UNIVERSITY OF IDAHO

College of Agriculture

The Smooth-Leaved Perennial Groundcherry

(*Physalis longifolia* var. *subglabrata*)

by

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Gerald W. Yeoumans and
Lambert C. Erickson

IDAHO Agricultural Experiment Station

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Summary

Numerous field trials (11) conducted over a period of several years showed that groundcherry populations could be drastically reduced by the following procedure: (a) after harvesting an early maturing cereal crop, irrigate to promote good weed growth, (b) about two weeks later spray with 2 to 4 pounds of amitrol or 2,4,5-T per acre, or a mixture of 2 pounds per acre of each, (c) **when and if Food and Drug Administrations regulations permit,** the cereal crop can be sprayed with 2 pounds per acre of 2,4,5-T when the grain is in the milk stage and the treatment can be repeated about 1 month after harvest.

All suggestions made here for groundcherry control with chemicals are subject to clearance and continuing approval by Federal and State regulations.

COVER PICTURES: A severe groundcherry infestation in a sugar beet field.

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Ralph J. Schaeffer[2]
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Lambert C. Erickson[3]

Introduction

Perennial groundcherry is native to the United States. This is a diversified genus and one or more species of this weed probably can be found in every state. The many species and varieties vary widely in their adaptation, distribution, and aggressiveness in crop competition. For all practical purposes, Idaho has only one form: a robust variety with wavy-edged, shiny leaves called smooth-leaved perennial groundcherry.

The genus **Physalis** is represented in the United States by 20 species and 30 varieties (12). The major dominant species in the agricultural areas of Idaho, Oregon, Utah, and Washington is **P. longifolia** var. **subglabrata.**

This perennial noxious weed was of only minor concern in agricultural production prior to 1945. Shortly thereafter, interest in its control was stimulated for the four following reasons: (a) this species is resistant to 2,4-D, (b) the infestations increased in density when 2,4-D reduced the competition previously provided by other broadleaved species, (c) more people began to recognize the weed as a severe crop competitor and, (d) it was spreading rapidly.

In 1945 Idaho had approximately 6,000 infested acres. By 1955 the estimated infested acreage had increased to 13,000 and by 1962 to 16,000 acres. Two counties, Owyhee and Fremont, reported its presence for the first time in 1962. This variety is native to this region. The original native stand was apparently centered in the vicinity of the junction of the Snake and Boise Rivers in southwestern Idaho. In this original habitat, perennial groundcherry thrived under climatic conditions approximating a mean of 75° F. in July, 26° F. in January, and an annual precipitation of about 8 inches. Despite its original arid habitat, the

