PHYTOTOXIC[1] EFFECTS OF AQUEOUS EXTRACTS OF FIELD BINDWEED AND OF CANADA THISTLE— A PRELIMINARY REPORT

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The control and elimination of noxious weeds in North Dakota has long been recognized as a major phase of the farming program. Recent intensified interest in weed control methods has created a need for determining the physiological effect of weed residues on the germination and development of the common North Dakota crops. This factor may prove important since proper conditions for seedling development are essential for normal plant growth.

That certain water soluble plant substances have inhibitory effects on the germination of some seeds has been known since the early 1900's and experiments have been conducted by many on this problem. See Evenari[4] for an extensive review of many of these experiments.

In our study the seeds of wheat and flax were germinated in the presence of various concentrations of aqueous residue extracts of the tops and roots of the perennial weeds Canada thistle *Cirsium arvense*, and field bindweed *Convolvulus arvensis*. This experiment is the first attempt to determine the inhibitory effect of these common North Dakota noxious weeds on plant development.

The dried tissue of the weedy plants was ground, placed in water in the proportions of 1 part residue to 20, 30, and 40 parts water, allowed to leach for 20 minutes, and the water soluble substances extracted with a Buchner filter. Duplicate Petri dishes containing 100 crop seeds each were set up for each of the various concentrations and controls. The seeds were placed in the Petri dishes between two filter papers which were then impregnated with a standard amount of aqueous extract of the desired concentration, and placed in a germinator at a temperature of 19°±2°C. Germination counts and growing point measurements were made on the fourth day. Seeds were regarded as having germinated when any seedling organ had attained a length of not less than 1.5 mm.

The phytotoxic action of top and root residues of field bindweed and Canada thistle on wheat and flax are shown graphically in figure 1 on flax seedling roots, and in figure 2 on wheat seedling tops. Each point on the graph represents measurements on lots of 600 seeds, expressed in percentages based on the length of the control being equal to 100%. The control length of the shoot of wheat averaged slightly more than 15 mm. and the root of flax averaged slightly more than 35 mm. In figure 1, it is shown that the extracts of field bindweed tops at a concentration of 1:20 inhibit the length of the roots of flax to 24% of the length of

[1]The term "phytotoxic" means a substance poisonous to growing plants.

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[4]Evenari, Michael. Germination Inhibitors. The Botanical Review, Vol. 15, No. 3 Mar. 1949.

Figure 1.

