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Effect of Tillage and Herbicide Treatments on Redvine (Brunnichia ovata) Subterranean Morphology

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Abstract

Redvine *Brunnichia ovata* (Walt.) Shinners is a perennial weed that reproduces from seed, rootstock, and rhizomes. Redvine infested areas that were exposed to different tillage practices, slicing techniques, and herbicide treatments were selected to excavate in order to observe rhizome and root morphology. When comparing tillage systems, deep tillage appeared to delay rhizome development following cultivation, but a characteristic branching occurred over time. Shallow cultivation (2.5 to 7.5 cm) concentrated rhizomes immediately below the depth of tillage; whereas, no-till areas concentrated rhizomes near the soil surface. Slicing the underground parts of redvine will not kill rhizomes if they are still attached to a live portion of the taproot. The same holds true for freezing and drying. Dicamba and glyphosate reduced the density of redvine rhizomes, but neither provided control of the entire underground plant structure. Nomenclature: dicamba, 3,6-dichloro-2-methoxybenzoic acid; glyphosate, *N*- (phosphonomethyl)glycine; redvine, (*Brunnichia ovata (*Walt.) Shinners*)* # BRVCI. Additional index words: Differential infestation, sensor applicator, dicamba, glyphosate, *Glycine max*.

Introduction

Redvine is a perennial weed that is native from south Illinois, Missouri to South Carolina, Florida, and Texas (DeFelice,1998). Redvine grows in wetlands or nonwetlands (Reed, 1988). It reproduces from seed, rootstock, and rhizomes, and its above ground stems are deciduous and will regenerate yearly if undisturbed. This is not the case in production fields where the aerial portions are annually killed back to the soil surface. The establishment from seed is an erratic process and requires that conditions be favorable for the germination and establishment processes for an extended time period. Seed are not normally produced on the current year's growth; therefore, they are not produced in the growers' fields. The rootstock can be extensive and reach several feet into the soil. These deep rootstocks must be killed in order to effectively control redvine.

Redvine has been a problem in some agronomic fields for many years, but the increased acceptance of reduced tillage systems has allowed redvine and other perennial weeds to become more problematic (Elmore, 1984). Some studies have shown deep tillage can reduce groundcover levels of redvine (Elkins et al., 1996; Castillo et al., 1999). Conversely, shallow tillage operations can result in the spread of redvine and other perennial weeds and increase groundcover levels (Soteres and Murray, 1982; Castillo et al., 1998).

In an effort to better understand the morphological characteristics of rhizome and root systems, observations were made of subterranean redvine plant parts that had been exposed to different tillage practices, and experiments were conducted to determine the regeneration capacity of redvine and the effects of deep tillage and herbicide application on subterranean plant parts.

Materials and Methods

Redvine infested areas that were exposed to different tillage practices, slicing techniques, and herbicide treatments were selected to excavate in order to observe the rhizome and root morphology. Observations were made regarding rhizome and root location and regeneration. Although various soil series were located in the vicinity, all observations were confined to a Sharkey series (very-fine, smectitic, thermic, Chromic Epiaquerts).

Experiment 1.--Over years, observations were made of several fields where redvine was actively growing. No-till and conventionally tilled areas were selected. Notes and measurements were taken on redvine below ground morphology. These were utilized to construct stylized drawings illustrating the primary differences in growth habit.

Experiment 2.--Dicamba, 2.2 kg ai/ha, was applied to an established redvine population in the fall of 1997 at the Northeast Research and Extension Center (Lat. 35° 40' 27", Long. 90° 04' 24" W) at Keiser, AR. The experiment contained paired plots with two replications. Each treated and untreated plot contained thirty individual redvine clusters. A garden stake and red flag were placed at each cluster to mark the location for future evaluation. Visual

