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NEBRASKA

POTATO EYES

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Environmental Effects

Premature vine death, foliar defects and enhanced disease susceptibility are among the problems that may be induced by unusual environmental effects. Some of them can be mistaken for herbicide injury or disease attacks. Environmental conditions adversely affecting the vine can lower metabolic and photosynthetic activities, constrict movement within the vine and defoliate. The following describes a number of environment happenings occurring in Nebraska that impact the potato plant:

Wind

Wind effects may be the most common environmental injury that I see in Nebraska and Wyoming. Wind injury appears in several forms and the degree of injury depends on the strength and duration of the wind.

Leaves injured by lesser winds appears as bronzed areas, brown with a shiny surface. The bronzing is due to the rubbing of leaves against each other. The bronzed areas tend to be brittle from drying out. When pressed, they crack forming a sharp-edged rip through the affected tissue. With higher winds, leaves not only bronze but tatter. Tattered leaves have a quarter to an inch sized tears with irregular brownish borders. Usually, leaf tissue does not hang from the tears and the edges of the leaflets show more tatter then inside the blade.

Wind, leaf tatter, bronzing

Stems may also be affected by winds. When exposed to milder winds, the stem may have just flopped around causing a slight weakness. With stronger winds, the vine may actually twist a bit casing a break or hinge-like weakness. If exposed to strong winds for several hours, the vine may actually twist all the way around, 360 degrees. This causes an irreversible pinch point in the stem. Under close examination, one may see the twist, and when the pinch point is cut open longitudinally, one will see that the xylem of the vascular tissue has enlarged and thickened forming “brace wood” tissue against the wind. This brace wood presses against and may collapse the phloem in the vascular tissue cutting off nutrient flow between the vine and the tubers.

Wind, stem brace wood

An effect of these symptoms is to reduce tuber growth and lower yields.

Sandblast

Related to wind damage, sandblasting of leaves occurs in sandy soils especially along the edges of the field where the wind picks up sand and pellets the leaves. *Leaves* are peppered with round holes due to sand shooting through. The holes may have smooth edges but as the wind continues, the edges become tattered. Bronze spotting is also often seen on the leaf surface and is due to sand bouncing off instead of going through the leaflet.

Lightning

During thunderstorms, lightning can strike and affect a small portion of a field. In general, it strikes poorly-drained areas, often near the center of a center-pivot where the ground tends to be wetter. The size of the affected area relates to soil moisture and strength of the discharge. Most commonly the area struck by lightning is circular or ellipsoid with a well demarcated border. Normally, plants within the area are uniformly dead or dying with the destruction diminished along the border. Border plants may show ozone injury as ozone is produced by the lightning discharge. If soil moisture varies considerably in the area, damage may be irregular. At first glance, the area may seem to have been attacked by a pathogen such as black leg or stem canker. Symptoms appear in less than 24 hours starting with the lower stem.

Sandblast, leaves

Stem tissue near the surface becomes soft, wet, and brown or black, similar to black leg but without the hollow center. The

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affected stem tissue will then dry up changing to a lighter color with the surface turning very light, off-white. When cut longitudinally, the inside of the stem will show the pith collapsed forming cross plates that look ladder-like. Depending on the lightning's discharge, stem symptoms move up the plant. The top of the plant collapses and dies quickly turning brown.

Tubers are affected although symptoms don't appear until later. Their skin form large brown/black blotches on opposite

Lightning, tubers and vine

sides where an electrical discharge passed. Some skin cracking occurs. A severe affect may result in a cooked tuber. The inside of the tuber may collapse forming a hollow area between the two outer blotches while the rest of the tuber may seem unaffected unless cooked. The tuber appearance is similar to that of bacterial ring rot. Affected tubers are prone to pathogenic invasion and usually decay in the field before harvest. Interestingly, other underground tissue, root and stem, are uninjured by lightning.

Ozone

Ozone, a molecule (O_3) formed by three atoms of oxygen, is a photochemical oxidant that disrupts photosynthetic and metabolic functions. It appears at ground level by being brought down by vertical winds from the stratosphere during electrical storms and is associated with lightning. Also, ozone is produced by a reaction between sunlight and the products of fossil fuel combustion such as from vehicle exhausts, electric power plants and fossil fuel furnaces. Ozone produced by the latter method is considered air pollution and can be held down by an air inversion. Air inversion occurs when warm air aloft traps cooler air near the ground. Damage by ozone is most severe on warm, clear, calm days when there is a high relative humidity and high air pressure. Injury occurs most in the afternoon and least at night.

