REVEGETATION OF SANDBLOWS IN VERMONT

UNIVERSITY OF VERMONT AND STATE AGRICULTURAL COLLEGE

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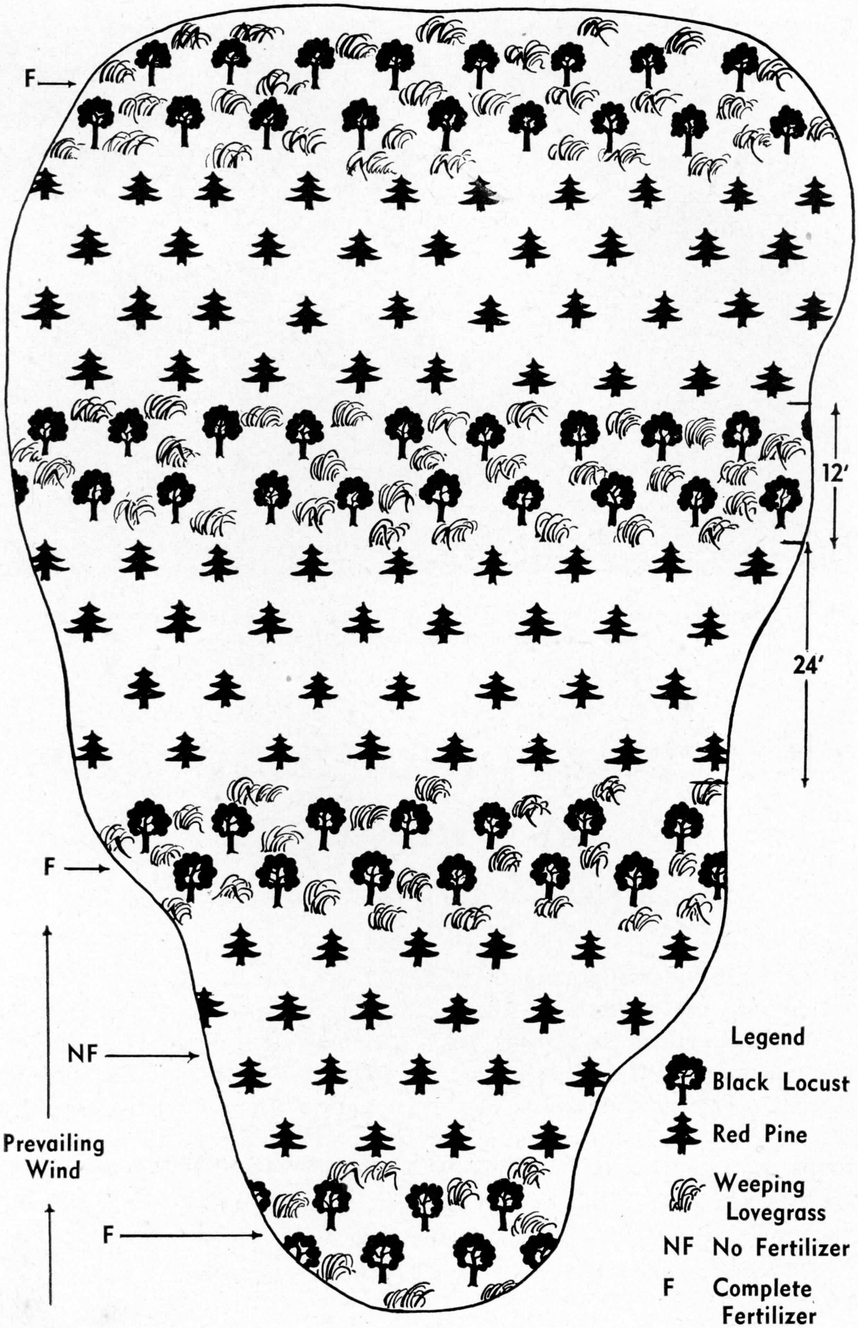

Diagram showing proposed method of planting sandblows.

