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Ropewick Applicator for Ditchbanks[1]

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ABSTRACT

A ropewick applicator designed to apply glyphosate to reed canarygrass (*Phalaris arundinaceae* L.) and other species on the slopes of ditchbanks was constructed and evaluated. Weighted dangling ropes suspended from a herbicide manifold penetrate the vegetative canopy and wipe herbicide on plants of various heights. A hydraulic motor and ram adjust the ropewick vertically and horizontally to permit treatment of weeds on the irregular slopes of ditchbanks. Weeds on ditchbanks with a slope of up to 1:1 may be treated with the applicator. Glyphosate applied through the ropewick generally controlled reed canarygrass as well as or better than when broadcast sprayed at 1.7 kg ai/ha.

Keywords: Phalaris arundinaceae, surfactant, selective application, glyphosate, irrigation water, drift control.

INTRODUCTION

The many niches present on ditchbanks serve as ideal habitats for a host of weed species. The identification of seeds of 164 plant species in the water of two irrigation canals and in the Columbia River near Paterson, Washington (5) indicates the great diversity of species that are adapted to ditchbanks. Many short, perennial plants with fibrous roots that do not interfere with the flow of water and whose seed does not pose a threat to irrigated farmland are desirable; they reduce or prevent erosion, compete with invading weed species, and provide wildlife habitat. Conversely, the most troublesome weeds are tall, rhizomatous and perennial. Improved methods are needed to control weeds selectively on ditchbanks. Only three postemergence herbicides are registered for use on ditchbanks of irrigation canals. Dalapon (2,2-dichloropropanoic acid) controls grasses selectively; 2,4-D [(2,4-dichlorophenoxy)acetic acid controls broadleaf plants selectively; and glyphosate [*N*-(phosphonomethyl)glycine] is non-selective. Many of the detrimental, as well as beneficial, plants of ditchbanks are grasses. Thus, with available herbicides and traditional spraying equipment it is difficult to control tall growing weedy perennial grasses without killing or seriously injuring most of the shorter desirable grasses (4). Also, some irrigation districts do not use 2,4-D on their rights-of-way because of potential drift to susceptible crops. Under such circumstances, the weeds are not controlled at all or they are controlled mechanically.

The ropewick applicator was designed to apply non-selective translocatable herbicides selectively to weeds that grow taller than crop plants. Several variations in the design and operation of the ropewick applicator were reported following Dale's description of the technique (2). These applicators were designed to control weeds on relatively level land (1, 3, 7, 8, 9), or on uneven, rolling terrain characteristic of pastures and rangeland (6). These designs are not suitable for treating weeds on the sloping, non-uniform banks of ditches and canals. We have constructed and evaluated a ropewick applicator consisting of multiple dangling ropes that are attached to a hydraulically controlled frame. The equipment enables the operator to easily adjust the angle of the ropes to conform to the slope of the ditchbank and to move the ropewick vertically or horizontally during application. Moreover, the dangling ropes let the herbicide contact upper and lower surfaces of leaves within the vegetative canopy.

MATERIALS AND METHODS

General description of applicator. The applicator consists of four major components shown in Figure 1a. Two of the components are used to adjust the ropewick to the proper angle (slope) and horizontal position on the ditchbank, and two are used to apply the herbicide.

The A-frame is a pivot point for the ropewick support frame. The support frame may be raised over small spoil banks, large rocks, or other irregularities commonly present on the upper slopes of ditchbanks by changing the angle of the A-frame (Figure 1b). The telescoping ropewick support frame, operated by a hydraulic motor geared to a roller chain (Figure 2a), moves the ropewick horizontally. Maximum extension of the ropewick is 3.4 m beyond the A-frame (Figure 2b). This feature is especially convenient when treating along the margins of canals where the distance between the bank and roadway is irregular and for treating clumps of vegetation that extend beyond the canal margin.