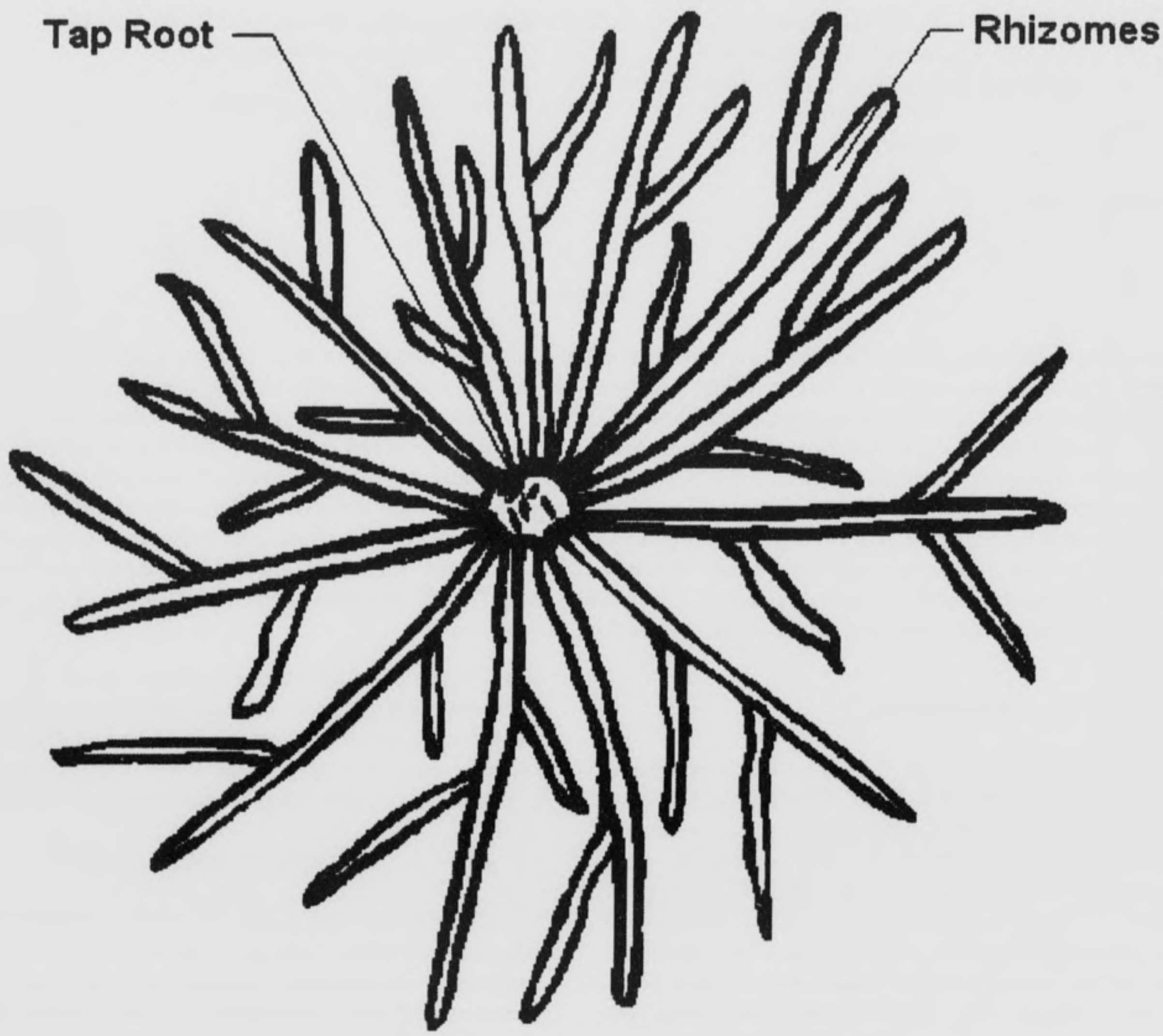

Fig. 1. Top view of redvine root severed within 2.5 to 5 cm of the soil surface. The rhizomes arise from adventitious buds near the top of the root.

control ratings were taken in the spring of 1998 and late summer of 1999. The plots remained undisturbed until August, 1999 when selected plots were excavated to observe redvine rhizomes and roots. A backhoe was used to create a flat, vertical surface near redvine plants, and small hand implements were used to remove soil from rhizomes and roots.

Experiment 3.--In February, 1998, redvine plants in the same area as Experiment 2 were sliced below the soil surface at depths of 7.5,15, 23 and 30.5 cm. A metal bar 50.8 cm wide and 0.6 cm thick was beveled on one side and mounted on a tractor. The bar was pulled at the four slicing depths through areas where redvine plants were present. The experimental design was completely randomized with four replications. In August, 1999, observations were made as in Experiment 2.

Experiment 4.--Selected plots were excavated in October, 1999 from an experiment (Lat. 35° 39' 54' N, Long. 90° 10' 49" W) that included no-till, conventional, and moldboard plow treatments. The tillage treatments were also sprayed with dicamba at 2.2 kg ai/ha in the fall and glyphosate at 0.84 kg ai/ha applied at the V2 and repeated at the V6 stage of soybean [*Glycine max (L.) Merr.*] growth. Plots were excavated using a backhoe. Underground plant