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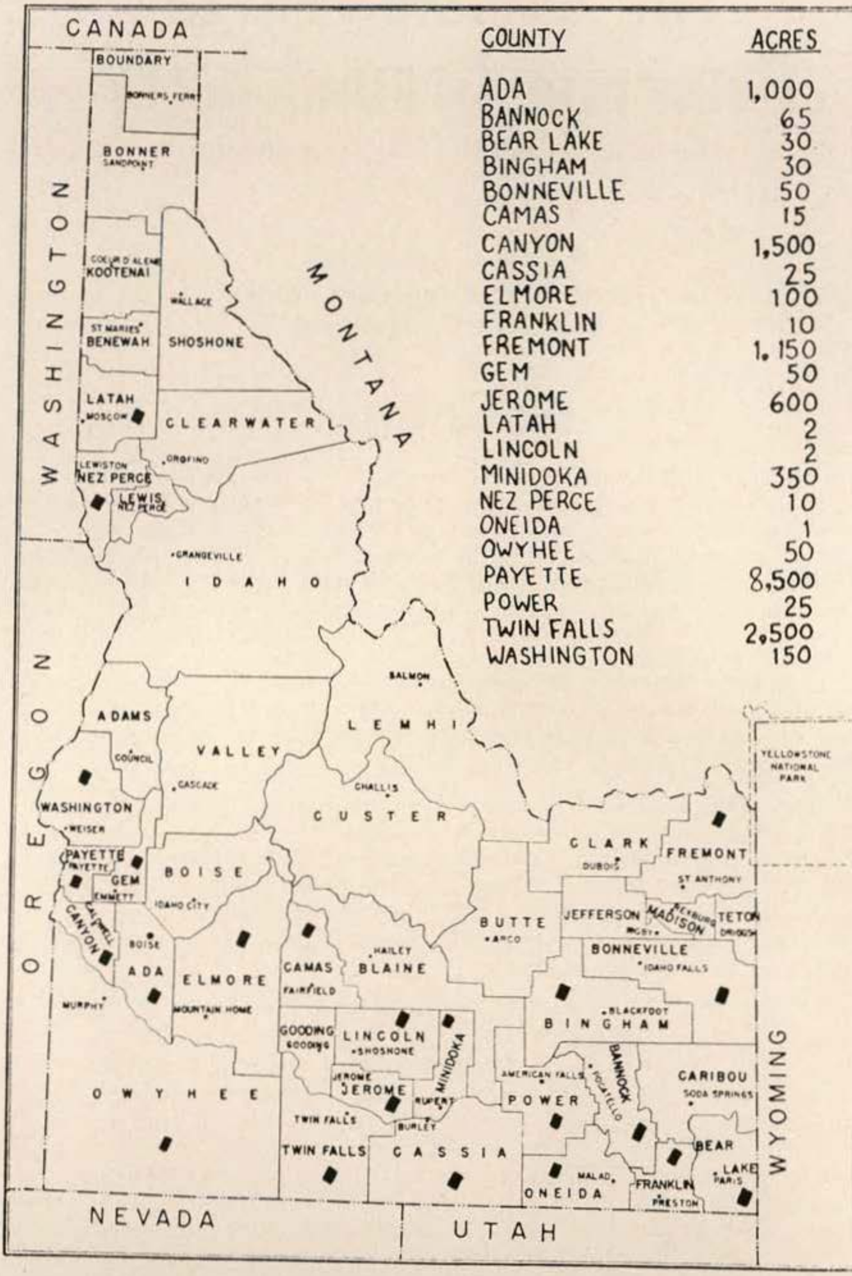

COUNTY	ACRES
ADA	1,000
BANNOCK	65
BEAR LAKE	30
BINGHAM	30
BONNEVILLE	50
CAMAS	15
CANYON	1,500
CASSIA	25
ELMORE	100
FRANKLIN	10
FREMONT	1.150
GEM	50
JEROME	600
LATAH	2
LINCOLN	2
MINIDOKA	350
NEZ PERCE	10
ONEIDA	1
OWYHEE	50
PAYETTE	8,500
POWER	25
TWIN FALLS	2,500
WASHINGTON	150

Fig. 1. Estimated acres infested with perennial groundcherry Physalis longifolia var. subglabrata in Idaho. Small, black boxes indicate the presence of perennial groundcherry within the county.

weed now thrives most luxuriantly under irrigated conditions. Figure 1 shows its present distribution and approximate acreage.

The conclusion that this variety originated in the proximity of Canyon County is based on its known dessemination pattern throughout Idaho and that neither Coulter and Nelson (1) in 1909 nor Rydberg (10) in 1917 identified or described this species and that neither investigated this particular area.

In the past this species has been identified as **P. subglabrata** (2) and as **P. virginiana** (12). The conclusions from the present study, based on field and herbarium specimens from Idaho and adjacent states concur with the 1959 classification by Hitchcock et al., (5) which identifies it as a variety of **P. longifolia.** The prime characteristics differentiating this variety from the species description given in 1902 by MacKenzie and Bush (9) are: deep, purple-brownish corolla throat, purple anthers, orange berries, and relatively glabrate wavy margined leaves on slender petioles. Some consolation for the confusion that has prevailed in the identification of this species can be found in the following statement by Gray (4) in 1857, "The North American flora hardly contains a more difficult genus for its size than **Physalis.**"

Plant Development and Growth

Smooth-leaved perennial groundcherry is a warm season plant. Cold temperature dormancy inhibits shoot emergency until approximately June 1. Shoots then continue to emerge until early fall. Typically, the plants flower from late June until frost. The berries mature from mid-August until late October. Consequently, all stages of floral development can be found on a single plant throughout the late summer and fall season. Late seeded or late maturing crops like beans and sugarbeets respectively provide ideal environments for groundcherry competition. They frequently submerge beet fields, and the berries are frequently crushed in harvesting beans. This leaves the sticky seed-containing pulp adhering to the bean seeds.

