Progress of Irrigation Research on Willamette Valley Soils

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FOREWORD

Future expansions of agricultural enterprises are likely to take place in the Willamette Valley. The future expansion of agricultural production will depend to a large degree upon the feasibility of introducing irrigated agriculture on the poorly drained soils in the Valley. Knowledge of irrigation feasibility is limited on the poorer-drained series of the Willamette Catena. A research program has been initiated to investigate the feasibility of irrigation on poorly drained soils with the following objectives: (1) to determine the production potential of irrigated agriculture on the Dayton, Amity, Woodburn, Willamette, and related soils of the Willamette Valley under different levels of management, (2) to determine the irrigation-water requirements of selected crops grown on the above-named soils under different systems of management, and (3) to determine the economic feasibility of irrigation based upon the results obtained under objectives (1) and (2).

The research program is conducted cooperatively by the Departments of Soils, Horticulture, Farm Crops, Agricultural Engineering, and Agricultural Economics. Results of the research program will be published each year. This report is based on results obtained in 1964, the second crop year of the experimental program. The report was prepared by the following: L. Boersma, G. O. Klock, and T. L. Jackson, Soils; H. J. Mack and M. T. Vittum*, Horticulture; W. Calhoun, Farm Crops; D. G. Watts, Agricultural Engineering; and E. N. Castle and S. N. Miller, Agricultural Economics.

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PROGRESS OF IRRIGATION RESEARCH ON WILLAMETTE VALLEY SOILS

INTRODUCTION

Expansion of agricultural production in the Willamette Valley will depend to a large degree on the feasibility of introducing irrigated agriculture on the poorly drained soils. At present only a small percentage of these soils are irrigated. The development of irrigation has been slow on the poorly drained soils. This is due to the fact that no effort was made to make water available as long as nonirrigated farming was quite successful. The development of irrigation on the poorly drained soils has also been slow because the flooded conditions for long parts of the winter make the soils less desirable from a standpoint of the chemistry of the soil, as well as the physics of the soil.

At the present time the so-called wet lands constitute a major natural resource used at a low level of efficiency. A growing demand will lead to increased efficiency and diversification of the present marginal type of operation. The relatively low level of efficiency of the present type of operation is demonstrated in Figure 1. On a relative scale, the return per acre of farmland is shown for several counties in the Valley as a function of the percentage of this income derived from grain, hay, and seeds. The rest of the income is derived from all agricultural products.

The growing of grass is at present the only feasible use for many poorly drained soils. Grass survives the flooded conditions during the winter, produces well during a late spring, and in areas which are short of moisture during the summer it produces seed on the winter storage of moisture.

Knowledge of irrigation feasibility is limited on the poorly drained series of the Willamette Catena. A study to obtain this information was initiated in the spring of 1963. The program has been made possible by support from several sources. Grant funds were provided by the Pacific Power and Light Company, the Pacific Northwest Plant Food Association--Soil Improvement Committee, the California Chemical Company, and the American Potash Institute. Glenn L. Jackson, vice president of Pacific Power and Light Company, provided land at the Dayton-Amity site, irrigation equipment, water, and power. For some experiments, the Wade Irrigation Company provided a solid-set system and the Rainbird Company provided part-circle sprinklers. Fertilizer was provided by several fertilizer companies, and limestone was donated by the Portland Lime and Cement Company.

The program is conducted cooperatively by the staffs of the Departments of Soils, Farm Crops, Horticulture, Agricultural Engineering, and Agricultural Economics. The Soils Department has assumed major responsibility and leadership of the program.

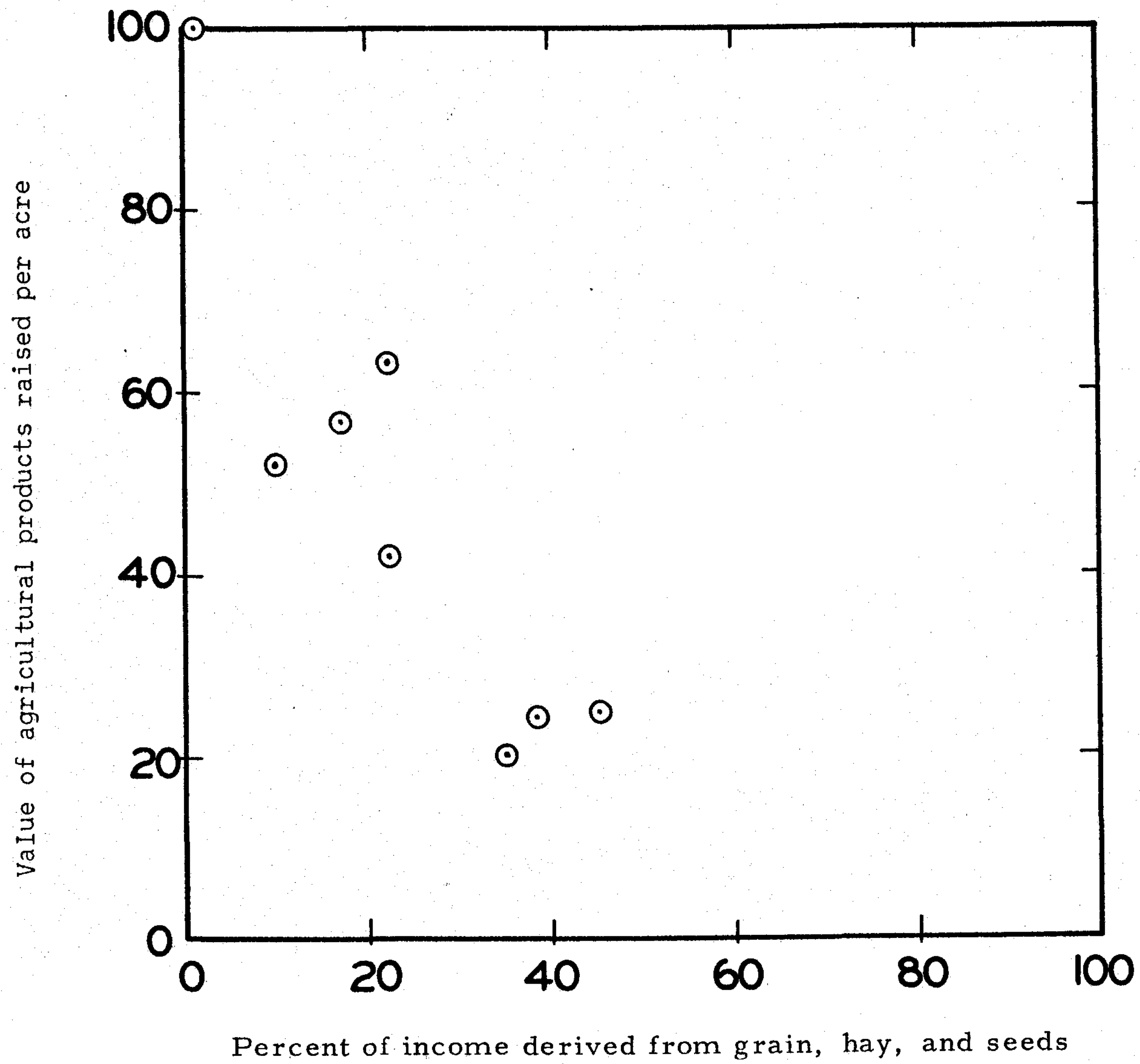


Figure 1. The value of agricultural products raised per acre as a function of the percent of this value derived from grain, hay, and seeds.

INTERPRETATION OF EXPERIMENTAL RESULTS

This is the progress report on the results of the second crop-year of a five-year research program. It presents useful information, but results must be interpreted with caution. The following points should be kept in mind when reading the report.

Climatic conditions

The 1964 growing season was cool, colder than the previous growing season. Temperatures throughout the summer were below normal. During May the mean temperatures were 5.0 degrees below normal, retarding the development of crops planted during the month considerably. A further indication of the coolness of the summer is the number of rainy days. Through September there were 59 rainy days. The long-time average number of rainy days during this period is only 33. Additional meteorological data from the station located on the Hyslop Agronomy Farm will be given later. Meteorologic data have been summarized in Table 1.

Discussion of experimental results

All experiments reported were designed to determine how yield is affected by treatments such as level of fertilization, amount of irrigation water applied, plant population, date of planting, variety, and soil type. All variables associated with climatic conditions cannot be controlled. It takes the right combination of all these practices to achieve top yields.

It is recognized, for example, that top yields are not obtained, no matter how much irrigation water is applied, unless an adequate amount of fertilizer is supplied. A different yield response will be obtained from irrigation on soil that is fertilized correctly than on a soil that is quite deficient in plant nutrients. This is referred to as an interaction between irrigation and fertility.

Most experiments were designed to study interactions between two or more important treatment effects that might affect production. For the discussion of the individual experiments, the treatments and treatment levels are stated. Results are then reported in the form of several tables. First, a table is given showing yields obtained with several treatments. The values shown are usually the average of three or four replications. Replications are necessary to eliminate differences due to normal soil variation and experimental errors in measuring the yield on small plots. Further tables provide an opportunity to evaluate the contribution made by the individual treatments to the yield.

