when applied as basal than when side-dressed after plant emergence. During the dry season, additional yield of 8 t/ha can be obtained when chicken manure and complete fertilizer are applied as basal than when applied 3 weeks after planting.

**Fertilizer Placement.** Place the fertilizer near the root zones so that plants can easily absorb the nutrients.

Apply the recommended amount of inorganic fertilizer in the furrow or 20 g (2 level tbsp) per hill at plant-

ing time. Cover fertilizer with a thin layer of soil before planting.

**Lime Requirements**

Liming is necessary in acidic soils (pH5 and below). This increases the availability of nutrients in the soil needed by the crop. The amount of lime to be applied depends on the pH and the type of soil. For different soil types with pH range of 4.00 to 5.00, the rate of application of lime (CaCO3) are as follows: 3.5 -1.5 MT for sandy loam; 4.5 - 2.0 MT for loam; and 6.0-7.5 MT for silty clay loam. Apply at least one month before planting.

**Planting**

Plant the seedpieces when the soil is either too wet nor too dry. Too wet soil causes seed rotting especially before emergence due to excessive moisture and lack of oxygen. On the other hand, the seedpieces dehydrate easily if sown on dry soil. Plant the tubers on light soils at 8-10 cm deep and on heavy soils at 5-7 cm deep. If planting in heavy soils is followed by heavy rain, loosen the spaces between the seeds with a hoe to allow aeration.

The proper distance of planting on a double row plot is shown below.

The seeding rate is 6 seedpieces/sq m or 50,000 seedpieces/ha.

Whole seeds at 35-55 mm size are recommended as planting materials for both seed and table potato production. However, in table potato production, seedpieces with a diameter larger than 50 mm may be cut to smaller pieces weighing 40-50 g. Knives used for cutting should be disinfected to avoid the transfer of seedborne disease. Plant the seedpieces on moist soil right after cutting.

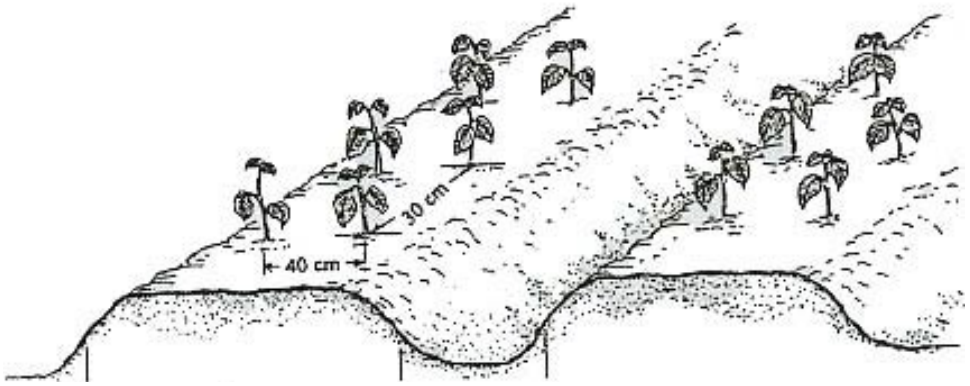

Figure 1. Measurement of a double row plot

**Water Management**

The moisture requirement of potato varies at different growth stages. If the soil is dry, the field should be irrigated 3-5 days before planting. After planting, potato requires a relatively low moisture level to harden the plants and lessen the incidence of tuber rotting. After emergence, the amount of water needed increases as the crop grows. The crop should have adequate moisture at stolon formation, tuber set and tuber growth. A period of interrupted growth due to insufficient moisture during tuber growth will result to the production of undersized and malformed tubers.

Inspect the soil within the root zones from time to time to determine the availability of soil moisture. The simplest method to do this is to form a soil ball. Get a handful of soil from the root zone area. If a ball can be formed and crumbled when dropped to the ground, the moisture in the soil is just right. However, if the ball does not crumble, there is too much water in the soil.

Water is applied either by overhead irrigation with the use of watering cans or by means of furrow irrigation. However, to avoid occurrence of fungal disease, furrow irrigation is recommended.

## CROP PROTECTION

**Weed Control**

Weeds compete for light, space, water and plant nutrients. Their roots absorb more water and nutrient than the shallow rooted potato. Weeds can reduce potato yield to as low as 38%. They serve as alternate hosts of virus diseases that cause tuber degeneration and low yield. Weeds cause faster spread of insect pests such as asphids and thrips, and diseases such as late blight, blackleg and rhizoctonia.

