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Early Frost Effects on Soybean

At what development stage, if any, are soybeans "safe" from damage by frost? Should beans be harvested green after a very early frost? How are the yield, protein and oil concentration, moisture content, and germination of the harvested seed affected?

Frost-damage experiment

A Wisconsin study designed to answer these questions, examined the effect of killing frosts at growth stages (GS) ranging from R4 to R8. See Table 1 for a description of these stages. The tested varieties ranging from early to late for Wisconsin, were 'Evans' (Gp. 0, 85 RM), 'Hodgson' (Gp. 1, 100 RM), 'Wells' (Gp.2, 110 RM), and 'Beeson' (Gp. 2, 115 RM).

Table 1. Description of podfilling stages

Growth Stage	Abbreviated stage title	Description
R4	Full pod	Pod 2 cm (3/4 inch) long at one of the four uppermost nodes on the main stem with a fully developed leaf.
R5	Beginning seed	Seed 3 mm (1/8 inch) long in a pod 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	50% of leaves yellow. Pods yellowing and one normal pod on the main stem 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 before soybeans have less than 15 percent moisture

The results were:

Yield and Yield Components

Yield was reduced in all varieties tested when frost was imposed at or before R6. (table 2). Earlier maturing varieties sustained significant yield losses from freezings at more advanced growth stages than later maturing varieties. Earlier freezings resulted in greater yield reductions, with maximum reductions occurring near G5 R5. Decreases in both the number of seeds per plant and seed size contributed to the overall yield reduction.

Maturity and Moisture

Maturity was hastened by some freezing treatment and was not delayed by any of the treatments. It is significant that beans on frost-damaged plants will mature and change color at least as

early and perhaps earlier than undamaged soybeans, however the frosted, dead leaves will remain on the plant. Moisture percentage of the harvested seed was unaffected by the freezing treatments.

Protein and Oil

Freezing did not significantly alter protein concentration of mature seeds, but oil concentration were affected at some stages. Significant reductions in oil resulted from freezing near and prior to R6 (Table 2).

Germination

There was no reduction in the germination percentages of seeds harvested from plants frosted at or after R6 when compared to a control in this study. However, other Wisconsin studies have found that soybean seed from plants that were filled prematurely by frost had low seedling emergence scores and the seed was extremely susceptible to fungal attack.

Summary

Soybean yields will not be hurt by frosts occurring after R7. A frost sometime between R6 and R7 may or may not affect yield, depending on the variety. The period beyond R7 is a “safety zone” and the period before R7 is a “possible risk zone” fro damage to yield from frost. These guidelines should be kept in mind when making decisions on variety selection, planting date, and double cropping.

In the event of a leaf-killing frost occurring when pods are still green or yellow, growers should wait until pods are the mature color before harvesting. If the frost occurred after R6, it is unlikely that oil and protein content of the harvested seed will be reduced. The most serious effect of any early frost on soybean may be in the potential reduction in the quality for seed purposes.

Table 2. Growth stage thresholds beyond which no significant reduction occurs for the variables shown when an 80% leaf-killing frost occurs.

	Variety			
Variable	Evans (85 RM)	Hodgson (100 RM)	Wells (110 RM)	Beeson (115 RM)
Yield	R7.2	R6.8	R6.4	R6.0
Seed number	R5.8	R5.6	R5.7	R5.6
Seed size	R6.0	R6.6	R6.8	R6.0
Maturity	R6.3	R7.5	R7.1	R7.2
Oil	R6.3	R5.8	R6.2	R5.8