Detection and Control of Sandblast Injury to Jojoba (Simmondsia chinensis [Link] Schneider) Seedlings

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Abstract

Injury to Jojoba seedlings and cuttings caused by windblown sand in the area of Ford Dry Lake, County of Riverside, California, is described. After wind erosion was reduced by a cover crop, some Jojoba seedlings were able to grow back despite having dead leaves and stems, or having their roots exposed up to 3 cm below the cotyledons. Barley was found to be successful in reducing sand movement in the field.

Introduction

Sandblast injury to crops has been recognized as a serious problem in many areas with sandy soils and strong winds. Although differences in crop tolerance to blowing soil have been reported (Woodruff et al., 1972), it seems that most of the traditional crops can be severely injured by sandblast. Soil eroded by wind can damage or destroy Wheat, *Triticum aestivum* L. (Woodruff, 1956); Beans, *Phaseolus vulgaris* L. (Skidmore, 1966); Cotton, *Gossypium hirsutum* L. (Armbrust, 1968; Fryrear, 1971); seedlings of several species of grass (Lyles and Woodruff, 1960; Fryrear et al., 1973); and several species of vegetable crops (Fryrear and Downes, 1975a; Woodruff et al., 1972).

Windblown soil can damage leaves and stems. According to Lyles and Woodruff (1960), the abrasive action of sand whitens leaves or produces a burning effect. Sandstorms can severely reduce plant stands when they occur soon after seedling emergence. Studies on sandstorm effects have centered on the seedling survival rate of several crops and on the effects of sandblast on the remaining plants (Fryrear and Downes, 1975a, 1975b; Downes et al., 1977).

Jojoba (*Simmondsia chinensis* [Link] Schneider) is a wild plant native to the Sonoran Desert of California and Arizona, U.S.A., and Sonora and Baja California, Mexico. This perennial shrub has attracted worldwide attention because of the liquid wax present in its seeds (Yermanos, 1974). There is considerable effort on the part of private companies to domesticate Jojoba. Most of the fields are being planted in desertic areas of California, Arizona, and Mexico. Gusty winds are quite frequent in the Sonoran Desert. We might expect that Jojoba, in its natural habitat, would be tolerant to the sand carried by the wind. Possibly, Jojoba seedlings are more tolerant to sandblast than other crops, but we have found that Jojoba seedlings can be severely damaged by windblown sand. This paper describes sandblast injury in Jojoba seedlings grown under cultivation in the California sector of the Sonoran Desert and outlines the method to reduce the blowing sand that causes this injury.

Farm Location and Wind Records

On September 15, 1982, the first 28 ha of a total of about 200 ha of Jojoba (*Simmondsia chinensis*) were direct-seeded in the area of Ford Dry Lake, County of Riverside, California. The seed was gathered from the wild. The farm soil belongs to the Carrizo-Rositas association, 0-9% slope, classified as Entisols by the Soil Conservation Service. Carrizo is sandy-skeletal, mixed hyperthermic, Typic Torriorthents. Rositas is mixed, hyperthermic, Typic Torripsamments (S. Quesenberry, Soil Conservation Service, Blythe, CA, United States Department of Agriculture). Particle size separation of three sites in the farm indicated that two sites had 3-6% gravel, 91-95% sand, 2-3% silt, and no clay. The third site had 36% gravel, 62% sand, 2% silt, and no clay (Table 1).

In November, 1982, a Sierra Misco 1036 (1825 Eastshore Highway, Berkeley, CA 94710) recording wind system was installed to provide a permanent record for wind speed and direction at 2.5 m above the ground. The instruments indicated that the prevailing winds came chiefly from the south, southwest, west, and northwest. The most frequent wind speed oscillated between 2.4 and 9.5 m/sec. However, there were days when the highest wind speed ranged between 9.5 and 11.9 m/sec. On November 26, 1982, winds with gusts up to 14.3 m/sec lasted for 8 h. Similar wind speeds were recorded during December. On January 27, 1983, winds of up to 19.1 m/sec were detected. During February, 1983, gusts up to 26.2 m/sec were measured.

Detection of Sandblast Damage

Three weeks after Jojoba seeds were sown, several spots in the field had newly emerged seedlings with necrotic leaves and stems. The dead tissue remained green, indicating a sudden death, like the one observed when there is an interruption of the water supply. However, the hypocotyl at or near the soil line and root system looked healthy. Plant samples were studied for the presence of pathogens. None was found.

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Table 1. Particle sizes from the first 20 cm of the soil at three sites.

