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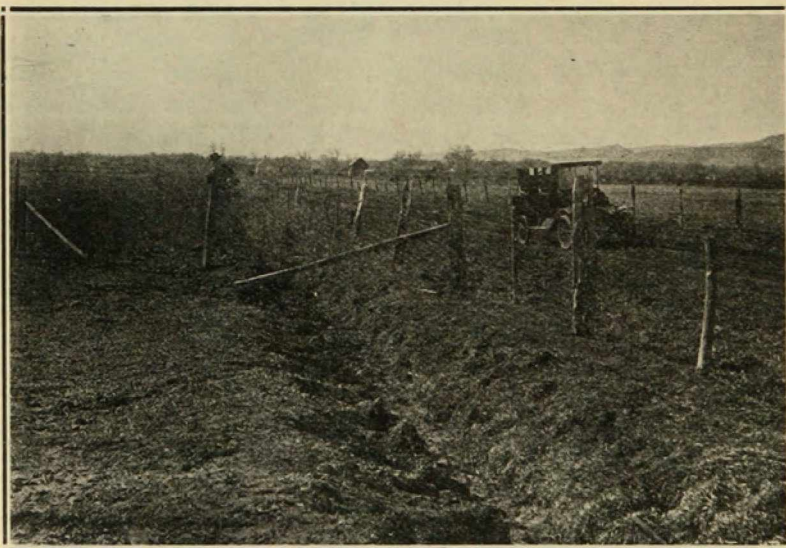
June, 1920

2)

The Agricultural Experiment Station  
OF THE  
Colorado Agricultural College

IRRIGATION WATER AS A  
FACTOR IN THE DISSEMINATION  
OF WEED SEEDS

By G. E. EGGINTON and W. W. ROBBINS



In the foreground, the grazed ditch bank is free from weeds, while across the fence the ungrazed bank is overgrown with weeds.

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# Irrigation Water as a Factor in the Dissemination of Weed Seed

By G. E. EGGINTON and W. W. ROBBINS

It is well known that there are many different agencies that are responsible for the spread of weed seeds. No other means of introducing weeds is probably so effective as the sale and distribution of impure commercial seeds. Weed seeds are also carried in screenings, in baled hay, in the packing about trees, in feed stuffs; they are taken from place to place in the hair or wool or on the feet of live stock; they are conveyed by birds. Light, winged seeds are often borne long distances by wind. In addition to the above means of seed dispersal, irrigation water is a most important factor in the dissemination of weed seeds in the irrigated sections of the western states. Ditch banks everywhere are densely overgrown with weeds, which shed their seeds in the water, and these are carried down stream, given a good soaking in transit, and planted on a well-soaked soil—all conditions being ideal for germination. In the belief that this was a prolific means of distributing weed seeds, an investigation was begun by this Station to determine the extent of distribution caused in this way. This investigation has just been completed and the results are given herewith.

It is believed that the data herein presented will serve to emphasize the fact that our irrigation waters are conveying tremendous quantities of weed seeds, that our ditch banks are more to be feared than our roadsides as sources of weed infestation, and that it will point to the need of regulations requiring the removal of weeds on ditch banks as well as along roadsides and show the value of grazing ditch banks for the control of weeds upon them.

Germination studies of weed seeds carried in irrigation waters are now under way. The results of these studies will be reported in a later bulletin of the Station.

## METHOD

It was deemed advisable at the start to obtain data as to the actual quantities of seeds carried by typical irrigation ditches. For this purpose a cylindrical seed trap of fine copper wire gauze was constructed (Fig.1). It measures 10 inches

long and  $3\frac{1}{4}$  inches in diameter. Floats on the side keep the trap partly above the water. The cross section of the water cut is a semi-circle having an area of 3.36 square inches. The trap was made long enough to give a total pore space at least three times the area of the opening, in order that there would

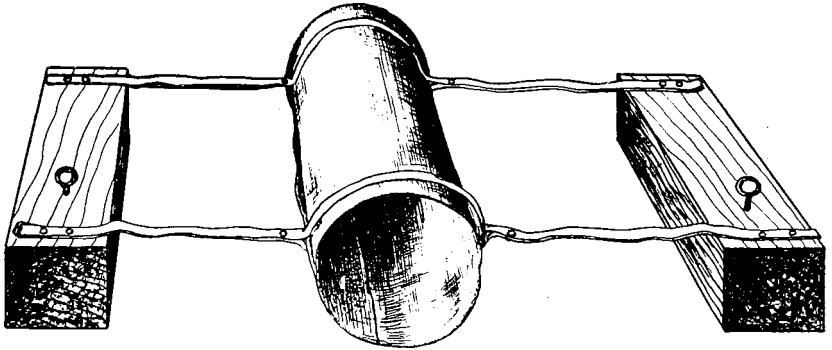


Fig. 1.—Seed trap of fine copper wire gauze, used in catching seeds floating on stream surface.

be little or no deflection of the water to either side. Of course, in practice it was found that at times when there was much material being carried in the ditches, accumulation of debris in the trap soon reduced the pore space to a point which caused a marked deflection of the current. For example, during the early part of the irrigation season, the ditches are carrying enormous quantities of weed seeds and other material. Then, the seed trap might fill to capacity in fifteen or twenty minutes. On the other hand, during the middle of the irrigating season, a similar seed trap might be left in the ditch for twelve hours without filling to capacity.

Metal eyes were screwed in the floats, and by means of cords attached to stakes on the ditch banks, the trap was held in mid-stream.

The traps were collected at the end of definite periods, and the seeds and other material washed from them. This process was facilitated by a removable gauze cap at the posterior end of the trap. The "catch" was laid out on glass plates in a dry compartment of the greenhouse and allowed to become thoroughly dry. It was then broken up by hand, spread out on a clean glass plate and worked over to separate out the weed seeds from debris. This tedious work was often made

Traps were set in a number of irrigation ditches in and about Fort Collins, Colorado. These included a large main ditch and several smaller ones. The data collected covered two seasons.

The ditches from which the seed catches were taken are designated as: No. 1 (the Arthur ditch), No. 2, and No. 3, which are laterals from No. 1.

The majority of catches were taken from No. 1 ditch which is, on the average, 12 feet wide, from 4 to 6 feet deep, and about 7 miles long, its source being the Cache la Poudre River two miles southeast of La Porte. The banks are steep and, in places, have been undermined by the current. The bottom of this ditch is covered by a layer of fine, silty mud, ranging in depth from 3 to 14 inches. Ditches No. 2 and No. 3 are 2 to 2½ feet wide; 1 to 3 feet deep, and about 1½ miles long. They have their sources from No. 1 ditch 1 mile apart. The bottoms of these ditches are rather sandy as compared with the bottom of ditch No. 1.

The seed traps were set in No. 1 ditch only when the water was 3 to 4 feet deep, and in No. 2 and No. 3 when the water was 6 inches or more in depth.

The velocity of the current varied from day to day. On those days on which the traps were set, the average velocity was 1 foot per second.

## INDIVIDUAL CATCHES OF WEED SEEDS

The following typical cases give the number of species of weed seeds and the number of seeds of each species in individual catches. It will be kept in mind that the cross-section of water cut by the trap was a semi-circle, 3.36 square inches in area.

### TEST No. 1. DITCH No. 2.

Date, June 1, 1918. Duration, 60 min.

Species of weed seeds, 7.  
Number of seeds, 72.

On pages 13, 14 and 15 will be found common names of the following plants.

<i>Chenopodium album</i> .....	7
<i>Iva xanthifolia</i> .....	3
<i>Polygonum aviculare</i> .....	2
<i>Taraxacum officinale</i> .....	56
<i>Verbena hastata</i> .....	2
<i>Ambrosia trifida</i> .....	1
<i>Leonurus cardiaca</i> .....	1

### TEST No. 2. DITCH No. 3.

Date, June 1, 1918. Duration, 80 min.