The growth of the root system, its vertical penetration and horizontal spread, is drastically influenced by the prevailing soil disturbance or cropping sequence. This variety develops a thick taproot when undisturbed by cultivation. A root system perhaps 20 years old (figure 2) was excavated in an abandoned orchard. The root measured over 2 inches in diameter below the crown and exceeded 1 inch in diameter at a depth of 36 inches despite increasing numbers of downward directed branches with increasing depth. Under cultivated field conditions, the plants develop a deep-spreading horizontal root system. The major horizontal roots are concentrated at depths from 8 to 18 inches.

Seed Development and Germination

Well-developed berries will contain from 50 to more than 100 seeds. The finely-pitted, lenticular seeds, about 2 mm across, vary in color from green to yellow with advancing berry maturity. Figure 3 shows the inflated calyx, the dried berry, and the flat slightly tubricled seed.

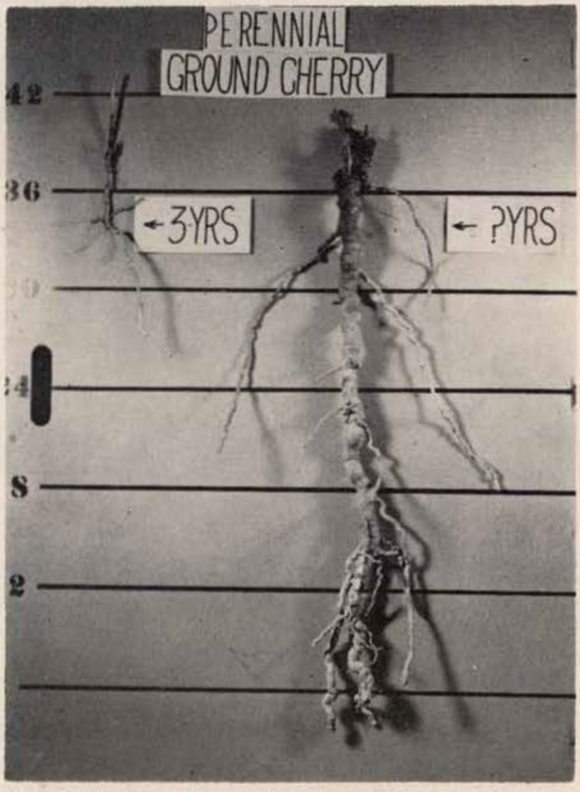

Fig. 2. Typical growth habits of perennial groundcherry roots when not disturbed by cultivations. Roots shown are perhaps 3 and 20 years old.

The fresh berry possesses a germination inhibitor. Depulping and washing removes the inhibitor, but an after-ripening inhibitor still prevents germination for about 6 additional weeks under laboratory storage conditions.

Germination studies revealed: (a) that the germination inhibiting substance was more concentrated in ripe than in green berries, (b) that mature seeds were inhibited more in germination than green seeds, (c) that seeds exposed to daylight during germination or moistened with a solution of potassium nitrate, singly or combined, inactivated the inhibitor, (d) that a soil-water media stimulated germination, while a soil-berry-extract media inhibited germination more than the berry extract media alone.

Seed germination percentages (table 1) obtained under the varying germination conditions and media were as follows: no seeds germinated when they were excluded from light; in light: (a) seeds in the blotter-water media germinated 31 percent, (b) in blotter and berry extract germination averaged 42 percent, (c) in blotter-water-potassium nitrate germination averaged 85 percent, (d) in soil-water media 54 percent, (e) in soil-water-potassium nitrate 91 percent, and (f) in soil-berry extract media germination was only 11 percent.