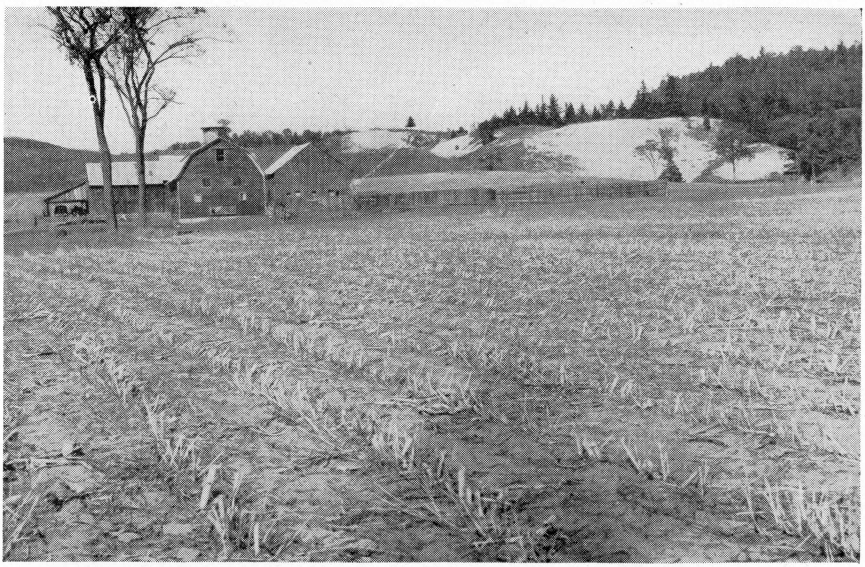

FIG. 1. Sandblow spots (rear of picture) are often eyesores, and blowing sand may menace valuable farmland (foreground).

Revegetation of Sandblows in Vermont[1]

JOSEPH B. KELLY, A. R. MIDGLEY, and K. E. VARNEY[2]

VERMONT has approximately 2,800 acres of active sandblows. These are not only useless in their present condition, but they are subjecting other land to damage by the drifting sand. Approximately 6,000 acres of Vermont farmland are subject to damage from this sandblow type of wind erosion. These sandblow areas are generally found associated with the Adams, Melrose, and other sandy soil types. Usually they are irregular in shape and rarely extend over more than five acres. These sandblow areas are eyesores on a farm and may affect the apparent value (see Figure 1). They may also cause unusual farm management problems.

[1] A cooperative project between the Soil Conservation Service, Research Division, U. S. Department of Agriculture, and the Vermont Agricultural Experiment Station.

[2] Assistant Research Agronomist (formerly Project Supervisor, SCS), Research Agronomist, and Assistant Research Agronomist, Vermont Agricultural Experiment Station. The authors acknowledge the assistance of R. D. Halligan in obtaining some of the data presented in this bulletin.

Considerable work has been done on sandblow and sand dune stabilization throughout the country, but little of the information available from other localities is specifically adapted to conditions in Vermont. On the Cape Cod sand dunes the control consists of brush mulching and planting with beach grass (*Ammophila* spp. After the beach grass is established sufficiently to prevent blowouts, usually after two or three years, pine trees and certain other desirable species are then planted.

On the Winooski demonstration project in 1937 and 1938, the Soil Conservation Service used several methods in reforestation of sandblows. These included brush and lath fences, mulches, and beach grasses, sometimes used singly and sometimes in combinations. Brush and lath fences proved expensive and in some cases failed to give entirely satisfactory results. Mulching was effective if properly done, but often there was little or no available material for mulching. Vegetative plantings of beach grasses in this area were too small to be conclusive. Plantings of black locust (*Robinia pseudoacacia*) survived on sandblows but were very slow in becoming established.

In the Pacific Northwest, the method of sand dune control consists of three steps. First, the dune is planted to beach and dune grasses to arrest the sand movement. Second, seedings or plantings of leguminous species are made as soon as the beach grasses have stilled the moving sand. These provide an abundant litter which helps to improve the fertility of the soil. Third, permanent grasses and legumes or shrubs and trees are established by seeding or planting them with the already established grasses and legumes.

In the southern great plains, sand dune reclamation consists of controlling the critical or "blowout" area by plantings, leveling the sand dunes with machinery, deep listing between and around the dunes to catch the sand, and planting the leveled dunes to Sudan grass, broom corn, kafir, or Hegari. Most of these crops, however, are not adapted to Vermont conditions. Neither do we have suitable legumes (except black locust) for use as in the Pacific Northwest.

