SASKATCHEWAN SOIL SALINITY PROGRAM
PROGRESS REPORT[1]

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During 1977 two new soil salinity research-demonstration sites were added, to make a total of nine sites now in operation. A number of other sites were investigated through the year, with a half dozen of these showing real potential for research-demonstration purposes (Refer Fig. 1).

Rotation plans comparing continuous grain cropping, extended grain cropping with sweet clover and a two year grain-fallow sequence are continuing on the nine sites. Most of the sites also have alfalfa and grasses seeded either as interceptor strips above seep areas or as part of the field rotation.

One aspect of 1977 on-site research was the application of various rates of nitrogen to the tall wheatgrass interceptor strip on Forman's soil salinity research-demonstration site. Excellent responses were obtained (Refer Table 1). The lower rates of nitrogen doubled the hay yield and the higher rates showed almost a tripling of yield. Rep. 8, located in a particularly severe saline seep with only sparse tall wheat growth, had very low check yields, consisting mainly of wild barley. The higher rates of nitrogen, however, appeared to activate the dormant kochia, resulting in very high hay yields, largely of kochia. This suggests interesting possibilities for drying up seep areas if the kochia can be utilized as a feed mix.

TABLE 1. YIELD RESPONSE OF TALL WHEATGRASS TO NITROGEN FERTILIZER (FORMANS)

	YIELDS IN KG/HA AT VARIOUS RATES OF NITROGEN IN KG/HA							
	38	check	57	75	check	150	check	225
rep. 1	587	372	587	1115	332	978	293	880
rep. 2	489	254	684	782	332	821	313	880
rep. 3	567	196	782	899	293	919	352	978
rep. 4	684	587	802	978	567	1408	587	978
rep. 5	1075	352	1115	1173	293	1173	587	1173
rep. 6	782	548	1173	1154	489	1212	489	1212
rep. 7	880	332	1075	1154	508	1310	782	1603
rep. 8	274	235	548	978	117	1545	274	1760
rep. 9	430	372	684	978	176	1115	332	978
rep. 10	684	293	587	352	352	880	391	1154
TOTAL YIELD	6452	3541	8037	9563	3459	11361	4400	11596
AVERAGE YIELD	645**	354	804**	956**	346	1136**	440	1160**

** denotes significant yield increase at the 1% level by paired "t" test.

[1] Presented at Soils and Crops Workshop, Saskatoon, Saskatchewan, February 8, 1978

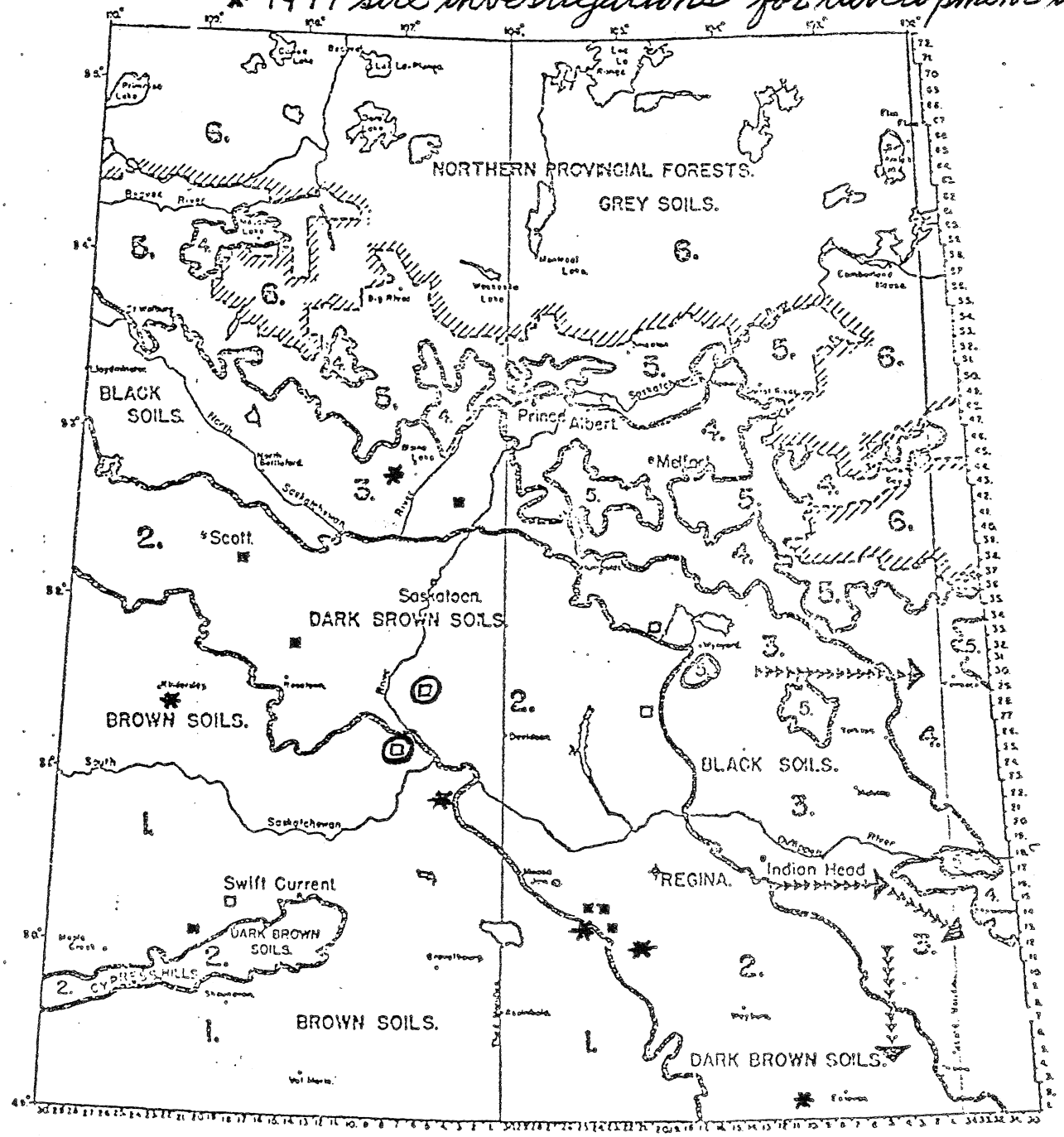
FIG 1. SASKATCHEWAN SALINITY PROGRAM RESEARCH-DEMONSTRATION SITES

■-1975 site locations

□-1976 proposed site locations ⊡ developed in 1976-77

▶▶-areas for future site locations

*-1977 site investigations - for development in 1978



— LEGEND —

1. Brown Soils of the open prairie, the most arid section of the province. Wide variations in crop yields and frequent severe droughts.
2. Dark Brown Soils of the prairie, less arid than the Brown Soils. Variable crop yields but less frequent severe droughts.
3. Black Soils of the parkland. Better moisture conditions and better average yields than on the prairie. Severe droughts rarely experienced.
4. Thick Black and Greyish Black Soils of the parkland-forest belt. Good moisture conditions and high crop yields.
5. Grey Wooded Soils of the forest region. Moisture conditions good, but soils are low in organic matter and general fertility.
6. Grey Soils and Muskeg of the unsettled Northern Provincial Forest. - - - - - - Boundary of Northern Provincial Forest Reserves.

SOIL SALINITY CROP TOLERANCE TESTING

H. M. Holm

Introduction

The 1976 expanded design used for testing crop tolerance to various salinity levels was continued in 1977 at Forman and Lowe soil salinity research-demonstration sites. Statistical analysis of results from the Forman site is reported in this paper.

Purpose

The experiment is designed to determine salt tolerance levels for selected cereal, oilseed and forage crops at four basic levels of soil salinity:

(1) Low Salinity Level (0 - 4 mmhos per cm conductivity)
- little effect on crops although yields of sensitive crops may be reduced at upper readings.

