STAND ESTABLISHMENT: Influencing factors

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STAND ESTABLISHMENT

“the sins of planting will haunt you all season”

Anonymous

A thought worth remembering!!

• This statement sums up the importance of stand establishment to a crop.

• It is the first step in the crop development process.

• Establishing stands can be a problem, especially so when attempting to do so from seeds.

• Germinating seed and emerging seedling are venerable to a wide range of conditions than can be detrimental.

• Therefore special care should be taken to employ all cultural practices that reduce risk and enhance the establishment potential of a crop.

• Often times mistake made during this operation can not be corrected.
• There are three distinct phases of importance to the occurrence of optimum stand establishment (Phase I = Seed bed preparation; Phase II = Germination & emergence; and Phase III = Seedling establishment.

• Seeds and seedlings are faced with certain vulnerabilities that must be reduced during each phase before success can be achieved.
Most growers consider that a crop or stand establishment begins with the sowing of seeds into a bed.

In reality, stand establishment should begin with the seed bed preparation process.

Seed bed prep is the initial step taken during the production of a crop.

Poorly prepared seed beds can cause serious stand reductions or even total stand loss.
“The facet of stand establishment in which the greatest sins are committed!”

- In this example, the field was plowed when the soil was too wet!
- It will be nearly impossible to get this field worked into a satisfactory seed bed for seed sowing and germination.
SEEDBED PREPARATION

• The seedbed is to the crop as the foundation is to the house
• Improper preparation leads to uneven emergence, lack of uniformity of stands, weed and pest problems
• Reduce yield
• Increased production cost
SEEDBED PREPARATION

• Year round undertaking
  – *Employ practices to enhance tilth and structure*
    • Immediate crop destruction
    • Keep weeds under control
    • Build organic matter
    • Pay attention to rotations

• In the previous example, it would take at least an entire growing season before the situation can be rectified.

• Even under the best of conditions, seed bed preparation is a year long process

• Crop residue requires time for decomposition to occur.

• Weed presence in a field will result in additional residue to be decomposed once bed preparation is initiated. They can also cause significant problems in established beds if left unchecked prior to planting. Unchecked infestations tend to increase the volume of weed seeds in the soil seed bank.

• Crop rotations come into play in the management of soil borne disease problems that can negatively impact crop stands
### PLANTING

**SEED PLACEMENT IMPACTS STAND ESTABLISHMENT**

**TOO DEEP:**
- Increased soil impedance pressure
- Reduced gas exchange
- Risk of waterlogging
- And or crusting effect

**TOO SHALLOW:**
- Risk of insufficient moisture for imbibition
- Risk of high temperature injury

- **Depth:** 3 times the seed width
OVER SEEDING CAN CAUSE PROBLEMS WITH UNIFORMITY/QUALITY

> Planted too thick

Poor in-row spacing
Phase II is defined as the period of time between radicle emergence through the seed coat (germination) until cotyledon (plantlet) emergences through the soil surface.
GERMINATION

- The process by which a viable (living) seed imbibes water, triggering respiration, protein synthesis and other metabolic activities which cause radicle emergence.

- Seed germination is the initial phase of the crop production process.
- This phase can be likened to the starter of an auto engine.
- The electrical current is passed from the battery to cause the ignition process of the engine.
- Scientifically, germination is defined as presented here.
GERMINATION

Seeds are considered to have germinated once radicle emergence has occurred

The germination process is considered completed once radicle (root like structure) has emergence through the seed coat as shown in this slide.
GERMINATION
(ENVIRONMENTAL FACTORS)

• Moisture
  – Seed content
  – Soil content
• Temperature
• Oxygen/gas exchange

• The seed germination process is impacted by two sets of conditions; *environmental factors and soils physical properties*. 
SEED MOISTURE CONTENT

- Seeds stored 4 - 5 % moisture content
- Water needed to active metabolic processes
- Excess moisture
  - inhibits gas exchange (stops metabolic processes)
  - leakage of sugars, organic and amino acids
  - increase pathogen susceptibility (substrate)
Oxygen & Gas Exchange

• Seeds are living organisms.
• Oxygen needed in metabolic process for germination to occur in vegetables
• Water logged soils force oxygen out of soil microclimate and stops processes
  – can cause physiological breakdown
  – decay as a result of pathogenic attack
Moisture & Germination

- Moisture stress
  - The greater the deficit the slower the germination and radicle emergence
  - Greater negative effect on seed with poor vigor
- More advanced germination the greater the impact of moisture stress
  - some evidence for cycling wetting and drying prior to planting enhances germination.