How Sandblows Are Formed

The soils on large areas in Vermont are derived from water-deposited sands of glacial origin. The soils developed from these sands are naturally droughty and low in fertility. When such soils were cleared for cultivation or pasturage, the organic matter was quickly oxidized or "burned" out of the soil and then the plant food elements leached out. Plant growth gradually decreased until there was little or no protective covering on these soils. Consequently, with the initial aid of some mechanical disturbance, winds began to move the soil particles by a saltation process (sand particles leaping and jumping) and gradually a sandblow developed. (See Figure 2.)

FIG. 2. Frequent cultivation and lack of fertility have caused this sparse vegetative covering which permits the beginning of an active sandblow. Note the rippling effect of the moving sand, a process known as saltation.

Mismanagement of sandy soils is largely responsible for the development of sandblows. Such land should never have been cleared of trees in the first place. However, if measures had been taken to keep up the fertility of the soil and a good vegetative cover had been maintained, sandblows would not have developed. Overgrazing, excavations, gullies, field roads, and cow trails on "runout" sandy soils are sometimes sufficient to cause the beginning of a sandblow. Once started, "sandblasting" helps to extend the sandblow because blasting sand injures and often kills plants in its path.

Revegetation Problems

It is no simple task to revegetate areas which are now active sandblows. Before any type of permanent vegetation such as trees can be established, the moving sand must be stabilized. Sand blasting will injure and quickly kill young tree plantings. The exposure of the roots of young plantings when sand moves away is also a serious factor. The dryness of the top six inches of sand during the summer months permits the growth only of plants especially adapted to droughty conditions. The high temperature of the bare sand also affects plant survival.

Lack of fertility is of primary importance, possibly more so than lack of moisture. The sand on these areas is extremely sterile and devoid of plant nutrients. It is very difficult and often impossible to establish any plant other than pine trees on this sand without supplying fertility. For quick stabilization, however, pines will not serve the purpose, but they may be desirable as a long-time plant which has commercial value. Thus, the whole problem is to stabilize the sandblow quickly so that pines or other desirable species can be planted with assurance of survival. This often involves the use of less desirable, quick-growing species of plants in the beginning to be followed by more desirable, slower-growing species. Fertility is essential for the growth of any quick-growing plant and it must be supplied in the form of fertilizers on these sands.

Native Plants on Sandblows

A number of native plants have been found growing on sandblows but in limited quantity. Usually these plants are found in protected areas or where moisture conditions are more favorable than on the average sandblow. False heather (*Hudsonia tomentosa*) is sometimes found growing in the low spots along the edges of sandblows. Native poplar (*Populus* spp.) and red osier (*Cornus stolonifera*) grow in some areas but usually not thick enough to give much protection. Poverty grass (*Danthonia spicata*), crabgrass (*Digitaria sanguinalis*), milkweed (*Asclepias syriaca*), horsetail (*Equisetum arvense*), mullen (*Verbascum thapsus*), and willow (*Salix* spp.) have also been found where the sandblow is partially stabilized. Gray birch (*Betula populifolia*) also comes in rapidly from natural seeding when the sandblow is partially stabilized.

Grasses Adapted to Sandblows

One of the objectives of this study was to determine which grasses could withstand the adverse conditions existing on sandblows and yet grow rapidly enough to produce a good mulch cover to stabilize the blowing sand. Accordingly, 22 different grasses and legumes were planted in sandblow areas. Fertilizers and lime were used at the time of planting to compensate for the low fertility of the sand. The most promising of these grasses were: weeping lovegrass (*Eragrostis curvula*), false cheegrass (*Calomogrostis epigiose*), sea lyme (*Elymus arenarius*), beach grass (*Ammophila breviligulata*), and American dunegrass (*Elymus vancouverensis*).

The other grasses grew very poorly and after the first year disappeared completely, whereas the above grasses grew well and produced an abundance of vegetative cover, particularly when high rates of fertilizer were used.

False cheegrass, sea lyme, beach grass, and American dunegrass must be planted from rootstocks. This requires a great amount of expense and labor even though these grasses effectively control the blowing sand.