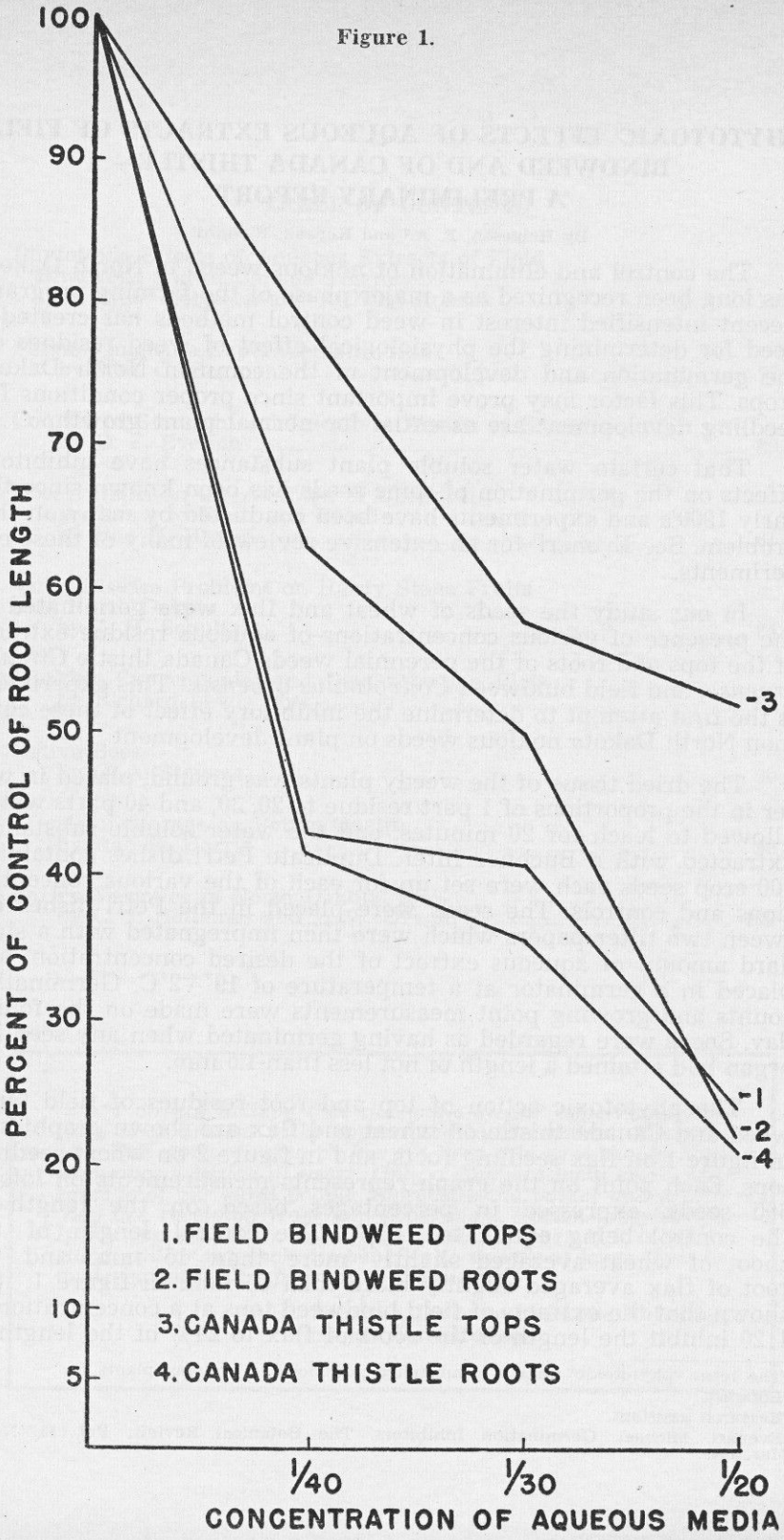
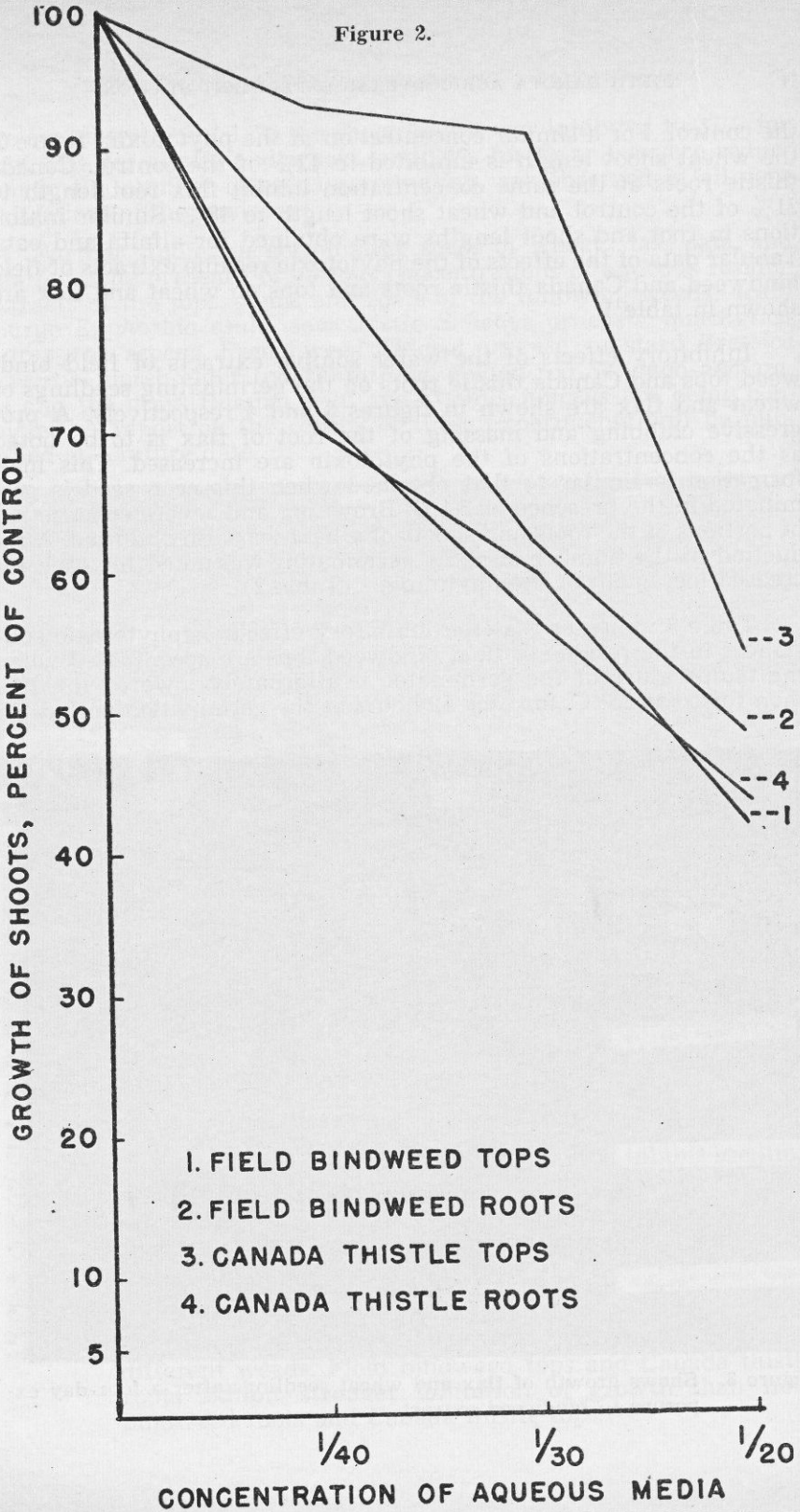

