Herbicide Control of Poisonous Plants

M.H. Ralphs, T.D. Whitson, and D.N. Ueckert

Poisonous plants are components of most vegetation communities. Many are native, yet some are introduced and have become naturalized. In the past, livestock poisoning by plants was largely attributed to overstocked and overgrazed ranges (Stoddart and Smith 1955). Desirable plants declined and noxious and poisonous plants increased or invaded. Reduced forage supply and excessive numbers of livestock forced animals to consume poisonous plants, which often resulted in catastrophic losses.

Ranges have improved in the last 30 to 50 years (Box and Malechek 1987), yet losses to poisonous plants still occur and cause major economic losses to the livestock industry. Recent estimates of direct loss to poisonous plants from deaths and abortions exceed $234 million annually on western rangelands and pastures (Nielsen et al. 1988). Other losses such as chronic illness, reduced production and weight loss; as well as indirect losses (increased veterinary and labor costs, supplementation and fencing) may exceed the above stated value of lost animals. Another significant cost is the altered management and inefficient use of range and pasture forages that result from the presence of poisonous plants. The presence of poisonous plants may restrict the time or season of use, the class or species of livestock grazed, and may prevent optimum use of the forage resource.

Unlike infectious diseases, there are essentially no antidotes to prevent poisoning or to revive poisoned animals. Solutions to toxic plant problems depend upon management to prevent livestock from consuming toxic amounts of the plant. Managers must learn to identify poisonous plants on their range, know when they are most toxic to the class of livestock they manage, and then devise management strategies to reduce the risk of poisoning.

However, good management alone may not sufficiently reduce poisoning problems. Infestations of some poisonous plants such as locoweed species (*Astragalus* spp.) may appear when weather conditions are favorable (Ralphs and Bagley 1989). Scattered infestations of poisonous plants such as larkspur (*Delphinium* spp.) may cause persistent problems (Ralphs et al. 1988). Competition and utilization problems caused by plants such as broom snakeweed [*Gutierrezia sarothrae* (Pursh) Britt. & Rusby] may reduce forage production (Ueckert 1979). Therefore, control practices may be necessary to reduce economic losses. Mechanical control and reseeding to adapted forage species may be necessary when ranges are severely degraded, such as the conversion of halogeton [*Halogeton glomeratus* (Bieb) C.A. Mey] to crested wheatgrass [*Agropyron cristatum* (L.) Gaertner] (Cook 1965). Biological control by insects may provide long-term suppression of introduced species if population densities of the specific bio-control agent can be maintained. However, biological control seldom provides a total solution to weed problems. Herbicide control offers the most direct and immediate relief of poisonous plant problems. The proper herbicide will kill or suppress the target plant and thereby eliminate the immediate threat of poisoning. In addition, production of desirable forage may increase if competition from the target plant is reduced.

Herbicides alone seldom provide a long-term solution to poisonous plant problems because of the open niche created after the control of the unwanted species. Seed reserves in the soil will germinate and reestablish the stand and other undesirable species may invade the site. However, herbicides may provide a useful tool in the total management framework to reduce the density of toxic plants to safe levels for livestock

A considerable amount of research for poisonous plant control has been conducted with the small number of herbicides currently registered for use on rangeland. Table 1 lists specific poisonous plants, the herbicides which have been evaluated for their control, rates of application, notes on timing and conditions of treatment, and references to the original research where additional details can be obtained. This table can serve as a reference for land managers and ranchers where herbicidal control of poisonous plants may be desirable.

Several factors must be considered in selection and use of herbicides: efficacy in killing or suppressing the target species; selectivity in controlling the target species without adversely affecting associated vegetation; timing of application and environmental conditions necessary for maximum efficacy of the herbicide; returns or benefits from controlling the weed and eliminating loss or risk of poisoning compared to the cost of treatment; and the response of associated forage. An assessment should be made of the above factors before any treatment program is implemented. If the assessment is positive, then the herbicide label should be followed carefully to ensure safety and to maximize herbicidal efficacy.

