*A new market is looming for weedkillers, based on extensive studies in the semi-arid Great Plains which showed conclusively*

# Herbicides Boost Soil Water Storage

By D. E. SMIKA AND G. A. WICKS

IN the semiarid Great Plains, water is the most frequent limiting factor in dryland crop production. To ensure water for crop production, summer fallow is extensively practiced. During the summer fallow period water is stored in the soil for the succeeding crop. Since summer fallow is necessary for stable dryland crop production in this area, it is of utmost importance to store as much water during the fallow period as possible. Soil water storage during fallow is known to be greater if residues are maintained on the soil surface during fallow and if weeds are controlled.

To determine the effects of herbicide use on soil water storage during fallow, treatments of herbicide alone and herbicide-subtillage combinations were compared with conventional tillage practices in rotations of winter wheat-grain sorghum-fallow (three-year rotation) and alternate winter wheat-fallow (two-year rotation) during three fallow periods.

The three-year rotation treatments were: $A_3$—conventional subsurface tillage as needed; $B_3$—atrazine at 2 pounds/acre applied as wettable powder pre-emergence in sorghum with subsurface tillage thereafter as needed;

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**TABLE 1. Soil water storage in a 10-foot profile and fallow period storage efficiency of three-year and two-year rotations. Average of three fallow periods, North Platte, Nebraska.**

| Rotation Treatment | Initial Soil Water | Soil Water Gain | Final Soil Water | Fallow Storage Efficiency |
|---|---|---|---|---|
| | — INCHES SOIL WATER — | | | PER CENT |
| THREE-YEAR ROTATION | | | | |
| $A_3$ Subtillage only | 9.2 | 7.3 | 16.5 | 35.4 |
| $B_3$ Subtillage-herbicide | 9.1 | 8.4 | 17.5 | 40.5 |
| $C_3$ Subtillage-herbicide | 9.2 | 8.3 | 17.5 | 40.1 |
| $D_3$ Herbicide only | 9.3 | 8.8 | 18.1 | 42.4 |
| $E_3$ Herbicide only | 9.4 | 8.5 | 17.9 | 41.1 |
| TWO-YEAR ROTATION | | | | |
| $A_2$ Plow-subtillage | 10.0 | 7.3 | 17.3 | 25.0 |
| $B_2$ Subtillage only | 10.0 | 9.4 | 19.4 | 32.0 |
| $C_2$ Subtillage-herbicide | 9.9 | 10.7 | 19.6 | 36.6 |
| $D_2$ Herbicide-subtillage | 10.0 | 10.8 | 20.8 | 37.0 |
| $E_2$ Herbicide only | 9.8 | 12.8 | 22.6 | 43.7 |

**TABLE 2. Grain yields obtained in three-year and two-year rotations as influenced by treatment. Three-year average.**

| Treatment | Crop Wheat | Crop Sorghum |
|---|---|---|
| | bushels/acre | |
| 3-YEAR ROTATION | | |
| $A_3$ Subtillage only | 52 | 75 |
| $B_3$ Subtillage-herbicide | 56 | 79 |
| $C_3$ Subtillage-herbicide | 54 | 84 |
| $D_3$ Herbicide only | 52 | 86 |
| $E_3$ Herbicide only | 54 | 88 |
| 2-YEAR ROTATION | | |
| $A_2$ Plow-subtillage | 46 | — |
| $B_2$ Subtillage only | 50 | — |
| $C_2$ Subtillage-herbicide | 49 | — |
| $D_2$ Herbicide-subtillage | 50 | — |
| $E_2$ Herbicide only | 53 | — |

Soil cover is extremely important in soil water storage during the fallow period. At top is field which was moldboard plowed and is completely bare of residue. Field in middle received conventional stubble mulch and mulch-tillage-herbicide combination treatments, and has a surface covering of about 50%. Field at bottom received complete herbicide treatment and has a complete soil coverage with residue. This residue is very effective in reducing evaporation, thus increasing soil water storage.