(2) Medium Salinity Level (4 - 8 mmhos per cm conductivity)
- yields of sensitive crops greatly reduced, yields of moderately sensitive crops reduced at upper readings.

(3) High Salinity Level (8 - 12 mmhos per cm conductivity)
- yields of tolerant crops reduced.

(4) Very High Salinity Level (12 - 16+ mmhos per cm conductivity)
- only highly tolerant crops survive.

Procedure

In early June, 1977 four 87 metre rows of 14 plant types (7 cereal, 5 oilseed and 2 forage crops) were seeded with a plot seeder at recommended field rates across a salinity gradient. Rows were spaced 0.3 metres apart and plant types were separated by 1.2 metre borders. (Refer Fig. 2, 3, Forman Site)

At emergence and during summer and at harvest each plant types performance was visually rated at each grid point on the salinity gradient.

At harvest, 1.8 metre lengths of the two centre rows of each plant type were sampled at each grid point on the salinity gradient for yield determination and statistical analysis. Soil samples from 0 - 15, 15 - 30 and 30 - 60 cm depths were taken at each grid location at time of crop harvest.

Results and Discussion

Tables 2 and 3, and Fig. 4 - 7 give yields of each crop in kilograms per hectare at the various salinity levels. In this graphic representation of results, salinity readings for the 0 - 15 cm depth were used. Because of late seeding, safflower and corn did not mature properly and were not included in the data. Safflower shows promise, however, and will be included in later testing.

Results for cereal crops in 1977 show barley averaging out far better than wheat or oats which correlates with 1976 data. The new Melvin barley variety as well as Husky performed remarkably well in overall yielding ability but Bonanza appears best in salt tolerance (refer regression analysis). The combined 1976 and 1977 averages for cereals follow the same pattern as for individual years. (refer Fig. 6)

Of the oilseed crops, sunflower continues to outperform the others. Flax did poorly in 1977 and was outdistanced by mustard and rapeseed. The combined 1976 and 1977 averages for oilseeds follow the same pattern as for individual years. (refer Fig. 7)

In order to report statistically on the results of crop yield vs salinity, regression analysis were run on the original data. To illustrate this procedure regression of the original yields (kg/ha) for representative crops, Bonanza barley, Neepawa wheat, Sunflower, and Flax, were plotted against electrical conductivity EC (mmhos/cm) both for 1977 and corrected 1976 data. (Correction of 1976 data was necessary because of an error in reported EC levels. This correction has not changed the previously reported order of crop tolerance to salinity.) These regressions are shown in Fig. 8 and 9.

In the regression analysis, salinity readings for the three sample depths to 60 cm were averaged. In regression analysis generally, the larger the negative regression slope the greater the crop tolerance to salinity. However, when using original data, because of inherent differences in crop yielding abilities, slope lines for the various crops cannot be directly compared.

In order to directly compare effects of salinity on crops with different yielding abilities, the regression line was extended to zero salinity. This yield at zero EC was calculated to be the normal yield and rated 100 per cent.

A second regression analysis was then done using percent of normal yield vs electrical conductivity to provide regression equations for the various crops. This is reported in Fig. 10 - 12 for 1977 results, corrected 1976 results and the combined 1976 and 1977 data. In percent of normal yield regression analysis, the smaller the negative slope the greater the crop tolerance to salinity, and the steeper the slope line the less the tolerance. Extent of salinity tolerance of the various crops thus becomes directly comparable.

The regression analysis based on percent of normal yield vs electrical conductivity facilitates comparisons among the various varieties and crop kinds in respect to salinity tolerance. Information outlined in Fig. 10 - 12 list the cereal and oilseed crops in order of salinity tolerance according to this method.

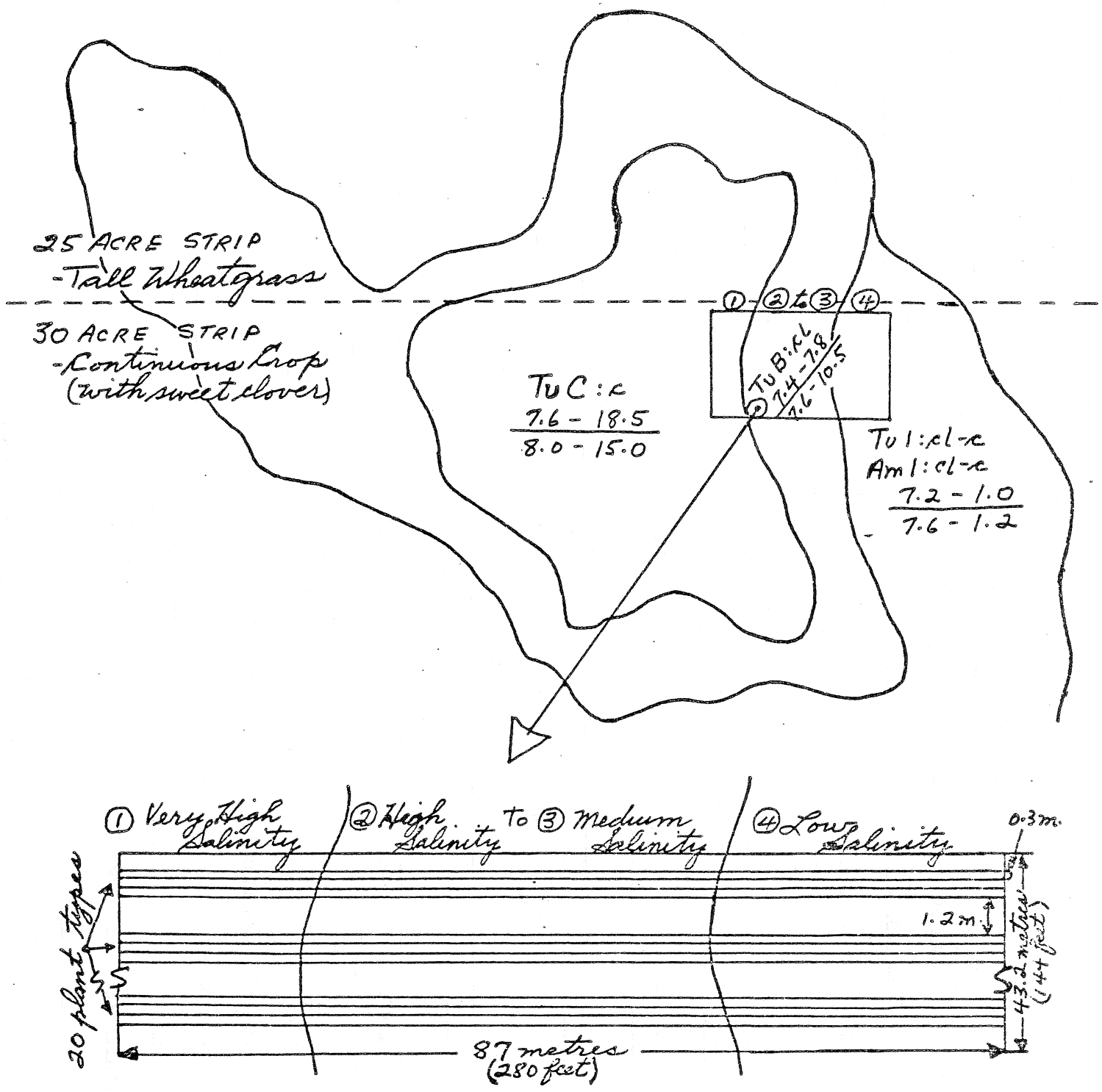


Fig. 2 Diagramatic sketch showing location and plot format of salinity crop tolerance test on Forman's research-demonstration site. Note soil classification indicating a salinity range from 18.5 mmhos/cm conductivity in surface of Tuxford C strongly saline soil, through 7.8 mmhos/cm in the surface of Tuxford B moderately saline soil to 1.0 mmhos/cm in the surface of essentially non-saline Tuxford 1 - Amulet 1 soil mixture.