Components used to apply the herbicide are two ropewick manifolds and a pressure equalizing tank. The ropewick manifolds, constructed of polyvinylchloride (PVC) pipe and tees, support the ropewicks and serve as a conduit and final reservoir for the herbicide solution. One end of each rope is formed into a brush-like wiper and the other end is fitted with a compression fitting for attachment to a tee in the manifold (Figure 3). One of each pair of ropes is weighted to prevent the ropes from becoming entangled and to penetrate the canopy. The vented pressure equalizing tank (Figure 4) is supplied with herbicide solution from the main herbicide supply reservoir (located on the tractor) by the spiral hose. A float valve in the equalizing tank maintains the tank one-half full, and the vent reduces the head pressure to atmospheric pressure

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[2]Res. Agron. and Biol. Res. Tech., respectively. Agric. Res. Serv., U.S. Dep. Agric., Irrigated Agric. Res. and Ext. Ctr., Prosser, WA 99350.

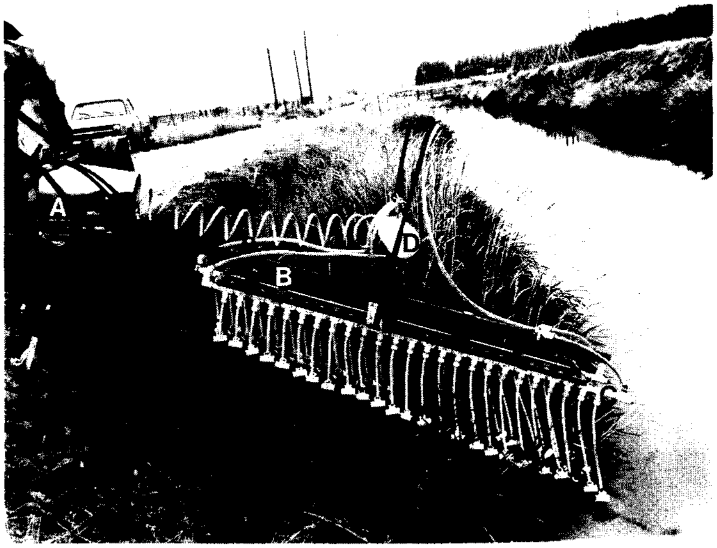

Figure 1a. Ropewick applicator positioned on a ditchbank infested with clumps of reed canarygrass. A. Hydraulically controlled A-frame to change the angle of the ropewick. B. Telescoping ropewick support frame extended about 0.5 m. C. Ropewick manifold containing vertical ropes spaced 7.6 cm apart. D. Vented pressure equalizing tank.

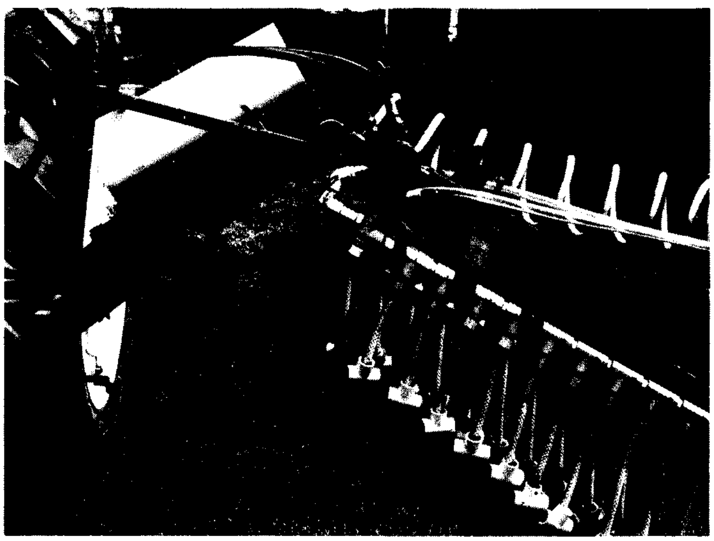

Figure 1b. The A-frame in an upright position to permit the telescoping frame and ropewick to extend over spoil banks that are common along the upper slope of irrigation canals.

before the herbicide solution is released into the ropewick manifolds. The pressure equalizing tank is fastened to a support rod by eye bolts which serve as a hinge. Thus, the equalizing tank is maintained in a relatively level position, regardless of the angle of the ropewick support frame.

