The Soybean Growers Field Guide For Evaluating Crop Damage And Replant Options

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INTRODUCTION

Establishing and maintaining an optimum plant stand is important for profitable crop yields. Crop injury occurs to soybeans somewhere in the state every year, with hail as the major cause. Hail annually causes crop losses valued at $60 million to soybeans in Minnesota. There currently is about $33 million spent annually on crop insurance premiums to hedge against losses due to hail. Losses vary by year, but annually average about $18 million paid to growers to compensate them for their losses.

Hail is not the only soybean crop destroyer. Crop injury may also be the result of insect feeding, flooding, low air temperature, soil crusting, or nutrient deficiencies. Inadequate stands may be due to poor germination or inadequate emergence. A cold seedbed or excess moisture slow soybean emergence and promote seed rots and seedling diseases, and chemical injury (fertilizers, insecticides, or herbicides) can also contribute to poor emergence. Crop injuries of many types occur due to hail, and early season hail injury may require a decision of whether to replant the crop. Extreme injury to agricultural crops, which is often the case with hail, can be an emotional event, and replant decisions should be made based on facts derived from research findings rather than from a grower's understandable "gut feelings" of disappointment and disgust.

Consequently, we developed this field guide to help you, the soybean growers, become more familiar with the stages of growth of the soybean plant, the function of plant structures, the plants' ability to regrow and recover following defoliation, and the yield losses that are associated with delayed planting and reduced plant population. This *Field Guide* will help you make good decisions regarding replanting based on the results of extensive university research on plant populations, planting dates, and plant damage. A comparison worksheet is included to help you calculate the expected differences in yield between a replanted field and a damaged field. Maturities of varieties recommended for late planting are also given.

PLANT GROWTH AND DEVELOPMENT

Growth stages are defined as vegetative (V) or reproductive (R). The vegetative stage begins when the seedling emerges (May) and continues until flowering (July) which begins the reproductive stages. During the vegetative stages, leaves develop and grow, the root system develops, nodules form to fix nitrogen, the main stem and branches grow, and reproductive structures begin to form. Vegetative stages normally develop to the V4 stage before flowering and the reproductive stages begin. Reproductive stages begin with R1 at beginning flowering and end at R8 with mature beans in early September.

Plant stages are determined by classifying leaf, flower, pod, and/or seed development. Staging requires identifying the nodes, which is the part of the main stem where the cotyledons and leaves are, or were, attached. A seedling soybean plant is shown with parts identified in S-1. A leaf is considered fully developed when the leaf at the node directly above it (the next younger leaf) has expanded enough so that the two lateral edges of each of the leaflets have partially unrolled such that they are no longer touching (S-2). The stages of growth are defined in Table 1. and some stages are shown in pictures S-3 to S-8.

Table 1. Growth stages of the soybean plant

Stages	Description
VE	Emergence – Cotyledons above the soil surface.
VC	Cotyledon – Unifoliolate leaves are unrolled sufficiently that the leaf edges are not touching.
V1	First node – Fully developed leaves at the unifoliolate node.
V (n)	nth node – The n represents the number of nodes on the main stem with fully developed leaves beginning with the unifoliolate leaves.
R1	Beginning bloom – One open flower at any node on the main stem.
R2	Full bloom - Open flower at one of the two uppermost nodes on the main stem with a fully developed leaf.
R3	Beginning pod – Pod 3/16” long at one of the four uppermost nodes on the main stem with a fully developed leaf.
R4	Full pod – Pod 3/4” long at one of the four uppermost nodes on the main stem with a fully developed leaf.
R5	Beginning seed – Seed 1/8” long at one of the four uppermost nodes on the main stem with a fully developed leaf.
R6	Full seed – Pod containing a green seed that fills the pod cavity at one of the four uppermost nodes on the main stem with a fully developed leaf.
R7	Beginning maturity – One normal pod on the main stem that has reached its mature pod color.
R8	Full maturity – Ninety-five percent of the pods have reached their mature pod color. Five to ten days of drying weather are required after R8 for the soybean moisture to be reduced to the desired less than 15 percent.