- Seeds need in imbibe adequate moisture in order to activate the germination process.
- Moisture deficits can significantly prevent or delay germination, can cause death due to desiccation of emerged radicles
- Excessive moisture can result in waterlogged soils deficient in adequate oxygen levels needed for germination. Under prolong depletion, seed decay can result.
- Excessive soil moisture can cause soil water logging which can negatively impact oxygen absorption and increase soil borne pathogen activity.
**GERMINATION**  
*(Soil physical properties)*

- Soil moisture content
- Soil temperature
- Soil insect and disease pressure
- Soil impedance

• Factors that impact germination are listed here.
• The soil/seed interphase is the contact zone or microclimate surrounding the seed in the soil.
• The soil moisture content and temperature in this microclimate has a big impact on germination rate and percentage.
• The influence of moisture content has been previously discussed.
FACTORS IMPACTING GERMINATION & EMERGENCE

• Soil temperature

• Soil temperature is a major regulating factor on the presence and buildup of soil borne insects and diseases.

• Each crop specie has its own temperature range for germination to occur.

• As a result, temperature extremes can cause poor germination and of most vegetable species.

• In some cases, such as spinach, high soil temperature can even cause a heat induced dormancy problem.

• Another way temperature can cause stand problems is through a “cooking” effect on emerging radicles and hypocotyls when excessively hot temperature occur in the seed soil interphase.
TEMPERATURE & GERMINATION

- Generally the higher the temperature the better the germination for most vegetables
  - *warm temperatures increases respiration rate and other metabolic processes*
- Each species has an optimum temperature range above or below which germination is reduced or inhibited
  - *temperature impact pathogen activity which can have a detrimental effect on germination*

• However, excessively high soil temperature can induce seed dormancy, as is the case for spinach, or even death of sensitive seeds.
• Excessively low temperature can cause chilling injury especially in seeds that have imbibed water and have started the germination process
### INFLUENCE OF SOIL TEMPERATURE ON GERMINATION

<table>
<thead>
<tr>
<th>CROP</th>
<th>Min</th>
<th>Max</th>
<th>Opt.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>40</td>
<td>100</td>
<td>85</td>
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<td>Carrot</td>
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<tr>
<td>Onion</td>
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</tr>
<tr>
<td>Pepper</td>
<td>40</td>
<td>95</td>
<td>85</td>
<td>45-90</td>
</tr>
<tr>
<td>Watermelon</td>
<td>60</td>
<td>105</td>
<td>95</td>
<td>70-90</td>
</tr>
</tbody>
</table>

- This slide lists a few examples of the temperature ranges for germination of the major vegetable crop of Texas.
INFLUENCE OF
SOIL TEMPERATURE ON EMERGENCE

<table>
<thead>
<tr>
<th>CROP</th>
<th>Min. days (F)</th>
<th>Max. days (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>4 @ 86</td>
<td>15 @ 50</td>
</tr>
<tr>
<td>Carrot</td>
<td>6 @ 77</td>
<td>51 @ 41</td>
</tr>
<tr>
<td>Onion</td>
<td>4 @ 77</td>
<td>136 @ 32</td>
</tr>
<tr>
<td>Pepper</td>
<td>8 @ 77</td>
<td>25 @ 59</td>
</tr>
<tr>
<td>Watermelon</td>
<td>3 @ 95</td>
<td>12 @ 68</td>
</tr>
</tbody>
</table>

Temperature also impact the rate of emergence after germination has occurred.
SOIL TO SEED CONTACT

- Onset of germination delayed at soil matrix potentials
- Highest germination % between -0.3 & -0.1
- Soil matrix potentials outside of this range – DELAYED GERMINATION

Germination may ultimately be determined by soil impedance of the soil matrix and the degree of contact of the seed to the soil.
SOIL TO SEED CONTACT

• Germination ultimately determined by:
  – the impedance of the soil matrix
    • *due to surface and colloidal forces*
  – the contact of the seed with soil moisture
    • *irrespective of the initial difference between the water potential of the seed interior and the soil*

