IPM - 2

Kentucky Integrated Crop Management Manual for Field Crops

"CORN"

Section 2
Pages 30 – 60

Agriculture and Natural Resources • Family and Consumer Sciences • 4-H Youth Development • Community and Economic Development

Kentucky Integrated Crop Management Manual for Corn

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For additional and current information please consult the following web sites:

For more IPM information and links to many pest and crop management sites view the IPM web page at:
http://www.uky.edu/Ag/IPM/

For the most current information on pests view the **Kentucky Pest News** at:
http://www2.ca.uky.edu/agcollege/plantpathology/extension/kpnindex.htm

For up-to-date weather, and crop and pest models view Ag-weather at:
http://wwwagwx.ca.uky.edu/Gisproducts.html

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William M. Brown. Pythium diseases (Pythium spp.) on corn, pg. 31; Genetic abnormalities on corn, pg. 47. Bugwood.org.

Clemson University. USDA Cooperative Extension Slide Series. Southern corn leaf blight, pg. 35; Physoderma brown spot, pg. 37; Gibberella stalk rot, pg. 38.

R. L. Croissant. Nitrogen (N) deficiency, pg. 45. Bugwood.org

Mary Ann Hansen. Virginia Polytechnic Institute and State University. Phosphorus (P) deficiency, pg. 45. Bugwood .org.

John Hartman. University of Kentucky. Anthracnose top die-back, pg. 38.

Cheryl Kaiser. University of Kentucky. Charcoal stalk rot, pg. 39.

Gary P. Munkvold, former Extension Pathologist, Iowa State University. Anthracnose stalk rot, pg. 39.

Lloyd Murdock. University of Kentucky. Potassium (K) deficiency, pg. 46.

Diane Perkins. University of Kentucky. Zinc (Zn) deficiency, pg. 45. Bugwood.org.

Richard Stuckey. University of Kentucky. Anthracnose on young plants and Anthracnose on single leaf, pg. 33; Gibberella ear rot, pg. 40.

University of Kentucky. Department of Entomology, Cooperative Extension Service Pesticide Applicator Training Slide Series. Bacterial wilt, pg. 34.

Paul Vincelli. University of Kentucky. Maize chlorotic dwarf virus, Maize dwarf mosaic virus on johnsongrass, Close-up of maize dwarf mosaic virus on corn, pg. 32; Northern corn leaf blight, pg. 34; Gray leaf spot, pg. 35; Common rust, Southern rust, pg. 36; Diplodia stalk rot, pg. 38; Diplodia ear rot and Fusarium kernel or ear rot, pg. 40.

Preface

Agriculture is the world's most important industry because of rapidly expanding populations which demand increased amounts of food and fiber. Crop protection problems associated with this increased production have become more complex. A simplistic approach to pest control leads to serious environmental complications. A truly successful pest management program must take a multi- disciplinary, multi-crop approach in order to supply the farmer with reliable pest control information. An approach to crop production based on sound economic, ecological, technical and social considerations is required to assist the farmer to achieve needed production levels, while maintaining food safety and environmental quality.

As a participant in Kentucky's IPM program, you are an important member of a team responsible for providing these types of information. Your enthusiasm, professionalism and ability will allow all of us to obtain the information the farmer needs to make important management decisions. Your sound judgment and dedicated effort will directly affect the success of this program.