SOIL AND CROP SAMPLING LOCATIONS (1 to 14)

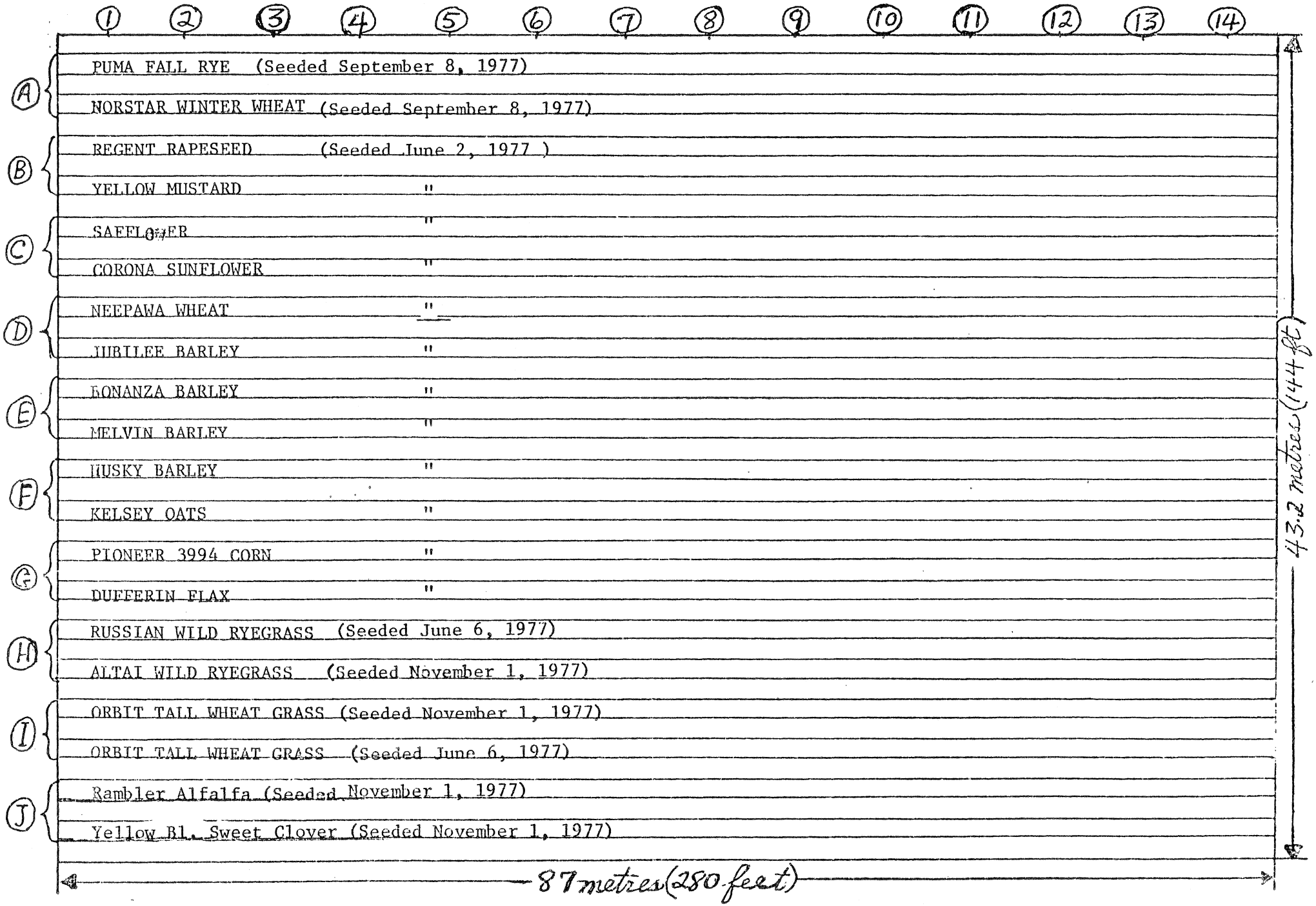


FIG. 3 Research design, Forman soil salinity crop tolerance plot, 1977

TABLE 2 AVERAGE CEREAL CROP YIELDS AT VARIOUS SOIL SALINITY RANGES, FORMAN SALINITY CROP TOLERANCE TEST, 1976 AND 1977

CROP TYPE	AVG. CROP YIELDS (KG/HA)*				NORMAL YIELD*** from REGRESSION (KG/HA)
	ELECTRICAL CONDUCTIVITY RANGES (MMHOS/CM)**				
	LOW (0-4)	MED (4-8)	HIGH (8-12)	V. HIGH (12-16+)	
BARLEY	****				
Bonanza '76	2800 (4)	2106 (2)	1774 (3)	899 (1)	3253
Bonanza '77	2094 (4)	1679 (3)	1535 (3)	744 (4)	2619
Peguis '76	2804 (3)	2340 (5)	1183 (2)	-- (0)	3400
Fairfield '76	2779 (3)	1749 (5)	1323 (2)	-- (0)	2942
Melvin '77	2899 (4)	2705 (3)	1431 (3)	1039 (4)	3859
Husky '77	3091 (1)	2560 (4)	1745 (4)	1114 (5)	3753
Jubilee '77	2097 (7)	1835 (3)	931 (4)	-- (0)	2940
AVG. YIELD '76	2794 (10)	2065 (12)	1427 (7)	899 (1)	
AVG. YIELD '77	2545 (16)	2195 (13)	1410 (14)	965 (13)	
2 Yrs - All Varieties	2652 (26)	2139 (25)	1417 (21)	949 (14)	
WHEAT					
Neepawa '76	1864 (5)	771 (1)	777 (1)	398 (3)	2287
Neepawa '77	1450 (7)	1252 (3)	461 (4)	-- (0)	2049
Glenlea '76	1677 (4)	992 (2)	777 (3)	248 (1)	2076
Hercules '76	1364 (5)	757 (1)	402 (1)	103 (3)	1681
AVG. YIELD 2 Yrs - All Varieties	1589 (21)	943 (7)	604 (9)	250 (7)	
OATS					
Sioux '76	1541 (6)	1365 (3)	891 (1)	-- (0)	2324
Kelsey '77	1485 (1)	1390 (4)	893 (4)	304 (5)	2250
AVG. YIELD 2 Yrs - All Varieties	1513 (7)	1378 (7)	892 (5)	304 (5)	

* Yields are reported in Kilograms per hectare. This is roughly comparable to yields in pounds per acre (conversion factor is 0.9). To obtain yields in lbs/ac multiply kg/ha by 0.9. To obtain yields in bus/ac divide by standard lbs/bus weight for the various crops.

** Salinity levels are expressed in millimhos per centimetre (mmhos/cm) for saturated paste extract on 0-15 cm sample.

*** Normal yield as determined from regression equation refers to yielding potential of crop at zero salinity.

**** (4) etc refers to the number of sampling sites or reps making up the average. In 1976 there were 10 reps, in 1977 there were 14 reps in total.

