# Progress of Research On Irrigation Feasibility For Dayton, Amity, Woodburn, Willamette, and Related Soils Of the Willamette Valley

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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 on 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, (3) To determine the economic feasibility of irrigation based on 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 1963. The report was prepared by the following cooperators: L. Boersma, T. L. Jackson and G. O. Klock, Soils; H. J. Mack, Horticulture; W. Calhoun, W. H. Foote and W. S. McGuire, Farm Crops; J. W. Wolfe, Agricultural Engineering; and E. N. Castle, Agricultural Economics.

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# INTRODUCTION

Future expansions of agricultural enterprises are likely to take place in the Willamette Valley. As population pressure increases, there will be an increasing demand for agricultural products raised and processed in western Oregon.

The future expansion of agricultural production will depend to a large degree on the feasibility of introducing irrigated agriculture on poorly drained soils in the Valley. At present, only a small percentage of the 1,000,000 acres of this land is irrigated, and the acreage which is irrigated is almost entirely restricted to the better-drained soils. Irrigation development has been slow on the poorly drained soils due to their physical characteristics and the success of nonirrigated farming. Interest in testing the feasibility of irrigated agriculture on poorly drained soils is not only motivated by possibilities of increased future demand, but also by the fact that there has been a reduction in grass seed prices, making non-irrigated farming less attractive.

Before any large scale development is likely to occur, the feasibility of irrigation on Willamette Valley soils must be demonstrated. Soils making up the Willamette catena include the following series in order of decreasing drainage characteristics: Willamette, Woodburn, Amity, Concord, and Dayton. These soils developed in fine alluvial-lacustrine sediments of Pleistocene age. The sediments form a broad, nearly level terrace plain across the Willamette Valley in northwestern Oregon. The soils extend over approximately 800,000 acres. Most of the area is used for production of grain, seed, and horticultural crops. The well-drained soils with no mottling above 36 inches make up the Willamette series. The moderately well-drained soils with mottling between 24 and 36 inches and with a fragipan below the $B_2$ horizon make up the Woodburn series. The imperfectly drained soils with mottling between 12 and 24 inches and commonly with fragipans below the $B_2$ horizon make up the Amity series. The poorly drained soils showing mottling within the top 12 inches and with a claypan in the upper part of the B horizon make up the Dayton series.

Knowledge of irrigation feasibility is limited on the poorer-drained series of the Willamette catena. Willamette and Woodburn soils do not have critical drainage problems, and their characteristics are such that a wide range of crops can be grown. Amity, Concord, and Dayton soils are more questionable, and more research information is needed on the feasibility of irrigation.

Water, soil, and crop management practices need to be explored for a range of crops to determine their production potential under irrigation. Poorly drained soils occur generally interspersed with better-drained soils. Therefore, the irrigation feasibility of the poorly drained soils is related to the irrigation feasibility of the better-drained soils.

Some information has been obtained on the production potential of irrigated field corn, barley, and sudan grass on these soils, but available resources have restricted the size of the program.

Recently Oregon State University has been able to make a more detailed study of the production potential of Willamette catena soils. The Agricultural Experiment Station received support for such a research program 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. The Wade Irrigation Company provided a solid-set system for one of the experiments. Fertilizer was provided by several fertilizer companies. Limestone was donated by the Portland Lime and Cement Company.

The research program was established on Dayton, Amity, and Woodburn soils with the expectation that information obtained on these soils could be extended to other members of the Willamette catena with a fair degree of reliability. The work on Woodburn soil was conducted at the Hyslop Agronomy Farm, and the work on Dayton and Amity soils was conducted on the Glenn L. Jackson farm near Lebanon. 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 for the program.

## INTERPRETATION OF EXPERIMENTAL RESULTS

This is a progress report of one year's results. It presents useful information, but results must be interpreted with caution. The same experiments conducted in different years on different sites or under slightly different climatic conditions might give different results. The land on the Jackson Farm was used for experiments of this type for the first time in the summer of 1963. Plowing and seedbed preparation were carried out later in the spring than would be possible in many seasons due to wet conditions. The land had previously been in ryegrass for a period of years. Since only limited time was available for initiating a new relatively large research program on this site, this first year it was impossible to do everything in the proper manner. Some problems developed that were not anticipated. Of course, detecting problems that might limit crop production is one of the objectives of the research. Lessons learned from this year's experience and results will aid in planning and conducting future experiments.

The 1963 late season was relatively cool. This undoubtedly affected the results obtained. Total rainfall was over 2 inches above the long-time average which delayed seedbed preparation and planting date. Temperatures during May, June, July, and August were below average. Mean temperature in June was nearly 2 degrees below average, and mean temperature in July was 4.5 degrees below average. A further indication of the coolness of the growing season is the mean maximum temperature, which was 7 degrees below average in July. Additional meterological data from the station located on the Hyslop Agronomy Farm will be given later.

Each treatment in the individual experiments was repeated or replicated three or four times. Replication provides a more reliable estimate of the real effect of a treatment on yield; it also permits a statistical analysis of data. Statistical analysis of data from an individual experiment tells the experimentalist or whoever is evaluating data whether differences in results obtained are due to real effects of the treatment, such as nitrogen or irrigation, or whether differences are likely to be due to the normal variation in yield found on all experimental sites. When it is found that one treatment, such as different levels of nitrogen, has a real affect on changing yield or some other crop quality, it is referred to as a significant effect. Where it is indicated in the report that a variable is significant at the 1 percent level, it means that, if the same identical experiment is repeated under the same identical conditions, 99 out of 100 times we would expect to obtain the same results. In other words, the odds are 99 out of 100 that there would be a real difference due to treatment and not just to soil variation and experimental error. Similarly, significance at the 5% level means that odds are 95 out of 100 that there would be real differences due to treatment. Unless reasonable size differences are obtained that are statistically significant, differences likely are due to the variation and experimental error that occur in every experiment and not to the treatment applied.

Anyone who grows crops recognizes that it takes just the right combination of all proven practices to achieve top yields. He recognizes, for example, that he will not get top yields from irrigation unless an adequate amount of nitrogen is supplied. In other words, he will get a different response in yield from irrigation on soil that is sufficiently fertilized with nitrogen than on soil that is quite deficient in nitrogen. This is referred to as an interaction between irrigation and nitrogen.

Most of the experiments were designed to study interactions between two or more important treatment effects that might affect production. Examples are irrigation, nitrogen, stand, variety, and date of planting.

When experiments are analyzed that have been designed to study interaction effects, an observation of yield data is made first. If differences are observed, a statistical analysis is then made to determine whether or not significant interactions were present. When significant interactions are present, data must be interpreted differently than if no interactions were present. In many of the experiments reported, significant interactions were obtained. Results are shown in "two-way tables". These tables are easy to read after one learns how they are organized. For example, in Table 5 on page 10, the four levels of irrigation --$W_0$, $W_1$, $W_2$, and $W_3$--are listed at the top of the table. The three levels of nitrogen, $N_1$, $N_2$, $N_3$, are listed along the left-hand side of the table. At the bottom of the table the mean yields for each of the irrigation treatments are given and along the right-hand side of the table are the mean yields of nitrogen treatments. In the upper left-hand corner of the table, the $N_1$, $W_0$ treatment yielded 0.46 tons per acre of grain. The highest yield of 2.80 tons per acre was obtained with the $N_2$, $W_3$ treatment. In studying the tables, do not place undue emphasis on small differences; these may be due to experimental error rather than to the effects of the treatment.

A progress report of one year's data does not provide a sound basis for developing recommendation practices. Accumulated knowledge over a period of years provides a much firmer basis for reaching sound decisions.

For a number of experiments it is stated that water was applied by the furrow method. This means that plot rows were ridged with level furrows between them. Water was delivered to individual furrows through a pipe manifold system. The furrows were closed with a dike at each end of the plot. This method was chosen because it offered a convenient way of applying the amount of water desired uniformly in a small plot experiment. Factors affecting the choice of this method for experimental purposes are quite different than those that a farmer would consider in choosing between sprinkler and furrow irrigation.