(See Figure 3.) Weeping lovegrass, on the other hand, is established by seeding much as any ordinary grass or legume. It is thus the most practical for stabilizing sandblows.

Weeping lovegrass is a rapid, vigorous-growing, perennial bunch grass which produces a quick, stabilizing soil cover. It has an unusually extensive root system consisting of many deeply penetrating roots of approximately the same size throughout. This thick mat of roots helps to hold the sand in place. Although weeping lovegrass is normally perennial, it often winterkills in Vermont. This is not serious, however, because with adequate fertility it produces an abundance of seeds each year which re-establish the stand. In fact, the dry mulch produced when weeping lovegrass winterkills may be more desirable than continued growth of the grass, especially when other species follow in the scheme of revegetation. Such a dead mulch of weeping lovegrass has been found to be only partially decomposed at the end of three years. Both the top growth and roots of weeping lovegrass, when maturity is reached, are very tough and resistant to decomposition.

Fig. 3. Beach grass spreads rapidly with adequate fertility, but cost of planting almost bars its use on large areas.

Trees and Shrubs Adapted to Sandblows

Since it is advisable to return sandblow areas to a permanent vegetation, it is well to consider which type of trees or shrubs can be used for this purpose. Since pines are valuable as a permanent cover, it seems desirable to plant sandblows to pines immediately, but this normally results in failure unless the blowing sand is first stabilized with a faster-growing tree or shrub which can later be replaced by pines.

The establishment and growth of several species of trees and shrubs on sandblow areas have been studied for several years. The following are some of the most promising species tested: black locust (*Robinia pseudoacacia*), red pine (*Pinus resinosa*), Scotch pine (*Pinus sylves-*

tris), white pine (*Pinus strobus*), hybrid poplar (*Populus* spp.-hybrid), sand cherry (*Prunus besseyi*), sand cherry-plum hybrid (*Prunus besseyi* x *americana*), multiflora rose (*Rosa multiflora*), and autumn elaeagnus (*Elaeagnus umbellata*).

Scotch pine usually has little value for lumber because of its scrubby characteristics, while white pine is subject to severe damage by the white pine weevil and blister rust. Hybrid poplar grows rapidly and appears to be disease free. Sand cherry and sand cherry-plum hybrid grow reasonably well and produce fruit that is excellent wildlife food. The fruit is also good for jams and jellies. Multiflora rose grows slowly and has little economic value except possibly as hedge fences. Autumn elaeagnus produces an abundance of small berries that are excellent food for wildlife. Black locust grows rapidly, responds to lime and fertilizer, and aids in restoring soil fertility. Limited quantities of black locust may be used for fence posts, the heartwood being very resistant to decay and commonly lasting from 50 to 75 years without replacement. Red pine is a good long-time cover that will be valuable lumber in 50 to 75 years.

Use of Fertilizer in Establishing Plant Cover

Fertilizer for Weeping Lovegrass. Fertilizer is essential to produce a quick cover with this grass. A deep-rooted plant, it can obtain sufficient moisture from the sand to support a luxuriant growth, but it must have the minerals, and particularly nitrogen, that are lacking on sandy soils. Except for leaching (loss in drainage water), a fertilizer treatment of 1,000 pounds or more of 10-10-10 would be good, but nitrogen is quickly lost on sand due to drainage percolation. Best results have been obtained when 1,500 pounds per acre of 5-10-10 is broadcast and raked into the surface at the time of seeding. In addition to this, a top-dressing of 200 pounds per acre of nitrate of soda or similar nitrogenous fertilizer in early summer has also proved beneficial.

When well fertilized, weeping lovegrass makes a luxuriant growth and produces an abundance of seeds which will re-establish the stand when the original plants are winter-killed. Picture on cover shows stand of lovegrass produced in one season, using fertilizer.

Fertilizer for Black Locust. Many deciduous type trees will respond to fertilization, especially when they are planted on sites that are chemically different from their natural habitat. This is true of black locust. Its natural habitat is on soils developed from limestone or on soils which have a high mineral content. For commercial plantations, its range is limited to the south central and southeastern portion of the United States, but it has been found to be adapted to certain soil conditions even in the cool climate of northern New England.