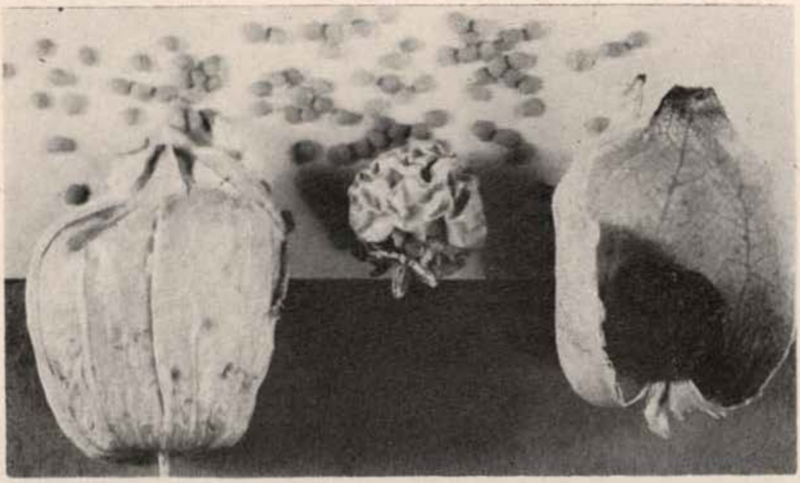

Fig. 3. Mature fruit of perennial groundcherry showing the dried inflated calyx, dried berry, and the cleaned seeds. All about actual size.

TABLE 1. Percentage germination of mature and green perennial groundcherry seeds under varying light conditions and germination media.

Light Exposure / Germination Media	Percent seed germination		
	Mature Seeds	Green Seeds	Mean
Dark			
Seeds between blotters (water)	0	0	0
Seeds between blotters (water + berry extract)	0	0	0
Seeds between blotters (water + berry extract + 0.2% KNO_3)	0	0	0
Daylight			
Seeds on blotter (water)	23	40	31
Seeds on blotter (water + berry extract)	31	54	42
Seeds on soil (water)	53	55	54
Seeds on soil (water + berry extract)	5	17	11
Seeds on blotter (water + 0.2% KNO_3)	80	90	85
Seeds on soil (water + 0.2% KNO_3)	88	94	91
Seeds on soil (water + 0.2% KNO_3 + berry extract)	73	59	66
Average	50	58	54
Subdued light*			
Seeds on blotter (water)	45	28	36
Seeds on blotter (water + berry extract)	15	50	32
Seeds on soil (water)	53	34	43
Seeds on soil (water + berry extract)	2	22	12
Seeds on blotter (water + 0.2% KNO_3)	78	84	81
Seeds on soil (water + 0.2% KNO_3)	97	90	93
Seeds on soil (water + 0.2% KNO_3 + berry extract)	69	53	61
Average	51	52	51

*Covered with Whatman No. 5 filter paper.

Plant Propagation

Greenhouse studies revealed that seedlings did not emerge from soil depths exceeding 2½ inches and that the optimum emergence depth was ½ inch. The time interval from seeding to seedling emergence increased approximately one day per ½ inch increment in seeding depth. That is, when seeds sown ½ inch deep emerged in 8 days, seeds sown 2 inches deep emerged after 11 days.

Seedlings became established perennials 4 to 6 weeks after seeding. Mortality in these young plants increased from 10 to 38 percent between 2 to 10 weeks. The seedling survival rate is perhaps 10 times higher than could be expected under field conditions. When the seedlings were severed at the soil surface at 2, 4, 6, 8, and 10 weeks after seeding, the re-establishment rate based on new shoots was 0, 0, 101, 202 and 258 percent, respectively. New root buds account for the increase in shoot numbers. However, the most important information obtained from this study was the data that showed seedlings must be killed before they are 6 weeks old. Otherwise, they will become established perennials.

Since field infestations appear to enlarge primarily from root growth and root segments spread by cultivation equipment, studies were made to determine the reproductive capacity of root system from root cuttings.

Table 2 shows the regenerative capacity of 3-inch root cuttings taken from the soil surface to depths of 36 inches. In brief, the data show that any portion of the root, to a depth of 36 inches, was capable of generating new shoots; segments from the upper 15 inches had the greatest reproductive capacity; and root dormancy was common throughout and increased in both frequency and duration at the greater depths.

