THE EFFECT OF REDUCING TILLAGE ON SUMMERFALLOW WHEN WEEDS ARE CONTROLLED WITH HERBICIDES IN THE BLACK SOILS ZONE OF SASKATCHEWAN

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Some 22 million acres of land are summerfallowed each year on the Canadian Prairies (Statistics Canada, April 2, 1976). It was shown at Indian Head by MacKay & Associates in 1889 (Anderson 1975) that land left idle on which weeds were controlled produced greater yields the following year, and thus the practice of summerfallow began on the prairies. When agriculture advanced to the parkland area of western Canada the practice was introduced there as well. Summerfallow is considered to be useful for controlling weeds, increasing soil moisture and nutrients and conditioning the soil for succeeding crop production. On loam soil in tanks at Swift Current, it was shown (Doughty et. al. in 1949) that some 13.5 cm (5.3") (26.8%) of the precipitation (50.5 cm) (20") that fell during the fallow period was conserved in the soil.

In the parkbelt we have shown that summerfallow is an inefficient method of storing soil moisture. On the average only about 10% (5.3 cm) (2.1") of the some 55 cm (22") of precipitation received during the 22 month fallow period is stored in the soil, and in addition about 42% of this storage takes place during the first fall and winter. (Bowren 1975).

In northeastern Saskatchewan, farmers summerfallow for moisture conservation, nutrient buildup, weed control, land management and to prepare the land for special crops or seed production. The production of seed requires that the crop be grown on ground free of certain weeds and volunteer grain of the same or another variety. Special crops such as rape, mustard, peas, etc. often perform better on fallow which has a bit more moisture, a better nutrient status, fewer weeds (there are often no herbicides that can be used to control some of the weeds in these crops) and less trash to impede the preparation of a good seedbed. In some cases a serious weed problem can be handled more economically by summerfallowing the land for one year. Yields on well managed stubble generally range from 65 to 90% of those on fallow.

It was shown at Swift Current (Korven et. al. 1962) that the best results were obtained when summerfallowing was started early in the spring (about seeding time). Under Swift Current conditions, the yield of wheat was usually about 4 bushels higher than when the first tillage on fallow was delayed to June 15, some 2-3 weeks after seeding time. The early tillage was mainly effective in controlling early weed growth and summerfallow started at this time usually required one or two extra tillage operations. No herbicides were used on these fallows.

In a later study at Swift Current (Anderson 1971) reported that if weeds were controlled by herbicides, the first tillage could be delayed until mid-June without affecting the results of the fallow. It was stated that further study was required to fully assess the effect of continually replacing tillage with herbicides on fallow.

Table 1. Precipitation and Soil Moisture Storage ($CM^{(1)}$ 0 - 1.2 m) on Fallow in N.E. Saskatchewan

(3 Year Rotation - 11 Year Average)

Location	1st Fall & Winter Nov 1 to Apr 30		Fallow Season May 1 to Oct 31		2nd Fall & Winter Nov 1 to Apr 30		Total		% of
	Prec. cm	Stored cm	Prec. cm	Stored cm	Prec. cm	Stored cm	Prec. cm	Stored cm	Prec. Stored
Melfort	15.5	3.1	25.4	2.3	12.5	0.8	53.3	6.7	12
Archerwill	14.0	2.3	32.3	0.8	12.5	1.3	58.7	4.3	7
Parkside	9.7	2.8	27.7	-0.5	8.9	3.6	46.2	5.8	13
Somme	17.5	0.5	30.5	2.0	17.3	-0.8	65.3	1.8	3
Average	14.2	2.2	29.0	1.2	12.8	1.2	55.9	5.3	10

Note - (1) Inches = cm x .394

On the average about 42% of the total storage took place during the first fall and winter.

Table 2. Soil Moisture Storage and Crop Yield on Fallow and Stubble in N.E.S.

Location	Years Avg.	Moisture in Soil (0-1.2m) Cm(1) Fall Fallow	Fall Stubble	Spring Fallow	Spring Stubble	Yield Kg/ha(2) Fallow	Yield Kg/ha(2) Stubble	Stubble Yield as % of fallow Yield
Melfort	14	42.2	36.1	44.5	41.7	2899	2588	89
Archerwill	11	22.3	19.3	23.4	21.6	2149	1466	68
Parkside	12	27.2	24.6	31.2	28.7	2514	1934	77
Somme	14	35.1	32.8	34.5	33.5	2699	2033	75
Average		31.7	28.2	33.4	31.4	2565	2005	78

Note: - (1) Inches = cm x .394
(2) lb/ac = kg/ha x .891

In an attempt to reduce the hazards of soil erosion, trash cover fallows and strip cropping were introduced (Anderson et. al. 1966; Dryden et. al. 1964; Hill 1953; Neatby 1944; and Ripley 1961). These methods work well on the drier parts of the prairies, but are not as effective in the park-belt where more tillage is required to control weeds and where the trash under the more humid conditions is decomposed quickly.