The value of lime and mineral fertilizers in increasing the growth rate of black locust planted on sand-

Table 1. Effect of Lime and Fertilizer on the Growth of Black Locust*

Treatment per acre	Height of trees in inches† End of 1st season	End of 3rd season
No treatment	18.6	28.2
Nitrogen—200 lbs. nitrate of soda	19.0	27.6
Lime—1,000 lbs. ground limestone	19.8	32.4
Fertilizer—700 lbs. 5-10-10	20.5	37.8
Fertilizer and limestone	23.2	49.0
Extra fertilizer‡	28.7	67.8
Extra fertilizer and limestone	30.5	78.0

* Material was broadcast unless otherwise stated.
† Figures represent averages of 40 trees in two locations.
‡ Extra fertilizer means 700 pounds 5-10-10 broadcast the first year, and 300 pounds of 5-10-10 spotted around the trees each succeeding year.

blows in northern Vermont is shown in Table 1. In other tests, extra nitrogen had little or no effect on the rate of growth. Also, such minor elements as boron and magnesium had little effect on the rate of growth or on the vigor of black locust trees when adequate mineral fertilizer and lime were used. According to U.S.D.A. Farmers Bulletin No. 1628, a rapid-growing locust tree is less susceptible to damage from the locust borer than is a stunted slow-growing tree.

Rates of Fertilizer for Black Locust. The rates of fertilizer to use on black locust depend primarily on the speed of growth wanted. Unusually high rates used in test plots have not indicated any danger from overfertilization on sand or sandy soils except when the tree is planted with its roots in direct contact with the fertilizer. Frequent fertilization at lower rates would be advisable, however, because of large leaching losses of potash when an excess of this nutrient is present. Table 2 shows that black locust is responsive to high rates of fertilizer and especially to lime.

The effect of further annual applications of low rates of fertilizer can be seen from the data in Table 1 by comparing the fertilizer treat-

Table 2. Fertilizer Rates for Black Locust*

Treatment (pounds per acre)	Height in inches, end of 3rd season: No lime	Ground limestone 1,000 pounds per acre
None	27.6	32.4
350	28.8	39.6
700	49.2	86.4
1400	66.0	96.0
2100	57.6	100.8

* Broadcast applications of 5-10-10.

ment with the extra fertilizer treatment.

From the data in Tables 1 and 2, it appears that an initial application of about 1,000 pounds per acre of ground limestone and 1,000 pounds of 5-10-10 is adequate. An additional annual application of 300 pounds per acre of 5-10-10 or 150 pounds per acre of 0-20-20, if no grass is to be grown, also seems desirable.

Methods of Applying Fertilizer for Black Locust. Table 3 shows the effect of various methods of fertilizer placement on the growth rate of black locust. Best results were obtained by applying fertilizer in the bottom of the hole when planting black locust trees. Probably this is due to the fact that this method places the fertilizer in the root zone where moisture is present, whereas the surface or lightly buried applications place the fertilizer where the sand dries out. Without moisture the fertilizer would be insoluble and therefore not available to the plants.

Considerable care should be taken, however, when using concentrated fertilizers in the bottom of the hole. If the plant roots are placed in direct contact with the fertilizer, some injury (burning) may occur which is apt to kill the young tree. A suggested method for planting trees by placing the fertilizer in the bottom of the hole is as follows: Using a long, narrow spade sink it in the position where a tree is to be planted. Push the spade forward opening a small hole and drop in a handful of fertilizer. Remove the spade and sink it about two inches away from the original opening. Push forward again and plant the tree in the new opening. This places the tree roots out of the fertilizer area, yet the fertilizer is deep and near the roots. This added spade operation may be justified on sand.

For annual fertilization, make spot applications, covering the ground area from the tree trunk out to the tips of the branches.

Fertilizer for Pines. The data in Table 4 show that high rates of fertilizer, even when broadcast, may cause poor survival of red pines. Coniferous trees do not respond to fertilization as do deciduous trees. Low rates of organic fertilizers are

Table 3. Fertilizer Placement for Black Locust*

Method of placement	Height of trees in inches: End of 1st season	Height of trees in inches: End of 3rd season
No fertilizer	25.0	46.8
Bottom of hole	47.0	90.0
Ringed buried (inside diam. = 12 inches)	37.5	60.0
Ringed buried (inside diam. = 22 inches)	37.0	63.6
Spotted on surface (spot 2 feet in diam.)	36.0	67.2
Broadcast	30.0	78.0

*400 pounds per acre of 5-10-10.

