# Boulder County Parks and Open Space Small Grants Report for 2005 Research Project

## Kochia Control to Aid in the Establishment of Perennial Grasses and Forbs

**Submitted by**

**Jim Sebastian, Research Associate and George Beck, Professor of Weed Science, Bioagricultural Sciences and Pest Management, Colorado State University, Ft. Collins, CO 80523-1177**

## Section 1: Abstract

Kochia is a common, spring annual weed that infests dryland crops, degraded pastures and rangelands, roadsides, and abandoned areas. Kochia can be a significant obstacle to reclaiming abandoned farmland or degraded pastures by competing with seeded species for limited resources. A field experiment was conducted during the 2005 field season to identify an herbicide or herbicide mixture that will selectively control kochia without injuring desirable seeded perennial grasses or forbs. The experimental design was a randomized complete block and treatments were replicated six times. The experiment was conducted in a reclaimed field where Boulder County Parks and Open Space personnel previously seeded a mixture of perennial grasses and forbs, but kochia competition interfered with establishment. Herbicide treatments include three rates each of dicamba plus diflufenzopyr (Overdrive), dicamba (Vanquish), fluroxypyr (Vista), carfentrazone (Aim), and sulfentrazone (Authority). We also will include six tank mixes of carfentrazone plus sulfentrazone as well as a non-treated control. A non-herbicide treatment was added to the study to alter C:N in the soil by applying sugar in six equal applications over the course of the growing season. Shrub baseline was taken in each plot before treatments are applied and inventoried again at the end of the growing season.

# Section 2: Introduction

Objectives:

**Objective 1:** Identify herbicide application options that will effectively kill kochia without injuring seeded desirable perennial grasses and shrubs thus, aiding their establishment

Hypotheses:

***Research hypothesis Ha:*** Specific herbicide treatments will selectively control kochia without injuring seeded desirable perennial grasses and shrubs.

***Null hypothesis Ho:*** No herbicide treatment will selectively control kochia without injuring seeded desirable perennial grasses and forbs.

Anticipated value of the proposed research:

Kochia is a very common, spring annual weed that infests dryland crops, degraded dryland pastures and rangeland, roadsides, and abandoned areas. Kochia can be a significant obstacle to reclaiming abandoned farmland or degraded pastures by competing with seeded species for limited resources, primarily soil moisture, especially during the establishment period. Typically for reclamation projects, seeded species are sown as a mixture of different perennial grasses and forbs with the goal of creating a diverse and stable plant community in the shortest period of time possible. Usually, competition from weeds that were in the soil seed reserve interfer with optimal establishment of the desired plant community. Many examples exist in the literature concerning the importance of suppressing or controlling weeds before seeding desirable species, particularly when addressing invasive perennial weeds, but many times annual weeds appear subsequent to the initial suppression/control effort and during the establishment period for the desirable seeded species. The latter event often precludes successful establishment of seeded species thus, negating one of the most expensive portions of the reclamation process.

Many land owners and land managers contend with annual weeds by mowing simply to keep the canopy open so seeded species have an improved opportunity to germinate and establish, while other land

managers choose to use an herbicide for the same purpose. Using a herbicide to control or suppress annual weeds during the establishment period becomes increasingly difficult when forbs are part of the seed mix because many annual weeds that are problems during reclamation are forbs themselves and it is difficult to find herbicides that will selectively control the weedy forbs yet not injure the seeded, desirable forbs. Our proposed research will identify an herbicide or herbicides that can be used to selectively control kochia during the establishment period without excessively injuring seeded grasses, forbs, or shrubs. The acquisition of such knowledge by personnel of the Boulder County Parks and Open Space Program will be a significant aid when reclaiming abandoned farmland or degraded pastures.

***Literature review*:**

Kochia (*Kochia scoparia* (L.) Schrader) is an annual weed in the Chenopodiaceae. It is an herbaceous , dicotyledonous plant that is a common weed in dryland and irrigated agriculture of the northwest regions of North America where it causes yield losses in a number of crops (Black et al. 1969; Buhler et al. 1985; Dexter 1982; Durgan et al. 1990). Uncontrolled kochia growth may severely interfere with crop growth and cause yield losses of more than 95% (Weatherspoon and Schweizer 1971).