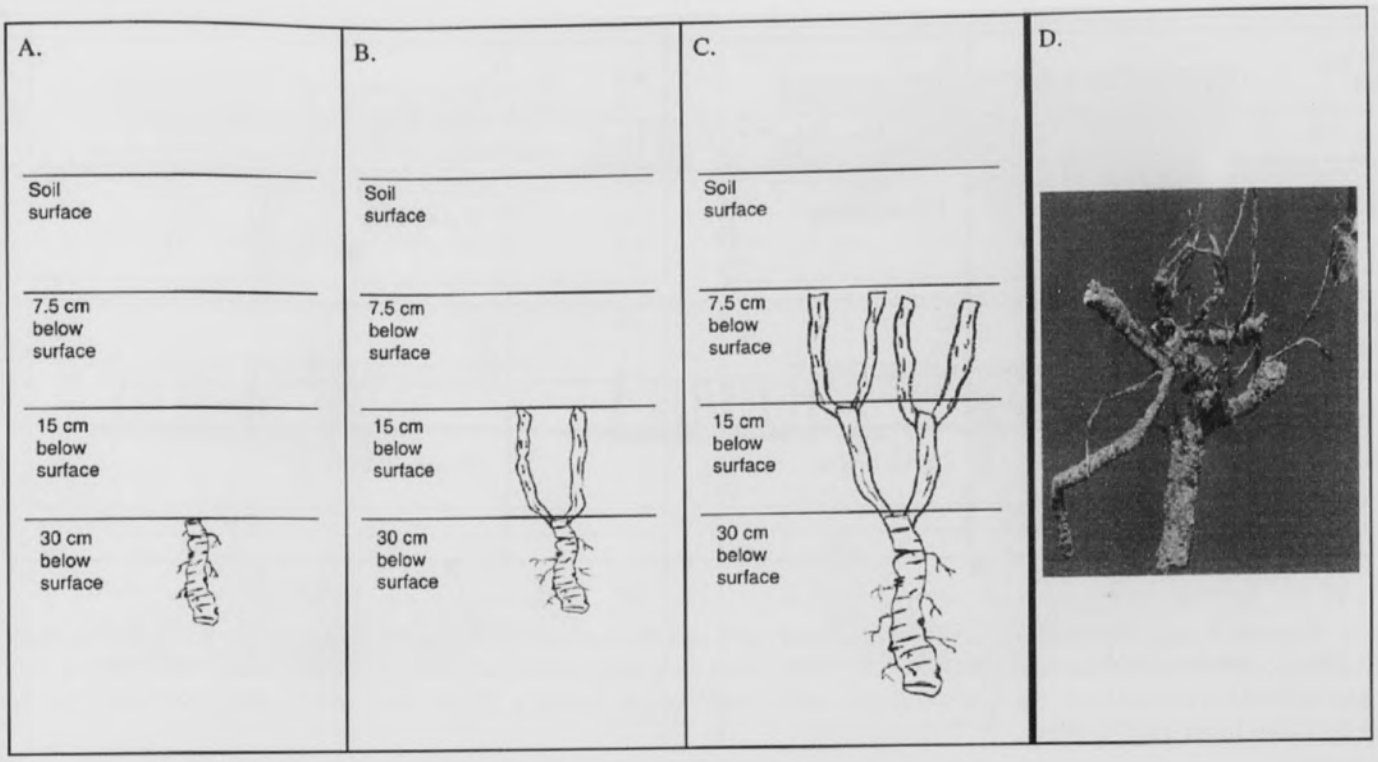

Fig. 2

Fig. 2. Regeneration of subterranean redvine growth after the plant is (A) severed at 30 cm, (B) subsequently years later, severed at 15 cm and (C) subsequently years later severed at a shallower depth of 7.5 cm. This figure illustrates the development of structures such as the one shown in D.

parts from a 15 cm depth by 76 cm wide by 58 cm long volume were collected. This process was repeated until only deep tap roots were occurring.

Experiment 5.--Two redvine infested fields (Lat. 35° 39' 55" N, Long. 90° 10' 57æW) had shallow fall tillage performed in October and November, 1999. Observations were made the next spring on the survival of underground plant parts that had at least 5 cm of underground stem exposed all winter. Stems which had newly developed leaves in the spring were considered alive. Various exposed rhizomes were pulled to determine if they were severed from the extensive underground plant parts.

Experiment 6.--A 16 ha field (Lat. 35° 43' 04" N, 90° 06' 36" W) with an extensive infestation of redvine was chosen for further evaluation of herbicide applications in the fall of 1998. Aerial photographs were taken in infra-red after the soybean leaves had dropped to provide a benchmark for the degree of redvine infestation. Glyphosate at 4.5 kg ai/ha was then applied by airplane. After soybean harvest, the producer planted wheat followed by a planting of soybean. The soybeans were planted in 48 cm rows which would allow a high clearance sprayer to be driven through the field prior to harvest after the soybean leaves had dropped. The experiment required the attachment of a Detectspray™ sensor applicator[1] to the sprayer. The sensor applicator activates each nozzle as it passes over the green redvine foliage. This prevents areas void of redvine from being sprayed and reduces the per acre cost for an entire field. Subsequent infra-red photographs can be taken and analyzed using computer programs that can determine the reduction in ground cover compared to the benchmark infestation.

