Weed Control for Conservation Tillage

A.F. Wiese[1]

Introduction

Conservation tillage systems using sweep plows or field cultivators leave a high percentage of crop residues on the soil surface, which protects the soil from wind and water erosion (Johnson, 1950; Jones and Johnson, 1982; Allen and Fenster, 1986; Johnson et al., 1974). These systems have been successful in semiarid areas because meager rainfall after plowing does not allow weeds to reestablish. In wetter areas, acceptable weed control has been obtained only where weeds were uprooted or inverted with disks or plows (Davidson and Santelmann, 1973).

In conservation tillage systems for semiarid areas where soil water storage during fallow periods is essential for profitable crop production, weeds must be plowed before they are 150 mm tall or storage of soil water will be depleted compared to weed-free areas. Under the same conditions, weeds had to be sprayed with herbicides before they exceeded 50 mm (Lavake and Wiese, 1979).

No-tillage, where weeds and volunteer crops are controlled with herbicides during fallow periods, is a relatively recent innovation for maintaining crop residues on the soil surface. This technique has been successful when suitable herbicides are available that control weeds between and in crops without injuring subsequent crops in the rotation (Wiese and Staniforth, 1973). In the future, as new herbicides are developed and marketed, no-tillage will become feasible in an increasing number of cropping sequences. However, from a practical standpoint, conservation or no-tillage systems that work are not adopted unless there is an economic advantage over conventional tillage.

Texas is a large and diverse state, and, consequently, cropping sequences, weed control, and conservation tillage systems vary. Figure 1 shows locations in the state where research is being conducted on conservation tillage and cropping systems. Research information is available from the Rio Grande Valley, Coastal Bend, Northern Gulf Coast, Central Texas Peanut Production area, Southern and Northern Blacklands, Rolling Plains, and the Southern and Northern High Plains. Because of limited time, only weed control research in conservation tillage systems from the Coastal Bend, Northern Gulf Coast, Central Texas, Blacklands, Rolling Plains, and High Plains will be discussed.

Coastal Bend

The effect of tillage on crop yield in rotations has been underway for 10 years on the clay loam soil at the Texas A&M Center at Corpus Christi. Cropping sequences for which minimum and no-tillage systems have been developed follow:[2]

Continuous Corn or Grain Sorghum

In these crop sequences with corn and sorghum, minimum tillage and no-tillage were compared. With minimum tillage, soil was sweep-plowed and bedded after harvest the same as for conventional tillage, but during winter, weeds are controlled with herbicides. With normal rainfall, this required one or two sprays with paraquat during November through February. Atrazine, which controls germinating weeds, was mixed with one of the sprays at 1.7 kg ha^{-1}. In years with below-average rainfall, only one application of paraquat and atrazine was required. After planting in late March or early April, 0.8 kg ha^{-1} of atrazine is banded over the row. Sorghum or corn was cultivated once, and escape weeds were controlled with a broadcast-directed layby treatment of paraquat.

In the no-tillage system, weeds that emerged after harvest but before October 15 were sprayed with glyphosate. During the winter, one to three sprays of paraquat were required depending on rainfall. One of the paraquat sprays contained atrazine at 1.7 kg ha^{-1}. After corn or sorghum was planted in late March or early April, 0.8 kg ha' of atrazine was banded over the row. Escape weeds were controlled with a broadcast-directed application of paraquat at layby when sorghum or corn was 0.3 m tall.

Upper Gulf Coast

Preliminary research with reduced tillage has been conducted at the Texas A&M Center at Beaumont. Rice was planted in the spring on clay soil that had not been tilled since the previous fall. Weeds were controlled with either paraquat or glyphosate before planting with a no-till drill. Adequate stands were obtained, and yields from this treatment were comparable to those with conventional tillage.'

Central Texas Peanut Production

Experiments with reduced- and no-tillage systems for peanuts have been underway since 1975 at the research station at Yoakum and on farmers' fields near Pearsall. The soil at both locations is fine sandy loam. Diseases that are a problem include southern blight, which is worse where crop residue is left on the soil surface, as well as both pod and stem roots. In these studies, yields were decreased and disease incidence increased if crop residue was left on the soil surface.

1Professor, Texas Agricultural Experiment Station, P. 0. Drawer 10, Bushland, Texas 79012.

'Personal communication with J. E. Matocha, Texas A&M Center, Route 2, Box 589, Corpus Christi, TX 78410.

'Personal communication with E. F. Eastin, Texas A&M Center, Route 7, Box 999, Beaumont, TX 77706.