Where the effect of irrigation levels on crop yield was tested in the experiments, the amount of water applied at each irrigation and the time of application were controlled by the soil-moisture tension curve. Soil-moisture tension relates the force with which water is held in the soil to the amount of water present in the soil. Two tensions are of particular importance. It is generally assumed that at field capacity the amount of water present in the soil corresponds to a tension of 0.33 bars. The tension corresponding to the soil-moisture content at which plants wilt is 15.0 bars. These two tensions give a measure of the total amount of water available in the soil for plant growth. An irrigation treatment allowing the soil to dry out to a tension of 6 bars is a dryer treatment than an irrigation treatment allowing the soil to dry out to 2.0 bars. Tensions measured for the control of irrigation levels should be measured in the soil horizon where the plants are actively taking up water. In this report irrigation levels are indicated by the symbol W. $W_0$ is the nonirrigated treatment in all experiments. $W_1$ is always the lowest level of irrigation. This treatment might be characterized as follows: $W_1$ = irrigate when the soil-moisture tension is 6.0 bars at the 12-inch depth. This means that the soil is permitted to dry out to moisture content corresponding to a tension of 6.0 bars. The next level of irrigation is then characterized as follows: $W_2$ = irrigate when the soil moisture tension is 2.0 bars at the 12-inch depth. This means that the soil is permitted to dry out to the moisture content corresponding to a tension of 2.0 bars. As a result of these criteria, the $W_2$-treatment will be irrigated more frequently than the $W_1$-treatment.

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

| | May | | June | | July | | Aug. | | Sept. | | Oct. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average | 1963 | Average | 1963 | Average | 1963 | Average | 1963 | Average | 1963 | Average | 1963 |
| Mean maximum temperature (°F) | 68.80 | 66.71 | 73.44 | 70.37 | 81.31 | 74.03 | 80.9 | 78.7 | 76.8 | 77.4 | 64.7 | 64.3 |
| Mean minimum temperature (°F) | 44.95 | 44.45 | 49.34 | 48.07 | 51.88 | 50.03 | 51.4 | 51.6 | 48.9 | 51.1 | 43.4 | 43.1 |
| Mean mean | 56.86 | 55.58 | 61.42 | 59.54 | 66.66 | 62.03 | 66.2 | 65.2 | 62.8 | 64.3 | 54.3 | 53.7 |
| Number rainy days | 12 | 13 | 9 | 13 | 3 | 10 | 3 | 9 | 6 | 8 | 13 | 23 |
| Number clear days | 11 | 9 | 10 | 6 | 18 | 4 | 17 | 11 | 15 | 14 | 8 | 0 |
| Number partially clear days | 12 | 14 | 11 | 13 | 10 | 20 | 9 | 7 | 10 | 13 | 11 | 24 |
| Number cloudy days | 8 | 8 | 9 | 11 | 3 | 7 | 5 | 3 | 5 | 3 | 12 | 7 |
| Rainfall (inches) | 1.72 | 3.94 | 1.17 | 0.98 | 0.33 | 0.59 | 0.39 | 0.65 | 1.49 | 0.94 | 3.14 | 2.77 |

## FIELD CORN FOR GRAIN

Field-corn-for-grain experiments were set up on both Woodburn soil (Hyslop Farm) and Dayton soil (Jackson Farm). The experimental layout on each farm was identical. The three treatments used were:

(1) Four irrigation levels

$W_0$--no irrigation

$W_1$--irrigate at a tension of 6 bars, 6-8" below original surface.

$W_2$--irrigate at a tension of 1.5 bars, 6-8" below original surface.

$W_3$--irrigate at a tension of 0.8 bars, 6-8" below original surface.

(2) Three nitrogen levels

$N_1$--60 lbs. N/A

$N_2$--120 lbs. N/A

$N_3$--180 lbs. N/A

(3) Two stand levels

$S_1$--15,000 plants per acre

$S_2$--25,000 plants per acre, except for $W_0$ which contained 10,000 plants per acre.

Water was applied by the furrow irrigation method and water requirements were determined by use of electrical resistance units (gypsum blocks) installed in the soil.

Field corn (Oregon 355) was grown with no irrigation and with three different levels of irrigation. Three levels of nitrogen fertilization and two levels of stand were superimposed on each irrigation level, giving a total of 24 different management treatments in the experiment. Crop yields and irrigation-water usage were the primary measurements made, although other observations and measurements were made on the crop and soil.

Table 2. Crop History Dates

| Treatment | Dayton soil | Woodburn soil |
|---|---|---|
| | Date | Date |
| Applied $NH_4NO_3$ and constructed ridges | May 25 | May 17 |
| Planted seed | May 27 | May 18 |
| Applied atrazine | May 28 | May 18 |
| Thinned corn to desired stand | July 3 | June 11 |
| First evidence of wilt on $W_0$ and $W_1$ | July 22 | -- |
| Harvested grain | October 24 | October 23 |

Table 3. Irrigation Water Applied in Inches

| Date | Dayton soil | | | | Date | Woodburn soil | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $W_0$ | $W_1$ | $W_2$ | $W_3$ | | $W_0$ | $W_1$ | $W_2$ | $W_3$ |
| June 5 | .5 | .5 | .5 | .5 | May 22-23 | .75 | .75 | .75 | .75 |
| July 9 | | | | 1.0 | June 18 | | | | 1.0 |
| July 19 | | | 1.5 | 1.0 | June 21 | | | | 1.0 |
| July 27 | | | | 1.5 | July 6 | | | 1.5 | |
| July 30 | | | 1.5 | | July 12 | | | | 1.0 |
| August 6-7 | | 3.0 | | 1.5 | July 16 | | | | 1.0 |
| August 10 | | | 1.5 | 1.5 | July 20 | | | 1.5 | |
| August 13 | | | 1.5 | | July 25 | | 1.5 | 1.5 | 1.0 |
| August 16 | | | | 1.5 | July 31 | | 1.5 | 1.5 | 1.5 |
| | | | | | August 9 | | | 1.5 | 1.5 |
| | | | | | August 14-15 | | 3.0 | 3.0 | 3.0 |
| Total | .5 | 3.5 | 6.5 | 8.5 | Total | .75 | 6.75 | 11.25 | 12.75 |
| Number of irrigations | 0 | 1 | 4 | 6 | Number of irrigations | 0 | 3 | 6 | 8 |

Table 4. Yield of Grain Corn at 15.5% Moisture and Percent Kernel Moisture at Harvest

| Treatment | | | Yield* | Dayton soil Kernel moisture | Yield | Kernel moisture |
|---|---|---|---|---|---|---|
| | | | T/A | Percent | T/A | Percent |
| $W_0$ | $N_1$ | $S_1$ | 0.37 | - | 0.74 | 44.8 |
| | | $S_2$ | 0.56 | - | 0.81 | 43.9 |
| | $N_2$ | $S_1$ | 0.63 | - | 0.72 | 46.5 |
| | | $S_2$ | 0.57 | - | 0.78 | 46.5 |
| | $N_3$ | $S_1$ | 0.52 | - | 0.64 | 48.7 |
| | | $S_2$ | 0.62 | - | 0.64 | 47.3 |
| $W_1$ | $N_1$ | $S_1$ | 1.81 | 44.7 | 2.47 | 43.7 |
| | | $S_2$ | 1.69 | 48.8 | 2.59 | 45.4 |
| | $N_2$ | $S_1$ | 2.08 | 48.8 | 2.54 | 44.2 |
| | | $S_2$ | 2.10 | 48.7 | 2.97 | 44.0 |
| | $N_3$ | $S_1$ | 1.99 | 48.0 | 2.38 | 48.6 |
| | | $S_2$ | 2.04 | 49.0 | 2.69 | 44.6 |
| $W_2$ | $N_1$ | $S_1$ | 2.26 | 45.3 | 3.04 | 41.7 |
| | | $S_2$ | 1.98 | 46.0 | 3.26 | 43.4 |
| | $N_2$ | $S_1$ | 2.41 | 47.5 | 3.01 | 43.4 |
| | | $S_2$ | 2.75 | 48.8 | 3.88 | 44.4 |
| | $N_3$ | $S_1$ | 2.34 | 47.5 | 3.10 | 44.3 |
| | | $S_2$ | 2.88 | 46.9 | 3.48 | 44.9 |
| $W_3$ | $N_1$ | $S_1$ | 2.13 | 45.5 | 3.14 | 44.7 |
| | | $S_2$ | 1.98 | 45.3 | 3.22 | 42.6 |
| | $N_2$ | $S_1$ | 2.65 | 47.0 | 3.24 | 44.5 |
| | | $S_2$ | 2.96 | 46.3 | 4.22 | 43.7 |
| | $N_3$ | $S_1$ | 2.30 | 48.1 | 3.24 | 43.5 |
| | | $S_2$ | 2.86 | 48.5 | 4.02 | 44.1 |

* Average for four replications.