Name of Separate	Diameter mm (range)	Site 1	Site 2	Site 3
		%	%	%
Gravel	2.0-1.0	3	6	36
Coarse sand	1.0-0.5	29	11	20
Medium sand	0.5-0.25	37	36	19
Fine sand	0.25-0.10	14	21	10
Very fine sand	0.10-0.05	15	23	13
Silt	0.05-0.002	2	3	2
Clay	<0.002	0	0	0

After injured Jojoba seedlings were detected and sandblast was suspected, a large number of seedlings showing several degrees of damage were protected with cardboard tubes open at both ends (5 x 5 x 15 cm plant bands; Monarch Mfg. Co., 13154 Road 140, Salida, CO 81201). The tubes were put over seedlings showing dead leaves and stems, or slightly damaged leaves and stems, or emerging seedlings that did not show damage. Moreover, 100 cuttings 25 cm tall were transplanted with the cardboard pots used to root them to see whether their older tissue could tolerate the abrasion of the windblown sand better than the younger tissue of seedlings.

A few weeks after seedlings were protected with cardboad tubes, they developed new healthy-looking leaves and stems. Those seedlings that had their first stem destroyed by sandblast were able to grow new shoots from the cotyledon axillary buds. Slightly damaged seedlings had sound new leaves, and emerging seedlings did not show any damage.

Shortly after the 25-cm tall cuttings were transplanted into the field, they showed a silvery damage on their leaves reminiscent of that caused by thrip. Later, the injured area took on a light brown coloration. This silvery damage had variable patterns. Sometimes the whole leaf showed damage; at other times only part of the leaf showed it. The latter happened when one leaf was close to another so that part of its surface was covered. The protected area did not present any damage but the rest of the leaf did. The stem showed a darkening of its brown color. After a few weeks, the leaves died.

In summary, the younger leaf and stem tissue of seedlings shriveled, turned dark green, and died when damaged by sandblast. Older leaf tissue of seedlings and cuttings whitened before dying. Older stem tissue of both seedlings and cuttings turned brown when damaged by the sand.

Fryrear and Downes (1975a) determined that wind with a speed of 10 m/sec can carry enough sand to destroy a crop of peppers after 20 minutes of exposure time. Furthermore, Fryrear and Downes (1975b) stated that sand blowing for 6 hours will destroy most crops. During the time that the jojoba plants were growing, winds up to 11.9 m/sec were quite frequent. In November 1982, winds up to 14.3 m/sec lasted for about 8 hours. This indicates that Jojoba seedlings and cuttings were exposed to severe sandstorms.

Wind erosion became evident in the area where the cardboard tubes and the transplanted cuttings were located. The wind added sand to the cardboard tubes. It also removed the sand surrounding them. By the end of December, 1982, about 5 cm of the top soil had been blown away. Seedlings and cuttings appeared dead. The seedlings had their main roots exposed about 3 cm below the cotyledons. Cuttings showed about 5 cm of the cardboard pots in which they were rooted.

Control of Wind Erosion

The most important factor in controlling wind erosion is the presence of a cover crop (Siddoway and Barnett, 1977). Thus, at the beginning of November, 1982, Barley (*Hordeum vulgare* L.) was planted between the rows of Jojoba to provide a vegetative cover to the field. The cereal was sown in rows 17.5 cm apart at a rate of 100 kg per ha. Barley was chosen because we consider it a crop that would grow fast even when high levels of salt and boron are present in the irrigation water, as is the case with water available on the farm. Also, a cover crop, if taller than the main crop, can be used to shelter a short crop from the wind (Radke and Hagstrom, 1977). Soybeans (*Glycine max* [L.] Merril), wind-sheltered with Maize (*Zea mays* L.), have been reported (Radke and Hagstrom, 1977) to show increased height, dry matter production, and leaf area index.

The Barley planted between the rows of Jojoba was able to grow enough to reduce the sand movement despite the severe damage inflicted on the Barley plants by the blowing sand. Later, in March 1983, several Jojoba seedlings that looked dead and had their roots exposed, and a few cuttings that also looked dead, developed new shoots. This demonstrates that Jojoba seedlings have a large capacity to survive under the harsh environment of the desert.

Conclusions

Despite their older tissue, Jojoba cuttings were not found to resist sandblast better than seedlings. Jojoba seedlings and cuttings can be destroyed by windblown sand. However, there seems to be variability within Jojoba populations for recovery after severe injury caused by sandblast. New land developed in the desert for cultivating Jojoba should be protected by a cover crop such as Barley to reduce wind erosion and to assure a proper environment for establishment of Jojoba plantations. Now that Jojoba growers are more frequently planting cuttings instead of seeds, it is advisable for them to establish a Barley crop before the cuttings are transplanted. Also, Jojoba growers should plant trees or other tall, fast-growing plants to provide a more permanent wind barrier.

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