Section 2

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Scouting Corn for Diseases

Paul Vincelli

Observation Times for Corn Diseases

```
                                                  SILK DENT
                  SEEDLING  KNEEHIGH  WHORL  TASSEL  DOUGH   MATURITY
                    April     May     June   July    August  September

Seedling Blights    *********************
Virus Complex                          ********************

Leaf Spots
  Anthracnose                 ********************
  Bacterial Leaf Blight      *****************************************
  Northern Corn Leaf Blight           ********************************
  Gray Leaf Spot                      ********************************
  Other (Rust, Brown spot, etc.)      ********************************

Stalk Rots
  Anthracnose Top Die Back                              **************
  Diplodia Stalk Rot                                      ************
  Gibberella Stalk Rot                                    ************
  Charcoal Stalk Rot                                      ************
  Anthracnose Stalk Rot                                   ************

Ear Rots
  Diplodia Ear Rot                                        ************
  Fusarium Ear Rot                                        ************
  Gibberella Ear Rot                                      ************
  Other Ear Rot                                           ************
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Description of Corn Diseases

Pythium diseases (Pythium spp.) on corn

Seedling Blights

Examination Period: Soon after emergence of corn seedlings and two more times at two week intervals. Observe two rows of plants l0 feet in length.

Symptoms: Pythium, Diplodia and Fusarium are the three fungi most often associated with seedling blight in Kentucky. The damping-off symptoms may occur before or after emergence. Pre-emergence symptoms often include a soft rot of stem tissues and discoloration of affected areas ranging from whitish-gray to pink, to dark brown or black. Post-emergence symptoms are yellowing, wilting and death of leaves. Examine underground parts thoroughly to rule out insect injury. Know what chemicals have been applied in case chemical injury may have occurred.

Occurrence: Look for seedling blight in poorly drained, cool, wet soils. Chemical injury usually follows closely the patterns of application. This is especially evident at the turn rows. Seedling blights are usually scattered with no regular pattern, although they may be associated with low, wet areas.

Rating Scale:
0 = no seedling blight observed;
l = 1-4% of plants affected;
2 = 5-20% of plants affected;
3 = 2l-l00% of plants affected.

Record: Record a rating of 0 to 3 for each site scouted.

Virus Complex

Examination Period: Once per month in June, July and August. Observe two rows of plants 10 feet in length at several representative locations.

Symptoms: Corn plants affected with the virus complex generally lack vigor, have an off-green to yellowish color, may be stunted and may develop reddening of leaves in mid to late season. Closer examination of leaves may reveal mottling, yellow to dark-green mosaic patterns or light green to yellow streaks and stripes in leaves. Nutrient problems can sometimes be confused with the virus complex. Nutrient problems generally affect a group of plants whereas virus-infected plants are often, but not always, individual plants that may be next to the healthy plants.

Maize chlorotic dwarf virus

Maize dwarf mosaic virus on johnsongrass

Close-up of Maize dwarf mosaic virus on corn

Occurrence: Often found in fields with a rhizome johnsongrass problem and where susceptible corn hybrids are grown. Check the University of Kentucky corn hybrid test results bulletin for hybrid reaction to virus complex.

Rating Scale:
0 = no virus symptoms observed;
l = 1-4% of plants showing symptoms, plants have an off-green color, little or no stunting;
2 = 5-20% of plants showing symptoms, definite off-green color, some plants stunted;
3 = greater than 20% of plants showing symptoms, definite stunting in many of the plants, some plants having reddish leaves, ear absent or small and poorly developed.

Record: Record a rating of 0 to 3 for each site observed.

Leaf Spots

Anthracnose

Anthracnose on young plants

Examination Period: Make observations every three weeks when plants are between the knee-high and whorl stages. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: Anthracnose, caused by the fungus Colletotrichum graminicola, is often the first disease that shows up on corn. Small, round to irregular, water-soaked spots first appear on lower leaves. Spots later turn yellow and then brown wit h reddish-brown borders. Numerous spots can cause leaf tips or entire leaves to turn yellow. With the aid of a hand lens, black spines can be seen arising from the center of the spots. Infection begins on lower leaves and can work its way up the plant.

Anthracnose on single leaf

Occurrence: Anthracnose causes a leaf spot disease when corn is in the seedling stage. Plants become somewhat resistant as the crop develops. If weather permits, plants of some hybrids become susceptible to the "top-dieback" and stalk rot phase of the disease later in the season (see stalk rot section). High moisture and moderate temperatures favor the disease. The early season disease is generally more severe in fields where continuous no-till corn has been grown. Detection of anthracnose at the seedling stage should alert scouts to watch for the disease later in the season.

Rating Scale:
0 = no anthracnose;
1 = lower most leaf contains some yellow anthracnose lesions;
2 = lower most leaf yellowed and dried up, anthracnose lesions found on second and third leaves;
3 = second and third leaves dried up and anthracnose found on highest leaves.

Record: Record a rating of 0 to 3 for each site observed.

Bacterial Wilt (Stewart's Wilt)

Bacterial wilt (Stewart's wilt)

Examination Period: Every four weeks from kneehigh through whorl stages and again every four weeks after tasseling until dent stage. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: The disease is characterized by leaves showing pale green to yellow streaks with irregular or wavy margins which run parallel to veins and may extend the length of the leaf. The streaked areas may die and become straw colored. Sometimes entire leaves die and dry up. Infections are most noted early in the pre-tassel (whorl) stage or later after tasseling. Infections after tasseling are generally more severe on upper leaves. Early season symptoms include plant death. Look for dark brown cavities in the lower stalk pith with no evidence of insect injury on lower stalk.

Occurrence: More prevalent following mild winters. The bacterium is carried through the winter and transmitted to corn by the corn flea beetle.

Rating Scale:
0 = no bacterial wilt symptoms;
l = an occasional streak lesion on several plants or one dead plant;
2 = all plants contain bacterial wilt lesions on one or more leaves or 2 to l0% of plants dead;
3= leaves severely wilted and dropping, nearly all leaves of all plants affected or over l0% of plants killed.

Record: Record a rating of 0 to 3 for each site observed.

Northern Corn Leaf Blight (NCLB)

Northern corn leaf blight