Since different cultural equipment will cut or break root segments into various lengths and deposit these segments at varying soil depths,

TABLE 2. Shoot and bud development 4½ months after planting by 3-inch long root segments, taken from 12 soil depths.

Root segments from soil depths (inches)	Performance by root segments %			Shoots emerged	Buds and shoots total	Average buds and shoots per active segment
	Active	Dormant	Dead			
0-3	80	4	16	24	58	2.9
3-6	89	11	0	22	75	4.4
6-9	88	12	0	22	47	2.0
9-12	92	8	0	24	54	2.1
12-15	88	12	0	25	80	2.7
15-18	94	6	0	22	54	1.6
18-21	82	18	0	15	31	1.1
21-24	91	9	0	21	54	1.7
24-27	84	8	8	15	21	1.0
27-30	74	19	7	17	26	1.3
30-33	73	27	0	8	15	1.8
33-36	77	23	0	8	15	1.5
Average	88	22		18.4	44.2	2.0

TABLE 3. Average number of shoots and buds produced by root segments of different lengths and diameters.

Root length (inches)	Segments less than ⅛ in. diameter		Shoots and buds total	Segments greater than ⅛ in. diameter		Shoots and buds total
	Shoots	Buds		Shoots	Buds	
2	1.0	3.6	4.6	2.0*	4.2	6.2
1	1.0	1.4	2.4	1.2*	2.2	3.4
½	1.0	1.0	2.0	1.6*	1.2	2.8
Average	1.0	2.0	3.0	1.6*	3.2	4.1

* Shoot numbers not significantly different.

the investigations were continued to determine the regenerative ability of different sized root segments and their ability to produce new shoots from several soil depths.

Additional studies (table 3) showed that segments only ½ inch long and ⅛ inch thick produced new shoots and roots. Essentially only one strong shoot was produced from roots ½ to 2 inches long when the root segments were not more than ⅛ inch in diameter. Buds, however, increased in numbers as root length and thickness increased. Bud initiation approximated one bud per each ½ inch of root length. After the first shoot developed, the remaining shoot buds were inhibited from further development by the shoot limiting hormone produced by the dominating shoot. When two shoots developed simultaneously, both held dominance and inhibited further development of the remaining shoot buds. New roots developed from the exposed pericyclic area (14) at the severed ends of the old roots, thereby giving the appearance that the root segments continued to elongate.

To determine the depth from which perennial groundcherry shoots could emerge, root segments 3 inches long were planted in soil at depths of 3, 6, 9, 12, and 18 inches. A shoot emerged at the soil surface from every segment planted at 3 and 6 inches and from 60 percent of the segments planted at 12 and 18 inches. Apical dominance was exhibited by the production of a single shoot per root segments regardless of the depth at which they were planted. Figure 4 shows the type of growth produced by the root segments planted at the four soil depths. These results revealed the practical impossibility of destroying root segments by deep plowing or deep soil burial.

Presence of Growth Inhibitors

Plants frequently contain substances which inhibit germination or growth of other species or of the same species (7). Extracts from groundcherry roots at 2 and 4 percent concentrations did not reduce germination of red or Ladino clover, alfalfa, wheat, barley or crested wheatgrass in greenhouse studies. However, these extracts caused distinct inhibition of root growth in all of these species, and growth inhibition increased as the extract concentration increased. After 2 weeks, root growth reductions of the plants, when compared with the normal germinating checks, averaged: 65, 59, 59, 34, 32 and 16 percent, respectively, in alfalfa, red clover, barley, wheat, crested wheat and white clover.