Lightning, stem ladder

Leaf symptoms to ozone exposure are termed "stippling" or "speckling" characterized by numerous tiny dots on the upper leaf surface. On potato, the speckles are usually brown or black but may be bronze, yellow or even white ("bleaching"). In extreme cases, the specks may fuse forming larger bronze areas. Symptoms begin with the oldest leaves and gradually work up into the plant as younger leaves get affected. Young, smaller plants are most susceptible to ozone injury. The degree of injury depends on the amount of ozone in the air and the duration of exposure to it. Heavy exposure can result in symptoms appearing in 24 hours and symptoms progress for 10-14 days after exposure. Due to the tissue collapse induced by ozone, leaves are prone to infection such as by early blight and will become senescent sooner. Yields may be decreased due to the early dying.

Potato is considered very sensitive to ozone such as alfalfa, barley, edible beans, beets (table and sugar), chicory, grapes, soybean, and many garden vegetables. Among potato, there is a wide range of ozone sensitivity, from susceptible ones such as Norchip and the Norlands to tolerant ones as Russet Burbank. On sensitive varieties, injury can occur with exposure as low as 0.04 ppm ozone for four hours.

PAN: Another photochemical oxidant is PAN or peroxyacetyl nitrate. After ozone, it is the most phytotoxic air pollutant. It is formed similarly to ozone. PAN causes leaves to develop bands or blotches of glazed, bronzed or silvery areas. Pre-mature senescence and defoliation may occur. Exposure to 0.01 to 0.05 ppm for one hour will induce symptoms. Potato is very susceptible as is alfalfa, pinto bean, beets (table and sugar), sunflower and several garden crops. Corn, sorghum and wheat are resistant.

Air Pollutants

A major air pollutant is sulfur dioxide (SO_2) which upon contact with water forms sulfuric acid (H_2SO_4). Potato is relatively tolerant of SO_2. Leaf symptoms start as dry papery blotches colored tan, straw or even white, and turn to interveinal browning or necrosis. Leaf veins remain green. Young and mid-aged plants and leaves are most sensitive. sensitivity is highest during days with bright sunlight and high relative humidity. Common sources of SO_2 release are electric power plants, fossil-fuel furnaces, oil refineries, mining of cupper, iron and sulfur, smelters. Exposure to 0.5 ppm for four hours or 0.25 ppm for eight hours may be injurious to some crops which may show symptoms as far as 30 miles for a source. Potato is considered somewhat tolerant as is corn, onion and sorghum. If SO_2 injury is suspected, one can check nearby, more sensitive crops such as alfalfa, beans, beets, soybean, and sunflower, or sensitive weeds such as pigweeds, ragweed and morning glory.

Ethylene (C_2H_4) is another pollutant from motor vehicle exhausts. It is also a natural hormone occurring in plants affecting growth and behavior. Ethylene can induce epinasty, plant twisting, defoliation etc. Potato is very sensitive to ethylene. Potato is rather tolerant of other pollutants such as chlorine and fluorine; They would give symptoms similar to SO_2.

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Environmental Effects

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Heat

Injury to high field temperatures other than drought stress may also be associated with sunlight.

Leaves become sun-scalded, turning brown and loosing their rigidity. Affected areas are moist and feel like thin, smooth, soft leather or membranous like a bat's wing then become brittle upon drying out.

Stems are affected by high soil temperature at soil level. This is especially true with small plants. The stem becomes girdled and the surface turns tan to white. It also becomes prone to rot organisms especially blackleg and stem canker.

Tubers exposed to high soil temperatures will become soft and be partially cooked. The inside will hollow out and the large cavity will have a dark border. This defect is call internal heat necrosis. When exposed to sunlight at high temperature, tubers turn dark green, dry up and become hard. This is a severe form of tuber greening called sunburn.