Table 5. Average Grain Yield at 15.5% Moisture on Dayton Soil

| Nitrogen | Irrigation $W_0$ | $W_1$ | $W_2$ | $W_3$ | Mean | Stand $S_1$ | $S_2$ | Mean |
|---|---|---|---|---|---|---|---|---|
| | T/A | T/A | T/A | T/A | T/A | T/A | T/A | T/A |
| $N_1$ | 0.46 | 1.75 | 2.12 | 2.06 | 1.60 | 1.64 | 1.55 | 1.60 |
| $N_2$ | 0.60 | 2.09 | 2.58 | 2.80 | 2.02 | 1.94 | 2.10 | 2.02 |
| $N_3$ | 0.57 | 2.02 | 2.61 | 2.58 | 1.94 | 1.79 | 2.10 | 1.94 |
| Mean | 0.54 | 1.95 | 2.44 | 2.48 | 1.85 | 1.79 | 1.92 | 1.85 |

Table 6. Average Grain Yield at 15.5% Moisture on Woodburn Soil

| Nitrogen | Irrigation $W_0$ | $W_1$ | $W_2$ | $W_3$ | Mean | Stand $S_1$ | $S_2$ | Mean |
|---|---|---|---|---|---|---|---|---|
| | T/A | T/A | T/A | T/A | T/A | T/A | T/A | T/A |
| $N_1$ | 0.78 | 2.53 | 3.15 | 3.18 | 2.41 | 2.35 | 2.47 | 2.41 |
| $N_2$ | 0.75 | 2.76 | 3.45 | 3.73 | 2.67 | 2.38 | 2.96 | 2.67 |
| $N_3$ | 0.64 | 2.53 | 3.29 | 3.63 | 2.52 | 2.34 | 2.71 | 2.52 |
| Mean | 0.72 | 2.56 | 3.29 | 3.51 | 2.53 | 2.35 | 2.71 | 2.53 |
| Stand | | | | | | | | |
| $S_1$ | 0.70 | 2.46 | 3.05 | 3.21 | 2.35 | | | |
| $S_2$ | 0.74 | 2.75 | 3.54 | 3.82 | 2.71 | | | |
| Mean | 0.72 | 2.56 | 3.29 | 3.51 | 2.53 | | | |

## DISCUSSION

### Dayton soil

Corn yields were changed significantly at the 1% level by irrigation and nitrogen variables and by the nitrogen-stand interaction, while the stand and irrigation-nitrogen interaction was significant at the 5% level. Irrigation treatments had the largest effect on yield. The lowest level of irrigation, $W_1$, had a total plot yield increase of four times over that of the nonirrigated treatment, $W_0$. Irrigation level $W_2$ produced an increase in yield over irrigation level $W_1$. Level $W_3$ increased yields over level $W_2$ only when nitrogen was at the $N_2$ level. Thus it appears that the additional effort of applying the extra 1.5 inches of water was only justified with the optimum nitrogen level. The peak of the nitrogen response curve was near the $N_2$ level. An increase in stand gave a slight increase in yield.

Yield data presented are somewhat difficult to interpret because much of the grain had not matured at the time it was harvested. This is indicated by the kernel-moisture percentages given. Further investigations of practices to speed maturity and decrease corn moisture at harvest time are needed.

Kernel-moisture samples were not taken from all of the nonirrigated plots because of difficulty in obtaining true representative samples due to low yields. With the three levels of irrigation, irrigation treatment effect upon kernel moisture was significant at the 5% level. The effect of nitrogen fertilization on kernel moisture was significant at the 1% level. Increased levels of irrigation decreased kernel moisture, and increasing level of nitrogen increased kernel moisture. The effect of nitrogen in delaying maturity has been demonstrated elsewhere. The effect of irrigation on the advancement of maturity was probably due to increased growth earlier in the season.

Nonirrigated plots had a substantial decrease in shelling percentages (data not shown). This was very evident from visual observations. Only a small percentage of the ears in these plots had a substantial amount of grain.

### Woodburn soil

Irrigation, nitrogen, stand, and nitrogen-stand and irrigation-stand interactions all had a significant effect upon grain yields at the 1%-significance level. The irrigation-nitrogen interaction was significant at the 5% level. This demonstrates that all treatments were quite effective in modifying final yields. The effect of the different levels of irrigation is clearly evident. The lowest level of irrigation, $W_1$, tripled the total plot yield over nonirrigated plots, $W_0$. Irrigation level $W_2$ gave a further increase in total plot yield over irrigation level $W_1$. Increase in yield produced by irrigation level $W_3$ was slight. The second level of nitrogen appeared to be the optimum of the levels tested. Increased stand gave increased yields.

The yield data presented are somewhat difficult to interpret because much of the grain had not matured.

Only the nonirrigated plots had a substantial decrease in shelling percentages.

## FIELD CORN FOR SILAGE

Field corn for silage experiments were set up on Dayton soil (Jackson Farm) and Woodburn soil (Hyslop Farm). Treatments for both farms were the same except that two levels of nitrogen were used on the Dayton soil and three levels on the Woodburn soil. The three treatments used were:

(1) Four planting dates

$D_1$--planted as early as feasible

$D_2$--planted 3 weeks later than $D_1$

$D_3$--planted 3 weeks later than $D_2$

$D_4$--planted 3 weeks later than $D_3$

(2) Three nitrogen levels

$N_1$--150 lbs. N/A

$N_2$--300 lbs. N/A

$N_3$--450 lbs. N/A (on Woodburn soil only)

(3) Three stand levels

$S_1$--40,000 plants per acre

$S_2$--80,000 plants per acre

$S_3$--120,000 plants per acre

All irrigating was done by the sprinkler method. The corn variety planted was Oregon 150. The corn was planted on four different dates, irrigated as uniformly as possible, and harvested for silage. Three different stand levels and three rates of nitrogen fertilization on the Woodburn soil were used for each date of planting. 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 7. Crop History Dates

| Treatment | Dayton soil Date | Woodburn soil Date |
|---|---|---|
| Planted $D_1$ | May 24 | May 16 |
| Applied $NH_4NO_3$ on $D_1$ | May 28-29 | May 17 |
| Applied atrazine on $D_1$ | May 28-29 | May 18 |
| Planted $D_2$ | June 14 | June 8 |
| Applied $NH_4NO_3$ on $D_2$ | June 14 | June 10 |
| Applied atrazine on $D_2$ | June 14 | June 11 |
| Planted and applied $NH_4NO_3$ and atrazine on $D_3$ | July 5 | July 1 |
| Planted and applied $NH_4NO_3$ and atrazine on $D_4$ | July 26 | July 19 |

Table 8. Irrigation Water Applied in Inches

| | Dayton soil | | | | | Woodburn soil | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Date | $D_1$ | $D_2$ | $D_3$ | $D_4$ |
| June 4 | .5 | .5 | | | May 31 | .75 | .75 | | |
| June 14 | 1.0 | 1.0 | | | June 13 | .75 | .75 | | |
| July 16 | | | 1.0 | 1.0 | June 22 | 1.0 | 1.0 | | |
| July 24 | 1.5 | 1.5 | | | July 1 | | | 1.0 | 1.0 |
| July 26 | | | 1.0 | 1.0 | July 16 | 2.0 | 2.0 | | |
| July 31 | 2.0 | 2.0 | | | July 19 | | | 1.0 | 1.0 |
| August 15 | 2.0 | 2.0 | 2.0 | 2.0 | July 24 | | | 1.0 | 1.0 |
| | | | | | July 28 | 1.5 | 1.5 | | |
| | | | | | August 8 | | | 1.5 | 1.5 |
| | | | | | August 9 | 2.0 | 2.0 | | |
| | | | | | August 20 | 3.0 | 3.0 | | |
| Total | 7.0 | 7.0 | 4.0 | 4.0 | Total | 11.0 | 11.0 | 4.5 | 4.5 |
| Number of irrigations | 4 | 4 | 3 | 3 | Number of irrigations | 5 | 5 | 4 | 4 |