Species of weed seeds, 10.  
Number of seeds, 35.

<i>Amaranthus blitoides</i> .....	2
<i>Amaranthus retroflexus</i> .....	1
<i>Chenopodium album</i> .....	9
<i>Iva xanthifolia</i> .....	1
<i>Iva ciliata</i> .....	1
<i>Polygonum persicaria</i> .....	1
<i>Rumex crispus</i> .....	1
<i>Taraxacum officinale</i> .....	16
<i>Grindelia squarrosa</i> .....	2
<i>Ambrosia trifida</i> .....	1

**TEST No. 3. DITCH No. 1.**  
**Date, June 1, 1918. Duration, 20 min.**

Species of weed seeds, 9.  
 Number of seeds, 20.

Amaranthus blitoides .....	5
Amaranthus retroflexus .....	2
Chenopodium album .....	1
Polygonum aviculare .....	1
Polygonum convolvulus .....	1
Rumex crispus .....	6
Taraxacum officinale .....	2
Teucrium occidentale .....	1
Grindelia squarrosa .....	1

**TEST No. 5. DITCH No. 3.**  
**Date, June 2, 1918. Duration, 180 min.**

Species of weed seeds, 14.  
 Number of seeds, 168.

Amaranthus blitoides .....	13
Amaranthus retroflexus .....	5
Chenopodium album .....	78
Iva xanthifolia .....	11
Polygonum aviculare .....	11
Polygonum convolvulus .....	12
Polygonum persicaria .....	1
Rumex crispus .....	6
Taraxacum officinale .....	12
Teucrium occidentale .....	15
Grindelia squarrosa .....	1
Salvia species .....	1
Ambrosia trifida .....	1
Franseria tomentosa .....	1

**TEST No. 8. DITCH No. 2.**  
**Date, June 3, 1918. Duration, 180 min.**

Species of weed seeds, 16.  
 Number of seeds, 129.

Salvia species .....	1
Ambrosia trifida .....	1
Solanum rostratum .....	1
Amaranthus blitoides .....	13
Amaranthus retroflexus .....	4
Carex species .....	1
Chenopodium album .....	21
Iva xanthifolia .....	10
Iva ciliata .....	1
Polygonum aviculare .....	7
Polygonum convolvulus .....	2
Polygonum persicaria .....	2
Taraxacum officinale .....	61
Verbena hastata .....	2
Ambrosia artemisaefolia .....	1
Malvastrum coccineum .....	1

**TEST No. 10. DITCH No. 1.**  
**Date, June 3, 1918. Duration, 180 min.**

Species of weed seeds, 9.  
 Number of seeds, 1,039.

Amaranthus blitoides .....	27
Amaranthus retroflexus .....	25
Carex species .....	6
Chenopodium album .....	22
Iva xanthifolia .....	16
Polygonum aviculare .....	9
Rumex crispus .....	3
Taraxacum officinale .....	930
Polygonum dumetorum .....	1

**TEST No. 13. DITCH No. 2.**  
**Date, June 5, 1918. Duration, 1,440 min.**

Species of weed seeds, 7.  
 Number of seeds, 64.

Amaranthus blitoides .....	11
Amaranthus retroflexus .....	9
Carex species .....	6
Iva xanthifolia .....	4
Polygonum aviculare .....	3
Rumex crispus .....	1
Taraxacum officinale .....	30

**TEST No. 15. DITCH No. 2.**  
**Date, June 5, 1918. Duration, 1,440 min.**

Species of weed seeds, 10.  
 Number of seeds, 84.

Amaranthus blitoides .....	7
Carex species .....	5
Chenopodium album .....	21
Iva xanthifolia .....	9
Polygonum aviculare .....	3
Polygonum convolvulus .....	2
Rumex crispus .....	1
Taraxacum officinale .....	34
Grindelia squarrosa .....	1
Verbena stricta .....	1

**TEST No. 16. DITCH No. 1.**  
**Date, June 5, 1918. Duration, 1,080 min.**

Species of weed seeds, 14.  
 Number of seeds, 149.

Amaranthus blitoides .....	13
Amaranthus retroflexus .....	12
Carex species .....	18
Chenopodium album .....	11
Iva xanthifolia .....	11
Polygonum aviculare .....	11
Polygonum convolvulus .....	1
Polygonum persicaria .....	2
Rumex crispus .....	1
Taraxacum officinale .....	65
Grindelia squarrosa .....	1
Ranunculus species .....	1
Ambrosia artemisaefolia .....	1
Echinochloa crus-galli .....	1

**TEST No. 18. DITCH No. 2.****Date, June 6, 1918. Duration, 300 min.**

Species of weed seeds, 13.

Number of seeds, 173.

Amaranthus blitoides .....	17
Carex species .....	9
Chenopodium album .....	21
Iva xanthifolia .....	7
Polygonum aviculare .....	10
Polygonum convolvulus .....	1
Polygonum persicaria .....	3
Rumex crispus .....	4
Ambrosia trifida .....	2
Taraxacum officinale .....	96
Echinochloa crus-galli .....	1
Nepeta cataria .....	1
Grindelia squarrosa .....	1

**TEST No. 20. DITCH No. 2.****Date, June 7, 1918. Duration, 300 min.**

Species of weed seeds, 12.

Number of seeds, 229.

Amaranthus blitoides .....	35
Amaranthus retroflexus .....	27
Carex species .....	46
Chenopodium album .....	56
Iva xanthifolia .....	8
Polygonum aviculare .....	20
Polygonum convolvulus .....	4
Rumex crispus .....	14
Taraxacum officinale .....	16
Grindelia squarrosa .....	1
Ranunculus species .....	1
Cleome serrulata .....	1

**TEST No. 25. DITCH No. 2.****Date, June 8, 1918. Duration, 720 min.**

Species of weed seeds, 11.

Number of seeds, 257.

Amaranthus blitoides .....	18
Amaranthus retroflexus .....	16
Carex species .....	28
Chenopodium album .....	33
Iva xanthifolia .....	1
Polygonum aviculare .....	15
Polygonum convolvulus .....	2
Polygonum persicaria .....	3
Rumex crispus .....	3
Taraxacum officinale .....	137
Argemone intermedia .....	1

**TEST No. 29. DITCH No. 1.****Date, June 11, 1918. Duration, 360 min.**

Species of weed seeds, 10.

Number of seeds, 199.

Amaranthus blitoides .....	7
Amaranthus retroflexus .....	17
Carex species .....	85
Chenopodium album .....	30

Iva xanthifolia .....	6
Polygonum aviculare .....	10
Polygonum persicaria .....	2
Taraxacum officinale .....	40
Verbena hastata .....	1
Panicum capillare .....	1

**TEST No. 30. DITCH No. 2.****Date, June 11, 1918. Duration, 360 min.**

Species of weed seeds, 5.

Number of seeds, 16.

Amaranthus retroflexus .....	2
Carex species .....	5
Chenopodium album .....	7
Rumex crispus .....	1
Taraxacum officinale .....	1

**TEST No. 32. DITCH No. 2.****Date, June 11, 1918. Duration, 360 min.**

Species of weed seeds, 18.

Number of seeds, 633.

Amaranthus blitoides .....	29
Amaranthus retroflexus .....	50
Carex species .....	208
Chenopodium album .....	235
Iva xanthifolia .....	15
Polygonum aviculare .....	21
Polygonum convolvulus .....	3
Polygonum persicaria .....	4
Rumex crispus .....	11
Taraxacum officinale .....	33
Grindelia squarrosa .....	4
Cleome serrulata .....	2
Ambrosia artemisaefolia .....	1
Panicum capillare .....	2
Nepeta cataria .....	4
Geranium species .....	4
Portulaca oleracea .....	7
Glyceria species .....	2

**TEST No. 34. DITCH No. 2.****Date, June 12, 1918. Duration, 360 min.**

Species of weed seeds, 14.

Number of seeds, 185.