Kochia is thought to be native to southern and eastern Russia and was introduced into North America from Europe as an ornamental because of its conical shape, dense growth, and variegated red pigmentation on some shoots (Holm et al. 1979). Kochia is a very serious problem in dryland wheat production in Colorado (P.Westra, personal communication) and infested fields often serve as sources for neighboring lands because kochia has a tumbleweed habit that helps to disperse its seeds (Becker 1978).

Kochia averages 12,000 seeds per plant under various competitive relationships (Thompson et al. 1994) and may produce as much as 23,000 seeds under optimum growth conditions (Nussbaum et al. 1983). Kochia seeds express very limited dormancy and do not require light to germinate (Everitt et al. 1983) and germination can occur with only one accumulated degree day above 10 C, which allows it to germinate very early in the spring (Alan and Wise 1985). This early germination habit gives kochia a competitive advantage over neighboring dormant perennial species because growing kochia will use soil moisture that otherwise could have been used by the perennial plants. This often equates to stand failures

of seeded species, but if kochia is successfully controlled, the probability of stand establishment of seeded species would be improved.

### *Literature cited*


Alan, L.R. and A.F. Wiese. 1985. Effect of degree days on seed emergence. Proc. South. Wed Sci. Soc. 38:448.

Becker, D.A. 1978. Stem abscission in tumbleweeds of the chenopodiaceae: kochia. Amer. J. Bot. 65:375-383.

Black, C.C., T.M. Chen, and R.H. Brown. 1969. Biochemical basis for plant competition. Weed Sci. 17:338-334.

Buhler, D.D., R.E. Ramsel, O.C. Burnside, and G.A. Wicks. 1985. Survey of weeds in winter wheat in Nebraska, 1980 and 1981. Proc. North Cent. Weed Sci. Soc. 40:109.

Dexter, A.G. 1982. Weedononics. Proc. North Cent. Weed Sci. Soc. 37:1-4.

Durgan, B.R., A.G. Dexter, and S.D. Miller. 1990. Kochia (*Kochia scoparia*) interference in sunflower (*Helianthus annus*). Weed Technol. 4:52-56.

Everitt, J.H., M.A. Alaniz, and J.B. Lee. 1983. Seed germination characteristics of *Kochia scoparia*. J. Range Manage. 36:646-648.

Holm, L., J.V. Pancho, J.P. Herberg, and D.L. Plucknett. 1979. A Geographical Atlas of World Weeds. New York, NY. John Wiley and Sons. p.203.

Nussbaum, E.S., A.F. Wiese, D.E. Crutchfield, E.W. Chenault, D. Lavake, and J.J. Green. 1983. Production and water use efficiency of weeds. Proc. South. Weed Sci. Soc. 36:146.

Thompson, C.R., D.C. Thill, and B. Shafii. 1994. Germination characteristics of sulfonylurea-resistant and –susceptible kochia (*Kochia scoparia*). Weed Sci. 42(1):50-56.

Weatherspoon, D.M. and E.E. Schweizer. 1971. Competition between sugarbeets and five densities of kochia. Weed Sci. 19:125-128.

Weed Sci. Soc. America. 1998. Herbicide Handbook. Supplement to Seventh Edition. K.K. Hatzios, ed. p. 13-16. Weed Science Society of America, Champaign, IL 66044-8897.

## Section 3: Methods

A field experiment was conducted in 2005 to test the efficacy of several registered herbicides to selectively control kochia without injuring seeded desirable grasses and forbs. The experiment will be established in the field where Boulder County Parks and Open Space personnel previously sowed desirable perennial grasses and forbs, but full stand establishment has been precluded by kochia competition. Herbicides to be tested include dicamba, fluroxypyr, carfentrazone, and sulfentrazone. The two former herbicides are classified as growth regulators whereas the latter two disrupt membranes by inhibiting protoporphyrinogen oxidase in chlorophyll biosynthesis and lead to the buildup of phytotoxic intermediates (Hatzios et al. 1998). Also of interest and will be included as a treatment, will be to simply modify the carbon to nitrogen ratio in the soil by applying sugar to plots. Soil samples will be taken at the end of the growing season from each plot and analyzed for C:N.