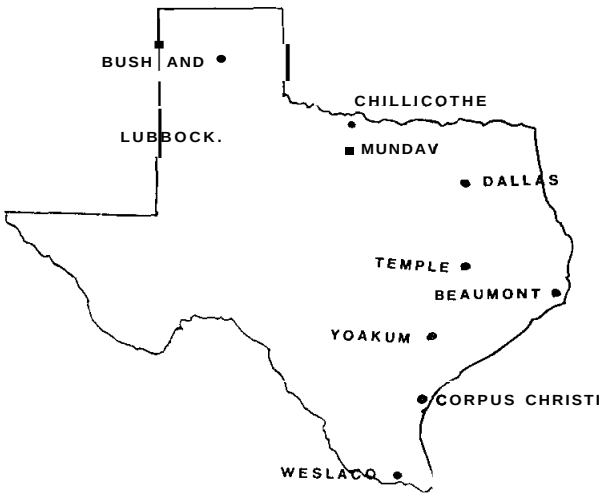

Figure 1. Locations of conservation tillage research in Texas: Weslaco, Rio Grande Valley; Corpus Christi, Coastal Bend; Beaumont, Northern Gulf Coast; Yoakum, Central Texas Peanut Area; Temple, Southern Blacklands; Dallas, Northern Blacklands; Munday and Chillicothe, Rolling Plains; Lubbock, Southern High Plains and Bushland, Northern High Plains.

Tillage systems compared were conventional, minimum, and no-tillage. In these studies, an oat cover crop was grown over the entire experimental area during the winter to prevent erosion. Conventional tillage was shredding the cover crop, moldboard plowing, disking, bedding, bed leveling, incorporating preplant herbicides, planting, and cultivation as needed. Minimum tillage was shredding the cover crop at either 0.15 or 0.3 m, disking, bedding, bed leveling, incorporating preplant herbicides, planting, no cultivation, and postemergence herbicides as needed to control weeds. A mixture of trifluralin and vernolate were the preplant herbicides used in the conventional and minimum-tillage systems. No-tillage involved shredding the cover crop 0.15 m tall, spraying paraquat or glyphosate to kill the cover crop and weeds, planting, applying alachlor preemergence, and spraying 2,4-DB mixed with either sethoxydim or fluazifop as needed to control broadleaved weeds emerging in the crop (Boswell and Grichar, 1981a, 1981b).

Research in 1985 and 1986 indicates that yields with no-tillage were comparable to conventional tillage when Texas panicum was controlled with sethoxydim. With no-tillage, an irrigation one day before digging also increased peanut yield. Disease problems were reduced in no-tillage when weeds were adequately controlled compared to early research.[4]

[4]Personal communication with W. J. Crichar, Texas Agricultural Experiment Station, P.O. Box 755, Yoakum, TX 77995.

Southern Blacklands

In this area, the most troublesome weed is Johnsongrass. Until recently, attempts to reduce tillage and leave crop residue on the soil surface have failed because this weed could not be controlled. Repeated tillage and cultivation had given the best control of Johnsongrass and crop yields.

Research over the past 8 years has shown the potential for no-tillage in the Blacklands. Planters have been developed that work in wheat stubble, sorghum stubble, or bermudagrass sod (Morrison and Gerik, 1982, 1983a). The concept of controlled traffic zones and permanent beds has been developed for Blackland conditions (Morrison and Gerik, 1983b; Gerik and Morrison, 1985; Morrison et al., 1985). Sorghum yields were not affected by no-tillage (Gerik and Morrison, 1984), but wheat yield was reduced by no-tillage in dry years (Gerik and Morrison, 1985).

In a no-tillage system where grain sorghum followed winter wheat, johnsongrass, annual weeds, and volunteer were controlled between crops with 0.84 kg ha^{-1} glyphosate applied in early October. At planting, a preemergence application of propazine and paraquat, each at 2.24 kg ha^{-1}, killed existing weeds and maintained the crop free of weeds until layby. Then a directed spray of MSMA and metolachlor was applied. This was compared to six tillage operations in a conventional tillage system to destroy crop residue. In the other half of the cropping sequence, when wheat was double-cropped after grain sorghum, volunteer sorghum, Texas panicum, and johnsongrass between the crops were controlled with one or two sprays of glyphosate at 0.84 kg ha^{-1} in August and October.