Examination Period: Every four weeks from whorl through dent stage. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: Symptoms of NCLB, caused by the fungus Setosphaeria turcica can often be confused with symptoms of bacterial wilt, especially late in the season. Lesions are long (l" to 6"), elliptical in shape with pointed ends, grayish-green or tan in color and develop first on lower leaves (see Corn Diseases I Picture Sheet). NCLB lesions differ from bacterial wilt lesions in that they are generally definite in shape, have greater width and do not follow leaf veins for extended lengths.

Occurrence: Look for this disease developing first on lower leaves when corn plants are from waist to shoulder high. The disease is favored by temperatures from 65-80˚F and heavy dew during the growing season.

Rating Scale:
0 = no symptoms;
l = a few lesions on lower leaves of some plants;
2 = nearly all plants have some lesions and lesions are not confined to only lower leaves;
3 = all plants have lesions on nearly all leaves, some or all leaves dried up and killed.

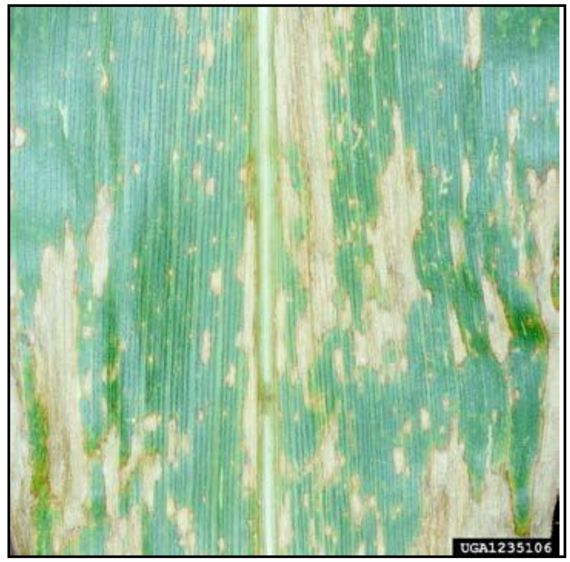
Record: Record a rating of 0 to 3 for each site observed.

Southern Corn Leaf Blight (SCLB)

Examination Period: Every four weeks from whorl through dent stage. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: Small, rectangular-shaped lesions are one-fourth by one-half to three-fourths inch in size. Lesions are parallel-sided and have buff to brown borders. Coalescing of lesions can cause leaf death. (See Corn Diseases I picture sheet.)

Occurrence: Infection begins on lower leaves and may continue to uppermost leaves. Symptoms are observed throughout the entire field. Warm (68-90˚F) weather is conducive to infection and disease development. Long dry periods are unfavorable.



Southern corn leaf blight

Rating Scale:
0 = no symptoms;
l = a few lesions on lower leaves some plants;
2 = nearly all plants have some lesions and lesions are not confined to only lower leaves;
3 = all plants have lesions on nearly all leaves; some or all leaves dried up and killed.

Record: Record a rating of 0 to 3 for each site observed.

Gray Leaf Spot

Examination Period: Every two weeks from tasseling to maturity. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: Long, narrow, parallel-sided, tan or gray-to-tan lesions, up to l/4 by l to 2 inches, may merge to form large gray blotches that kill leaves. Appears similar to southern corn leaf blight (especially in the early stages of lesion development), except gray leaf spot has lesions that are longer and more grayish in color.


Gray leaf spot

Occurrence: Infection begins on lower leaves and may continue to uppermost leaves. Symptoms are observed throughout the field. Warm, damp weather and overcast foggy days are conducive to infection and disease development. Successive corn plantings in the same field and minimum tillage practices increase this disease. Long dry periods are unfavorable for disease development.

Rating Scale:
0 = no symptoms;
l = a few lesions on lower leaves of some plants;
2 = nearly all plants have some lesions and lesions are not confined to only lower leaves;
3 = all plants have lesions on nearly all leaves; some or all leaves dried up and killed.

Record: Record a rating of 0 to 3 for each site of observed.

Common Rust

Common rust

Examination Period: Every four weeks from whorl through dent stage. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: The rust fungus attacks corn leaves by producing circular to oblong golden-brown to cinnamon-brown pustules on both leaf surfaces. Rust pustules contain a thin membrane that ruptures exposing the brightly colored spores of the fungus. About mid-season, these pustules turn to a brownish- black color, which can be found on mid to upper leaves.

Occurrence: Cool temperatures of 60-72˚F and high relative humidity favor rust development and spread.

Rating Scale:
0 = no symptoms;
l = a few pustules on a few leaves of some plants;
2 = most leaves on all plants contain scattered populated pustules;
3 = nearly all leaves of all plants contain numerous pustules; some leaves have turned brown and withered.

Record: Record a rating of 0 to 3 for each site observed.

Southern Rust

Southern rust

Examination Period: Every four weeks from whorl through dent stage. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: Symptoms are somewhat similar to common rust, however, with southern rust the pustules (uredia) are light cinnamon brown, circular to oval and densely scattered on the upper leaf surface. The chocolate brown to black stage (telia) is circular to elongate, frequently appearing in circles around the uredial pustules and remaining covered by the epidermis longer than in common rust.

Occurrence: Disease is favored by high temperature (80˚F) and high relative humidity. Southern rust is not as common year to year as is common rust.

Rating Scale:
0 = no symptoms;
l = a few pustules on a few leaves of some plants;
2 = most leaves on all plants contain scattered populated pustules;
3 = nearly all leaves of all plants contain numerous pustules; some leaves are chlorotic and dry.

Record: Record a rating of 0 to 3 for each site observed.

Physoderma Brown Spot

Physoderma brown spot

Examination Period: Every four weeks from whorl through dent stage. Observe two rows of plants l0 feet in length at several representative locations.

Symptoms: Lesions at first appear as very small oblong to round yellowish spots on the leaf blade, leaf sheath and stalk. Lesions may occur in bands across the leaf blade and primarily occur on the part of the leaf closest to the stalk. With age, the yellowish spots turn to chocolate brown to reddish brown and join together to form large irregular angular blotches. Infected stalks may break at the nodes.

Occurrence: Quite common on many hybrids, although it rarely causes economic damage. Temperatures from 75-86° F and free water on leaf surface favor this disease.

Rating Scale:
0 = no symptoms;
l = a few yellow lesions on a few of the plants;
2 = many plants contain lesions which are chocolate to dark brown in color;
3 = nearly all plants infected, some plants showing stalk breakage.

Record: Record a rating of 0 to 3 for each site observed.

Stalk Rots

Anthracnose Top-Die-Back

Examination Period: One time when lower leaves begin normal yellowing anywhere between two to three and one-half feet above ground level.

Symptoms: When corn plants begin their normal yellowing, or "firing" from the bottom of the plant upward, anthracnose top-dieback (Colletotrichum graminicola) affected plants also begin to yellow or redden from the top down . The three to four leaves about ear level that remain green are very striking to the eye. Yellowing, reddening and dying of corn plant tops can be caused by severe lower stalk rot by anthracnose rot of the upper stalk by anthracnose or by borer holes made by insects. Make sure you rule out insect injury before making your diagnosis of anthracnose top-dieback.

Anthracnose top die-back

Occurrence: The anthracnose fungus is favored by moderate temperatures and high moisture. Time of infection may vary dependent on hybrid and weather. Generally, when plants begin to fire from the base of the plant top symptoms can be observed, if present.

Rating Scale: Count the number of plants per 20 plants at each location that have the top two or more leaves discolored (yellowish or reddish). Distinguish these symptoms from symptoms caused by the virus complex. Record the number of infected plants on the form.

Record: Of the twenty plants observed at each location, record the number having the top two or more leaves showing a yellowish or reddish discoloration.