Results and Discussion

Experiment 1.--Redvine plants were observed to have an array of rhizomes emerging in many directions from adventitious buds located on the upper portion of the

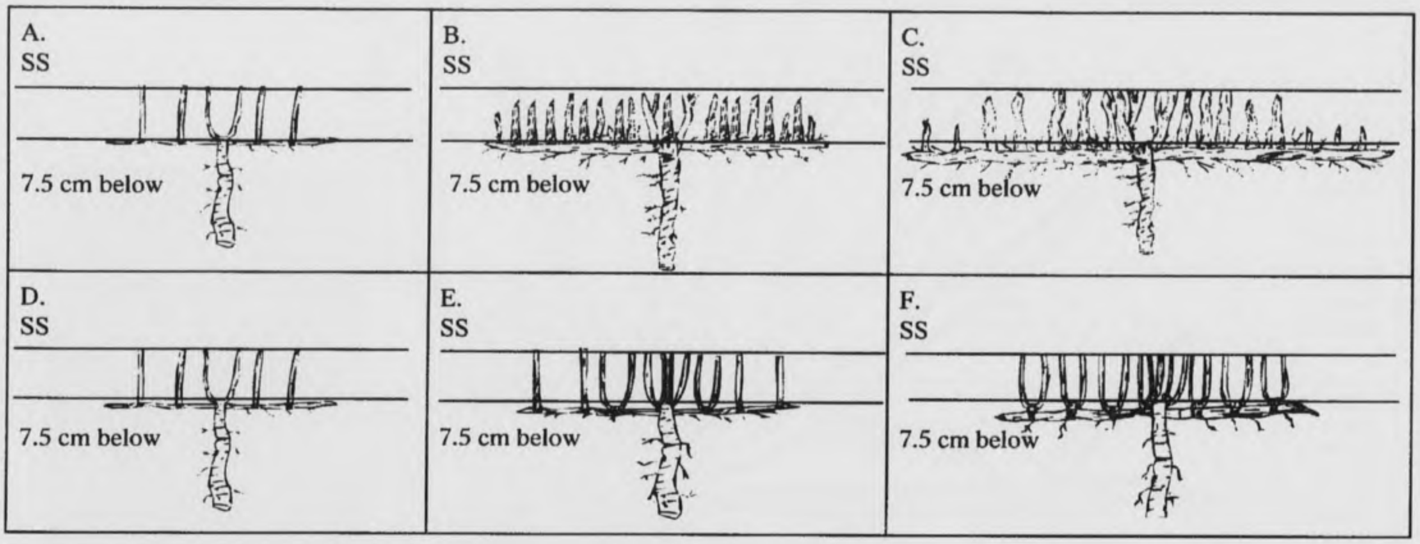

Fig. 3. Transverse cross-sectional view of the idealized redvine subterranean growth to illustrate growth habit when a field is converted to no-till from continuous shallow cultivation. First year comparison in spring before annual shallow tillage is (A) no till and (D) tilled; second year comparison under same conditions in spring is (B) no tilled and (E) tilled. Similarly, the third year is (C) no tilled and (F) tilled.

severed taproot (Fig. 1). From this array of rhizomes, additional rhizomes emerge at nodes along these underground stems creating a mass of subterranean growth. As above ground stems arise from other nodes on the rhizomes, dense clusters of vines can be formed.

Where deep tillage with a moldboard plow was used, the rootstock was severed at a depth of circa 23 to 30 cm (Fig. 2a). The rhizome and root portions that were severed were turned up and exposed to freezing and drying, which has been shown to kill these rhizomes and roots (Castillo et al., 1998). It appeared that first year growth from the remaining taproot was in the form of stems that would emerge in late season (Fig. 2b). When the above ground stems were removed by shallow cultivation or harvesting equipment, multiple stems arose from adventitious buds on the stem (Fig. 2c-d).

Where shallow cultivation is followed by shallow cultivation or no-till, rhizomes tend to form quickly near the soil surface (2.5 to 7.5 cm). No-till areas seem to have larger rhizomes and above ground stems than areas that receive continuous shallow cultivation (Fig. 3a-c; Fig. 3d-f).

Shallow cultivation disturbs the surface of the soil and prunes the redvine rhizomes. Thus, the redvine rhizomes were found in areas immediately below the zone of cultivation. Conversely, rhizomes growing in no-till soils can be located closer to the soil surface and grow undisturbed. Thus, the redvine does not have to regenerate plant parts that have been destroyed.

Experiment 2.--Visual ratings of treated plots showed 100% control in the spring of 1998 compared with 100% survival in the untreated plots. However, visual ratings in the summer of 1999 showed 100% survival in both the treated and untreated plots.