Authors are range scientist, USDA/ARS Poisonous Plant Lab. Logan, Utah 84321; extension weed specialist and associate professor, Dept. of Plant Soil and Insect Science, Univ. of Wyoming, Laramie; and research professor, Texas Agr. Exp. Sta., San Angelo.

Information in this report regarding use of herbicides was taken from published literature. Mention of chemical names does not constitute endorsement by the authors. All uses of herbicides must be registered by appropriate state and federal agencies. Local authorities should be consulted for use and application of particular herbicides in each state and locality.

HERBICIDES FOR CONTROL OF POISONOUS PLANTS

Species	Herbicide	Rate lb ai/ac	Time of Application	Remarks	Authors
Arrowgrass (Seaside) *(Triglochin maritima)*	Mutsulfuron[1]	.5 oz/ac	Seed stalk elongation	Use .5% surfactant.	Whitson, 1989
Bitterweed *(Hymenoxys odorata)*	2,4-D[2]	1	Late autumn to early spring before flowering	Apply when actively growing before flowering temperature above 72° F and soil moist.	Bunting and Wright, 1974 Landers et al., 1981 Sperry and Sultemeier, 1965 Ueckert et al., 1980
	2,4-D + dicamba	.75 .25			
	2,4-D+ picloram	.5 .12			
	Picloram Tebuthiuron	.5 .5-1	Autumn to spring during any growth stage.	Effective when temperature below 60° F.	D.N. Ueckert, unpublished data
	Metsulfuron	1.25 oz/ac	Late autumn to early winter.	Apply to seedlings ≤2 in tall, and actively growing.	
	Clopyralid	.25	Late autumn to spring.	Apply when plants are actively growing.	
Colorado rubberweed Pingue *(Hymenoxys richardsonii)*	2,4-D	2	Pre-bud stage during active growth.	Retreatment may be necessary.	Johnson, 1962
Death camas (*Zigadenus* spp.)	2,4-D	1.5-3	Early spring, 3-5 leaf stage.	Spraying ineffective if treatment delayed	Bohmont, 1952 Hyder and Sneva, 1962
Goatsrue *(Galega officinalis)*	2,4-D + Dicamba	1-2 0.5	May to June when plants are 6 to 8 in high.		Evans and Ashcroft, 1982
Common Goldenweed *(Isocoma coronopitolia)*	2,4-D + picloram	.8-1.8 .2-.4	Spring.	Apply under favorable growing conditions.	Mayeaux & Crane, 1982
	Picloram	.5-1	"		
	Triclopyr	.5-1	"		
Rayless goldenrod *(Isocoma wrightii)*	2,4-D	1	"	Apply under favorable growing conditions.	Sperry 1953, 1967
	Picloram	1-2	Late summer.	After good rains.	Miller 1971, 1972
	Dicamba	1-2	"		
	Picloram pellets	.5-1	Summer-autumn.	Prior to rain.	Ueckert et al., 1983
Greenwood (Sarcobatus vermiculatus)	2,4-D	2	Spring when actively growing.	Use diesel oil carrier (2-3 gal). Treatment for 2 or 3 years may be necessary.	Cluff et al., 1983
Halogeton *(Halogeton glomeratus)*	2,4-D	2	Early branching, pre-bloom stage.	Provides 1 year control. Reinfests from seed unless planted to desirable grasses.	Cook and Stoddart, 1953 Cronin, 1965 Morton et al. 1959 Zappettoni, 1953
Hemlocks Water hemlocks (*Cicuta* spp.)	2,4-D	2	Bud to early bloom stage.	Remove, livestock after spraying. Plants sometimes become palatable after treatment.	Dewey, 1989
Poison hemlock *(Conium maculatum)*	2,4-D + dicamba	2.5 1	Before plants reach bud stage.	May require additional treatment the following year.	USDA, 1988
Hemp dogbane *(Apocynum cannabinum)*	Picloram 2,4-D	0.5 1	When plants are actively growing.	Repeated treatments may be necessary.	Robinson and Jeffery, 1972

