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Crop Rotations as a Method of Disease Control

There are many control methods available to growers that can help to reduce the possibility of developing a disease on their crops. Some of these are cultural control methods that aim to reduce or eliminate the amount of pathogens present in a field. One old, but practical method that most growers are well aware of and frequently use is crop rotation. Like all pest control methods, however, it is important to understand how it works and to use it correctly, in order to maximize the effectiveness of this technique.

The goal of crop rotation is to reduce pest populations and pathogens present in the soil. Many pathogens survive in the soil from year to year in one form or the other, usually as sclerotia, spores, or hyphae. Continuously planting the same crop can increase the population levels of any soil-borne pathogen that may be present. The populations can potentially build up to such a degree, that it becomes difficult to grow that crop without yield losses. By using proper crop rotations, focusing on crops that are not identified as hosts for the targeted pest/or pathogen, disease and/or pest issues will eventually be eliminated, as most pest populations decline in 2 to 3 years without a suitable host. There are a few mitigating factors, however, that limit the effectiveness of crop rotations which need to be considered, before rotating into another crop.

The botanical classification is an important issue that should be taken into account when planning a crop rotation. Plants that belong to the same family often also share the same pest problems, so repeatedly planting within the same plant family; will also thwart the goal of reducing pathogen levels in the soil. As an example: Broccoli, cabbage, turnips, and mustard greens appear very different from another, however, they all belong to the mustard family (Brassicaceae), and therefore share some common pest problems. Rotating between these plants will likely increase the chance of problems with soil-borne diseases such as: black leg; black rot; Fusarium yellows; and clubroot. A successful rotation, aiding in the reduction of pest populations in the soil, would include crops outside of the mustard family.

Another factor to be considered in relation to planning an effective crop rotation, is that it is not a very effective method for controlling pathogens that have a wide host range. Examples of these would be: *Rhizoctoinia solani*; *Sclerotium rolfsii*; *Pythium* species; and root knot nematodes. These pests have such wide range of suitable host crops/plants, that they would be difficult to control through the use of crop rotations.

Additionally, some pests produce resting structures that are able to survive in the soil for long periods of time. Rotations of 3 to 5 years may have very little effect on the population levels in the soil of certain pests. As an example, Clubroot of Crucifers can persist in the soil for 7 years, while white rot of Alliums can easily survive as sclerotia in the soil for over 50 years.

In summary, crop rotation has a long history of success and remains one of the best, widely practiced, method of cost effective disease prevention and control. Growers and consultants should, however, still carefully consider all factors in employing its use.

Foliar Diseases of Carrots

Carrots are grown in several regions of California with the Southern San Joaquin Valley being the most concentrated area of carrot production. Other areas in California where carrots are grown are the southern desert valleys, Antelope Valley, central coast, Cuyama Valley, and the upper Owens Valley. These diverse growing areas allow year-round production of carrots in California.

The fall season marks the time period when a major portion of carrot acreage is ready for harvest across Kern County. The warm fall days and occasional late fall storms can be ideal conditions for a variety of foliar diseases on mature carrots. This is particularly true with Alternaria leaf blight (*Alternaria dauci*), which can be especially troublesome during some years. Other foliar diseases of carrots are minor issues, or tend to be sporadic problems in some fields, depending on location and season.

Leaf blights can be caused by several different plant pathogens and can be difficult to identify in the field, with symptomology may be very similar, but actually be caused by completely different microorganisms. The aid of trained personnel is critical in managing these diseases, as proper identification, is key to determining the most effective treatment protocol.

The most damaging foliar disease to California grown carrots is Alternaria leaf blight. Although there are effective control methods, it continues to cause considerable losses each year. The concerning symptom on carrots is a considerable amount of defoliation, which reduces yields indirectly, as less green leaf tissue means reduced photosynthetic activity and weak tops. Losses are realized due to the fact that weakened carrot tops cannot be lifted by mechanical harvesters and many carrots are left behind in the field.

At the onset, visual inspection will reveal the appearance of individual, necrotic lesions, which appear as dark-brown to black, along the margins of the leaf blade. Lesions on the petioles are tan with a black border, or are entirely black. Symptoms appear first and most severely on the older foliage, so overwhelming the plant, that defoliation ensues.

Another disease common to carrots, which also produces tell-tale lesions is, early blight of carrot (*Cerocospora carotae*). Unlike Alternaria leaf blight, which produces dark lesions along the leaf margins (and petioles), lesions of early blight are circular, tan colored and may be located on any part of the leaf. Early blight tends to be more of a problem in coastal areas, but can also be problematic in Kern County during years with cool, wet autumn weather patterns.

Bacterial leaf blight (*Xanthomonas campestris)* is yet another leaf blight of carrots that can be difficult to distinguish. While Alternaria and Cerocospora are both fungi, Xanthomonas is a one-celled bacterium. Bacterial leaf blight can be distinguished from the other leaf blights by the presence of oozing bacterial cells from lesions on the petioles or flower stalks. The lesions on the leaves and petioles are black and appear very similar to lesions caused by Alternaria leaf blight, however, bacterial leaf blight lesions tend to be watery or greasy in appearance.

Alternaria and bacterial leaf blight can both be carried on the seed. Ensure the use of clean seed helps prevent the introduction of these pathogens into the field, and most seed companies will provide the disease index for individual seed lots. A practice common among seed companies today involves hot water soaking, along with fungicides; it has proven to be an effective treatment to ensure that the seed is clean before being passed along to growers.

These microorganisms may also survive in the soil on previously infected carrot debris, they cannot, however, survive in the soil on their own. Once the debris is broken down, these plant pathogens will

die. Working crop debris after harvest and rotating out of carrots (Apiaceae or Umbelliferae family) for 2 to 3 years, will assure that no surviving inoculum remains in the soil.