In recent research (Brown, 1986) in a 3-year grain sorghum-cotton-winter wheat rotation, one crop was harvested each year because winter wheat was planted immediately after cotton harvest. No-tillage and reduced tillage were compared in that cropping sequence. Johnsongrass was controlled with herbicide treatments in the fall after harvest or in the spring before planting, depending on the crop. Reduced tillage was primary fall tillage followed by use of herbicides to control weeds in the spring. Johnsongrass was controlled before planting with glyphosate in both reduced tillage and no-tillage. The most successful fall no-tillage treatment was glyphosate and a herbicide that persisted in the soil to control winter annual weeds. This was atrazine before planting sorghum and oryzalin plus prometryn before cotton. Because wheat was double-cropped into cotton, herbicides with a long soil residual could not be used in cotton. Herbicides used just before or preemergence in row crops were propazine plus metolachlor for sorghum and prometryn and metolachlor in cotton. Fluazifop at 0.15 kg ha^{-1} was sprayed over the top of cotton, and glyphosate was sprayed after sorghum harvest. Comparisons were made using glyphosate in the fall followed by either glyphosate or paraquat in the spring. Both gave excellent control of johnsongrass and increased sorghum yields. Glyphosate or paraquat sprayed only in the spring did not control johnsongrass. Johnsongrass control and sorghum yields for 1984

through 1986 were greatest with no-tillage. Yields of cotton and control of johnsongrass were best with the system of reduced tillage.

In addition to johnsongrass, browntop panicum, and green foxtail were troublesome grass weeds. Tumble pigweed was the most prevalent broadleaf weed.

Rolling Plains

Research with conservation tillage is being conducted at the Texas Agricultural Experiment Station at Munday on Miles fine sandy loam and at Chillicothe on fine textured soil. Research at Chillicothe is primarily reduced tillage using both furrow diking and herbicides to minimize the cost of operation and greatly reduce the number of trips over the field.

Sandy Soil-Munday[5]

Sorghum to Sorghum

Using one or two sprays of paraquat, glyphosate, 2,4-D, or a mixture of 2,4-D and glyphosate to control weeds from harvest until planting has been a successful weed control practice. A residual herbicide such as terbutryn, alachlor, or metolachlor has been sprayed in February or March with a contact herbicide to control weeds until planting. Safened seed must be used with alachlor or metolachlor. During seeding, stubble on the top of the bed was removed by a sweep ahead of the planter, and, consequently, another spray of residual herbicide was needed at planting. Beds were rebuilt and weeds controlled with two cultivations in the crop. One of the cultivations in the sorghum could be eliminated with a directed spray of paraquat, or trifluralin incorporated at layby. Application of atrazine shortly after harvest eliminated one of the contact sprays during the winter and the residual herbicide ahead of planting. In a 5-year study, sorghum yields were the same with no-tillage as with conventional tillage.

Cotton to Cotton

Trifluralin at 0.8 kg ha-1 was incorporated with a rolling cultivator into undisturbed beds in early spring. This kept the crop weedfree until another application of trifluralin at 0.4 kg ha^{-1} was incorporated at layby. This system kept cotton weedfree for the entire season without cultivation or hoeing. Yields were better than with conventional tillage.

Wheat to Wheat

Weeds in wheat were controlled with 2,4-D, MCPA, bromoxynil, dicamba, chlorsulfuron, or metsulfuron-methyl. After harvest, stubble was sprayed with 18 g ha^{-1} of chlorsulfuron mixed with either glyphosate or paraquat. Grass weeds that emerged after summer rains were controlled with paraquat, glyphosate, or sweep-plowing. Weeds in no-tillage were hardest to control after harvest when they germinated in poor stands of wheat.

Fine Textured Soil, Chillicothe

Sorghum to Sorghum

Several reduced tillage systems involving diking every other row, diking all rows, and a combination of diking and subsoiling to 0.3 to 0.4 m have been compared to conventional tillage with moldboard plowing, disking, and bedding. A preemergence herbicide was applied to all systems just after planting. Yields with diking and subsoiling were better than with conventional tillage. This was especially true on the upper part of 60-m plots that had slopes from 0.1 percent to 0.4 percent (Gerard et al., 1984).

Cotton to Cotton

A comparable system of reduced tillage in cotton gave similar results, but differences were not as great. Weeds were controlled in the crop with a preemergence herbicide (Gerard et al., 1984). Lint yields on the dryland cotton were increased more than 110 kg ha^{-1} by a combination of diking and subsoiling.