Table 9. Yield of Corn Silage in Tons of Dry Matter per Acre and Percent Dry Matter

| Dayton soil Treatment | Dry matter yield T/A | Dry matter percent | Woodburn soil Treatment | Dry matter yield T/A | Dry matter percent |
|---|---|---|---|---|---|
| $D_1$ $S_1$ $N_1$ | 7.24 | 26.9 | $D_1$ $S_1$ $N_0$ | 8.55 | |
| $N_2$ | 10.09 | 31.8 | $N_1$ | 11.72 | 29.7 |
| | | | $N_2$ | 12.07 | 26.9 |
| | | | $N_3$ | 10.04 | 24.7 |
| $S_2$ $N_1$ | 9.47 | 28.8 | $S_2$ $N_1$ | 11.05 | 25.2 |
| $N_2$ | 10.03 | 28.6 | $N_2$ | 10.00 | 21.8 |
| | | | $N_3$ | 10.29 | 20.7 |
| $S_3$ $N_1$ | 11.21 | 31.6 | $S_3$ $N_1$ | 9.91 | 21.8 |
| $N_2$ | 11.96 | 32.2 | $N_2$ | 10.11 | 24.1 |
| | | | $N_3$ | 10.24 | 22.8 |
| $D_2$ $S_1$ $N_1$ | 7.56 | 31.2 | $D_2$ $S_1$ $N_0$ | 6.62 | |
| $N_2$ | 8.74 | 32.6 | $N_1$ | 7.15 | 21.2 |
| | | | $N_2$ | 7.84 | 24.1 |
| | | | $N_3$ | 6.43 | 22.2 |
| $S_2$ $N_1$ | 8.86 | 29.2 | $S_2$ $N_1$ | 8.00 | 21.1 |
| $N_2$ | 9.98 | 32.3 | $N_2$ | 10.07 | 21.0 |
| | | | $N_3$ | 7.62 | 17.0 |
| $S_3$ $N_1$ | 10.06 | 30.6 | $S_3$ $N_1$ | 10.00 | 21.8 |
| $N_2$ | 9.63 | 28.9 | $N_2$ | 9.31 | 19.5 |
| | | | $N_3$ | 11.18 | 24.0 |
| $D_3$ $S_1$ $N_1$ | 2.36 | 18.3 | $D_3$ $S_1$ $N_0$ | 5.95 | |
| $N_2$ | 1.98 | 16.5 | $N_1$ | 4.52 | 20.6 |
| | | | $N_2$ | 6.66 | 31.2 |
| | | | $N_3$ | 5.66 | 25.2 |
| $S_2$ $N_1$ | 2.80 | 16.6 | $S_2$ $N_1$ | 5.92 | 21.7 |
| $N_2$ | 3.63 | 19.4 | $N_2$ | 7.22 | 24.6 |
| | | | $N_3$ | 6.55 | 22.9 |
| $S_3$ $N_1$ | 2.80 | 14.8 | $S_3$ $N_1$ | 5.70 | 18.3 |
| $N_2$ | 3.71 | 21.3 | $N_2$ | 7.55 | 24.6 |
| | | | $N_3$ | 6.46 | 19.9 |

Table 9. (Continued)

| Treatment | Dayton soil Dry matter yield T/A | Dayton soil Dry matter percent | Treatment | Woodburn soil Dry matter yield T/A | Woodburn soil Dry matter percent |
|---|---|---|---|---|---|
| $D_4$ $S_1$ $N_1$ | 1.36 | 16.7 | $D_4$ $S_1$ $N_0$ | 3.59 | |
| $N_2$ | 1.35 | 18.5 | $N_1$ | 3.48 | 18.6 |
| | | | $N_2$ | 2.34 | 14.1 |
| | | | $N_3$ | 3.63 | 22.9 |
| $S_2$ $N_1$ | 1.56 | 15.1 | $S_2$ $N_1$ | 2.90 | 16.9 |
| $N_2$ | 1.35 | 15.7 | $N_2$ | 3.50 | 17.1 |
| | | | $N_3$ | 4.79 | 23.5 |
| $S_3$ $N_1$ | 1.97 | 16.8 | $S_3$ $N_1$ | 3.99 | 15.1 |
| $N_2$ | 1.54 | 14.5 | $N_2$ | 4.72 | 20.6 |
| | | | $N_3$ | 3.90 | 18.6 |

Table 10. Average Yields of Dry Matter for Dayton Soil

| Planting dates | Stand $S_1$ | $S_2$ | $S_3$ | Mean | Nitrogen $N_1$ | $N_2$ | Mean |
|---|---|---|---|---|---|---|---|
| $D_1$ | 8.67 | 9.79 | 11.59 | 10.01 | 9.30 | 10.71 | 10.01 |
| $D_2$ | 8.15 | 8.92 | 9.85 | 8.97 | 8.83 | 9.12 | 8.97 |
| $D_3$ | 2.16 | 3.21 | 3.25 | 2.87 | 2.65 | 3.10 | 2.87 |
| $D_4$ | 1.35 | 1.45 | 1.75 | 1.51 | 1.63 | 1.41 | 1.51 |
| Mean | 5.08 | 5.84 | 6.61 | 5.84 | 5.60 | 6.10 | 5.84 |
| Nitrogen | | | | | | | |
| $N_1$ | 4.63 | 5.67 | 6.50 | 5.60 | | | |
| $N_2$ | 5.54 | 6.02 | 6.72 | 6.10 | | | |
| Mean | 5.08 | 5.84 | 6.61 | 5.84 | | | |

Table 11. Average Yield of Dry Matter for Woodburn Soil

| Planting dates | $S_1$ | $S_2$ | $S_3$ | Mean |
|---|---|---|---|---|
| $D_1$ | 11.27 | 10.45 | 10.09 | 10.60 |
| $D_2$ | 7.13 | 8.57 | 10.16 | 8.62 |
| $D_3$ | 5.63 | 6.59 | 6.57 | 6.26 |
| $D_4$ | 3.16 | 3.85 | 4.34 | 3.78 |
| Mean | 6.79 | 7.37 | 7.79 | 7.31 |

Table 12. Average Dry Matter Percentages for Dayton Soil

| Planting dates | Stand $S_1$ | $S_2$ | $S_3$ | Mean |
|---|---|---|---|---|
| $D_1$ | 29.3 | 28.7 | 31.9 | 30.0 |
| $D_2$ | 31.9 | 30.7 | 29.7 | 30.8 |
| $D_3$ | 17.4 | 18.1 | 18.0 | 17.8 |
| $D_4$ | 17.6 | 15.4 | 15.6 | 16.2 |
| Mean | 24.1 | 23.2 | 23.8 | 23.7 |
| Nitrogen | | | | |
| $N_1$ | 23.2 | 22.4 | 23.5 | 23.0 |
| $N_2$ | 24.9 | 24.0 | 24.2 | 24.3 |
| Mean | 24.1 | 23.2 | 23.8 | 23.7 |

Table 13. Average Dry Matter Percentages for Woodburn Soil

| Planting dates | Stand $S_1$ | $S_2$ | $S_3$ | Mean |
|---|---|---|---|---|
| $D_1$ | 27.1 | 22.6 | 22.9 | 24.2 |
| $D_2$ | 22.5 | 19.7 | 21.8 | 21.3 |
| $D_3$ | 25.6 | 23.1 | 20.9 | 23.2 |
| $D_4$ | 18.5 | 19.2 | 18.1 | 18.6 |
| Mean | 23.5 | 21.1 | 20.9 | 21.8 |
| Nitrogen | | | | |
| $N_1$ | 22.6 | 21.2 | 19.3 | 21.0 |
| $N_2$ | 24.1 | 21.1 | 22.2 | 22.5 |
| $N_3$ | 23.7 | 21.0 | 21.3 | 22.0 |
| Mean | 23.5 | 21.1 | 20.9 | 21.8 |

# DISCUSSION

## Dayton soil

The most significant result shown by this experiment was that corn planted after June 15 did not give satisfactory yields. Yields of silage from corn planted on July 5 and July 27 dropped to approximately 30% and 17%, respectively, of yields obtained with the June 14 planting. This year's results suggest that a double-cropping system is not feasible on this soil type with corn varieties presently used in the Willamette Valley. The increase in stand produced a significant increase in yield.