Spores can also be blown into a field from volunteer carrots or other nearby fields, in these situations, fungicide treatments may be required for Alternaria leaf blight and early blight. This is especially true in the San Joaquin Valley in the fall when climatical conditions are often ideal for the disease to occur. An early application of fungicide at the 3 to 4 leaf stage is commonly used to keep disease pressure low. Frequent scouting of fields will help determine when and if additional applications are needed.

Bacterial leaf blight is controlled with the use of copper fungicides. Other types of fungicides will not control bacterial leaf blight. Copper fungicides are sometimes used as a preventive for Alternaria leaf blight and Cercospora leaf blight, however, if disease is actually detected, then other fungicides are required. Again, proper identification of the pathogen is key to determining the most effective treatment protocol.

Charcoal Rot of Potatoes (and other crops)

Charcoal rot is a common soil fungus in the San Joaquin Valley, and is caused by the soil-born fungus *Macrophomina phaseoli*, common in warmer regions of the world. It can be found as the cause of a root rot problem in various crops, and is most commonly found on the crowns and roots of melons. Normally it has minimal economic significance here, however, with the hot temperatures we are currently experiencing it can be a severe problem, causing serious losses, especially for late planted potatoes, which are now being harvested.

The disease is aptly named due to a charcoal discoloration that occurs on the root and stems of affected plants. The discoloration is very superficial and can be easily scraped off with a fingernail. On potatoes, however, the concern is not the root discoloration, but the fact that it can infect the tuber and cause discoloration inside.

Tuber infections usually begin on the stem end of the tubers, but can be found on the eyes and lenticels also. It is more noticeable on white potato varieties as black lesions on the surface that extend into the tuber.

Seedling Diseases of Vegetables

Seedling disease can be caused by a variety of different fungi affecting plants in early growth stages. Seedling diseases are often a complex involving two or more different fungi which infect and debilitate a young plant. Additionally, seedling disease may appear at different stages of the young plant's growth. Whatever fungi or growth stage of the seedling is affected, nearly all crops propagated from seed face serious loss due to seedling diseases.

The effects of seedling disease may appear as a seed rot (pre-emergence damping off), seedling decay before the seedling emerges (also a pre-emergence damping off), seedling decay after the seedling emerges (post-emergence damping off), or seedling root rot (root pruning). In pre-emergence damping off, the seed rots and never germinates, or the seed germinates but the seedling succumbs to the disease and dies before it can emerge. Post-emergence damping off is when the seedling emerges and then dies soon after. Whether the seedling disease is a pre or post-emergence damping off, the results are thin and uneven plant stands. The overall effects of seedling root rots are often subtle, causing reduced seedling vigor.

The fungi that cause seedling diseases of vegetables are common pests to most all seeded plants. The most common are *Pythuim* species and *Rhizoctonia solani*. These are fungi that are common in most agricultural soils, including the soils of the San Joaquin Valley. Other fungi that infect vegetables

seedlings are some specific species of *Rhizoctonia* besides *R. solani*, certain *Fusarium* species, and *Phytophthora* species.

Many *Pythium* species have very wide host ranges, including vegetables, and can be found in most all agricultural soils. Various *Pythium* species can cause pre and post-emergence damping off. Rotted seeds will be water soaked and mushy when squeezed. The roots of infected seedlings will be water soaked in appearance and gray in color. It may also cause a root rot in fields with poor drainage, in which case the plants in wet areas will be yellow and stunted.

Rhizoctoina solani is also very common in most soils and also has a very wide range of host plants that it can survive on. Different races or anastomiss groups (AG) of *R. solani* exist and more than one AG type can infect vegetables seedlings. Symptoms of *Rhizoctonia solani* damping off of vegetables are almost indistinguishable from plants infected by *Pythium* species. Symptoms include seed rot and damping off. The roots may be discolored, generally more so than with *Pythium* species.

The classification of the genus *Fusarium* is always complex and confusing, simply put - there are various species of *Fusarium* that have been shown to cause seedling diseases. It is important to understand when discussing *Fusarium*, that infection by these fungi is very host specific. In addition, *Fusarium* is often not the primary pathogen, but merely a strong secondary that may follow *Pythium* or *Rhizoctonia*, but in conjunction with these fungi, help cause stand loss. Due to the fact that *Fusarium* spp. is often associated with these other fungi, their symptoms are all essentially the same. There may be more root discoloration, especially at the root tips, and colors such as purple and red may be visible on the roots.

Proper growing conditions at planting, is critical to avoiding seedling disease issues, as plants are generally able to outgrow it when conditions favor rapid germination and growth, thereby minimizing the effects of seedling diseases.

Fields should be worked before planting. Proper tillage breaks down compaction layers, removes low spots, encourages the breakdown of plant residue, which may harbor fungal pathogens and enables the soil to drain properly.

Seed should be of high quality with the highest percent germination available seed used. High quality seed will generally produce more vigorous seedlings that will help out grow any seedling disease problems. If possible, plant during a period that favors rapid germination and growth. Seeds that have to germinate during cool wet periods will have a tougher time than those planted in warmer conditions. Avoid planting too deeply, which causes slow emergence. Seedlings are most susceptible to seedling disease from the time of planting to emergence.

Finally, seed treatments are available for various vegetables. Some fungicides are specific as to the type of fungi they control, so one or more fungicides may be required. Fungicides can protect the seedlings from early disease problems and let the plant grow more vigorously in its early growth stages. Check with your seed supplier or farm advisor to determine which seed treatments are be available for your particular commodity.

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