Herbicides and rates were as follows: dicamba + diflufenzopyr (Overdrive) 0.125, 0.188, and 0.25 lb ai of dicamba/A; dicamba (Vanquish) 0.25, 0.5, and 0.75 lb ai/A; fluroxypyr (Vista) 0.125, 0.188, and 0.25 lb ai/A; carfentrazone (Aim) 0.016, 0.024, 0.031 lb ai/A; and sulfentrazone (Authority) 3.0, 3.49, and 3.98 lb ai/A; no herbicides; and sugar at 3,600 lb/A. We also included several tank mixes of carfentrazone plus sulfentrazone at 0.016 + 3.0 oz ai/A; 0.024 + 3.0 oz ai/A; 0.016 + 3.49 oz ai/A; 0.024 + 3.49 oz ai/A; 0.016 + 3.98 oz ai/A; and 0.024 + 3.98 oz ai/A. Herbicides were applied with a $CO_2$ backpack sprayer using water as a carrier at 21 gallons per acre. Sugar was applied in six equal applications (approximately 1 month intervals) over the course of the growing season of 600 lb each using a centrifugal fertilizer spreader. The experimental design was a randomized complete block and treatments were replicated six times. Plot size was 10 by 30 feet. We determined baseline populations of seeded and desirable forbs by counting each plant by species in each plot and inventoried similarly again in September.

## *Application Timing and Growth Stages*

Sugar treatments were applied at biweekly intervals from April 13, 2005 through June 27, 2005 with a broadcast spreader at 600 lbs/A at each of 6 timings. Two passes were taken through each plot to provide a uniform application of sugar.

Herbicides were applied on June 9, 2005 when kochia (*Kochia scoparia L.*, KCHSC) was 0.25 to 0.5 inches tall, prickly lettuce (*Lactuca serriola L.*, LACSE) was bolting and 4 to 18 inches tall, and field bindweed (*Convolvulus arvensis L.*, CONAR) had 3 to 14 inches long runners. Seeded cool season grass species were green needlegrass (*Stipa viridula Trin.*, STIVI) 24 to 30 inches tall, Western wheatgrass (*Agropyron smithii*, AGRSM) late boot and 14 to 17 inches tall, Indian ricegrass (*Oryzopsis hymenoides*, ORYHY) post seedset and 12 to 16 inches tall. Seeded warm season grass species were big bluestem (Andropogon gerardii, ANDGE) and blue grama (*Bouteloua gracilis*, BOUGR) were both dormant, and sideoats grama (Bouteloua curtipendula, BOUCU) was 3 leaf and 4 to 5 inches tall. Drilled shrub species present were fringed sage (*Artemisia frigida*, ARTFR) vegetative and 3 to 8 inches tall, rubber rabbitbrush (Chrysothamus nauseosus, CHRNA) vegetative and 3 to 5 inches tall, fourwing saltbush (Atriplex canescens ATRCA), 2-3 inches tall, vegetative, winterfat (Ceratoides lanata, CERLA), vegetative and 5 to 8 inches tall, and Louisiana sage vegetative, 2 to 4 inches tall.

## *Growing Conditions*

Cool and wet weather occurred from April through late June 2005. Although kochia density was extremely high in 2004 at this site, kochia did not emerge until late spring 2005 and grew very little after emergence. The cool, wet conditions and high density and canopy of prickly lettuce that had already emerged in the fall of 2004 competed with kochia and kept it suppressed. Prickly lettuce canopy became fairly dense and kochia did not compete very well. In July 2005, the daily temperatures were above 90 degrees Fahrenheit with no precipitation and most of the kochia and prickly lettuce dried out and died without setting seed. Field bindweed also dried out but re-grew with fall moisture.