• Soil to seed contact can influence the soil matrix potential.
• Excessive soil to seed contact can reduce stand due to soil impedance.
SOIL FACTORS IMPACTING GERMINATION & EMERGENCE

• **Soil impedance** – *the pressure or barrier effect soil has on emergence.*

  • This can be due to excessive planting depth resulting in too thick an area of soil to be penetrated by the emerging seedling;
  • Excessive soil depth above the seed to causing intense pressure applied to the emerging seedling
  • In can also be in the form of a soil surface crust too hard to be penetrated by the emerging seedling.
  • Therefore, proper planting depth and cultural practices which reduce the effect of soil impedance should be employed.
SOIL IMPEDANCE

- Emergence force of seed hypocotyls will determine how effective a specie is in overcoming the negative effect of soil impedance.
- Small seeded crops such as carrots lack good emergence force.
- Crust and/or deep planting very disastrous to crops lacking good emergence force.
EMERGENCE VIGOR

• The ability of a hypocotyls to rapidly emerge through the soil profile and emerge above the soil surface.

• The ability to overcome the effects of soil impedance is known as emergence vigor.

• Emergence vigor of a species is the characteristic which determines the degree of stand established when soil impedance is an impacting factor.

• Species with good emergence vigor have the ability to push through excessive depths, soil crusts or compacted situations.
FACTORS IMPACTING GERMINATION & EMERGENCE

• Soil insect and disease pressure

• As stated above pest problems can cause injury and/or death of germinating seeds.

• The higher the population pressure of these organisms the greater the negative impact on seed germination.

• Often times the microclimate within the soil can increase or decrease the pathogen populations
• Phase III - the final phase of the stand establishment process.

• It is the period of time between the emergence of the cotyledons through the soil surface until the development of a fully functional root system to absorb water and nutrients needed for growth and the development of true leaves needed to manufacture food reserves needed for growth.
SEEDLING ESTABLISHMENT

• The time from seedling emergence from the soil until 2 – 4 true leaf stage
  • Impacted by
    » Insects
    » Diseases
    » Soil moisture and temperature
    » Wind Desiccation
    » Sand basting
    » Hail
    » Chemical injury

• These are the major factors success during Phase III of the process.
• The first 3 are the similar to those previously described in the Phases I & II and are concerned mostly with the below bed surface microclimate.
• These factors also important during Phase III. However, the above bed surface conditions now come into play.
• Excessive soil surface temperature can cause a “frying effect” as the young seedling emerges through the soil surface.
• Excessive soil moisture can induce water logging and damping off of seedlings
• The last 4 conditions cause injury or death by a physical injury to the seedling prior to it obtaining sufficient mass to withstand their effects.
• Therefore, the longer the time required for seeds to germinate, emerge and to be established as seedlings the greater is the potential for stand reductions
STAND ESTABLISHMENT

GOAL

• TO REDUCE THE TIME REQUIRED FOR SEED GERMINATION TO SEEDLING ESTABLISHMENT

• THE LONGER THE PERIOD OF TIME THAT THE SEEDLING REMAIN BELOW THE SOIL SURFACE THE GREATER THE INCIDENCE OF SEEDLING DEATH OR INJURY!!

• Factors such as soil borne diseases, soil insects, moisture levels and temperature have a greater chance of impacting germination and emergence the longer it takes for germination and emergence to occur.

• Therefore it is imperative that a favorable environment be created to allow the accomplishment of this goal.
Once a seedling has successfully passed through all three of the Phases, sand is considered to be establishment.
3 COMPONENTS OF STAND ESTABLISHMENT

1. Good Soil Conditions
2. Viable Seeds
3. Favorable Microclimate

• From the previously presented information it can be concluded that there are three major components necessary for successful stand establishment.
GOOD SOIL CONDITIONS

(COMPOENT # 1)
**IDEAL SEED BED SOIL CONDITIONS**

- Well pulverized
- Free of clods and plant residue
- Firm and level
- Provide good soil to seed contact

*Enables maximum moisture imbibition which enhances germination rate, enables uniform emergence and provides maximum stands*
MEANS of ACHIEVING GOOD SOIL to SEED CONTACT

- Avoid working soil when wet
- Avoid excessive disking, causes compaction restricts root growth & yield
- Pulverize soil to the point that it is free of clods and debris
  - Rotovators are ideal implements
• As indicated earlier, seed is the central focus of any stand establishment system.
• Without viable seed, germination is reduced or prevented.
• As a result, poor stands or crop failure will occur.
SEEDS

• **Embryonic or New plants**
  – *plant in miniature*

• **Contained in a Dispersing structures**
  – *protected in a cover (the seed coat) until a self sufficient autotrophic organism can be established*

• Basically a seed is a self contained life support system for transferring a miniature plant from its mother plant to the final place where it is to be established in a media.