In discussions following the tables, statements are made about the importance of the yield variations which were observed. When it is

Table 1. Meteorological Observations Made at the Station Located on the Hyslop Farm

	May		June		July		August		September		October	
	Average	1964	Average	1964	Average	1964	Average	1964	Average	1964	Average	1964
Mean maximum temperature (°F)	68.8	63.0	73.4	69.0	81.3	78.5	80.9	77.2	76.8	73.3	64.7	66.3
Mean minimum temperature (°F)	44.9	40.3	49.3	47.5	51.9	50.7	51.4	50.4	48.9	43.9	43.4	40.7
Mean mean (°F)	56.9	51.6	61.4	58.3	66.7	64.6	66.2	63.8	62.8	60.1	54.3	53.5
Number rainy days	12	14	9	14	3	9	3	13	6	9	13	10
Number clear days	11	6	10	4	18	12	17	8	15	7	8	10
Number partially clear days	12	17	11	17	10	16	9	17	10	22	11	17
Number cloudy days	8	8	9	9	3	3	5	6	5	1	12	4
Rainfall (inches)	1.85	0.55	1.29	0.88	0.32	0.57	0.38	0.23	1.30	0.31	3.53	1.25

indicated that a treatment changed the yield with significance at the 1% level, it means that if the same experiment were repeated under the same conditions, the same results would be obtained 99 out of 100 times. This statement is based on a statistical analysis which is necessary to indicate whether yield differences are the results of the treatment or merely due to the normal variation in yields found on all experimental sites.

Soil moisture content

Where the effect of irrigation levels on crop yields was tested, the amount of water applied at each irrigation and the time of application was based on the amount of water present at a given time. The amount of water in a soil determines how strongly the water is retained. The smaller the amount of water in the soil, the stronger it is retained. The relationship between amount of water and retention is shown in Figure 2. It is the relationship used for the Woodburn soil. The measure of retention used in the diagram is bars. The graph of Figure 2 shows that when the moisture content of the soil is 17%, the retention of the Woodburn soil for water corresponds to 5 bars. This means that a plant must "pull" on the water with a pull exceeding 5 bars to be able to obtain water. A high-retention value indicates a great retention of the soil for water, and this occurs when the soil is dry.

Plants cannot withdraw water when tensions are greater than 15 bars. After free drainage has ceased in a soil, the tension corresponds to approximately 0.3 bars. Because of these two conditions, plants can only use water which is retained with tension greater than 0.3 bars (additional water would drain from the soil) or smaller than 15.0 bars (at this moisture content the plant permanently wilts). In Figure 2 this amount is 13% by weight. Three horizontal scales are used for the figure. The first scale gives the amount of water in percent weight, the second scale shows the same amount in inches of water per foot of soil, and the last scale shows the amount of water as a percent of the total amount available for plant growth. This quantity is 0% at 13.0 bars and 100% at 0.3 bars.

Where the experimental plan states that the plot is to be irrigated at 1.0 bars, it can be determined from Figure 2 that this corresponds to an irrigation at the time 75% available water was left.

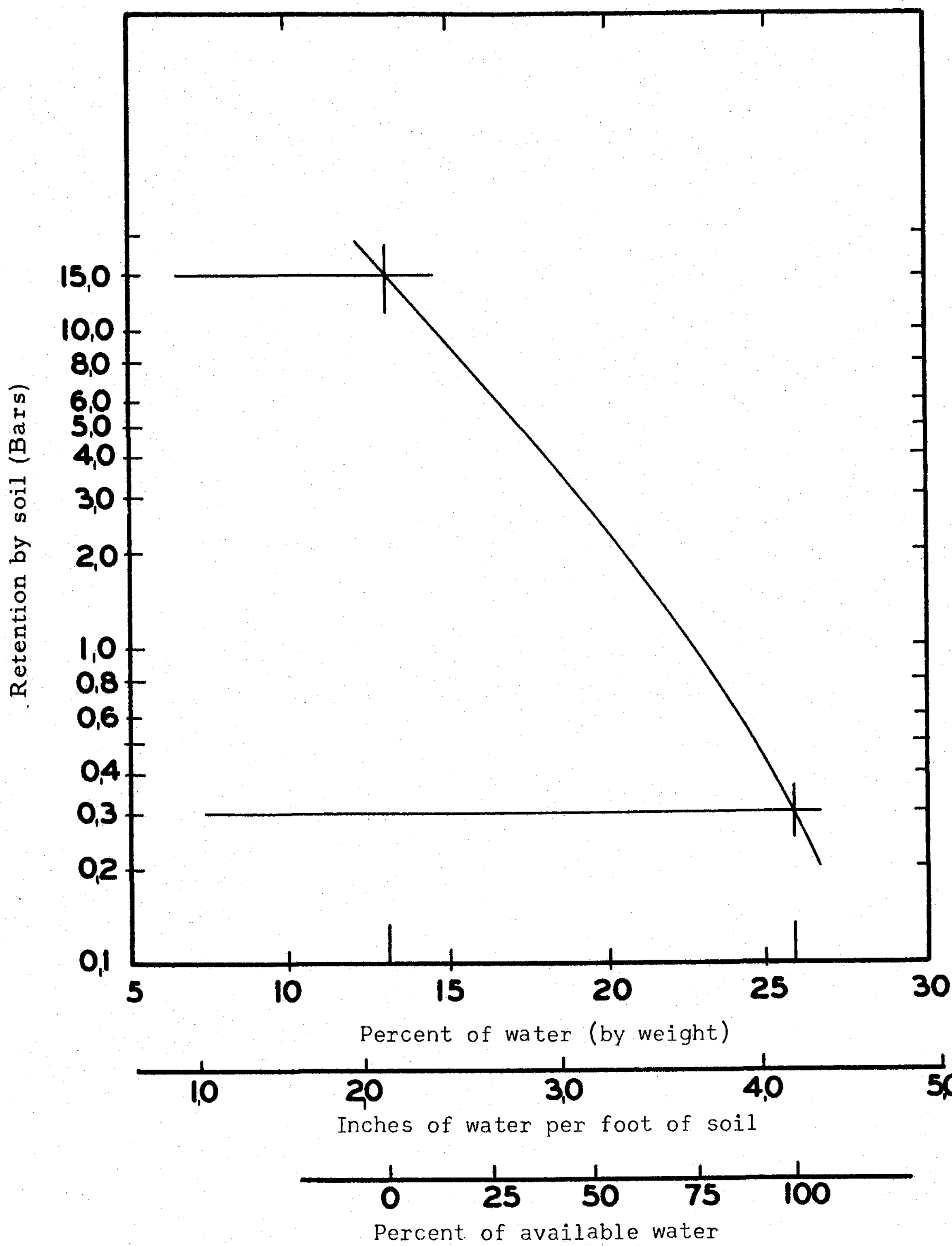


Figure 2. The retention of water by Woodburn soil expressed in bars as a function of the water content expressed in three different units.

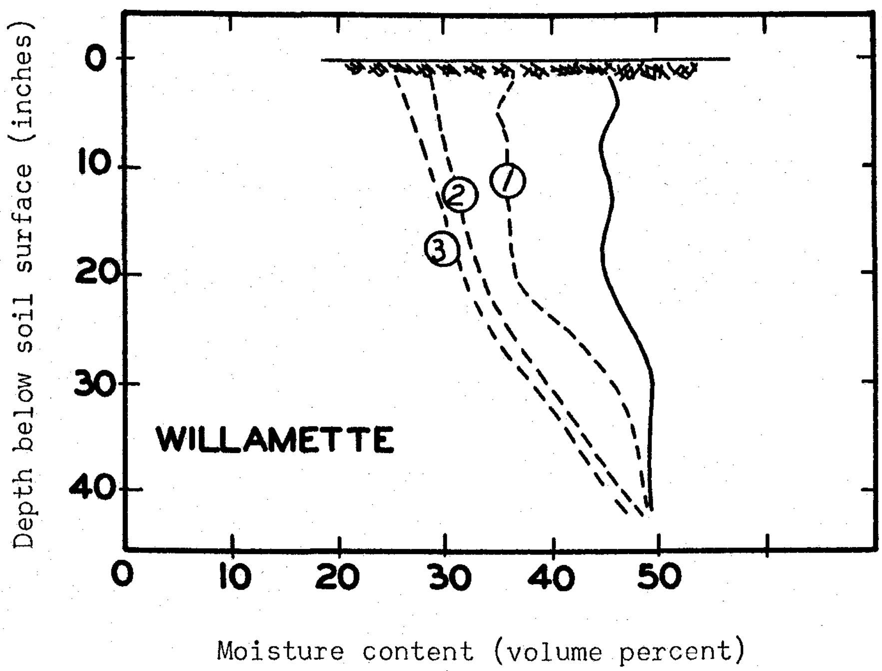
DRAINAGE CHARACTERISTICS OF POORLY DRAINED SOILS

Diversification of agricultural enterprise on poorly drained soils with the help of irrigation can only be successful when drainage problems are taken care of adequately. Large quantities of water must be removed to avoid flooded conditions during the winter. The solution to the drainage problem involves many steps. Before any field drainage program can be successful, outlets for farm drainage installations must be provided in community-type drainage projects. Improvement is needed all the way from the tile drain or surface ditch on the field to the stream improvement many miles downstream from the field.