Amaranthus blitoides .....	23
Amaranthus retroflexus .....	55
Carex species .....	2
Chenopodium album .....	67
Iva xanthifolia .....	6
Polygonum aviculare .....	11
Polygonum convolvulus .....	5
Polygonum persicaria .....	1
Rumex crispus .....	6
Taraxacum officinale .....	4
Nepeta cataria .....	1
Oxalis stricta .....	1
Syntherisma humifusum .....	2
Lupinus species .....	1

**TEST No. 38. DITCH No. 2****Date, June 21, 1918. Duration, 240 min.**

Species of weed seeds, 15.

Number of seeds, 331.

Amaranthus blitoides	26
Amaranthus retroflexus	57
Ambrosia artemisiæfolia	1
Carex species	110
Chenopodium album	85
Echinochloa crus-galli	1
Iva xanthifolia	7
Polygonum aviculare	12
Polygonum convolvulus	2
Polygonum persicaria	1
Portulaca oleracea	15
Ranunculus species	1
Taraxacum officinale	3
Verbena hastata	4
Grindelia squarrosa	6

**TEST No. 40. DITCH No. 2.****Date, June 18, 1918. Duration, 300 min.**

Species of weed seeds, 16.

Number of seeds, 266.

Amaranthus blitoides	31
Amaranthus retroflexus	31
Carex species	90
Chenopodium album	67
Grindelia squarrosa	3
Iva xanthifolia	5
Nepeta cataria	2
Polygonum aviculare	12
Polygonum convolvulus	1
Polygonum persicaria	1
Portulaca oleracea	10
Rumex crispus	1
Taraxacum officinale	2
Verbena hastata	8
Polygonum engelmannii	1
Capsella bursa-pastoris	1

**TEST No. 41. DITCH No. 2.****Date, June 21, 1918. Duration, 360 min.**

Species of weed seeds, 16.

Number of seeds, 863.

Amaranthus blitoides	85
Amaranthus retroflexus	158
Carex species	365
Chenopodium album	170
Ambrosia trifida	1
Cleome serrulata	1
Grindelia squarrosa	1
Iva xanthifolia	39
Polygonum aviculare	30
Polygonum convolvulus	9
Polygonum persicaria	4
Rumex crispus	7
Taraxacum officinale	8
Verbena hastata	3
Capsella bursa-pastoris	3
Avena sativa	6

**TEST No. 42. DITCH No. 2.****Date, June 19, 1918. Duration, 420 min.**

Species of weed seeds, 24.

Number of seeds, 1,364.

Amaranthus blitoides	69
Amaranthus retroflexus	238
Carex species	655
Chenopodium album	230
Cleome serrulata	1
Geranium species	5
Grindelia squarrosa	9
Helianthus annuus	2
Iva xanthifolia	23
Oxalis stricta	1
Polygonum aviculare	27
Polygonum convolvulus	10
Polygonum persicaria	8
Portulaca oleracea	23
Rumex acetosella	1
Rumex crispus	16
Salvia species	3
Solanum rostratum	3
Taraxacum officinale	22
Verbena hastata	3
Capsella bursa-pastoris	1
Medicago lupulina	1
Veronica species	1
Avena sativa	12

**TEST No. 43. DITCH No. 1.****Date, June 19, 1918. Duration, 420 min.**

Species of weed seeds, 20.

Number of seeds, 763.

Amaranthus blitoides	28
Amaranthus retroflexus	22
Carex species	542
Chenopodium album	73
Ambrosia trifida	1
Geranium species	1
Grindelia squarrosa	2
Helianthus annuus	1
Iva xanthifolia	23
Polygonum aviculare	30
Polygonum convolvulus	9
Polygonum persicaria	2
Ranunculus species	1
Rumex crispus	9
Setaria viridis	3
Solanum rostratum	1
Taraxacum officinale	8
Teucrium occidentale	1
Urtica gracilis	1
Avena sativa	1

**TEST No. 47. DITCH No. 2****Date, June 20, 1918. Duration, 240 min.**

Species of weed seeds, 13.

Number of seeds, 299.

Amaranthus blitoides	21
Amaranthus retroflexus	21
Carex species	174



Chenopodium album	40
Grindelia squarrosa	2
Iva xanthifolia	13
Polygonum aviculare	14
Polygonum convolvulus	4
Rumex acetosella	3
Cleome serrulata	1
Taraxacum officinale	4
Teucrium occidentale	1
Polygonum engelmannii	1

Grindelia squarrosa	4
Urtica gracilis	3
Verbena hastata	18
Ranunculus species	2
Solanum rostratum	1
Helianthus annuus	1
Geranium species	3
Portulaca oleracea	3
Polygonum engelmannii	2
Capsella bursa-pastoris	3
Avena sativa	1

**TEST No. 54. DITCH No. 1.****Date, June 26, 1918. Duration, 360 min.**Species of weed seeds, 4.  
Number of seeds, 16.

Amaranthus retroflexus	2
Carex species	4
Chenopodium album	5
Polygonum aviculare	5

**TEST No. 57. DITCH No. 2.****Date, June 26, 1918. Duration, 360 min.**Species of weed seeds, 16.  
Number of seeds, 518.

Amaranthus blitoides	46
Amaranthus retroflexus	111
Carex species	51
Chenopodium album	107
Iva xanthifolia	2
Polygonum aviculare	19
Polygonum convolvulus	14
Polygonum persicaria	2
Geranium species	3
Portulaca oleracea	4
Rumex crispus	5
Taraxacum officinale	2
Urtica gracilis	3
Verbena hastata	145
Polygonum engelmannii	1
Lappula occidentale	3

**TEST No. 62. DITCH No. 1.****Date, July 2, 1918. Duration, 360 min.**Species of weed seeds, 23.  
Number of seeds, 377.

Amaranthus blitoides	47
Amaranthus retroflexus	108
Carex species	41
Chenopodium album	82
Iva xanthifolia	7
Polygonum aviculare	31
Polygonum convolvulus	2
Polygonum persicaria	4
Rumex crispus	5
Stellaria media	3
Taraxacum officinale	5
Teucrium occidentale	1

**TEST No. 71. DITCH No. 1.****Date, July 30, 1918. Duration, 1,080 min.**Species of weed seeds, 6.  
Number of seeds, 24.

Amaranthus blitoides	5
Chenopodium album	5
Grindelia squarrosa	1
Iva xanthifolia	1
Polygonum aviculare	4
Rumex crispus	8

**TEST No. 72. DITCH No. 1.****Date, Aug. 13, 1918. Duration, 1,440 min.**Species of weed seeds, 6.  
Number of seeds, 18.

Amaranthus blitoides	4
Amaranthus retroflexus	1
Polygonum aviculare	4
Polygonum convolvulus	4
Rumex crispus	4
Sonchus asper	1

**TEST No. 74. DITCH No. 1.****Date, July 29, 1918. Duration, 480 min.**Species of weed seeds, 3.  
Number of seeds, 3.

Amaranthus blitoides	1
Carex species	1
Polygonum aviculare	1

**TEST No. 75. DITCH No. 1.****Date, July 31, 1918. Duration, 1,440 min.**Species of weed seeds, 2.  
Number of seeds, 2.

Amaranthus blitoides	1
Rumex crispus	1

**TEST No. 76. DITCH No. 3.****Date, July 26, 1918. Duration, 1,440 min.**Species of weed seeds, 6.  
Number of seeds, 7.

