is a consulting turfgrass specialist. As such he has studied many of the underlying problems in course construction which lead to turf maintenance problems. He lists five key causes of problem greens which affect operators and owners of golf courses.

Specific Problem Areas:

No. 1 problem, according to Calhoun, exists because many golf courses were built years ago with only native soil of the area. From year to year various types of topdressing have been added, layer upon layer. Next problem, he says, is the fact that many courses have been built with poorly engineered plans and specifications. No. 3 problem area has been the "cutting of corners" because of a shortage of funds or financing. Poor supervision or inspection during construction of greens accounts for many not meeting specifications. And finally, the fifth problem listed by Calhoun is the "built-in" problems which result from poor maintenance procedures, particularly regarding use of topdressing and soil amendments.

Seasonal changes also unduly affect problem greens. Most greens, Calhoun states, will recuperate in the fall and the following spring after being given a good renovation treatment. Areas where cold winters prevail benefit by the natural aeration of freezing and thawing.

Then in the spring, grass on such greens gets a good start and by May is in excellent shape. But deterioration begins shortly with heavy foot traffic which reaches a peak during the hottest part of the summer. Greens soil which was a lively dynamic medium in the spring becomes a compressed often soggy plastic-like mass. Pore space is lacking to the point that life-giving oxygen for grass growth is choked off. With this low oxygen supply condition, excessive (toxic) carbon dioxide concentration and

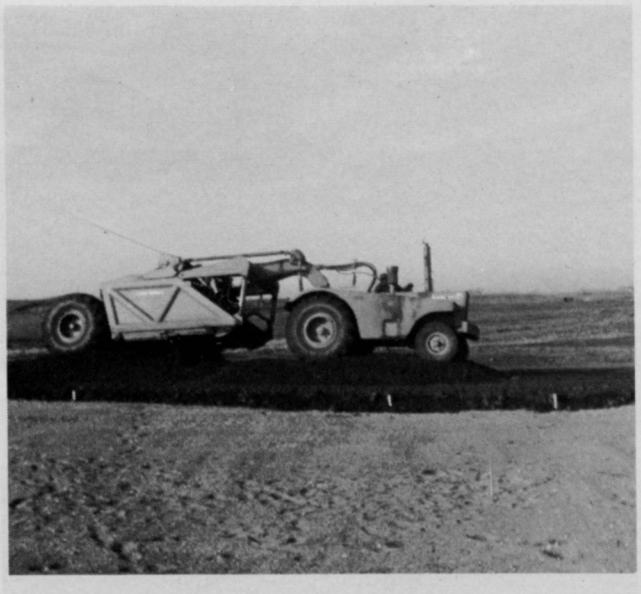
Step 1. Roto-tilling soil in 20-foot strips permits equipment to work on both sides without compacting. Soil has previously been spread to rough 4-inch depth by grading.

Step 2. Peat (1½ inch depth) is added to roto-tilled topsoil. Work is being done at Jesup Golf and Country Club, Jesup, Ia. Considerable work was done by hand labor.

Step. 3. Calculated amount of sand was dumped beside mixing strip prior to spreading. Then sand (1½ inch depth) was placed on top of peat. Doing work in strips facilitates mixing with equipment.

Step 4. Sand, peat, and topsoil are mixed thoroughly with roto-tiller. This final mix will be moved to green site and carefully spread to avoid compaction.

Green site prior to adding mix. Mix is pushed onto site. Heavy equipment is used on green only after buildup of 10 inches or more of topsoil mix.



Equipment such as this used at Jesup, Ia., course is practical for moving and handling topsoil mix.

Drainage system is installed prior to forming of basin for green. This important step is often neglected.

other toxic byproducts such as methane and cyanide derivitives are often formed. Research further shows that at the same time, physiological processes of water and nutrient uptake are drastically curtailed or altered. This causes unbalance in the other numerous functions of normal plant behavior.

With a physiologically disabled turf population, high temperature periods often bring on failure. Many golf greens do not reach this critical stage but only approach it by degrees. Good judgment and luck often enable the superintendent to pull the green through in fair shape.

Solutions:

Poorly constructed greens require many unnecessarily wasteful and expensive hours of maintenance. Calhoun makes this statement advisedly because superintendents often have to do their best with what is available. But it may be wise, he believes, to consider spending some extra money in the beginning, knowing that it will be amortised in savings over the years. Choices for the golf course administration are (1) to build greens properly from the start, (2) to rebuild problem greens at one time or piecemeal as budgeting permits, or (3) maintain, renovate, and gradually improve existing greens. The latter is usually standard procedure.