The importance of adequate drainage conditions in the spring is demonstrated in Figure 3. The moisture content is shown as it changes with depth for a well drained soil (Willamette Series) and a poorly drained soil (Dayton Series). The solid line indicates the moisture content when the soil is completely saturated. The Willamette Soil Series contains approximately 45% water at all depths when completely saturated. The Dayton soil contains approximately 50% moisture when completely saturated, except at depths from about 12 to 20 inches. At these depths the saturated moisture content is almost 8% less, indicating a much more compact layer. This layer, made up of clay, is very slow to wet up and does not transmit much water even when completely wet.

The soil moisture content on April 14 is indicated in Figure 3 by the dashed line labeled (1). This line is not shown for the Dayton profile, indicating that this soil was still completely saturated at this date. The Willamette profile had lost almost 10% water down to a depth of over 20 inches and showed appreciable drying down to a depth of 40 inches. The moisture contents on April 28 are shown by the dashed line labeled (2). The Dayton profile showed some drying to a depth of 10 inches and about a 2% water loss to a depth of almost 20 inches. At this date the Dayton profile was certainly not at a moisture content desirable for plowing. The amount of drying which had taken place in the Willamette profile is self-explanatory. Even on May 12, the water loss from drying was still very small on the Dayton soil.

Figure 4 shows water table fluctuations recorded on Willamette and Dayton sites during the winter and spring of 1963-1964. Also shown is the total amount of rainfall which had accumulated at each date, starting on November 14, 1963. Only during periods when the total amount of rainfall accumulated rapidly (January 17-27) did the water table reach the surface of the soil on the Willamette site. However, the water table on the Dayton site was at the soil surface almost throughout the entire period of measurement. Table 2 shows the number of days the water table was closer than five inches to the surface of the soil during the winter of 1963-1964.



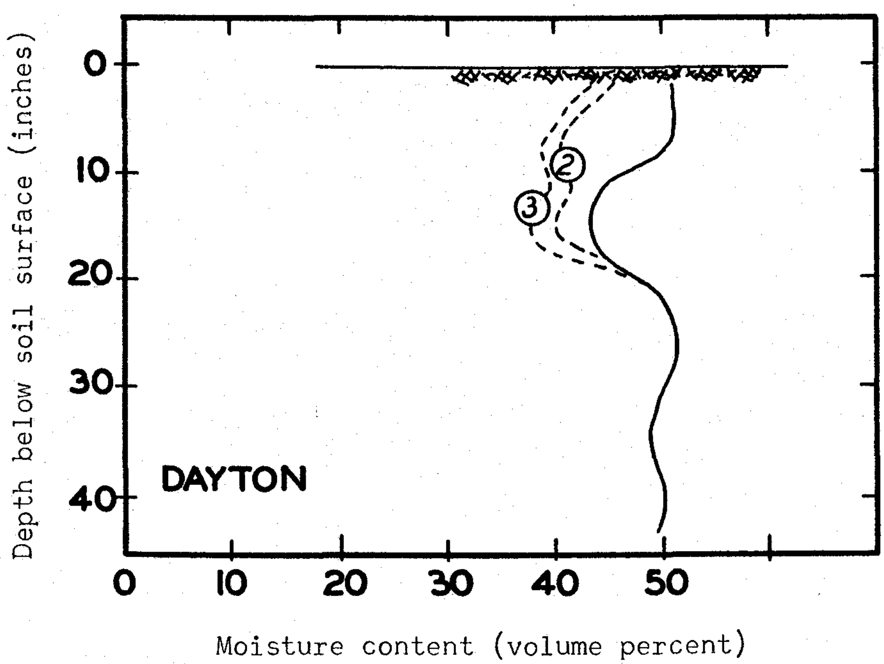


Figure 3. Moisture as a function of depth below the soil surface on April 14, April 28, and May 12, 1964.

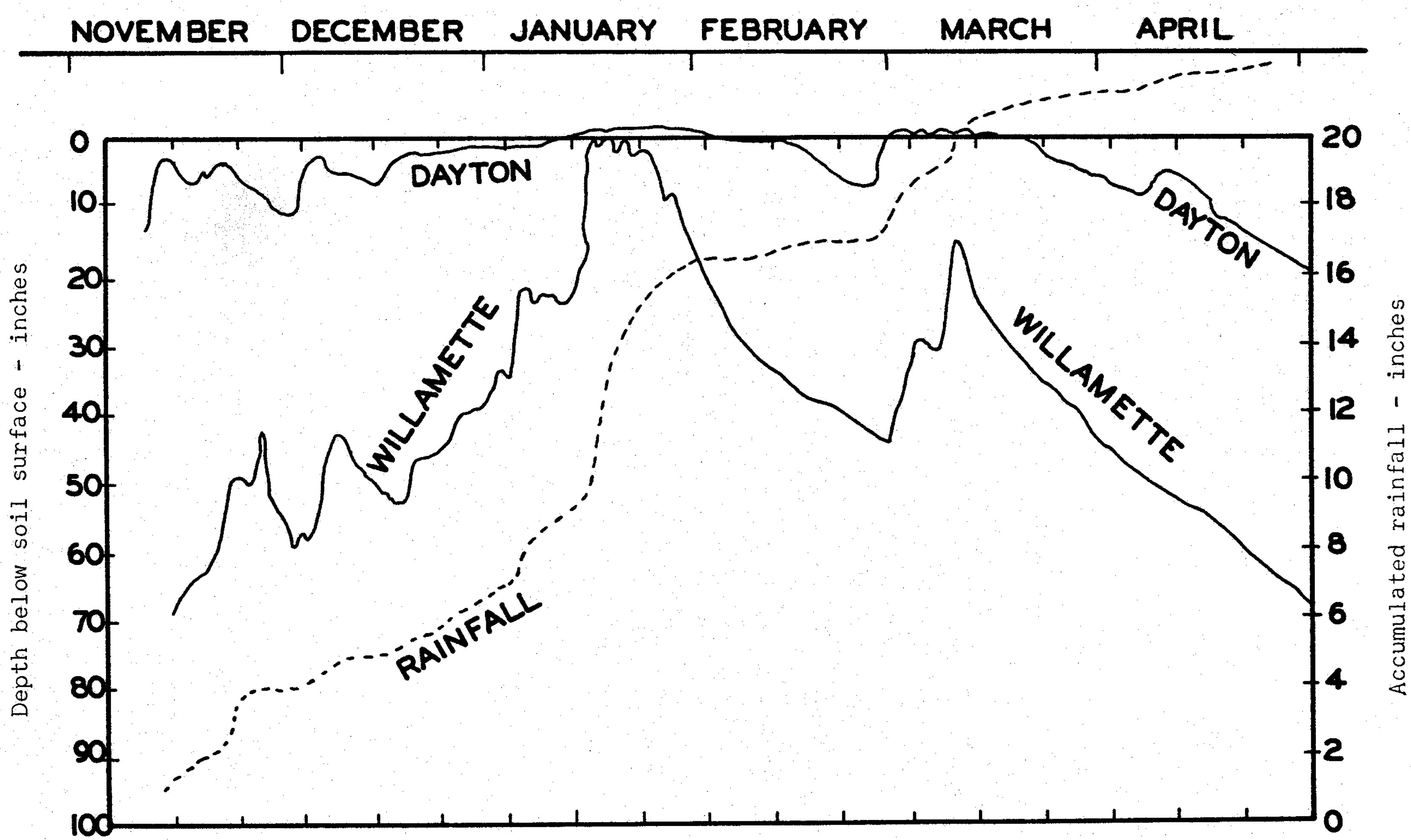


Figure 4. Water table fluctuations on Willamette and Dayton Series, 1963-64.

Table 2. Number of Days the Water Table Was Closer Than Five Inches to the Surface of the Soil During the Winter of 1963-1964

Soil Series				
Willamette	Woodburn	Amity	Concord	Dayton
12	28	40	82	123

The implications of poor drainage are many. Future research must resolve how improved drainage is best obtained.

FIELD CORN FOR GRAIN

Three experiments involving the use of field corn for grain were conducted in 1964. The first experiment was set up on Woodburn soil (Hyslop Farm) to determine the effect of different levels of irrigation, nitrogen, and stand, on fields. The second field-corn-for-grain experiment was conducted on three soil series of the Willamette Catena: Woodburn soil (Hyslop Farm), Amity soil, and Dayton (Jackson Farm). The objective of this experiment was to test the feasibility of utilizing management practices such as early termination of irrigation, level of irrigation, stand, and nitrogen to influence the rate at which field corn matures. In a third experiment several varieties were compared.

Experiment I

Objective: determine the effect on yields of field corn of different levels of irrigation, nitrogen, and stand.