TABLE 3 AVERAGE OILSEED CROP YIELDS AT VARIOUS SOIL SALINITY RANGES, FORMAN SALINITY CROP TOLERANCE TEST, 1976 AND 1977

CROP TYPE	AVG. CROP YIELDS (KG/HA)*				NORMAL YIELD*** FROM REGRESSION (KG./HA)
	ELECTRICAL CONDUCTIVITY RANGES (MMHOS/CM)**				
	LOW (0-4)	MED (4-8)	HIGH (8-12)	V. HIGH (12-16+)	
SUNFLOWERS					
Krasnodarets '76	1631 (2)****	997 (4)	791 (2)	719 (2)	1812
Corona '77	2618 (6)	2392 (4)	1581 (3)	815 (1)	2984
AVG. YIELD (2 yrs) TWO VARIETIES	2125 (8)	1695 (8)	1186 (5)	767 (3)	
MUSTARD					
Yellow Mustard '76	786 (1)	736 (2)	612 (4)	165 (3)	1173
Yellow Mustard '77	898 (6)	880 (1)	676 (3)	285 (4)	1077
AVG. YIELD (2 yrs)	842 (7)	808 (3)	664 (7)	225 (7)	
RAPESEED					
Torch '76	--- (0)	465 (5)	123 (3)	30 (2)	1187
Regent '77	918 (6)	751 (1)	639 (3)	124 (4)	1157
AVG. YIELD (2 yrs) TWO VARIETIES	918 (6)	608 (6)	381 (6)	77 (6)	
FLAX					
Dufferin '76	1090 (6)	1016 (3)	445 (1)	--- (0)	1634
Dufferin '77	--- (0)	309 (6)	193 (4)	29 (4)	892
AVG. YIELD (2 yrs)	1090 (6)	663 (9)	319 (5)	29 (4)	

* Yields are reported in kilograms per hectare. This is roughly comparable to yields in pounds per acre (conversion factor is 0.9). To obtain yields in lbs/ac multiply kg/ha by 0.9. To obtain yields in bus/ac divide by standard lbs/bus weight for the various crops.

** Salinity levels are expressed in millimhos per centimetre (mmhos/cm) for saturated paste extract on 0-15 cm sample.

*** Normal yield as determined from regression equation refers to yielding potential of crop at zero salinity.

**** (2) etc. refers to the number of sampling sites or reps making up the average. In 1976 there were 10 reps, in 1977 there were 14 reps in total.

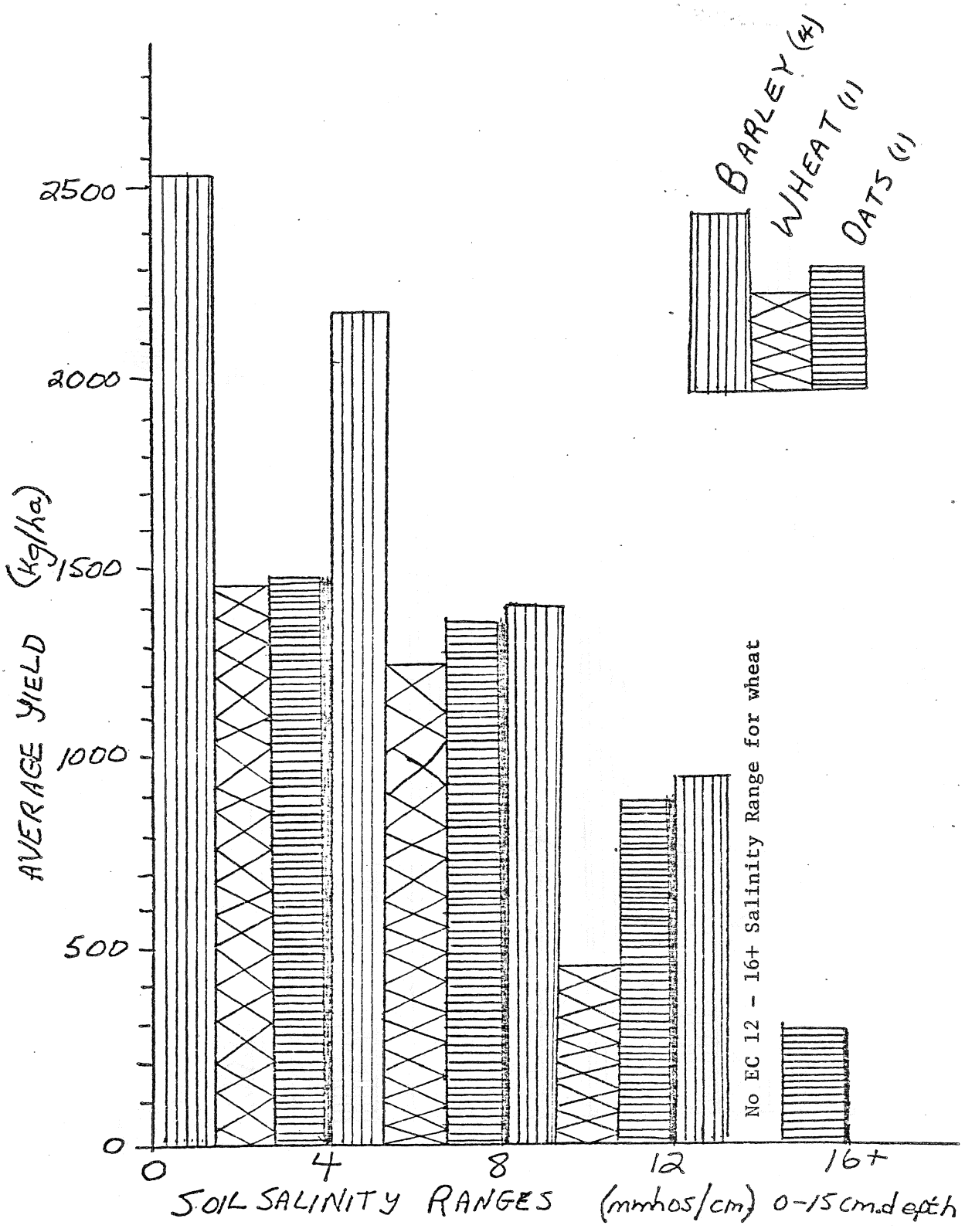


FIG. 4 Average barley yields (4 varieties) vs average wheat yield (1 variety) vs average oats yield (1 variety) at various soil salinity levels, Forman salinity crop tolerance test, 1977.