Dry-matter percentages of silage planted July 5 and July 26 were much lower than those of earlier plantings. This is evidence of the immaturity of the crop. Nitrogen and stand treatments did not have any significant effect on dry-matter content. However, individual treatment data do indicate the possibility of a second-order interaction with nitrogen and date. While this effect was not significant, it is probably worth noting that yield increases of 10% were realized from nitrogen with the first planting, whereas the same rate of nitrogen produced a slight decrease with the last planting.

## Woodburn soil

Treatments on Woodburn soil were the same as on Dayton soil other than the one additional nitrogen level.

Again, corn planted for silage after June 15 did not produce the yields obtained with earlier planting dates. The difference was not as pronounced as that on Dayton soil. This indicates that using a double-cropping system on this soil type may be promising. However, a study of the economics of this system is needed to evaluate its potential value.

Stand treatments were significant at the 5% level with increasing stand giving greater yields on the second, third, and fourth planting dates. But the highest yields were produced with the lowest stand on the first planting date. The date x stand interaction was significant.

Applications of 300 and 450 pounds of nitrogen per acre did not increase yields significantly above those obtained with the 150 pound rate. The first increment of nitrogen did produce a significant increase in yield on the first planting date.

The first planting date in combination with the lowest stand was the only treatment which produced ears that were of about optimum maturity for silage.

## BUSH BEANS

A bush bean irrigation experiment was initiated on both Dayton soil and Woodburn soil. Treatments were the same on both soils. The two treatments used were:

(1) Four irrigation levels

$W_1$--irrigate at 2.5 bars, 1 foot below top of ridge

$W_2$--irrigate at 1.5 bars, 1 foot below top of ridge

$W_3$--irrigate at 0.8 bars, 1 foot below top of ridge

$W_4$--irrigate at 0.5 bars, 1 foot below top of ridge

(2) Two nitrogen levels

$N_1$-- 50 lbs. N/A

$N_2$--100 lbs. N/A

Irrigation water was applied by the furrow-irrigation method. The bean variety planted was Tendercrop.

Table 14. Crop History Dates

| Treatment | Dayton soil Date | Woodburn soil Date |
|---|---|---|
| Applied Eptam 3 lbs./acre | May 28 | May 31 |
| Applied $NH_4NO_3$ to $N_2$ plots and ridged | May 31 | |
| Applied $NH_4NO_3$ | | June 1 |
| Planted with 300 lbs. 16-20-0 per acre in row | June 3 | June 3 |
| Harvested reps 2, 3, and 4 | | August 16 |
| Harvested rep 1 | | August 17 |
| Harvested all reps | August 22 | |

Table 15. Irrigation Water Applied in Inches

| | Dayton soil | | | | | Woodburn soil | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | $W_1$ | $W_2$ | $W_3$ | $W_4$ | Date | $W_1$ | $W_2$ | $W_3$ | $W_4$ |
| June 18 | 1.0 | 1.0 | 1.0 | 1.0 | June 3 | .75 | .75 | .75 | .75 |
| July 9 | | | | 1.0 | June 12 | .75 | .75 | .75 | .75 |
| July 17 | | | 1.0 | | July 2 | | | 1.0 | 1.0 |
| July 20 | | | | 1.0 | July 5 | | | | 1.0 |
| July 23 | | 1.0 | | 1.0 | July 12 | | 1.5 | 1.0 | 1.0 |
| July 27 | | | 1.5 | | July 16 | | | | 1.0 |
| July 30 | 1.5 | 1.5 | | 1.5 | July 20 | | | 1.0 | 1.0 |
| August 2 | | | 1.5 | 1.5 | July 25 | 1.5 | 1.5 | 1.5 | 1.5 |
| August 6 | 1.5 | | | | July 31 | 1.5 | 1.5 | 1.0 | 1.0 |
| August 10 | | 1.5 | 1.5 | 1.5 | August 6 | | | 1.5 | 1.5 |
| August 16 | 1.5 | 1.5 | 1.5 | 1.5 | August 9 | 1.5 | 1.5 | 1.5 | 1.5 |
| Total | 5.5 | 6.5 | 8.0 | 10.0 | Total | 6.0 | 7.5 | 10.0 | 12.0 |
| Number of irrigations | 3 | 4 | 5 | 7 | Number of irrigations | 4 | 5 | 8 | 10 |

Table 16. Yields of Bush Beans in Tons per Acre on Dayton Soil

| Treatment | | Replication 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| | | T/A | T/A | T/A | T/A |
| $W_1$ | $N_1$ | 3.48 | 1.66 | 0.58 | 0.96 |
| | $N_2$ | 3.78 | 1.64 | 3.31 | 0.14 |
| $W_2$ | $N_1$ | 0.14 | 4.43 | 5.44 | 1.64 |
| | $N_2$ | 3.22 | 5.40 | 1.47 | 1.31 |
| $W_3$ | $N_1$ | 4.52 | 3.92 | 4.65 | 0.65 |
| | $N_2$ | 0.29 | 6.19 | 0.14 | 2.70 |
| $W_4$ | $N_1$ | 2.00 | 4.14 | 2.83 | 1.52 |
| | $N_2$ | 1.38 | 5.30 | 4.04 | 3.05 |

Table 17. Yields of Bush Beans in Tons per Acre on Woodburn Soil

| Treatment | | Replication 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| $W_1$ | $N_1$ | 3.40 | 3.25 | 3.37 | 2.79 |
| | $N_2$ | 2.83 | 2.74 | 3.69 | 3.41 |
| $W_2$ | $N_1$ | 3.93 | 4.12 | 3.06 | 3.25 |
| | $N_2$ | 3.12 | 4.83 | 3.34 | 3.72 |
| $W_3$ | $N_1$ | 5.23 | 3.92 | 3.77 | 4.24 |
| | $N_2$ | 5.95 | 5.79 | 5.47 | 4.98 |
| $W_4$ | $N_1$ | 5.75 | 4.21 | 4.83 | 3.99 |
| | $N_2$ | 5.43 | 6.33 | 6.33 | 4.98 |

Table 18. Average Yields of Bush Beans on Woodburn Soil

| Nitrogen | Irrigation $W_1$ | $W_2$ | $W_3$ | $W_4$ | Mean |
|---|---|---|---|---|---|
| | T/A | T/A | T/A | T/A | T/A |
| $N_1$ | 3.20 | 3.59 | 4.29 | 4.69 | 3.94 |
| $N_2$ | 3.17 | 3.75 | 5.55 | 5.77 | 4.56 |
| Mean | 3.19 | 3.67 | 4.92 | 5.23 | 4.25 |

Table 19. Summary of Percent of Beans Passing Indicated Sieve Sizes for Woodburn Soil

| Treatment | | Size 1-4 Percent | Size 5-7 Percent | Treatment | Size 1-4 Percent |
|---|---|---|---|---|---|
| $W_1$ | $N_1$ | 66 | 34 | $W_1$ | 64 |
| | $N_2$ | 63 | 37 | | |
| $W_2$ | $N_1$ | 65 | 35 | $W_2$ | 62 |
| | $N_2$ | 59 | 41 | | |
| $W_3$ | $N_1$ | 71 | 29 | $W_3$ | 68 |
| | $N_2$ | 66 | 34 | | |
| $W_4$ | $N_1$ | 73 | 27 | $W_4$ | 71 |
| | $N_2$ | 69 | 31 | | |
| | | | | $N_1$ | 69 |
| | | | | $N_2$ | 64 |

# DISCUSSION

## Dayton soil

Bush beans were grown under four different irrigation levels. Two levels of nitrogen fertilization were used for each irrigation level, giving a total of eight different management treatments. Bean yeilds and irrigation water usage were the main measurements.