Levels of treatments used:

(1) Four irrigation levels

W_0--no irrigation

W_1--irrigate at a tension of 6 bars, 12 inches below the soil surface

W_2--irrigate at a tension of 1.5 bars, 12 inches below the soil surface

W_3--irrigate at a tension of 0.8 bars, 12 inches below the soil surface

(2) Two stand levels

S_1--15,000 plants per acre

S_2--25,000 plants per acre

(3) Three nitrogen levels

N_1--60 pounds nitrogen per acre

N_2--120 pounds nitrogen per acre

N_3--180 pounds nitrogen per acre

Water was applied by means of part-circle sprinklers, and water requirements were determined by use of electrical resistance units (gypsum blocks) installed at depths of 12 and 30 inches in the soil.

Field corn (Oregon 355) was grown with no irrigation, except 0.75 inch of water at planting time to obtain uniform stand, and three different levels of irrigation. Three levels of nitrogen fertilization and two levels of plant population (stand) were superimposed on each irrigation level, giving a total of 24 different management treatments in the experiment. All treatments were planted in one uniform block, and the plant populations were obtained by thinning. All treatments received 60 pounds per acre of nitrogen as 16-20-0, banded at planting time. The additional nitrogen for the N_2 and N_3 treatments was added by sidedressing NH_4NO_3 (33.5-0-0). Frequent irrigations were necessary because only small amounts of water could be applied at each irrigation. Ponding occurs readily on Woodburn soils as a result of the relatively low infiltration rates.

Crop history and irrigation dates and amounts are shown in the following tables. Yields are shown and compared with the identical experiment on Woodburn soil in 1963. Crop yields and irrigation-water usage were the primary measurements made, although other observations and measurements were made on the crop and soil.

Table 3. Crop History Dates

Plowed field	---
Planted seed	May 4
Applied atrazine	May 27
Thinned for stand	June 18
Sidedressed additional nitrogen	June 25
Tasseling	July 25
Harvested	November 2

Table 4. Irrigation Water Applied in Inches

Date	W_0	W_1	W_2	W_3
	Inches	Inches	Inches	Inches
May 25	0.75	0.75	0.75	0.75
June 19	--	--	1.0	1.0
June 26	--	--	1.0	1.0
July 6	--	--	0.5	0.5
July 9	--	--	0.5	0.5
July 12	--	0.5	0.5	0.5
July 13	--	0.5	--	0.5
July 16	--	--	0.5	0.5
July 20	--	0.5	0.5	1.0
July 24	--	0.5	0.5	0.5
July 28	--	--	0.5	0.5
July 29	--	--	--	1.0
August 7	--	0.5	0.5	0.5
August 8	--	0.5	--	0.5
August 11	--	--	1.0	1.0
August 15	--	0.75	0.75	0.75
August 23	--	--	15	1.5
August 25	--	1.0	1.0	1.0
September 3	--	1.0	1.0	1.0
Total (1964)	0.75	6.5	12.0	14.5
Total (1963)	0.75	6.75	11.25	12.75

Table 5. Yield of Grain Corn at 15.5 Percent Moisture and Percent Kernel Moisture at Harvest

Treatment	1964 Yield*	1964 Kernel moisture	1963 Yield**	1963 Kernel moisture
	T/A	%	T/A	%
W_0 S_1 N_1	0.86	25.3	0.74	44.8
N_2	0.83	31.1	0.72	46.5
N_3	0.77	30.5	0.64	48.7
S_2 N_1	0.51	33.8	0.81	43.9
N_2	0.49	31.8	0.78	46.5
N_3	0.61	32.3	0.64	47.3
W_1 S_1 N_1	2.26	32.2	2.47	43.7
N_2	2.36	30.2	2.54	44.2
N_3	2.56	31.4	2.38	48.6
S_2 N_1	2.54	31.4	2.59	45.4
N_2	2.75	30.2	2.97	44.0
N_3	2.62	33.2	2.69	44.6
W_2 S_1 N_1	2.90	33.3	3.04	41.7
N_2	3.11	32.3	3.01	43.4
N_3	3.25	31.3	3.10	44.3
S_2 N_1	3.29	33.4	3.26	43.4
N_2	3.38	31.5	3.88	44.4
N_3	3.33	32.3	3.48	44.9
W_3 S_1 N_1	3.60	34.8	3.14	44.7
N_2	3.79	32.8	3.24	44.5
N_3	3.72	33.9	3.24	43.5
S_2 N_1	3.54	34.0	3.22	42.6
N_2	3.92	33.7	4.22	43.7
N_3	3.95	30.8	4.02	44.1

*Average for three replications.

**Average for four replications.

Table 6. Average Grain Yield (Tons per Acre) at 15.5 Percent Moisture

	Irrigation				Stand		
	W_0	W_1	W_2	W_3	S_1	S_2	Mean
Nitrogen	T/A	T/A	T/A	T/A	T/A	T/A	T/A
N_1	0.73	2.40	3.09	3.54	2.43	2.52	2.44
N_2	0.66	2.56	3.25	3.86	2.46	2.64	2.58
N_3	0.69	2.59	3.29	3.84	2.58	2.63	2.60
Stand							
S_1	0.85	2.39	3.09	3.70	--	--	--
S_2	0.54	2.95	3.33	3.79	--	--	--
Mean	0.69	2.51	3.21	3.75	2.51	2.57	2.54

Discussion

The extreme contrast in yields between irrigation levels assured a significant effect at the 1% significance level. The increased levels of nitrogen did not give the response that was shown in the 1963 experiment. This may be due to high residual nitrogen level in the soil. The use of soil testing should be considered to determine the need for nitrogen on Woodburn soil for future experiments.

One of the more notable comparisons to be made with the results of 1963 is the marked difference in maturity. The corn in 1964 was considerably more mature than it was in 1963, even though the mean temperature was lower during the growing months. Much of this difference can be contributed to the two-week earlier planting date in 1964. Selective samplings taken during the growing season to determine the percent moisture in the grain at different stages indicated that when the kernels are ripening, the water loss amounts to approximately 1% of moisture per day. According to these results, a two-week earlier planting should correspond to approximately 14% less moisture at harvest time. This conclusion is in agreement with the information shown in Table 5. In 1964 the moisture percentages were from 10-14% below those of 1963.

Experiment II

Objective: test the feasibility of utilizing management practices to influence the rate at which field corn matures. Levels of the three treatments used were:

(1) Three moisture variables. Irrigate all plots at a tension of 1.0 bars, 6-8 inches below original soil surface.

D_1--terminate irrigation at first sign of tasseling

D_2--terminate irrigation one complete irrigation after D_1

D_3--irrigate throughout entire season

(2) Two stand levels

S_1--15,000 plants per acre

S_2--25,000 plants per acre

(3) Two nitrogen levels

N_1--60 pounds nitrogen per acre

N_2--180 pounds nitrogen per acre

All irrigations up to the first termination date were by sprinklers. Water was subsequently applied on the plots of treatments D_2 and D_3 by flooding basins between the rows.

The soil was prepared by throwing up ridges with a set of border discs and rolling. The seed was planted on the ridges. This procedure was used to provide basins for the basin irrigations.

The corn variety planted was Oregon 355. The entire experiment was planted in a uniform block and the desired plant population was obtained by thinning. All treatments received 60 pounds of nitrogen per acre as 16-20-0 on the Woodburn soil, as 16-48-0 on the Amity and Dayton soils, banded at planting time. The N_2 treatment received the additional nitrogen as NH_4NO_3 (33.5-0-0) sidedressed. Muriate of potash (0-0-54) was applied as a broadcast application at the rate of 160 pounds per acre on the Amity soil and at the rate of 200 pounds per acre on the Dayton soil.

Crop history, irrigation dates, and amounts and yields of the experiments are shown in the following tables.

Table 7. Crop History Dates

Treatment	Woodburn soil	Amity soil	Dayton soil
Plowed field	----	May 8	May 9
Constructed ridges	May 6	May 15	May 15
Planted seed	May 8	May 16	May 16
Applied atrazine	May 14	May 27	May 27
Thinned for stand	June 18	June 17	June 17
Sidedressed additional nitrogen	June 25	June 26	June 26
First sign of tasseling	July 23	August 1	August 2
Harvest	November 3	October 23	October 24

Table 8. Irrigation Water Applied in Inches

Woodburn soil				Amity soil				Dayton soil			
Date	D_1	D_2	D_3	Date	D_1	D_2	D_3	Date	D_1	D_2	D_3
	Inches				Inches				Inches		
May 25	1.25	1.25	1.25	May 25	0.75	0.75	0.75	May 24	0.75	0.75	0.75
June 19	0.50	0.50	0.50	June 29	1.0	1.0	1.0	June 27	1.0	1.0	1.0
June 26	1.0	1.0	1.0	July 11	1.5	1.5	1.5	July 10	1.5	1.5	1.5
July 6	1.5	1.5	1.5	July 22	2.5	2.5	2.5	July 24	2.5	2.5	2.5
July 16	1.75	1.75	1.75	August 3	2.0	2.0	2.0	August 5	1.0	1.0	1.0
July 22	1.0	1.0	1.0	August 18	---	2.0	2.0	August 21	---	2.0	2.0
July 28	3.0	3.0	3.0	Sept. 4	---	---	2.0		---	---	---
August 11	---	2.0	2.0		---	---	---		---	---	---
August 22	---	---	2.0		---	---	---		---	---	---
Sept. 4	---	---	2.0		---	---	---		---	---	---
Total	10.0	12.0	16.0		7.75	9.75	11.75		6.75	8.75	8.75

Table 9. Yield of Grain Corn at 15.5 Percent Moisture and Percent Kernel Moisture at Harvest

Treatment	Woodburn soil		Amity soil		Dayton soil	
	Yield*	Kernel moisture	Yield*	Kernel moisture	Yield*	Kernel moisture
	T/A	%	T/A	%	T/A	%
D_1 S_1 N_1	2.70	31.0	1.73	36.9	2.31	38.3
N_2	2.96	39.9	2.33	35.5	2.39	37.0
S_2 N_1	3.21	30.8	1.85	38.9	2.52	37.6
N_2	2.99	31.4	3.04	37.8	2.61	39.2
D_2 S_1 N_1	3.28	32.8	1.70	39.0	2.45	38.6
N_2	3.72	30.2	2.34	36.9	2.72	38.6
S_2 N_1	3.69	33.3	2.02	38.3	2.66	39.6
N_2	3.95	34.3	3.51	37.9	2.75	39.6
D_3 S_1 N_1	3.42	36.5	2.00	39.5	----	----
N_2	3.81	33.2	2.87	39.1	----	----

* Average for four replications.