Table 4. Survival of Red Pines at End of First Season on Fertilized Plots*

Treatment—pounds per acre	No. planted	No. alive	Percent survival	Average height in inches 3rd year
No treatment	60	15	25	14.8
Nitrogen—200 lbs. nitrate of soda	60	36	60	15.5
Lime—1,000 lbs. ground limestone	60	34	57	15.1
Fertilizer—700 lbs. 5-10-10	60	17	28	14.9
Fertilizer and limestone	60	16	27	12.9
Extra fertilizer†	60	0	0	0.0
Extra fertilizer and limestone	60	4	7	11.3

* Fertilizer was broadcast unless otherwise stated.

† Extra fertilizer means 700 pounds 5-10-10 broadcast the first year, and 300 pounds 5-10-10 spotted around the tree each succeeding year.

commonly used in nursery beds, but there is little evidence that field fertilization of pines is beneficial.

High rates of mineral fertilizers not only affected the survival of pine plantings but also slowed down the rate of growth, possibly because of fertilizer injury to the young seedlings which did survive. From these data it is apparent that little is to be gained by any fertilization for pines, and much harm can be done by overfertilization, particularly on very sandy soils. It appears that the lime used in this test served only to counteract somewhat the toxic effect of high concentrations of other minerals and is of little value as a plant nutrient for pines. A light application of nitrogen may be of some value but it is not recommended. An explanation of the low survival on the check plot may be that on these bare sands, no grass grew if fertility was lacking. The absence of a grass protection commonly causes damage to pine seedlings because of the intense reflected heat from the sand.

Black Locust a Soil Builder

Black locust (*Robinia pseudoacacia*) is a legume tree with a strong, spreading root system that feeds heavily on subsoil minerals. Being a legume it has the ability to utilize atmospheric nitrogen. Each fall, the black locust tree drops its leaves and leaf stems, forming a mat on the soil surface. Gustafson[3] reported in 1935 that better than four tons per acre of dry matter had accumulated in three years beneath a 25-year-old locust grove. He found that locust leaves contain 2.33 percent nitrogen and suggested black locust as a means of controlling sand dunes and increasing the fertility of the soil. Garman and Merkle[4] also showed that black locust materially

[3] Gustafson, A. F. Composition of black locust leaf mold and leaves and some observations on the effects of the black locust. Jour. Amer. Soc. Agron. 27:237-239. 1935.

[4] Garman, W. H., and Merkle, F. G. Effect of locust trees upon the available mineral nutrients of the soil. Jour. Amer. Soc. Agron. 30: 122-124. 1938.

