Protecting plant stands: Peanut industry moves quickly to address emerging disease threat

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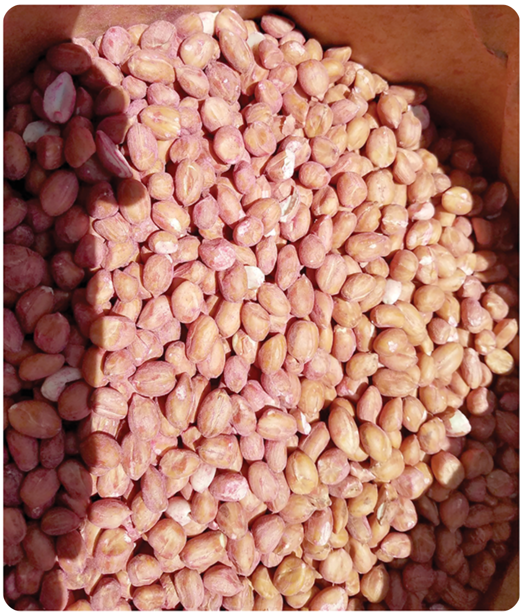
Uniform stands of 4 plants/ft are recommended for runner peanuts to obtain maximum yield and manage stand-sensitive diseases such as tomato spotted wilt virus that can cause serious crop loss. Numerous seed- and soil-borne diseases can threaten stands if not controlled. With increasing heat and drought stress, such as experienced in 2019, *Aspergillus* is of particular concern. Seed treatment fungicides are the first line of defense, but the unexpected development of resistance to a key fungicide class (QoIs) just prior to planting in 2020 caused the industry to rapidly alter its standard programs. Another major industry change is a shift from dust formulations to a liquid polymer delivery system.

As with any crop, the first step toward successful production is getting the optimum number of plants growing at the right time of the year. For peanuts in Georgia, that means four uniformly emerging plants per foot of row in either single rows or as the total of two twin rows. This stand has consistently provided the greatest yield potential but also is an important component in the integrated management of tomato spotted wilt virus (TSWV), a devastating disease that nearly ended the peanut industry in Georgia in the 1990s. To achieve this plant population, a seeding rate of 6 seeds/ft is recommended although some growers will plant higher seeding rates to ensure having an adequate stand.



Commercial peanut seed treated with a dust formulation showing the potential for inadequate and nonuniform application of treatment with this technology.

Some issues with obtaining peanut stands are similar to those facing any other crop. Planting at the best time (mid-April through late May) after soils have warmed adequately is critical. Average daily soil temperatures of at least 68°F at the 4-inch depth for three consecutive days are recommended. Preparation of a friable seedbed with excellent seed-to-soil contact is important as is planting depth (normally about 1.5 to 2 inches, shallower in heavier soils). Adequate soil moisture should be present for uniform germination. If irrigation is needed, it is best to apply it to the soil before planting. This allows the soils to reach appropriate temperatures before putting seed in the ground. Herbicides can affect developing peanut plants both pre- and post-emergence, but that is a topic that could be an article by itself. Yet even when all is done right, there can still be problems.

Peanut seedlings are tough and able to conquer adverse conditions (such as soil crusting) that can be devastating to some other crops. Peanut has a very large seed that must be removed from a tough hull (pod) during the shelling process. Damage to the seed during this process can include bruising and death to tissue of the cotyledons, which can then serve as entry points for pathogens. Also, the tip of the radicle (embryonic root) is exposed on a peanut seed and can be easily damaged during shelling and handling. The seed also have a fragile testae (seed coat) that is important in protecting the seed from infection as well as physically holding the cotyledons of the seed together. If the testae is damaged or removed, seed quality is greatly impaired. This can be caused by physical damage or issues at harvest or subsequent handling (such as over-drying) as well as during the shelling process.

Seed Treatment Fungicide

Another important factor is seedling disease. Since peanut pods develop in the soil, they are exposed to a wide range of pathogens as they mature, and many of these can be seedborne. In fact, one of the most overlooked but essential inputs for peanut production is an effective seed treatment fungicide. I have often said that growers get more financial return (by far) from the money they pay for seed treatment than any other input on the crop. I have often seen lower quality (but legal for sale) seed planted without a seed treatment be completely wiped out with not a single surviving plant.