Discussion

The objective of this experiment on the three soil series was to evaluate the effect of several management factors on yield and maturity. The response to treatments varied considerably among the three soils. The experimental results for each soil series will be discussed separately.

General observations

The general observation can be made for results on all three soils that the kernel moisture percentages at harvest, which are a measure of the degree of maturity, were about 10% less than those obtained with the field-corn-for-grain experiments in 1963. Much of the increase in maturity can be attributed to the two-week earlier planting date in 1964. Previous reference was made to the observation that corn appears to maturate at the rate of about 1% per day. The 8-day difference in planting dates was one of the important reasons for the difference in maturity of corn grown on these three soils.

It appears that terminating irrigation about two weeks after full tasseling was most effective in maintaining maximum yields and hastening maturity. Irrigations late in the season tend to increase the soil moisture at the time fall rains start, resulting in conditions too wet for fall mechanical harvesting. Yields among the three soils differ considerably for identical treatments.

There are several reasons for this, none of which has been completely investigated. Lime is certainly one of the more critical factors. A poorly drained soil requires a greater supply of heat to raise the soil temperature to desired levels than a more well drained soil, such as the Woodburn soil used in this experiment.

Woodburn soil

Table 10. Average Grain Corn Yields at 15.5 Percent Moisture for Woodburn Soil

	Irrigation termination dates			Stand		
	D_1	D_2	D_3	S_1	S_2	Mean
Nitrogen	T/A	T/A	T/A	T/A	T/A	T/A
N_1	2.96	3.48	3.83	3.13	3.71	3.42
N_2	2.97	3.84	4.06	3.50	3.75	3.62
Stand						
S_1	2.83	3.80	3.62	----	----	----
S_2	3.10	3.87	4.28	----	----	----
Mean	2.96	3.66	3.95	3.37	3.73	3.52

Table 11. Average Grain Corn Percent Kernel Moisture for Woodburn Soil

	Irrigation termination dates			Stand		
	D_1	D_2	D_3	S_1	S_2	Mean
Nitrogen	%	%	%	%	%	%
N_1	30.9	33.0	36.0	33.5	33.2	33.3
N_2	30.6	32.3	34.3	31.1	33.7	32.4
Stand						
S_1	30.5	31.5	34.9	----	----	----
S_2	31.1	33.8	35.5	----	----	----
Mean	30.8	32.7	35.2	32.3	33.5	32.9

Terminating irrigation at tasseling on the Woodburn soil experiment definitely increased maturity (up to 4.4%), but it reduced the yield considerably. The experimental area was in corn production in 1963, and the residual fertility level may have influenced the lack of response to the light rate of nitrogen. The soil in the D_3 plots was too wet at harvest time to support satisfactory mechanical harvesting equipment, while the soil in the D_1 and D_2 plot areas was relatively dry.

Amity soil

Table 12. Average Grain Corn Yields at 15.5 Percent Moisture for Amity Soil

	Irrigation termination dates			Stand		
	D_1	D_2	D_3	S_1	S_2	Mean
Nitrogen	T/A	T/A	T/A	T/A	T/A	T/A
N_1	1.79	1.87	1.93	1.81	1.91	1.86
N_2	2.69	2.92	3.28	2.51	3.41	2.96
Stand						
S_1	2.03	2.02	2.43	----	----	----
S_2	2.44	2.79	2.77	----	----	----
Mean	2.24	2.40	2.60	2.16	2.66	----

Table 13. Average Grain Corn Percent Kernel Moisture for Amity Soil

	Irrigation termination dates			Stand		
	D_1	D_2	D_3	S_1	S_2	Mean
Nitrogen	%	%	%	%	%	%
N_1	37.9	38.6	39.6	38.5	39.0	38.7
N_2	36.6	37.4	38.3	37.2	37.7	37.4
Stand						
S_1	36.2	37.9	39.3	----	----	----
S_2	38.4	38.2	38.7	----	----	----
Mean	37.3	38.0	39.0	37.8	38.4	----

The statistical analysis of the Amity soil experiment did not show a significant difference in yield among irrigation termination dates, but the difference in maturity among treatments was significant at the 1% significance level. The response to increased nitrogen was significant at the 1% significance level for both yield and maturity. It should be noted that the yield response to nitrogen was very high. The corn was planted in an area that was in Sudan grass in 1963, and there was probably very little residual nitrogen. On the 60 pounds of nitrogen per acre treatment (N_1) the additional irrigations increased the yield 20 bushels per acre. The yield response to the N_2 nitrogen level was much greater for the high plant population than it was for the low plant population.

Although the difference in maturity among irrigation treatments was significant, the difference was very small (1.7%). The moisture content of the grain was too high for storage without being put through a dryer.

Dayton soil

Table 14. Average Grain Corn Yield at 15.5 Percent Moisture for Dayton Soil

	Irrigation termination dates		Stand		
	D_1	D_2	S_1	S_2	Mean
Nitrogen	T/A	T/A	T/A	T/A	T/A
N_1	2.42	2.55	2.38	2.59	2.48
N_2	2.50	2.73	2.55	2.68	2.62
Stand					
S_1	2.35	2.58	----	----	----
S_2	2.56	2.70	----	----	----
Mean	2.46	2.64	----	----	----

Table 15. Average Grain Corn Percent Kernel Moisture for Dayton Soil

	Irrigation termination dates			Stand		
	D_1	D_2	D_3	S_1	S_2	Mean
Nitrogen	%	%	%	%	%	%
N_1	37.9	39.1	----	38.4	38.6	38.5
N_2	38.0	39.4	----	37.8	39.7	38.7
Stand						
S_1	37.6	38.6	----	----	----	----
S_2	38.4	39.9	----	----	----	----
Mean	38.0	39.3	----	38.1	39.3	----

The D_3 treatment was not completed on the Dayton soil because the soil moisture tension did not drop low enough to require the additional irrigation. None of the treatments were statistically significant. The experimental area was in corn production the previous year, and residual nitrogen may have accounted for a higher yield on the N_1 treatment than on the Amity soil. Considering the lack of response to the increased nitrogen level (N_2), it appears that some factor other than fertility is limiting maximum yields on Dayton soil. Soil temperature may be one of these limiting factors.

Again, the kernel moisture percentages at harvest time were too high for storage without drying, but they were much lower (10%) than those measured on Dayton soil in 1963.

Experiment III

Objective: compare the maturity of several corn varieties grown for grain on Dayton soil.

During the experiments of 1962, it became obvious that the biggest problem with corn production on Dayton soil is high moisture content in the grain at harvest time. During the 1963 growing season, five varieties were grown. They were planted on May 20 and harvested on October 24. Results are shown in Table 16.

Table 16. Average Grain Yield at 15.5 Percent Moisture and Percent Kernel Moisture at Harvest on Dayton Soil.

Variety	Yield *	Kernel moisture *
	T/A	%
Nodak Hybrid 307	2.24	33.5
W-346	2.01	39.8
AES Hybrid 101 **	0.70	33.5
ORE 355	1.58	39.8
W-260	1.95	34.1
W-273	2.06	37.8

* Average of four replications.
** Poor plant populations.

Discussion

The planting of five corn varieties was considered a preliminary step in the search for varieties suitable for growing grain corn on Dayton soil. The results, although quite preliminary, must be considered encouraging. The unit moisture percentages of some varieties were quite low. It should be pointed out that the short stalks of some of the early varieties are desirable for sprinkler irrigation.