Cotton-Sorghum-Cotton

In early spring following cotton harvest, beds were rebuilt, furrow dikes replaced, and propazine at 1.3 kg ha^{-1} was sprayed in one operation. Sorghum was planted in late May. Weeds in the crop are controlled with additional propazine applied preemergence. After sorghum harvest, 1.1 kg ha^{-1} trifluralin was incorporated with a disk bedder in the winter. Fertilizer was applied just before planting, and dikes were installed at this time. Yields were markedly increased over conventional tillage, which was moldboard plowing one or more diskings, herbicide incorporation, fertilizer application listing beds, rolling cultivation, and planting.[6]

Sorghum-Fallow-Wheat-Fallow

Following sorghum harvest, beds were rebuilt and furrow dikes replaced. Chlorsulfuron was sprayed in the spring at 18 g ha^{-1}, and wheat was planted in the fall. Sweep-plowing was done before planting to flatten beds and control escape weeds. Grass weeds that emerged early in summer were controlled with paraquat or glyphosate. Weeds in wheat were controlled with 2,4-D, MCPA, metsulfuron-methyl, or dicamba. After wheat harvest in June, beds were established, furrow dikes replaced, and propazine was sprayed at 2.2 kg ha^{-1} to control weeds during the fallow period before planting sorghum.

Cotton-Fallow-Wheat-Fallow[6]

Following cotton harvest, beds were rebuilt and furrow dikes installed. Chlorsulfuron was sprayed at 18 g ha^{-1} in March, and wheat was planted in the fall. Sweep-plowing ahead of planting was used to kill escape weeds and flatten beds. Weeds in wheat were controlled with 2,4-D, MCPA, bromoxynil, or dicamba. After wheat harvest, beds were established, furrow dikes replaced, and diuron (N'-(3,4-dichlorophenyl)-N,N-

5Personal communication with D.G. Bordovsky, Texas A&M Station. Route 2, Box 2E, Munday, TX 76371.

6Personal communication with D G Bordovsk), Texas A&M Station, Routc 2 Box 2E. Munday TX 76371

dimethylurea) or prometryn at 1.8 kg ha^{-1} was sprayed to control weeds until the next spring. Then fertilizer was chiseled in and trifluralin at 0.8 kg ha^{-1} was incorporated with a disk bedder before planting cotton. After planting, furrow dikes were replaced.

Wheat to Wheat

Chlorsulfuron was applied at 18 g ha^{-1} to wheat in February or early March. After harvest in late May or early June, weeds and volunteer that emerged after summer rains were controlled with glyphosate, paraquat, or sweep-plowing.

Southern High Plains

Systems of weed control are being developed for several cropping systems used in sandy soils in the vicinity of Brownfield and for loam soil at the Texas A&M Center at Lubbock.[7]

Cotton to Cotton

Excellent control of annual weeds and cotton yields were obtained from a one-pass operation of spraying trifluralin or pendimethalin and incorporating the herbicides while in the process of disk bedding. Broadleaf weeds that emerged in the crop were controlled with a directed spray of diuron or prometryn. Grass weeds in the crop were controlled with sethoxydim or fluazifop.

Sorghum to Cotton

In the spring after sorghum harvest, weeds present in the stubble were controlled with glyphosate or paraquat. After cotton planting, a preemergence spray of dipropetryn at 4.5 kg ha^{-1} controlled both pigweed and volunteer sorghum for the entire season. Fluazifop or sethoxidim controlled johnsongrass or volunteer sorghum that emerged in the cotton.

Wheat to Cotton (Double Crop)

Wheat or another small grain sown in cotton stubble to reduce erosion was killed in the spring with paraquat or glyphosate. A mixture of 2,4-D and glyphosate was used safely if applied several weeks before planting. Dipropetryn sprayed shortly thereafter prevented weed emergence before planting and in the cotton crop. If soil was sandy loam or finer texture, prometryn was used instead of dipropetryn.

Wheat-(Fallow)-Cotton

Wheat was maintained weed free with 2,4-D, MCPA, or metsulfuron-methyl. After wheat harvest, existing weeds were controlled with glyphosate or paraquat mixed with either diuron, prometryn, terbutryn, or dipropetryn. Weeds that emerged later in the summer were controlled with sprays of glyphosate or paraquat. Either dipropetryn or prometryn was applied the next spring before cotton planting. Broadleaved weeds in the cotton were controlled with directed sprays of diuron or prometryn. Annual or perennial grass weeds in the cotton were controlled with fluazifop or sethoxydim (Abernathy et al., 1985).

[1]Personal communication with L.E. Clark, Texas A&M Center, P.O. Box 1658, Vernon, TX 76384.

Wheat to Sorghum

Weeds were controlled from wheat harvest to sorghum planting on a Pullman clay loam soil with either terbutryn or atrazine mixed with 2,4-D (Baumhardt et al., 1985). Weeds in the sorghum crop were controlled with an additional preemergence spraying of terbutryn. Yields of sorghum were increased over disk tillage if mulch level on the plots was 10 tonne ha^{-1}. Sorghum yield was not increased if crop mulch on the soil surface was 1 tonne ha^{-1} or less.