Detailed description of applicator. The A-frame is constructed of 2.5 cm square, hollow steel bar (3mm wall thickness) that extends 60 cm beyond the outside edge of the tractor tire. The hydraulic cylinder (30 cm stroke) located in the center of the A-frame and attached to a pivot at the distal end of the A-frame controls the angle of the ropewick support frame (Figure 2a). A pivot point at each corner of the A-frame enables the operator to readily

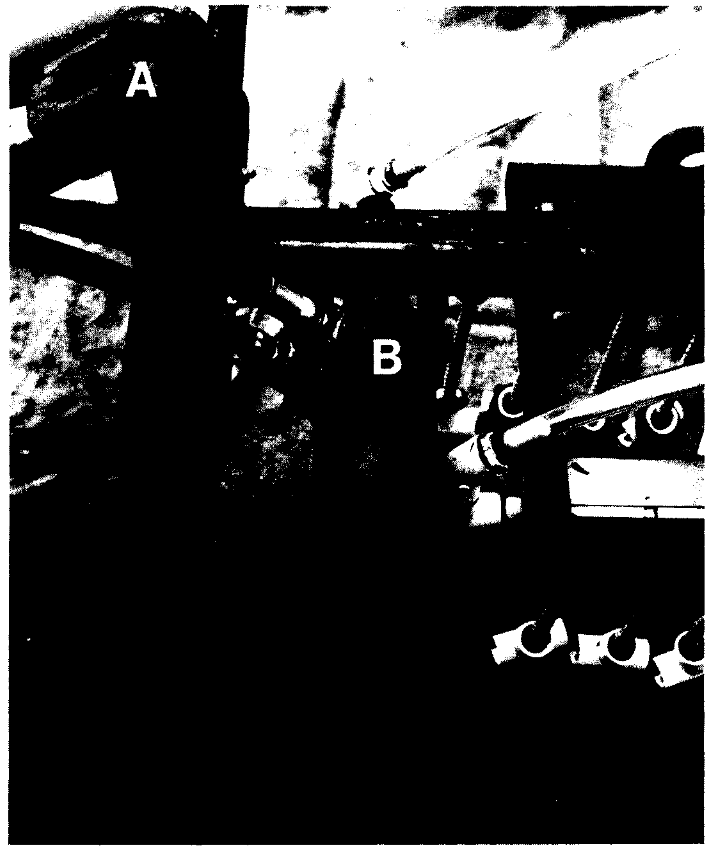

Figure 2a. A Distal end of A-frame that contains the hydraulically controlled pivot for changing the angle of the telescoping ropewick support frame. B. Hydraulic motor to operate the roller chain, which moves the telescoping ropewick support frame horizontally.

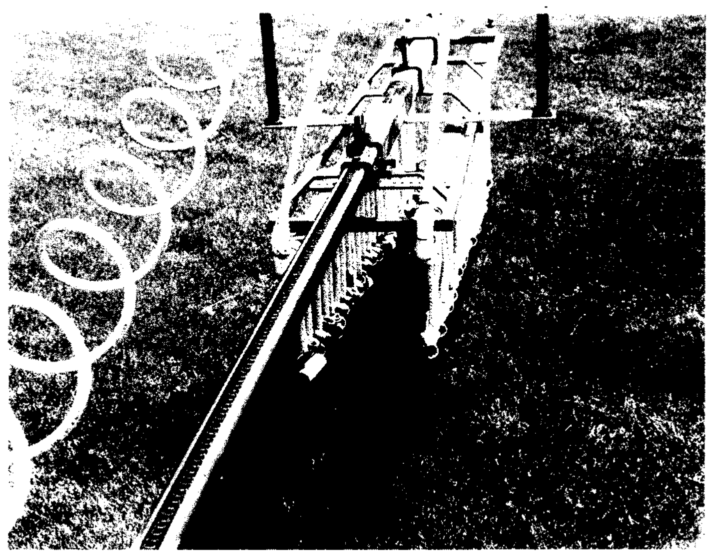

Figure 2b. Ropewick support frame in extended position exposing the roller chain.