• Seeds are the focal point of the stand establishment process.

• The entire process should be centered around ways in which to protect the miniature plant until it has emerged from the its life support system, emerged from the soil and established itself.
VIABLE SEED

• Seed Having The Ability To Germinate and develop into a seedling once planted!
FACTORS INFLUENCING SEED VIABILITY

1. Seed coat (*testa*)
2. Food reserves
3. Dormancy
4. Condition under which seed produced
5. Storage conditions
SEED COAT CHARACTERISTICS

- Surface area
- Nature of the surface
- Mucilage content
- Thickness
- Porosity

- The seed coat is the packaging that protects the miniature plant.
- The denseness or hardness of the seed coat can determine both rate and percentage of germination. The harder or more dense the seed coat the more difficult will be the germination,
• **Thickness or Porosity**
  – can impede water uptake
  – restrict radicle emergence
  – impact gas exchange
  • *These then interact to slow or stop respiration and other metabolic processes associated with germination*
SEED FOOD RESERVES

• Quantity determined by the quality of the seed crop
  – Growing conditions
  – Harvest
  – Storage

• Since the seed is the life support system for the miniature plant the greater the seed reserves contained within the seed the greater the incidence of germination and stand establishment.
• Food reserve is dependent upon these conditions.
• When seed is harvested and how it is stored will also influence food reserve. If immature seed is harvested insufficient reserves will result.
• Poorly stored seed may result in increased respiration rate which in turn result is the reserves being used prior to planting.
CONDITIONS UNDER WHICH SEED CROP IS GROWN

• **Stressed plants are weak plants which in turn produce unviable or poor germinating seed**

• The more stressful growing conditions the less will be the food reserves.
SEED DORMANCY

• The failure of seed to germinate even under apparently favorable conditions
  – Due to a inherent blocking mechanism within the seed

• This is a genetically controlled factor.
• Seed with a dormancy problem have to be handled in such a manner to break or reduce the length of dormancy.
• This can be accomplished chemically, physically or culturally.
SEED DORMANCY

• Causes:
  – Chilling requirement
  – Excessive temperature
  – Inhibitors
  – Seed coat thickness

• These are the most common causes of seed dormancy.
FAVORABLE ENVIRONMENT

(COMPOENT # 3)
ROOT ZONE MICROCLIMATE (POST GERMINATION TEMPERATURE & MOISTURE STRESS)

- Radicle injury or death
- Hypocotol injury or death
- No, or poor or uneven stands
- Reduced yield

Stress conditions occurring during the stand establishment process can result in reduced vigor, delayed maturity and reduced yields.

Once some species, such as the cucurbits, are stressed during this stage of crop development, they never seem to recover and reach their yield and quality potential.
### INFLUENCE TEMPERATURE ON EARLY GROWTH

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- The temperatures listed in this table show the range for optimal early plant growth.
- Therefore, cultural practices which provide ideal microclimate during the establishment phases are suggested to insure maximum stand, yield and quality.
• This study consisted of conventional pepper planting versus the use of a covered trenched bed technique we developed at the TAMU AREC @ Uvalde.

• This top left hand corner shows the covered trench planted beds at cover removal.

• The lower left hand corner show the size of seedling from the conventionally planted beds at the time than the covers were removed. Compare the size of these to those in the lower center grown under the covers.

• Plants on the right show the fruiting stages from each system. The covered trench grown plants had fruit nearing maturing while those from the conventionally planted beds were just initiating fruit buds.
SEEDING RATE

– *Inadequate rates, poor stands due to*
  • *lack of potential seedlings emerging*
– *Excessive rates*
  • *over crowding weak spindly plants*
SUMMARY: Major factors impacting good stand establishment

• Seed Quality
• Proper Seedbed Preparation
• Seedbed Moisture
• Soil temperature
• Soil impedance
• Soil borne pathogens

Therefore cultural systems that include or provide the optimum conditions that favorably influence these factors should be followed.
“The sins of planting will haunt you all season!”