HERBICIDES FOR CONTROL OF POISONOUS PLANTS

Species	Herbicide	Rate lb ai/ac	Time of Application	Remarks	Authors
Larkspur (*Delphinium* spp.)					
Waxy larkspur (*D. glaucescens*)	Picloram + 2,4-D	1 2	Before flower stage.	Plants should be actively growing at the time of treatment.	Maki, Lacy and Snoder, 1983
Tall (*D. barbeyi*) or Duncecap (*D. occidentale*) larkspur	Glyphosate	2	"	Apply to individual plants with hand sprayer or wipe-on applicator.	Cronin, 1974 Mickelsen, et al., 1990 Mueggler, 1952 Ralphs et al., 1990 Whitson, 1988
	Metsulfuron	1 to 2 oz	Vegetative or early bud stage.	Use .5% surfactant.	
	Triclopyr	4	"	Treat 2 successive years.	
	Picloram	1-2	Vegetative to bloom stage.	May damage associated vegetation at higher rates	
Low larkspur (*D. nelsonii*)	2,4-D	1.5-3	Fully emerged but before flowering.		Hyder et al., 1956
Plains larkspur (*D. geyeri*)	Picloram + 2,4-D	.25-.5 .5	Bud stage		Alley and Lee, 1970
Locoweed and milkvetch (*Oxytropis* and *Astragalus* spp.)	2,4-D	2	Bud to flower stage.	Plants should be actively growing at treatment time.	Alley, 1976 Bohmont, 1952 Cronin et., 1981 Freebarn and Whitson 1988 Freeman, 1980 Freeman et al., 1982 Norris, 1951 Ralphs et al., 1988 Ueckert, 1985 Whitson, 1988 Williams and Ralphs, 1989
	Dicamba	1	"		
	Clopyralid	.25-.5	"		
	Triclopyr	2	"		
	Metsulfuron	.25 oz	Vegetative stage.	Apply in autumn in the southwest when plants are beginning to grow.	
	Picloram	.25-.5	"		
	Picloram + triclopyr	.25 .25	Autumn.		
	Clopyralid + triclopyr	.25 .25	"		
	Picloram + dicamba	.25 .25	"		
	2,4-D + dicamba	.75 .25	" "		
Lupine (*Lupinus* spp.)	2,4-D	2	Bud to early bloom.		Bohmont, 1952 Keeler et al. 1977 Mueggler, 1952 Parker, 1959 Ralphs et al., 1987
	2,4-D + dicamba	1 .5	"		
	Triclopyr	.5-1.5	"		
Milkweed (*Asclepias* spp.)	2,4-D + picloram	1 .5	Before plants reach full bloom.		Bhowmik, 1982 Cramer and Burnside, 1981
	Glyphosate	2		Non-selective, apply to individual plants.	
Sand Shinnery Oak (*Quercus havardii*)	Tebuthiuron	.5-1	Winter.		Pettit, 1979 Jones & Pettit, 1984
Orange sneezeweed (*Helenium hoopesii*)	2,4-D	4	Prebloom stage.		Doran, 1951