Where the decision is made to get along with problem facilities, the fundamental procedure is to open or fracture the soil, and preferably permit entrance of desired soil amendment materials to improve air and water circulation. But as the budget permits, Calhoun believes it best to start a rebuilding program for greens. Money saved in lower maintenance costs will soon pay the original bill.

Green Structure:

Basically, a well structured soil which provides a good putting surface will have the ability to hold properly sized pore spaces for adequate water and air ciruculation within the growth medium.

Construction features of such a green involve four key components. First is the greens topsoil mixture for a growth medium to accommodate grass. No. 2 is a coarse ingredient such as concrete sand to impede downward movement of the topsoil mix. Then, thirdly, a coarser ingredient with particle size of ¼- to ⅜-inch diameter, such as pea gravel, is needed to permit rapid downward movement of excess water but which will hold back the finer material. Finally, the fourth feature consists of hollow, permeable conduits to carry away the excess water as it drains off. The greens section of the United States Golf Associ-

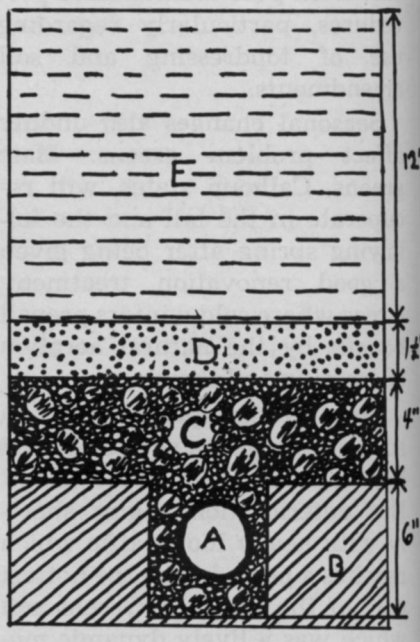


Figure 1. USGA Cross Section of a Putting Green Profile Showing a Trench and Tile Line. A. 4-inch diameter tile. B. Subgrade of native soil or fill material. C. Gravel—preferably pea gravel of approximately ¼" diameter. Minimum thickness 4 inches. D. Coarse sand—this sand should be a size of 1 mm. or greater. One and one-half to 2 inches in thickness. E. Topsoil mixture. Minimum thickness of 12 inches.

ation must be credited for the original concentrated research to develop an idealized green profile. Figure 1 shows a cross section of the USGA standard specifications.

The USGA recommends a loose, 12-inch minimum thickness layer of well drained topsoil mixture, a 1½- to 2-inch layer of coarse sand with particle size 1 millimeter or greater and a 4-inch minimum thickness layer of pea gravel of approximately ¼-inch diameter particle size. Water will drain through these layers into a 4-inch tile drain.

Because placing a layer of sand over a layer of gravel without mixing the two in the process is a problem, few contractors are willing to do the meticulous job necessary for such an installation. Further, golf course administrations often balk at the relatively high cost involved. So, Calhoun says, a compromise method is often used which consists of using a mixture of sand and gravel in a single 5- to 6-inch layer under the topsoil. Excess water then drains through this layer and into the conduits. This permits quite rapid although slower drainage and at the same time impedes the downward movement of the topsoil mixture. See Figure 2.

Topsoil Mixture:

Calhoun deals in basic fundamentals in describing a good green topsoil mixture. Ordinarily, he says, it is made up of a natural native soil, sand, and a good quality of somewhat decomposed hypnum or sedge peat (See picture series on topsoil mixture used at Jesup Golf and Country Club, Jesup, Ia., construction of which was designed and supervised by Calhoun). Commercial products are on the market, Calhoun says, other than these mentioned which also do a good job. The final determination as to how much of each ingredient to use is best left for judgment of a qualified specialist. Such a specialist can provide a laboratory physical test of the materials to be used along with recommendations and specifications. At the same time it is advisable to arrange supervision and inspection during the progress of construction.

As a rule, the range of sand volume to be used will fall between 45 and 65 percent of the total final volume. The peat, Calhoun believes, should consist of 10 to 20 percent of the total. It is commonly believed that a soil with 30- to 50-percent sand in the natural state would not require much additional sand, but this is not the case. The sand in most natural soil consists of very small particle sizes and tends to clog rather than contribute much to the drainage and circulation characteristics necessary in the final profile.

