STUDIES ON THE ERADICATION OF SPURGE NETTLE, JATROPHA TEXANA MUELL. ARG.

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The natural habitat of spurge nettle is on areas of deep sandy soil. The distribution of the species *Jatropha texana* Muell. Arg., according to Small (1913), is in Oklahoma, Arkansas, and Texas. A similar plant, *Jatropha stimulosa Michx.*, also occurs in the southern part of the United States. Spurge nettle does not spread rapidly because young plants must develop from a few large seed, which are not easily covered by natural agencies. The seed are also palatable, and it is quite probable that a high percentage are destroyed by rodents or other forms of wild life.

Spurge nettle does not seriously interfere with the growth of row crops on deep sandy soil because the root system develops below the zone in which the roots of cultivated crops are most abundant. Where spurge nettle plants are numerous on grassland or in fields where small grain is planted, the quantity of the more desirable vegetation will be reduced because a considerable portion of the surface area may be occupied by the above-ground portion of this weed. Spurge nettle is also objectionable in pastures and cultivated fields because the spines on the leaves and stems contain a toxic substance which is very irritating to the skin of animals, including man, when a forceful contact with the plant occurs.

Several procedures have been recommended for the control of different kinds of perennial plants. Clean cultivation, chemical treatment, and the use of smother crops are all effective, but each method has its limitations. Plant food which is stored in the roots of perennial plants during certain periods of plant development is utilized during the first stages of vegetative development in the spring or at any time during the growing season if the top is removed. According to Grandfield (1930), the carbohydrate and nitrogen content of several pasture weeds increased rapidly from flower bud to full bloom stage. Effective control of field bindweed (*Convolvulus arvensis* L.) has been obtained by cultivating the land with sweeps from 8 to 12 days after new growth appears to exhaust the supply of stored plant food in the roots. At least 2 years of fallow are required to kill bindweed plants which have been growing on the land for several seasons. Fallow cannot be recommended for the control of perennial weeds like spurge nettle on sandy land, especially in the Great Plains area, because wind erosion may cause serious damage to the surface soil when the land is not protected by a vegetative cover.

Many different chemicals have been recommended for the control of weeds, and a list of these materials can be obtained from standard textbooks on weed control. Common salt is one of the materials that has been used for the eradication of different kinds of vegetation because it is easy to obtain. From ½ to 2 pounds per square foot is usually applied. Recent use of this material has been made in the eradication of common barberry (Kempton and Thompson 1925). When a sufficient quantity of common salt is applied to increase the osmotic pressure of the soil solution to a point equal to or above the osmotic pressure in the root hairs, moisture cannot enter the plant. The effect of high concentrations of common salt will cause exosmosis and subsequent plasmolysis of the plant cells. When the entire surface of the soil is covered with salt and a sufficient quantity is added to kill perennial roots to a depth of 4 feet, a sterile condition of the soil is produced and crops cannot be grown on the land for varying periods of time, depending on the texture of the soil and climatic conditions which prevail. Rudolfs (1921) found that 8 tons of salt per acre would prevent the development of sprouts from green stumps and kill shrubs such as poison ivy and other vegetation occurring on these areas. Experiments conducted at Hays, Kansas (Call and Getty 1923), show that 20 tons of salt per acre is needed to control bindweed. Treatments applied in 1913 prevented the growth of other plants except Russian thistle for a period of 10 years. When salt is applied to soil containing a considerable quantity of clay, the sodium in the sodium chloride will replace calcium in the clay complex and calcium chloride will appear in the drainage water. The presence of considerable quantities of sodium clay in a fine-textured soil reduces the rate of absorption of rain; consequently the rate of salt removal by leaching under such conditions is retarded, and plant growth will be restricted until the salt concentration of the soil solution is reduced to a point which will not interfere with water absorption by roots or physiological processes occurring in the above-ground portion of the plant.

The use of sodium chlorate for the control of Canada thistle (*Cirsium arvense* L.) was reported by Aslander (1926). Since that time, various chlorates have been used by many different investigators for the eradication of perennial plants. The chlorates may be added to the soil as a dry powder, or they may be dissolved in water and sprayed on the foliage. Under average conditions, 2 or 3 pounds per square rod are required for the control of most perennials. Where 2 or 3 applications are made, the total quantity per square rod may eventually be as high as 8 or 10 pounds. This is an expensive treatment; however the cost is no greater than that for the use of carbon disulphide which is applied in holes varying from 12 to 18 inches in depth and 18 to 24 inches apart in order to control bindweed and other perennial plants (Rogers and Hatfield 1929).