Native shrub and grass species in this experiment were drilled in fall 2003. A portion of these shrubs and grasses emerged and established root systems in 2004 while others emerged in 2005. Cool and wet weather during spring 2005 favored establishment of perennial cool season seeded grass and shrub species at this site.

## Section 4: Results

Herbicide treatments did not interfere with the establishment of drilled native shrub species in this experiment and in many cases there was an increase in shrub densities with herbicide treatments compared to untreated control plots (Table 1).

### *Shrub Stand Counts*

Baseline shrub stand counts were conducted in April 2005 when shrubs were just coming out of dormancy and again in September 2005, approximately 4 months after herbicide treatments were applied. Shrub species densities were very low and scattered through the study site when baseline data was collected. Shrub species were identified and counted in each 10 x 30 ft plot (300 $ft^2$ area, Table 1). Baseline shrub stand counts ranged from a low of zero rabbitbrush plants to a high of three fringed sage plants/300 $ft^2$.

Almost all native shrub species doubled in density in untreated control plots by September 2005 compared to baseline stand density counts that were taken in April 2005. This was most likely in response to favorable shrub growing conditions and relatively low weed densities. Saltbush was the only shrub in this study that declined in density in untreated plots compared to baseline stand counts. This may have been due to saltbush's inability to compete with seeded species, particularly grasses, or site conditions were not favorable for saltbush establishment.

Fringed sage density increased two to four-fold in all herbicide treated plots except Vista or Authority applied at 0.25 or 0.22 lb ai/A in 2005 compared to untreated control plots; however, these were not always statistically different. The herbicide treatment with the broadest increase in species establishment compared to the untreated control plots was Aim + 2,4-D amine (0.024 + 1 lb ai/a).

Saltbush, rabbitbrush, and Louisiana sage increased two, three and four-fold with Aim + 2,4-D amine, respectively. Fringed sage increased almost two-fold with this same treatment; however, this was not statistically different than the untreated plots.

Fringed sage was the easiest and rabbitbrush tended to be the toughest shrub species to establish at this study site. Fringed sage densities varied from 11 to 37 plants/plot while rabbitbrush densities varied from one to three plants/plot with different treatments. Saltbush was the only shrub species to decrease in untreated control plots where no herbicides were sprayed. This may indicate that saltbush does not compete well with other weeds or did not establish well under these particular soil, moisture, and weather conditions.

Shrub establishment would have likely decreased in untreated plots with greater differences for establishment between sprayed and unsprayed plots if there would have been more broadleaf weed competition.

## *Shrub Injury and Weed Control Ratings*

It was very difficult to monitor shrub herbicide injury in 2005 due to the hot, dry conditions. Most shrubs dried out in July 2005 due to the droughty conditions and started to recover in October, 2005 with fall precipitation and cooler temperatures. No shrub injury ratings were conducted in 2005. Shrub stand counts will be conducted in 2006 to determine if there were any shrub stand losses caused by herbicides.

Although some of the herbicides appeared to control kochia, prickly lettuce, and field bindweed in this study, weed density was scattered and made weed control visual evaluations inconsistent through the study site. Weed control ratings were not taken in 2005 due to poor recruitment and growth of all broadleaf weeds at this site but will be taken in 2006 if there are adequate weed densities.

## *Sugar Treatments*

High sugar concentrations have been found to alter C:N levels in soils and excessive available nitrogen is known to favor weed germination and establishment . Sugar treatments did not influence any of the shrub species densities in this experiment.

## *Key Points*

- Favorable growing conditions existed in 2005 for shrub recruitment and establishment except possibly for saltbush. Most shrub species showed an increase in stand counts between April and September.

- Herbicide treatments did not interfere with shrub establishment and in some cases (i.e. 13 of 22 treatments with fringed sage) may have aided in the establishment. Shrub densities were variable through the study site and it is debatable whether establishment was enhanced by herbicide treatments. Stand counts in 2006 will likely provide a better indication of any changes that have occurred.