Northern High Plains

Over the last 25 years, tillage methods, weed control techniques, and planting equipment for different irrigated and dryland cropping sequences have been studied at the USDA Conservation and Production Research Laboratory, Bushland, Texas (Wiese et al., 1960; Wiese et al., 1967; Jones et al., 1985). As a result, many successful minimum-tillage and no-tillage methods have been developed. The soil at the research laboratory is Pullman clay loam that contains about one-third each of sand, silt, and clay, and has a pH of 7.0 and 1.5 percent organic matter. Rainfall averages 18 inches annually. Results of many studies have been summarized into a practical guide for extension people and growers (Wiese et al., 1986).

Sorghum to Sorghum

No-tillage proved to be impractical because it was difficult and expensive to control volunteer sorghum plants. Research has shown it is best to chisel anhydrous ammonia into furrows and then rebuild beds in the spring by bed splitting or with either a disk bedder or sweep rod weeder. Weeds in sorghum were controlled with atrazine or propazine, if subsequent herbicide residue in the soil was not a problem, or with terbutryn if a short residual herbicide was needed to grow the next crop. Metolachlor and alachlor are short residual herbicides; however, sorghum seed must be treated with a safener (Allen et al., 1980; Allen, 1985).

Sorghum to Small Grain (Double Crop)

Short residual herbicides, such as terbutryn, alachlor, and metolachlor, had to be used in sorghum when wheat was planted after sorghum the same year. Wheat was planted in standing stalks or after shredding, and then watered for emergence. If nitrogen carryover was not sufficient, anhydrous ammonia was chiseled in the furrows after sorghum harvest. Dry or liquid fertilizer was top-dressed before the wheat jointed in early spring.

Corn **to** Small Grain (Double Crop)

A short residual herbicide or no herbicide had to be used in the corn so the double-cropped small grain was not injured. Alachlor or metolachlor were used on any soil, and cyanazine could be used on fine sandy loam or finer-textured soil. Weeds in the corn that escaped the preemergence herbicide were cultivated or controlled with directed sprays of linuron or ametryn. A postemergence spray of dicamba controlled small broadleaf

[7]Personal communication with J. R. Abernathy and W. J. Keeling, Texas A&M Center, Route 3, Box 219, Lubbock, TX 79401.

weeds less than 25 mm tall. After corn harvest, wheat was planted in standing or shredded stalks and "watered up." If southwestern corn borer was a problem, undercutting corn stalks before wheat planting reduced overwintering borers. Fertilizer, if needed, was applied as suggested in the section for sorghum to small grain (Musick et al., 1977).

Corn to Corn

Winter annual weeds and volunteer corn plants were controlled in the spring with 2,4-D, glyphosate, a mixture of 2,4-D and glyphosate, or paraquat. Shredding stalks, chiseling in the row, or shallow sweep-plowing before March to uproot stalks helped control corn borer. Shallow rotary tillage to expose root crowns also controls corn borer. Atrazine was applied at planting for weed control, and small sweeps placed ahead of planters killed volunteer in the row. Cultivation after emergence was effective for controlling volunteer between the rows. Fertilizer was applied dry or by chiseling anhydrous ammonia into furrows during the winter in furrow-irrigated fields, or liquid fertilizer was applied through a center pivot during sprinkler irrigation of the crop. It may be necessary to rebuild beds; however, "furrowing out" to carry furrow irrigation water was usually sufficient.

Wheat to Sorghum (Double Crop)

Sorghum was planted directly into heavy wheat stubble with unit planters and coulters, or a grain drill could be used if the wheat stubble residue was not over 2.8 tonne ha^{-1}. Because the soil was usually very dry at this time, sorghum has to be irrigated for emergence. Weeds and volunteer wheat were controlled with 2.2 kg ha^{-1} of atrazine sprayed post-emergence in an oil-water emulsion carrier. Anhydrous ammonia was knifed into furrows after the crop emerged. Wheat could not be double-cropped back immediately after the sorghum crop was harvested because of atrazine residue in the soil. Wheat could be planted the next season. (Allen et al., 1975).

Wheat-(Fallow)-Sorghum

Dry atrazine formulations were applied at 3.3 kg ha^{-1} to wheat stubble immediately after wheat harvest before weeds emerged. Weeds in wheat must be controlled with 2,4-D, MCPA, dicamba, or metsulfuron-methyl. Broadleaf weeds in wheat stubble were controlled with either 2,4-D or dicamba mixed with the atrazine. If both broadleaf and annual grass weeds were present in the stubble, they had to be controlled by mixing paraquat with atrazine, using a separate spray with glyphosate, or a 2,4-D-glyphosate mixture. If annual grasses emerged after treatment, a sweep-plowing or spraying with paraquat or glyphosate was necessary. Terbutryn or propazine applied in March or April assured a weed-free sorghum crop. Sorghum grain yields were increased about 1,100 kg ha^{-1} (Unger et al., 1977; Wiese and Unger, 1983; Unger and Wiese, 1979).