HERBICIDES FOR CONTROL OF POISONOUS PLANTS

Species	Herbicide	Rate lb ai/ac	Time of Application	Remarks	Authors
Snakeweed (broom) *(Gutierrezia sarothrae)*	2,4-D	2	Spring during active growth.	Must be actively growing.	Gesink et al., 1973 Jacoby et al., 1982 Mayeaux and Crane, 1982
	Picloram	.25-.5		In Northern U.S. apply in early summer in the vegetative stage. In the Southwest apply in fall to early winter in the post flower stage	McDaniel, 1985 McDaniel & Duncan, 1987 Schmutz & Little, 1970 Sosebee et al., 1982ab Sperry and Robinson, 1963 Whitson and Ferrell, 1988
	Tebuthiuron	.5-7.5			
	Mutsulfuron	.5 oz			
Spring parsley *(Cymopterus watsonii)*	2,4-D	2	Bud to early bloom growth.		Williams et al., 1970
St. Johnswort *(Hypericum perforatum)*	2,4-D	2-3	Spring during active growth.	Can be suppressed by Klamathweed beetle.	Huffaker and Kennett, 1959
Tarbush *(Flourensia cernua)*	Tebuthiuron	.75-1	Winter.		Ueckert, Jacoby and Hartmann, 1982
Senecio Tansy ragwort *(Senecio jacobaea)*	2,4-D	1-2	Early bolting stage.	Can be suppressed by Cinebar moth.	Bedell et al., 1984 Whitson et al., 1985
	Clopyralid	.5	Rosette stage.		
	Metsulfuron	1-1.5 oz	"		
	Picloram	.25-.5	"		
	Dicamba + 2,4-D	.25 + .75	"		
Threadleaf groundsel *(Senecio douglassii var longilobus)*	2,4-D	1	April-June		Jones et al., 1982 Sharrow et al., 1988
	Picloram	1	Autumn		
	Picloram + 2,4-D	.25 .75	"		
Western braken fern *(Pteridium aquilinum)*	Dicamba	4-8	Before fronds emerge.		
	Amitrole	8			
	Ammonium thiocyanate	1:1 moler ratio			Cook et al., 1981
	Asulam	3-6			Steward et al., 1979
Western false hellebore *(Veratrum californicum)*	2,4-D	2	Late spring after last Leaf has expanded.	May require one additional treatment	Williams & Kreps, 1970 Williams & Cronin, 1981

[1]Metsulfuron is a dry flowable formulation and is expressed as ounces of product per acre. All other herbicides are expressed as pounds active ingredient per acre.
[2]The low volatile ester (LVE) formulation of 2,4-D is normally preferred for rangeland uses except near cropland or desirable broadleaf species.

Literature Cited

Alley, H.P., and G. Lee. 1990. What can be done about controlling larkspur on western rangelands. Down to Earth 26:31-32.

Alley, H.P. 1976. Research in weed science. Wyo. Agr. Exp. Sta. Res. J. 91Rm p. 79-82.

Bedell, T.E., R.E. Whitesides, and R.B. Hawkes. 1984. Pasture management for control of tansy ragwort. Pacific N.W. Coop. Exp. Pub. 210. Oregon State Univ., Corvallis, Ore.

Bhowmik, P.C. 1982. Herbicide control of common milkweed *(Aeclepias syriaca)*. Weed Sci. 30:349-351.

Bohmont, D.W. 1952. Chemical control of poisonous range plants. Wyo. Agr. Exp. Sta., Bull. 313.

Box, T.W., and J.C. Malechek. 1987. Grazing on the American rangelands. Proc. West. Sec. Soc. Animal Sci. 38:107-115.

Bunting, S.C., and H.A. Wright. 1974. Control of bitterweed with fall and winter applications of 2,4-D amine. J. Range Manage. 27:381.

Cluff, G.J., B.A. Roundy, R.A. Evans, and J.A. Young. 1983. Herbicide control of greasewood *(Sarcobatus vermiculatus)* and salt rabbitbrush *(Chrysothamnus nauseosus* sbp. *consimilis)*. Weed Sci. 31:275-279.

Cook, C.W. 1965. Grass seedling response to halogeton competition. J. Range Manage. 18:319-321.

Cook, G.T., N.H. Stephen, and H.J. Duncan. 1981. Influence of ammonium thiocyanate on scorching and control of braken *(Pteridium aquilinum)* by amitrole. Weed Sci. 29:196-200.

Cook, C.W., and L.H. Stoddart. 1953. The halogeton problem in Utah. Utah Agr. Exp. Sta. Bull. 364.

Cramer, G.L., and O.C. Burnside. 1981. Control of common milkweed *(Asclepias syriaca)*. Weed Sci. 29:636-640.

Cronin, E.H. 1974. Evaluation of some herbicide treatments for controlling tall larkspur. J. Range Manage. 27:219-222.

Cronin, E.H. 1965. Ecological and physiological factors influencing chemical control of *Halogeton glomaratus*. USDA Tech. Bull. 1325.

Cronin, E.H., M.C. Williams, and J.D. Olsen. 1981. Toxicity and control of Kelsey milkvetch. J. Range Manage. 34:181-183.