change the angle of the frame (Figure 1b). For this pivot, a 5.7 cm diam pipe (3mm wall thickness) is welded to the square tubing and a 7 cm diam sleeve (6.3mm thickness) over the pipe forms the pivot. The sleeve is held in the

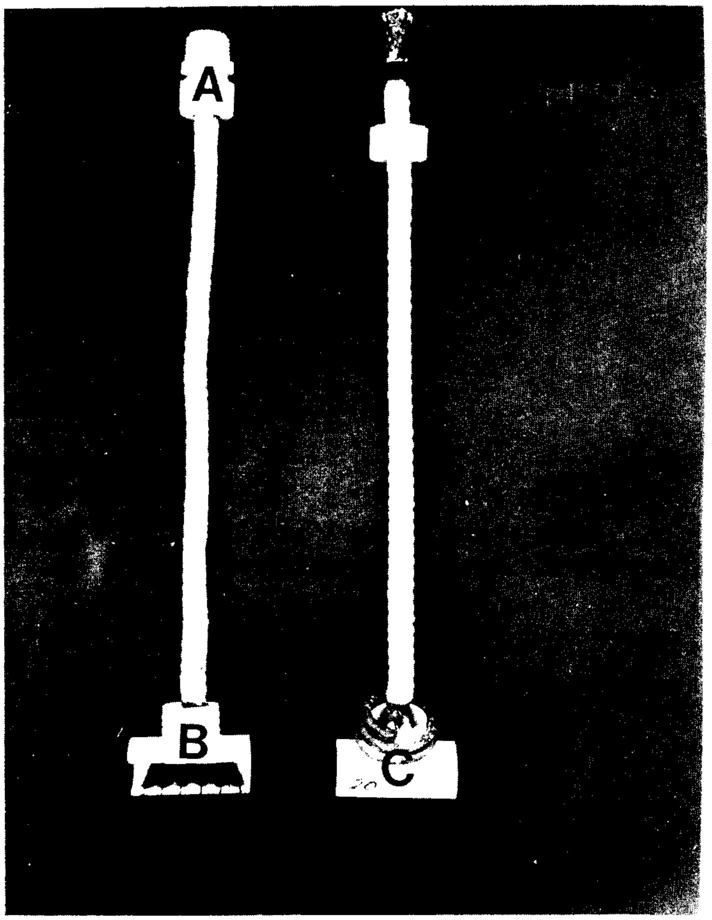

Figure 3. Individual ropes for the ropewick manifold. One rope of each pair is weighted to help prevent tangling of the ropes and aid in penetrating the canopy. A. Compression fitting. B. 1.9 cm diam PVC pipe tee used to separate strands of rope to form a brush or mop. C. Lead weight.