A test of significance among treatments was not made on yields because of the extreme variance among replications. This was due to the poor and erratic early growth of the bean seedlings. At about one week after emergence, primary leaves of beans were chlorotic, and these abnormal foliage symptoms were also present later in the trifoliate leaves. In an area which included plots from replications 1 and 3 near the center of the irrigation experiment, this condition of abnormal growth was most severe. Although improved over earlier conditions, plants never showed good growth and vigor even at the end of the experiment at harvest (where the condition was so severe earlier). Yield of pods was the lowest from these plots regardless of irrigation and nitrogen levels. Yields were the highest in plots in replication 2 which appeared to be less affected by poor early growth. Subsequent observations have suggested that manganese toxicity may have been a contributing factor in causing chlorosis and poor growth of the bean plants.

Because of erratic growth and extreme variation in yield, very little useful information on the effects of irrigation and nitrogen levels on yield was gained from this experiment.

## Woodburn soil

A much more homogeneous yield among replications was obtained on Woodburn soil than with the beans on Dayton soil. The analysis of variance showed both irrigation and nitrogen to be significant.

Yields were increased as the number of irrigations and amount of water were increased. Average yield of the $W_4$ irrigation level was approximately 2 tons per acre, or 63% higher than yield of the $W_1$ irrigation level. A higher percentage of sieve size 1-4 pods were produced at the $W_3$ and $W_4$ moisture levels than at $W_1$ and $W_2$, indicating that at higher moisture tensions there was an acceleration of maturity. Limited observations from only one replication showed that number of pods per plant was highest in the $W_4$ irrigation level.

Yield from the 100 lb.-N rate was significantly higher than from the 50 lb.-N rate, averaging approximately 0.6 tons per acre higher, when all irrigation levels were combined. Although the irrigation x nitrogen interaction was not significant, the 100 lb.N-rate increased yields more at $W_3$ and $W_4$ than at $W_1$ and $W_2$ irrigation levels. At the 50 lb.-N rate a higher percentage sieve size of 1-4 pods were produced than at the 100 lb.N-rate.

## A COMPARISON OF SPRINKLER IRRIGATION WITH LEVEL-FURROW IRRIGATION

An experiment was set up to compare sprinkler irrigation with furrow irrigation on Dayton soil. The test crop was bush beans. Both the sprinkler and furrow plots were irrigated on the same day with the same amount of water. Both treatments were irrigated at 0.8 bars at one-foot depth. The Tendercrop variety was planted.

Table 20. Crop History Dates

| Treatment | Date |
|---|---|
| Applied Eptam | May 28 |
| Ridged ½ of the plots | May 31 |
| Planted beans with 300 lbs/A of 16-20-0 banded in the row | June 3 |
| Harvested beans | August 22 |

Table 21. Yield of Bush Beans in Tons per Acre

| Treatment | Replications | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Mean |
| | T/A | T/A | T/A | T/A | |
| Furrow | 6.65 | 6.49 | 6.05 | 5.90 | 6.27 |
| Sprinkler | 6.39 | 6.96 | 6.41 | 5.78 | 6.39 |

## DISCUSSION

Under the conditions of this test there was no significant difference in yield of beans between the two methods of irrigation, ridged furrow and level sprinkler. A slightly higher percentage of smaller sieve pods was obtained from the sprinkler method than from the ridged-furrow method, suggesting that sprinkler irrigation may have modified (lowered) temperatures to delay maturity slightly.

Because of a conflict in scheduling the picking crew, beans were harvested when slightly past optimum maturity for best grades and dollar returns. With this delay in harvesting, it is estimated that total yields would be 1.5 to 2.0 tons less than shown in the preceding tables, if harvested at about "ideal" maturity.

On the basis of this one-year test, use of furrow irrigation for experimental plots appears to be feasible, and results on yields of beans appear to be comparable to those from sprinkler-irrigation treatments. However, to extrapolate these results to larger experimental plots or larger acreages on this and other soil types would need further study.

## BUSH BEANS - FERTILITY EXPERIMENT

A fertility experiment with bush beans was initiated on Dayton soil on the Jackson Farm. All plots were irrigated at 0.8 bars at 1 foot. The different treatments tested are listed in the yield tables.

Table 22. Crop History Data

| Treatment | Date |
|---|---|
| Applied Eptam | May 25 |
| Applied lime treatment | May 27 |
| Planted the beans | June 6 |
| Harvested the beans | August 22 |

Table 23. Irrigation Water Applied in Inches

| Date | Amount |
|---|---|
| June 20 | .75 |
| July 16 | 1.0 |
| July 27 | 1.5 |
| August 2 | 1.5 |
| August 12 | 1.5 |
| August 20 | 1.0 |
| Total | 7.25 |

Table 24. Yields of Bush Beans in Tons per Acre and Percent of Beans Passing a Number 4 Sieve

| Treatment* | | Yield | Beans passing No. 4 sieve |
|---|---|---|---|
| | | T/A | Percent |
| 1. $N_1P_2$ | $L_0$ | 5.94* | 28.1 |
| | $L_3$ | 3.61 | 33.4 |
| 2. $N_1P_2K_1$ | $L_0$ | 2.61 | 31.5 |
| | $L_3$ | 7.02 | 30.4 |
| 3. $N_1P_2K_2$ | $L_0$ | 2.05 | 43.8 |
| | $L_3$ | 6.17 | 30.0 |
| 4. $N_1P_2K_2Zn$ | $L_0$ | 1.64 | 36.5 |
| | $L_3$ | 5.23 | 22.4 |
| 5. $N_1P_2K_2Mg$ | $L_0$ | 2.33 | 36.1 |
| | $L_3$ | 6.33 | 32.0 |
| 6. $N_1P_2K_2ZnMg$ | $L_0$ | 2.13 | 34.5 |
| | $L_3$ | 6.10 | 29.8 |
| 7. $N_1P_2K_1Mg$ | $L_0$ | 2.95 | 34.1 |
| | $L_3$ | 7.51 | 29.7 |
| 8. $N_1K_2$ | $L_0$ | 2.61 | 33.4 |
| | $L_3$ | 5.38 | 33.6 |
| 9. $N_1P_1K_2$ | $L_0$ | 2.46 | 34.9 |
| | $L_3$ | 6.02 | 33.3 |
| 10. $N_2P_2K_2$ | $L_0$ | 4.71 | 27.3 |
| | $L_3$ | 7.94 | 31.1 |
| 11. $N_2P_1K_2$ | $L_0$ | 4.41 | 26.5 |
| | $L_3$ | 6.10 | 28.2 |

$N_1$, $N_2$ = 50, 100 lbs. N/A; 50 lbs. N banded at planting as $(NH_4)_2SO_4$; the second increment of N was broadcast as $NH_4NO_3$; $P_1$, $P_2$ = 60, 120 lbs. $P_2O_5$/A as conc. super; $K_1$, $K_2$ = 60, 120 lbs. $K_2O$/A as K Cl; Zn = 5 lbs. Zn/A, Mg. = 15 lbs. Mg/A, Zn & Mg as sulfates; $L_3$ = 3 T lime/A broadcast 10 days before planting (May 26).

50 lbs. N plus all P, K, Zn, Mg was banded about 2 inches to the side and 2 inches below the seed at planting.