FIELD CORN FOR SILAGE

Field corn for silage experiments were conducted on Woodburn soil (Hyslop Farm) and Dayton soil (Jackson Farm). The treatments for the experiment were somewhat different on each soil. Planting dates were scheduled so that the second (D_2) and third (D_3) planting dates on Woodburn soil corresponded to the first (D_1) and second (D_2) planting dates respectively on Dayton soil. The treatments used were:

Woodburn soil:

(1) Three planting dates
D_1--planted as early as feasible
D_2--planted three weeks later than D_1
D_3--planted three weeks later than D_2

(2) Two stand levels
S_1--40,000 plants per acre
S_2--80,000 plants per acre

(3) Three nitrogen levels
N_1--100 pounds nitrogen per acre
N_2--200 pounds nitrogen per acre
N_3--300 pounds nitrogen per acre

Dayton soil:

(1) Two planting dates
D_1--planted same dates as Woodburn D_2
D_2--planted same dates as Woodburn D_3

(2) Two varieties
V_1--Oregon 150
V_2--Oregon 355

(3) Two stand levels
S_1--40,000 plants per acre
S_2--80,000 plants per acre

(4) Two nitrogen levels
N_1--100 pounds nitrogen per acre
N_2--200 pounds nitrogen per acre

All irrigations were by the sprinkler method, and irrigation water was applied to maintain the soil water tension below 1.0 bars at the one-foot depth. The corn variety planted on Woodburn soil was Oregon 150. In the Dayton soil experiment, the soil was broadcast before planting with 200 pounds per acre of muriate of potash. The objectives of the experiment were to determine yields to be obtained from corn planted at different dates and to test the responses to different management factors. Silage yield and irrigation water usage were the main measurements made. The late plantings were included as an attempt to determine the feasibility of a double-cropping system in which corn silage is grown after the harvest of a spring crop.

Table 17. Crop History Dates

Treatment	Woodburn soil	Dayton soil
Planted D_1	April 30	May 22
Planted D_2	May 23	June 13
Planted D_3	June 15	----
Applied atrazine	May 14	May 27
Sidedressed additional nitrogen	June 27	June 27
Harvested all plantings	September 16	September 17

Table 18. Irrigation Water Applied in Inches

Woodburn soil		Dayton soil	
Date	Inches	Date	Inches
May 27	0.75	May 25	0.75
June 20	0.5	June 25	0.5
June 27	1.0	July 7	1.0
July 3	1.0	July 28	3.0
July 13	1.5	August 21	1.0
July 23	1.5		
August 12	1.5		
August 18	1.5		
September 4	1.5		
Total	13.75		6.25 *

* Total may have been influenced by seepage from nearby irrigated plots.

Table 19. Yield of Corn Silage in Tons of Dry Matter per Acre and Percent Protein

Woodburn soil: Treatment	Dry matter yield*	Percent protein	Dayton soil: Treatment	Dry matter yield**	Percent protein
	T/A	%		T/A	%
D_1 S_1 N_1	6.89	6.63			
N_2	6.49	8.16			
N_3	7.02	8.17			
S_2 N_1	8.27	5.94			
N_2	8.09	6.97			
N_3	8.34	8.67			
D_2 S_1 N_1	5.32	7.42	D_1 V_1 S_1 N_1	4.41	5.33
N_2	6.21	7.97	N_2	5.80	6.76
N_3	5.85	8.50	S_2 N_1	6.12	4.40
			N_2	7.61	6.16
S_2 N_1	7.57	6.15	V_2 S_1 N_1	4.47	6.74
N_2	7.30	7.47	N_2	6.34	7.18
N_3	7.61	7.18	S_1 N_1	6.18	5.55
			N_2	7.11	5.35
D_3 S_1 N_1	5.70	6.94	D_2 V_1 S_1 N_1	3.85	6.50
N_2	5.20	9.93	N_2	4.30	7.26
N_3	6.68	8.49	S_2 N_1	4.96	4.86
			N_2	5.80	6.07
S_2 N_1	5.59	7.51	V_2 S_1 N_1	3.24	7.46
N_2	6.67	6.70	N_2	3.59	7.13
N_3	5.82	9.76	S_2 N_1	3.70	6.16
			N_2	4.65	6.92

* Average for two replications.
** Average for one replication.

Table 20. Average Yields in Tons per Acre of Dry Matter for Woodburn Soil

Planting dates	Nitrogen			Stand		Mean
	N_1	N_2	N_3	S_1	S_2	
	T/A	T/A	T/A	T/A	T/A	T/A
D_1	7.58	7.29	7.67	6.80	8.23	7.51
D_2	6.45	6.75	6.73	5.79	7.49	6.64
D_3	5.65	5.93	6.25	5.85	6.03	5.93
Mean	6.56	6.66	6.89	6.15	7.25	6.70

Table 21. Average Yield in Tons per Acre of Dry Matter for Dayton Soil

	Dates			Variety		
	D_1	D_2	Mean	V_1	V_2	Mean
Variety	T/A	T/A	T/A	T/A	T/A	T/A
V_1	6.02	4.73	5.37	----	----	----
V_2	6.03	3.79	4.91	----	----	----
Nitrogen						
N_1	5.33	3.94	4.63	4.87	4.40	4.63
N_2	6.71	4.58	5.65	5.87	5.42	5.65
Stand						
S_1	5.29	3.74	4.52	4.03	5.01	4.52
S_2	6.75	4.78	5.76	5.24	6.29	5.76
Mean	6.02	4.23	5.14	4.63	5.65	5.14

Woodburn soil

Yields on corn silage were lower in 1964 than those obtained in 1963 with the same treatments. The reason for this decrease in yield is that the silage was harvested earlier in 1964. The corn had not reached its peak dry weight. The experiment does give a comparison between treatments. The corn planted on April 30 produced 27% more dry matter than the corn planted on June 15. The yields from the June 15 planting were still quite satisfactory. Increasing stand from 40,000 to 80,000 plants per acre gave an increased yield response of 18%. Very little lodging was experienced with the high plant population. There was no significant difference between the nitrogen treatments.

Dayton soil

The response to different planting dates was much greater on Dayton soil. The yield of corn silage from the May 22 planting was 43% greater than the yield of the June 13 planting. The average yields for the 200 pounds of nitrogen per acre treatments (N_2) were equal to those of the Woodburn soil for the corresponding planting dates. The 200 pounds of nitrogen per acre treatment increased average yields 22% over the 100 pounds nitrogen per acre treatment, and the high plant population, S_2, increased average yield 27% over that of the low plant population, S_1. "Firing," which is evidence of nitrogen deficiency, appeared in the lower leaves of the plants in the N_1 treatment. This may have been influenced by the heavy forage plowed under on the experimental area before planting. The corn variety Oregon 150 had a 10% increase in yield over that of Oregon 355.

SILAGE VARIETY TRIAL

Five varieties of corn silage were planted on Dayton soil. Short growing season varieties were included as part of the research effort to determine the feasibility of a double-cropping system. The varieties were planted May 20 and harvested October 24.

Table 22. Yield of Corn Silage in Tons of Dry Matter per Acre and Percent Protein

Variety	Yield*	Protein*
	T/A	%
KC 3	7.97	8.39
Idahybrid	7.66	7.83
Oregon 150	8.67	4.75
KM 589	8.00	6.20
KM 24	5.67	6.47
Oregon 355	7.98	7.72

* Average of four replications.

The experiment was initiated as an exploratory study and yielded no conclusive information.

BUSH BEANS - IRRIGATION EXPERIMENT

Bush beans irrigation experiments were conducted to determine the interrelationships between soil moisture levels and yield for three soils in the Willamette Catena. Experiments on the Woodburn soil (Hyslop Farm) and the Amity and Dayton soils (Jackson Farm) were identical. Treatments were as follows:

Three irrigation levels

W_1--Irrigate at 2.5 bars, 1 foot depth
W_2--Irrigate at 0.8 bars, 1 foot depth
W_3--Irrigate at 0.5 bars, 1 foot depth

Two levels of nitrogen (on one variety)

N_1--50 pounds nitrogen per acre
N_2--100 pounds nitrogen per acre

Two varieties of bush beans

V_1--Gallatin 50
V_2--OSU 2065 Bush Blue Lake

A similar bush bean irrigation experiment was conducted on Chehalis soil at the OSU Vegetable Research Farm near Corvallis. Moisture levels were maintained as shown above; no differential rates of nitrogen were used; however, four varieties were used: Tendercrop, OSU 2065 Bush Blue Lake, Asgrow 274, and Gallatin 50.

Planting dates were as follows: Chehalis-June 10, Woodburn-June 10, Amity-June 11, and Dayton-June 11. Row spacing was 30 inches.

All treatments received 50 pounds of nitrogen per acre (N_1) banded at planting. This nitrogen was supplied by use of 16-20-0 fertilizer on the Chehalis and Woodburn soils and by 16-48-0 on the Amity and Dayton soils. The additional 50 pounds of nitrogen for the N_2 treatment was sidedressed in the form of ammonium nitrate.

The Amity and Dayton soils also received 150 pounds of muriate of potash (0-0-54) and 75 pounds of borated gypsum broadcast before planting. In addition, 50 pounds of potassium sulfate per acre was banded at planting.

Irrigation water was applied with part-circle sprinklers on the Woodburn, Amity, and Dayton soil experiments and with "plot irrigators" on the Chehalis soil.

Considerable difficulty was encountered in maintaining the desired moisture tension levels. There was extreme variation in the calibration curves of the commercial gypsum plugs used for measuring soil moisture tension. Use of single calibration curves led to erroneous interpretation in some cases.

