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RECOVERY AND NUTRIENT CONTENT OF SANDBLASTED SOYBEAN SEEDLINGS[1]

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ABSTRACT

Soybean [*Glycine max* (L.) Merr.] seedlings were exposed to a 13.4-m/sec wind velocity and wind plus sand (<1.17 mm diameter) for 0, 5, 10, and 15 min at 6 g/cm width/min to study the effect of wind and sandblast injury on their growth and nutrient content. Soybeans can tolerate a soil loss of 6 g/cm width for 5 min without a significant (5% level) reduction in vegetative yield. Exposures to wind or wind plus sand increased the nitrate-nitrogen concentration 443 ppm for the 5-min wind treatment to 1,390 ppm for the 15-min wind plus sand treatment. Iron concentration was increased only where vegetative production was unaffected, i.e., 5-min wind, 5-min wind plus sand, and 10-min wind. Other nutrient concentrations were unaffected by the treatments. Sandblast injury can change a plant's metabolic processes before there is any visual damage.

Additional key words: **Nitrate-nitrogen, Nitrogen metabolism, Iron uptake.**

WIND erosion is increasing on the sandy soils of Iowa (4) and Ohio (8), reportedly because of tillage practices associated with a soybean [*Glycine max* (L.) Merr.] culture and because of larger soybean acreages.

Studies dealing with abrasive injury to cotton (*Gossypium hirsutum* L.) seedlings (2), tomato (*Lycopersicon* sp.) seedlings (3), grass and alfalfa (*Medicago sativa* L.) seedlings (7), green bean (*Phaseolus* sp.) seedlings (9), and established wheat (*Triticum aestivum* L.) stands (11) have provided some information on soil-abrasive injury to plants. In one of the few on nutrient contents of plants exposed to abrasive injury, foliar-applied urea uptake was increased after sandblasting by wheat seedlings (1). Wind alone is known to increase the relative contents of P and K (10).

Finding no previous work on the effects of abrasive injury on soybean growth and nutrient uptake, I attempted to determine these effects.

MATERIALS AND METHODS

Soybeans (*Glycine max* L. Merr. var. "Wayne") were started from seed in 18-cm-diameter pots in the greenhouse in 4 kg of masonry sand, screened to remove particles larger than 3.35 mm. Pots were watered daily with dilute Hoagland solution. Nutrient treatments were complete, −N, −P, −K, −NP, −NK, −PK, and −NPK.

One week after emergence, plants were thinned to three per pot. At 4 weeks the potted plants were exposed in the wind tunnel to a 13.4-m/sec windspeed and to wind plus sand (< 1.17 mm in diameter) at 6 g/cm width/min for 0, 5, 10, and 15 min. After exposure, all pots were watered with the complete nutrient solutions. All treatments were replicated three times.

Three weeks after exposure, plants were measured for height, tops (aboveground parts) were harvested, and roots were washed. Tops and roots were dried at 70 C for 48 hours and weighed. The tops were ground (< 20 mesh) and analyzed for total N by the Kjeldahl method as described by Jackson (6) and for nitrate by the alphanaphthylamine method described by Hanway et al. (5). One-half gram of plant material was wet-ashed with nitric acid, perchloric acid, and water (v/v 1:1:1). Phosphorus was determined by the vanadate-molybdate-yellow method of Jackson (6); K, by flame spectrophotometry; and Zn, Fe, Cu, Mn, Ca, and Mg, by atomic absorption spectrophotometry.

RESULTS AND DISCUSSION

The trends for exposures and exposure times were the same for all nutrient treatments; therefore, only the results from the complete treatment are reported.

Soybean seedlings tolerated 6 g/cm width/min for 5 min of soil loss without a significant decrease in dry-matter production. Wind plus sand was more damaging than wind alone, but wind alone for 15 min reduced dry-matter production (Table 1) but did not affect plant height or root weights. Visual signs of damage were apparent only at the 10- and 15-min exposures to wind plus sand.

Even though the dry-matter production was not significantly reduced by 5 or 10 min of wind or 5 min of wind plus sand, the concentration of Fe and nitrate was increased (Table 1). These were the only nutrients significantly affected.

The nitrate increase without a change in total N indicated a possible decrease in the activity of nitrate reductase, the enzyme system involved in nitrate reduction. No explanation can be given for increases in Fe concentrations where dry weight is unaffected.

Table 1. Effect of wind and sandblast injury on dry weight and concentrations of Fe, P, and nitrate-nitrogen of soybean seedlings 21 days after exposure.

Treatment	Dry weight	Iron	Phosphorus	Nitrate-nitrogen
	g	ppm	ppm	ppm
Check	11.33 a*	127 b	9,000 ab	1,040 c
Wind, 5 minutes	11.33 a	195 a	10,000 a	1,483 b
Wind + sand, 5 minutes	11.00 a	174 a	7,800 b	1,830 ab
Wind, 10 minutes	11.33 a	187 a	9,230 ab	1,870 ab
Wind + sand, 10 minutes	9.67 b	155 b	8,030 b	1,970 ab
Wind, 15 minutes	10.00 b	148 b	8,030 b	2,270 a
Wind + sand, 15 minutes	8.33 c	128 b	7,800 b	2,430 a

* Means followed by the same letter are not statistically different at the 5% probability level by Duncan's multiple range test.

Research is needed to establish whether the N-reductase system is disrupted and what happens to nitrate and Fe concentrations when soybean plants are exposed to wind and wind plus sand for longer than 15 min.

Data given here indicate that sandblasting can change a plant's metabolic processes before there is any visual damage.

SUMMARY

Soybean seedlings can tolerate a soil loss of 6 g/cm width for 5 min without a significant reduction in vegetative yield. Exposures to wind and wind plus sand for as little as 5 min can affect the N metabolism of the soybean plant.

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