In recent years, the practice of summerfallowing itself has been questioned on many counts. Among other things, it has been shown that it increases the break down of organic matter and humus. It increases the salinity of soils that tend to be saline, and it increases the hazards of wind and water erosion (Nielsen 1967; Rennie 1973; Anderson 1975; and Bowren 1965). For these reasons it should be kept to a bare minimum. On grain farms in the black and grey wooded soils region of Saskatchewan some 15 - 25% of the cultivated land in fallow on each farm would seem to make economic sense under current conditions. Each farmer must balance his management and decide how much fallow is best for his particular farm operation.

In an attempt to improve the trash conservation features of summer-fallow on parkland soils, we conducted two studies on Melfort silty clay loam soil (12% organic matter) where weed control with herbicides was introduced to replace some of the tillage on fallow. These studies were conducted in a two year fallow, wheat rotation, with the treatments falling on the same plot each year, so that the accumulative effects could be studied. The treatments were in plots 7.5 (25') x 60 m (200') replicated four times.

Table 3. Effect of Delaying the Start of Tillage on Fallow for Wheat - Melfort, Saskatchewan

Time of 1st Tillage	Machine	Soil Analysis Prior to Seeding Wheat: Moisture Storage (0-122 cm) Total cm[a] Spring 11 Yr av	NO_3[b] (0-61 cm) p.p.m. Fall 7 Yr av	p[c] (0-15 cm) p.p.m. Fall 7 Yr av	Surface Soil Particle < 0.84 mm Spring 11 Yr av	Wheat 11 Year Average: Yield[d] kg/ha	Weight[e] kg/hl	Protein Content Percent 8 Yr av	Crop Conditions in Recent 5 Years of Program: Crop (1) Stand (0-9)	Broad-leaved Weeds(2) in crop (0-9)	Wild Oats (3) in Crop (0-9)
After harvest	Cultivator	45.4	7.9	17.2	41	3470	80.1	16.5	8.5	8.4	7.9
After harvest	Discer	45.1	7.9	17.7	41	3527	80.1	16.7	8.6	8.5	8.5
May 1	Discer	45.6	7.4	16.5	40	3546	80.2	16.7	8.6	8.5	7.6
May 15	Discer	44.0	7.5	16.5	41	3477	80.0	16.6	8.5	8.5	7.6
June 1	Discer	45.1	8.1	17.9	41	3547	80.1	16.5	8.4	8.5	8.1
June 15	Discer	44.4	8.3	17.9	41	3545	80.1	16.7	8.5	8.3	7.8
After harvest*	Discer	44.7	7.8	17.3	43	3551	80.0	16.5	8.7	8.4	8.1
July 1	Discer	44.8	7.0	16.8	41	3443	80.0	16.5	8.4	8.5	7.8
July 15	Discer	44.6	8.2	17.9	41	3493	80.0	16.4	8.5	8.4	8.2
L.S.D.		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.			

Note: * - Discer in fall and tillage resumed again July 1.
(1)- Crop stand - 9 = good.
(2)- Broadleaved weeds; 9 = few in crop with normal herbicide treatments.
(3)- Wild oats; 9 = few when liquid avadex was used on crop
a - Inches = cm x 0.394
b - lb/NO_3/ac = p.p.m. x 8
c - lb/p/ac = p.p.m. x 2
d - lb/ac - kg/ha x .891
e - lb/bu = kg/hl x .777

In the initial study herbicides were evaluated for use in the early part of the fallow year to allow the first tillage operation to be delayed and thus leave the trash to protect the field. In this study the initiation of tillage was started the previous fall after harvest and at bi-weekly intervals the following spring on the various treatments. In the early part of the season herbicides were used to control broadleaved weeds such as winter annuals, stinkweed, flixweed and shephard's purse, and annual weeds such as buckwheat, lamb's quarter, pigweed and mustard. The herbicide treatments were followed with tillage as shown in Table 3. The study was repeated on the same plots for 11 years. The herbicide used was a phenoxy type herbicide at the rate of .5 (8 ozs/ac) to 1.1 (16 ozs/ac) kg/ha, depending on the weeds present.

The results of this study show that it is possible to delay the tillage until June 15 or later, depending on the growing conditions on summerfallow without reducing the yield, nutrient or moisture buildup, or other effects of the summerfallow. In addition, it was possible to retain the original treash for a longer period to protect the soil from erosion. There was no advantage to starting tillage on summerfallow after harvest in the fall. The summerfallow treatments where the tillage was started in the fall, or beofre May 15 usually required 2-4 more tillage operations for weed control than those started after June 15. These results are in agreement with those found at Swift Current.

In the second experiment the effect of replacing tillage in the spring and again in the fall with herbicides was studied. In this trial the amount of tillage that was replaced varied among the treatments from 0-100 percent. The treatments (Table 4) were also applied to the same plots in a two year rotation for 11 years.

In treatments where tillage and herbicides were combined for weed control the tillage was performed during mid-summer to control volunteer grain and grassy weeds. Herbicides were used in these treatments to control winter annual and annual broadleaved weeds at the start of the fallow program and to control perennial broadleaved weeds at the end of the fallow program in the fall.