To reduce yield loss due to weeds, the field should be thoroughly prepared and relatively free from weeds during the early stage of growth (4-6 weeks after planting). A well-prepared land will have less weed problems and allows the crop to compete better with the weeds.

Control weeds by hand pulling, hoeing the field and hilling-up or by mulching (2-5 cm thick). Hill-up when the plants are 15-25 cm

high or at 30 days after planting, after which additional cultivation should be avoided. Pre-emergence application of 0.25 kg a.i./ha of metribuzin (Sencor) and 0.5 kg a.i./ha of prometryn followed by hilling-up 30 days after planting is effective in controlling weeds.

**Insect Pests and Their Control**

Thrips (Thrips tabaci Lindeman and Thrips palmi Karny). These are small soft bodied insects about 1-1.2 mm long. The larvae are dark yellow and slow moving while the adults are brown and fast moving.

The larvae (nymps) and adults damage the leaves by piercing the surface and sucking the plant juices, causing the bronzing and drying up of leaves.
Plowing and harrowing of the field after harvest reduce thrips population in the soil. Overhead and surface irrigation have similar effects. The seedling stage should not coincide with the peak population of thrips which occurs during the dry months of the year. They come in a variety of colors, ranging from yellowish green to grayish green and yellow to brown. The winged forms are usually dark in color. Both the nymphs and adults are destructive.

Remove and dispose weeds and other host plants. Other crops which serve as alternate hosts like onion, cabbage, cauliflower, cucurbits, and tomato should not be grown in rotation with potato in threatened areas.

When weather conditions favor the development of thrip population, resort to chemical pesticides. Spray chemicals from emergence up to 57 days.

**Tuber moth** (Phthorimaea operculella Zeller). Small gray-colored moth with narrow wings fringed with hair and mottled with black and brown spots.

Newly hatched larvae or caterpillars are colorless to pale pink. When fully grown, they reach 9-11 mm in length. They are white to creamy with a dark brown head. The dorsal surface has a light green shade which changes to pale pink when ready to pupate.

Like most other moths, the larval or caterpillar stage is destructive. During the day they take refuge on the foliage and on the ground and become active at dusk.

The eggs hatched on the leaf surface. The larvae tunnel in the leaves and feed on the leaf tissues. They move down to the leaf veins, petioles and into the stems and tubers leading to the loss of leaf tissue, death of growing points and weakening or breaking of stems. Damage from tuber moth infestation may reach as high as 45% in the field.

The damage becomes worse when the larvae tunnel into the tubers by way of the eyes or sprouts. The larvae make black excreta-filled tunnels which extend inside the tuber. Even harvested potatoes are not safe from tuber moth attack if these have not been properly protected or treated before storing. One hundred percent loss in storage is common.

Even before actual infestation, remove and burn volunteer potatoes and plants (including crop residues) left in the field after harvest to prevent the build-up of the moth population. Cover developing tubers by hilling-up with at least 6 cm of soil.

Irrigate on schedule to help control the pest and to keep the soil from drying and forming cracks which serve as entry points for moths and larvae. Remove tubers from the field on the day of harvest to prevent oviposition on newly harvested potatoes by adult tuber moths.

Many chemical pesticides (Table 1) are available in the market if cultural measure prove inadequate. Avoid using restricted pesticides (Appendix A) which still find their way to third world countries.

Before storage, dip seed potato tubers in solution of either Decis 2.5 EC (at 2 tnsp/20 liters of water) or Kafil 10 EC (at 3 tbsp/20 liters of water) for 5-10 minutes. A 20 L solution can accommodate 20 kg of potatoes at a time. A total of 60 kg of seed tubers can be treated with the prepared 20 L solution. Prevent the entry of moths into the storage house by putting insect-proof nets or screens on doors and windows.

**Aphids** (Myzus persicae Sulzer; Macrosiphum euphorbiae Thomas; Aphids gossypii Glover). Aphids or plant lice are minute, sluggish, soft-bodied insects. They gather in large numbers on the plant. Once they have established themselves, they hardly move. With a few exemptions, these insects are wingless.

