PHYSIOLOGICAL DISORDERS OF GINSENG PLANTS

Physiological disorders are distinguished from other problems in that they are not caused by disease organisms (virus, bacteria or fungal) or by activities of other pests such as insects or by nutritional deficiencies. They are physical or chemical changes in a plant from what is normal, caused by an external factor. Some of the physiological changes that can occur are listed below, but not in order of severity or most likely to happen.

Chemical Injury

Any kind of foreign chemical applied in the wrong dosage or at the wrong time is capable of doing physical damage. Even water in a droplet can cause burned tissue if the sun shines through the sphere. This is not likely under ginseng shade. Most damage of this type will come from pesticides applied at too high rates or during very hot parts of the day. E.g., Dithane DG is recommended 1/2 strength or less on young plants (seedlings) and should not be sprayed in the heat of the day. Damage from this appears as red and/or yellow spots on the leaves or leaf tips turning brown. Other types of chemical injury will vary from brown spots, stunted or misshapen plants, to death of a plant.

Cold Injury and Frost

Ginseng plants can sustain some frost in the spring without major damage but we don't know what this threshold is. This injury is the cause of deformed plants, puckered leaves, to complete death of a plant. The British Columbia ginseng industry has been victim of this problem a few times since 1982. The spring of 1992 was the worst event where the temperature dropped to approximately -5°C near Kamloops in mid May and even colder at places like Merritt. Freezing as severity increases will kill parts of a leaflet, a whole leaflet, whole leaf systems and even above ground stems if severe enough. The damaged plants will show evidence very quickly.

It is also felt that very cold but not freezing for sustained periods will cause puckering of leaf tissue on young plants.

It was also observed that having the shade up at the time of the frost was a protection to a substantial degree. Plants in the Merritt area, that were under tarps, where a more severe frost occurred sustained some to considerable damage, so shade is not a total security. Because of this, it is recommended that growers have shade up when plants are starting to come through the mulch. We do not know how many degrees of frost the shade will protect to. Shade will only be helpful in certain types of frost, mainly the radiative type where air masses are not moving (calm). Shade is no protection from advective frosts, as these are windy condition along with cold temperatures.

Avoiding areas where late spring frost is a regular occurrence would seem to make sense. High elevation and marginal areas within a plant hardiness zone are most likely to be affected though there are some frost pockets in most areas.

Genetics

Although this is an internal factor and not really a physiological one, plants can do weird things sometimes when its own system goes awry. This could cause many factors from variegated plants, distorted plants, seed colour other than red, multiple stems etc. Some of these mutations have been collected and used by scientists in other crops and there is no reason why this cannot happen in ginseng. If you see an unusual event you may consider saving it for future considerations or donating it to a research facility who may be able to use it. Some of these genetic factors could look like other disorders or may not be genetic at all but rather insect injury, disease, poor nutrition, or physical injuries as examples.

Heat Stress Injury

This has become a major physiological disorder of ginseng in the hot interior and is much different than direct sun injury discussed later.

When the temperature is extremely hot, a plant needs to bring water from the roots to the leaves stems etc. and out the stomata (small openings), a process known as transpiration. This cools the leaves and plant parts and prevents heat stress injury. If enough water cannot be carried up the plant system, the plant will voluntarily let some of its leaf surface die. If severe enough all the tissue will die. Damage from this stressed condition will appear as a white to light brown papery areas and will occur very quickly.

Generally when the temp is very high in the interior of British Columbia, the relative humidity is quite low, causing the plant to need more water. If this is combined with inadequate soil moisture, a further aggravation will occur. Light soils can also be a factor as they don't hold as much water to be available to the plants as heavier soils do.

RECOMMENDATIONS

- Make sure when going into a hot period that adequate soil moisture exists (see section on Irrigation in this guide, page 54).
- Use the above ground irrigation system as a cooling device, turning it on for short periods of time (10 – 20 min.) during the heat of the day. A temperature of 35°C seems to be the temperature trigger for this process to start. You may need to do this up to four times each hot day. This will not add any major amount of water to the soil system as most of it will be caught by the plants and mulch. This will reduce the temperature under the tarp as well as increasing the Rh. The danger of droplet burning is minimal as the sun has little direct contact and in any case would be less severe than the effects of the high temperature stress problems. (See also the section on Water Management and Irrigation Systems page 53 for more information.)

The heat stress factor can also be a concern during the period of seed formation. This is not fully understood but there can be poor to no seed formation when severe heat occurs during this developmental stage. It would be logical that this damage would happen at flowering time where physical damage to flower parts could occur. Pollen grain damage is the most suspected problem, as ginseng is indigenous to an area with cooler temperatures and higher Rh, at all times during the plant growth cycle. The result of this damage will be small pinkish berries prior to seed picking time, that have no seeds in them and fall off easily when touched. This can occur in some parts of the garden and / or on specific plants in the garden, e.g., different flowering times, or ones that are higher in the canopy.