In putting the topsoil mixture ingredients together, Calhoun has found it best to lay out 20-foot wide strips for mixing. This permits equipment to work on each side of the strip without disturbing the mix during the process.

Further, when the mixture is hauled and placed beside the green it can be worked onto the green with heavy equipment. But he makes sure that the equipment never crosses the green until at least 10 inches of the topsoil mixture is in place. This is done by working the mix onto the green ahead of the machine.

Costs are difficult to estimate, Calhoun says, because of the difference in wages between areas. Generally, he has figured labor at $3 per hour which makes materials handling run 40 to 50¢ per square foot. Thus, a medium sized green of 5000 square feet will run from $2000 to $2500.

Summary:

Fundamentals of proper green construction, Calhoun strongly believes, must be carefully followed to avoid later problems and high maintenance costs. Mistakes which appear small during construction can cause future troubles. It is as important money-wise and efficiency-wise, he says, to hire a professional to design the green and to administer construction, as it is for an expensive building. When done right, excellent greens and happy golfers result, which is the primary purpose for the venture.

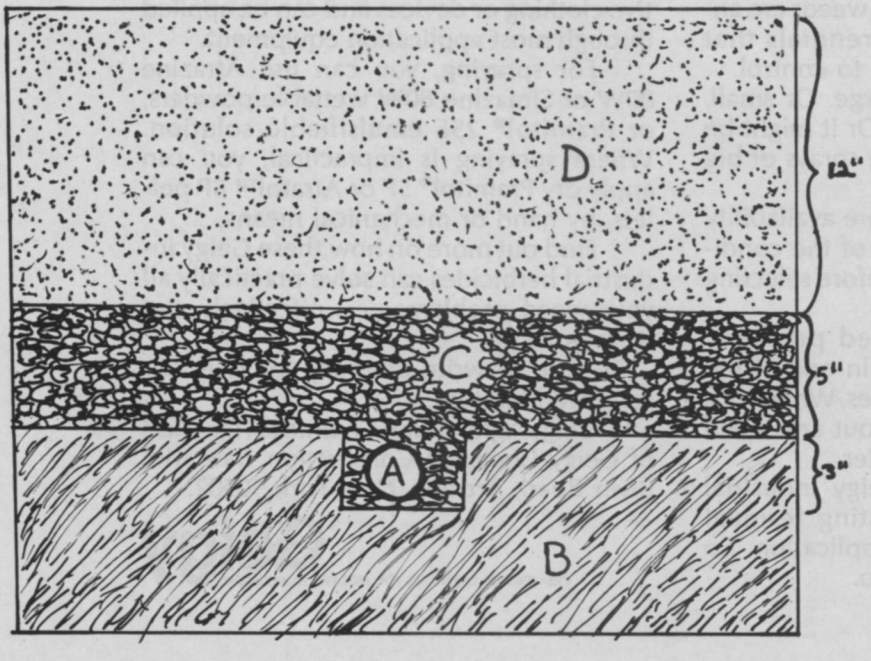


Figure 2. Cross Section of a Putting Green Profile with Simplified Construction and Lower cost. A. Hollow performance drainage conduit. B. Subgrade. C. Coarse sand-gravel mixture. D. Topsoil mixture. (45-65% sand).

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In Brief:

Niagara Chemical Division of FMC Corporation has developed a urea-carbamate compound which shows high promise as a soil sterilant for railway, utility, and highway rights-of-way and for industrial sites. The new broad spectrum herbicide, designed specifically for non-crop uses is in the final trial stages and will be test marketed for one year. WEEDS TREES AND TURF magazine presents in this October, 1968 issue a complete report on the new product.

In Final Testing Stages for Non-Crop Uses

New Broad Spectrum Herbicide

DEVELOPMENT of a broad spectrum herbicide that demonstrates high effectiveness as a soil sterilant for railroad, highway and utility rights-of-way, industrial sites, and non-crop farm areas has been disclosed by FMC Corporation's Niagara Chemical Division.

The material, substituted urea-carbamate compound that combines the recognized herbicidal activity of each of these molecular structures, has received an experimental permit that allows test marketing for a period of one year. Under development for the past four years, it is expected to receive full registration during the current year.