Dewey, S.A. 1989. Water hemlock. p. 108. Utah Weed Control Handbook. Utah Coop. Ext. Ser. EC 301.

Doran, C.W. 1951. Control of orange sneezeweed with 2,4-D. J. Range Manage. 4:11-15.

Evans, J.D., and M.L. Ashcroft. 1982. Goatsrue. Utah Agr. Exp. Sta. Res. Rep. 79.

Freeman, M.R. 1980. Herbicidal control of woolly locoweed and garbancillo in the Davis Mountains of Texas. M.S. thesis, Sul Ross State Univ., Alpine, Texas.

Freeburn, J.W., and T.D. Whitson. 1988. Control at silky crazyweed *(Oxytropis sericeo)* on rangeland. p. 80. *In:* T.D. Whatson and M. Ferrell (ed.), Rangeland Research and Demonstrations. Univ. Wyo. Coop. Ext. Ser. Prog. Rept., Laramie, WY.

Freeman, M.R., D.N. Ueckert, and J.T. Nelson. 1982. Woolly locoweed and in forage response to herbicides in west Texas. Tex. Agr. Exp. Sta. Bull. 1398.

Gesink, R.W., H.P. Alley, and G.A. Lee. 1973. Vegetative response to chemical control of broom snakeweed on a blue grama range. J. Range Manage. 26:139-143.

Huffaker, C.B., and C.E. Kennett. 1959. A ten-year study of vegetational changes associated with biological control of Klamath weed. J. Range Manage. 12:69-82.

Hyder, D.N., F.A. Sneva, and L.D. Calvin. 1956. Chemical control of sagebrush larkspur. J. Range Manage. 9:184-186.

Hyder, D.N., and F.A. Sneva, 1962. Chemical control of foothill death camas. J. Range Manage. 15:25-27.

Jacoby, P.W. Jr., C.H. Meadows, M.A. Foster, and T.G. Welch. 1982. Control of broom snakeweed *(Xanthocephalum sarothrae)* with fall application of foliar herbicides. Texas Agr. Exp. Sta. Prog. Rep. 4031.

Johnson, T.N. Jr. 1962. Chemical control of Colorado rubberweed in Arizona. Weeds 10:328-329.

Jones, R.D., D.N. Ueckert, J.T. Nelson, and J.R. Cox. 1982. Threadleaf groundsel and forage response to herbicides in the Davis Mountains. Texas Agr. Exp. Sta. Bull. 1422.

Jones, V.E., and R.D. Pettit. 1984. Low rates of tebuthiuron for control of sand shinnery oak. J. Range Manage. 37:488-489.

Keeler, R.F., L.F. James, J.L. Shupe, and K.R. Van Kampen. 1977. Lupin-induced crooked calf disease and a management method to reduce incidence. J. Range Manage. 30:97-102.

Landers, R.Q., Jr., D.N. Ueckert, and L.B. Merrill. 1981. Managing bitterweed to reduce sheep losses. Texas Agr. Ext. Ser. L-1845.

Maki, J., J. Lacey, and L. Snoder. 1983. Reduce cattle loss by tall larkspur control. Montana Farmer Stockman. 17 March 1983. pp. 98-100.

Mayeaux, H.E., Jr. and R.A. Crane. 1982. Control of threadleaf snakeweed *(Gutierrezia microcephala)* and common goldenweed *(Isocoma coronopifolia)* with herbicides. Weed Sci. 30:249-254.

McDaniel, K.C., and K.W. Duncan. 1987. Broom snakeweed *(Gutierrezia sarothrae)* control with picloram and metsulfuron. Weed Sci. 35:837-841.

McDaniel, K.C. 1985. Snakeweed control with herbicides. New Mexico Agr. Exp. Sta. Bull. 706.

Mickelsen, L.V., M.H. Ralphs, J.O. Evans, and D.L. Turner. 1990. Herbicide control of duncecap larkspur *(Delphinium occidentale).* Weed Sci. 38:153-157.

Miller, R.V. 1971. Results of rayless goldenrod control demonstrations. Texas Agr. Ext. Serv. Mimeo. Rep. Nov. 15, 1971.

