Preventive Weed Control—Methods and Equipment

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Weed control on the farm costs less when sources of weed infestation are eliminated. The United States Department of Agriculture has estimated the average annual loss in the United States due to weeds at five billion dollars (1)[2]. The loss has been described by Sylwester and reported by Anderson (1) , as being the greatest single loss after soil erosion facing agriculture today.

These losses can be reduced by consistent programs of weed control on non-crop lands. In the western states, about 6 percent of the land area within irrigation projects is made up on non-crop lands such as canals, laterals, drainage ditches, rights-of-way, farmsteads, farm roads and farm ditches. This comparatively small area plus public rights-of-way and fence rows probably are sources of most weed infestation of irrigated fields. Not to be overlooked, however, are watershed areas which contribute water supply to projects. Weedy plants on watersheds above irrigation projects shed seeds into the water and thus they reach irrigated fields. Consequently, practical control measures should include watershed areas along with ditchbanks, county and state roads, fence rows, and other non-cropped land.

Benefits of preventive weed control programs are not restricted to savings on the farm. General benefits of roadside and utility line spraying programs listed by Sylwester (2) include:

> 1. Eradication of noxious weeds, 2. Easier mantenance, 3. More permanent control, 4. Elimination of traffic hazards, 5. Elimination of health hazards, 6. Improved utility services, and 7. Improved beauty.

Experience with weed control programs along irrigation and drainage ditches on Reclamation projects has shown that other benefits are:

> 1. Conservation of water by decreasing evapo-transpiration and seepage losses; 2. reduction of operation and maintenance costs by facilitating inspections, preventing ditch breaks, decreasing siltation in ditches, allowing more accurate measurement of water, and prevention of erosion.

A major benefit of ditchbank weed control programs is the prevention of weed seed spread by irrigation water. To determine amounts of weed seeds carried by irrigation water, Wirth (3) , placed a flat screen in a farm turnout on the Kendrick Irrigation Project, Wyoming, and collected weed seeds for a period of one hour. The test was conducted in September, 1948. The ditchbank for about one-half mile above the turnout was predominantly covered with sweet clover and Russian thistle. The total seed count for the hour indicated 326 seeds consisting of the following: Sweetclover—306, Downy Brome—1; Russian Thistle—3; Wild Salsify—2; and Wild Lettuce—14. Work done by Hope and reported by Bruns and Rasmussen

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[2] Numbers in parentheses refer to literature cited.

(4) shows that the flow in an irrigation ditch could carry a weed seed load which amounts to a deposition of 170,800 seeds per acre of land in one G-inch irrigation.

The influence of underwater submergence on the viability of weed seed has been investigated by Bruns and Rasmussen (4) . They concluded:

> 1. Germination of Canada thistle seed after removal from the water increased from 53 to 92 percent during the first two months. The average germination of the seed dropped below 6 percent after ten and eleven months when water temperature was high. However, germination increased again as water temperature declined. 2. The germination of Russian Knapweed seed increased from one-half percent to 57 percent after two months of fresh-water storage and then fluctuated between 1 and 30 percent with a rise and fall in water temperature during the remainder of the storage period. 3. No germination of poverty weed seed occurred before two months of fresh-water storage. The germination of this weed increased to a peak of 43 percent after seven months, but dropped to less than 3 percent after 10 and 11 months. Germination again increased as water temperature declined. 4. Germination of morning glory seed fluctuated between .2 and 9 percent except for a peak germination of 17 percent after 18 months of storage. 5. White top seed either germinated or disintegrated appreciably in fresh-water storage and 98 percent or more of the seeds were no longer viable after 6 months.

From the above, itis apparent that irrigation water is an effective agent for disseminating weed seeds.

The most important element of preventive weed control programs is a consistent year-by-year application of adapted weed control practices directed toward eventual replacement of weeds with desirable vegetation. The control program should be developed after a survey of the entire weed problem. This includes type, distribution and extent of weed infestations; soil conditions, topography and drainage of infested areas; accessibility of infestations; sources and quality of water supply; cropping patterns adjacent to infested areas; damages done by weeds; and the justifiable expenditure for control. An analysis of the foregoing factors determines the methods and equipment best suited to tackle a particular problem.

Preventive weed control on ditch banks employs mechanical, chemical and vegetative methods of control. General costs of these various methods based on Reclamation irrigation project experience are given in Table 1. These are general costs and may vary widely depending upon conditions and the size of ditch banks. The details of weed control techniques used on irrigation systems have been described by Balcom (5) .

Table 1.—Some Typical Weed Control Costs for Irrigation Systems.

Method	Cost Per Unit	Method	Cost Per Unit
Burning (Hand Labor)	$50.00/mile	Spraying 2,4-D (Annual Weeds)	$ 5.00/acre
Burning (Power Equipment)	7.00-28.00/mile	Soil Sterilization (CMU)	140.00/acre
Mowing (Power Mower)	9.00/mile	Soil Sterilization (Borascu)[1]	150.00/acre
Spraying 2,4-D (Willow Control)	13.00/Acre	Grass Planting	16.00/acre

[1] Concentrated Borascu

Principal mechanical control methods for annual and biennial weeds are burning and mowing, preferably used when ditch banks traverse cropped areas which are susceptible to injury by 2,4-D or other chemicals. Mowing is generally used on easily travelled, smooth ditch banks while burning technique is used on rough, rocky irrigation ditch banks. An advantage of both methods is that their timely application will prevent the spread of weed seeds. The plans and specifications for various types of burning equipment used on Reclamation projects have been compiled by Bowser (6) .