Wheat-(Fallow)-Corn

After wheat harvest, atrazine mixed with 2,4-D at 3.3 and 1.1 kg ha^{-1} was sprayed on the stubble to control existing weeds, volunteer wheat, and any weeds that may germinate during the 11-month fallow period. Annual grass weeds that may emerge after treatment with atrazine have to be controlled with sweep-plowing or a spray with either paraquat or glyphosate. In the spring before planting corn, another herbicide with residual in the soil must be sprayed to control weeds until planting and in the crop (Unger, 1986).

Sorghum-(Fallow)-Wheat

In early April, following sorghum harvest the previous fall, chlorsulfuron, metsulfuron-methyl, terbutryn, or cyanazine were applied to reduce the number of tillage operations in the summer before planting wheat in the fall. Existing weeds were controlled with 2,4-D, glyphosate or paraquat. A practical limited-tillage system during the spring following sorghum harvest was disk bedding followed by deep injection of anhydrous ammonia with chisels or sweeps in the middles so beds were not destroyed. Weeds were controlled for the remainder of the fallow period with a heavy duty sweep-rod weeder or rolling cultivator (Wiese and Lavake, 1984).

Wheat to Wheat

Applying chlorsulfuron at 24 g ha^{-1} in March to growing wheat controlled broadleaf weeds late into the summer. Weeds and volunteer that emerge in midsummer were controlled with glyphosate, a mixture of 2,4-D and glyphosate, paraquat, or sweep-plowing. Another possibility was using cyanazine and terbutryn after wheat harvest along with paraquat or glyphosate to kill existing weeds. Volunteer wheat had to be controlled or wheat-streak mosaic infected the new crop. If stubble was not loosened by sweeps or other tillage operations, a regular drill passed through standing stubble without trouble. Fertilizer was chiseled into the furrows before rebuilding beds (Allen et al., 1976). Using this system of no-tillage, wheat yields were increased about 300 kg ha^{-1}.

Wheat-(Fallow)-Wheat

Applying 24 g ha^{-1} of chlorsulfuron or metsulfuron-methyl to growing wheat in March controlled weeds in the crop and in the stubble up to when volunteer wheat emerged after harvest. Volunteer wheat and other weeds that emerged during the summer and fall were controlled with paraquat or glyphosate. Applying chlorsulfuron to fallow soil the next April reduced the number of weeds emerging the summer before wheat planting. Those that emerged had to be controlled with contact herbicides or shallow sweep-plowing.

Cotton to Sorghum

In the spring before planting sorghum, a minimum of tillage and fuel was used if old cotton beds were not destroyed but rebuilt with a disk bedder or sweep-rod weeder. A preplant application of propazine at 1.7 kg ha^{-1} was incorporated with a rolling cultivator. Additional terbutryn was applied at planting for weed control in the sorghum. If safened seed was used, alachlor, metolachlor, or a propazine-metolachlor mixture could be used also. If beds did not need rebuilding, winter annual mustard, kochia, and Russian thistle

emerging in March were controlled in early April with 2,4-D. Glyphosate or paraquat controlled weeds before planting sorghum, and terbutryn applied preemergence controlled weeds in the crop. Using single-row cotton and double-row sorghum reduced planting problems (Valliant, 1973).

Sorghum to Cotton

In the spring before planting cotton, 2,4-D mixed with prometryn was applied in late March or early April to kill mustard (Descurainia spp.), kochia *[Kochia scoparia* (L.) Schrad.], and Russian thistle *(Salsola iberica* Sennan & Pau). This kept beds weed-free until planting. If weeds were a problem before planting, they were killed with paraquat or glyphosate.

The cotton was treated with a preemergence application of either prometryn, alachlor, or metolachlor. Weeds would be controlled also when old beds were rebuilt with a disk bedder or sweep-rod weeder before planting cotton. Sorghum stalks may need to be shredded or chopped before rebuilding beds. Trifluralin or pendimethalin was incorporated with a rolling cultivator as beds were being rebuilt. Broadleaf weeds in the crops were controlled with directed sprays of duiron or prometryn. Grass weeds could be controlled with sethoxydim or fluazifop. Using double-row sorghum and single-row cotton facilitates planting (Valliant, 1972; Wiese et al., 1967).