SOYBEAN PLANT PARTS AND THEIR FUNCTIONS

Cotyledons Food stored in the cotyledons provides energy for the young plant until it has developed enough leaves to manufacture its own food (S-1).

Leaves A primary function of leaf tissue is to intercept light (solar energy) and convert it into food (chemical energy). This food is used by the young plant to develop roots,

stems, and more leaves. The growth rate depends partially on the amount of leaf area of the plant.

Growing Point The terminal growing point at the top of the plant is a group of rapidly dividing cells where new leaves are forming. The growing point is part of the "shoot apex" shown in soybean picture S-1. Other similar groups of cells are located in each leaf axil and may be sites for re-growth when the uppermost growing point is damaged or removed from the plant.

Leaf Axil The leaf axil is the point where the leaf's petiole (its stem) is attached to the main stem or a branch.

Axillary Buds These buds are located inside the leaf axils (S-1) and are also growing points, but are semi-dormant as long as the growing point at the top of the plant is alive. When the top of the main stem is cut-off, any one of these axillary buds may grow and ultimately look like a main stem. On normally growing plants, branches may grow from these axillary buds when soybean stands are sparse. Flowers and pods may also form from these buds.

REGROWTH PATTERN OF DAMAGED SOYBEAN PLANTS

Typical Regrowth Pattern A soybean plant will usually regrow when the main stem has been cut off . The cut-off may have been due to insect feeding, hail, sand blasting, or other causes. One or more axillary buds may develop after a main stem has been cut. Usually one becomes dominant because it develops to a greater degree than other "branches." Later, it can easily be mistaken for the original main stem unless the lower plant section is carefully inspected to locate the cut-off point (S-9).

Plants cut off below the cotyledons **will not** recover (see remnants of dead plants on the right in picture S-9). In any plant stand evaluation, count these plants as dead. While some hail damaged plants that look like they should recover do eventually die, most regrow from either one or both of the axillary buds located at the node below where they were cut off.

Main Stem Cut Above The Cotyledons Plants cut above the cotyledonary node will re-grow if there is sufficient cotyledon tissue to provide the plant with energy to regrow. Plants in picture S-10 are cut above the cotyledons. The plant on the left does not have sufficient cotyledon tissue left to sustain the plant; count these plants as dead. The plant on the right has all of one and part of the other cotyledon; it should regrow. The rate of regrowth is influenced by the amount of cotyledonary tissue remaining.

Main Stem Cut Above The Unifoliolate Node Plants cut off above the unifoliolate node (S-11) can regrow from any of the four axillary buds located in axils at the cotyledonary node, and the unifoliolate leaf node, but are most likely to regrow from one or both of the upper buds at the unifoliolate node.

Green leaf tissue is the key to generating regrowth. Even though the unifoliolate leaves may be shredded and torn, the remaining green tissue is still able to generate regrowth. This regrowth should be visible within three to four days if growing conditions are favorable.

In addition to shredding and cutting stems, hail may bruise plant stems (S-12). Bruises usually occur on the lower portion of the stem. The intensity of bruising ranges from a mild bruise, which is a simple break in the outer stem tissue, to a severe bruise, which exposes the central stem tissue. Bruises on mature soybean plants are shown in picture S-13; the bruising occurred during the early vegetative stages.

Plants with bruised stems that recover after a hailstorm may break at any time before harvest. Such broken-over (lodged) plants usually produce pods and seed. Since they are lying on the ground, however, harvesting them may not be possible. Yield is not affected on bruised plants that do not break over. The challenge is to accurately determine which plants will break over at a later time, and which plants sustained only slight bruising. Unfortunately, this is nearly impossible to determine shortly after hail damage.

WHETHER TO REPLANT

One of the most stressful and important decisions a farmer has to make is whether to replant when plant stands are reduced because of some kind of injury to the crop. The seven factors for evaluating whether to replant are 1) the existing plant stand, 2) distribution of the plant stand, 3) calendar date, 4) weed situation, 5) seed availability, 6) cost to replant, and 7) yield potential of the existing crop.