A mixture of sulphuric acid and sodium arsenite has been recommended by Crafts (1937) to destroy various types of annual and perennial vegetation. He has found that the quantity of material required to kill the roots of perennial plants depends to a very great extent upon soil conditions. The chief advantage of the arsenic-sulphuric acid mixture is the low cost as compared with other treatments. Arsenic is a poisonous substance and cannot be used on areas where livestock are grazed. Sulphuric acid is very corrosive, and special spray equipment must be used when this material is applied (Brown and Streets 1928); consequently these disadvantages may favor the use of other chemicals which are not poisonous and are more convenient to apply.

EXPERIMENTAL RESULTS

Several different methods which have been proposed for the control of perennial types of vegetation were applied to spurge nettle plants growing on an area of deep loamy sand located about 15 miles southwest of Stillwater, Oklahoma. The land was utilized for pasture; consequently poisonous chemicals could not be used. These experiments were conducted during the 4-year period, 1937-1940, and the spurge nettle plants were treated as follows:

1. Plants cut twice each year at bloom stage.
2. Plants sprayed with sodium chlorate.
3. Application of dry sodium chlorate to soil.
4. Application of dry common salt to soil.
5. Application of volatile liquids to soil.

Spurge nettle had been growing on the land where these tests were conducted many years. A view of the pasture before treatments were started is shown in Figure 1.

The extensive development of an old spurge nettle root in deep sandy soil is shown in Figure 2. This root weighed 20 pounds when it was removed from the soil. The top of the root was 18 inches below ground level and had a maximum circumference of 16 inches. At a depth of 72 inches below the surface of the ground, the root diameter was approximately ¼ inch. The top of the root is too deep to be cut off by ordinary tillage implements, and to eradicate large numbers by digging a hole so that the root could be cut off below the crown would require a large amount of labor.

Plants which were cut twice each year for the 4-year period to prevent seed development were still making a rapid recovery in the fall of 1940 after the tops had been removed the second time that season. Cutting at more frequent intervals would eventually kill these plants, but how long it would take is a problem which was not answered in this study.

The first chemical treatment was made on June 12, 1937, when 50 plants were sprayed with a solution of sodium chlorate containing one pound of chemical in one gallon of water. Two weeks later, an examination of these plants was made, and all of the leaves had been killed. These plants recovered during the fall of 1937, and in 1938 they did not show any apparent effect of the previous treatment. It has been suggested by Crafts and Rosenfels (1939) that plant leaves may not be able to retain and absorb a sufficient quantity of a chemical spray to cause the death of the roots; consequently under such conditions successive treatments are required which must be applied as soon as a maximum leaf area has developed in order to eventually kill the plant. He also found that certain sprays applied late in the afternoon were more effective than sprays applied during the hotter portion of the day and that a more effective kill was obtained when the soil was relatively dry because the leaves absorbed the chemical solutions which were sprayed on them more rapidly under those conditions.

On October 1, 1938, 80 spurge nettle plants were treated with dry sodium chlorate at the rate of 2 ounces per plant by a method which was designed to prevent any young shoots from reaching the surface of the ground. The top of each plant was removed and an excavation was made with a spade to a depth of 6 or 8 inches. The dry chemical was applied on an area approximately 4 to 6 inches in diameter around the exposed stem of each plant, and the hole was filled with soil. Seventy plants were also treated with a solution of sodium chlorate containing 2 pounds of chemical in one gallon of water. The top of each plant was removed and about 50 ml of the solution was poured on the end of the exposed stem and on the soil surrounding the stem. A study of this area on July 15, 1939, indicated that 20 of the treated plants had survived where the dry sodium chlorate had been applied. A second count was made on October 19, 1940, and 23 plants were found on this area. Assuming that all of these plants were treated 2 years previous, the treatment destroyed slightly more than 70 percent of the spurge nettles. Fifty of the 70 treated plants survived where the sodium chlorate solution was applied, according to counts made on July 15, 1939. The smaller quantity of sodium chlorate which was applied in solution probably accounted for the less effective results of this treatment. It was quite evident from a later examination that less than ½ ounce of sodium chlorate for each spurge nettle plant was not sufficient to control this type of vegetation on sandy land.

Volatile liquids were also applied to 4 areas where spurge nettles were growing on June 3, 1939. Fifty-one plants were treated with 50 ml of carbon disulphide; 36 plants were treated with 40 ml of gasoline; 24 plants with 80 ml of gasoline; and 60 plants with 40 ml of ethylene chloride. In all cases the tops of the plants were removed with a hoe, and holes were bored to a depth of 12 inches adjacent to the exposed stem. The liquids were poured into the holes through a large funnel and the openings were closed. All of these treatments retarded the development of the spurge nettles for several weeks, as compared with plants with tops cut at the same time but not treated. Stakes which were placed in the pasture to locate the boundaries of the plots treated with volatile liquids were dislodged by grazing livestock during winter and spring months and an accurate count of plants on these areas could not be made. However a vigorous growth of nettles appeared on all of these plots in the spring of 1940. It is quite evident from this experiment that the volatile liquids which were used could not be recommended for the control of spurge nettles without increasing the quantity of liquid which would also increase the expense of treatment.