Amaranthus retroflexus	1
Chenopodium album	2
Rumex crispus	1
Ambrosia trifida	1
Iva xanthifolia	1
Verbena hastata	1

**TEST No. 77. DITCH No. 1.**  
**Date, Aug. 1, 1918. Duration, 1,440 min.**

Species of weed seeds, 3.	
Number of seeds, 3.	
Amaranthus blitoides .....	1
Carex species .....	1
Rumex crispus .....	1

**TEST No. 79. DITCH No. 1.**  
**Date, July 22, 1918. Duration, 360 min.**

Species of weed seeds, 2.	
Number of seeds, 2.	
Rumex crispus .....	1
Secale cereale .....	1

**TEST No. 81. DITCH No. 1.**  
**Date, Aug. 1, 1918. Duration, 1,440 min.**

Species of weed seeds, 3.	
Number of seeds, 4.	
Amaranthus blitoides .....	2
Rumex crispus .....	1
Agropyron tenerum .....	1

**TEST No. 86. DITCH No. 1.**  
**Date, July 25, 1918. Duration, 600 min.**

Species of weed seeds, 3.	
Number of seeds, 4.	
Amaranthus retroflexus .....	1
Chenopodium album .....	2
Polygonum aviculare .....	1

**TEST No. 90. DITCH No. 1.**  
**Date, July 23, 1918. Duration, 1,080 min.**

Species of weed seeds, 2.	
Number of seeds, 2.	
Amaranthus blitoides .....	1
Rumex crispus .....	1

**TEST No. 91. DITCH No. 1.**  
**Date, July 25, 1918. Duration, 600 min.**

Species of weed seeds, 2.	
Number of seeds, 2.	
Polygonum convolvulus .....	1
Rumex crispus .....	1

**TEST No. 96. DITCH No. 1.**  
**Date, Aug. 22, 1918. Duration, 4,320 min.**

Species of weed seeds, 3.	
Number of seeds, 4.	
Ranunculus species .....	1
Amaranthus blitoides .....	2
Polygonum aviculare .....	1

**TEST No. 100. DITCH No. 1.**  
**Date, Aug. 10, 1918. Duration, 2,880 min.**

Species of weed seeds, 3.	
Number of seeds, 13.	
Amaranthus blitoides .....	4
Rumex crispus .....	6
Polygonum aviculare .....	7

**TEST No. 101. DITCH No. 1.**  
**Date, Aug. 3, 1918. Duration, 1,440 min.**

Species of weed seeds, 7.	
Number of seeds, 48.	
Amaranthus blitoides .....	16
Amaranthus retroflexus .....	6
Chenopodium album .....	7
Polygonum aviculare .....	8
Rumex crispus .....	8
Solanum rostratum .....	1
Ranunculus species .....	2

**TEST No. 106. DITCH No. 1.**  
**Date, Aug. 10, 1918. Duration, 720 min.**

Species of weed seeds, 7.	
Number of seeds, 30.	
Carex species .....	1
Chenopodium album .....	4
Polygonum aviculare .....	7
Amaranthus blitoides .....	8
Polygonum convolvulus .....	1
Rumex crispus .....	10
Polygonum engelmannii .....	1

**TEST No. 107. DITCH No. 1.**  
**Date, Aug. 14, 1918. Duration, 1,440 min.**

Species of weed seeds, 7.	
Number of seeds, 23.	
Amaranthus blitoides .....	4
Amaranthus retroflexus .....	1
Carex species .....	2
Chenopodium album .....	2
Polygonum aviculare .....	4
Rumex species .....	9
Geranium species .....	1

**TEST No. 110. DITCH No. 1.**  
**Date, June 5, 1919. Duration, 15 min.**

Species of weed seeds, 15.	
Number of seeds, 191.	
Taraxacum officinale .....	20
Chenopodium album .....	23
Carex species .....	27
Amaranthus blitoides .....	27
Amaranthus retroflexus .....	38
Iva xanthifolia .....	15
Polygonum aviculare .....	22
Papaver species .....	3
Grindelia squarrosa .....	3
Rumex crispus .....	3
Verbena stricta .....	1
Leonurus cardiaca .....	1
Polygonum convolvulus .....	1
Cleome serrulata .....	1
Solanum rostratum .....	1

**TEST No. 114. DITCH No. 1.**  
**Date, June 5, 1919. Duration, 15 min.**

Species of weed seeds, 18.	
Number of seeds, 310.	
Taraxacum officinale .....	30
Carex species .....	77
Amaranthus blitoides .....	51

Amaranthus retroflexus	49
Iva xanthifolia	42
Polygonum aviculare	22
Chenopodium album	22
Rumex crispus	6
Helianthus annuus	2
Ambrosia artemisaefolia	3
Grindelia squarrosa	3
Argemone intermedia	1
Solanum rostratum	1
Papaver species	1
Polygonum persicaria	1
Verbena bracteosa	2
Leonurus cardiaca	3
Mentha species	4

**TEST No. 118. DITCH No. 1.****Date, May 5, 1916. Duration, 15 min.**

Species of weed seeds, 17.

Number of seeds, 99.

Taraxacum officinale	27
Chenopodium album	24
Amaranthus blitoides	4
Amaranthus retroflexus	7
Amaranthus graecizans	1
Iva xanthifolia	4
Rumex crispus	8
Polygonum aviculare	9
Polygonum convolvulus	5
Polygonum persicaria	1
Cleome serrulata	1
Solanum rostratum	1
Ambrosia artemisaefolia	2
Setaria viridis	2
Lappula occidentale	1
Verbena hastata	1
Mentha species	1

**TEST No. 121. DITCH No. 1****Date, May 19, 1919. Duration, 15 min.**

Species of weed seeds, 21.

Number of seeds, 208.

Taraxacum officinale	6
Amaranthus blitoides	20
Amaranthus retroflexus	41
Rumex crispus	12
Chenopodium album	30
Polygonum aviculare	25
Polygonum convolvulus	7
Polygonum persicaria	3
Ambrosia artemisaefolia	4
Iva xanthifolia	23
Carex species	3
Echinochloa crus-galli	6
Setaria viridis	3
Papaver species	8
Cleome serrulata	1
Grindelia squarrosa	1
Mentha species	4
Verbena bracteosa	8
Helianthus annuus	1
Leonurus cardiaca	1
Panicularia grandis	1

**TEST No. 123. DITCH No. 1.****Date, May 20, 1919. Duration, 15 min.**

Species of weed seeds, 18.

Number of seeds, 189.

Taraxacum officinale	6
Rumex crispus	5
Chenopodium album	30
Amaranthus retroflexus	57
Amaranthus blitoides	16
Polygonum aviculare	25
Iva xanthifolia	16
Carex species	3
Verbena bracteosa	9
Polygonum convolvulus	4
Papaver species	6
Polygonum persicaria	3
Echinochloa crus-galli	2
Mentha species	3
Argemone intermedia	1
Syntherisma humifusum	1
Solanum rostratum	1
Grindelia squarrosa	1

**TEST No. 124. DITCH No. 1.****Date, May 20, 1919. Duration, 15 min.**

Species of weed seeds, 20.

Number of seeds, 191.

Taraxacum officinale	34
Amaranthus blitoides	20
Amaranthus retroflexus	28
Chenopodium album	41
Iva xanthifolia	12
Polygonum aviculare	16
Polygonum convolvulus	3
Polygonum persicaria	3
Rumex crispus	5
Carex species	4
Grindelia squarrosa	5
Papaver species	7
Ambrosia artemisaefolia	2
Verbena bracteosa	4
Solanum rostratum	1
Echinochloa crus-galli	1
Setaria viridis	1
Leonurus cardiaca	1
Mentha species	2
Helianthus annuus	1

**TEST No. 126. DITCH No. 1.****Date, May 20, 1919. Duration, 15 min.**

Species of weed seeds, 20.

Number of seeds, 192.

Taraxacum officinale	18
Chenopodium album	28
Amaranthus blitoides	22
Amaranthus retroflexus	39
Iva xanthifolia	32
Polygonum aviculare	16
Rumex crispus	8
Polygonum convolvulus	3
Polygonum persicaria	5
Echinochloa crus-galli	3
Grindelia squarrosa	2

Papaver species	3
Malvastrum coccineum	2
Verbena bracteosa	2
Salvia lanceolata	1
Atriplex truncata	1
Mentha species	4
Leonurus cardiaca	1
Setaria viridis	1
Carex species	1

**TEST No. 133. DITCH No. 1.****Date, May 22, 1919. Duration, 15 min.**

Species of weed seeds, 11.