Plant Population When stands are reduced by hail early in the growing season, plants compensate for skips within the row by producing additional branches. If all of these branches are harvested, the seed yield of soybeans is reduced only slightly, even if more than half of the plants are missing. Branches are shown in S-7 with pods and seeds formed. Theses contribute to yield and should be harvestable during normal combining with the header close to the ground. As plant density within the row decreases (fewer plants/foot), distribution of the remaining plants within the row becomes important in producing yields comparable to those from fields with higher densities.

Table 1. shows the effects of plant population on soybean yield. This relationship is valid for all soybean row spacings. For example, when stands are reduced to 50 percent of optimum population, yields are reduced only 10 percent (assuming weeds do not compete with remaining plants). Replanting just to re-establish a full stand is not usually economically justified when weeds are not a problem.

Table 1. Effect of population reduction on yield

Plants per acre	Percent of optimum stand	Percent of optimum yield produced
157,000	100	100
118,000	75	98
78,000	50	90
39,000	25	75

Determine the number of live plants in your field. Do not try to visually estimate the remaining stand. This will lead you to underestimate the live plant population.

The length of row equivalent to one-thousandth of an acre for various row spacings is given in Table 2. Measure the distance for 1/1000th of an acre for your row spacing and count the number of live plants in that row section. Do not count plants that are badly bruised, or those you do not think will recover. Then multiply that count by 1000 to determine the number of healthy plants per acre. Several checks should be made throughout the field. Ideally, scout the entire field to identify areas of the field that do not need replanting. Finally, determine the expected yield reduction from the reduced stand by using Table 2.

Table 2. Length of row to equal 1/1000th of an acre for various row widths

Row spacing (inches)	Row Length
40	13 feet 1 inch
36	13 feet 6 inches
30	17 feet 5 inches
22	23 feet 9 inches
15	34 feet 10 inches

The Drum Hoop Method is an easy way to make a stand count for very narrow rows and for solid-seeded soybeans (seeded with a drill or an air seeder). Use the ring that holds the lid on a 55-gallon drum to determine the plant population. Throw or roll the hoop on the ground at random and, when it falls, count the number of live plants inside the circle. Do this at several locations and average the plant counts inside the hoop. Determine the plant population using Table 3.

A 55-gallon drum ring has a diameter of 22 3/4". Other throw rings can be made from just about anything that can be formed into a lightweight ring. The hard-type anhydrous hose makes and ideal ring due to its rigidity. A 22 3/4" ring can be made from a 71 1/2" length of tubing or hose by connecting the ends with a hose connector.

Hula-hoops make ideal throw rings. Most have a diameter of 32" which can be duplicated by joining the ends of a 101" length of hose. Stand counts from 32" diameter rings are also given in Table 3.

Table 3. Plant populations for various plant counts within a circle with a diameter of 22 3/4 inches and 32 inches

Number of plants in circle	Plants per acre (X 1000)	
	22 3/4" circle	32" circle
3	46	
4	62	
5	77	
6	93	47
7	108	55
8	123	62
9	139	70
10	154	78
11	170	86
12	190	94
14		109
16		125
18		140
20		156
22		171
24		187
26		203

If you have a suitable ring that has a diameter other than that given above, you may simply use the following formula to calculate your plant stand. Again, simply throw or roll the hoop at random, count the live plants, average these counts over several circles throughout the area that you are measuring, and use the formula below to determine your plant stand.

$$\frac{\text{\# of plants within the ring X 7990}}{\text{ring diameter (in.) X ring diameter (in.)}} = \text{\# of plants per acre (X 1000)}$$

LEAF LOSS AND SOYBEAN YIELD

Leaves removed from the soybean plant during the vegetative stages (up to V4) will **not** have an effect on seed yield. Evaluate plants for bruises and stand, and do not consider leaves removed or damaged. Leaves removed during the R stages (grain filling) **will** reduce yield, however. The amount of the reduction depends upon the amout of leaf area destroyed and the growth stage when leaves are removed. Since the R stages occur at later calendar dates when replanting would not normally be considered, leaf loss is not a consideration in the replanting decision.