Excavation of rhizomes and roots revealed that some rhizomes had been killed back to their juncture with other rhizomes and the main root system. Certain rhizomes and roots that were not killed indicated that the herbicide may not be translocated in concentrations high enough to kill the entire root system in some cases.

New rhizomes emerged from nodes below the level of lethal herbicide concentration. It took almost two years for this regeneration to occur indicating that one herbicide application will give control, but only for about a year. If lethal concentrations of herbicide are not reaching the entire underground plant structure in one application, repeat applications are needed after regeneration in order to eliminate redvine by chemical means.

Experiment 3.--The conditions following the slicing of the redvine roots were moist with temperatures above freezing. The portion of the taproot above the slice survived and supported the rhizomes and the above ground stems attached to them. The portion of the taproot below the slice

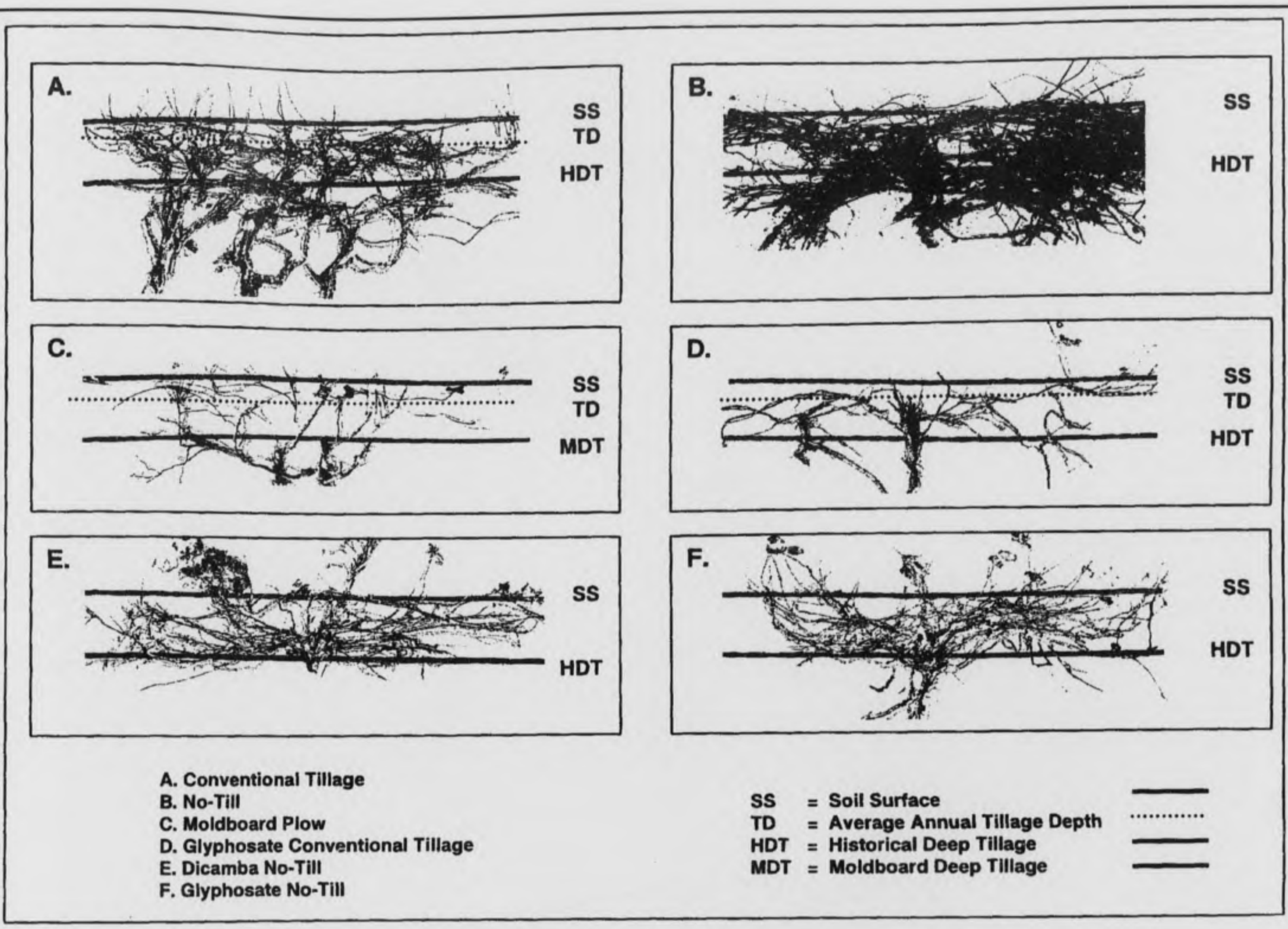

Fig. 4. Typical subterranean redvine growth found after various combinations of tillage and herbicide treatments for a period of three years: conventional shallow tillage (A), no till (B), and moldboard plow (C) with no dicamba or glyphosate applied. Conventional tillage with glyphosate applied in season is shown in (D). No till in combination with dicamba in the fall is shown in (E) and in combination with glyphosate in season is shown in (F). The soil surface indicated by SS is always at the 0 cm depth. The average annual tillage depth (TD) varies at different field locations from approximately 5 cm to 10 cm. Observing the morphology of the subterranean redvine plant, the historical deep tillage depth (HDT) is readily determined. The depth of the moldboard plowing (MTD) is also readily determined by the morphology and in this study ranged from 30 to 35 cm deep.

began regenerating rhizomes from adventitious buds located immediately below the slice.

Thus, if conditions are favorable following the severing of the taproot both portions will live and continue to infest the area. If temperatures below freezing had occurred, or if dry conditions had occurred, the severed portions may have died. Castillo et al. (1998) were able to kill underground plant parts by placing them in a mixture of ice and water for 24 hours and reduced sprouting by 89% 20 weeks after planting when the parts had been air dried for 24 hours.

Experiment 4.--Plots tilled with a moldboard plow had considerably fewer rhizomes than other tillage treatments (Fig. 4). Observations showed that regeneration occurred from deep within the soil and took 2 to 3 years to produce a significant reinfestation (Fig. 4c). It was obvious that deep tillage provided good control of redvine initially, but it did not eliminate the plant. However, multiple deep tillage operations might eliminate redvine over time by increasing the amount of subterranean biomass that would be exposed to the various climatic elements.

Conventional tillage resulted in a rhizome population that was less dense than no-till (Fig. 4a-b). Even though the