Table 1. Common Insect pests attacking white potatoes and their chemical control.

| Insect Pest | Recommended Insecticide | Mode of Action | Rate of Application (kg/ha or tbsp/19 L of water) | Spray Interval (Days) |
|---|---|---|---|---|
| Thrips | Dicarsol 50 WP | Contact | 4 kg or 2-4 tbsp | 5-7 |
| | Garvox 200 WP | Contact | 1.4 kg or 2 tbsp | 7-10 |
| | Lannate L | Contact | 1.0 L or 3-6 tbsp | 5-7 |
| | Mesurol 50 WP | Contact | 0.4 kg or 2-4 tbsp | 7-10 |
| | Selecron 500 EC | Stomach/Sytemic | 0.8 L or 1 1/2-2 tbsp | 7-10 |
| Tuber Moth | Birlane 20 EC | Stomach | 1.5 L or 5 tbsp | 7 |
| | Decis 2.5 EC | Stomach | 0.38 L or 2 tbsp | 7 |
| | Garvox 20 WP | Contact | 1.4 kg or 2 tbsp | 7-10 |
| | Hostathion 40 EC | Stomach | 1.01 L or 2 tbsp | 7-10 |
| | Kafil 10 EC | Contact | 1.01 L or 2 tbsp | 7 |
| | Tamaron 40 EC | Systemic/Contact | 1.01 L or 2 tbsp | 7 |
| Aphids | Birlane 20 EC | Stomach | 1.5 L or 3 tbsp | 7 |
| | Decis 2.5 EC | Stomach | 0.38 L or 2 tbsp | 7 |
| | Garvox 20 WP | Contact | 0.4 kg or 2 tsp | 7-10 |
| | Hostathion | Stomach | 1.01 L or 2 tbsp | 7-10 |
| White | Lannate L | Systemic | 1.01 L or 2 tbsp | 5-7 |

Note: the Fertilizer and Pesticide Authority (FPA) prohibits application of chemicals without thorough understanding of the instructions on the label. In case of pesticide poisoning refer to aid instructions in Appendix B.

Aphids pierce potato leaves and succulent stems and suck off the plant juices. This causes wilting, severe curling and yellowing of leaves and stunting of infected plants. Aside from direct damage due to sap withdrawal, aphids pose greater anger because of their ability to transit a variety of virus diseases such as potato leafroll virus (PLRV) and potato virus Y (PVY).

Rogue out all infected plants to prevent aphids from spreading viruses in the field. All volunteer plants should likewise be removed. Keep the field free from weeds which serve as alternate hosts for aphids to deny the pest access to other sources of food with or without a standing crop. Practice clean culture whenever possible. At times, although natural factors such as heavy rain keep aphid population down, infestation may still occur.

**Cutworms**

**Common Cutworms** (*Spodoptera litura* Fabr.) and **Black Cutworms** (*Agrotis ipsilon* Hufnagel). Larvae worms feed actively at night on the young and mature leaves, making small holes on leaf blades. The young stems often cut off at ground level resulting gaps.

Plowing the fields to expose worms to predators before planting to help continue the cutworms infection. Handpicking of worms and field sanitation are necessary.

**Mole Crickets** (*Gryllotapha africana* Pal de Beauvios). The crickets feed on the roots of the plants and the base of the seedings. The insects chew the surfaces of tubers in the soil causing rounded excavations.

Adults can be light-topped to control infestation. Flooding of the field before planting is a preventive control. Tubers should also be harvested as soon as possible after maturity.

## DISEASES AND THEIR CONTROL

**Virus Disease**

**Potato Leafroll Virus (PLRV)**. This is a disease which significantly reduces yield by 30-50% depending on the variety and strain of the virus.

Leafroll virus is transmitted by green aphids (Myzus persicae).

However, other species of aphids can also serve as vectors.

Leafrolling is the main symptom of the disease. The edge of mature leaves rolls upward becomes dry and thickens. The leaves easily break when pressed. The plants grow upright become stunted and are light green. In some potato varieties the underside or base of the leaves turn reddish or purplish.

To control potato leafroll virus: 1) plant certified seed potatoes, 2) remove and destroy diseased plants, 3) control aphids, 4) eliminate volunteer plants, 5) isolate seed potato area from fields intended for table potato production.

**Rugose Mosaic**. This disease is due to the presence of different viruses singly or in combination (PVY, PVY + PVX, PVY + PVX + PVA). The disease affects the potato seed stock.

PVY is mainly transmitted by aphids. Symptoms of the disease are: yellowing of the leaflets; leaf drop; premature death of plants; dwarfing of plants and mottling and crinkling of leaves.

PVX is the most widespread potato viruses and causes yield reduction of up to 15%. It is often field transmitted through the sap in contact with transfer agents like wind, animals, machinery, other plant roots, cutting knives, infected sprouts and biting insects. Symptoms are: 1) dwarfing of the plant and reduced leaflet size; 2) in combination with A or Y, X causes crinkling, rugosity or necrosis.

To control rugose mosaic: 1) plant disease free or certified seed tubers 2) remove and destroy diseased plants, 3) control insect vectors (aphids), 4) remove all volunteer plants, 5) observe strict sanitation when cutting seedpieces.