100
90
80
70
60
50
40
30
20
10
5
PERCENT OF CONTROL OF ROOT LENGTH
-3
-1
-2
-4
1. FIELD BINDWEED TOPS
2. FIELD BINDWEED ROOTS
3. CANADA THISTLE TOPS
4. CANADA THISTLE ROOTS
1/40
1/30
1/20
CONCENTRATION OF AQUEOUS MEDIA

Figure 2.


100
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GROWTH OF SHOOTS, PERCENT OF CONTROL
--3
--2
--4
--1
1. FIELD BINDWEED TOPS
2. FIELD BINDWEED ROOTS
3. CANADA THISTLE TOPS
4. CANADA THISTLE ROOTS
1/40
1/30
1/20
CONCENTRATION OF AQUEOUS MEDIA

the control. For a similar concentration of the phytotoxin, figure 2, the wheat shoot length is inhibited to 42% of the control. Canada thistle roots at the same concentration inhibit flax root length to 21% of the control and wheat shoot length to 48%. Similar inhibitions in root and shoot lengths were obtained for alfalfa and oats. Tabular data of the effects of the phytotoxic residue extracts of field bindweed and Canada thistle roots and tops on wheat and flax are shown in table 1.

Inhibitory effects of the water soluble extracts of field bindweed tops and Canada thistle roots on the germinating seedlings of wheat and flax are shown in figures 3 and 4 respectively. A progressive clubbing and massing of the root of flax is to be noted as the concentrations of the phytotoxin are increased. This malformation is similar to that obtained when this crop seed is germinated in the presence of 2,4-D. Browning and severe constriction of portions of the roots and shoots of wheat was also observed. A reduction in the number of seeds germinating was noted for each increased increment of the phytotoxin, (Table 2).

Table 3 indicates that the inhibitory effects of phytotoxic substances in the residue of field bindweed tops are accentuated when the temperature of the germinator is alternately lowered to 12°C. then raised to 25° C. for each 12 hours of the germination period. At

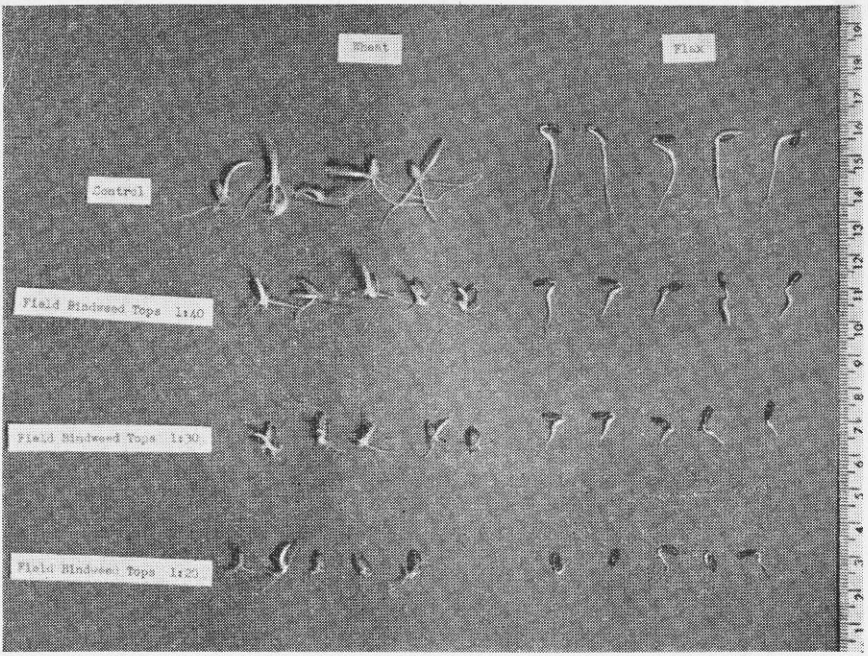

Figure 3. Shows growth of flax and wheat seedlings after a four-day exposure to bindweed extract.

the concentration of 1:20 the shoot length was inhibited to 37% for oats, 34% for alfalfa and wheat, and 20% for flax. A severe reduction in the number of seeds germinating was observed in all concentrations of the phytotoxin.

