# Progress of Irrigation Research On Willamette Valley Soils




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## FOREWORD

The future expansion of agricultural production in the Willamette Valley will depend to a large degree upon the feasibility of introducing irrigated agriculture on the poorly drained soils in the Valley. 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 1966, the fourth crop-year of the experimental program. The report was prepared by the cooperators: L. Boersma, project leader, G. O. Klock, T. L. Jackson, and D. T. Westermann, Soils; H. J. Mack, Horticulture; W. Calhoun, W. H. Foote, and W. Kronstad, Farm Crops; J. W. Wolfe, Agricultural Engineering; and R. C. Youmans, Agricultural Economics.

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## CONTENTS

# 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 of flooded conditions for long periods during the winter. As a result of the winter flooding, the soils can usually not be worked until late in the spring.

At the present time, the so-called wet lands constitute a major natural resource used at a low level of efficiency. A growing demand for agricultural products will lead to increased efficiency and diversification of the present types of operation.

The growing of grass for seed production is at present the only feasible use for many of the 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 water.

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, Chairman of the Board of the Pacific Power and Light Company, provided land at the Dayton-Amity site, irrigation equipment, a pump installation to obtain 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 staff members 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.

# INTERPRETATION OF EXPERIMENTAL RESULTS

H. B. Cheney

This is the progress report on the results of the fourth 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 making interpretations of reported results:

## Climatic conditions

The 1966 growing season in general was favorable for agricultural production on poorly drained soil. Again the spring was drier than usual, making early planting possible. During the months of May and June, the total rainfall was only 1.27 inches, whereas the long-time average for this period is 3.24 inches. A further indication of the dry spring can be found in a comparison of the number of cloudy days with the long-time average conditions. The spring temperatures were about normal. Additional meteorological data are given in Table 1. The observations were made at the station located on the Hyslop Agronomy Farm.

## 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 may 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 treatments 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. Additional 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 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.

## Field trips

During the summer of 1966, several guided tours were conducted on the experimental sites. One general field trip was conducted on August 3 and 4. This event was organized in cooperation with the Extension Service, the Association of Manufacturers of Sprinkler Irrigation Equipment, and the Pacific Power and Light Company. The program included tours of the research plots and demonstrations of sprinkler irrigation equipment by about twenty manufacturers. Guided tours were conducted for a period of two days. The exhibits and research plots were visited by over 1,500 people. Some of the scenes of this event are shown in Figures 1 and 2.