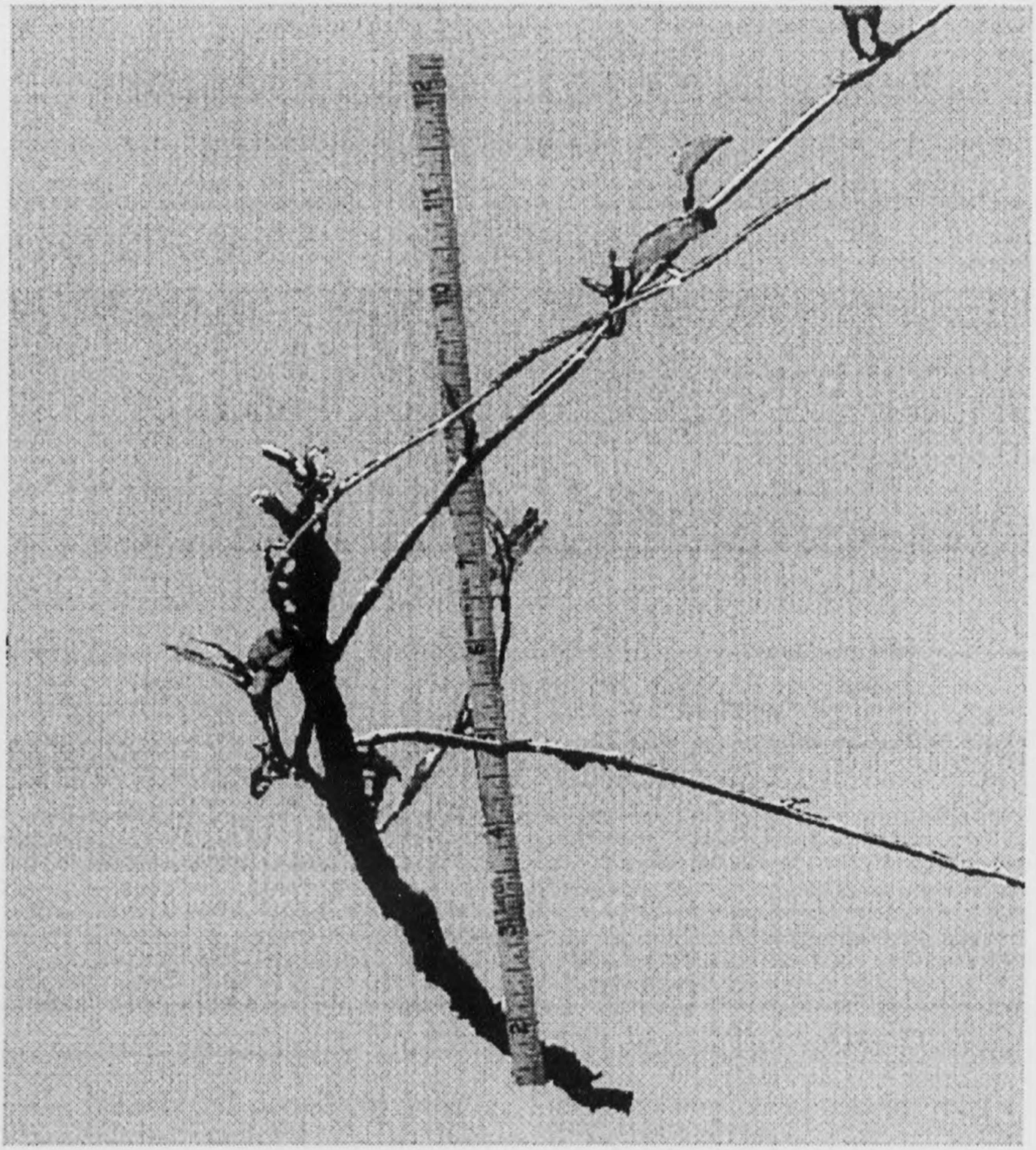

Fig. 5. Typical redvine subterranean plant parts exposed by plowing in the fall of 1999. This photograph taken in the spring of 2000 shows that this plant had survived the winter.

conventional tillage was shallow, rhizomes were killed in the tillage zone and had to be replaced. Conversely, rhizomes