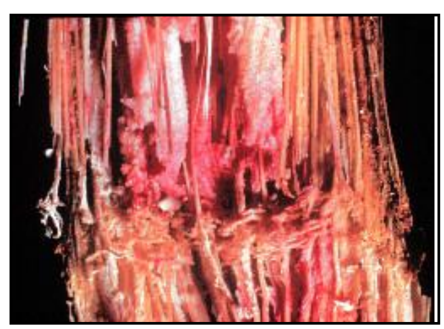
Lower Stalk Rots of Corn

Examination Period: One time at harvest maturity before crop is harvested or the last scouting period, whichever comes first.

Diplodia stalk rot

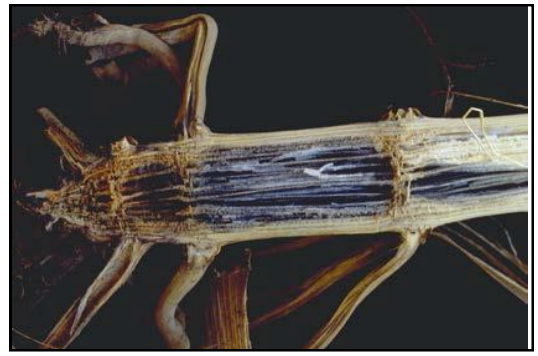
Symptoms: In Kentucky, late season lower stalk rot is commonly caused by one of four fungi, Diplodia, Gibberella, Macrophomina or Colletotrichum. Distinguishing characteristics of the four stalk rots are as follows:

1. Diplodia stalk rot - (Diplodia maydis). Appears several weeks after silking with affected plants dying suddenly and resembles frost injury. The lower stalk is spongy and discolored Small, dark-brown to black spots (pycnidia) may develop just below the stalk epidermis near nodes, although these are difficult to find without some experience. Upon splitting the stalk a disintegrated brownish pith is encountered.



Gibberella stalk rot

2. Gibberella stalk rot - (Gibberella zeae). Leaves suddenly turn dull, grayish green and lower internodes soften and turn tan or brown. Small superficial black spots (perithecia) of the fungus may at times be seen on the stalk. The stalk interior frequently shows a pink to reddish discoloration and shredded pith . The pink discoloration, and superficial perithecia which may be easily dislodged by rubbing a fingernail, over them distinguish Gibberella from Diplodia stalk rot.



Charcoal stalk rot

3. Charcoal Rot - (Macrophomina phaseolina). Charcoal rot begins as a root infection, spreads into the lower stalk internodes and causes early ripening, shredding and breaking at the crown. The black spots (sclerotia) on the vascular strands of the shredded pith give the interior of the stalks a charred appearance (hence its name) and are a characteristic sign of this disease

4. Anthracnose stalk rot - (Colletotrichum graminicola). Dark discoloration on exterior nodes and internodes of corn stalks). Occasionally dark spines can be seen in darkened areas with the aid of a hand lens. Interior shredding of stalk pith is also common.

5. Fusarium stalk rot - (Fusarium verticillioides). Pith whitish-pink to salmon-colored. Can be difficult to distinguish from Gibberella; lab analysis often usually necessary for diagnosis of this stalk rot.

Anthracnose stalk rot

Occurrence: Symptoms of stalk rots are frequently first noted on early maturing varieties and on corn stalks producing two ears. Production of two ears further reduces stalk sugar content and results in wobbly stalks. Some surface discoloration, especially around the nodes, may be noted. Unbalanced fertility, low Potassium (K), poor soil drainage, mechanical and insect damage, foliar diseases, variety, excessive plant density and inadequate row spacing influence the development of stalk rots.

Rating Scale: Examine 20 stalks in each of five sites per field. Check for stalk rot by either of the following methods: 1.) Squeeze the base of the stalk with your hand or 2.) Push the stalk 8 to 10 inches from its vertical position to check for lodging. Record number of plants containing disintegrated brownish pith (Diplodia), pink or reddish discoloration (Gibberella), black, charred appearance (Charcoal rot) and/or dark black exterior and shredded pith (Anthracnose). Some plants may have more than one fungus present. If so, record both. Observe any injury that may have occurred due to corn borers or other insects and enter observations on survey report following SCOUT COMMENTS.

Record: List the four types of stalk rots described previously and record the number of stalks showing symptoms of each. Some plants may have more than one type of fungus present and should be recorded for both. Note any observation of insect damage.

Action: Schedule the field for early harvest if 10 to 15% of the plants are showing stalk rot. If harvesting early, be sure to dry grain quickly to prevent ear and kernel rots.

Ear Rots

Examination Period: One time at harvest maturity before crop is harvested.

Symptoms: The more common ear rots occurring in Kentucky include: Diplodia, Gibberella and Fusarium. Color photos of each of these ear rots can be found in the Corn Diseases II Picture Sheet. Distinguishing characteristics of the three ear rots are given below.

1. Diplodia ear rot - is often characterized by a white mold found growing between kernels. The mold, which can cover the entire ear and become quite extensive, usually begins at the ear base and moves up from the shank. Black pycnidia may be scattered on husks, floral bracts and sides of kernels. Husks on ears may become bleached with inner husks adhering tightly to one another or the ear. Infected ears are often lightweight and stand upright in the field.

2. Gibberella ear rot - is associated with a reddish mold often beginning at the ear tips. Early infection may cause the entire ear to rot and husks to be pressed tightly to the ear and pink to red mold growth between husks and ears.

3. Fusarium kernel or ear rot - usually infects only individual or groups of kernels scattered over the ear. Salmon-pink to reddish-brown discoloration occurs on kernels, especially in areas that have been damaged by ear worms or corn borers.

Diplodia ear rot

Gibberella ear rot

Fusarium kernel or ear rot

Occurrence: Ear rots are most often observed on corn hybrids that have poor husk development, on ears that have been damaged as a result of insect or bird feeding, or on hybrids that tend toward ear maturation in the upright position. Injured kernels, wetting and rewetting of the ear, and plant stresses earlier in the year enhance ear rot development. Ear rots are generally not observed until late in the season, near harvest maturity.

Rating Scale: Examine 20 ears in a row in each of five locations in the field by observing husks and then husking ears to look at ears and kernels. Where two ears occur on the same plant, observe only one ear; thus, you will be examining 20 plants preferably from the same 20 plants used for stalk rot data.

Record: Record the type of ear rot and the number of ears showing symptoms per 20 ears observed at each site. If possible use the same stalks observed for stalk rot and observe only one ear per stalk.

SOIL SAMPLING AND SOIL TESTING

Lloyd Murdock

The most important factor of soil testing and fertility recommendations is obtaining a good soil sample. There is more room for error in this step than any other in getting reliable soil test results and recommendations.

<u>Method</u>:

The proper procedures for obtaining a good soil sample are well-established. Publication AGR-16 contains a complete explanation of these procedures.

<u>Time of Sampling</u>:

An excellent time for sampling is anytime after harvest and before fertilizer is applied for the next crop. Recent fertilizer applications can distort the soil test results and fertilizer recommendations. If sampling after planting, soil samples should be taken at least six weeks after the last fertilizer application. The best time to sample is in the late winter or spring for that year's fertilization. This gives all the nutrients in the soil and those released by the plant a chance to equilibrate. Fall sampling is also good but needs attention paid to sampling location to ensure a more representative sample in row crops. An equal number of samples should be taken from the row middle and from next to the row.