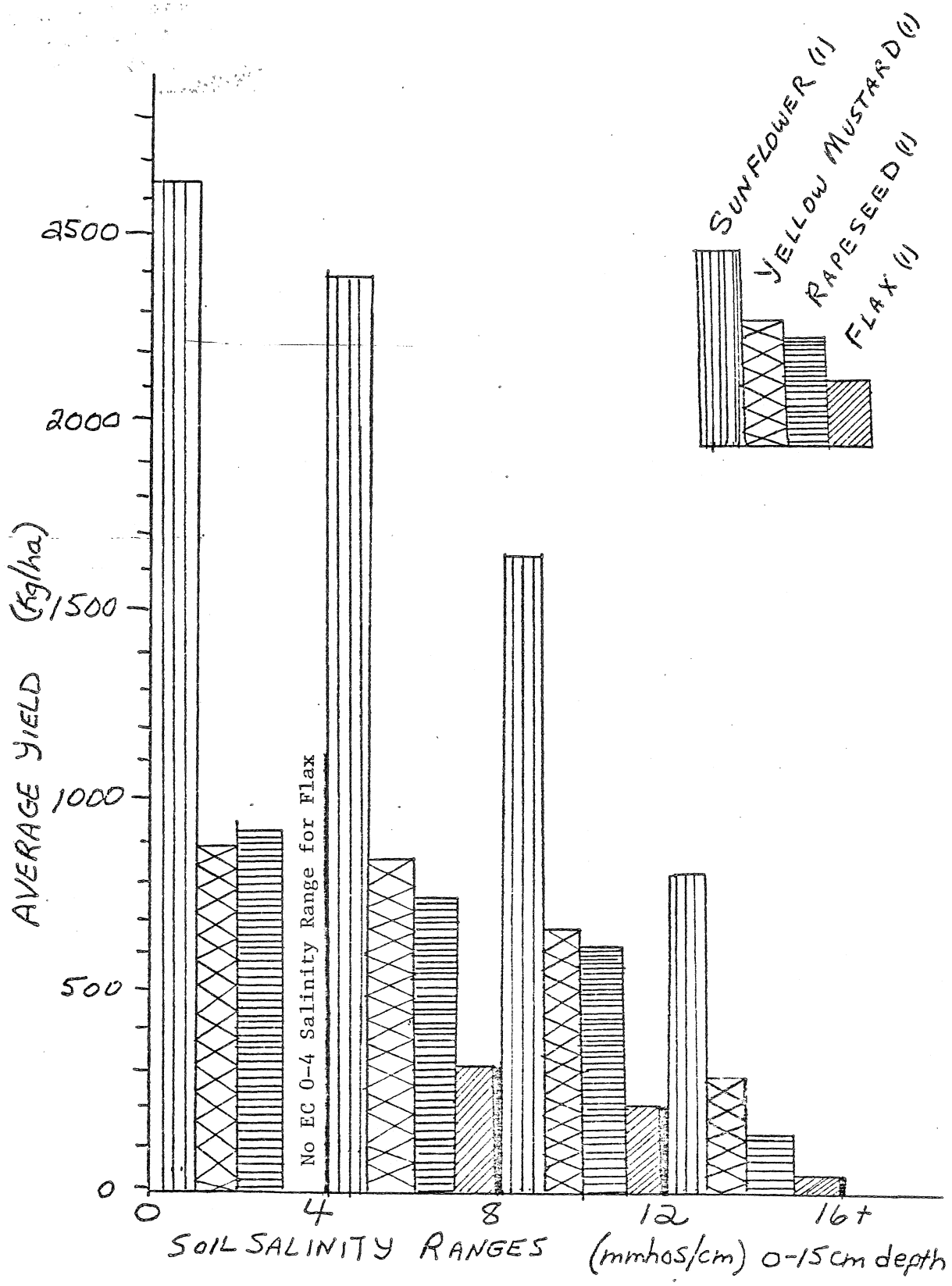


FIG. 5 Average sunflower yield (1 variety) vs average Yellow Mustard yield (1 variety) vs average rapeseed yield (1 variety) vs average flax yield (1 variety), Forman salinity crop tolerance test, 1977

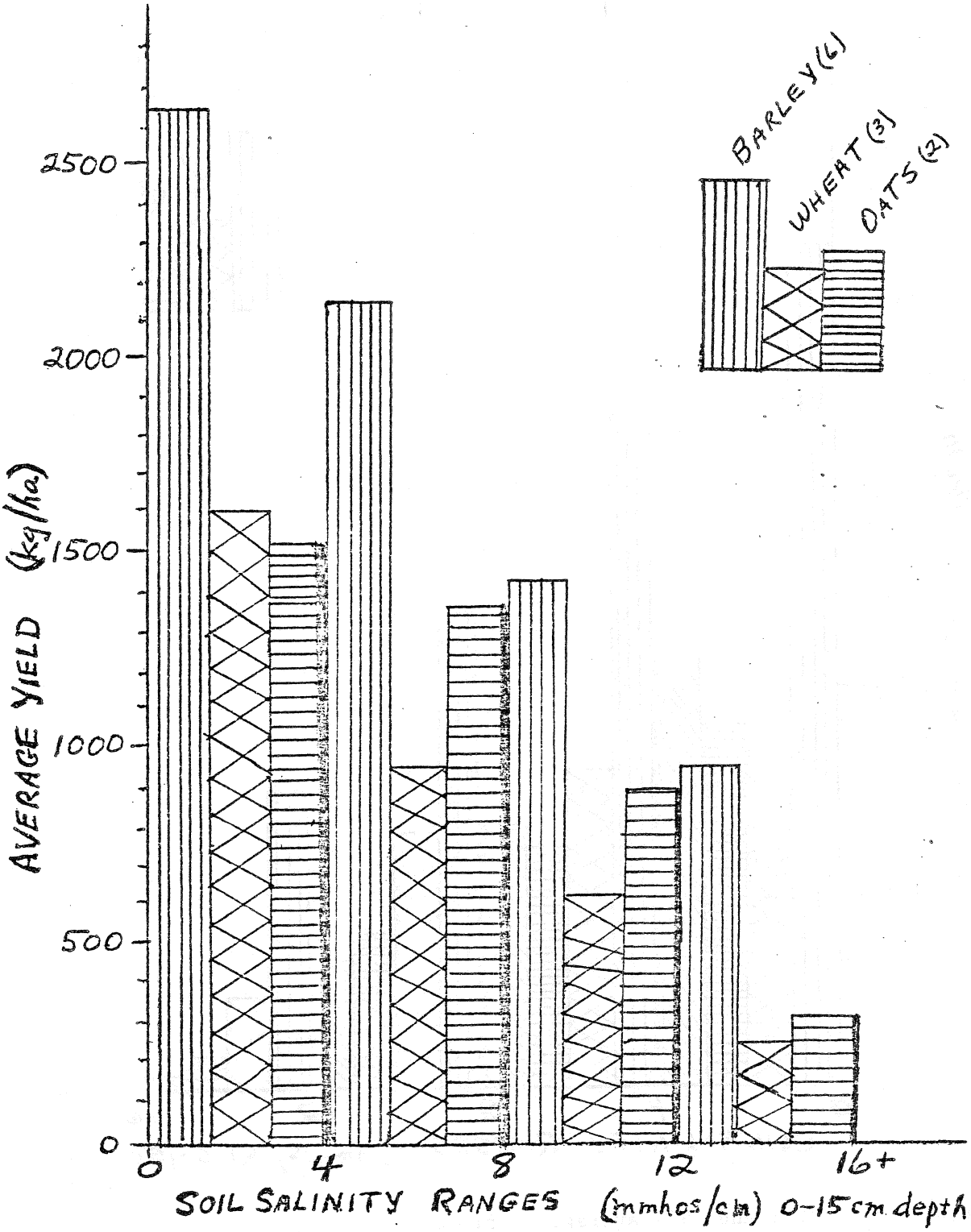


FIG. 5 1976 and 1977 average barley yields (6 varieties) vs average wheat yields (3 varieties) vs average oat yields (2 varieties), Forman salinity crop tolerance test.