Miller, R.V. 1972. Poisonous plant control. pp. 42-43 *In:* Extension Advances Progress. Texas Agr. Ext. Ser. Ann. Rep. 1972.

Morton, H.L., R.H. Haas, and L.C. Erickson. 1959. Halogeton and its control Idaho Agr. Exp. Sta. Bull. 307.

Mueggler, W.F. 1952. Effects of several chemicals on tall larkspur and associated tailcup lupine. USDA/FS Res. Note INT 4. Intermountain Forest and Range Exp. Sta., Ogden, Utah.

Nielsen, D.B., N.R. Rimbey, and L.F. James. 1988. Economic considerations of poisonous plants on livestock. pp. 5-16 *In* L.F. James, M.H. Ralphs and D.B. Nielsen (eds.), The Ecology and Economic Impact of Poisonous Plants on Livestock Production. Westview Press, Boulder, Colo.

Norris, J.J. 1951. The distribution and chemical control of species of *Senecio, Astragalus,* and *Baileya in the highlands range area of west Texas. PhD. dissertation, Texas A&M Univ., College Station Tex.*

Parker, K.G. 1959. Lupine. *In* Chemical Control of Range Weeds. USDA/USDI Range Seeding Equipment Committee. U.S. Govt. Printing Office, Washington, DC. p.F15.

Pettit, R.D. 1979. Effects of picloram and tebuthiuron pellets on sand shinnery oak communities. J. Range Manage. 32:196-200.

Ralphs, M.H., and V.L. Bagley. 1988. Population cycles of Wahweap milkvetch on the Henry Mountains and seed reserve in the soil. Great Basin Natur. 48:541-547.

Ralphs, M.H., D.L. Turner, L.C. Mickelsen, J.O. Evans. 1990. Herbicide control of tall larkspur *(Delphinium barbeyi).* Weed Sci. 38:573-577.

Ralphs, M.H., J.D. Olsen, J.A. Pfister, and G.D. Manners. 1988. Plant-animal interactions in larkspur poisoning in cattle. J. Anim. Sci. 66:2334-2342.

Ralphs, M.H., L.V. Mickelsen, D.L. Turner, and D.B. Nielsen. 1988. Control of white locoweed *(Oxytropis sericea).* Weed Sci. 36:353-358.

Ralphs, M.H., M.C. Williams, and D.L. Turner. 1987. Herbicide control of Velvet lupine *(Lupinus leucophyllus).* Weed Tech. 1:212-216.

Robinson, L.R., and L.S. Jeffery. 1972. Hemp dogbane growth and control. Weed Sci. 20:156-159.

Schmutz, E.M., and D.E. Little. 1970. Effects of 2,4,5-T and picloram on broom snakeweed in Arizona. J. Range Manage. 23:354-357.

Sharrow, S.H., D.N. Ueckert, and A.E. Johnson. 1988. Ecology and toxicity of *Senecio* species with special reference to *Senecio jacobaea* and *Senecio longilobus.* pp 181-196 *In:* L.F. James, M.H. Ralphs and D.B. Nielsen (eds). The Ecology and Economic Impact of Poisonous Plants on Livestock Production. Westview Press, Boulder, Colo.

Sosebee, R.E., W.W. Seipp, D.J. Bedunah, R. Henard. 1982a. Herbicide control of broom snakeweed. Range and Wildlife Dept. Texas Tech. Univ., Noxious Brush and Weed Control Research Highlights. Vol. 13:18.

Sosebee, R.E., W.W. Seipp, and J. Alliney. 1982b. Effect of timing of herbicide application on broom snakeweed control. Range and Wildlife Dept. Texas Tech Univ. Noxious Brush and Weed Control Research Highlights. Vol. 13:19.

Sperry, D.E., and E.D. Robinson. 1963. Chemical control of perennial broomweed. Texas Agr. Exp. Sta. Prog. Rep. 2273.

Sperry, D.E., and G.W. Sultemeier. 1965. Bitterweed its control in relation to soil moisture. Sheep and Goat Raiser 45:14-17.