Table 4. The Effect of Chemicals to Reduce Tillage on Summerfallow; Melfort, Sask.

Fallow Treatment	Yield of Wheat[1] 11 Yr Av kg/ha	Soil Nutrients p.p.m. NO_3-N[2] 9 Yr Av (0-61 cm)	Soil Nutrients p.p.m. P[3] 7 Yr Av (0-15 cm)	Soil H_2O cm[4] (0-1.2 m) 8 Yr Av Spring
Chemicals only	3547	13.9	31	57
Tillage only	3427	12.7	30	55
Tillage (15/6) and chemicals	3507	11.6	29	56
Tillage (15/6, 1/7) and chemicals	3517	14.1	33	58
Tillage (15/6, 1/7, 15/7) and chemicals	3537	12.2	30	58

Note - 1 - lb/ac = kg/ha x .891
2 - lb of n/ac = p.p.m. x 8
3 - lb of P/ac = p.p.m. x 2
4 - inches = cm x 0.394

The results of this study show that some of the tillage on summerfallow can be replaced with timely herbicide applications for broadleaved weed control without reducing the effect of the summerfallow. In this way, a better trash cover can be retained throughout the summerfallow period to protect the soil from wind and water erosion. These results generally agree with those found at Swift Current (Anderson 1971). Grassy type weeds such as quack grass, wild barley and volunteer grain were not controlled with the phenoxy type herbicide but required tillage or an expensive desiccant type herbicide for their control. Thus on a farm scale it would not be economically feasible to control all growth with herbicides at present.

There were no adverse accumulative effects measured during this eleven year period where summerfallow was done by reducing the tillage and adding some herbicides for weed control. The treatments where chemicals only were used had as much nitrate nitrogen and phosphorus in the surface soil as tilled fallows. The chemical fallows did, however, develop weed problems that were difficult to control with the herbicide used. These could usually be controlled if one or two timely tillage operations were introduced into the program.

These summerfallow studies show that at Melfort two timely herbicide treatments at 0.5 (8 ozs/ac) to 1.0 (16 ozs/ac) kg/ha each (one in the early and one in the latter part of the fallow program) will save from 3-5 tillage operations on fallow. This will normally reduce the tillage on fallow by about 50%, thus resulting in a saving of energy and a greater concentration of trash cover to protect the field from soil erosion.

REFERENCES

(1) Anderson, C.H. 1971. Comparison of tillage and chemical summerfallow in a semi-arid region. C.J. Soil Sci. 51: 397-403.

(2) Anderson, C.H. 1975. A history of soil erosion by wind in the Palliser triangle of western Canada. Research Branch, Can. Agr. Hist. Series No. 8.

(3) Anderson, D.T.; Anderson, C.H.; Bisal, F.; Bowren, K.E.; Dowley, W.K.; Dryden, R.D.; Janzen, P.J.; Deys, C.H.; McCurdy, E.V.; Molbert, E.S.; Smith, A.D.; Thompson, J.L.; and Wenhardt, A. 1966. Soil erosion by wind, cause damage, control. C.D.A. Pub. 1266.

(4) Bowren, K.E. 1965. Stop spring soil erosion. Saskatchewan Farm Science, U. of S., Saskatoon. Vol. 12, No. 4, Page 1.

(5) Bowren, K.E. 1972. Moisture storage during summerfallow. Research Highlights, Res. Station, Melfort, Saskatchewan. 1972. page 50-51.

(6) Bowren, K.E. 1975. Summerfallow a production tool. Research Highlights, Res. Station, Melfort, Saskatchewan. page 62-65.

(7) Doughty, J.L.; Staple, W.J.; Lebane, J.J.; Warder. F.G.; and Bisal, F. Soil moisture, wind erosion and fertility of some Canadian prairie soils. C.D.A. Pub. 819.

(8) Dryden, R.D.; Dowley, W.K.; and Hill, K.W. 1964. Control of soil drifting in southwestern Manitoba. C.D.A. Pub. 1178.

(9) Hill, K.W. 1953. Soil drifting its causes and control. C.D.A. Pub. 896.

(10) Nielsen, K.F. 1967. Fertilizer - the key to soil fertility and building good soil tilth - the effect of summerfallowing. Free Press Weekly. April 2, 1967.

(11) Neatby, K.W. Water erosion of soil on the prairie provinces and its control. Line Elevators Farm Service Berl. No. 3. March, 1944.

(12) Rennie, D.A. 1973. Evidence shows summerfallow is an undesirable management practice. Saskatoon Star Phoenix. February, 1973.

(13) Ripley, P.O. 1961. Soil erosion by water damage! Prevention! Control! C.D.A. Pub. 1083.

(14) Statistics Canada 1976. Intended acreage of principal field crops in Canada - 1976. Statistics Canada Field Crop Reporting Series No. 2. April 2, 1976.

(15) Tinline, M.J. and Brown, D.A. 1938. The summerfallow in Manitoba. C.D.A. Pub. 620.