The wide variety of weed control chemicals and application methods changes rapidly with results of continuous widespread research. A compilation of chemical methods which have been satisfactorily used is given in Table 2.

Table 2—Chemicals Used to Control Land Weeds on Irrigation Systems.

I. Selective Herbicides
   1. 2,4-D Ester, Amine (1 to 5 lbs. acid/A)
   2. 2,4, 5-T (1-5 lbs./Acre)
   3. Sinox (1 gal. in 100 gals, water at rates 80-120 gals./A)
   4. TCA (Perennial grasses 80-150 lbs./A; Annual grasses 20-60 lbs./A)

II. Contact Herbicides
   1. Water-soluble: sodium chloride, calcium chloride, ammonium sulfamate, sodium chlorate, sodium arsenite, sulfuric acid.
   2. Diesel Oil Spray (120-150 gals./acre—several applications per season to kill weedy grasses)
      (a) Pentachlorophenol, dinitro secondary butyl and amyl phenols (4 lbs. in 100 gals, oil)
      (b) Dow General, Sinox General, or Chipman General (114 lbs. in 100 gals, oil)
   4. Aromatic Oils
      Shell weedkiller 20, Standard weedkiller 2, Richfield weedkiller A, and General Petroleum weed exterminator oil (30-50 gals./A)
   5. Oil Emulsions
      (a) 4 lbs. Pentachlorophenol, 6 gals. Diesel Oil, 4/5 lbs. wetting agent, in 94 gals, of water
      (b) 2-3 pints Sinox, Dow, or Chipman General, 15-30 gallons oil made up to 100 gals, with water.

III. Soil Sterilants
   1. Sodium chlorate (6 lbs./sq. rod)
   2. Borax (30 lbs./sq. rod)
   3. Borascu (30 lbs./sq. rod)
   4. Concentrated Borascu (15 lbs./sq. rod)
   5. Polybor-chlorate ($1^1/_2$ lbs. in 1 gal.—covers 50 sq. ft. or 8 lbs./sq. rod)
   6. CMU (10-60 lbs./acre)

IV. Soil Fumigants
   1. Carbon disulphide
   2. Shell DD
   3. Chloropicrin
   4. Ethyl Dibromide

Equipment used for weed spraying is described by Bowser (6) , Akesson and Harvey (7) and Price, et al (8) . After reviewing the various types of spraying equipment used on Reclamation irrigation projects, Graham (9) developed the following specifications for spray equipment:

Spray pressure—75-150 pounds per square inch; 100 psi generally adequate.

Pumps—Capable of supplying required volume at 100 pounds

per square inch . . . tendency is toward rotary or turbine type pumps. A self-priming pump is preferred and should be available for filling the tank.

Types and sizes of spray tanks—noncorrosive, easily cleaned, no leakage. Tank size depends on pump capacity and water availability. For a pump delivering 30 to 50 gallons per minute the most economical capacity is 300 to 500 gallons . . . minimum tank capacity 10-15 gallons for each gallon per minute required by the spray boom.

Agitator—A requirement of all spray units; should operate while workers fill the tank and while spraying.

Booms—$1^1/_4$ inch pipe for booms with capacities up to 18 gallons per minute; $1^1/_2$ inch for larger capacities; boom length depends on spraying conditions.

Nozzles—Uniformly spaced 12 to 18 inches and set at a height for double coverage; nozzles set on side of boom to prevent plugging; shutoff valve in supply line leading to boom where it can be easily reached; relief valve installed between pump discharge and stop-cock; pressure gauge installed between pump discharge and stop-cock.

Handgun—Should be on all equipment.

Although equipment meeting these specifications has been found to operate satisfactorily, many enginering improvements still remain to be made. Anderson (1) , in discussing chemical weed control equipment, lists the following challenges to the agricultural engineers.

The equipment should more satisfactorily resist corrosive, abrasive and other deleterious effects of a wide range of weed and other farm control chemicals. Simpler, more effective, and more economical pumps should be designed. Functionally designed long-life nozzles with greater attention to particle size and pattern should be developed. Working parts should be arranged into more compact and practical mountings for tractors in the case of tractor-mounted, tractor-powered units. The use of directional spray equipment and shields to protect the pay crop should be develpoed further.

Experience on Reclamation projects has aptly demonstrated that weeds on irrigation systems can be controlled with least expense by establishing stands of desirable grasses. In Region 7 of the Bureau of Reclamation, it takes about five years to establish solid grass stands with such grasses as smooth brome, crested wheatgrass, western wheatgrass, intermediate wheatgrass and sand love grass. The. grasses are planted in mixtures. A 50-50 mixture of smooth brome and crested wheatgrass. has proven highly successful in south central and western Nebraska. While grasses are being established, undesirable vegetation is reduced by spraying 2,4-D. Then following establishment of grasses, ditch banks can be pastured under a controlled grazing program. In this way, weed control costs become and remain minimized . . . beneficial use of the ditch banks is made . . . weed seeds are not spread . . . and erosion is reduced.

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