Further studies in germinating seeds of wheat, flax, oats, and alfalfa in the presence of various concentrations of aqueous residue extracts of the tops, stems and roots of the following weeds: leafy spurge *Euphorbia esula,* sow thistle *Sonchus arvensis,* quackgrass *Agropyron repens,* Frenchweed *Thlaspi arvense,* mustard *Brassica arvensis,* marsh elder *Iva xanthifolia,* golden rod *Solidago nemoralis* and the grass Russian wild rye *Elymus junceus* are being conducted. A report on the results of these experiments will be published at a future date.

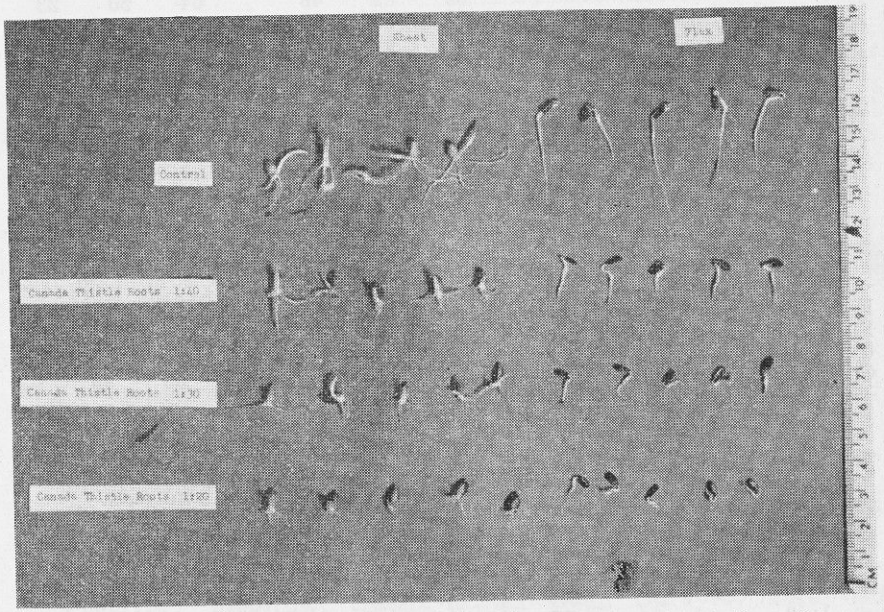

Figure 4. Shows growth of flax and wheat seedlings after a four-day exposure to Canada thistle extract.

The results of this experiment indicate that:

(1) Phytotoxic substances in the weeds tested inhibit seedling growth and germination.

(2) Increasing the concentration of the phytotoxic solution results in a progressive decrease in germination and growth of roots or shoots.

(3) The inhibitory action of the different weeds tested varies as to parts of the weed plant used for residue and as to different weeds. Field bindweed tops and Canada thistle roots exhibit stronger inhibition of growth than field bindweed roots and Canada thistle tops.

(4) Variations in germinator temperature affects the inhibitory action of the phytotoxins on both germination and top length of all crop seeds tested.

Table 1. Reduction in growth due to toxic substances leached from field bindweed and Canada thistle roots and tops expressed as per cent of control.

Weed residue extracted	Field crop: Wheat tops			Flax roots		
	Concentration of extract					
	1:40	1:30	1:20	1:40	1:30	1:20
Field bindweed tops	70	60	42	43	42	24
Field bindweed roots	83	62	48	64	50	23
Canada thistle tops	93	92	54	78	58	52
Canada thistle roots	70	57	48	43	36	21

Table 2. Reduction in germination due to the toxic substances leached from field bindweed and Canada thistle roots and tops.

Weed residue extracted	Field crop: Wheat				Flax			
	Concentration of extract							
	Check	1:40	1:30	1:20	Check	1:40	1:30	1:20
Field bindweed tops	94	93	91	88	94	93	91	83
Field bindweed roots	91	90	90	89	93	89	88	82
Canada thistle tops	94	90	89	87	95	89	87	87
Canada thistle roots	95	92	89	86	95	83	78	76

Table 3. Toxic effects of bindweed tops at alternate temperatures of 12° C and 25°C on the growth of wheat, flax, alfalfa, and oats.

Concentration of extract	Crop plant: Wheat	Flax	Alfalfa	Oats
Control (water)	100%	100%	100%	100%
1:40	57	39	57	49
1:30	51	37	44	50
1:20	34	20	34	37

Table 4. Toxic effects of bindweed tops at alternate temperatures of 12°C and 25°C on the germination of wheat, flax, oats, and alfalfa. Expressed as per cent germination.

Concentration of extract	Crop plant: Wheat	Flax	Alfalfa	Oats
Control (water)	95	93	66	97
1:40	88	76	62	35
1:30	85	65	62	21
1:20	76	35	50	12