-Shrub establishment differences may be related to site and weather conditions rather than response to herbicides; however, there was no significant decrease in shrub densities with herbicide treatments.

- Herbicides may be a viable tool for land managers to control broadleaf weeds and to establish native shrubs and grass species. However, caution should be used where desirable shrub or forbs are present. Banvel and 2,4-D are known to injure broadleaf forbs and shrubs. Climatic and other site conditions may have existed in this particular study such that there was very little evidence of forb and shrub injury.

- Although kochia and other broadleaf weeds were not present in high enough populations to be evaluated in this study, years with high densities of broadleaf weeds could potentially cause greater differences between treated and non-treated plots for the establishment of drilled shrubs and grasses (greater competition).

## *Other Considerations*

Native shrub and grass species in this experiment were drilled in fall 2003. A portion of these shrubs and grasses emerged and established root systems in 2004 while others emerged in 2005. Although there didn't appear to be any shrub losses in this experiment caution should be used when spraying areas that have newly emerged native seedling shrubs and forbs. Another study will be established in an adjacent site in spring 2006 to determine effects of these same herbicides on seedling shrubs.

*Table 1.* Shrub stand counts

| Herbicide[1] | Rate (lb ai/a) | Fringed sage[2] | Louisiana sage[2] | Winterfat[2] | Rabbitbrush[2] | Saltbush[2] |
|---|---|---|---|---|---|---|
| | | (#/Plot) | | | | |
| | | September 2005 | | | | |
| Overdrive | 0.13 | 21 | 4 | 3 | 1 | 2 |
| | 0.19 | 20 | 3 | 3 | 1 | 2 |
| | 0.25 | 26 | 8 | 7 | 2 | 2 |
| Vanquish | 0.25 | 19 | 3 | 4 | 3 | 4 |
| | 0.5 | 21 | 3 | 3 | 1 | 2 |
| | 0.75 | 15 | 3 | 4 | 1 | 2 |
| Vista | 0.13 | 21 | 2 | 3 | 1 | 3 |
| | 0.19 | 37 | 0 | 5 | 2 | 3 |
| | 0.25 | 10 | 2 | 6 | 1 | 3 |
| Aim | 0.016 | 25 | 3 | 4 | 1 | 3 |
| + 2,4-D Amine | + 1 | | | | | |
| | 0.024 | 18 | 2 | 9 | 3 | 4 |
| | + 1 | | | | | |
| Aim | 0.031 | 33 | 3 | 3 | 2 | 2 |
| Authority | 0.19 | 27 | 4 | 6 | 2 | 3 |
| | 0.22 | 11 | 2 | 3 | 1 | 0 |
| | 0.25 | 20 | 4 | 5 | 1 | 2 |
| Aim | 0.016 | 26 | 2 | 6 | 1 | 1 |
| + Authority | + 0.19 | | | | | |
| | 0.025 | 34 | 5 | 4 | 1 | 2 |
| | + 0.19 | | | | | |
| | 0.16 | 25 | 2 | 5 | 1 | 4 |
| | + 0.22 | | | | | |
| | 0.024 | 28 | 2 | 6 | 2 | 5 |
| | + 0.22 | | | | | |
| | 0.016 | 19 | 5 | 6 | 1 | 2 |
| | + 0.25 | | | | | |
| | 0.024 | 26 | 1 | 5 | 3 | 1 |
| | + 0.25 | | | | | |
| Sugar | 600 | 16 | 3 | 5 | 2 | 0 |
| Control | | 11 | 2 | 4 | 1 | 1 |
| LSD (0.05) | | 10 | 4 | 5 | 2 | 3 |
| CV | | 41 | 107 | 91 | 105 | 129 |

[1] Non-ionic surfactant (Activator 90) added to all treatments at 0.25% v/v.
[2] Shrub counts is the number of shrub species counted in each 10' x 30' plot (300 square foot area).