Number of seeds, 208.

Taraxacum officinale	158
Chenopodium album	22
Amaranthus blitoides	10
Amaranthus retroflexus	7
Polygonum aviculare	4
Ambrosia artemisaefolia	1
Iva xanthifolia	1
Rumex crispus	2
Setaria viridis	1
Verbena bracteosa	1
Lepidium apetalum	1

**TEST No. 136. DITCH No. 1.****Date, May 23, 1919. Duration, 10 min.**

Species of weed seeds, 14.

Number of seeds, 69.

Taraxacum officinale	1
Amaranthus blitoides	15
Amaranthus retroflexus	5
Chenopodium album	13
Iva xanthifolia	8
Polygonum aviculare	9
Polygonum persicaria	2
Papaver species	5
Polygonum convolvulus	3
Rumex crispus	1
Grindelia squarrosa	1
Verbena bracteosa	3
Setaria viridis	2
Melilotus alba	1

**TEST No. 137. DITCH No. 1.****Date, May 23, 1919. Duration, 15 min.**

Species of weed seeds, 14.

Number of seeds, 287.

Taraxacum officinale	174
Chenopodium album	26
Amaranthus blitoides	7
Amaranthus retroflexus	39
Iva xanthifolia	13
Polygonum aviculare	12
Carex species	4
Polygonum persicaria	3
Polygonum convolvulus	1
Solanum rostratum	1
Verbena bracteosa	3
Rumex crispus	1
Grindelia squarrosa	2
Papaver species	1

**TEST No. 140. DITCH No. 1.****Date, May 24, 1919. Duration, 15 min.**

Species of weed seeds, 16.

Number of seeds, 213.

Taraxacum officinale	3
Chenopodium album	58
Amaranthus retroflexus	51
Amaranthus blitoides	44
Iva xanthifolia	12
Polygonum aviculare	19
Polygonum convolvulus	2
Papaver species	8
Panicularia grandis	1
Mentha species	2
Verbena bracteosa	5
Teucrium occidentale	1
Setaria viridis	2
Carex species	1
Helianthus annuus	2
Bidens frondosa	1

**TEST No. 141. DITCH No. 1.****Date, May 24, 1919. Duration, 15 min.**

Species of weed seeds, 17.

Number of seeds, 391.

Taraxacum officinale	245
Amaranthus blitoides	28
Amaranthus retroflexus	34
Chenopodium album	38
Polygonum aviculare	23
Polygonum persicaria	1
Iva xanthifolia	5
Polygonum convolvulus	2
Verbena bracteosa	3
Rumex crispus	2
Ambrosia trifida	1
Cleome serrulata	1
Carex species	4
Papaver species	1
Melilotus alba	1
Grindelia squarrosa	1
Mentha species	1

**TEST No. 144. DITCH No. 1.****Date, May 24, 1919. Duration, 15 min.**

Species of weed seeds, 16.

Number of seeds, 748.

Taraxacum officinale	461
Chenopodium album	64
Amaranthus retroflexus	63
Amaranthus blitoides	73
Polygonum aviculare	59
Iva xanthifolia	5
Polygonum convolvulus	4
Sonchus asper	7
Rumex crispus	6
Cleome serrulata	2
Polygonum persicaria	1
Verbena bracteosa	2
Argemone intermedia	1
Malvastrum coccineum	1
Ambrosia artemisaefolia	1
Grindelia squarrosa	1

**TEST No. 149. DITCH No. 1.****Date, May 27, 1919. Duration, 15 min.**

Species of weed seeds, 17.

Number of seeds, 302.

Taraxacum officinale	171
Chenopodium album	47
Amaranthus retroflexus	30
Amaranthus blitoides	14
Polygonum aviculare	15
Iva xanthifolia	7
Rumex crispus	4
Polygonum convolvulus	2
Papaver species	2
Grindelia squarrosa	1
Setaria viridis	2
Verbena bracteosa	2
Mentha species	2
Argemone intermedia	1
Leonurus cardiaca	2

**TEST No. 152. DITCH No. 1.****Date, May 27, 1919. Duration, 15 min.**

Species of weed seeds, 17.

Number of seeds, 222.

Taraxacum officinale	121
Amaranthus blitoides	17
Amaranthus retroflexus	16
Chenopodium album	27
Polygonum aviculare	11
Iva xanthifolia	7
Polygonum convolvulus	4
Papaver species	4
Rumex crispus	4
Setaria viridis	2
Verbena bracteosa	2
Helianthus annuus	2
Echinochloa crus-galli	1
Polygonum persicaria	1
Mentha species	1
Carex species	1
Cleome serrulata	1

**TABLE I.—FREQUENCY OF DIFFERENT SPECIES OF WEED SEEDS IN 156 DITCH SAMPLES**

Species—	No. of samples in which occurred
Agropyron tenerum—Slender wheat grass	6
Alopecurus aristulatus—Wolf tail	2
Amaranthus blitoides—Prostrate pigweed	138
Amaranthus graecizans—Tumble weed	3
Amaranthus retroflexus—Tall pigweed	131
Ambrosia artemisaefolia—Ragweed	21
Ambrosia trifida—Giant ragweed	19
Arenaria species—Sandwort	4
Argemone intermedia—White prickly poppy	13
Atriplex truncata—Salt bush	1
Avena fatua—Wild oats	1
Bidens frondosa—Beggar ticks	1
Brassica juncea—Indian mustard	1
Brassica nigra—Black mustard	1
Bromus inermis—Brome grass	2
Capsella bursa-pastoris—Shepherd's purse	6
Carex species—Sedge	99
Cleome serrulata—Rocky Mountain bee plant	25
Chenopodium album—Lamb's quarter	131
Echinochloa crus-galli—Barnyard grass	17
Euphorbia marginata—Snow-on-the-mountain	1
Franseria tomentosa—Poverty weed	1
Galium aparine—Cleavers	2
Geranium species—Geranium	15
Glyceria species—Manna grass	1
Grindelia squarrosa—Gumweed	60

Species—	No. of samples in which occurred
<i>Helianthus petiolaris</i> —Sunflower .....	16
<i>Iva ciliata</i> —Rough marsh elder .....	2
<i>Iva xanthifolia</i> —Marsh elder .....	105
<i>Kochia scoparia</i> —Fireweed or burning bush .....	1
<i>Lactuca scariola</i> —Wild lettuce .....	1
<i>Lappula occidentale</i> —Beggar's lice .....	6
<i>Leonurus cardiaca</i> —Motherwort .....	16
<i>Lepidium apetalum</i> —Peppergrass .....	2
<i>Lupinus</i> species—Lupine .....	2
<i>Lycopus americanus</i> —Water horehound .....	1
<i>Malvastrum coccineum</i> —False mallow .....	5
<i>Medicago lupulina</i> —Black medick .....	1
<i>Melilotus alba</i> —White sweet clover .....	2
<i>Mentha</i> species—Mint .....	17
<i>Nepeta cataria</i> —Catnip .....	8
<i>Opuntia polyacantha</i> —Prickly pear .....	1
<i>Oxalis stricta</i> —Wood sorrel .....	3
<i>Papaver</i> species—Poppy .....	32
<i>Panicum capillare</i> —Witchgrass .....	3
<i>Panicularia grandis</i> —Manna grass .....	3
<i>Polygonum aviculare</i> —Knotweed .....	133
<i>Polygonum convolvulus</i> —Wild buckwheat .....	88
<i>Polygonum dumetorum</i> —Smartweed .....	1
<i>Polygonum engelmannii</i> —Smartweed .....	12
<i>Polygonum pennsylvanicum</i> —Pennsylvania smartweed .....	1
<i>Polygonum persicaria</i> —Lady's thumb .....	70
<i>Portulaca oleracea</i> —Purslane .....	14
<i>Potentilla monspeliensis</i> —Cinquefoil .....	2
<i>Ranunculus</i> species—Buttercup .....	23
<i>Rosa</i> species—Wild rose .....	1
<i>Rumex acetosella</i> —Sheep sorrel .....	7
<i>Rumex crispus</i> —Curled dock .....	122
<i>Salsola tragus</i> —Russian thistle .....	1
<i>Salvia</i> species—Sage .....	4
<i>Salvia lanceolata</i> —Sage .....	4
<i>Setaria glauca</i> —Yellow foxtail .....	2
<i>Setaria viridis</i> —Green foxtail .....	20
<i>Solanum rostratum</i> —Buffalo bur .....	28
<i>Solanum</i> species—Wild potato .....	2
<i>Sonchus asper</i> —Rough sow thistle .....	3
<i>Stellaria media</i> —Chickweed .....	2
<i>Syntherisma humifusum</i> —Small crabgrass .....	3
<i>Taraxacum officinale</i> —Dandelion .....	104
<i>Teucrium occidentale</i> —Wood sage .....	12
<i>Thalictrum</i> species—Meadow-rue .....	1
<i>Tragopogon</i> sp.—Oyster plant .....	1
<i>Urtica gracilis</i> —Slender nettle .....	11
<i>Verbena hastata</i> —Blue vervain .....	25