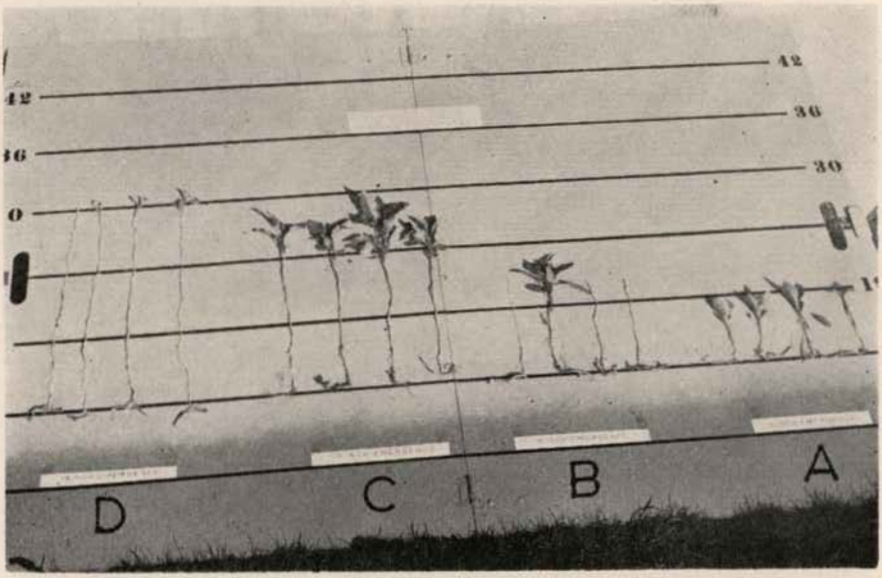

Fig. 4. Perennial groundcherry growth 2½ months after planting root segments at (A) 3-inch, (B) 6-inch, (C) 12-inch, and (D) 18-inch soil depths. Shoots from the 18-inch planting depth had just reached the soil surface.

Influence of Soil Types, Soil Fertility, Soil Moisture, and Light on Groundcherry Growth and Herbicide Response

(Soil Fertility and Soil Moisture)

Representative virgin soils of acid-forest (Helmer) neutral (McAvoy) and alkali (Parma) types were included in greenhouse and field studies to determine the adaptation of this species to these soil types and to different nitrogen and moisture levels. The results showed that perennial groundcherry was adaptable to the Helmer and McAvoy but not to the Parma type. It has a salt concentration gradient equivalent to 17.2 atmospheres.

To promote good initial growth all the plants were maintained at a soil moisture of 1/3 atmosphere, or field capacity, until the first top-growth was removed. The two-nitrogen levels included were: no nitrogen added, and 100 pounds equivalent added per acre. Figure 5 shows some of the equipment used for determining moisture utilization in this study.

Table 4 shows the characteristics of the soils used in this study and the plant growth as influenced by nitrogen and moisture levels. In brief it was determined that:

(a) This species was significantly better adapted to the neutral and acid

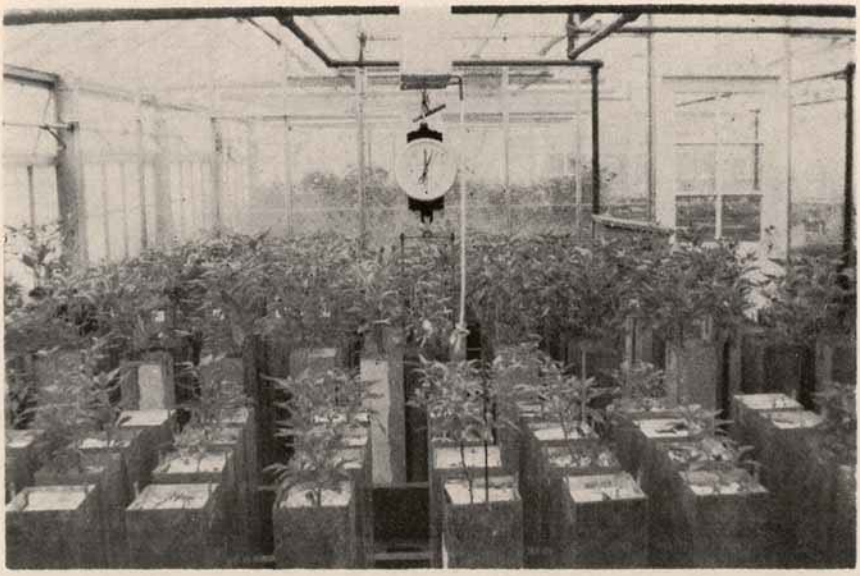

Fig. 5. Partial view of plants and equipment used in study of growth responses by soil types, and two nitrogen levels. Cans in foreground contain Parma soil, those in background contain McAvoy and Helmer.