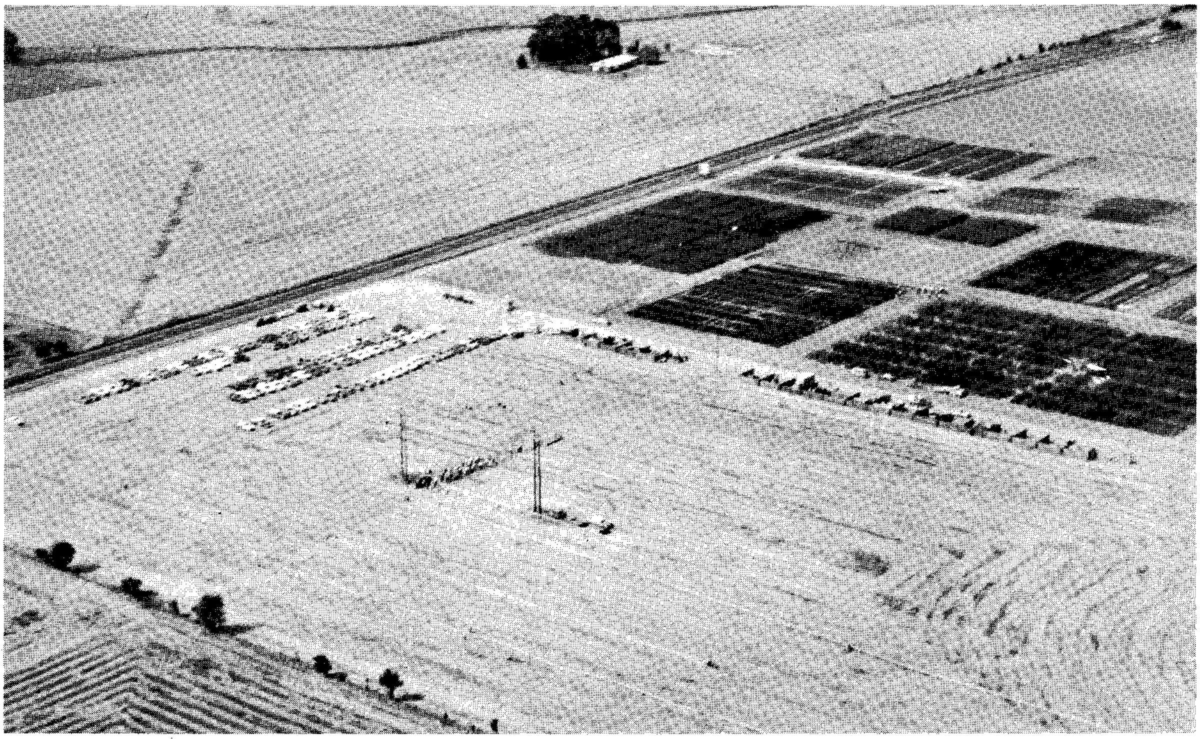

Figure 1. Field days are an important part of the program. Sprinkler irrigation demonstrations are shown in the foreground, research plots in the background.

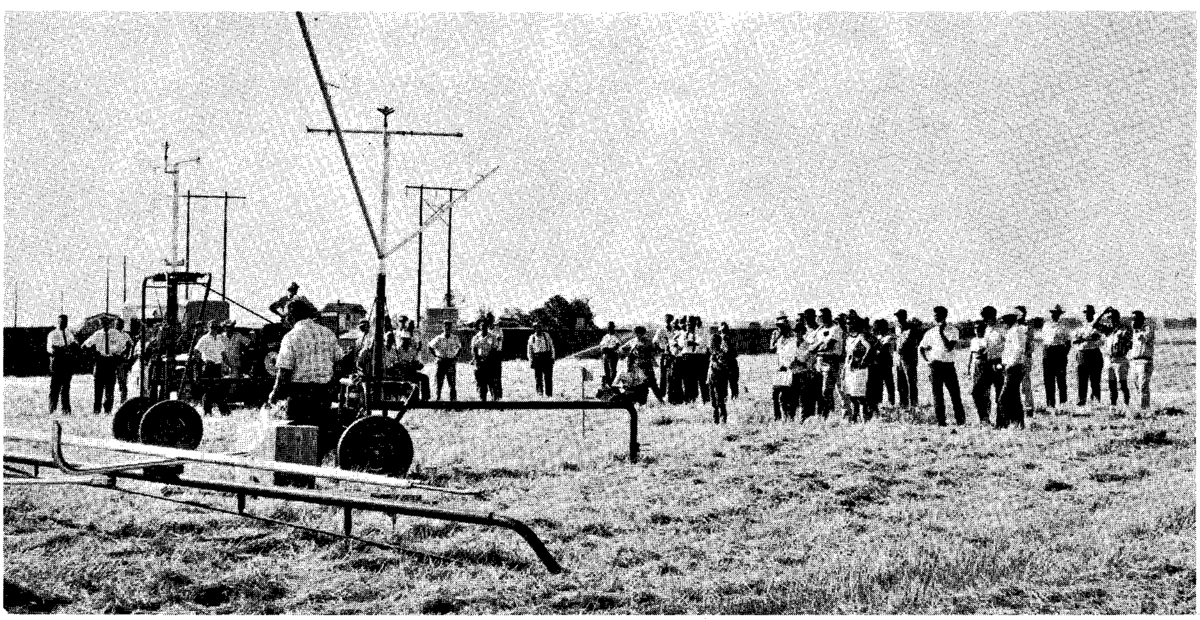

Figure 2. One of the tour groups is brought up-to-date on some of the latest developments in sprinkler irrigation equipment.

