

## TRANSVERSE AND CRESCENT CRACKS IN SOYBEAN COTYLEDONS ASSOCIATED WITH IMBIBITION

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**ABSTRACT.** — Transverse and crescent cracks in cotyledons and cotyledon fracture were induced in soybean seeds by placing them in water (room temperature) prior to planting. These injuries resulted in reduced rates of seedling growth or non-emergence, depending on location and severity of the cotyledon damage. The cracks also were induced by allowing seeds to swell for 12 hours on wet filter paper at 10 degree intervals from 10 to 60°C. The highest percentage of cotyledon cracking (100%) was observed at the lowest temperature and the lowest percentage (19%) at the highest temperature. These cotyledon cracks were apparently caused by uneven swelling during imbibition.

In a study of cell death in pith tissue of soybean (*Glycine max* L.) seedlings, Liu (1966) often observed transverse and crescent cracks in the upper surface of cotyledons of young seedlings in all 24 varieties studied. By anticipating a small percentage of damaged seedlings in each experiment and overplanting to permit selection of uniform seedlings having no obvious cotyledon damage, Liu was able to complete the study of parenchyma cell death in pith tissue of normal seedlings. This type of cell death also occurred in seedlings with injured cotyledons. For future studies of the cell death process in soybeans, more uniform stands are desired. Thus, an explanation of the cotyledon injury was required.

We thought that cotyledon injury could be due to injuries to the seed during harvesting (Bainer and

Borthwick, 1934). More recent studies suggested that soybean cotyledons could be injured by preharvest moisture conditions and during storage (Metzer, 1967; Tachibana, *et al.*, 1968). Earlier literature indicated that cracked cotyledons could result due to rough harvesting and cleaning treatments (Humphrey, 1958; Moore, 1957). Cracks in cotyledons reduced field stands due to weakened plants even when the seeds were treated with fungicides and planted under favorable field conditions. Internal injuries in those reports included bruised and fractured seed leaves, roots, and plumules with complete or partial fractures noted in many plant parts or at the point of attachment of one part or another. Other studies also had shown that transverse cotyledon cracks reduced germination, seedling growth and yield (Atkins, 1958; Waters and Atkins, 1959).

In an attempt to reduce seedling growth rate differences, we soaked seeds and removed seed coats after various stages of imbibition in shallow water and observed further growth stages after planting in sand and peat mixtures. Transverse cotyledon cracks were observed more frequently after soaking. When cotyledons from swollen seeds were examined before planting, it was obvious that the cracks had occurred during imbibition and not after

planting. Individual cotyledons on wet filter paper (either with lower or upper epidermis in contact with the water) developed crescent cracks, beginning in the boundaries of the wet and dry tissue. Complete fractures often occurred.

We did find literature to suggest that seeds of beans, peas, and corn were damaged due to differences in seed coat permeability, rate of water imbibition, and uneven swelling (McCullum, 1953; Shull and Shull, 1932). Resuhr (1941) described injury to soybean seeds due to 24 hours of soaking, the injuries being spotting and split cotyledons. The purpose of this paper is to present selected data from a number of similar studies designed to test the hypothesis that the transverse and crescent cracks (partial or complete fractures) occur in soybean seeds during imbibition.

#### MATERIALS AND METHODS

In each of six replicates, 30 seeds of variety Wayne and Shelby were selected for uniform size and absence of visible damage. Each 30-seed sample was divided into two groups of 15 seeds, one group being placed in a 9 cm Petri dish containing a 9 cm filter paper and 15 ml of water (room temperature) for 30 minutes of soaking. The seeds of both groups were planted at a depth of 5 cm in unsterilized sand and peat (equal volume, 6" diameter plastic pots) watered to saturation. Seedlings grew at room temperature for 14 days.

One four-replicate study of the effect of temperature was conducted using seeds of Wayne. Sixty seeds, four Petri dishes with filter paper, and 100 ml of tap water were placed in incubators at 10, 20, 30, 40, 50, and 60°C. When the water reached

the desired temperature, 15 seeds and 10 ml of water were placed in each Petri dish and the swollen seed examined 12 hours later.

#### RESULTS AND DISCUSSION

Typical results from one replicate are presented for the study of water soaking effects on planted seeds. Five days after planting, all of the 15 untreated seeds of Shelby and 14 of Wayne had emerged. The last seedling of Wayne emerged on the seventh day. Of these, one cotyledon of Shelby and four of Wayne showed some small transverse cracks. On the eleventh day after planting, seedlings were uniform in height in both varieties.

Of the seed soaked in water before planting, seven seeds of Shelby and seven of Wayne had emerged five days after planting. Five additional seedlings of Shelby and four of Wayne emerged on the seventh day. On the ninth day, another seedling of Wayne emerged. None of the other seeds germinated in either variety. Of the 12 seedlings of Wayne, 22 cotyledons were counted, 14 with one or more cracks. Two seedlings had one cotyledon as a result of complete fracture near the point of attachment to the hypocotyl. Only three seedlings had both cotyledons without cracks. Of the 12 seedlings of Shelby, 24 cotyledons were counted, all with one or more cracks. On the eleventh day after planting, seedlings of both varieties were irregular in height. The non-emerged seeds of both varieties had severe cracks or complete fractures near the plumule.

Each experiment with our seeds of these varieties resulted in more cotyledons of Shelby with cracks than those of Wayne. We would prefer more trials with several sources of

seed before suggesting that this is due to varietal differences to cotyledon cracking. We conclude that uneven swelling caused a small percentage of seedling damage in our previous experiments. Whether these cracks predispose the seedlings to pathogens or alters the cell death pattern in pith tissue remains to be studied.

The amount of damage to seeds of Wayne (average of four replicates) during 12 hours of soaking in water at various temperatures was as follows: 10°C, 100% of the seeds with one or both cotyledons cracked; 20°C, 92%; 30°C, 93%; 40°C, 80%; 50°C, 55%; and 60°C, 19%. These observations are in agreement with those of McCollum (1953) for snap beans germinating in water or soil; as temperature increases (from 10 to 30°C), cracking decreases, especially in soil conditions. We believe, as did Shull and Shull (1932) and McCollum (1953) for their seeds, that cracks in soybeans occur simultaneously with water uptake as a result of uneven swelling producing a tension crack in the dry interior portion or along the boundary between wet and dry tissue. It may be that the rate of penetration of water into the seed tissue at higher temperatures creates moisture gradients less conducive to cracking. Orphanos and Heydecker (1968) reported that oxygen deficiency in the interior of soaked snap beans resulted in injury and killing. Although we did not see ungerminated seeds without severe cracks or complete fractures in cotyledons, it may be that similar oxygen deficiencies exist in soybeans also under prolonged soaking. Further study on this problem is required to discover

the extent of seed damage due to soaking in wet fields and the relationship of this type of seed damage to vigor, disease resistance, and yield.

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