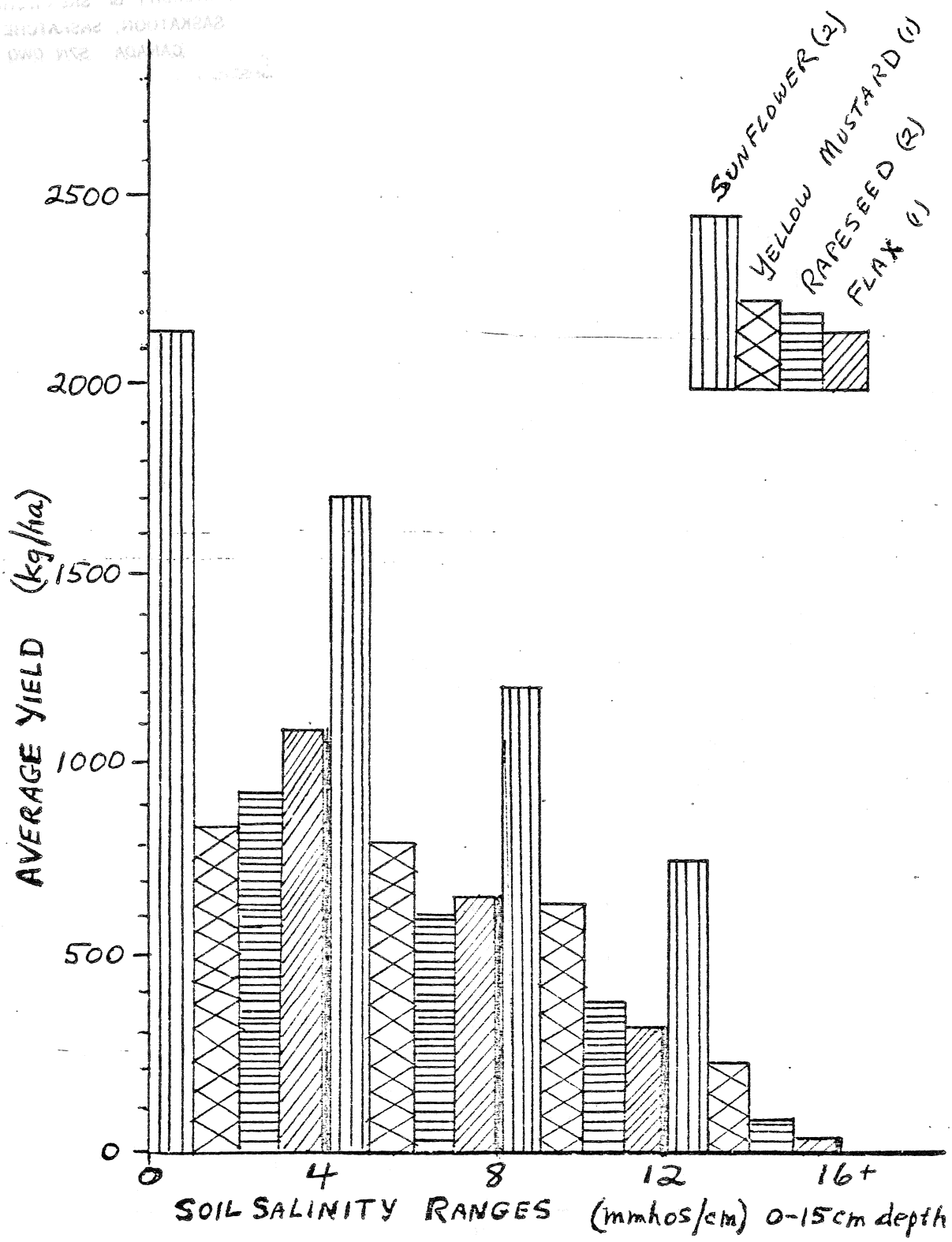


FIG. 7 1976 and 1977 average sunflower yields (2 varieties) vs average yellow mustard yields (1 variety) vs average rapeseed yeilds (2 varieties) vs average Flax yields (1 variety).

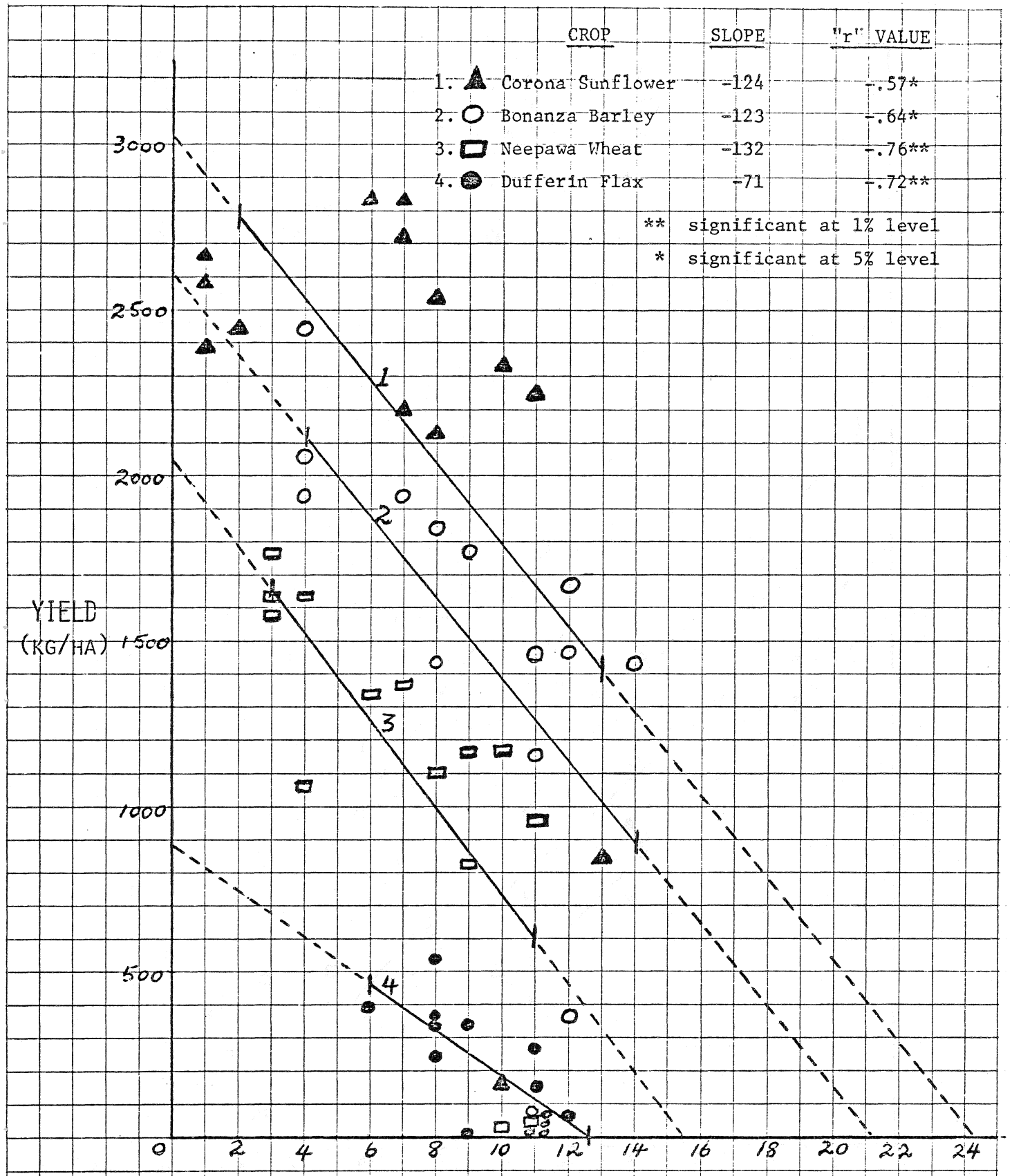


FIG. 8 Regression of crop yield vs salinity for representative crops from original data, Forman research-demonstration site, 1977. Because of inherent differences in crop yielding abilities, slope lines for the various crops cannot be directly compared from the original data. The solid portions of slope lines are plotted known values. The dotted portions are projected values from the regression analysis.