**$C_3$**—atrazine granules at 1.5 pounds/acre applied immediately following wheat harvest and again at 2 pounds/acre as wettable powder pre-emergence in the sorghum with subsurface tillage thereafter as needed; **$D_3$**—same as $C_3$ except contact herbicide used instead of subsurface tillage; **$E_3$**—atrazine at 2 pounds/acre pre-emergence in the sorghum with contact herbicide as needed for subsequent weed control.

Treatments in the two-year rotation were: **$A_2$**—spring plow following wheat harvest with subsurface tillage thereafter as needed; **$B_2$**—subsurface tillage following wheat harvest and thereafter as needed; **$C_2$**—atrazine granules at 2 pounds/acre one year, and at 1.5 pounds/acre in the other two years following wheat harvest, followed immediately by subsurface tillage, and subsurface tillage thereafter as needed; **$D_2$**—atrazine granules applied at 1.5 pounds/acre following wheat harvest with subsurface tillage thereafter as needed; **$E_2$**—same as $D_2$ except contact herbicide used in place of subsurface tillage.

Treatments of both rotations were randomized in three replications.

The contact herbicide used varied depending on the weed species to be killed (grassy or broadleaf), portion of the fallow period, and climatic conditions at the time of application. The number of applications per fallow period ranged from five to seven. Herbicides used and their rates were: amitrole at 0.5 to 2 pounds/acre, paraquat at 1 pound/acre, and 2,4-D at 1 pound/acre.

Subsurface tillage equipment mounted on tool bars were: five 32-inch sweeps, three 60-inch sweeps, and a 12-foot rodweeder with shovel points attached immediately in front of the rod. All herbicide and tillage operations were performed only when necessary to control weed growth between emergence and 2 inches in height.

## ALL HERBICIDE TOPS

The storage pattern of all treatments in both rotations was constant all years of the study. The three-year average gain in soil water during the 11-month fallow period of the three-year rotation is shown in Table 1. It can readily be seen that all treatments receiving herbicide applications ($B_3$ $C_3$ $D_3$ and $E_3$) gained more soil water than the conventional tillage treatment ($A_3$), with the all herbicide treatment ($D_3$) having the largest gain.

The additional gain in water storage in the all herbicide treatment is attributed to maximum preservation of residues and maximum weed control. Soil water storage in the herbicide treatments was greater than 40% of the total precipitation received during the fallow period while storage efficiency of the conventional tillage treatment was only 35%.

In the two-year rotation, the three-year average soil water gain during the 14½-month fallow period ranged from a low of 7.3 inches with spring plow (bare soil) to a high of 12.8 inches with complete use of herbicides (Table 1). Where mulch was present ($B_2$) soil water gain was over 2 inches greater than with bare soil ($A_2$), showing the importance of the presence of residue on the soil surface for soil water storage.

The high storage with the all herbicide treatment is attributed to nearly complete weed control and preservation of nearly 50% of the initial residue throughout the fallow period. The tillage-herbicide combination treatments and the subtillage only ended the fallow period with only 26% of their initial residue quantity. The soil water content of the all-herbicide treatment was near field capacity in the surface foot.

## ALL HERBICIDE YIELDS HIGHEST

The grain yields obtained in this study are presented in Table 2. In the three-year rotation, winter wheat yields from some of the herbicide treatments were higher than from the conventional tillage check; others were the same, but in no instance were they lower. The grain sorghum yields on the other hand were all higher from the herbicide treatments than from the conventional tillage treatment. The winter wheat yields in the two-year rotation, in general, reflect the water storage pattern. Yields were lowest with the plow-subtillage treatment and highest with the all herbicide treatment.

The herbicides used in this study were considered the best available*, but their performance under dryland conditions was erratic, which on occasion necessitated an additional herbicide application to maintain weed control. However, when reliable herbicides for dryland become available, the potential for their use during the summer fallow period should be great. ☆

*The mention of herbicides by specific name is for the benefit of the reader and does not constitute endorsement by the United States Government.