TABLE 4. Growth response and moisture utilization efficiency in perennial groundcherry as affected by soil types and moisture-nitrogen levels.

Initial plant growth response			Regrowth response after removing original top growth	
Soil type nitrogen and moisture levels	**Ave. plant dry wt. in grams**	**Plant dry wt. gm./7000 ml. water used**	**Ave. plant dry wt. in grams**	**Plant dry wt gm./7000 ml. water used**
Helmer soil (pH 5.8, ppm salt 140, EC* 0.20, % N 0.215)				
Low N.				
High H_2O	4.1	0.28	5.7	1.2
Low H_2O			2.5	0.5
High N.				
High H_2O	7.4	0.51	6.8	1.2
Low H_2O			8.1	1.5
McAvoy soil (pH 7.4, ppm salt 525, EC* 0.75, % N 0.085)				
Low N.				
High H_2O	4.6	0.27	6.1	2.1
Low H_2O			3.2	1.2
High N.				
High H_2O	6.2	0.36	6.9	1.8
Low H_2O			5.5	2.4
Parma soil (pH 7.7, ppm salt 7,687, EC* 11.0, % N 0.049)				
Low N.				
High H_2O	1.6	0.09	1.3	0.5
Low H_2O			1.5	0.6
High N.				
High H_2O	1.3	0.07	1.2	0.4
Low H_2O			1.5	0.6

*electrical conductivity

soils although the major infested areas tend toward being alkaline.

(b) Plant weights were about 50 percent greater in the high nitrogen levels in the Helmer and McAvoy soils but were reduced greatly in the Parma soil.

(c) Based on water used per unit of dry-plant-weight produced, moisture utilization was 34 and 41 percent more efficient at high nitrogen levels respectively in the Helmer and McAvoy soils. In the Parma soil nitrogen intensified salt toxicity and decreased the utilization efficiency of water.

(d) High nitrogen levels produced 2 to 3 times more flowers in plants in the Helmer and McAvoy soils but depressed plant flowering in the Parma soil.

(e) High nitrogen levels decreased the moisture content in plants, except in the Parma soil.

When the preceding information was obtained, the plants were transferred to the field for climatic conditioning. Subsequent studies with the herbicide amitrol applied at 2 pounds per acre, revealed that the plants grown at low moisture and low nitrogen levels sustained the least root injury from the herbicide. These results agree with those obtained in other studies (3), showing that high soil moisture and nitrogen levels increased the sensitivity of the plants to herbicides. For instance, much greater kills of Canada thistle were obtained with 2,4-D (8) when ample nitrogen was used in the cropping sequence.

(Light and Herbicide Toxicity)

Jordon et al., (6) found that low light intensity and high temperatures increased the sensitivity of plants to 2,4-D. Wiese and Rea (13) reported that 2,4-D absorption continued for a period of 3 weeks and amitrol for 3 days.

To develop further information on role of light in herbicide effectiveness, 180 plants were grown in the greenhouse under uniform natural plus supplemental light conditions. They were then divided into the following sub-groups for conditioning prior to applying the herbicides: (a) continued in the usual light, (b) placed in darkness for 24 hours, and (c) placed in darkness for 24 hours both before and after the herbicide applications. These sub-groups were then further divided and treated at ¼, ½, and 1 pound per acre, respectively, with 2,4-D, 2,4,5-T, silvex, TBA, and amitrol. Leaves collected for starch analyses revealed abundant starch in the light exposed plants, a trace in the 24 hour darkened plants, and no detectable starch in the 48 hour darkened plants.

Weekly visual evaluations of the herbicide treated plants revealed that the toxicity symptoms became evident first in the light exposed plants, secondly, in those darkened 24 hours, and last in the plants darkened both before and after treating. Final toxicity evaluations, based on total plant weights 4½ months after treating showed no significant differences in the toxic effects: (a) 2,4,5-T, silvex and amitrol were most toxic and of equal rank, and (b) 2,4-D and TBA were least toxic. Furthermore, no significant differences were found among the three light exposures.