Called Tandex™, the herbicide is distinguished by its ability to control a wide spectrum of weeds, including woody species, and its low order of toxicity. It can be applied as either a preemergence or postemergence treatment to combat annual and perennial broad-leaved weeds and grasses as well as woody species.

Formulations:

In its final testing stages, Tandex herbicide is available as an 80% wettable powder (80WP) and as a 4% granular (4G). The wettable powder can be applied in either water or herbicidal oil. Oil or oil-water mixtures are preferred over water where rapid contact kill of vegetation is desired. Addition of a wetting agent at levels up to 1% has also been found to increase the contact activity.

Biological Activity:

Although the new herbicide is primarily absorbed through the roots, it is also absorbed slowly through the foliage. Optimum results have been achieved when sufficient moisture was available after treatment to carry the material into the root zone.

Weeds may still appear after preemergence application, but they soon become chlorotic and the foliar tissues subsequently dessicate and die. Woody species may bear some leaves after treatment, but they also gradually become chlorotic and die. Postemergence applications have been found most effective when applied to rapidly growing weeds or brush.

Soil Sterilization:

As a soil sterilant the new herbicide appears most promising for use along railroads, highway shoulders, under asphalt or cement roads, runways, parking lots within military installations, tank farms, industrial sites and in non-crop farm areas.

Tandex 80WP has been effective as a wettable powder or granular formulation in controlling a broad spectrum of annual broadleaf weeds and grasses at a rate of 2.4 to 4.8 pounds active ingredient per acre. It has been

New broad spectrum herbicide, Tandex™, was applied along this industrial fence in Oildale, Calif., to control annual broadleaf weeds and grasses. Plot in foreground was treated with 7.5 lbs. per acre of Tandex 80WP. Plot behind it was treated at 3.75 lbs. per acre. Application was made in March, 1966. Photo was taken in May, 1967.

applied at 5.6 to 9.6 pounds active ingredient per acre where fibrous-rooted perennial weeds predominate. A rate of 12 to 24 pounds active ingredient per acre may be required to provide long term residual control of perennial weeds having extensive underground rootstocks. The higher levels of dosage ranges are needed for soils high in clay or organic matter or where existing weed growth is approaching maturity.

The use of sterilant herbicides frequently involves an initial treatment followed by annual applications at lower dosages to maintain vegetation control. On areas containing diverse weed populations, Tandex 80WP has been successfully employed at from 10 to 15 pounds per acre the first year, 6 to 8 pounds the second year, and 3 to 4 pounds in subsequent years. Higher application rates are necessary for use on areas predominantly infested with deep-rooted perennial weeds on heavy soil-types and in areas subject to high rainfall.

Brush Control:

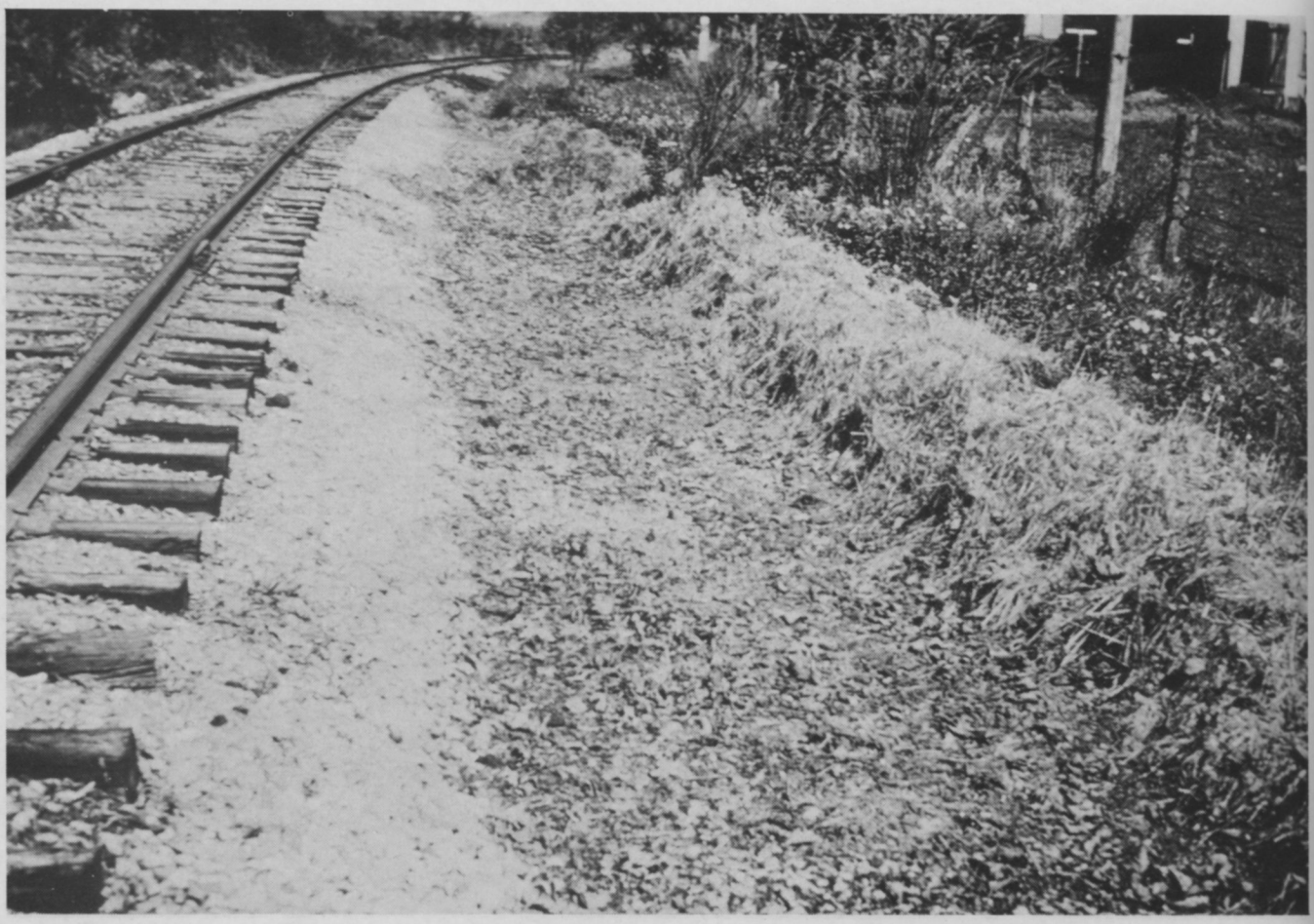
To control brush along rights-of-way, fence rows, and other non-crop areas, where an understory of sod is not to be completely eliminated, a 3-pound rate of Tandex 80WP (plus surfactant) per 100 gallons of water has been sprayed on the foliage. When applied at full-foliage time, this treatment controlled a wide variety of brush species, including conifers and maples, both of which are difficult to control with 2,4-D and 2,4,5-T or their combinations.

Excellent control of hardwood and coniferous brush species has been noted with the use of foliar sprays containing 1.5 pounds of Tandex 80WP combined with 2-pound acid equivalents of a mixture of 2,4-D and 2,4,5-T esters per 100 gallons of spray in areas where dangers from the toxic vapors of the phenoxy compounds do not exist.

Basal soil treatment with a 10% granular form at rates of 1 to 5 ounces formulated material per shrub has provided good control of interior live oak and California scrub oak. Granules were scattered evenly around the base of shrubs within the drip line. Broadcast applications at 10 to 20 pounds active material per acre have resulted in good control of interior live oak and yerba santa and have given complete vegetation control in firebreak areas.

Treatments:

Label directions in the permit



Annual, perennial, and woody weed species along this Maryland right-of-way were treated in June, 1967, with Tandex 4G at 350 pounds per acre (14 lbs. actual). Picture was taken in October, 1967.

issued for experimental use of Tandex recommend that application of either the wettable powder or the granular be made just before or during the period of active growth of the weeds to be controlled. For best results, sufficient moisture from rainfall or artificial means is necessary after application to carry the chemical into the root zones.