PLANTING DATE AND SOYBEAN YIELD

Since early-May plantings usually result in maximum yields, lower yields should be expected for later plantings. Table 4. lists expected yield reductions for various later plantings. Another consideration for later planting is the later maturity of replanted fields.

Table 4. Soybean yield losses and yield potential due to planting after May 1

Planting Date	Yield loss (%)	Yield Potential (%)
May 1	0	100
May 5	1	99
May 10	2	98
May 15	3	97
May 20	6	94
May 25	9	91
May 30	13	87
June 4	18	82
June 9	24	76
June 14	30	70
June 19	36	64
June 24	43	57

WEED STATUS

The weed status of the field is an important consideration in determining whether to replant, even when enough healthy plants with good distribution remain after a hailstorm. The rate at which soybeans recover will influence their competitive ability with weeds and their sensitivity to various weed control practices. In relatively weed-free fields, soybeans that are not too severely injured will probably recover and grow fast enough so that combinations of cultivation, and applications of post-emergence herbicides, will effectively control weeds, and prevent or minimize competition from weeds. Weeds 1 to 3 inches in height can be controlled with cultivation if the crop is tall enough to prevent it from being buried by soil. Cultivating 1 to 2 inches deep will control most weeds, and a

shallow cultivation will usually control annual weeds with little crop stress or soil moisture loss.

In late spring, when soybeans might be replanted, the major weeds likely to exist are foxtails, crabgrass, quackgrass, black nightshade, and waterhemp. These weeds are shown in photos S-27 through S-38. Assess the weed situation -- what weeds are there in the field? What is the size of the weeds? Can they be controlled, and at what extra cost? The weed status may be such that replanting into severe competition from weeds is not a good choice. Growing weeds would have a major competitive advantage over the reseeded crop. Therefore, if one needs to replant and there are weeds, the weeds need to be tilled before replanting.

OTHER CONSIDERATIONS

Replant costs Replant costs including seed, labor, and fuel currently represent approximately 15% of the original crop potential. Replant costs are **extra**, so reduce the yield potential by 15% to pay the replant costs. Although these vary greatly from farm to farm and year to year, be sure to include other real costs into the costs of replanting. These include interest on loans taken to replant, and opportunity costs due to time spent replanting that could have been used for other profitable (or profit-saving) activities.

Seed availability and maturity choice Is good-yielding, earlier-variety seed available? When replanting soybeans, resist the temptation of switching to an earlier variety too soon. Soybeans have an amazing capacity to catch up when planted late. Warm June weather hastens vegetative growth, while short days and cool nights in September push soybeans to mature. Planting the same variety two to three weeks later in the spring will result in only a few days to a week in delayed maturity.

Unless you were already flirting with frost by planting your original stand to a very long season variety, you need not (and should not) move to an earlier variety until you are into the second week of June. At this point, plant a soybean variety with a relative maturity rating of 0.5 units shorter than your original soybeans. For instance, if you live in Central Minnesota and originally planted a RM 1.7 variety, by about June 10 switch to an early group I soybean (such as a RM 1.2). Late June replants may need to be switched to a variety that is one (whole) maturity unit shorter than you would normally plant. Some examples of maturities of public varieties are shown in Table 5.

Tandem planting Sometimes the decision to replant is not difficult. Example: The population is very low (less than 50,000 plants per acre), and the weed control is excellent. Under these conditions, you can plant alongside the original row to increase the stand and yield (S-15). The later planted rows will mature a few days later, but that should not be a problem for harvesting and handling the crop. You should wait until the later planted soybeans are combine-ready to havest.