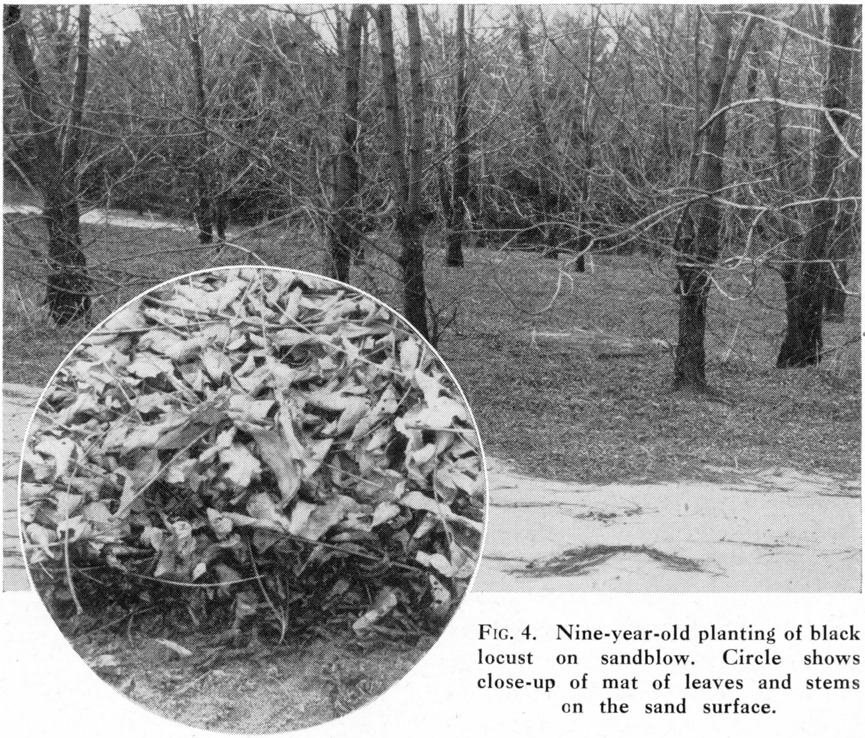

FIG. 4. Nine-year-old planting of black locust on sandblow. Circle shows close-up of mat of leaves and stems on the sand surface.

increases the readily available nutrients in the surface soil beneath the trees.

The amount of leaf mold deposited beneath a 9-year-old stand of black locust on a sandblow was determined in October, 1946, and was found to be four and one-half tons per acre (see Figure 4 above). It was concluded that most of this material was of recent deposit since any high nitrogen material decomposes quite rapidly. A chemical analysis of this leaf mold, as well as an analysis of the dry locust leaves, is reported in Table 5.

The nitrogen returned to the soil by 4.5 tons of black locust leaf mold is equivalent to 1,000 pounds of nitrate of soda per acre. The potash content is equivalent to 13 pounds of 50 percent muriate of potash, phosphorus equivalent to 100 pounds of superphosphate, and lime equivalent to 280 pounds of ground limestone. These elements, taken annually from the atmosphere and the subsoil and returned to the surface soil, are no small factor in rebuilding the fertility of the soil.

Recommendations for Revegetating Sandblows

The following procedure is suggested as being practical and economical for revegetating sandblows in Vermont. First of all, fence the area to prevent cattle from grazing

Table 5. Chemical Composition of Black Locust Leaf Mold and Dry Leaves*

Composition	Leaf mold	Dry leaves
	%	%
Nitrogen (N)	1.912	2.258
Phosphorus (P_2O_5)	0.238	0.254
Potassium (K_2O)	0.072	0.082
Calcium (CaO)	1.777	1.525

* Composition given as percentage dry basis.

it. Then in the spring, as soon as the frost is out of the ground, lay the area out in alternate 12-foot grass-locust strips and 24-foot pine strips. (See page 2.) These strips should be at right angles to the prevailing winds and the first strip should be a grass-locust strip.

Fertilize the grass-locust strips at the rate of half a ton of ground limestone and 1,000 pounds of 5-10-10 per acre. Broadcast weeping lovegrass seed, at the rate of 3 pounds per acre, on these areas and rake the lime, fertilizer, and seed into the surface in one operation. Since the grass-locust strips occupy but one-third of the total area, only four bags of limestone, three bags of a 5-10-10 fertilizer, and 1 pound of weeping lovegrass seed would be needed to stabilize an acre. It is essential to seed the grass early so that it can become established before the surface of the sandblow dries out.

Plant the black locust trees (rooted nursery stock) at 6-foot intervals in two staggered rows in the grass strips, using a small handful of 0-20-20 fertilizer in the bottom of each hole. If more rapid growth is desired, fertilize black locust annually at this rate for four or five years. For annual fertilization, broadcast about the base of the trees, covering the area extending out to the ends of the outer limbs of the tree. Locust trees and lovegrass will make rapid growth when properly fertilized. (See Figures 5 and 6.)

Early the second spring or perhaps the fall after planting lovegrass, plant red pine in the 24-foot space between the grass-locust strips with a 6-foot spacing of the trees in four staggered rows. Do not use fertilizer with pines as it would do little good and is apt to harm the young trees. The weeping lovegrass-black locust strips will have stabilized the blowing sand and, by the second year, much reseeding frequently occurs even in the space where pines are planted. Of course, lovegrass will not grow well in the pine strips without fertilizer, but there is usually sufficient growth to produce a light mulch under the unfertilized pine plantings.