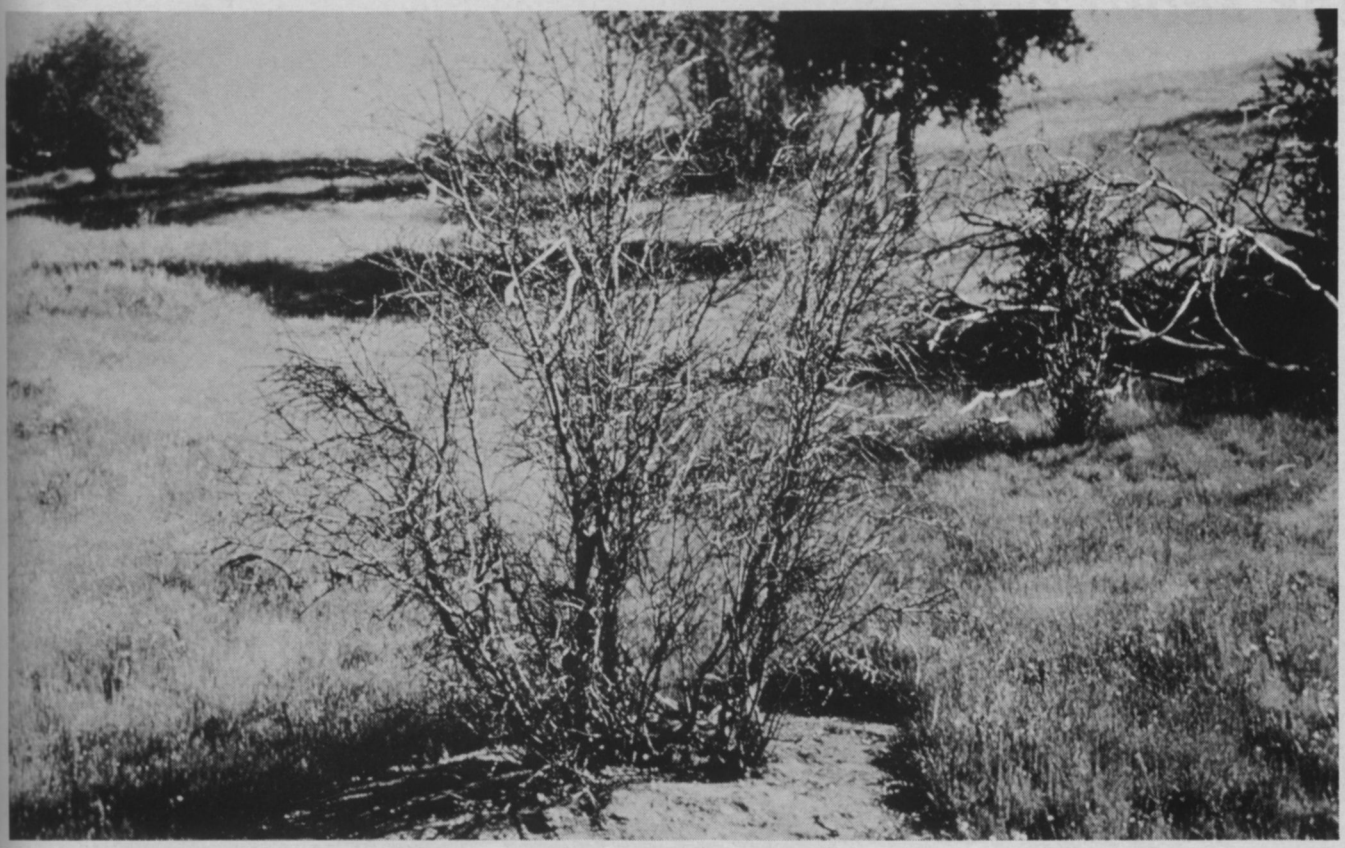
A dosage of 3 to 6 pounds of Tandex 80WP or 60 to 120 pounds Tandex 4G per acre is suggested to control: barnyardgrass, bromegrass, bluegrass, buckhorn plantain, cheatgrass, crabgrass, cinquefoil, clovers, cheeseweed, dog fennel, fiddleneck, foxtail, lambsquarter, pigweed, puncture vine, purseland, ragweed, smartweed, sudangrass, thistles, and turkey mullein.

A rate of 7 to 12 pounds of Tandex 80WP or 140-240 pounds of Tandex 4G per acre is suggested to control bindweed, brambles, docks, gumplant, ground cherry, Canada thistle, horsetail, milkweed, nettles, quackgrass, sheep sorrel, velvetgrass, and western ragweed.