**Fungal Diseases**

Late Blight (Phytophthora infestans (Mont.) de Bary). It is the most destructive disease of potato. At present, it remains a limiting factor in potato production in the Philippines.

It disease affects leaves, stems, and tubers. It appears on the leaves as pale-green, irregular spots. In moist weather, spot widen heir centers and turn dark brown or black. On the lower sides of the leaves a whitish ring forms around the dead areas.

Stems and petioles turn brown when infected. Under damp conditions the whole stem may turn black in a short time and die.

Tubers get infected in the soil by rain-borne spore from blighted tops and at harvest by contact with blighted stems or leaves. The first symptom of the disease in potato tubers is the presence of a shallow, reddish brown dry rot that spreads irregularly from the surface through the flesh. Soft rots often follow the late blight rot and can completely destroy the tuber.

To control late blight: 1) plant certified seed-potatoes, 2) destroy or eliminate all potato cull piles, 3) plant resistant varieties such as Granola, Conchita, and Greta during rainy season, 4) spray with any of the fungicides like Dithane M-45, Manzate 200, Manzineb, Curzate-M, Daconil, or Defolatan/ 4F.

**Rhizoctonia canker** (*Rhizoctonia solani* Kuhn). The causal organism can be transmitted through tubers. It can thrive on several hosts and survive a wide range of temperatures. It is destructive to emerging sprouts particularly when the soil is cold and wet.

Long, brown lesions occur on affected shoots, stems and stolons. The sprouts often decay before reaching the surface of the soil. Roots also decay if infected. This usually results in miss or gaps in the plot. When plants are attacked after they emerge, affected stems become covered with mycelia.

Infected plants are characterized by a general lack of vigor, foliage curling and turning pinkish or purplish. Often, small green or reddish tubers above the soil surface are formed as a result of the interference of starch translocation.

The tubers which are small and numerous form into a tight cluster, thereby forming an abnormal appearance. In mature tubers, the most common symptom of the disease is the presence of numerous, hard, dark spots on its surface.

Control the disease by: 1) using certified seed potatoes, 2) planting chitted or pre-sprouted tubers, 3) avoiding cold and wet soil for planting, 4) covering the seed pieces with not more than 5 cm of soil to promote rapid growth of the plants, and 5) practicing crop rota-

tion with cereals.

**Bacterial Diseases**

**Common Scab** (Streptomyces scabies (Thextes) Walksman and Henric). Common scab is a soil-borne disease which occurs throughout the world. It is most prevalent in neutral and slightly alkaline and light sandy soils, especially during dry season.

Symptoms are observed mostly on tubers where small, brownish, and slightly raised spots appear. These spots enlarge, coalesce and become corkly on the surface. The disease makes the tubers less edible an unmarketable.

To prevent the establishment of the disease in scab-free field, 1) use scab-free seed potatoes for planting, 2) practice 3-5 year crop rotation, preferably with legumes, 3) do not apply large amounts of fresh manure in the field, 4) maintain high soil moisture levels during and after tuber set for 4-9 weeks, and 5) avoid overliming.

When growing potatoes on mildly infested soils, use sulfur and acid fertilizers like amonium sulfate or urea.

**Blackleg** (*Erwinia corotovora ssp. corotovora* Dye). The disease affects the seeds, stems and tubers.

At the early stage of infection, leaves turn yellow and roll even when the plants have just emerged from the soil. As the disease progresses, the stem in contact with the soil becomes black including the stolons and tubers. Moisture and high temperature hasten the progress of these symptoms which leads to plant wilting and death.

Control measures include: 1) planting of certified seeds, 2) avoid cutting seed tubers, 3) practice crop rotation with cereals, legumes and other non-host crops, 4) practice field sanitation, 5) destroy potato cull piles which serve as source of disease, 6) remove infected potato plants and tubers to reduce the amount of infection in the field or storage.

**Bacterial wilt** (*Pseudomonas solanacearum* E.F. Smith). A bacterial disease of potato that is extremely destructive in tropical and subtropical regions. The causal organism lives in the soil and is distributed through irrigation water and farm floods. Root to root contact also transmits the bacterium.

The first symptom of the disease is slight wilting of the plant during the hottest part of the day. Affected plants recover during cool nights but the wilting continues until the plants die. The center of the stem is brown when cut. Grayish white droplets of bacterial slime ooze from the cut stem when suspended in a glass of water.

If an infected tuber is cut crosswise, a brownish circle appears underneath the skin and sticky and milky slime comes out.