in the no-till plots generated new growth in addition to the existing plant structures, which allowed the underground plant structures to increase in number and size at all the upper soil levels.

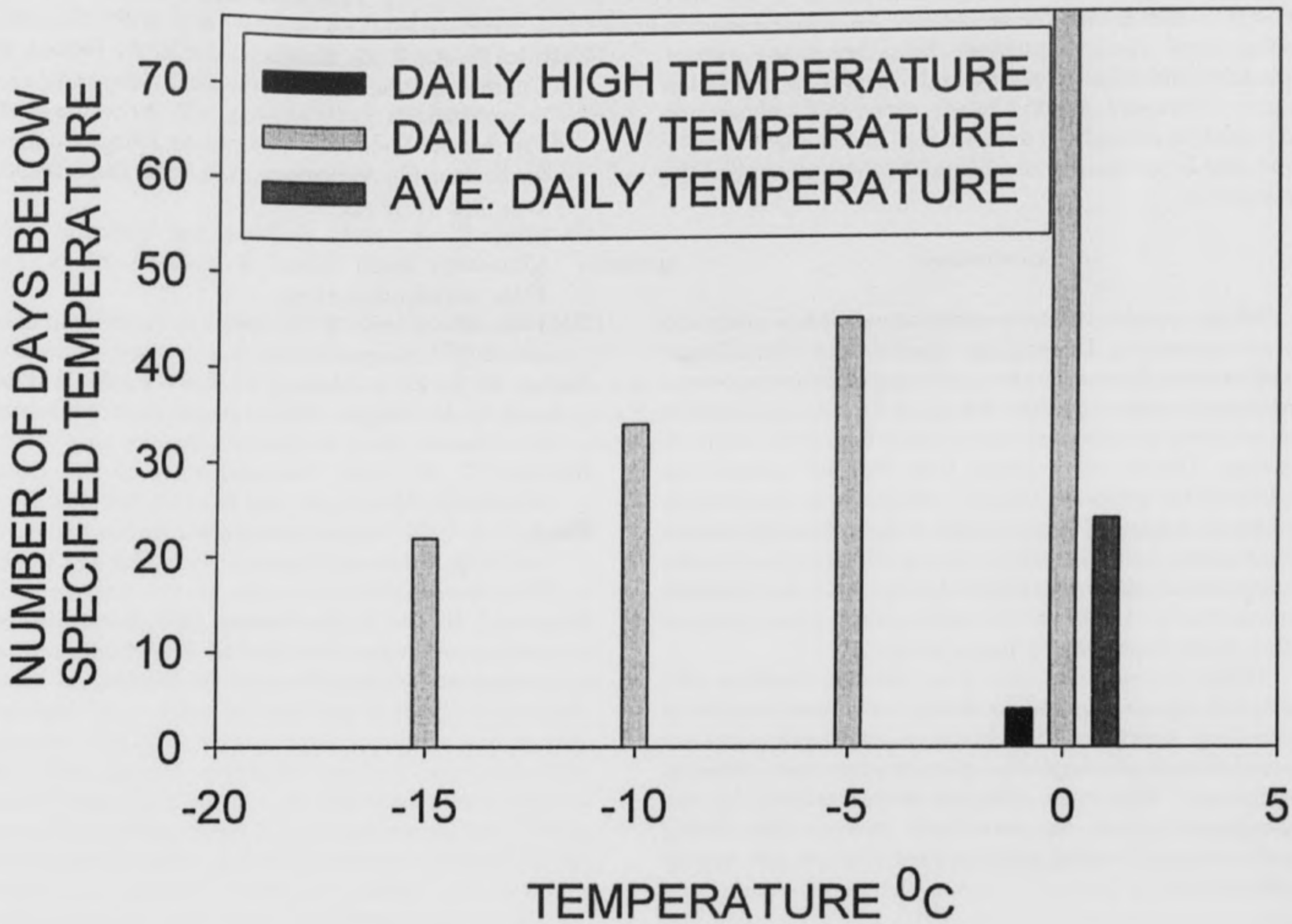

Fig. 6. The occurrence of cold temperatures at Keiser, AR during winter of 1999-2000.