One issue unique to peanuts is the challenge of applying the seed treatment without damaging the fragile testae. Such damage is much more likely to occur if the seed coat gets wet as happens when any type of liquid is applied. This has prevented the use of liquid seed treatments on peanut seed and is the reason dust formulations are still the standard for this crop. The equipment used to apply this dust is not very precise, and there is considerable variability in dosing rates. Liquid and polymer-based seed treatments are used on many other crops where this is not an issue, and the use of polymer seed treatments on peanut is already standard in some areas of the world. Changes in polymer formulations and application equipment are rapidly making this technology more suitable for use on peanuts, and several large-scale commercial seed treaters are now transitioning to polymer-based peanut seed treatments. Such formulations offer huge advantages in terms of reduced worker and pollinator exposure from dust formulations and the ability to apply more components to seed such as growth regulators, insecticides, and even inoculants for nitrogen fixation. There are also benefits in the physical handling of polymer-treated seed such as flowability and maintaining the structural integrity of the seed coat.

However, for a seed treatment to be effective, the fungicidal components must be effective on the target pathogens. There are numerous pathogens that can seriously damage peanut seed and seedlings, and they can be both seed- and soil-borne. Some of the most damaging are fungi, specifically *Aspergillus*, *Rhizoctonia*, *Rhizopus*, and *Pythium* (which is actually an oomycete, not a fungus). Several species of *Rhizopus* can cause a rapid rot that literally turns intact seed to mush in a matter of days. This fungus can grow rapidly and move down the furrow, rotting additional seeds, especially with higher seeding rates. With wet soils and stressful conditions, *Pythium* and *Rhizoctonia* can rot seed and seedlings. These diseases are worse in heavier soils and with deeper-planted seed that will be slower to emerge. In fact, the outcome of this interaction is a race—the faster a plant develops, the less likely it is to succumb to the effects of the disease. Obviously, the environment plays a big role in this interaction.

Aspergillus Pathogens

One of our most damaging seedling diseases in recent years has been Aspergillus crown rot, caused by the fungus *Aspergillus niger*. Crown rot is easily identified by the abundant, fuzzy black sporulation on the necrotic, shredded tissue just below the soil surface. Plants usually emerge normally but wilt suddenly and die at about 14 to 35 days after planting. One problem associated with this disease is this delayed development that makes replanting an unlikely option. Seed treatments help control crown rot, and in-furrow sprays of Abound (Syngenta) have been very effective, at least until recent years. Research at the University of Georgia in Tifton, GA has shown a high incidence of *A. niger* isolates from peanut seed with high levels of resistance to QoI (quinone outside inhibitor) fungicides like azoxystrobin, a key component in

Dynasty PD seed treatment from Syngenta (Jordan et al., 2019). The fact that *A. niger* can be seedborne at a high incidence is troubling as this is a very effective mechanism of long-range distribution.

Yet another very bad pathogen associated with peanut seed is *Aspergillus flavus*. It has yellow-green spores and usually rots the seed prior to emergence. This pathogen gets a lot more attention as the source of highly carcinogenic aflatoxin and low-value Seg 3 peanuts. It is well known to survive and even thrive in hot, dry conditions. While it is present in peanuts at some level every year, 2019 will long be remembered for the incredible heat and drought experienced across the Peanut Belt from August through September. As the scorching temperatures persisted, even irrigated fields were stressed and wilted. The first effect observed was a spike in Seg 3 peanuts at grading, which also translated into greatly increased aflatoxin levels in peanuts coming out of storage. This alone cost the industry millions of dollars in reduced crop values of contaminated peanuts that had to be regraded and/or crushed for oil stock.