Table 25. Average Yields of Bush Beans

| Treatment | | Fertilizer variable 0 | Zn | Mg | Zn Mg |
|---|---|---|---|---|---|
| | | T/A | T/A | T/A | T/A |
| $N_1P_2K_2$ | $L_0$ | 2.05 | 1.64 | 2.33 | 2.13 |
| | $L_3$ | 6.17 | 5.23 | 6.33 | 6.10 |
| | | $K_0$ | $K_1$ | $K_2$ | |
| $N_1P_1$ | $L_0$ | 5.94 | 2.61 | 2.05 | |
| | $L_3$ | 3.61 | 7.02 | 6.17 | |
| | | $P_0$ | $P_1$ | $P_2$ | |
| $N_1K_2$ | $L_0$ | 2.61 | 2.46 | 2.05 | |
| | $L_3$ | 5.38 | 6.02 | 6.17 | |
| | | $N_1$ | $N_2$ | | |
| $P_2K_2L$ | $L_0$ | 2.05 | 4.71 | | |
| | $L_3$ | 6.17 | 7.94 | | |

## DISCUSSION

Introduction of new crops such as bush beans, sweet corn, field corn, and others on Dayton soils makes it necessary to evaluate the fertility requirements of these crops on poorly drained soils. Chemical analyses of the soil indicated that fertility problems would be encountered that are not normally found on better-drained soils where these crops are grown in the Willamette Valley.

The following soil analyses values were found on the location where this experiment was established: pH - 4.9, P - 20 lb./A, K - 0.11 me/100g, Ca - 2.6 me/100g, Mg - 1.4 me/100g, C.E.C. - 13.0 me/100g, Boron - 0.7 ppm. These soil analyses indicate an extremely acid condition, moderate phosphorus levels, low potassium levels, and adequate levels of magnesium.

The fertility experiment was established using Tendercrop bush beans. Four replications were used with each replication being split with a 3 T/A application of hydrated lime 10 days before planting. Eleven fertilizer treatments were then randomized in each replication so that the fertilizer treatments crossed both lime treatments in one continuous strip.

Table 22 gives fertilizer treatments applied, yield of beans harvested, and sieve sizes of samples graded. Optimum soil moisture was maintained throughout the experiment with a solid-set sprinkler system. Eptam was applied 12 days before planting to control weeds. An excellent stand of beans was obtained on all plots and the seedlings appeared to have good vigor until 3 weeks after planting. At this time a chlorotic appearance developed on all treatments, and all plants appeared to be severely affected until about 7 weeks after planting.

A response to lime became apparent across all fertilizer treatments. The limed plots were the first ones to start looking normal. Potassium application seemed to increase the severity of the problem in seedling stages. The added rate of nitrogen and phosphorus appeared to alleviate the problem t o some extent.

By harvest time there were marked K deficiency symptoms on all plots with no K added. Response to N, K, and lime were very evident.

These plots were planted June 6 and hand picked on August 22. This was 3 to 4 days past the optimum stage of maturity and accounts for the high percentage of over mature beans noted in the samples graded. Over maturity, which could not have been avoided because of a scheduling conflict with the picking crew, probably added 1.5 to 2 tons to the yield on this experiment.

The following statistically significant differences undoubtedly would have been significant regardless of harvest date:

1. There was a 50% increase in yield from lime with a marked lime-potassium interaction.

   In the absence of K, limed reduced yields.

   In the absence of lime, K reduced yields.

   Lime and K together increased yields.

2. In general, lime hastened maturity.

3. Phosphorus increased yields in the presence of lime, but decreased yields, or had little effect, in the absence of lime.

4. Zn decreased yields. This decrease in yield was consistent with or without both lime and Mg.

5. Increasing the rate of N from 50 to 100 pounds of N/A increased yields with a bigger increase in yield in the absence of lime; the lime x N interaction was significant.

6. Zn hastened maturity. This would mean that the decrease in yield from Zn was greater than the harvested yield data actually showed.

Chemical analyses are being carried out on plant samples from this experiment. These will be summarized and distributed to cooperators later. Analyses on recently matured leaves taken at flowering time show Mn values in excess of 1,000 ppm. on plots without lime. Application of lime reduced the Mn content to about 40% of the lime zero values.

## FORAGE LEGUMES

An experiment was established to evaluate the effect of irrigation and fertilizer treatments on the production of forage legumes on Dayton soils.

This experiment was established as a series of strip plots with four replications.

First main plots -- irrigation treatments.

Second main plots -- legume species.

Third main plots -- lime treatments.

All fertilizer treatments cross both rates of lime and are on both legumes -- Granger lotus and New Zealand white clover. Four observational plots were seeded to alsike and strawberry clover.

| Irrigated plots* | Nonirrigated plots |
|---|---|
| 1. $P_0K_2Mo_1$ | 1. $P_0K_0Mo_1$ |
| 2. $P_1K_2Mo_1$ | 2. $P_0K_2Mo_1$ |
| 3. $P_2K_2Mo_1$ | 3. $P_2K_2Mo_1$ |
| 4. $P_2K_1Mo_1$ | 4. $P_2L_1Mo_1$ |
| 5. $P_2K_0Mo_1$ | 5. $P_2K_0Mo_1$ |
| 6. $P_0K_0Mo_1$ | |
| 7. $P_2K_2Mo_0$ | |
| 8. $P_2K_2Mo_2$ | |

The fertilizer treatments were as follows: $P_1$, $P_2$ = 40, 80 lbs. $P_2O_5$/A; $K_1$, $K_2$ = 60, 120 lbs. $K_2O$/A; $Mo_1$, $Mo_2$ = 0.4, 0.8 lbs. Mo/A; 40 lbs. S/A on all plots' 2 lbs. B/A on all plots.

## DISCUSSION

The seedbed was prepared and lime and Eptam were applied during the first week of June. The legume species were seeded on June 10 in 7 x 25 foot plots using a 7-inch drill spacing. $P_1$, $K_1$ was band applied at planting time on all plots scheduled to receive P and K.

A poor stand was obtained, especially on the nonlimed plots. This made it necessary to reseed the plots in July. Sprinkler irrigation was uniformly applied to all plots during the summer of 1963 to ensure the best establishment of all legumes.

Plots were clipped in early September, and alta fescue was seeded at right angles to the legume plots.

Phosphorus and potassium treatments will be applied in March. The plots will be harvested throughout the season with a forage-plot harvester. Irrigation will probably be applied with a sprinkler system using part-circle sprinklers.

## SELECTED POSSIBLE CROPS

Crops which appear as possibilities for Dayton soil areas were grown on the Glen L. Jackson Farm to observe their behavior. Observations were made of crop development and yield measurements were made. The crops tested were peas, sweet corn, soybeans, and Sudangrass.

### Peas

An experiment was set up next to the bush bean fertility experiment. This experiment was designed to give information concerning optimum yield of peas with adequate fertilization and good management. Variables included in the experiment were lime, phosphorus, and potassium. The peas were planted on June 6 in rows spaced one foot apart. The fertilizer was banded beside the seed at the rates indicated below.

The following treatments were used with each treatment duplicated on lime and unlimed plots with four replications: (1) $N_1P_2K_2$; (2) $N_1P_2$; and (3) $N_1K_2$. A split plot design was used. $N_1$ was at the rate of 100 pounds per acre of ammonium sulfate. $P_2$ was 120 pounds of $P_2O_5$ per acre in concentrated super phosphate and $K_2$ was 120 pounds of $K_2O$ per acre. Three tons per acre of lime was used.

## EXPERIMENTAL RESULTS

Average results of the four replications for yield, shelling percentages, and tenderometer readings are given in the two-way tables following the analysis of variance.

A second crop of peas was planted just after July 4 and matured in October, but they did not fill out uniformly. No yield data were recorded.

Table 25. Yields of Peas

| Treatment | Unlimed | Limed | Means |
|---|---|---|---|
| | T/A | T/A | T/A |
| $N_1P_2$ | 1.90 | 2.45 | 2.17 |
| $N_1K_2$ | 1.50 | 1.81 | 1.65 |
| $N_1P_2K_2$ | 1.82 | 2.39 | 2.11 |

Table 26. Shelling Percentage

| Treatment | Unlimed | Limed | Means |
|---|---|---|---|
| | Percent | Percent | Percent |
| $N_1P_2$ | 42.3 | 39.2 | 40.8 |
| $N_1K_2$ | 36.6 | 34.4 | 35.5 |
| $N_1P_2K_2$ | 41.6 | 40.5 | 41.1 |
| Lime means | 40.2 | 38.1 | 39.1 |

Table 27. Tenderometer Readings

| Treatment | Unlimed | Limed | Means |
|---|---|---|---|
| $N_1P_2$ | 103.6 | 94.2 | 98.9 |
| $N_1K_2$ | 101.7 | 95.0 | 98.3 |
| $N_1P_2K_2$ | 105.2 | 97.0 | 101.1 |
| Lime means | 103.5 | 95.4 | 99.5 |

Sweet corn

One area about two acres in size was planted to sweet corn. One half of the area was planted about June 10 and the second half about June 20. A standard rate of 30 pounds of nitrogen and 90 pounds of $P_2O_5$ per acre were banded at planting time. Seventy pounds of nitrogen, 40 pounds of $P_2O_5$, 100 pounds of $K_2O$ and 25 pounds of sulfur were broadcast for each area prior to planting and disked into the seedbed. Optimum irrigation was maintained throughout the growing season.

