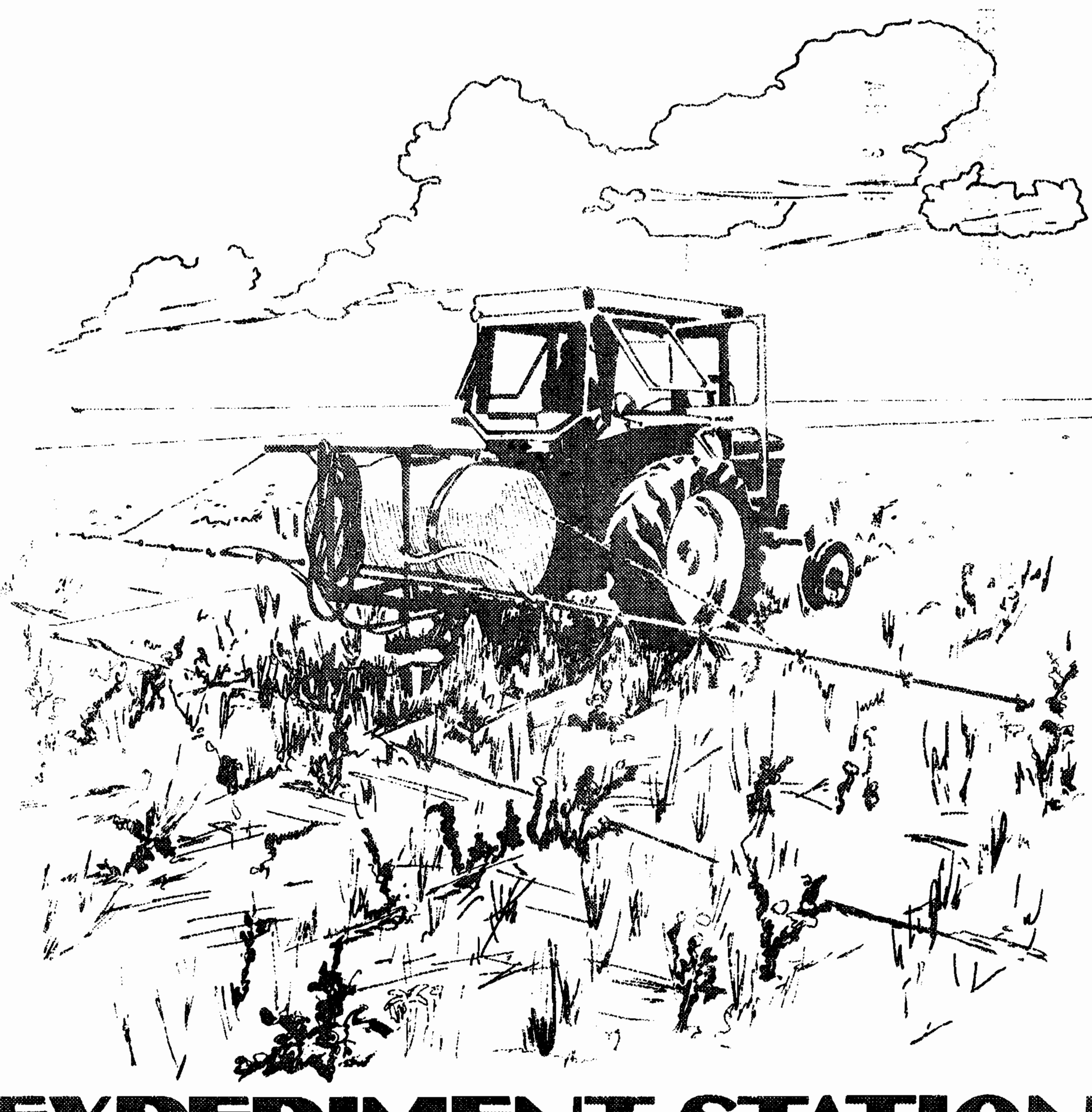
COLORADO
STATE
UNIVERSITY
EXPERIMENT
STATION
FORT COLLINS
BULLETIN 588S

CHEMICAL FALLOW IN THE CENTRAL GREAT PLAINS



EXPERIMENT STATION

Randy L. Anderson and
Darryl E. Smika[1]