Dicamba and glyphosate were similar in their effects on redvine. The use of either herbicide reduced the rhizome density in both the conventional and no-till treatments (Fig. 4d-f). Although the herbicides provided a high percentage of control compared to no herbicide or tillage (Fig. 4b, e and f), there was not sufficient translocation of lethal concentrations of herbicide to kill the entire underground plant structure. These observations were similar to those in Experiment 2.

Experiment 5.--A typical plant that was considered alive is shown in Fig. 5. The 1999-2000 winter season exhibited temperatures below freezing a sufficient number of times to kill susceptible plant tissue. Temperatures reached 0°C or below 77 times, -5°C or below 45 times, -10°C or below 34 times, and -15°C or below 22 times (Fig. 6). It is obvious that these conditions were colder than those reported in Castillo's greenhouse study (1999) where he obtained 100% mortality from 24 hours of 0°C in moist conditions. Therefore, if freezing is not killing the redvine in the field, there must exist a conditioning effect and/or a dry freezing effect under field conditions.

When the exposed rhizomes were pulled, those that were considered alive were attached to currently living plant parts that were still located underground. On exposed rhizomes that did not have new leaves, some were attached to underground living plant parts, and others were not. Those not attached to living underground plant parts were all found to be dead. Thus, it is obvious that without underground plant structures to supply moisture and energy, the above ground exposed rhizomes will die.

Experiment 6.--An adequate soybean stand was obtained following wheat, but the crop did not grow well after emergence due to the dry conditions which prevailed throughout the summer. A poor plant canopy allowed weeds to compete season-long and remain green after soybean maturity. This prevented any color differentiation among weed species present; thus, rendering sensor application and infra-red photographs useless for evaluation purposes. However, it was visually noted that redvine was still prevalent throughout the field and had not been totally eliminated by glyphosate at 4.5 kg ai/ha that was applied the previous fall.

Conclusions

Tillage systems influence subterranean redvine rhizome and root structures. Deep tillage applied over several years at different depths can create a characteristic subterranean branching structure. Shallow tillage (2.5 - 7.5 cm) creates a concentration of rhizomes immediately below the depth of plowing. The no-till systems that did not receive an application of herbicide allowed redvine root structures to proliferate, especially near the soil surface. The application of herbicides with perennial vine activity can reduce the density of redvine, but there does not appear to be adequate translocation to kill the entire underground plant structure with a single application.

Tillage systems that can sever redvine rhizomes and roots and expose them to air drying conditions can aid in controlling redvine. The rhizomes and roots that are severed from the underground plant structure may die from desiccation. Rhizomes that remain attached to the underground plant structure will survive the drying conditions, and freezing temperatures alone do not appear to affect them.

Literature Cited

Castillo, T. A., T. C. Keisling, and **L. R. Oliver.** 1998. Cultural and chemical redvine (*Brunnichia ovata*) control in soybean. *In* T. C. Keisling (ed.) Proceedings of the 21st Annual Southern Conservation Tillage Conference for Sustainable Agriculture. Ark. Agri. Expr. Stn. Spec. Rep. 186. 16-18 pp.

Castillo, T. A. 1999. Cultural and chemical redvine (*Brunnichia ovata*) control in soybean. M. S. Thesis. Univ. of Arkansas. 81 pp.

DeFelice, M. S. 1998. SWSS weeds of the US and Canada [CD-ROM computer file].

Elkins, W. C., D. R. Shaw, J. D. Byrd, Jr., M. A. Blaine, and **C. H. Tingle.** 1996. Long-term redvine control. Proc. South. Weed Sci. Soc. 49:22.

Elmore, C. D. 1984. Perennial vines in the Delta of Mississippi. Miss. Agric. and For. Exp.Stn. Bull. No. 927.

Reed, P. B. 1988. National list of plant species that occur in wetlands: Southeast (Region 2). U. S. Fish and Wild. Ser. Biol. Rep. 88(26.2).

Soteres, J. K. and **D. S. Murray.** 1982. Root distribution and reproductive biology of honeyvine milkweed (*Ampelamus albidus*). Weed Sci. 30:158-163.