Cotton to Cotton

A minimum of tillage and energy was used when old beds were not destroyed, and trifluralin or pendimethaliin was preplant incorporated with a rolling cultivator in March before winter weeds became established. This controlled weeds before planting and throughout the season. A no-tillage system was developed for flat land or where beds were not rebuilt. Winter annual mustard, kochia, or Russian thistle that emerge in March were economically controlled with 2,4-D in late March or early April. Paraquat or glyphosate were used to kill existing weeds before planting. Theni prometryn, alachlor, or metolachlor were used preemergence in the crop. Broadleaf weeds in the crop were controlled with directed sprays of diuron or prometryn.

Wheat (Fallow) Cotton

Weeds in wheat stubble were controlled with glyphosate, paraquat, a mixture of 2,4-D and glyphosate, or dicamba. Residual weed control was achieved with fluometuron at 2.2 kg ha^{-1}, or atrazine or propazine each at 1.4 kg ha^{-1}. The next April, existing winter annual broadleaf weeds such as mustards, kochia, and Russian thistle were controlled with a mixture of 2,4-D and prometryn. The rate of prometryn was about 0.5 kg ha' above that recommended for the soil type to have enough herbicide to keep cotton weed-free (Wiese and Harman, 1982, 1983, 1985).

Cotton (Fallow) Wheat

In mid-April following cotton harvest, chlorsulfuron at 24 g ha^{-1} mixed with 2,4-D controlled winter annual broadleaf weeds. If winter annual grasses were growing, paraquat, a mixture of 2,4-D and glyphosate, or glyphosate was mixed with the chlorsulfuron. Grassy weeds that emerged during late summer were controlled with paraquat or glyphosate. These weeds would also be controlled during bed rebuilding operations required for furrow irrigation of wheat. Herbicides that were used in the wheat crop must not injure the following crop of cotton (Wiese and Harman, 1985).

NOTE!

In all cases, herbicides and rates of application must be in accordance with labels and soil types. Cropping sequence restrictions for herbicides must be observed.

Literature Cited

Abernathy, J. R., J. W. Keeling, and R. W. Lloyd. 1985. Weed control in reduced-tillage cotton on sandy soils. P. 199 *in* Proc. Beltwide Cotton Prod. Res. Conf. Natl. Cotton Council of Am., Memphis, TN.

Allen, R. R., T. J. Musick, F. O. Wood, and D. A. Dusek. 1975. No-till seeding of irrigated sorghum double-cropped after wheat. Trans. ASAE. 18:110-113.

Allen, R. R., T. J. Musick, and A. F. Wiese. 1976. Limited tillage of furrow-irrigated winter wheat. Trans. ASAE. 19:234-236, 241.

Allen, R. R., T. J. Musick, and D. A. Dusek. 1980. Limited tillage and energy use with furrow-irrigated grain sorghum. Trans. ASAE. 23:346-350.

Allen, R. R. 1985. Reduced tillage-energy systems for furrow-irrigated sorghum on wide beds. Trans. ASAE. 28:1736-1740.

Allen, R. R., and C. R. Fenster. 1986. Stubble-mulch equipment for soil and water conservation in the Great Plains. J. Soil and Water Cons. 41:11-16.

Baumhardt, R. L., R. E. Zartmen, and P. W. Unger. 1985. Grain sorghum response to tillage method used during fallow and to limited irrigation. Agron. J. 77:643-646.

Boswell, T. E., and W. J. Grichar. 1981a. Comparison of no-till, minimum, and full tillage in peanuts. Proc. of the Am. Peanut Res. and Educ. Soc. 13:112.

Boswell, T. E., and W. J. Grichar. 1981b. Comparison of land preparation in peanut production. Texas Agri. Exp. Sta. PR-3860. 4 pp.

Brown, S. M. 1986. Weed control systems for no-till crop rotations in the Central Texas Blackland prairie. Ph.D. dissertation. Texas A&M Univ. Soil and Crop Sci. Dept. 72 pp.

Davidson, J. M., and P. W. Santelmann. 1973. An evaluation of various tillage systems for wheat. Okla. Agri. Exp. Sta. Bull. B-711. 17 pp.

Gerard, C. J., P. D. Sexton, and D.M. Conover. 1984. Effect of furrow diking, subsoiling, and slope position on crop yields. Agron. J. 76:945-950.

Gerik, T. J., and J. E. Morrison Jr. 1984. No-tillage of grain sorghum on a shrinking clay soil. Agron. J. 76:71-76.

Gerik, T. J., and J. E. Morrison Jr. 1985. Wheat performance using no-tillage with controlled wheel traffic on a clay soil. Agron. J. 77:115-118.