Another effect that was less widely anticipated was much higher than normal amounts of *Aspergillus flavus* in the peanut seed. This was first noticed at the Georgia State Seed Lab where thousands of commercial peanut seed lots are assessed to certify germination. When the early samples were processed in the winter of 2020, it became apparent that the germination of commercial peanut seed lots was going to be generally low and highly erratic. Also, even though all seed were treated with fungicides, in some lots a yellow-green fungus was found growing rampantly on the germination blotters. Our lab obtained isolates and positively identified the pathogen as *A. flavus.* We also started assaying seed lots and found that many were nearly 100% contaminated with this deadly pathogen (Brenneman et al., 2020). Additional contributions were made by Dr. Emran Ali, Director of the University of Georgia Plant Molecular Diagnostic Lab in the Plant Pathology Department in Tifton. He extracted

DNA from the pathogen and demonstrated clearly that many of the isolates were highly resistant to the QoI fungicides, just as the *A. niger* isolates. This resistance was previously unknown but helped explain the unexpected explosion of this fungus in peanut seed for planting in the 2020 season (i.e., those produced in the drought of 2019). The combination of unprecedented heat and drought during pod fill, in addition to a surge of resistance to one of our main seed treatment fungicides, created a "perfect storm" for seed quality issues that plagued our spring plantings in 2020.

Left: Aspergillus flavus on germinating seed. Right: Aspergillus crown rot.

Loading peanut seed and preparing to plant.

Backup Plan: A Switch in Seed Treatment

Thankfully, the industry had a backup plan. As mentioned earlier, Dynasty PD has been used to treat nearly all the peanut seed in Georgia for a number of years. In 2016, UPL introduced Rancona V PD as a seed treatment to control seed rot. Both products contain a mix of three different active ingredients to control the wide range of potential peanut seed pathogens. However, the active ingredients are very different. Dynasty contains azoxystrobin, fludioxinil, and mefenoxam, whereas Rancona contains ipconazole, carboxin, and metalaxyl. Previous field trials in my program consistently showed both to be very good seed treatments (Brenneman & Bell, 2021), but Dynasty still held the great majority of the market. However, one effect of the emerging resistance was that Dynasty was much less effective than Rancona on many seed lots with large differences in germination. This apparently was due in large part to the azoxystrobin in Dynasty now having little effect on either *A. flavus* or *A. niger* due to the occurrence of Cyt B G143A and Cyt B F129L mutations (Ali et al., 2021). These mutations are well characterized and known to be associated with high and moderate levels of resistance to QoI fungicides. In *A. flavus* for example, isolates with the Cyt B G143A and F129L mutations had ED_{50}[1] values of 114 and 50 ppm, respectively while the sensitive isolates were less than 1 ppm (Ali et al. 2021). If these fungicide-resistant pathogens are not present in specific seed lots, then treatments containing QoI fungicides should still be effective.

Left: Field plots with the two rows to left planted to seed treated with Rancona at 4 oz/100 lb. The two rows to the right were planted with the same seed but with no seed treatment. ***Right****: Treated seed plated on a non-selective medium to evaluate fungal populations. All seed were from the same seed lot. The plates to the left were treated with Dynasty and those to the right were treated with Rancona, and the yellow-green fungus is Aspergillus flavus. Note the differences in germination of the seed.*

Peanut seed has to be at least 75% germination for the seed to be legal for sale, so the difference in treatment applied made the difference of whether seed were legal to sell or not based on the germination. Needless to say, most in the industry made a rapid change to Rancona, even as the seed was being shelled and bagged to go to the field. In fact, UPL ran extra shifts in spring 2020 trying to meet demand and still could not produce enough to supply all the market. Seed quality was not great in 2020, and there were stand issues, but these would have no doubt been worse if the change to Rancona had not been made.

Fortunately the growing conditions for peanut were much better in 2020 than in 2019, especally during the latter part of the season when the pods were developing. This resulted in better yields, but just as importantly much better seed quality. The assays to date have indicated uniformly higher germination percentages in this year's seed. Also, while some individual lots still show greater germination with Rancona, there have been fewer germination differences between Rancona and Dynasty in this year's seed. Does this mean the problem has gone away? That is probably not the case! Based on observations in other pathosystems, these same mutations for fungicide resistance are generally pretty stable and persist in the field once they develop. A more likely explanation for our current situation is simply that overall levels of *Aspergillus* are much lower in 2021 seed due to the good growing conditions. However, if projections of climate patterns are accurate, we will almost certainly be dealing with more hot, dry conditions and therefore more *Aspergillus* issues in the future. But for now, prospects are favorable for the upcoming crop, which is just being planted. Of course, there are many things that can still go wrong, but the combination of good seed and a highly effective seed treatment is a great way to start the year.

References

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