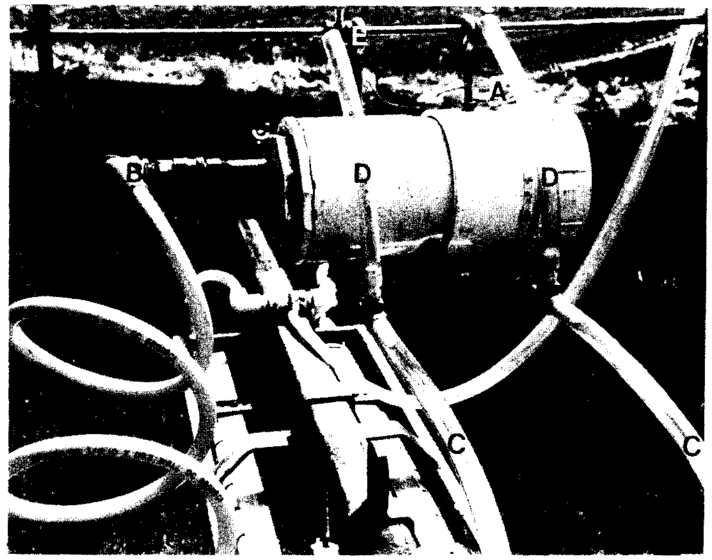

Figure 4. Pressure equalizing tank with supply and discharge hoses, vents, and carrier. A. Equalizing tank vent. B. Supply hose to float valve located inside the tank. C. Discharge hoses to the ropewick manifolds. D. In line vents in discharge hoses. E. Carrier that maintains the tank in a relatively level position regardless of the angle of the telescoping ropewick support frame.

center of the A-frame by collars at either end, which also provide a smooth, flat surface for the sleeve to rotate against. The sleeve is welded to the proximal end of the ropewick support frame and to a yoke that is attached to the piston-end of the hydraulic cylinder with a 2 cm diam steel pin (Figure 2a). This arrangement allows the ropewick support frame to be adjusted from slightly above horizontal to 45° below horizontal by operating the hydraulic cylinder from the tractor. The total unit beyond the A-frame can be raised manually and secured in an upright position for road travel by removing the two L-shaped pins located at the apex of the A-frame.

The telescoping ropewick support frame is constructed of two hollow square steel bars (6.3mm wall thickness) that are of different dimensions. The outer bar (6.4 cm by 6.4 cm by 1.8 m) carries the manifold of dangling ropes. The inner bar (5.1 cm by 5.1 cm by 2.4 m) supports and moves the outer bar. A slot, 2 cm wide and 1.8 m long, is machined on the upper face of the inner bar to accommodate a number 40 roller chain, which is driven by a 22.7 l/min hydraulic motor. The roller chain passes over a driven sprocket located 1.75 m from the drive sprocket. Chain tension is adjusted by turning a bolt that passes through a threaded plate inside the distal end of the inner bar; the opposite end of this bolt is attached to the driven sprocket support. Ends of the roller chain are attached to a steel block, which is bolted to the proximal end of the outer bar. Activation of the hydraulic motor by a hydraulic control valve located on the tractor moves the outer bar (and attached ropewicks) to the horizontal position desired. The spiral herbicide supply hose shown in Figure 2b is self coiling and automatically adjusts to the distance that the support frame is extended.

A rectangular frame, 1.8 m long by 37 cm wide, is attached to the large bar of the telescoping support frame by three 5 cm by 0.5 cm U-shaped steel straps (Figure 1a). This frame is constructed of a 2.5 cm square hollow bar which is welded at the corners. Two 1.8 m by 1.9 cm sections of angle iron are bolted to the underside of the rectangular frame to serve as supports for the ropewick manifolds. Manifolds are attached to the angle irons with hose clamps.

Two ropewick manifolds are constructed of 1.9 cm diam PVC pipe and fittings; PVC tees are spaced every 7.6 cm along the manifold. One outlet of each tee is fitted with a threaded compression fitting and ends of the manifold terminate in a tee (distal end) or L and 45° elbow (proximal end), Figure 1a. Tees at the distal end of the manifolds are fitted with pipe plugs for draining the manifolds and with hose adapters to which 1.9 cm vent hoses are attached. The open end of the vent hoses must be maintained above the pressure equalizing tank as shown in Figure 1a. A 45° elbow at the proximal ends of the manifolds is fitted with a hose adapter to accept the 1.9 cm diam herbicide supply hose from the pressure equalizing tank. In-line vent tubes that extend above the pressure equalizing tank also are required in the herbicide supply hose to prevent air locks.