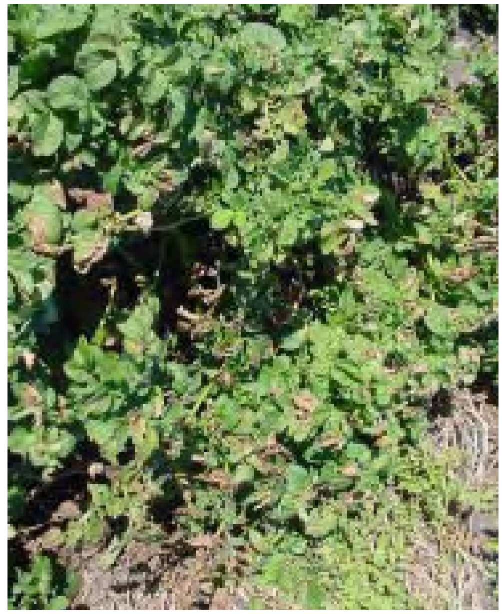
Heat, tuber necrosis

Heat, tuber sunburn

Frost or Low Temperature

Frost may induce a non-lethal injury to the vines that may be confused with herbicidal damage or virus-induced symptoms. Frost injury is mostly associated with temperature drops at high altitude and in northern growing regions. Sensitivity to frost varies with varieties.

Leaves collapse and show a wilting appearance; affected areas with appear black when wet and brown when dry. Around freezing temperatures may cause irregular growth and graying to browning across the blade. Slight damage may cause a yellowing (chlorosis) of leaf blades and veins. Veins may be mottled. Young leaves may have dark (necrotic) specks. Symptoms of affected tissue persist through season even when the rest of the leaflet continues to grow. Early season exposure slows vine growth.



Frost, vines

Symptoms appear similar to injury by PGR-type herbicide.

Sensitivity to frost varies with varieties. Tolerance to frost may be bred from wild species into commercial varieties in the future. Foliar-applied cytokinin-like PGRs may give some protection against injury but more research is needed.

Hail

Hail is not uncommon from spring to autumn at high altitudes but potatoes are remarkably resilient to its damages compared to other crops as corn and beans. The severity of hail injury, its importance and degree of recovery are dependent on the amount and size of the hail, the growth stage of the plants, the variety affected, the weather after the hail, and practices used. The greatest affect on yield occurs when there is severe hail two to three weeks after tuber initiation or early tuber bulking. For many varieties, this corresponds to two to four weeks after flowering.

Leaves tear appearing tattered and also have holes through the blades where small hail went through. Damage is similar to that caused by sandblasting. Protecting fungicides application is recommended as early blight and alternata blight can invade. Vines may be partially completely defoliated. If 25% or less defoliation occurs early or late in the season, or 10% or less during mid-season (bulking), there may be little affect on yield with good management practices and cooperative weather. [These are the same defoliation thresholds used scheduling treatment of eating/chewing insects as Col. potato beetle.]

Stem injury is the main reason for crop loss due to hail. At the point of impact, hail can break the stem at worst, can go deep enough to cut the vascular tissue and expose it, and, at the least, form a whitish, papery, oval-shaped bruise on the surface. All of these open a portal for pathogens such as aerial black leg. Vine maturity may be delayed due to the recovery period after hail. The application of sulfur as Thiosul through the center-pivot may help in recovery from slight to moderate damage.

Tubers are not directly affected. However, mid-season hail reduces yield by inducing late sets resulting in more smaller tubers. Also, mis-shaping of tubers may occur due to erratic growth as the vine tries to recover. Late-season hail may reduce tubers solids (lower specific gravity).

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Flooding

Flooding causes oxygen in the soil to decrease and not be available to the roots resulting in oxygen deprivation. It is associated with compacted soil and low areas with poor drainage. Early season flooding may reduce and delay emergence, and promote stem rots, blackleg and stem/stolon canker. Mid and late season flooding may reduce yields and increase mis shaping of tubers.

Plants in wet field areas are more susceptible to late and early blights. Tuber lenticels will enlarge increasing the risk of bacterial soft rot, pythium leak and pink rot. Tubers harvested after late-season flooding do not store well and break down.

Check out the Nebraska Potato Eyes on the WWW at:
http://www.panhandle.unl.edu/peyes.htm