245

CHEMICAL FALLOW IN THE CENTRAL GREAT PLAINS[2]

1. Agronomist and Soil Scientists, Agricultural Research, Central Great Plains Research Station, Akron, CO 80720.

2. Contribution from USDA-ARS
January 1984
500

International Standard Serial Number 0095-8646

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Several herbicides alone and in combinations were tested on the Central Great Plains to determine if chemical fallow is a feasible alternative to mechanical tillage for weed control in winter wheat. Weed control was maintained for 348 or more days during the fallow season by the herbicide treatments. No herbicide treatment resulted in a winter wheat (Triticum aestivum L.) yield less than that obtained with conventional tillage, while four treatments resulted in significant yield increases.

In all fallow seasons, above normal precipitation was received, insuring adequate degradation of the residual herbicides. No carryover injury to winter wheat was observed with any herbicide treatment. However, carryover may occur after a drought.

INTRODUCTION

West of the 100° meridian, annual precipitation is between 11 and 22 inches, and the practice of fallow is mandatory for winter wheat production. The advantages of winter wheat grown on fallow in the Central Great Plains over continuous winter wheat culture include (a) higher average yearly grain yields, (b) higher average straw yields for mulching, (c) less risk of a dry seedbed, and (d) a reduced effect of intermittent drought (Greb, et al, 1974).

Greb (1977) listed factors maximizing fallow efficiency: a) stubble should remain upright during winter months to retain snow, b) fallow should be accomplished with the least tillage possible, and c) fallow land should be weed-free from the date of harvest to the date of planting. The use of persistent herbicides to control weeds could eliminate tillage operations and maintain the standing stubble. Wicks and Smika (1973) found that a chemical fallow system with no tillage retained 46 percent of the winter wheat residue on the surface at planting time, a stubble mulch system retained only 21 percent, while a plow system retained no residue.

To maximize the amount of stored water, weeds must be controlled throughout the fallow season. Greb and Fenster (1981) found that undisturbed weeds removed 2 to 6 inches of soil water between harvest and fall dormancy, with 800 to 2700 pounds per acre of weed biomass produced. Comparing fallow-period water storage, Smika and Greb (1978) found that no-tillage water storage efficiency was 52 percent, compared to 25 percent for conventional tillage with a blade plow.

The use of chemical fallow has increased yields. Smika and Greb (1978) reported that yields for a no-tillage fallow system were 10 bushels per acre greater than with a conventional tillage system. Greb and Zimdahl (1980) compared conventional spring tillage fallow with chemical fallow, utilizing atrazine [2-chloro-4-(ethylamino)-6-(isopropylamine)-s-triazine], paraquat (1,1′-dimethyl-4,4′-bipyridinium ion), glyphosate [N-(phosphonomethyl)glycine], and amitrole (3-amino-s-triazole), over a 10 year period. The chemical fallow treatment stored 1.5 inches more water than conventional tillage, and yielded 7.4 bushels per acre more grain. Soil nitrate content, straw yield, and the protein content of the grain also were higher with the chemical fallow treatment.

The objectives of this study were to determine; a) the suitability of selected herbicides to achieve the objectives of fallow as outlined by Greb (1977), b) the rate at which herbicides can be applied to avoid residual carryover into the winter wheat crop, and c) the effects of the herbicide treatments on winter wheat yield.

MATERIALS AND METHODS

Several herbicides at various rates and combinations were tested over three, 14-month fallow periods on a Weld silt loam, (montmorillon-itic, mesic Aridic Paleustoll). The upper 3 inches of soil had a pH of 7.4 and an organic matter content of 1.3 percent.

Plots were 24 by 100 feet and treatments were replicated three times in a randomized complete block design. Herbicides were applied with cone nozzles at a pressure of 50 pounds per square inch with a water carrier rate of 18 gallons per acre.