Control measures include: 1) planting certified seeds in non-infected soil, 2) rotating potato with non-solanaceous plants like cereals, legumes, etc., and 3) eliminating volunteers and solanaceous weeds which serve as alternate hosts of the disease.

**Nematodes**

Plant parasitic nematodes are tiny and earthwormlike. They feed by piercing and sucking the plant juice. They damage roots, stems, buds or leaves. The root-feeding types are the most common in Benguet and Mountain Province.

A number of plant parasitic nematodes have been noted in potato growing areas. The most destructive is the potato golden nematode or cyst nematodes (Globodera rostochiensis Woll) This pest can cause losses of up to 15% on potato crops without visible symptoms. Complete economic crop failure can result when nematode densities are high.

The symptoms are wilting, stunting, and premature aging of the plant. Potato affected by this pest may resemble plants having root injury due to drought. Infected plants display symptoms of nutrient deficiency such as chlorosis, stunting, wilting during hot periods of the day, and early death. Plant growth is generally poor. The roots of affected plants are shallow, short and may show rotting, swelling or galls of different sizes.

Nematodes are widespread. But some areas like forest sites which have been recently opened for farming, may still be cleared of nematodes. In such instances, quarantine measures must strictly observed. Seedpieces to be used in these sites should also be carefully inspected.

One practical means of bringing down the pest' population level in infested areas is by incorporating

chicken manure into the soil before planting.

Rotation of non-host crops can also decrease the incidence of nematodes, but nematode-susceptible crops such as tomatoes, eggplants, cucurbits, carrots an beans should not be grown.

Nematodes unprotected by living roots die early when exposed to sunlight. In nematode-infested fields, pull out the roots of the harvested crop and other residues.

The use of resistant varieties like Granola is also one way of controlling nematodes.

Potato cyst nematode can also be effectively controlled by a biocontrol agent, Paecilomyces lilacinus. Simply dip the potato tubers in the fungal suspension for 10 minutes before planting.

**APPENDIX A.**

**LIST OF BANNED PESTICIDES**

According to the Pesticide Action Network, the following chemicals cause poisoning, food contamination and serious environmental problems:

1. HCH/Lindane
2. Chlordane/Heptachlor*
3. Chlordimeform
4. DBCP
5. DDT*
6. Aldrin/Pildrin*/Endrin*
7. EDB
8. Pentachlorophemel (PCP)
9. Paraquat
10. Parathion
11. 2, 4, 5 - T
12. Temik (Aldecarb)

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* Restricted in developed countries but continually find their way to the Philippines.

**APPENDIX B.**

**FIRST AID TREATMENT FOR PESTICIDE POISONING**

**A. For unidentified pesticide swallowed:**

1. Use albumen or eggwhite if activated charcoal is not available. Eggwhite prohibits gastro-intestinal absorption of toxic chemicals.

2. Adults should take in eggwhite of 3 eggs and children should take in eggwhite of 4 eggs.

3. Upon giving the eggwhites, rush the patient to a reliable hospital.

**B. For identified pesticide swallowed:**

1. Induce the person to vomit by inserting the index finger or "tagaturo" or "hintuturo" up to the pharynx.

2. The victim with the following conditions should not induced to vomit:

a) drowsy, unconscious or in a state of convulsion (the victim might choke).

b) a pregnant woman in her third trimester of pregnancy.

c) has a cardiac disease.

d) has swallowed a corrosive poison, since throat and mouth might get burned.

3. Never give salt to induce vomiting, it might cause salt poisoning.

**C. For swallowed chemicals with organochlorines, nitro, chlorophenols and organonitrogen.**

1. Do not give milk or cream or other materials containing vegetable or animal fat.

**D. For inhaled poisons**

1. Wrap the patient with a blanket to avoid chilling.

2. Avoid moving the victim.

3. Victim's clothes should be loosened to enhance easy respiration.

4. If the victim is in an enclosed room, open all windows and doors or bring the patient where there is fresh air. Before the first aider enters the contaminated room, he should use a respirator or any material that would prevent him from inhaling the chemicals.

**E. Never give alcohol to victims.**

Chemicals

a) immediately wash with clean water and bath soaps. The eyes should be washed for 15 minutes.

b) Never wash the contaminated portion with detergents and cleansers. This enhances the absorption of chemicals.

**F. If the patient is brought to the hospital, bring along the pesticide container or memorize or write the label or name.**

Source of Planting Materials:

Baguio National Crop Research Development Center
Guisad Valley, Baguio City
Superintendent
Mrs. Josephine Ayban