Johnson, W. C. 1950. Problems involved in stubble-mulch farming on wheat lands of the Southern High Plains. USDA Circular No. 860. 18 pp.

Johnson, W. E., C. E. Van Doren, and E. Burnett. 1974. Summer fallow in the Southern Great Plains. Conserv. Res. Rpt., No. 17. Agric. Res. Serv. U.S. Dept. Agric., Washington, D. C., pp. 86-109.

Jones, O. R., and W. C. Johnson. 1982. Dryland cropping practices in the Southern Great Plains. USDA-ARS Agric. Reviews and Manuals. ARM-S-24, 16 pp.

Jones, O. R., P. W. Unger, and D. W. Fryrear. 1985. Agricultural technology and conservation in the Southern High Plains. J. Soil and Water Conserv. 40:195-198.

Lavake, D. E., and A. F. Wiese. 1979. Influence of weed growth and tillage interval during fallow on water storage, soil nitrates, and yield. Soil Sci. Soc. Am. J. 33:565-569.

Morrison, J. E., Jr., and T. J. Gerik. 1982. Flexible mounts for disks on a conservation planter. Paper No. 8-1016. ASAE, St. Joseph, MI 49085.

Morrison, J. E., Jr., and T. J. Gerik. 1983a. Flexible mounted double discs for conservation planters. Trans. ASAE 26:1044-1045.

Morrison, J. E., Jr., and T. J. Gerik. 1983b. Wide beds with conservation tillage. J. Soil and Water Cons. 38:231-232.

Morrison, J. E., Jr., T. J. Gerik, and F. W. Chichester. 1985. No-tillage system for high clay soils. Proc. Internat. Conf. on Soil Dynamics, Auburn, AL. June 19, 1985. 14 pp.

Musick, T. J., A. F. Wiese, and R. R. Allen. 1977 Management of bed-furrow irrigated soil with limited- and no-tillage systems. Trans. ASAE 20:666-672.

Unger, P. W., A. F. Wiese, and R. R. Allen. 1977. Conservation tillage in the Southern Plains. J. Soil and Water Conserv. 32:43-48.

Unger, P. W., and A. F. Wiese. 1979. Managing irrigated wheat residues for water storage and subsequent dryland grain sorghum production. Soil Sci. Soc. Am. J. 43:582-588.

Unger, P. W. 1986. Wheat residue management effects on soil water storage and corn production. Soil Sci. Soc. Am. J. 50:764-770.

Valliant, J. 1972. 1972 grain sorghum tillage-irrigation study. *In:* Annual Report, High Plains Research Foundation. pp. 99-104. Plainview, TX.

Valliant, J. 1973. 1973 Cotton tillage-irrigation study. *In:* Annual Report, High Plains Research Foundation. pp. 115-120. Plainview, TX.

Wiese, A. F., J. J. Bond, and T. J. Army. 1960. Chemical fallow in the Southern Great Plains. Weeds 8:284-290.

Wiese, A. F., E. Burnett, and L. E. Box Tr. 1967. Chemical fallow and dryland cropping sequences. Agron. J. 59:175-177.

Wiese, A. F., and D. W. Staniforth. 1973. Weed control in conservation tillage. *In:* Conservation Tillage. Proc. Natl. pp. 108-114. Cons. Tillage Conf., Des Moines, IA. March 1973. Soil Conserv. Soc. of Am. Ankey, IA.

Wiese, A. F., and W. L. Harman. 1982. Research and experience with no-tillage cotton. *In:* Proc. Beltwide Cotton Production Res. Conf. pp. 224. National Cotton Council of America, Memphis, TN.

Wiese, A. F., and W. L. Harman. 1983. Cost and effectiveness of paraquat and glyphosate for weed control in limited tillage systems with wheat and cotton. *In:* Proc. Beltwide Cotton Production Res. Conf. pp. 245-251. National Cotton Council of America, Memphis, TN.

Wiese, A. F., and P. W. Unger. 1983. Irrigation + dryland farming + limited tillage—a profitable combination. J. Soil and Water Conserv. 38:233-236.

Wiese, A. F., and D. E. Lavake. 1984. Herbicides in no-tillage systems involving wheat. Tex. Agri. Exp. Sta. MP-1547. 17 pp.

Wiese, A. F., and W. L. Harman. 1985. Minimum tillage cotton in the Southern Plains. pp. 199. *In:* Proc. Beltwide Cotton Production Res. Conf. National Cotton Council of America, Memphis, TN.

Wiese, A. F., P. W. Unger, R. R. Allen, O. R. Jones, and W. L. Harman. 1986. Minimum tillage systems for the Texas Panhandle. Texas Agri. Exp. Sta. MP-1597. 8 pp.