Common salt was applied as a spot treatment to 30 spurge nettle plants on June 10, 1938. The method of treatment was similar to the procedure which was used where the dry sodium chlorate was applied. About one pound of salt was placed over and around the exposed end of the stem or stems of each plant and the hole was filled with soil to prevent livestock from disturbing the salted areas. Eleven plants were present on this area on October 19, 1940, but many of them were small, and it is quite probable that some of them had not been treated with salt. On June 9, 1939, 125 plants were treated with common salt as previously described at the rate of ½ to one pound per plant. One area of 28 plants was carefully marked, and only 2 plants had appeared on this area by October 19, 1940. Several holes were dug in areas where salt had been applied, and dead nettle roots were found.

Since a toxic concentration of the various chemical treatments must remain in the soil for a considerable period of time after the initial application of salt is made, a study was made of the chloride content of different soil horizons taken from 5 different locations where common salt had been in contact with the soil for 16 and 28 months. Two locations were selected where no plants had appeared after the salt treatment had been applied. In 3 locations a weak vegetative growth had developed. Results of these analyses are given in Table I.

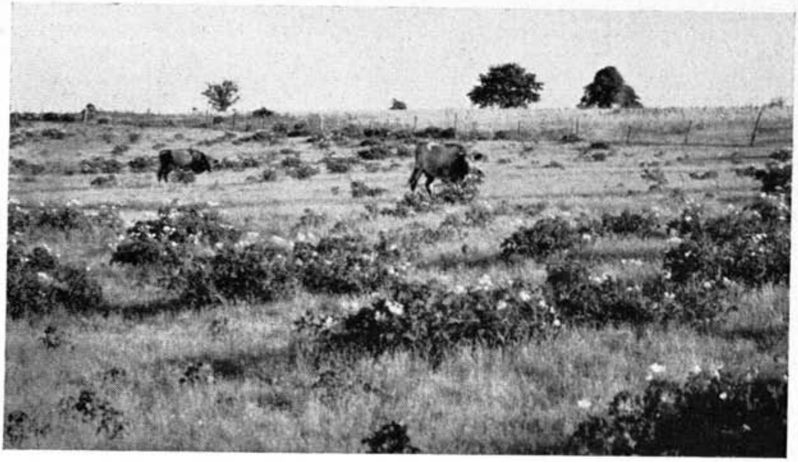
TABLE I.

Chloride content of soil layers collected from sandy land where common salt was applied at the rate of 20 to 40 tons per acre as a spot treatment to eradicate spurge nettle

Depth of sample in inches	Condition of plant and concentration of salt in percent					
	Dead plant*•	Dead plant**	Weak plant**	Weak plant**	Weak plant**	Weak plant
0 - 6	.013	.067	.000	.067	.054	.027*
6 - 12	.013	.393	.013	.067	.027	....
12 - 18	.013	.637	.040	.135	.054	....
18 - 24	.013	.040	.027	.155	.081	....
24 - 36	.040	.222	.027	.122	.081	....

* 0-20 inches deep; salt applied 28 months previous to sampling.
** Soil sampled 16 months after treatment.

FIGURE 1.



Spurge nettle (*Jatropha stimulosa*) on a sandy upland soil used for pasture.

FIGURE 2.

Spurge nettle root system. Depth from surface of soil to lower tip of root in picture was 72 inches. Weight of root, 20 pounds. Maximum circumference, 16 inches.

Although the exact quantity of salt which was added to these different locations was not determined since the original application was measured and not weighed, the maximum variation would be from 10 to 40 tons per acre or ½ to 2 pounds per plant, which should have been found in the second 6-inch layer of soil if no leaching had occurred. This would be equivalent to a concentration of 1 to 4 percent of the total weight of a 6-inch layer of this soil. The analyses show that only one of the 5 locations which were examined contained an appreciable concentration of salt. This spot was treated 16 months before the samples were collected. Some chloride was present in each profile and the general tendency was for higher concentrations to be present in the lower horizons. Rainfall has leached the salt from this sandy soil more rapidly than reported by other investigators working on soils containing a higher percent of silt and clay (Call and Getty 1923; Kiesselbach, Petersen, and Burr 1934). In view of the fact that a toxic concentration of common salt or other chemical must remain in the soil for at least 2 years to destroy the spurge nettle roots, it would not be expensive to cover the salted areas with a piece of tar paper about 7 inches square to divert the downward movement of soil moisture during periods of abundant rainfall and prevent the salt from leaching into the lower soil horizons.