Table 23. Crop History Dates

Treatment	Woodburn soil	Amity soil	Dayton soil	Chehalis soil
	Date	Date	Date	Date
Applied potash	------	May 15	May 15	------
Applied borated gypsum	------	May 15	May 15	------
Plowed experimental area	------	May 22	May 22	------
Applied Eptam, 3 pounds per acre	June 9	June 1	June 1	------
Planted	June 10	June 11	June 11	June 10
Sprayed for halo blight	July 22	July 21	July 21	------
First bloom	July 20	July 22	July 25	------
Harvested	Aug. 17	Aug. 21	Aug. 21	Aug. 15-20

Table 24. Irrigation Water Applied in Inches

Woodburn soil			
Date	W_1	W_2	W_3
	Inches		
June 18	1.0	1.0	1.0
July 2	0.8	0.8	0.8
July 6	1.5	1.5	1.5
July 12	---	---	1.8
July 16	0.5	0.5	0.5
July 20	1.5	1.5	1.5
July 23	1.5	1.5	1.5
July 24	0.5	0.5	0.5
July 28	1.8	1.8	0.8
Aug. 7	0.5	0.5	0.5
Aug. 11	---	0.8	0.8
Total	8.6	9.4	10.2

Amity soil			
Date	W_1	W_2	W_3
	Inches		
June 25	1.0	1.0	1.0
July 7	---	1.5	1.5
July 17	---	1.0	1.0
July 24	---	1.0	---
July 28	---	1.0	1.0
Aug. 5	1.0	---	---
Aug. 7	---	---	1.5
Aug. 12	0.5	0.5	0.5
Aug. 14	0.5	0.5	0.5
Aug. 19	1.0	0.8	0.8
Total	4.0	7.3	7.8

Dayton soil			
Date	W_1	W_2	W_3
	Inches		
June 24	1.0	1.0	1.0
July 2	0.5	0.5	0.5
July 6	---	1.0	1.0
July 18	---	1.0	1.0
July 30	---	---	1.0
Aug. 3	---	1.0	---
Aug. 5	---	---	1.5
Aug. 12	---	0.5	0.5
Aug. 14	---	0.5	0.5
Aug. 17	1.0	1.0	1.0
Total	2.5	6.5	8.0

Chehalis soil			
Date	W_1	W_2	W_3
	Inches		
June 29	1.0	1.0	1.0
July 6	---	---	2.9
July 8	---	1.8	---
July 10	1.8	---	---
July 17	---	---	2.3
July 21	---	2.5	---
July 27	---	---	1.5
July 28	---	2.2	---
July 29	2.2	---	---
July 31	---	---	1.4
Aug. 7	---	---	1.4
Aug. 10	---	1.4	---
Aug. 12	---	---	1.3
Total	5.0	8.9	11.8

Table 25. Yields of Bush Beans in Tons per Acre and Percent of Bush Beans Passing a Number 4 Sieve

Treatment	Chehalis Yield	Chehalis Percent of 4's	Woodburn Yield	Woodburn Percent of 4's	Amity Yield	Amity Percent of 4's	Dayton Yield	Dayton Percent of 4's
	T/A	%	T/A	%	T/A	%	T/A	%
W_1 V_1	5.14	46	4.33	61	4.40	40	2.32	48
V_2	2.95	54	4.43	42	4.50	43	2.23	34
W_2 V_1	6.07	35	4.54	53	4.29	39	4.41	39
V_2	5.54	59	5.42	51	3.80	53	3.76	39
W_3 V_1	6.80	44	5.17	47	4.26	44	4.30	44
V_2	4.70	58	5.66	51	3.82	58	3.49	42
W_1 N_1	----	--	4.33	61	4.40	40	2.32	48
N_2	----	--	4.14	62	5.20	41	2.86	40
W_2 N_1	----	--	4.54	53	4.29	39	4.41	39
N_2	----	--	4.61	62	5.67	40	4.37	36
W_3 N_1	----	--	5.17	47	4.26	44	4.30	44
N_2	----	--	5.44	42	5.52	38	4.83	38

Yields from 5 replications in tons per acre; percent sieve-size 4 and under.

Table 26. Average Yields of Bush Beans on Woodburn Soil

	Moisture level W_1	W_2	W_3	Mean
Nitrogen	T/A	T/A	T/A	T/A
N_1	4.33	4.53	5.16	4.68
N_2	4.14	4.60	5.44	4.73
Mean	4.24	4.57	5.30	4.70
Variety				
V_1	4.33	4.54	5.17	4.68
V_2	4.43	5.42	5.66	5.17
Mean	4.38	4.98	5.41	4.93

Table 27. Average Yields of Bush Beans on Amity Soil

	Moisture level			
	W_1	W_2	W_3	Mean
Nitrogen	T/A	T/A	T/A	T/A
N_1	4.46	4.29	4.26	4.33
N_2	5.20	5.67	5.52	5.46
Mean	4.83	4.98	4.89	4.90
Variety				
V_1	4.46	4.29	4.26	4.34
V_2	4.50	3.80	3.82	4.04
Mean	4.48	4.05	4.04	4.19

Table 28. Average Yields of Bush Beans on Dayton Soil

	Moisture level			
	W_1	W_2	W_3	Mean
Nitrogen	T/A	T/A	T/A	T/A
N_1	2.32	4.41	4.30	3.69
N_2	2.86	4.37	4.83	4.02
Mean	2.59	4.39	4.57	3.85
Variety				
V_1	2.32	4.41	4.30	3.68
V_2	2.23	3.76	3.49	3.16
Mean	2.27	4.08	3.90	3.42

With the exception of Amity soil, yields of bush beans at the higher levels of moisture (W_2 and W_3) were significantly greater than at the low moisture level (W_1). The 2.5 bar tension level was too dry for optimum yields. There was no significant difference between yields at the W_2 and W_3 levels. In some cases the W_2 yields were higher than those of W_3.

Because of differences in sieve-size grades of beans at harvest, yield comparisons would be more valid if all were adjusted to a common or standard sieve-size grade. Therefore, some of the difference in yield which appears in Table 28 would perhaps not be as great if harvest of all treatments and varieties could have been made at an identical maturity or grade.

When means of treatments are combined, yields were highest on the Chehalis soil, followed by Woodburn, Amity, and Dayton.

Yields of the Gallatin 50 variety in general were higher than those of OSU 2065 Bush Blue Lake. This difference was not consistent, however, since in some treatments yields of OSU 2065 were higher than yields of Gallatin 50.

Woodburn soil

Difference in yields between the three moisture level treatments was significant, with a 25% increase in yields from the W_1 treatment to the W_3 treatment. This increase was due to an additional 1.5 inches of irrigation water. The response to the additional 50 pounds of nitrogen per acre in the N_2 treatment was not significant. This increase was significant on the 1963 bush bean experiments on Woodburn soil. The level of residual nitrogen in the soil may have caused the difference in response to nitrogen in 1964 from that in 1963.

The OSU 2065 variety showed a significant 10% increase in yield over the Gallatin 50 variety. This difference was less when grades were considered. The Gallatin 50 had a higher percentage of sieve sizes 1, 2, and 3.

Amity soil

There was no significant difference in yields between the three irrigation levels. Although the W_1 treatment received only 4 inches of irrigation water, and the W_3 treatment received 8 inches, the moisture level at bloom may have been high enough on all treatments not to affect bloom set.* For this reason, yields would be nearly equal on all treatments.

The response in yield (26%) to the additional 50 pounds of nitrogen per acre in the N_2 treatment was significant at the 1% significance level.

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* Similar results were obtained in an experiment designed to study water relations in detail.

The response to the additional nitrogen was shown in the plant color and increased foliage growth.

There was no significant difference in yield between the two varieties planted. The Gallatin 50 yields were slightly higher than those of the OSU 2065 variety. The bush bean grades were very similar between the two varieties and the two levels of nitrogen.

Dayton soil

The 1964 experiment was more successful than a similar previous trial. Plant growth was quite uniform. The variation in yield was greater than that which is desired, but each of the variations can be contributed to an infection of halo bacterial blight.

A 75% difference in average yield was obtained between the W_1 and W_3 treatment. This increased response to irrigation may be attributed to the low moisture-holding capacity of Dayton soil. Yields were quite satisfactory on the W_2 and W_3 irrigation treatments, although the bean grades were higher than optimum.

The yield response to the additional 50 pounds of nitrogen per acre (N_2) was significant, although the response was not as great as it was on the Amity soil. The irrigation by nitrogen interaction was also significant at the 1% significance level.

There was no significant difference in yield between the two varieties. The Gallatin 50 yields were slightly higher than those of the OSU 2065.

Chehalis soil

Yield data indicated a significant increase in yield of bush beans at the two higher moisture levels (irrigated at 0.8 and 0.5 bars moisture tension) when compared to the low moisture level (irrigated at 2.5 bars tension). There was no significant difference in yields between the two higher moisture treatments. When yields from all irrigation treatments were combined, it was found that Gallatin 50 and Asgrow 274 yielded highest, followed by Tendercrop and OSU 2065.

These data substantiate earlier results of irrigation experiments on Chehalis soil, where highest yields were usually found when 4 to 6 irrigations supplied 8 to 10 inches of water.