Corn presents a special problem if the soil is sampled when the crop is growing. As the height of the plants reach three feet it becomes increasingly difficult to walk through the field and view the terrain for any areas that need separate sampling. In the process of early season scouting notes should be recorded and areas needing special attention should be out lined on the field map. The best overall suggestion for early sampling when special notes are lacking is to wait at least six weeks but sample while the general crop condition and field are still visible.

Late application of nitrogen to corn and the use of anhydrous ammonia require some special attention. When nitrogen is applied four to six weeks after planting, the best time for early sampling would be just before the delayed application. When anhydrous ammonia is applied between the row anytime after planting, do not sample within six inches of the application slit.

Soil cores should not be taken from where fertilizers were banded in or beside the row. If it is not known where the fertilizer band is located, then no soil cores should be obtained within 4 to 6 inches of corn rows if row fertilizer was used.

Soil samples for alfalfa, small grains and soybeans can be taken anytime in summer or fall as long as it is at least six weeks after the last fertilizer application. It is always best to sample after the final harvest for the year or before spring planting or regrowth begins. In a double-cropping system (small grains and soybeans), sampling before the small grain planting is sufficient for fertilizer recommendations to be made for both crops.

Soil Sampling Depth:

Crop	Depth of Sample
Alfalfa and pastures	4"
No-till corn or soybeans	4"
Conventional corn or soybeans	6-8"

Identifying Compacted Soil

Lloyd Murdock

Most compaction results from the use of machinery on soil which is too wet to work well, or from overworking soil and destroying its natural structure. Pressure from tires and tillage tools compress more soil into a given volume. In the process, the natural soil aggregates are broken down and large pores become smaller. This generally causes the soil to be more difficult for plant roots to penetrate.

A soil penetrometer, tiling rod or a three foot length of 3/8-inch diameter steel rod sharpened on one end and having a handle welded to the other end are easy tools to use in identifying compacted layers. Such tools should be marked in six inch increments and should uniformly be pushed into the soil when the moisture content is too wet for tillage. Under these conditions, compacted layers can be "felt" due to resistance in pushing the rod through the soil, and depth to and thickness of the compacted zone can be identified.

The best method for identifying soil compaction is with a soil penetrometer. This is similar to a tiling rod but has a gauge that measures the amount of pressure required to push the rod into the soil. An Annual Field Compaction Record Sheet is on page 53 and gives instructions on how to use the penetrometer and how to make a field recording.

Regardless of the method used, a number of sites in each field should be checked (similar to a soil test) and if severe compaction is found it needs to be confirmed. In addition to a compacted soil, the penetrometer will give high readings for a dry soil and heavy clay layer. Therefore, if severe compaction is found in a field then a soil probe or shovel needs to be used to look at the layer that was found compacted and confirm that high readings were not due to a clay or dry layer.

ANNUAL FIELD COMPACTION RECORD

University of Kentucky
Department of Agronomy

FARM ______________________ **FIELD** _______________ **ACRES**_________________

MAJOR SOIL TYPE _____________________________ **YEAR**_______________________

Site	Reading	Depth of Highest Reading
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Site	Reading	Depth of Highest Reading
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

SUMMARY

% of reading 200 or less _________

Most common depth of readings 300 or more _______

% of reading 300 or more _________

METHOD

Push penetrometer into the soil slowly (do not surge). Note the highest psi reading and the depth at which it occurs. Continue to push until the resistance drops and note the depth where this happens.

Always use the penetrometer when the soil is too wet for proper tillage and when it is not saturated with water.

Avoid or test separately field entrances and turn row areas that have excessive traffic and do not represent the field. Readings should be taken in a random manner over the rest of the field.

INTERPRETATION

With readings of 300 psi or above, the compaction is considered severe. If 1/3 of the readings are 300 or more, a corrective action and change in tillage practices should be considered. When 1/2 of the field readings are 300 or more, then changes definitely need to be made. If severe compaction is identified in only a portion of the field, then corrective action should only be considered in that portion.

EXAMPLE RECORD

Site	Reading	Depth of Highest Reading
1	175	6-12
2	200	9-15
3	300	9-15
4	175	6-12
5	300+	9-15
6	225	9-15
7	200	6-12
8	300+	6-15
9	150	3-18
10	250	9-15

SUMMARY

% of readings 200 or less _50_

% of readings 300 or more _30

Most common depth of readings 300 or more 9-15

Recognizing Nutrient Deficiencies in Corn

A nutrient deficiency symptom in a plant does not always indicate a shortage of fertilizer. Under unfavorable growing conditions, such as drought or cold or wet weather, plants may not be able to take up the nutrients.

A field history and a soil test provide the best information needed to determine if a deficiency exists and the fertilizer needs for your crop. Your local County Extension Office can provide you with the equipment and instructions needed to have your soil tested. The following are symptoms of nutrient deficiencies in corn:

Nitrogen (N)

Young plants deficient in Nitrogen are stunted, spindly and pale green to yellowish green. In more mature crops, the older leaves will become a pale yellow while the new leaves remain green. This is because nitrogen is transferred from old to new leaves. Because of this, the nitrogen deficiency symptoms will appear first and be the most severe in the older leaves. There will be a V - shaped yellowing of the leaves starting at the tips and moving down the center vein. The edges of the leaves may remain green. Deficiency symptoms will appear on the bottom leaves and appear to work its way up the plant.

Nitrogen (N) deficiency

Phosphorus (P)

Mild deficiencies of phosphorus cause reduced growth and few leaf symptoms. Young plants will appear stunted and dark green in color. The root systems of small plants are often not efficient in taking up phosphorus from the soil. Symptoms due to this will often disappear when the plants are 24 to 40 inches tall.

Phosphorus (P) deficiency

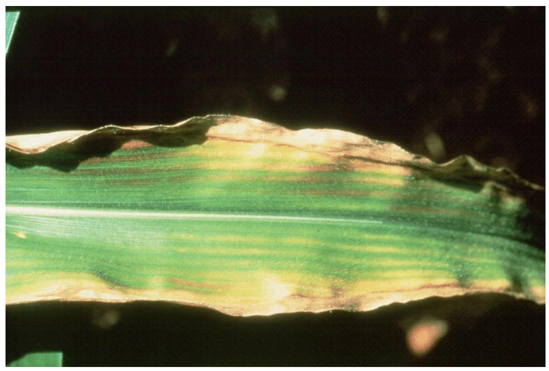
Phosphorus deficiencies often appear first and are most severe in the older leaves, working its way up the plant. In some varieties, purple or a purple-red color develop on the dark green older leaves. The color may be only on the outside margins of the leaf or the entire leaf may turn. Young leaves are usually not affected. The tips of old leaves may also turn yellow. The color will advance toward the base of the leaf either in a broad front or along the edges of the leaf. The yellow area then turns brown as the plant tissue dies.

Phosphorus deficient plants may produce only one ear with fewer and smaller kernels than normal.

Potassium (K)