Table 5. Examples of relative maturities (RM) of several public varieties grown in Minnesota

Variety	RM	Variety	RM
Daksoy	00.6	Parker	1.5
McCall	00.7	Freeborn	1.6
Jim	00.7	Bert	1.8
Glacier	00.8	Granite	1.8
Agassiz	0.0	Archer	1.9
Traill	0.0	Faribault	1.9
Lambert	0.8	Hardin 91	2.0
Hendricks	0.9	Sturdy	2.0
Kato	1.3	IA2021	2.1
		IA2008R	2.2

Although early summer temperatures do allow for soybeans to grow rapidly, they will still tend to be shorter at flowering time, because flowering date is due almost entirely to the day-length (therefore, day, of the year). For this reason, it is important to replant soybeans at a slightly higher population, and in narrow rows or solid-seeded, if possible. This will allow the most efficient use of the early season sun and its energy.

MAKING THE REPLANT DECISION

By using the information on plant population and late planting, you can compare the estimated losses from the hailstorm with the yield potential and costs associated with replanting the crop. For the existing crop, consider the weed situation. What is the population of weeds? The species? Can they be controlled if the crop is left? If not, what effect will they have on regrowth and yield potential of the existing crop? And at what extra cost?

The following worksheet will help you to decide whether it will pay to replant. The alternative which has the higher yield potential should be the more profitable option. You will also need to consider the availability of seed, and replant costs for seed, labor, and fuel. Fill in the following worksheet and compare the yield potential of the existing crop with that of a replanted crop.

Replant costs may be partially or completely compensated for if you have crop hail insurance that carries a replant clause. If you have insurance, notify your agent about your loss and ask about replant cost-sharing.

SOYBEAN COMPARISON WORKSHEET

FIELD NOT REPLANTED:
Estimated loss due to:

Reduced stand	_____%
Weed Condition	Good, Fair, or Poor
SUM OF LOSSES	_____%

REMAINING CROP POTENTIAL OF EXISTING STAND _____%

FIELD REPLANTED:
Estimated loss due to:

Late Planting	_____%
Replanting	15%
SUM OF LOSSES	_____%

CROP POTENTIAL OF A REPLANTED CROP _____%

SUMMARY

The soybean was domesticated in China prior to 1100 BC. It probably developed from *Glycine soja*, a wild species still commonly found as a weed in the Far East. Like corn, the soybean is completely domesticated; i.e. it is never found in the wild.
The soybean was first brought to the North American Colonies in 1765 by a seaman named Samuel Bowen. It did not become a crop of importance in the U.S. until the cultivar Mammoth was introduced in the 1880's for forage production. Soybean became an important forage crop, first in the South, then in the Midwest. It was grown alone as a hay crop or intercropped with corn for silage production. The soybean remained primarily a forage crop until the late 1930's when World War II acreage (890,000 acres) was harvested for seed. Today the soybean is the leading source of edible vegetable oils and high protein feed supplements for livestock worldwide, and the leading agricultural commodity export (economic basis) in the United States.

Soybeans are grown on about 6.5 million acres annually in Minnesota. Average yields have been about 38 bushels per acre; the state average record yield of 42 bushels per acre was produced in 1998 on nearly 7 million acres. The value of the annual crop is about $1.3 billion which makes it the number two cash crop (behind corn) for Minnesota farmers.

We believe that your farming experience, the amazing regenerative capabilities of the soybean, and use of the research findings reported in this *Field Guide,* will ensure your growing profitability and success.

SOYBEAN COMPARISON WORKSHEET

FIELD NOT REPLANTED:
Estimated loss due to:

Reduced stand	_____%
Weed Condition	Good, Fair, or Poor
SUM OF LOSSES	_____%

REMAINING CROP POTENTIAL OF EXISTING STAND _____%

FIELD REPLANTED:
Estimated loss due to:

Late Planting	_____%
Replanting	15%
SUM OF LOSSES	_____%

CROP POTENTIAL OF A REPLANTED CROP _____%

SOYBEAN COMPARISON WORKSHEET

FIELD NOT REPLANTED:
Estimated loss due to:

Reduced stand	_____%
Weed Condition	Good, Fair, or Poor
SUM OF LOSSES	_____%

REMAINING CROP POTENTIAL OF EXISTING STAND _____%

FIELD REPLANTED:
Estimated loss due to:

Late Planting	_____%
Replanting	15%
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CROP POTENTIAL OF A REPLANTED CROP _____%