The herbicides tested were: atrazine, cyanazine {2-[[4-chloro-6-(ethylamino)-s-triazin-2-yl]amino]-2-methylpropionitrile},isouron[N'-[5-(1,1-dimethylethyl)-3-isoxazolyl]-N,N-dimethylurea], metribuzin 4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H -one], and terbutryn [2-(tert-butylamino)-4-(ethylamino)-6-(methylthio)-s-triazine]. Herbicide rates (as active ingredient) and combinations are shown in Table I. The conventional tillage treatment consisted of cultivating the plot area with a sweep plow to control weeds 4-to 6 times each fallow season. Herbicide treatments were applied on August 6, 1978, and July 17 of 1979 and 1980, with paraquat at 0.2 pounds per acre tank-mixed with each herbicide to eliminate existing weeds. Terbutryn was applied on April 23 of 1979 and 1980, as a spring application. When weed growth covered more than 15 percent of the plot area during the fallow season (determined visually), the plots were sprayed with paraquat at 0.2 pounds per acre and 2,4-D [(2-4-dichlorophenoxy)acetic acid] at 0.3 pounds per acre and the conventional tillage treatment was cultivated with a sweep plow. Winter wheat was planted with a hoe drill in mid September, 14 months after the initial herbicide application. All plots received a blanket application of 60 pounds nitrogen per acre before seeding.

Grain yields were determined by harvesting 1064 square feet of each plot. Total water content in the soil profile at seeding time was determined gravimetrically in 1 foot increments to a depth of 6 feet with two subsamples per plot. The date on which weeds occupied more than 15 percent of the plot area was recorded for each treatment.

RESULTS AND DISCUSSION

The average duration of weed control (more than 85 percent of the plot area weed-free) maintained during the fallow seasons by each herbicide treatment is shown in Table I. The major weeds were volunteer wheat and Russian thistle (Salsola kali L.). Atrazine + cyanazine maintained weed control the longest, 386 days (August 8) followed by Atrazine alone with 369 days of control and the high rate of isouron, controlling weeds for 370 days. The addition of cyanazine with atrazine lengthened weed control by 17 days compared to atrazine alone.

In the remaining atrazine combination treatments, lower rates of atrazine were used than in the atrazine alone treatment and weed control durations were shorter than the atrazine alone treatment. These results indicate that the efficacy of the combinations was not as great as that of atrazine alone and that the second herbicide did not compensate totally for the lower atrazine rates. Terbutryn controlled weeds for 100 days, indicating its potential as a spring applied herbicide during fallow.

The average precipitation over the duration of weed control maintained by each treatment is listed in Table I. Atrazine + cyanazine, atrazine alone, and isouron at 0.6 pounds per acre received 22.6, 21.1, and 21.1 inches of precipitation, respectively, all values being greater than the average precipitation for the whole fallow season at this site. The three fallow seasons of this study received 18 percent to 22 percent more precipitation than the 10-year average at the experimental site

(Table II).

In this study, no visible injury to the winter wheat crop was observed with any herbicide treatments. Carryover damage to the winter wheat crop may result if a fallow season occurs with below normal precipitation. Terbutryn carryover from a spring application may also result if a drought occurs. Precipitation received during terbutryn's 100-day weed control period in this study was 10.4 inches (Table II), which equaled the average amount of rain received between application (April 23) and planting (September 15) in the 1970's.

No herbicide treatment resulted in yields less than those obtained with conventional tillage (Table III). Atrazine alone and isouron at 0.6 pounds per acre resulted in the highest grain yields -- 139 percent and 144 percent, respectively -- of the conventional tillage treatment. The two atrazine + metribuzin combinations also resulted in significant yield increases compared to conventional tillage.

Only 5 percent of the yield difference was correlated to total water storage in the soil profile at planting time, indicating that factors other than more stored soil water may have increased grain yield above that of the conventional tillage treatment. These possible factors may be: residual herbicide activity sufficient to provide weed control but not damage the following wheat crop; a reduced weed seed source to infest the following wheat crop; more soil water near the surface in the herbicide treated plots, resulting in more vigorous wheat seedling growth, which may have reduced the incidence of soil borne winter wheat diseases.

CONCLUSIONS

Herbicide treatments adequately maintained weed control for 348 or more days during the fallow season, yet did not result in any winter wheat grain yield decreases compared to the conventional tillage treatment. Several herbicide treatments resulted in yield increases, even though stored soil water was not increased, indicating that factors other than soil water and weed control may influence grain yields. The data indicates that chemical fallow is an alternative to mechanical tillage. However, if a drought should occur, a possibility may exist for carryover injury to the winter wheat crop.