BUSH BEANS - LIME-FERTILIZER EXPERIMENT

Fertilizer and lime experiments carried out during 1963 showed a marked response from lime (when applied with K), a response from K (when applied with lime), a response from P, and a response from N. Manganese toxicity was identified, from plant analyses, as an important factor affecting plant growth and the reduction of Mn content with application of lime was one of the important reasons a response from lime was observed.

Greenhouse experiments carried out during the winter showed that source of K and Cl, and application of lime were important factors affecting the uptake of manganese.

As a result of the information outlined above, an experiment was established for 1964 where the following treatments could be compared: (1) all fertilizer treatments crossed 3 rates of lime; (2) 0, 60, and 120 pounds of K_2O per acre as KCl was combined with 0, 20, and 40 pounds of sulfur per acre as $CaSO_4$ - each rate of sulfur was applied in combination with each rate of K; (3) 0, 60, and 120 pounds of K_2O per acre as K_2SO_4 was combined with 0, 45, and 90 pounds of Cl per acre as $CaCl_2$ - each rate of Cl was applied in combination with each rate of K. This made a total of 18 treatments applied across the three rates of lime that made it possible to identify the specific effects of chloride (Cl) on the uptake of manganese by beans and on the yield of beans. The eighteen treatments are listed below.

	KCl	$CaSO_4$		K_2SO_4	$CaCl_2$
1.	0	0	10.	0	0
2.	1	0	11.	1	0
3.	2	0	12.	2	0
4.	0	1	13.	0	1
5.	1	1	14.	1	1
6.	2	1	15.	2	1
7.	0	2	16.	0	2
8.	1	2	17.	1	2
9.	2	2	18.	2	2

This experiment was established adjacent to the county road running north along the boundary of the experimental area. The drainage ditch along this road provided a marked drainage differential across the experimental area. Since poor drainage increases the availability of manganese, this drainage differential had a definite effect on the growth of the beans. Therefore, the yield data from this experiment have not been included.

The following effects were evident in this experiment:

1. Application of lime increased growth.
2. Application of potassium increased growth.
3. Treatments where chloride was included (KCl or K_2SO_4 plus $CaCl_2$) resulted in poorer growth of the beans.
4. Broadcast treatments of KCl appeared to yield better than the band applications of KCl.

A second location has been selected for this experiment, where the drainage was uniform during the 1964-1965 winter. Lime treatments were applied in the fall of 1964. A combination of KCl, K_2SO_4, $CaSO_4$, $CaCl_2$ treatments similar to those applied in 1964 will be established. We hope to do a better job of evaluating these treatment effects during 1965.

BUSH BEANS GROWN ON FALL RIDGED PLOTS

An experiment was set up to compare the yields of bush beans grown on Dayton soil kept above the water table during the winter months and bush beans grown on Dayton soil in an undrained condition. Drainage was accomplished with 18-inch high "ridges," 6 feet from center to center, thrown up with contour border-discs in the fall of 1963. These ridges were constructed on randomly selected plots with four replications.

The two experimental treatments were:

(1) Two soil surface conditions maintained through the 1963-1964 winter

R--ridged in fall

A--ridges retained for planting with minimum tillage
B--ridges leveled to original surface in spring and plowed for conventional seed bed

F--flat throughout the winter

A--minimum tillage
B--plowed for conventional seed bed

(2) Two lime levels on each tillage treatment

L_1--no lime
L_2--limed at the rate of 3 tons per acre, fall 1963

The sprinkler method of irrigation was used on this experiment. Twenty-five pounds of nitrogen per acre as NH_4NO_3 was broadcast before planting and 50 pounds of nitrogen per acre as 16-20 was banded at planting time. The row spacing was 36 inches on all treatments. Seed was planted June 2 and the beans were harvested August 22. The ground was prepared May 20.

Table 29. Yields of Bush Beans in Tons per Acre*

Treatment	Yield	Treatment	Yield
	T/A		T/A
FA L_1	2.78	RA L_1	3.40
L_2	2.80	L_2	3.54
FB L_1	2.70	RB L_1	2.87
L_2	2.85	L_2	3.31

* Average for four replications.

Table 30. Average Yields of Bush Beans

	Fall treatment		
	Flat	Ridged	Mean
Spring treatment	T/A	T/A	T/A
A	2.79	3.48	3.13
B	2.78	3.09	2.93
Lime treatment			
L_1	2.74	3.14	2.94
L_2	2.83	3.43	3.13
Mean	2.78	3.28	3.03

Average bush bean yields were 18% higher on plots which were fall ridged as compared with those left in their natural surface condition in the fall. An even greater increase in average yield (25%) was recorded for the limed fall ridge plots as compared with the unlimed plots left in their natural surface condition. Although these differences in yield are quite large, none of the treatments were significant in the analysis of variance. This lack of significance is caused by the large variance within treatments. The plots had a considerable amount of halo blight which contributed to this large variance. The total average yield was less than the yield for the Dayton bush bean irrigation experiment.

Treatment differences were very evident about July 1. Plants on soil left in its natural surface condition were quite chlorotic and showed poor growth. The bush beans on the ridge plots showed good growth and vigor and there was very little evidence of chlorosis.

SELECTED POSSIBLE CROPS

Several crops which might possibly fit in cropping systems for Dayton soil areas were grown on the Glenn L. Jackson Farm to observe their development on this soil. Crop development was observed and yield measurements were made.

Peas

Peas were grown with four variables. The variables were: two planting dates and limed and unlimed areas. The first planting of peas was made with a drill on May 30 and the second planting was on June 15. Improper use of the drill resulted in a very erratic stand. Yield measurements were not made. Peas from both planting dates matured satisfactorily and a yield response from the lime was evident.

Sweet corn

Sweet corn was planted on two different dates, May 16 and June 13. Fertilizers used were 160 pounds per acre of muriate of potash (0-0-60) and 85 pounds per acre of NH_4NO_3 (33.5-0-0) broadcast before planting. Sixty pounds of nitrogen in the form of 16-48-0 was banded at planting. The plant population was 25,000 plants per acre and row spacing was 36 inches.

Yields were 4.3 tons per acre for corn planted on May 16, and 3.7 tons per acre for corn planted on June 13. The first planting was harvested on September 15, and the second planting was harvested October 10. The second planting date was too late for this area. Many of the ears did not fully develop. The yields obtained were less than those reported for the Jackson Farm in 1963. The 1963 planting was on Amity soil, and the 1964 planting was on predominantly Dayton soil. The plant population in 1964 was too high and may have reduced yields. The nitrogen level was too low.

Black dry beans

Black dry beans which had not previously been grown in this area of the Willamette Valley were planted. The beans were planted June 12 and emerged quite early. The plants were very vigorous and formed a solid crop cover with 30-inch row spacing. They were not affected by the halo blight present on the farm.

Random plots for yield measurements were cut and dried in the field. An effort was made to thrash the beans from the selected plots with a rubber rub-bar thrasher, but the beans were too dry and shattered. Thus no yield data are available. A yield estimate of 1.5 tons per acre was made.

The remainder of the beans were windrowed and thrashed with a combine. Some cracking of the beans also occurred. Development of proper dry-bean harvesting equipment will be required for future experimentation with this crop.

Sutters pink dry beans or pinto dry beans

Pinto dry beans were planted next to the black dry bean plot and managed in the same manner. Yield data were not obtained for the same reasons. The pinto beans matured early in September, about two weeks earlier than the black dry beans. Yields were estimated to be average, and the beans were of good quality.

FALL ESTABLISHMENT OF SELECTED CROPS

Flax, white clover, crimson clover, orchard grass, rape, oats and vetch, and wheat were planted in the fall of 1964. These crops were planted in large plots on Dayton soil with two replications. All plots except for the wheat received the normal seed bed preparation. The wheat plot was slightly "ridged" to provide surface drainage. The flax was planted September 10; the clovers, rape, and orchard grass were planted September 22; and the wheat and oats and vetch were planted October 17.

A good stand was obtained only with the wheat and flax. Yields from these plots will be given in the next progress report.

FORAGE LEGUMES

The forage experiment was started in the summer of 1963 to evaluate the effect of lime, fertilizer treatments, and irrigation on the production of Granger lotus and New Zealand white clover. The most important yield effects from these experiments are summarized in the following table:

Table 31. Yield of New Zealand White Clover and Granger Lotus in Pounds per Acre Dry Weight*

	Without irrigation		With irrigation	
	White clover	Lotus	White clover	Lotus
	Lbs. / A	Lbs. / A	Lbs. / A	Lbs. / A
Maximum yield	6,600	8,000	10,000	12,600
Increase from lime	1,200	1,000	1,200	1,200
Increase from potassium	600	1,200	2,000	2,500
Increase from irrigation	---	---	4,000	4,800

* Plot yields are frequently a little higher than field yields.

The yields from irrigated forage crops were excellent when the proper fertilizer was applied and successful nodulation achieved. The excellent stand and nodulation are undoubtedly major factors contributing to good yield from lotus.

The first cutting was June 1; second cutting, July 18; and third cutting, September 10. The nonirrigated plots dried up after the second cutting, so a third cutting was not possible.