High Salts (Electrical Conductivity)

This is another area that is not really a physiological factor but could cause symptoms that appear as physical problems. Small stunted plants, or leaf tip burn could be typical problems related to this. See the sections on Site Selection and Site Preparation for more information.

Mechanical Injury

This is where plants are physically damaged by people, wind, animals or equipment. There are a number of factors that would reduce this kind of injury and is important as every point of tissue injury is a potential entry point for disease.

- Reduce the number of times equipment passes through the garden. Centre beds are most susceptible, where the spray equipment travels and many times problems are noticed there first.
- Have wheel guards on all your equipment.
- Have proper clearance on all equipment.
- Reduce the number of people entering gardens and exercise care when you are in them, especially three and four year-old gardens.
- Have windbreak protection if necessary as plants bashing into plants can cause injury.
- Have narrow wheels on all equipment.

Nutrient Deficiency/ Excesses (Imbalances)

This again is not a physiological disorder but can appear as such. Every plant reacts to extreme highs and lows of nutrients, some reactions being quite evident, others less so. See the Nutritional Requirement section, page 46, for a review of the effects one could expect. Plants can be stunted, deformed or suffer things like leaf tip or leaf margin burn from this. This injury may look similar to disease, wind injury, chemical injury or sun scald in various situation. Different nutrient imbalances will give different reactions and an imbalance in one nutrient can make another one unavailable or unfunctional.

Relative Humidity (Rh)

In this situation we are generally talking about low Rh causing problems but high Rh can also cause problems. Low Rh will only occur as a problem in combination with high or excessive temperatures and was discussed in the heat stress section earlier. High Rh over long periods of time can also allow certain disease organisms to get established.

Rusty Root

(See under 'Specific Diseases of Ginseng' Section page 113)

Soil Problems

The selection of a good site for growing ginseng was discussed earlier in the sections titled Site Selection and Site Preparation so only minor discussion will take place here.

This as a physiological effect on the plant can take many forms and texts are written on them, but briefly the following are important with ginseng.

- COMPACTED SOIL Can cause root deformation and difficulty in digging with breaking and bruising of roots. Certain types of soil can do this and the addition of OM will help most situations. Clay soils tend to give the most concern here. Compaction can also cause water to percolate slowly into the soil, causing warterlogging conditions.
- NUTRIENT IMBALANCES As mentioned earlier these can cause problems but generally can be amended. Some conditions need to be amended before seeding occurs as they cannot be done after. Refer to the section on Nutritional Requirements for Ginseng for more information.
- SOIL CHEMICAL IMBALANCES These can cause physiological plant disorders but can generally be remedied before seeding. If they cannot, another site selection would be in order. Only a proper soil analysis can determine a problem and what needs to be done. See the Ginseng Industry Directory and Supplier Guide for lists of laboratories and the section Site Preparation for more information.
- LOW ORGANIC MATTER (OM) In many soils this can cause conditions as where the soil becomes extremely compacted and difficult to work with. This can be corrected prior to planting but not after so care should be taken to ensure OM is adequate.

Sun Scorch (Sun Scald)

This is damage which occurs when full sunlight is allowed to shine directly on a plant. This damage occurs around the edges of the gardens, especially on the south and west sides. Plant tops are generally killed by mid season when this is allowed to happen. Some growers use side shades to help this situation, others simply extend the end of the shade beyond the beds or let them burn off to the sun line. Having the side shades may be a trade off with decreased cooling in the garden due to reduced ventilation through the garden for cooling and drying of the foliage. An exception to this is light on the plants in the very early or very late part of the day.

This condition can also be noticed when tarps have excessive openings at the edges or are torn leaving gaps. It is probably a good idea to have an extra tarp or two around in case one for some reason is damaged excessively. One day with direct sun will damage plants in mid season. If an extreme situation happens, and the plant vegetative parts are lost in mid-season, the good news is that the root will have formed next years bud by this time and will grow tops again next year. You do though lose a partial seasons growth.

Water Stress

As the title implies, this is where the plant gets to much or not enough water to function properly. The following areas have been observed as causing water stress situations.