A good stand of sweet corn was obtained on both planting dates. There was little indication of purple discoloration that was attributed to phosphorus deficiency which was so apparent in the field corn.

A number of areas were selected at random and were measured for yield when the corn was ready for processing. The early corn was harvested on September 17, and the second planting was harvested October 22.

Table 28. Yield of Sweet Corn

| | Grade 1 | | Grade 2 | | Culls | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| Planting | Number ears/A | Wt.T/A | Number ears/A | Wt.T/A | Number ears/A | Wt.T/A | Number ears/A | Wt.T/A/ | lbs./ear |
| Date 1 | 14,004 | 3.96 | 7,740 | 1.46 | 5,724 | 0.59 | 27,468 | 6.0 | 0.44 |
| Date 2 | 12,744 | 3.72 | 7.344 | 1.48 | 6,048 | 0.74 | 26,136 | 6.0 | 0.46 |

## SOYBEANS

Soybeans were grown in a 2-acre block. The location of this demonstration is indicated on the map of the experimental area. The soybeans did not grow very well during this particular year. Yield data were taken by harvesting sample plots on September 9. Yield was 4.3 tons per acre.

## SUDANGRASS

Sudangrass was planted in a 2-acre block. The location of this demonstration is indicated on the map of the experimental area. The sudangrass showed good growth. Yield data were taken by harvesting sample plots on September 9. Yield was 5.5 tons per acre on a wet-weight basis.

## FALL ESTABLISHMENT OF SELECTED CROPS

Several crops were planted in small plots in the fall. These plots were irrigated to obtain emergence. At this time the experimental results are considered entirely negative. The control of ryegrass was inadequate, and all plantings were completely covered by the grass. Crops planted in these plots were flax, white clover, orchard grass, Merion bluegrass, oats and vetch, and wheat.

## APPENDIX

During the past few years several irrigation experiments have been conducted similar to the experiments reported herein. Results of these trials are reported below for reference purposes.

1. Response of field corn to irrigation, plant population, and nitrogen in soils of the Willamette Catena, 1962.

This study may be considered a forerunner of the program reported in this progress report. The purpose of this study was to make a preliminary investigation of the productivity of some of the soils within the Willamette Catena under different systems of soil management. The response of field corn to different combinations of management practices was measured in terms of yield of shelled corn, shelling percentage, and ear moisture at harvest. The results are shown in the table below.

Table 29. Mean Yields of Shelled Corn for Each Treatment at Each Site in tons Per Acre at 15.5% Moisture

| Treatment | Sites | | | |
|---|---|---|---|---|
| numbers | Willamette | Woodburn | Amity | Dayton |
| 1 | 1.65 | 1.39 | 1.27 | 0.36 |
| 2 | 1.39 | 1.46 | 1.28 | 0.39 |
| 3 | 1.47 | 1.33 | 1.00 | 0.33 |
| 4 | 1.77 | 1.66 | 1.44 | 0.28 |
| 5 | 3.59 | 3.42 | 3.10 | 2.97 |
| 6 | 3.72 | 4.07 | 3.80 | 3.26 |
| 7 | 3.83 | 4.03 | 3.63 | 2.94 |
| 8 | 4.35 | 4.59 | 4.14 | 3.52 |

Table 30. Treatments Used in the Experiment

| | | Plants/Acre | Pounds N/Acre |
|---|---|---|---|
| 1 | Nonirrigated | 9,000 | 60 |
| 2 | Nonirrigated | 9,000 | 180 |
| 3 | Nonirrigated | 14,000 | 60 |
| 4 | Nonirrigated | 14,000 | 180 |
| 5 | Irrigated | 18,000 | 60 |
| 6 | Irrigated | 18,000 | 180 |
| 7 | Irrigated | 22,000 | 60 |
| 8 | Irrigated | 22,000 | 180 |

The conclusion of this study was that the soils at the Willamette, Woodburn, and Amity sites had greater productivity for field corn than did the soil at the Dayton site in 1962. More detailed information is contained in a thesis by J. L. Anderson entitled "Response of field corn to irrigation, plant population, and nitrogen on soils of the Willamette Catena." This thesis is on file in the Soils Department.

2. Barley irrigation feasibility study.

During the years 1960, 1961, 1962, and 1963 experiments were conducted by the Farm Crops Department in cooperation with the Soils Department to measure the effect of irrigation on the yield and quality of Hannchen barley on Woodburn soil. The barley was planted in plots 30 feet x 30 feet and received one irrigation as nearly to bootstage as possible. About 4 inches of water was applied at this time. A second irrigation was applied. Results are shown in the following table.

Table 4. Yield of Hannchen Barley in Pounds per Acre

| Treatment | Year | | | | Average |
|---|---|---|---|---|---|
| | 1960 | 1961 | 1962[1/] | 1963[2/] | |
| Nonirrigated | 3,401 | 1,991 | 4,531 | 2,246 | 3,042 |
| Irrigated | 4,163 | 2,300 | 4,382 | 3,352 | 3,549 |
| Percent increase | 22 | 16 | -3 | 49 | 17 |

[1/] Average yield for two levels of irrigation and two levels of nitrogen fertilizer.

[2/] Average yield for two levels of irrigation.

Response of barley to irrigation depends to a large degree on the planting date. Barley planted late at a time when part of the soil-moisture storage has already been depleted responds well to irrigation.

3. Sudangrass irrigation feasibility study.

During the years 1960, 1961, and 1962 experiments were conducted by the Farm Crops Department in cooperation with the Soils Department to measure the effect of irrigation on the yield and quality of sudangrass on Woodburn soil. Treatments and results are reported in the tables.

Table 32. Treatments and Yield of Piper Sudangrass

| 1960 | | | 1961 | | | 1962 | | |
|---|---|---|---|---|---|---|---|---|
| Treatment | | Yield | Treatment | | Yield | Treatment | | Yield |
| Irrigations No. | Nitrogen Lbs./A | Dry matter T/A | Irrigations No. | Nitrogen Lbs./A | Dry matter T/A | Irrigations No. | Nitrogen Lbs./A | Dry matter T/A |
| 0 | 50 | 1.64 | 0 | 50 | 0.72 | 0 | 75 | 1.64 |
| 0 | 25-25 | 1.77 | 0 | 150 | 1.03 | 0 | 150 | 1.48 |
| 0 | 150 | 1.82 | 0 | 25-25 | 0.87 | 0 | 37.5-37.5 | 1.76 |
| 0 | 50-50-50 | 1.79 | 0 | 75-75 | 0.71 | 0 | 75-75 | 1.85 |
| 2 | 50 | 3.16 | 2 | 50 | 2.47 | 2 | 75 | 3.01 |
| 2 | 25-25 | 3.05 | 2 | 150 | 2.57 | 2 | 150 | 3.68 |
| 2 | 150 | 3.53 | 2 | 25-25 | 2.47 | 2 | 37.5-37.5 | 3.14 |
| 2 | 50-50-50 | 3.22 | 2 | 75-75 | 3.01 | 2 | 75-75 | 3.44 |
| 5 | 50 | 2.80 | 4 | 50 | 2.75 | 5 | 75 | 4.07 |
| 5 | 25-25 | 2.99 | 4 | 150 | 3.42 | 5 | 150 | 4.94 |
| 5 | 150 | 4.09 | 4 | 25-25 | 2.54 | 5 | 37.5-37.5 | 4.68 |
| 5 | 50-50-50 | 3.71 | 4 | 75-75 | 3.83 | 5 | 75-75 | 5.01 |