A mild potassium deficiency will cause stunted growth and pale green foliage. With a severe deficiency, plants will become very stunted and have spindly stems. Potassium deficiencies, like most others, appear first and are more severe in older leaves. Symptoms begin with the tip of the older leaves turning a pale yellow. This quickly turns to pale brown and spreads along the edge of the leaf towards the base. The center vein of the leaf and the area around it will turn a pale green.

Potassium deficient plants may produce only one ear which will be pointed and underdeveloped at the tip. The kernel size will also be smaller than normal.



Potassium (K) deficiency

Zinc (Zn)

Symptoms of Zinc deficiency usually appear within two weeks after plants emerge. Young leaves will have light streaks that will turn to a broad white band starting from the edge of the leaf and extending to the center vein. The leaf edges, center vein area and tip will remain green. Zinc deficiency symptoms will develop first and be the most severe on new leaves. Cold, wet soil conditions can cause temporary Zinc deficiencies in young plants due to a small, slow growing root system that reduces the uptake of zinc. These symptoms usually disappear when the plant passes the sixth leaf stage.

Ear and tassel development are both effected by a zinc deficiency. Ears will be small with only a few grains and the tassel may be distorted and free of pollen if the deficiency is severe.

Zinc (Zn) deficiency

Genetic Stripe

White stripes in leaves and a scattering of some white leaves can be what is known as Genetic Stripe. This condition may occur on only a few scattered plants and may even appear on only one side of the plant. The cause is due purely to genetics and should not be confused with a disease or deficiency symptom

Genetic abnormalities on corn

Growth Stages of Corn

Jim Herbek

Growth Stage	Description
<u>Vegetative (V):</u>	(Begins with seedling emergence and ends with tasseling).
Emergence (VE)	Tip of the plant (coleoptile) is emerged from the soil surface. After emergence, vegetative corn growth stages are determined by leaf stages until tasseling occurs. Each leaf stage is defined according to the uppermost leaf that has a **<u>visible</u> leaf collar**. Starting at the bottom of the plant, count all leaves with a visible collar. The uppermost leaf counted with a visible collar is the leaf stage. The collar (discolored line) is between the leaf blade and leaf sheath. The back of the collar is the first part of the collar that will be visible.
1st leaf (V1)	Collar of 1st leaf visible. First leaf is usually oval-shaped. Subsequent leaves are longer and come to a sharper point.
2nd leaf (V2)	Collar of 2nd leaf visible.
nth-leaf	(n) number of leaves on plant with a visible collar. The (n) will fluctuate with hybrid and environment. Leaf development usually occurs at the rate of two fully emerged leaves per 7-10 days, but the time interval between leaf stages as well as total leaf numbers developed may vary between different hybrids/maturities, growing seasons, planting dates and locations. As plants develop, some of the lowest leaves are torn from the plant. If this occurs, leaf stage can be determined by examining internode length at the base of the stalk. To do this, corn plants must be dug and the lower stalk split lengthwise completely through the base. The first three internodes between the first four leaf nodes never elongate. The first elongated stalk internode (4th internode) is usually ½ inch in length. The first node above this internode is the fifth leaf node (5th leaf attached). Once this node has been determined, the remaining visible collars can be counted. The 5th internode (below the sixth leaf node elongates to about 1 inch and the 6th internode (below the 7th leaf node) elongates to about 2 inches.
Tasseling (VT)	The last branch of the tassel is completely visible. Silks not yet visible.

Growth Stage	Description
Reproductive (R):	(Begins with silking and ends with physiological maturity).
Silking (R1)	Silks are visible outside the ear husks on 50% of the plants. Occurs approximately 2-3 days after tasseling. Pollen is shedding.
Blister (R2)	Cob is full size. Kernels appear as white translucent grains. Endosperm and inner fluid of kernel is clear in color. Approximately 10-14 days after silking.
Milk (R3)	Inner fluid of kernel resembles a milk-like substance. Kernel displays yellow color on the outside (for yellow hybrids). Approximately 18-22 days after silking.
Dough (R4)	Endosperm has developed a heavy dough-like consistency. Approximately 24-28 days after silking. Just prior to R5, kernels begin to form dents or dry in tops of kernel.
Full Dent (R5)	All kernels are dented. Approximately 35-42 days after silking. The kernels are drying down, beginning at the top where a hard layer of starch is forming. This starch layer appears as a line across the kernel when viewed from the back side (opposite side of embryo). With maturity, the hard starch layer/line will advance toward the bottom of the kernel. The accumulated starch will be hard above the line and soft below the line as it advances.
Physiological Maturity (R6)	Kernel has reached maximum dry weight, but the grain will still have high moisture. The hard starch layer has advanced completely to the base of the kernel and a black or brown abscission layer has formed at the kernel base. This black layer formation occurs progressively from the tip ear kernels to the basal kernels of the ear. Determine by breaking an ear of corn in half, pulling off a kernel, and examining the tip for a black layer. Grain is approximately 30-35% moisture content, but this can vary between hybrids and environments.
Maturity	Grain is mature and drying. Seed moisture content of < 30%. "Maturity" at this stage is entirely a matter of moisture loss until harvest. Average moisture loss is 1/2% per day, but can range up to 1-2 % per day depending on weather and hybrid.

DETERMINING PLANT POPULATIONS IN CORN

Jim Herbek

Stand counts should be made from two to four weeks after emergence. Count the number of plants in 20 feet of row. The distance is measured by laying a 10 foot rope between the rows or using a measuring tape. Count the number of plants on both sides of the rope or tape (for a total of 20 linear feet of row for each count). Do this in five places in the field for each 50 acres or portion thereof, thus giving a **total of 100 linear feet of row** for each 50 acres or less.

Try to pick out representative rows for stand counts. If areas of the field are quite different in respect to stands, these areas should be counted and noted separately. The exact 20 feet of distance for each count (total of 100 linear feet for 5 counts) **is important** due to the nature of the population formula, which is based on 100 feet of row (see table below).

Examples of the number of population determinations needed for various field sizes are given below.

41 acre field = one population determination (100 feet of row)
69 acre field = two population determinations (100 feet of row each)
136 acre field = three population determinations (100 feet of row each)
218 acre field = five population determinations (100 feet of row each)

Row width: Measure the distance between rows in several locations to determine the row spacing. Or, check with the producer to find out what row width they used in planting.

Determination of populations per acre: Multiply the total number of plants counted in 100 feet of row by the "C" (conversion) factor for the appropriate row width (see table below).

Row Width	C Factor*
15”	348.48
19"	275.11