Sperry, D.E. 1953. Rayless goldenrod-a poisonous range plant in Texas. J. Range Manage. 6:6-10.

Sperry, D.E. 1967. Experimental studies on the control of rayless goldenrod and perennial broomweed. Texas Agr. Exp. Sta. PR-2456.

Stewart, R.E., A.W. Cooley and A. Guardigli. 1979. Asulam controls western bracken *(Pteridium aquilinum)* on forest land in western Oregon. Weed Sci. 27:589-594.

Stoddart, L.A., and A.D. Smith. 1955. Range Management, 2nd Ed. McGraw-Hill, New York. pp. 234-257.

Ueckert, D.N., S.G. Whisenant, and G.W. Sultemeier. 1983. Control of rayless goldenrod *(Isocoma wrightii)* with soil applied herbicides. Weed Sci. 31:143-147.

Ueckert, D.N. 1979. Broom snakeweed effect on shortgrass forage production and soil water depletion. J. Range Manage. 32:216-220.

Ueckert, D.N., G.J. Scifres, S.G. Whisenant, and J.L. Mutz. 1980. Control of bitterweed with herbicides. J. Range Manage. 33:465-469.

Ueckert, D.N. 1985. Management of selected poisonous plants on semiarid rangelands in west Texas with herbicides. p. 32-41 *In:* A.A. Seawright, M.P. Hegarty, L.F. James and R.F. Keeler, eds. Plant Toxicology. Queensland Poisonous Plant Comm., Queensland, Australia.

Ueckert, D.N., P.W. Jacoby, Jr., and S. Hartmann. 1982. Tarbush and forage response to selected pelleted herbicides in the western Edwards Plateau. Texas Agr. Exp. Sta. Bull. 1393. 6p.

USDA. 1988. Suggested guidelines for weed control. USDA/ARS Agr. Handbk No. 565, p. 167.

Whitson, T.D., B. Hawkes, J. Brown, D. Humphrey, and D. Langland. 1985. Effect of herbicide treatments on tansy ragwort control. Res. Prog. West. Soc. of Weed Sci. pp. 52-53.

Whitson, T.D. 1989. Tall larkspur control with various herbicides. pp. 84-86 *In:* Whitson and M. Ferrell (eds.) Range Research and Extension Demonstration in Weed Science 1989. Wyo. Coop. Ext. Ser. Prog. Rep., Laramie, Wyo.

Whitson, T.D., and M.A. Ferrell. 1988. Broom snakeweed control in two rangeland locations. pp 4-11 *In:* T. Whitson and M. Ferrell (eds.), Rangeland Research and Extension Demonstration in Weed Science. 1988. Wyo. Coop. Ext. Ser. Prog. Rept. Laramie, Wyo.

Whitson, T.D. 1988. Control of two groved milkvetch *(Astragalus bisulcatus)* with various herbicides. pp. 88-89. *In:* T. Watson and M. Ferrell (eds.) Rangeland Research and Extension Demonstrations in Weed Sci. Wyo. Coop. Exp. Ser. Prog. Rept. Laramie, WY.

Whitson, T.D. 1989. Control of arrowgrass with metsulfuron. p. 70-71 *In:* T. Whitson and M. Ferrell (Ed.) Rangeland Research and Extension Demonstrations 1989. Univ. Wyo. Coop. Ext. Serv. Prog. Rept., Laramie, Wyo.

Williams, M.C., M.H. Ralphs. 1989. Control of Wasatch milkvetch *(Astragalus miser* var. *oblongifolius)* on mountain range. Weed Tech. 3:110-113.

Williams, M.C., L.B. Kreps, and E.H. Cronin. 1970. Chemical control of spring parsley on rangeland. Weed Sci. 18:623-625.

Williams, M.C., and L.B. Kreps. 1970. Chemical control of western false hellebore. Weed Sci. 18:481-483.

Williams, M.C., and E.H. Cronin. 1981. Ten year control of western false hellebore *(Veratrum californicum).* Weed Sci. 29:22-23.

Zappettini, G. 1955. Halogeton-rangeland menance. Western Pasture J. 4:2-3.