Variations of the procedure outlined above may prove just as practical under certain conditions depending on the seriousness of the sandblow.

FIG. 5. Weeping lovegrass and black locust growing the second summer on sandblow.

Cost of Revegetating

The planting of weeping lovegrass in strips will cut down the cost of revegetation considerably over what it would be if the entire area were fertilized and seeded. The major cost items are fertilizer, seed, trees, and labor. The fertilizer and seed cost is reduced to a third by using the strip system. For example, to revegetate an acre by this strip method, one would need 1 pound of weeping lovegrass seed (mix seed with sand to facilitate sowing), 300 pounds of 5-10-10 fertilizer broadcast for the grass, 300 pounds of ground limestone broadcast for black locust, and 100 pounds of 0-20-20 fertilizer in holes when planting the black locust trees. The cost of the fertilizer and weeping lovegrass seed for an acre then would be about $12 to $15 at current prices. The cost of black locust and red pine planting stock might be a small item as they are quite often available through some federal or state conservation agency. The labor cost would vary, depending on that which is available. It is estimated that 20 man hours would be required to apply fertilizers and plant an acre of sandblow.

It should be emphasized that even though the cost of revegetating sandblows appears to be high, fertilization may mean the difference between success or failure. This added cost is especially justified on small areas that are eyesores and thereby affect the apparent value of the farm. Moreover, such areas are not only valueless in their present

Fig. 6. Same as Figure 5, photographed at the end of the third season of growth.

condition, but are often a serious threat to good land nearby. By planting sandblow areas to trees, it is possible that some fence posts can be harvested in 25 to 30 years from the black locust, and in 50 to 75 years the pines will be marketable timber. When the cost of revegetating is prorated over the length of time required to realize a return from the investment, the cost then is about a dollar per acre per year or less.

Summary

Methods used in Vermont for stabilization and control of sandblows in the past, which involved the use of brush or lath fences and beachgrass plantings, have been expensive. For this reason research was undertaken to determine a more economical and practical method of revegetating sandblows. The value of mulch has been recognized by several workers, but it is often difficult to obtain sufficient mulching material. The value of fertilizing weeping lovegrass for producing a mulch in-place has been demonstrated on sandblows. After stabilization of the sand with weeping lovegrass, black locust, which is a legume tree, is recommended as a soil builder and possibly as a short-time tree crop. Strips of pine can then be planted to provide a permanent vegetative cover.

The use of fertilizer is a necessity for the quick production of a cover with weeping lovegrass. This grass has an unusually extensive root system that penetrates into the subsoil and enables the plant to live under

droughty conditions. Moisture is not a limiting factor once weeping lovegrass becomes established on sandblows, but fertility is almost always extremely low on sandblows.

The natural habitat of black locust is on highly mineralized soils, especially limestone soils, but it is adaptable to various conditions of moisture and fertility. For rapid growth on sandblows, it is necessary to supply black locust with mineral fertilizers, especially until the tree gets a good root system established.

If a large amount of brush matting is available, it can be used to good advantage to stabilize the sand around the young pine trees and thus eliminate the need for a quick-growing grass mat. However, sufficient brush matting is usually difficult to obtain and apply, and the beneficial results are not as satisfactory as when strips are fertilized and planted to locust trees and lovegrass.

The value of black locust as a soil builder is shown by an analysis of the dry leaves and the leaf mold on the surface of the soil. The sand beneath an eight-year-old grove of black locust has already begun to take on the color and appearance of a somewhat normal soil.

Red pine appears to be better than other pines for use on sandblows after the sand has been stabilized. It is less susceptible to insect and disease damage than other pines and is also a valuable species for lumber purposes. Its use affords a long-time cover that has a future value as marketable timber.

The expense of revegetating sandblows by the methods proposed here is considerably less than previous methods studied. For an acre, $12 to $15 at current prices will cover the cost of weeping lovegrass seed and fertilizer and in many cases this would be the only cash outlay. The methods suggested here for stabilizing sandblows do not preclude the use of brush mulching which may be available from woodlot improvement operations on the farm. However, when brush material is not available, the production of a mulch is possible by the methods outlined here, and revegetation of sandblows becomes a practical undertaking.

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