Individual wicks for the manifold are constructed of 30 to 60 cm lengths of 13 mm diam rope that has a diamond braid polyester covering over an acrylic yarn core. The diamond braid covering is removed from 12 cm at one end of each rope, and the six strands of the acrylic yarn core are separated. Each strand is inserted into a 2mm-wide slot cut into a 1.9 cm diam PVC pipe tee, which has one side removed (Figure 3). A 5mm diam hole located at the back of each slot prevents compression of the yarn after insertion in the tee. PVC pipe glue brushed over the polyester covering at both ends of the rope prevents fraying.

Individual ropes are attached to the ropewick manifold with the threaded compression fittings. Ropes on one manifold are weighted on the vertical stem of the tee with 30 cm (110 gm) of 6.3mm diam lead (Figure 3). The two manifolds are 30 cm apart.

The pressure equalizing tank is constructed of 10 cm diam PVC pipe and end caps or plugs (Figure 4). A small float valve installed in the end plug prior to assembly is adjusted to maintain the pressure equalizing tank half full. This float valve is the type used in evaporative coolers and stock watering tanks. The original rubber valve seat was replaced with a neoprene seat because the rubber seat was not durable. An 8mm diam vent is drilled in the top of the tank and two eye bolts screwed into threaded holes in the top of the tank serve as a hinge.

Performance of applicator. The applicator was evaluated for weed control on ditchbanks of irrigation canals in the Yakima Valley of Washington over a 3-year period. It was evaluated at four sites in 1981, two sites in 1982, and one site in 1983. The primary target species was reed canarygrass.

Glyphosate as the Roundup®[3,4] formulation was evaluated in 1981. Rodeo®[3,4] the formulation of glyphosate that is now registered for use on aquatic sites, was evaluated in 1982 and 1983. Roundup solutions contained a 2:1 ratio of water to herbicide (v/v), with no additional surfactant. After evaluating numerous ratios of water, Rodeo, and surfactant, a ratio of 20:8:3, respectively, was selected. The surfactant X-77[4,5] (a mixture of alkylaryl-polyoxyethylene, glycols, free fatty acids, and isopropanol) was added to all Rodeo solutions.

Ropewick applications at 1.6 and 3.2 km/hr were compared to broadcast spraying 1.7 kg a.i./ha glyphosate in 280 L/ha at 206 kPa. The spray treatment was applied with a tractor-mounted CO_2 sprayer equipped with four flat fan nozzles on 51 cm spacings. Treatments were arranged end-to-end along the ditchbank in a randomized block design with three replications. Data were subjected to analysis of variance and means were separated using Fisher's Protected LSD test at the 5% level of significance. Individual plots were 1.8 m wide and ranged from 91 m long in 1981 to 400 m long in 1983. Slope of the ditchbanks ranged from about 1:1 to 1:2, but the bank was relatively uniform within each site.

[3]Product of Monsanto Chemical Company, 800 North Lindbergh Blvd., St Louis, MO 63166.

[4]Mention of a trademark, proprietary product, or vendor does not constitute a guarantee of the product by the U.S. Dep. Agric., nor imply its approval to the exclusion of other products or vendors that may also be suitable.

[5]Product of Chevron Chemical Company, San Francisco, CA 94119.

Treatments were applied each year when the reed canarygrass was in the boot-to-early-flower stage of development (late May to early June). Efficacy of the treatments was evaluated 2 months after application by two individuals and their ratings were averaged. Weed control was based on the percentage of necrosis and chlorosis as compared to untreated plants.

RESULTS

Performance of applicator. With one exception (East Lateral), glyphosate applied through the ropewick applicator controlled reed canarygrass as well as or better than did a broadcast spray at 1.7 kg/ha (Table 1). Necrosis of foliage developed more rapidly on plants that were treated with the ropewick, but 60 days after treatment there were few differences in control when the Roundup formulation was used.