20"	261.36
24"	217.80
30"	174.24
36"	145.20
38"	137.56
40"	130.68

*To find the “C” (conversion) factor for other row spacings, divide 43,560 by the row spacing (in feet) and then divide that result by 100 (for 100 linear feet of row counted).

<u>Example</u>:

Stand Count for 100 feet = 150
Row Width = 30 inches
174.24 x 150 = 26,136 plants per acre

When more than 50 acres are involved in a field, determine the plant population for the whole field by averaging the plant populations that were obtained for each 50 acre portion.

If possible, also draw a map of the field indicating the location of each 50 acres or portion thereof counted and the average plant population obtained in each location.

Plant populations in corn can range from 16,000 to over 30,000 plants per acre, but will generally be in the range of 22,000 to 28,000 plants per acre.

ESTIMATING CORN YIELDS PRIOR TO HARVEST

Jim Herbek

Step 1. Determine ear population of good ears in 1/1000 acre. Do not include "nubbins" in the count. The length of a single row needed to equal 1/1000 acre for various row widths are shown below.

Row Length to Sample
(1/1000 acre)

Row width in inches*	Length of row
40	13'
38	13'9"
36	14'6"
30	17'5"
20	26'
15	34'10"

*To determine the length of row needed for other row spacings, divide 43,560 by the row spacing (in feet) and then divide that result by 1000.

One check of yield for each 20 acres in size is suggested. Crop uniformity greatly influences the accuracy. The less uniform the field, the greater the number of samples that should be taken to estimate yield for the field. Repeat the procedure throughout the field as many times as you deem to be representative. Obviously, the more samples you measure, the more accurate the estimate. This “estimate” method provides only “ballpark” grain yields and is probably only accurate within plus or minus 30 bushels of the actual yield.

Step 2. Determine ear size:
Randomly select and determine the ear size of three ears in each 1/1000 acre.

Ear size is determined by counting the number of kernel rows and the average number of kernels per row. Do not include the extreme butt or tip kernels in these counts.

Step 3. Calculate estimated yield for **each** of the three ears per check site using the formula: number of ears in the check site x number of kernel rows x average number of kernels per row x .01116. The result is the grain yield per acre at 15.5% grain moisture.

Step 4. Average the three determinations (3 ears) of estimated yield at each check site. The field estimate will be the average of all check sites. Draw a map of the field indicating the yield estimate for each check site

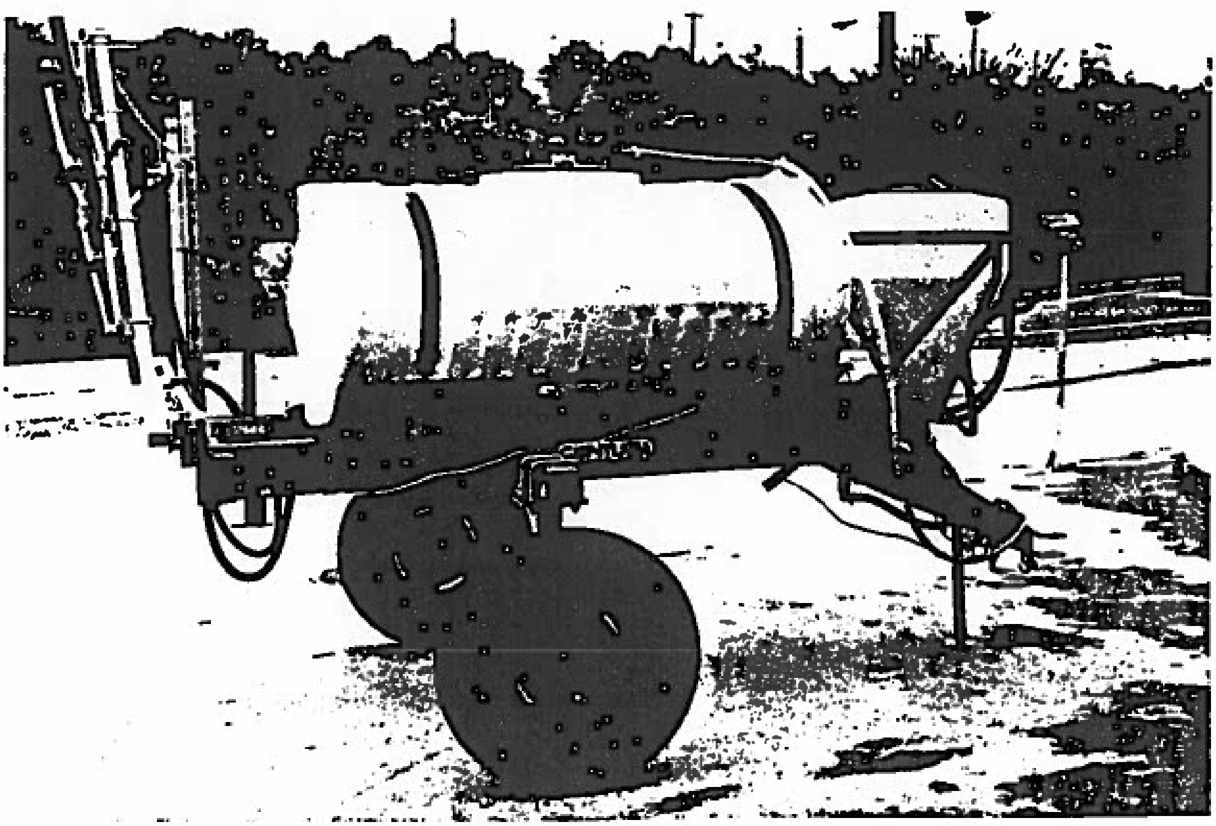
(Adapted from the Corn Yield Calculator, Developed by the Agriculture Engineering Dept., University of Illinois)

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXTENSION SERVICE

PB 1461

Tennessee In-Field Sprayer Mounted Rinse System (TISMRS)

**A Sprayer-Mounted Rinse System
To Eliminate Or Reduce Pesticide Waste And Disposal Problems**



Tennessee In-Field Sprayer Mounted Rinse System (TISMRS)

A Sprayer Mounted Rinse System To Eliminate Or Reduce Pesticide Waste And Disposal Problems

James B. Wills Jr., Associate Professor, and
Timothy N. Burcham, Assistant Professor
Agricultural Engineering

Introduction

For several years, farmers and agricultural producers have been trying to comply with EPA guidelines for proper and safe disposal of excess agricultural chemical spray materials and rinsate (rinse water) from pesticide application operations. Dumping or draining of unused concentrated agricultural chemicals which have been diluted with water or crop oils is illegal and can present a serious threat to groundwater supplies and the environment. Applications of chemicals in excess of label rates can saturate soil particles and interfere with the natural capacity of the soil to absorb and biodegrade them. Agricultural chemicals applied at or below label rates will be broken down rather quickly as part of the natural decomposition process. Soils saturated with pesticides can be particularly hazardous near water sources used for drinking water.

Complete application of diluted pesticides is both safe and legal when the materials are applied to crops according to label directions in the field. Producers with the capability of emptying and rinsing tanks in the field while spraying crops could greatly reduce legal and safety problems associated with rinsate and excess spray material disposal.

In-Field Sprayer Rinse System

A system that allows chemical applicators to rinse and spray unused spray dilutions in the field is available. This system permits legal and environmentally safe use of rinse water and excess spray dilutions (see **Note 1**). The chemical applicator can leave the field with reduced concentrate to dispose (see **Note 2**) of at the farmstead rinsepad. This reduces the chance of an accidental release of concentrate at the farmstead, which is normally close to drinking water sources. Sprayer components such as hoses, nozzles, regulators, tanks and pumps will have a longer life when cleaned after each use, as many agricultural chemicals are somewhat corrosive.

***Note 1:** The TISMRS does not replace conventional sprayer rinse pads. It is an additional component to a properly designed sprayer*

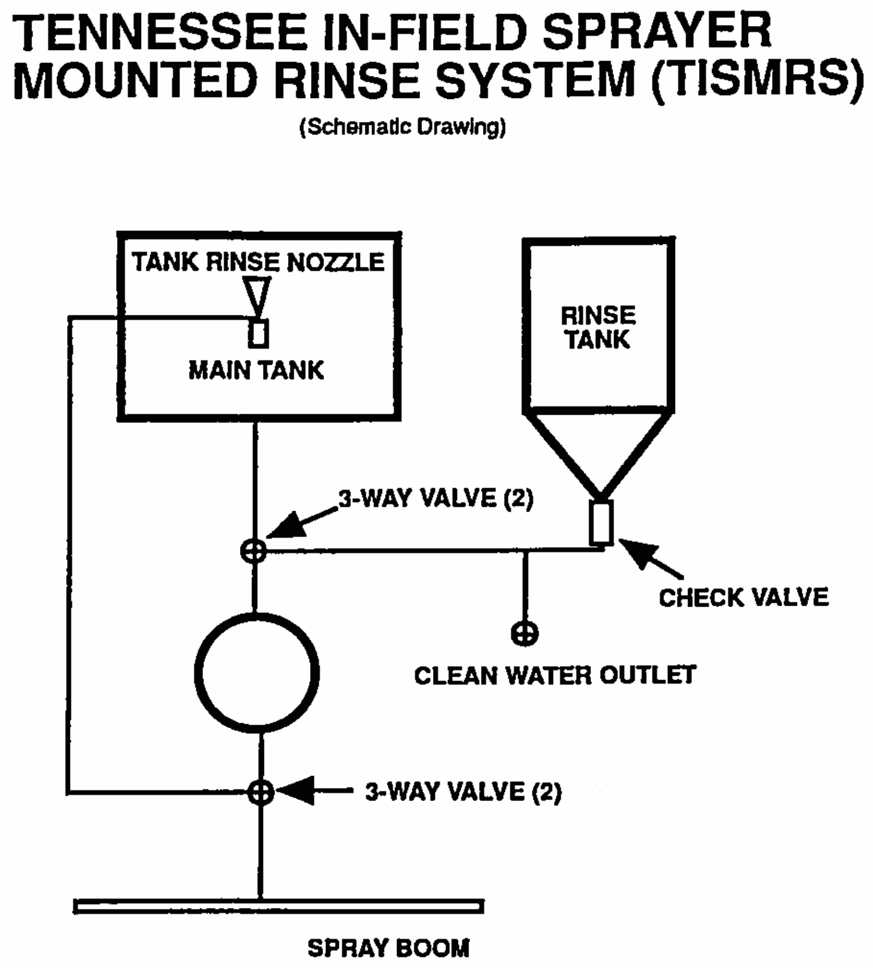


Illustration 1

clean-up and pesticide handling facility.

Note 2: *Due to the tank shape and design on some spray systems, a small amount of spray mixture may remain in the spray tank when the sprayer is termed "empty." In some cases, this mixture can be as much as 10-15 gallons, but is more commonly about one to two gallons. Even if this spray material cannot be completely removed during the normal spraying process, it will be significantly diluted during the rinse process, thereby presenting less potential contamination and corrosion problem for the spray applicator.*

The pressure system allows mounting of the clean water rinse tank at the most convenient location on the sprayer without regard to the level of the primary tank when self-priming type pumps are used. The sprayer pump is then used to pump water through a system of two control valves to a discharge hose for rinsing and flushing of the sprayer tank and components. A simple backflow prevention valve is used to prevent contamination of the clean water tank by chemicals within the sprayer system. A second discharge hose can be mounted between the water supply and the sprayer system as a clean water source for hand washing or emergency use.

System Costs

The rinse tank and most of the necessary components to construct the system can be purchased from local sources in most areas for approximately $200 or less. The tank rinse nozzle is available from Spraying Systems Company at a cost of about $180.

Suggested size for the clean water tank is 10 percent of the primary sprayer tank capacity or 15 gallons, whichever is larger. A minimum of 15 gallons is needed for adequate rinsing, even on smaller systems. Systems with tanks larger than 150 gallons should use a 35-gallon cone-shaped rinse tank. Both 15 and 35 gallon sizes are readily available.

Components Needed To Add Tennessee Sprayer-Mounted Rinse System To Existing Sprayers

1. **Funnel-bottom tank for clean water.**

DETAILS OF RINSE TANK CONNECTION TO EXISTING SPRAYER SYSTEM

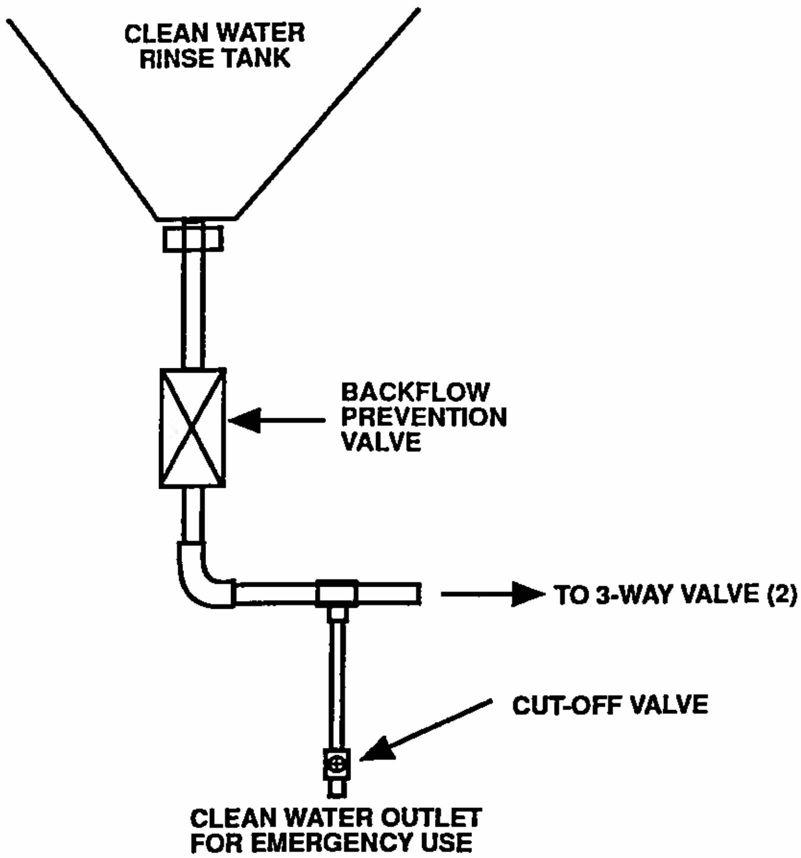


Illustration 2