Species—	No. of samples in which occurred
<i>Verbena stricta</i> —Hoary vervain .....	6
<i>Verbena bracteosa</i> —Bracted vervain .....	34
<i>Verbena bipinnatifida</i> —Bipinnate vervain .....	1
<i>Veronica</i> species—Speedwell .....	1
<i>Avena sativa</i> —Oats .....	11
<i>Secale cereale</i> —Rye .....	2
<i>Andropogon sorghum</i> —Amber cane .....	1

From the above table it will be seen that the weed seeds most frequently met with in the irrigation waters examined are:

- Prostrate pigweed (*Amaranthus blitoides*).
- Tall pigweed (*Amaranthus retroflexus*).
- Sedge (*Carex* sp.).
- Lamb's quarters (*Chenopodium album*).
- Tall marsh elder (*Iva xanthifolia*).
- Door-weed (*Polygonum aviculare*).
- Black bindweed (*Polygonum convolvulus*).
- Curled dock (*Rumex crispus*).
- Dandelion (*Taraxacum officinale*).

TABLE II.—SHOWING THE ESTIMATED NUMBER OF SEEDS, OF A FEW REPRESENTATIVE SPECIES, WHICH PASSED A GIVEN POINT ON A 12-FOOT DITCH DURING A PERIOD OF 24 HOURS

KIND OF SEED	Caught on 3/4" surface Cross-section 4.14 Sq. In.		Floating on 12' surface Cross-section 234.00 Sq. In.		Date
		Time		Time	
Dandelion ( <i>Taraxacum officinale</i> ) .....	461	15 min.	10,355,904	24 hrs.	5/24/19
Lamb's quarters ( <i>Chenopodium album</i> ) .....	58	15 min.	1,302,912	24 hrs.	5/24/19
Pigweed ( <i>Amaranthus retroflexus</i> ) .....	57	15 min.	1,280,448	24 hrs.	5/20/19
Wild buckwheat or field bindweed ( <i>Polygonum convolvulus</i> ) .....	4	15 min.	89,856	24 hrs.	5/20/19
Curled dock ( <i>Rumex crispus</i> ) .....	6	15 min.	134,785	24 hrs.	5/24/19
Marsh elder ( <i>Iva xanthifolia</i> ) .....	7	15 min.	157,248	24 hrs.	5/22/19
Green foxtail ( <i>Setaria viridis</i> ) .....	2	15 min.	44,928	24 hrs.	5/22/19
Sunflower, wild ( <i>Helianthus petiolaris</i> ) .....	2	15 min.	44,928	24 hrs.	5/24/19

The examples cited in the above table do not represent the largest catch of any one species in a 15-minute period.

**TABLE III.—SHOWING TOTAL NUMBER OF ALL SPECIES PASSING A GIVEN POINT ON A 12-FOOT DITCH DURING A PERIOD OF 24 HOURS**

No. of Species	No. of Seeds Caught in 15 Minutes on a Surface of 3¼". Cross-section 4.14". sq. inches	No. of Seeds Passing a Given Point in 24 Hours on a 12 foot Surface. Cross-section, 234 sq. inches	Dates
15	191	4,290,624	6/ 5/1919
18	310	6,963,840	6/ 5/1919
17	99	2,223,936	5/17/1919
21	208	4,672,512	5/19/1919
18	189	4,245,696	5/20/1919
20	191	4,290,624	5/20/1919
11	210	4,717,440	5/22/1919
14	69	1,550,016	5/23/1919
16	213	4,384,832	5/24/1919
17	391	8,783,424	5/24/1919

These estimates are based on 15-minute catches and represent a few of the average samples.

The following ten samples of soil from Ditch No. 1 were taken in late October. The samples were from the bottom and sides, and each contained 36 cubic inches of soil.

**TABLE IV.—SEEDS IN MUD OF DITCH**

Species of weeds—	No. of seeds	Species of weeds—	No. of seeds
<b>Sample No. 1</b>			
<i>Iva xanthifolia</i> .....	1	<i>Iva xanthifolia</i> .....	35
<i>Polygonum persicaria</i> .....	1	<i>Polygonum aviculare</i> .....	2
<i>Amaranthus blitoides</i> .....	2	<i>Rumex crispus</i> .....	2
<i>Amaranthus retroflexus</i> .....	3	<i>Taraxacum officinale</i> .....	1
<i>Chenopodium album</i> .....	1	<b>Sample No. 7</b>	
<b>Sample No. 2</b>			
<i>Amaranthus retroflexus</i> .....	2	<i>Amaranthus blitoides</i> .....	5
<i>Chenopodium album</i> .....	2	<i>Amaranthus retroflexus</i> .....	6
<i>Polygonum persicaria</i> .....	1	<i>Polygonum convolvulus</i> .....	4
<i>Rumex crispus</i> .....	1	<i>Polygonum aviculare</i> .....	2
<b>Sample No. 3</b>			
<i>Amaranthus blitoides</i> .....	5	<i>Carex sp.</i> .....	1
<i>Amaranthus retroflexus</i> .....	4	<i>Chenopodium album</i> .....	4
<i>Chenopodium album</i> .....	5	<i>Portulaca oleracea</i> .....	1
<i>Echinochloa crus-galli</i> .....	4	<b>Sample No. 8</b>	
<i>Polygonum aviculare</i> .....	4	<i>Polygonum convolvulus</i> .....	2
<i>Polygonum convolvulus</i> .....	2	<i>Polygonum aviculare</i> .....	1
<i>Rumex crispus</i> .....	9	<i>Carex sp.</i> .....	1
<b>Sample No. 4</b>			
<i>Amaranthus blitoides</i> .....	2	<i>Chenopodium album</i> .....	3
<i>Chenopodium album</i> .....	1	<i>Portulaca oleracea</i> .....	3
<i>Polygonum convolvulus</i> .....	1	<i>Amaranthus blitoides</i> .....	4
<b>Sample No. 5</b>			
<i>Amaranthus blitoides</i> .....	5	<i>Amaranthus retroflexus</i> .....	10
<i>Amaranthus retroflexus</i> .....	4	<b>Sample No. 9</b>	
<i>Carex sp.</i> .....	1	<i>Rumex crispus</i> .....	19
<i>Chenopodium album</i> .....	4	<i>Chenopodium album</i> .....	3
<i>Polygonum aviculare</i> .....	6	<i>Amaranthus blitoides</i> .....	2
<i>Polygonum persicaria</i> .....	1	<i>Polygonum convolvulus</i> .....	4
<i>Tragopogon sp.</i> .....	1	<i>Melilotus alba</i> .....	3
<b>Sample No. 6</b>			
<i>Amaranthus blitoides</i> .....	2	<i>Iva xanthifolia</i> .....	1
<i>Amaranthus retroflexus</i> .....	3	<b>Sample No. 10</b>	
		<i>Rumex crispus</i> .....	19
		<i>Hordeum jubatum</i> .....	63
		<i>Amaranthus blitoides</i> .....	2
		<i>Amaranthus retroflexus</i> .....	1
		<i>Melilotus alba</i> .....	1
		<i>Polygonum convolvulus</i> .....	1





The factors which affect the number of weed seeds carried in irrigation ditches are as follows:

1. Flora of ditch bank and adjacent territory.
2. Season of the year.
3. Velocity and direction of wind.
4. Velocity of irrigation stream.
5. Buoyancy of weed seeds.