- Heat — where the plant cannot take water up fast enough for its needs (Heat Stress). Wilting would be an indicator but there is a fine line between wilting and actual damage.
- Improper maintenance of irrigation equipment and / or breakdown with long repair times.
- Plugging of sprinkler heads for prolonged periods of time that are not detected.
- Competition from other plants — e.g., large trees. Trees have massive root systems often reaching as far out each direction as the tree is tall. (E.g., a 60 foot tree can have a 120 foot diameter root system).
- Not enough water in the soil, making it hard or impossible for the ginseng plant to retrieve it.
- Another water stress area caused by excessive moisture is mainly noted on sloped sites. This is when water from rain (or over the shade watering) runs down the shade cloth and drips off at the cables or an end, causing wet areas. This creates ideal situations for phytopthora organisms to get started. Long periods of rain can also cause stress due to excess water. There are a number of factors that aggravate this problem.
  - what direction the weave of the shade cloth runs down slope
  - percentage of slope involved (higher slopes give greater potential for problems)
  - type of rainfall or over shade irrigation and light is worse as it tends to sit on the cloth, where heavy rain will penetrate the cloth
  - condition of soil moisture before the rain or irrigation occurrence, as already wet soil will not be able to absorb any more water

Wind Injury

This is not a major factor here for the plants themselves but can be a secondary one. Wind will create more evaporation from the leaf surface on a hot day, aggravating a heat stress factor. Avoiding windy sites may be a site selection issue. Building gardens with a strong anchor system is also important. Often double anchors are used on the windy side of a garden for extra security. Some of the affects of wind are as follows:

- Wind can blow down the structure or rip out a tarp causing structural and plant damage.
- Sandblasting can also be a factor where a garden is adjacent to an open field subject to wind erosion. This will or can create entry points for disease. This can also be as simple as plant parts rubbing together causing surface scarring which are also entry points.
- Wind injury can also be a factor in seed yield reduction by banging seed heads around, a situation called shattering.

Winter Injury

This section could be included under frost injury but is substantially different, thus is treated separately. Early hard frosts in the fall or early spring warm spells are the causative factors here.

Ginseng has a short dormancy requirement thus is ready to grow by about January first of any year. If an early warm spell occurs, some movement of plant fluids can occur to the point where a hard subsequent frost can damage the bud for the next growth period. Ginseng will not form another bud for new growth the same year as it is damaged, as many other plants will.

Winter soil temperature is also a factor. Injury in the form of slight deformation of leaves to sever injury or death can occur from excessively low soil temperature. This is where the Zone 3 rating is mainly derived from. From experience in British Columbia it would appear ginseng may be a Zone 3b or even a Zone 4 plant from its reaction to cold temperature situations. Ginseng plant roots can only stand a winter soil temperature of -5°C before injury will start to occur.

Early fall freezes can also affect the root before it has fully hardened off and is ready for winter. The fall of 1985 saw -25°C temperatures for an extended periods early in the fall. Some damage (approximately 5%) was noticed in some areas.

Proper mulch depth and quality will give some protection for this disorder. This can be more of a concern in windy areas. See the section Mulching for Ginseng Beds for more information.

The winter weather can also create problems with snow pack melting. Long periods of thawing in mid winter can melt snow and cause water to sit in gutters or even over beds in lower areas. This **MUST be** removed somehow to eliminate root damage by diseases later on. Ginseng will not tolerate wet feet for even short periods (24 hours) without some damage. Periods of warm / cold / warm / cold are a potential hazard with ginseng especially combined with poor mulch cover or when it happens at certain times of the year.

Premature Bud Development (Late Fall)

Under certain conditions in the fall some one year old ginseng plants will develop new leaves (and sometimes flower heads) from next years bud. If this happens early in the fall the root may develop a second bud for the second growing season. If it happens late (just before hard frosts) this will not happen. This development is using up stored root nutrients for what should be year two, thus is making the root vulnerable to winter damage.

It is suspected that weather patterns are the major cause of this and where August is cooler than normal and September is warmer and sunnier than normal we probably will see more of this condition. Observations of up to 5-8 percent have been seen. It also shows the dormancy requirements of some roots is very short.

Another connected feature to this is where the second year bud does not push leaves but does begin to expand and open slightly. This probably makes the bud more susceptible to winter injury as well but no hard data is available at this point.

If this is occurring or has occurred in your gardens it seems there is little one can do to prevent it, but you need to make sure there is adequate straw mulch cover for over winter protection. This condition does not seem to be connected to the depth of straw during the year. A very cold winter with little or no straw cover could create the potential of more winter damage to the developing bud. A good snow cover would probably be the best protection for this condition.

There maybe a genetic connection to this problem where certain seed sources may have more tendency to do this. There has not been the chance to observe situations where different seed sources are planted side by side and one source does not do this while another does. There is generally no record of the origin of a seed lot so studying this phenomenon will be difficult.

Summary Statement

As you can see, there are a number of things that create physiological problems. On a crop like ginseng with such high input costs, you cannot afford to make any mistakes. Learn to anticipate what might happen and be prepared. Learn to see what your garden is doing and how it reacts to all the variable situation it is subjected to.