These results indicate that if herbicides are translocated only by the photosynthate stream; they were absorbed and translocated equally well regardless of leaf-starch content at the time of treatment. In this instance there was no discernable herbicide decomposition during the 24 or 48 hour dark intervals when the plants were excluded from light.

Field Control Investigations

Field control experiments included studies on the control of the smooth-leaved perennial groundcherry under field cropping conditions, in permanent grass pastures, and in non-cropped areas. The herbicide rates used ranged from selective quantities to rates so high that at least temporary soil sterility resulted. Table 5 summarizes some of the results obtained when 2,4-D, 2,4,5-T, amitrol, and silvex were applied to groundcherry on amply irrigated land.

When the herbicides given in table 5 plus one other herbicide, TBA, were applied in a grain field in late fall and seeded to wheat the following spring, the results were far less promising (11). Applications of 50, 100, and 150 pounds of 2,4-D per acre reduced the groundcherry stand an average of 36 percent; 20, 40, and 60 pounds of 2,4,5-T gave an average reduction of 66 percent; silvex at 15, 30, and 45 pounds per acre

TABLE 5. Percentage reductions obtained under field conditions after 1 and 2 years when groundcherry was treated with 4 herbicides at two rates. Percentage reduction

Herbicide and rate per acre	1 year after application	2 years after application
2,4-D at 2 pounds	16	38
2,4-D at 80 pounds	70	76
2,4,5-T at 2 pounds	83	95
2,4,5-T at 80 pounds	94	99
silvex at 2 pounds	94	99
silvex at 80 pounds	95	99
amitrol at 4 pounds	92	98
amitrol at 8 pounds	95	99

reduced the stand an average of 22 percent; 10, 20, and 30 pounds of amitrol reduced the stand 11 percent; and TBA at the same rates as amitrol reduced the stand 71 percent. All of these materials at these high rates also reduced the yield of wheat, indicating that they were present in the soil in quantities detrimental to wheat through at least part of the following growing season. The three rates of each material represent costs of approximately 50, 100, and 150 dollars per acre.

A groundcherry control study in a closely foraged bluegrass sheep-pasture was designed to determine the combined and interacting effects of soil moisture, fertilizers, and herbicides. The results from this study showed: that neither nitrogen nor phosphorus influenced the stand of groundcherry the following year, that neither of these elements enhanced the toxicity of 2,4,5-T or amitrol, and that normal soil moisture levels significantly increased the toxicity of herbicides over sub-normal soil moisture levels.

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AGRICULTURAL RESEARCH FOR IDAHO

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MOSCOW—Home Station. 1,100 acres; Elevation 2,564 feet; Established 1892. Basic and Applied Research in all fields.

SANDPOINT — Branch Station. 98 acres; Elevation 2,100 feet; Established 1912. Research on The Cut-over Lands of Northern Idaho.

LEWISTON—Field Station. 22 acres; Elevation 1,413 feet; Established 1948. Basic and Applied Research on Fruits and Vegetables.

PARMA—Branch Station. 60 acres; Elevation 2,274 feet; Established 1935. Onion and Carrot Hybrids, plus research on other vegetables and fruits.

CALDWELL — Branch Station. 320 acres; Elevation 2,375 feet; Established 1906. Beef, Dairy Cattle and Sheep Nutrition and Management Research.

TWIN FALLS — Branch Station. 80 acres; Elevation 3,745 feet; Established 1950. The "Bean" Station with Research on New Varieties and Cultural Practices.

ABERDEEN — Branch Station. 238 acres; Elevation 4,400 feet; Established 1911. Potato Varieties, Disease and Storage and Cereal Grain Research, Wheat Quality Lab also located here.

TETONIA — Branch Station. 590 acres; Elevation 6,200 feet; Established 1919. Production and Maintenance of Foundation Seed Stocks of Grains, Grasses and Potatoes.

DUBOIS — U.S. Sheep Experiment Station - Western Sheep Breeding Lab. Established 1915. Nutrition Research and Breed Improvement—U. of I cooperating.