### DITCH BANK VEGETATION

In the construction of irrigation ditches, both large and small, new soil is brought to the surface, and consequently the banks present a denuded surface (Fig. 2). This loose soil composing the banks is a favorable habitat in which weeds readily establish themselves. As a result, in a very few years, a new ditch, unless grazed, is densely overgrown with many species of weeds. The species of weeds represented on ditch

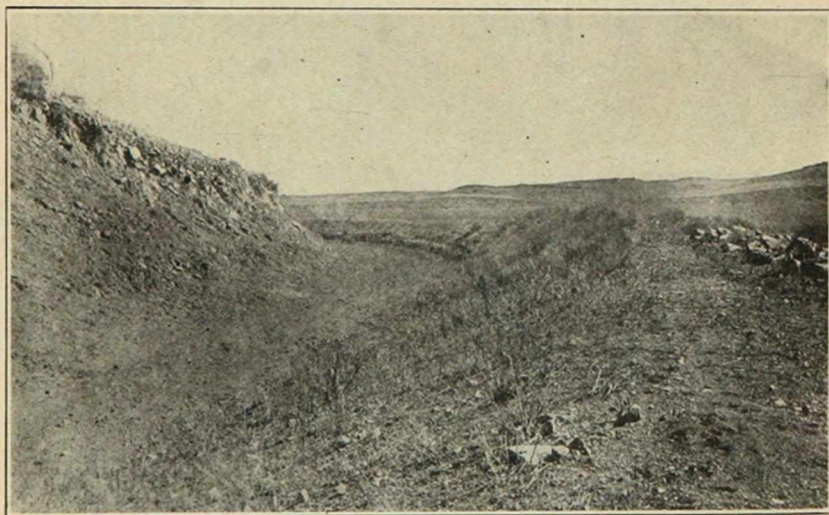


Fig. 2—A newly constructed ditch. The banks present a denuded surface, and a favorable situation in which weeds may establish themselves.

banks are those inhabiting the roadsides and fields of the locality. On account of the water supply along ditches, the stand of weeds along them is denser and the individual plants are larger than along roadsides and in waste places. (Fig 3.)

As a rule there is a greater number of weed species on a new ditch bank than on an old one. As vegetative development proceeds there is a reduction in the number of species and an increase in the number of individuals of the successful species.



Fig. 3—An irrigation ditch heavily overgrown with tall weeds.

One may find on a section of an old ditch bank almost a pure stand of one or two weeds such as sweet clover (*Melilotus alba*), tall ragweed (*Ambrosia trifida*), Rocky Mountain beeplant (*Cleome serrulata*), tall marsh elder (*Iva xanthifolia*), and fire-ball (*Kochia scoparia*). The above species often form rather pure stands along ditches. A few species of sedges, chiefly *Carex nebraskensis*, and the grasses, such as *Panicularia grandis*, become established at the water's edge along old ditches, and occupy the soil to the exclusion of other plants. These two species are not weeds in fields and their growth along ditch banks is to be encouraged. Furthermore, the grasses and sedges are excellent soil binders.

Ordinarily, there is little opportunity for a ditch bank to pass through a normal vegetative development. Almost annually there is disturbance of the habitat by the washing of water, by the cleaning of the ditch, and by the mowing of the

vegetation. Consequently, in many respects, a ditch bank usually presents an early stage in plant succession, with its large number of species.

### SEASONAL RELATIONS

When water is first turned into the ditches in the spring, there is an enormous number of weed seeds and debris of all kinds carried into the stream. During the irrigation season many weed seeds sink in transit and become lodged in the mud, and during the non-irrigation season there is a heavy accumulation of seeds in the soil of ditch bottoms and sides which are blown there by the wind. The first flush of water in the spring washes these seeds down with the current.

The greatest number of seeds comes with the first flush of water in the spring—reference is here made to samples collected in May and June. This being true, it would be advisable, when practicable, to avoid turning water into the field laterals and rows, until considerable water has been run through the ditches.

The seed-shedding period of some weeds is readily detected, of course, in the collections from the seed traps. This is particularly noticeable in the case of weeds which shed their seeds quite completely within a short period, such as the dandelion.

Following the first two or three weeks of flow in the spring there is a decrease in the amount of seeds and debris carried by the ditches. Reference is made to samples collected in July and August.

The weed seeds carried in irrigation streams are by no means only from weeds which border them. Seeds are carried long distances by the wind, fall in the water, and are conveyed by the current. The prevailing direction of the wind and the relative position of streams and weed infested areas, as well as the velocity of the stream, are factors which affect the number of seeds carried.

Seeds are carried long distances by streams. The distance any particular kind of seed will travel depends upon the velocity of the water, the character of the water surface, the specific gravity of the seed, and character of the seed coat. Some seeds, such as Indian mustard (*Brassica juncea*), Hare's-

ear mustard (*Conringia orientalis*), Frenchweed (*Thlaspi arvense*), broad-leaved plantain (*Plantago major*), and Shepherd's purse (*Capsella bursa-pastoris*), are heavier than water and sink immediately if agitated. Such seeds would not be carried long distances except in very swiftly running water.

If some seeds alight gently on the surface of water, and the water surface is undisturbed, as in the case of a slowly running stream, the seeds will float for a long time, but if the surface is agitated, as it would be in the case of a swiftly running stream, the seeds readily sink. See Table V.)

### BUOYANCY OF WEED SEEDS

Some weed seeds float for an indefinite period if laid carefully upon a smooth water surface, and the surface is not disturbed (See Table IV). However, many of the same species of seeds sink if they fall on the surface from a short distance above the water. The following experiment in which seeds were dropped from a height of 5 feet upon a water surface was intended to simulate the situation along ditch banks where the seeds fall from weeds over-hanging the water.

TABLE VI.—BUOYANCY OF SEED—WHEN DROPPED INTO WATER FROM A HEIGHT OF 5 FEET THRU A ½" GLASS TUBE INTO A 250 C. C. BEAKER—100 SEEDS OF EACH SPECIES USED

Kind of Seed—	Floated	Sank
<i>Echinochloa crus-galli</i> .....	100	0
<i>Rumex crispus</i> (hulled).....	33	67
<i>Rumex crispus</i> (unhulled).....	100	0
<i>Amaranthus graecizans</i> .....	23	77
<i>Sisymbrium altissimum</i> .....	39	61
<i>Solanum triflorum</i> .....	50	50
<i>Sophia incisa</i> .....	76	24
<i>Abutilon abutilon</i> .....	28	72
<i>Onagra strigosa</i> .....	100	0
<i>Portulaca oleracea</i> .....	28	72
<i>Hyocyamus niger</i> .....	100	0
<i>Cuscuta planiflora</i> .....	52	48
<i>Lolium temulentum</i> .....	64	36
<i>Capsella bursa-pastoris</i> .....	70	30
<i>Polygonum convolvulus</i> .....	87	13
<i>Carduus arvensis</i> .....	96	4
<i>Brassica arvensis</i> .....	30	70
<i>Plantago lanceolata</i> .....	30	70
<i>Thlaspi arvense</i> .....	30	70