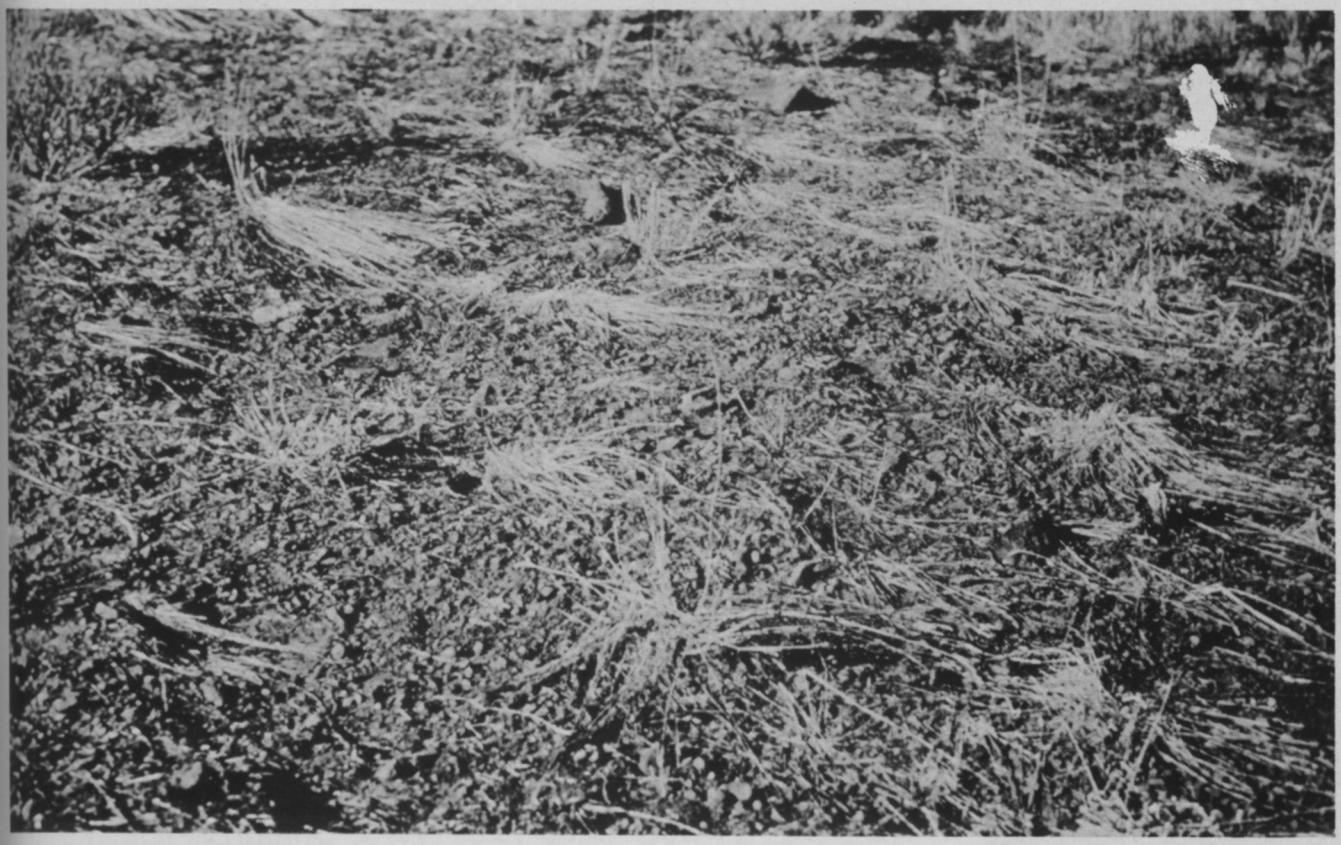
To control Johnsongrass, an application of 5 to 10 pounds of Tandex 80WP or 100-200 pounds of Tandex 4G per acre during the dormant season is specified. It should be followed later with foliar applications of MSMA at 4 pounds per acre.

Label dosage of 15 to 30 pounds of Tandex 80WP or 300 to 600 pounds of Tandex 4G are suggested to control: ash, aspen, elderberry, hawthorn, sumac, Bermudagrass, dallisgrass, nutgrass, vaseygrass, field bindweed, poison ivy and hedge bindweed. For saltgrass control restrict treatments to soils low in organic or clay content.

Along this highway in San Jose, Calif., Tandex 80WP was applied at 7.5 lbs. per acre in March, 1967, followed by a maintenance treatment rate of 3.75 lbs. per acre in February, 1968. Picture was photographed in April, 1968.



This interior live oak at North Fork, Calif., was treated with Tandex 4G at 500 pounds per acre (20 pounds actual) in January, 1968. Picture was taken in April, 1968.



Among the weeds controlled at this location in Susanville, Calif., were: crested wheatgrass; downy brome; various broadleaf weeds, sagebrush; horsebrush; and lupine. Tandex 4G was applied at 100 pounds per acre in November, 1966. Picture was taken in September, 1967.

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