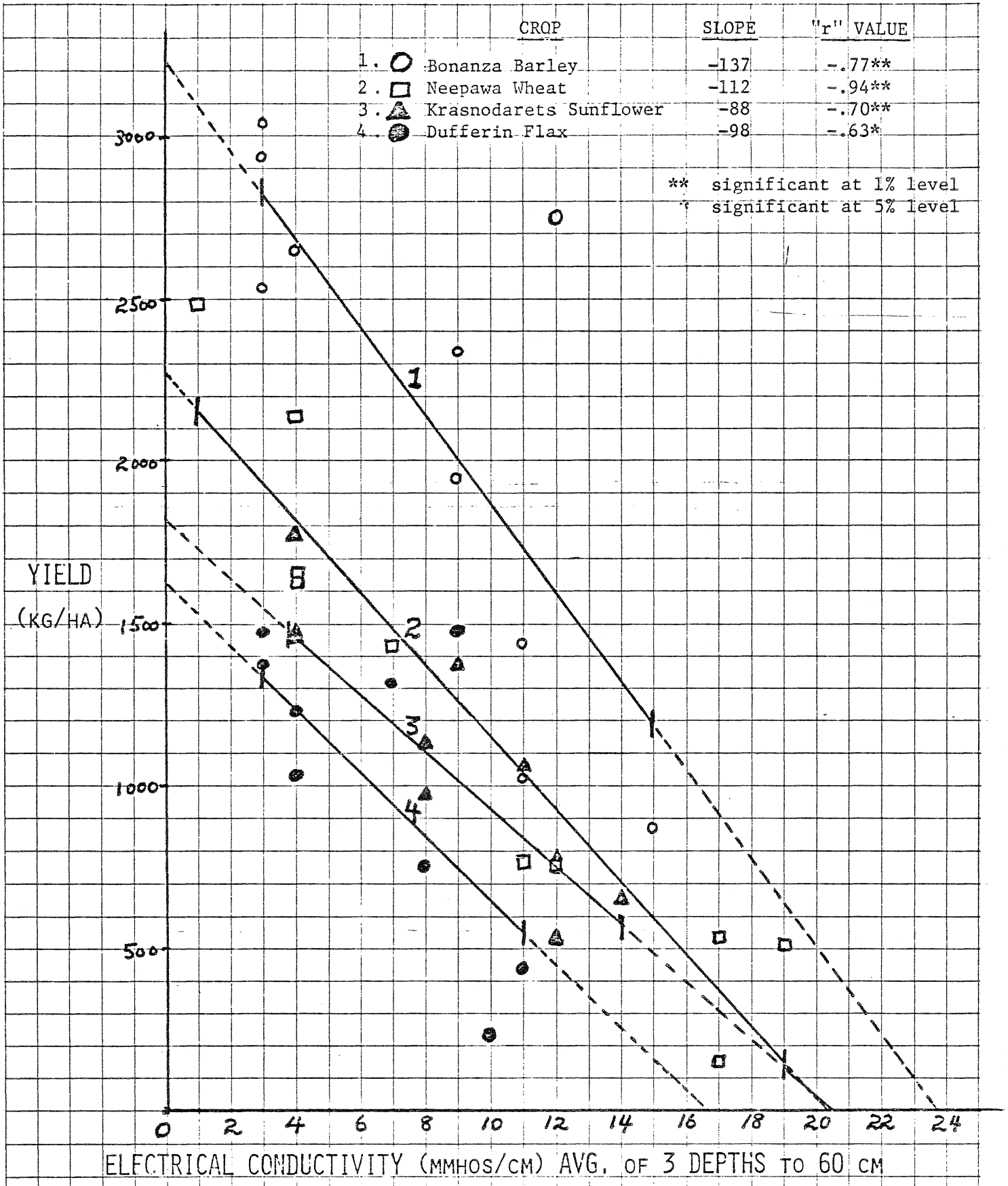


FIG. 9 Regression of crop yield vs salinity for representative crops from original data, Forman research-demonstration site, 1976 corrected. Because of inherent differences in crop yielding abilities, slope lines for the various crops cannot be directly compared from the original data. The solid portions of slope lines are plotted known values. The dotted portions are projected values from the regression analysis.

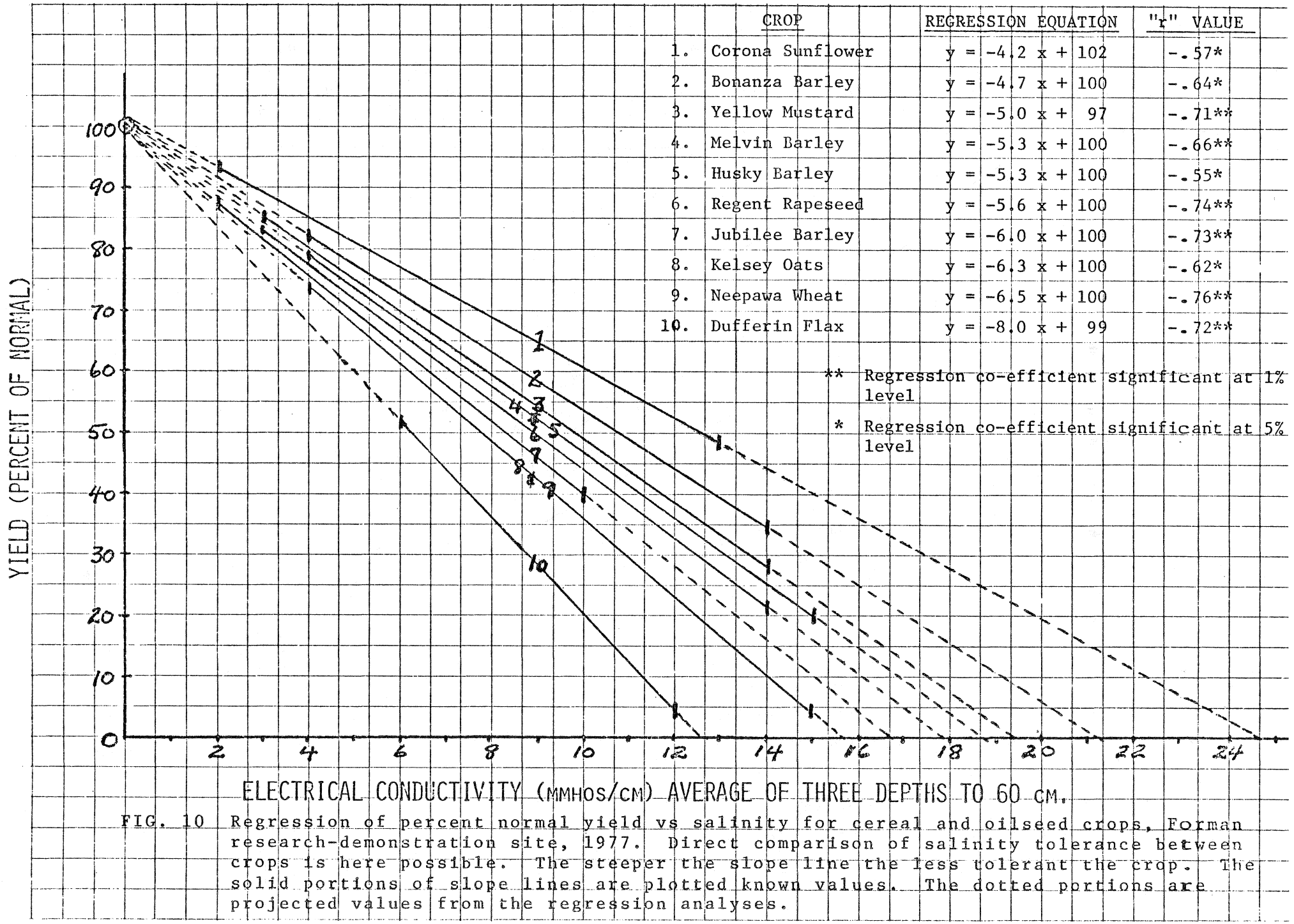
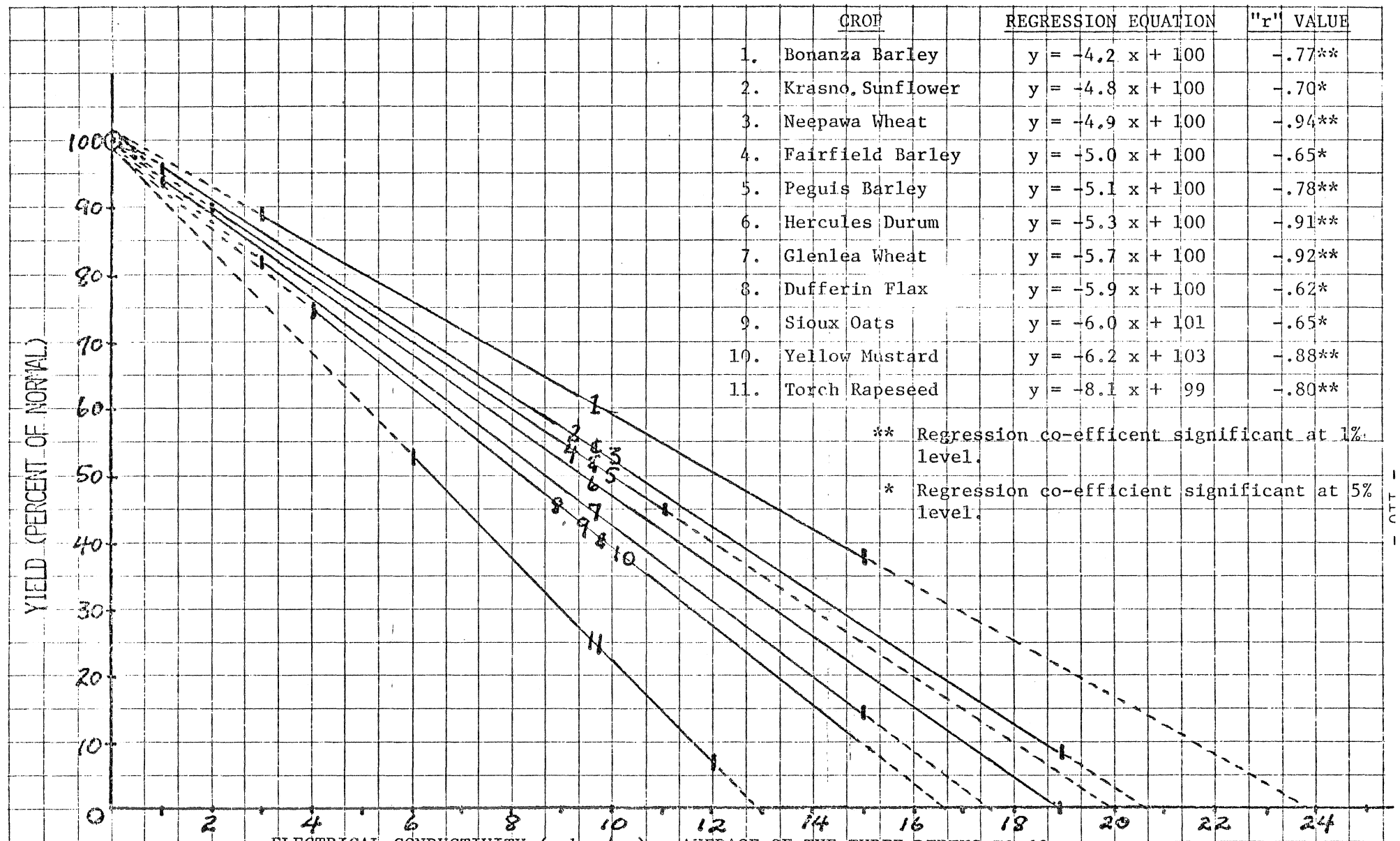