The Rodeo formulation applied as a spray was inferior to the same formulation applied through the ropewick at 1.6 km/hr on Satus 2 and to both 1.6 and 3.2 km/hr on Lateral 4 (Table 1). In 1982 the stand of reed canarygrass on Satus 2 ditchbank was dense (456 stems/m^2) and continuous, whereas it was moderate (ca. 150 stems/m^2) and in a clumped distribution on Lateral 4. Differences in stand density probably account for the significantly better control on Lateral 4 than on Satus 2, regardless of application method or rate of travel for the ropewick.

DISCUSSION

These data show that the ropewick applicator described is an effective device for the application of glyphosate to weeds on sloping, non-uniform ditchbanks. In preliminary

TABLE 1. CONTROL OF REED CANARYGRASS WITH GLYPHOSATE[1] APPLIED THROUGH THE DANGLING ROPEWICK APPLICATOR OR BROADCAST SPRAYED IN 1981, 1982, AND 1983.

Canal name	Speed	Application[2] type	Control[3] 1981	1982	1983
	(km/hr)		%		
Satus 2	1.6	RW	97	55	—
	3.2	RW	93	42	—
	3.7	Spray	94	30	—
LSD (0.05)			NS	16	—
Lateral 4	1.6	RW	93	96	85
	3.2	RW	90	96	73
	3.7	Spray	90	77	50
LSD (0.05)			NS	7	8
East Lateral	1.6	RW	90	—	—
	3.2	RW	85	—	—
	—	Spray	100	—	—
LSD (0.05)			14	—	—
SVID	1.6	RW	97	—	—
	3.2	RW	97	—	—
	3.7	Spray	97	—	—
LSD (0.05)			NS	—	—

[1]Herbicide solution was a 2:1 ratio of water to Roundup in 1981 s and a 20:8:3 ratio of water, Rodeo and X-77 surfactant in 1982 and 1983.
[2]RW = ropewick; spray applied at 1.7 kg ai/ha in 280 l/ha.
[3]Data collected 60 days posttreatment.

experiments, 2,4-D[2,4-dichlorophenoxy)acetic acid] and amitrole (1*H*-1,2,4-triazol-3-amine) plus ammonium thiocyanate also were effective when applied with the ropewick applicator.

The ropewick applicator has several advantages over broadcast spraying on ditchbanks besides the ability to apply a nonselective herbicide in a selective manner. Two important advantages are the elimination of physical drift to adjacent crops and preventing contamination of irrigation water with herbicides.

Glyphosate and the dimethylamine salt of 2,4-D are registered for use on irrigation ditchbanks as sprays if the application is in an upstream direction and if the overlap on the water surface does not exceed 30 cm. These restrictions necessitate unproductive travel to the upstream edge of both banks of an area to be treated. The ropewick should permit treatment in either direction because contamination of irrigation water is eliminated.

Canal rights-of-way are adjacent to a host of different crops that are susceptible to herbicides used for weed control on ditchbanks. Drift of the herbicide to these crops may injure or deposit illegal residues in the crops. For these reasons, herbicides can be sprayed only when the wind velocity does not exceed 5 to 8 km/hr. Consequently, wind can force equipment and labor to remain idle and delay application beyond the time when weeds are most susceptible. The ropewick applicator can be operated safely at considerably higher wind speeds. Thus, equipment and labor can be used more efficiently.

Another advantage of the ropewick is that the time required for filling and mixing is drastically reduced, compared to spraying. Enough herbicide solution for 8 hours operation of the ropewick may be mixed at one time. Usually water from an irrigation canal can be used to dilute glyphosate for spraying, but if the canal water is turbid, water must be transported to the site of application. Under these conditions, the additional cost of operating a tank truck is eliminated by use of the ropewick.

The ropewick applicator described, and variations of it, should permit the selective control of tall weeds on ditchbanks without harming the valuable shorter plants which are necessary for erosion control and as competitive vegetation.

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