Kind of Seed—	Floated	Sank
<i>Taraxacum officinale</i> .....	100	0
<i>Lactuca scariola</i> .....	95	5
<i>Gaura parviflora</i> .....	95	5
<i>Lappula occidentale</i> .....	99	1
<i>Amaranthus powelli</i> .....	46	54
<i>Brassica nigra</i> .....	35	65
<i>Datura stramonium</i> .....	100	0
<i>Brassica juncea</i> .....	26	74
<i>Salvia lanceolata</i> .....	25	75
<i>Cichorium intybus</i> .....	78	22
<i>Plantago major</i> .....	48	52
<i>Ambrosia artemisiifolia</i> .....	100	0
<i>Camelina sativa</i> .....	65	35
<i>Lepidium apetalum</i> .....	82	18
<i>Sonchus oleraceus</i> .....	100	0
<i>Eriogonum effusum</i> .....	100	0
<i>Heracleum lanatum</i> .....	100	0
<i>Aquilegia coerulea</i> .....	20	80
<i>Polanisia trachysperma</i> .....	52	48
<i>Tragopogon porrifolius</i> .....	100	0
<i>Syntherisma sanguinale</i> .....	100	0
<i>Ambrosia trifida</i> .....	100	0
<i>Amaranthus retroflexus</i> .....	41	59
<i>Panicum capillare</i> .....	96	4
<i>Conringia orientalis</i> .....	17	83
<i>Chenopodium album</i> .....	36	64
<i>Saponaria vaccaria</i> .....	50	50
<i>Helianthus petiolaris</i> .....	79	21
<i>Senecio spartioides</i> .....	100	0
<i>Polygonum persicaria</i> .....	82	18
<i>Syntherisma humifusum</i> .....	100	0
<i>Kochia scoparia</i> .....	20	80
<i>Euptoraum purpureum</i> .....	100	0
<i>Kuhnia glutinosa</i> .....	100	0
<i>Iva xanthifolia</i> .....	100	0
<i>Eragrostis major</i> .....	2	98
<i>Setaria viridis</i> .....	46	54
<i>Setaria glauca</i> .....	94	6

### GRAZING DITCH BANKS

One of the most effective and economical ways of keeping weeds down along irrigation ditches is by grazing. Sheep, cattle, and horses are used for this purpose. The fencing and grazing of the larger irrigation ditches is becoming a more common practice, and one to be strongly recommended. It is believed that in a few years measures will be taken to compel

ditch companies to keep irrigation banks free from weeds. In some instances this may be accomplished by mowing (Fig. 4)

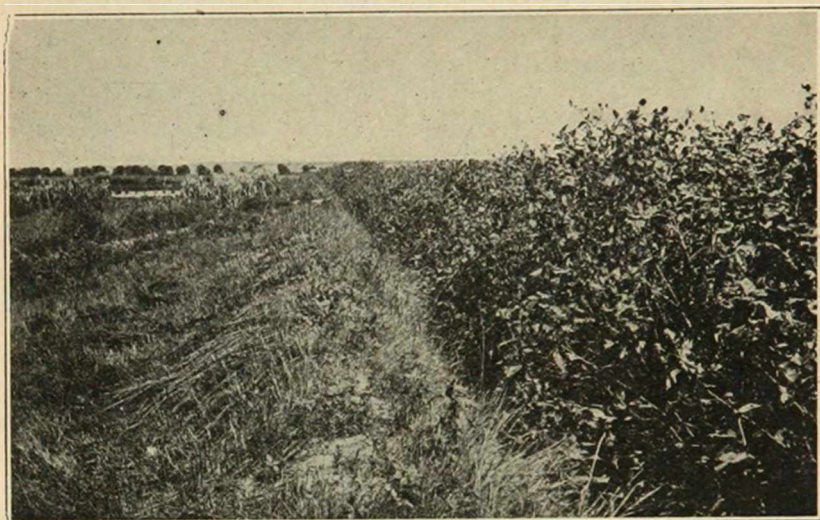


Fig. 4—A ditch between two farms. One farmer has mowed his side of the ditch, the other has allowed his to grow to weeds.

the weeds before seeding, but fencing and grazing will prove more effective, and the results more permanent. And, too, the area along ditches which is now worse than wasted, will not only be kept clean of weeds, but will be made to support several head of stock.

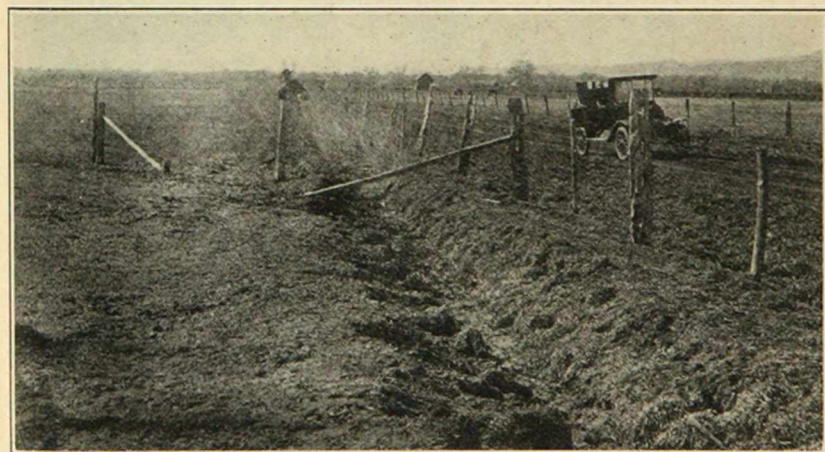


Fig. 5—In the foreground, the grazed ditch bank is free from weeds, while across the fence the ungrazed bank is overgrown with weeds.

The effects of grazing upon the vegetation of ditch banks are strikingly shown where one side or section of a ditch is grazed and the other side or adjacent section is ungrazed. Figure 5 graphically illustrates this.

It is not unusual to see grazed ditch banks grown over with a fair stand of grasses, chiefly Kentucky blue grass. Continued grazing results in rapid reduction of annuals, and a proportionate increase of perennials.



Fig. 6—Small lateral ditch bank densely overgrown with smooth brome grass. This grass occupies the ground to the almost total exclusion of weeds.

### SEEDING OF DITCH BANKS

Figure 6 shows a small lateral ditch bank on the Agricultural College campus densely overgrown with smooth brome grass (*Bromus inermis*). This perennial almost entirely excludes all weed growth. Its more general use on ditch banks should be encouraged. An excellent quality of seed is obtainable.

The writers acknowledge the assistance of Miss Caroline M. Preston, who made the drawing for Figure 1, and of Mr. George Spidel, who collected and analyzed many of the samples.



### SUMMARY

1. Irrigation water is a most important factor in the dissemination of weed seeds in the irrigated sections of the western states, conveying tremendous quantities of weed seeds.

2. In 156 weed seed catches from three different ditches, a total of 81 different species of weeds were found, those most frequently met with being prostrate pigweed, tall pigweed, sedge, lamb's quarters, tall marsh elder, door weed, black bindweed, curled dock, and dandelion. The number of weed seeds passing a given point on a 12-foot ditch during a period of 24 hours may reach several millions.

3. Our ditch banks are more to be feared than roadsides as sources of weed infestation.

4. The early irrigation waters are most heavily loaded with weed seeds.

5. Many weed seeds rest during the non-irrigating season in the mud of the ditch.

6. Weed seeds differ in the readiness with which they sink or float and this is determined somewhat by the condition of the water surface and by the manner in which the seeds alight upon it.

7. Some seeds float for days no matter how they strike the water surface or how it is agitated; some float if laid on the water carefully and the surface is not disturbed, but sink readily if the surface is agitated, or sink almost immediately if they strike the surface with some force.

8. Ordinarily, grazing is one of the most effective and economical ways of keeping weeds down along large irrigation ditches.

9. In some instances, the seeding of ditch banks to brome-grass (*Bromus inermis*) is to be encouraged.