The composition of the roots of 2 plants which survived the chlorate treatment and 2 plants from which the tops were removed twice each year for 4 years was compared with the root system of one plant which had not been disturbed during this period. The results of these analyses are given in Table II.

TABLE II

Size, moisture content, and chemical composition of spurge nettle roots from plants surviving chlorate treatment, plants with tops removed twice each year, and an undisturbed plant

Previous treatment	Wt. of Green root	Maximum circumference	Moisture content	Total Sugars*	Total carbohydrates*	Soluble nitrogen*	Total nitrogen*
	lbs.	*in.*	%	%	%	%	%
Dry sodium chlorate	3.3	6.8	81.6	3.6	15.4	0.4	1.2
Dry sodium chlorate	14.5	13.3	86.1	9.6	25.3	0.6	1.5
Tops cut twice each year	21.5	19.8	82.9	6.3	19.3	0.5	1.4
Tops cut twice each year	20.0	16.0	82.9	3.1	17.7	0.2	0.6
Undisturbed plant	2.8	7.5	78.1	7.8	24.2	0.6	1.4

*Chemical analyses made by Dr. J. E. Webster, Dept. of Agr. Chem. Res., Stillwater, Oklahoma.

These analyses indicate that the greatest differences occurred in the quantity of total sugar and soluble nitrogen in these plants. One of the chlorate-treated plants and one of the plants from which the tops were cut twice each year were much lower in food reserves than the others. Apparently the 2 treated plants which were similar in composition to the undisturbed plant had recovered sufficiently from the respective treatments to accumulate a normal supply of root reserves. There was a marked difference in the size of these roots; however the moisture content of the roots was quite similar, the untreated plant being slightly lower, possibly because it had grown on a slightly drier location. The 2 largest roots were quite unlike in composition, indicating that one plant had suffered more from the removal of the top twice each year than the other.

In no instances did the spot treatments with sodium chlorate or common salt prevent the growth of grass on this land, which would indicate that the movement of soluble salts in this soil has been downward and that no appreciable upward movement as a result of capillary activity has occurred. The cost of treating spurge nettles with sodium chlorate at the rate of 3 ounces for each plant would be approximately two cents for material. This concentration is needed to maintain a toxic condition in sandy soil for a sufficient period of time to eradicate these plants where leaching is not reduced by some additional treatment. It is quite probable that 3 pounds of chemical dissolved in one gallon of water would provide a sufficient concentration so that ½ pint of solution poured on the cut stem of each plant and covered with soil in order to decrease the rate of leaching would reduce the labor cost of treatment and be as effective as a treatment applied in a band 6 or 8 inches below the surface of the ground. Common salt applied at the rate of one pound for each plant would cost approximately one cent for material. It is quite probable that smaller quantities of both chemicals would be effective if the rate of leaching could be controlled by some practical method which would not increase the total cost of treatment. Since the feeding horizon of the spurge nettle root is several feet below the surface of the ground except where a shallow sandy soil rests on a subsurface horizon high in clay content, the important effect of chemical treatment is to destroy new shoots emerging from the root and prevent them from reaching the surface of the ground. Where individual plants are scattered over a field, spot treatments with sodium chlorate or common salt are not expensive and offer an economical method for the control of spurge nettles. Where a thick stand of these plants occurs in sandy soil, the cost of treatment may be relatively high as compared with the value of land. Spraying the foliage with a 10 percent solution of sodium chlorate at regular intervals might be less expensive than the use of dry chemical applied to the soil.

SUMMARY

Studies on the eradication of spurge nettle (*Jatropha texana* Muell. Arg.) were made to compare methods which have been used for the control of other perennial types of vegetation. Cutting the tops of plants twice each year for 4 years retarded their development but did not destroy them. Applications of common salt at the rate of one pound per plant or dry sodium chlorate at the rate of 3 ounces per plant is sufficient to prevent the development of spurge nettles when rate of leaching does not remove these chemicals from the soil profile before the food reserves in the roots of the spurge nettle are reduced to a point where growth cannot occur. Volatile liquids (carbon disulphide, gasoline, and ethylene chloride) were not effective in the control of the spurge nettle on deep sandy soil.

Common salt applied as a spot treatment for the control of spurge nettle at the rate of 10 to 40 tons per acre on a deep loamy sand soil was leached below a depth of 36 inches from the surface of the ground in 2 years. The total annual rainfall during this period was approximately 30 inches. Plant food reserves in the roots of one plant which survived the chlorate treatment and one plant from which the top had been cut at least 8 times in 4 years were much lower than in an undisturbed plant or in 2 other plants which had been able to maintain or build up plant food reserved in their roots after the different treatments had been made.

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