Table I. Duration of weed control maintained by each herbicide treatment and the precipitation received during the weed control period averaged over years.

Herbicide	Rate	Duration of weed control[1]	Precipitation of weed control period
	(pounds per acre)	(days)	(inches)
Atrazine + cyanazine	1.0+2.0	386 (Aug. 8)d	22.6c
Isouron	0.6	370 (July 23)c	21.1b
Atrazine	1.0	369 (July 22)c[2]	21.1b
Atrazine + isouron	0.6+0.4	358 (July 11)b	17.5a
Atrazine + metribuzin	0.7+0.7	358 (July 11)b	17.5a
Atrazine + metribuzin	0.7+0.5	356 (July 9)b	17.5a
Isouron	0.5	348 (July 1)a	17.3a
Terbutryn (spring)[3]	3.0	100 (Aug. 1)	10.4

[1] Weed control is defined as more than 85 percent of the plot area weed-free.

[2] Means followed by the same letter within each date are not significantly different at P = 0.05 level as determined by the Duncan's Multiple Range Test.

[3] Terbutryn was not included in statistical analysis.

Table II. Monthly precipitation received in each fallow season at the experimental study area at Akron, Colorado.

Month	Amount of precipitation				
	Fallow season	1978-79 (inches)	1979-80 (inches)	1980-81 (inches)	1971-80 Ave. (inches)
July 17th		0	2.5	4.1	1.2
August		4.1	4.5	1.5	2.0
September		0	0.5	0.7	1.4
October		0.8	0.5	0.3	0.4
November		0.4	1.4	0.4	0.8
Dec.-Feb.		0.7	1.7	0.3	0.9
March		1.9	1.4	2.4	1.1
April		1.5	0.9	1.6	1.7
May		3.5	2.0	4.5	3.2
June		3.7	1.9	1.6	1.8
July		2.8	4.7	5.8	2.4
August		4.5	1.5	1.7	2.0
September 15th		0.4	0.6	0.2	0.7
		24.3	24.1	25.1	19.6

Table III. Winter wheat grain yields and total water storage in the soil profile at planting for each weed control treatment, averaged over years.

Weed control treatment	Rate (pounds per acre)	Grain yield (bushel per acre)	Total soil water (inches)
Isouron[a]	0.6	40.7	16.8
Atrazine[a]	1.0	39.3	18.3
Atrazine + metribuzin[b]	0.7+0.5	34.3	17.2
Atrazine + metribuzin[b]	0.7+0.7	34.3	18.4
Terbutryn (spring)[b]	3.0	32.3	16.0
Isouron[b]	0.5	30.6	15.6
Atrazine + isouron[b]	0.6+0.4	30.0	15.1
Atrazine + cyanazine[b]	1.0+2.0	28.3	15.1
Conventional tillage[a]	-	28.3	16.6
LSD 0.05		4.7	1.3

[a] Values for these treatments were averaged over three years.

[b] Values for these treatments were averaged over two years.

REFERENCES

1. Greb, B. W. 1977. Principles of fall weed control and residue management in a fallow-winter wheat rotation. Ecofallow Conf. McCook, NE.

2. Greb, B. W., and C. R. Fenster. 1981. Water use by weeds in a wheat fallow system. Great Plains Conserv. Till. Fact Sh. 2806.

3. Greb, B. W., D. E. Smika, N. P. Woodruff, and C. J. Whitfield. 1974. Summer fallow in the Central Great Plains. pp. 51-85. In Summer fallow in the Western United States. USDA-ARS Conserv. Res. Rep. No. 17.

4. Greb, B. W., and R. L. Zimdahl. 1980. Ecofallow comes of age in the Central Great Plains. J. Soil Water Conserv. 35:230-233.

5. Smika, D. E. 1970. Summer fallow for dryland winter wheat in the semiarid Great Plains. Agron. J. 62:15-17.

6. Smika, D. E., and B. W. Greb. 1978. Chemical fallow for drouth insurance. Colo. State Univ. Agric. Exp. Stn. PR-17, 1 p.

7. Wicks, G. A., and D. E. Smika. 1973. Chemical fallow in a winter wheat-fallow rotation. Weed Sci. 21:97-105.