Size - 15 gallon tank for sprayers with tanks up to 150-gallon capacity. Rinse tank should hold 10 percent as much as the main sprayer tank for tanks more than 150 gallons in size.

2. **Backflow prevention valve** (check valve) to prevent contaminated material from main tank from entering the clean water tank.

Note: A backflow prevention valve of 1-inch diameter or larger should be used to minimize the flow resistance to the suction side of the pump.

3. **Tank rinsing nozzle** to be mounted inside the main sprayer tank. Sprayers with more than one tank will need one nozzle for each tank that carries spray chemicals. At least two manufacturers make several tank rinsing nozzles for various sizes and configurations of sprayer tanks.

4. **Two three-way valves.** One valve is inserted into the suction line of the sprayer to control the source of material to the pump. Another valve is inserted into the pressure side of the line to control flow to either the tank rinsing nozzle or the spray boom for discharge.

5. **Necessary plumbing fittings** to connect tank, valves, nozzle and backflow prevention valve to existing plumbing on a sprayer.

Procedures For Installation Of The Tennessee In-Field Sprayer Mounted Rinse System (TISMRS)

1. Mount the clean water rinse tank to the sprayer in a convenient location for filling, but not so it will interfere with the operation of the sprayer or obstruct the operator's view.

   Mounting hardware will be determined by the size of the rinse tank, the shape of the tank, the layout of the sprayer on which it is to be mounted and the construction skill of the person mounting the tank. The tank holder may be permanently welded to the existing sprayer frame or it may be constructed so it can be removed by bolting to the sprayer frame. **Design**

and construction of this mounting hardware is left to the installer of the rinse system, since so many sprayer shapes and designs are involved. The rinse tank will be connected to the sprayer pump through pipes or hoses; therefore, the installer can be very flexible as to the location of the rinse tank with respect to other sprayer components. Materials strong enough to carry a full tank of water across rough terrain should be used to construct the frame for the rinse tank.

2. Refer to the schematic drawing for the TISMRS system (Illustration 1) for the approximate location of 3-way valve (1) (see illustration 3). Between the main sprayer tank and the suction side of the pump, install a 3-way valve at a location easily accessible to the operator for operation of the valve during rinse cycles. Most sprayers will have a "rubber" hose for the suction line which can easily be cut for installation of the 3-way valve. Three-way valves with female threads on each outlet will require a "hose barb" fitting which is threaded on one end to fit the female threaded ends of the valve (Illustration 4). The opposite end of the hose barb will accept the rubber hose and is secured with a hose clamp.

One connection to the three-way valve will be to the suction line to the outlet of the cone-shaped rinse tank. A backflow prevention valve is installed in this line (Illustration 2) to protect the clean water from back flows contamination from the main spray tank. A second connection to this 3-way valve is the suction line from the outlet of the main spray tank. The third connection is to the suction side of the sprayer pump.

Sprayers with "hard" suction lines such as galvanized steel or a similar material will require installation in a similar manner to the above instructions with some minor changes in hardware.

Three-way valves have two positions only. When the valve is properly installed in the suction line, the valve will direct fluid to the pump from the main tank in one position and from the rinse tank in the second position (See illustration 4).

3. The second 3-way valve (2) is installed on the pressure side of the pump, preferably near the main boom control valve which should be convenient for the operator to use (See illustration 1 or 5). Most sprayer control manifolds are made of rigid materials such as steel or hard plastic. Use of a 3-way valve with threaded female ends will usually minimize the time and

DETAILS OF 3-WAY VALVE INSTALLATION ON SUCTION LINE

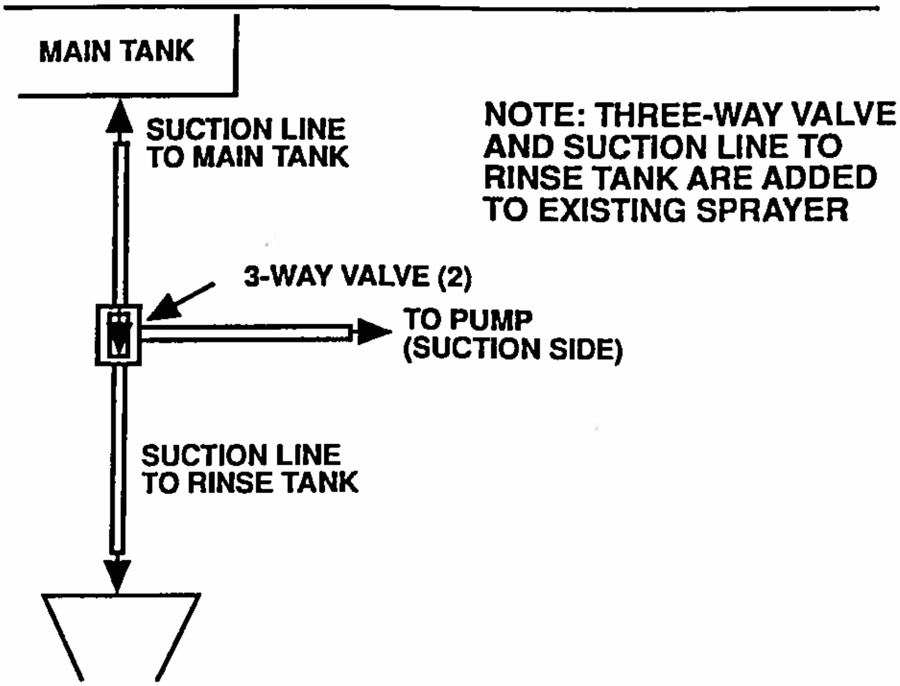
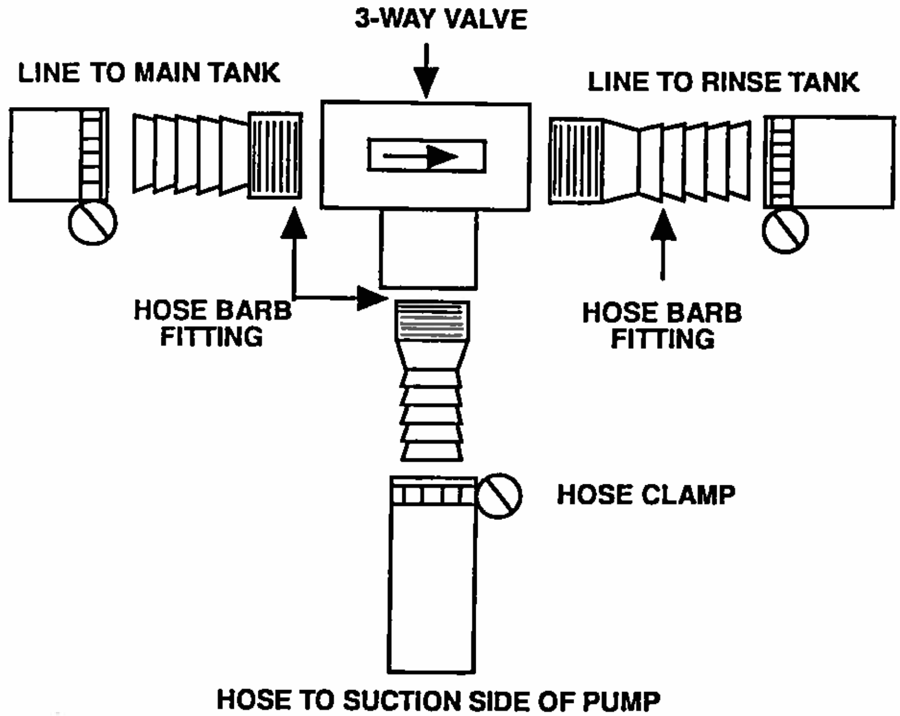


Illustration 3

DETAILS OF 3-WAY VALVE INSTALLATION ON SUCTION LINE



NOTE: ARROW ON 3-WAY VALVE POINTS IN DIRECTION FO FLOW

Illustration 4

hardware needed for installation.

4. The tank rinsing nozzle is mounted inside the tank (Illustration 6). This requires installation of a conduit through the tank wall at some point, preferably near the center of the tank. The nozzle is designed to be mounted in the center of the tank for most efficient operation. A "bulk head" fitting is normally used to connect devices through a tank wall. Holes in polyethylene or plastic tanks can be made using a hole saw of the proper size or a sabre saw. Metal tanks will usually require a metal hole-saw with a metal cutting blade to cut out for the bulk head fitting. Locate the bulkhead fitting slightly above the center level of the tank such that the tank rinse nozzle will be in the center of the tank when properly mounted. The line from the rinse nozzle goes to one side of 3-way valve (2) (Illustration 5). The line to the main spray boom is mounted to the opposite end of the same 3-way valve (see illustration 5). The third connection to 3-way valve (2) is the pressure line from the pump.

5. A clean wash water line can be installed for emergency use in the field. A "T" fitting is installed on the suction line from the rinse tank. A short length of hose or rigid pipe can be installed in the third side of the "T" with a ball valve or gate valve. This water source will be gravity flow only and should be mounted below the bottom elevation of the rinse tank for adequate flow.

Procedures For Using The Tennessee In-Field Sprayer Mounted System

The main tank on the sprayer should be empty or nearly empty before a rinse cycle is initiated. Only clean water should be used in the rinse tank. To accomplish a triple rinse as recommended by disposal experts, follow the simple procedures listed below to properly rinse a sprayer tank.

1. Turn the 3-way valve (1) to direct flow to the tank rinse nozzle.

DETAILS OF 3-WAY VALVE INSTALLATION ON PRESSURE SIDE OF PUMP

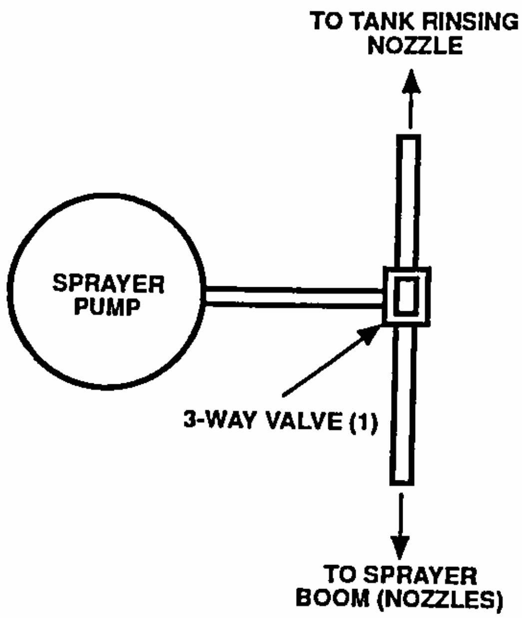


Illustration 5

VIEW OF TANK RINSING NOZZLE IN MAIN TANK

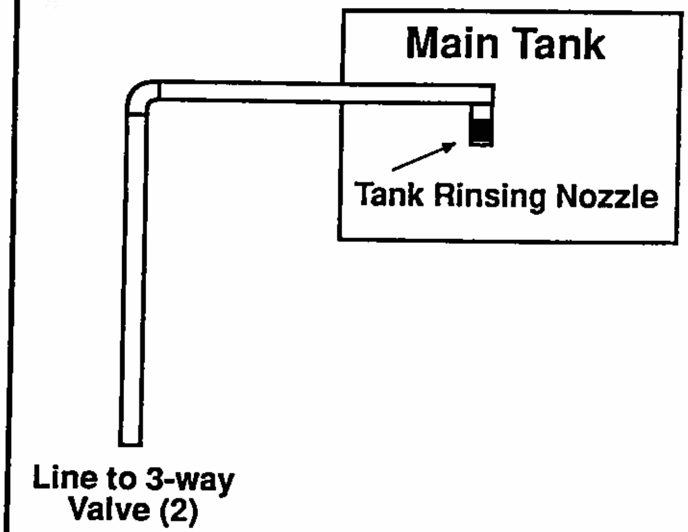


Illustration 6

2. Turn the 3-way valve (2) to direct flow from the clean water rinse tank.

3. Start the sprayer and allow one-third of the water in the rinse tank to be pumped through the tank rinse nozzle to the main tank.
4. Turn the 3-way valve (2) back to the main tank flow.

5. Allow the water in the main tank to circulate for at least one minute.

6. Turn the 3-way valve (1) to direct flow back to the boom. Apply rinsate with the sprayer moving in the desired rinsate disposal area until the main spray tank is empty.

7. Repeat steps 1 thru 7 to accomplish three separate rinse cycles.

Note: *For stubborn chemicals that are difficult to rinse from tanks, you can increase the length of the rinse cycle in step 5 to allow extra rinse time during each cycle. Research is in progress in the Agricultural Engineering Department at The University of Tennessee to evaluate effective rinse times. As data become available, the above instructions will be updated accordingly.*

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