FIG. 10 Regression of percent normal yield vs salinity for cereal and oilseed crops, Forman research-demonstration site, 1977. Direct comparison of salinity tolerance between crops is here possible. The steeper the slope line the less tolerant the crop. The solid portions of slope lines are plotted known values. The dotted portions are projected values from the regression analyses.



	CROP	REGRESSION EQUATION	"r" VALUE
1.	Bonanza Barley	y = -4.2 x + 100	-.77**
2.	Krasno. Sunflower	y = -4.8 x + 100	-.70*
3.	Neepawa Wheat	y = -4.9 x + 100	-.94**
4.	Fairfield Barley	y = -5.0 x + 100	-.65*
5.	Peguis Barley	y = -5.1 x + 100	-.78**
6.	Hercules Durum	y = -5.3 x + 100	-.91**
7.	Glenlea Wheat	y = -5.7 x + 100	-.92**
8.	Dufferin Flax	y = -5.9 x + 100	-.62*
9.	Sioux Oats	y = -6.0 x + 101	-.65*
10.	Yellow Mustard	y = -6.2 x + 103	-.88**
11.	Torch Rapeseed	y = -8.1 x + 99	-.80**

** Regression co-efficent significant at 1% level.

* Regression co-efficient significant at 5% level.

FIG. 11 Regression of percent normal yield vs salinity for cereal and oilseed crops, Forman research-demonstration site, 1976 corrected. Direct comparison of salinity tolerance between crops in here possible. The steeper the slope line the less tolerant the crop. The solid portions of slope lines are plotted known values. The dotted portions are projected values from the regression analyses.

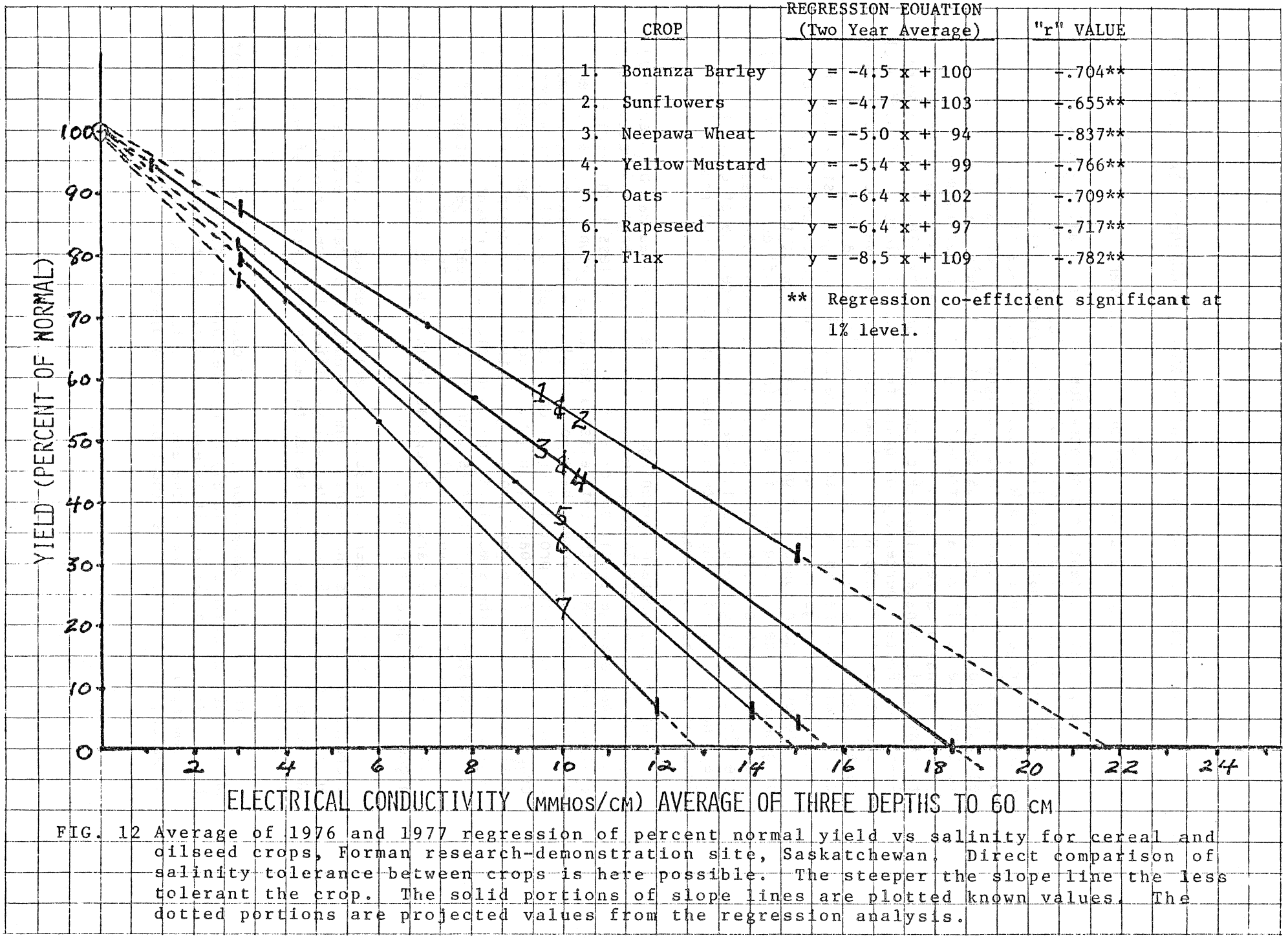


FIG. 12 Average of 1976 and 1977 regression of percent normal yield vs salinity for cereal and oilseed crops, Forman research-demonstration site, Saskatchewan. Direct comparison of salinity tolerance between crops is here possible. The steeper the slope line the less tolerant the crop. The solid portions of slope lines are plotted known values. The dotted portions are projected values from the regression analysis.