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

| | May | | June | | July | | August | | September | | October | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Avg.* | 1966 | Avg.* | 1966 | Avg.* | 1966 | Avg.* | 1966 | Avg.* | 1966 | Avg.* | 1966 |
| Mean maximum temperature ($F^o$) | 67.7 | 69.3 | 72.9 | 73.7 | 81.2 | 78.5 | 81.1 | 81.6 | 75.8 | 76.0 | 64.2 | 64.2 |
| Mean minimum temperature ($F^o$) | 45.5 | 42.2 | 49.2 | 48.3 | 51.6 | 50.9 | 51.2 | 50.7 | 48.3 | 49.7 | 43.0 | 40.9 |
| Mean mean temperature ($F^o$) | 56.6 | -- | 61.1 | -- | 66.4 | -- | 66.2 | -- | 62.1 | -- | 53.6 | -- |
| Number of rainy days | 12 | 9 | 9 | 9 | 3 | 5 | 3 | 3 | 6 | 9 | 13 | 12 |
| Number of clear days | 11 | 11 | 10 | 4 | 18 | 15 | 17 | 19 | 15 | 9 | 8 | 6 |
| Number partially clear days | 12 | 18 | 11 | 24 | 10 | 14 | 9 | 11 | 10 | 20 | 11 | 16 |
| Number cloudy days | 8 | 2 | 9 | 2 | 3 | 2 | 5 | 1 | 5 | 1 | 12 | 9 |
| Rainfall (inches) | 1.93 | .49 | 1.31 | .76 | 0.34 | .49 | 0.41 | .27 | 1.34 | 1.71 | 3.78 | 3.18 |

* 30-year average (1931-1960)

# FIELD CORN FOR GRAIN

Two experiments involving the use of field corn for grain were conducted in 1966. The first experiment was conducted on Amity soil (Jackson farm) to determine the influence of ridging and the use of mulches on grain yield and maturity. In the second experiment, numerous varieties were tested with optimum irrigation and fertilizer application to determine yield and degree of maturity as measured by the moisture percentage of the grain at the time of harvest.

## EXPERIMENT I

G. O. Klock and W. Calhoun

Objective: To test the effects of ridging and the application of mulches on yield and maturity of field corn.

Levels of treatments used:

(1) Two seedbed conditions.

F -- natural seedbed.

R -- ridged seedbed.

(2) Three types of mulch.

1 -- "asphalt" soil mulch.

2 -- Humusite.

3 -- no mulch (check).

The ridges were prepared on three-foot centers with a set of contour discs. The ridges were subsequently packed with a flexible roller. The seed was planted on top of the 9 inch high ridges and on the flat seedbed with a standard two row corn planter. The three mulch treatments were designed to increase soil temperature and hasten germination and plant development. The petroleum mulch was an asphalt type material sprayed on the soil immediately after planting in a band approximately 6 to 8 inches wide and 0.5 to 1.0 millimeters thick. The Humusite, a granulated "coal" type material with a chemical analysis of 3-0-0, was spread over the surface of the soil in a 6 to 8 inch wide band over the row immediately after planting at a rate of 5,000 pounds per acre.

The field corn variety used was Pride 5, and a plant population of 20,000 plants per acre was maintained. All treatments received 150 pounds per acre of muriate of potash before planting, 375 pounds per acre of 16-48-0 banded at the time of planting and 200 pounds per acre of 33.5-0-0, broadcast after planting. During the growing season, 15.25 inches of irrigation water were applied with full-circle sprinklers.

The information concerning the cultural practices used is shown in Table 2. The corn yields shown in Table 3 are adjusted to 15.5% water in the shelled corn. Conversions were made by means of a table giving pounds of ears required to yield 56 pounds (1 bushel) of shelled corn at 15.5% water in the grain on a wet weight basis. The table was prepared by the Iowa State University Cooperative Extension Service.[1] Corn yields and kernel moisture were the principal measurements made.

Table 2. Crop History Dates

| Treatment | Date |
|---|---|
| Applied Eptam | May 4 |
| Planted and applied mulches | May 4 |
| Thinned for stand | June 23 |
| Harvested | October 19 |

Table 3. Yield of Grain Corn on Amity Soil Adjusted to 15.5 Percent Moisture and Percent Kernel Moisture at Harvest

| Treatment | Yield* | Kernel moisture* |
|---|---|---|
| | T/A | % |
| F1 | 3.86 | 24.1 |
| F2 | 3.84 | 24.6 |
| F3 | 3.69 | 25.6 |
| R1 | 4.10 | 24.7 |
| R2 | 4.07 | 24.9 |
| R3 | 3.37 | 27.8 |

1 Iowa State University, Agron. 553, November 1961.

* Average for four replications.

Table 4. Average Grain Corn Yield Adjusted to 15.5 Percent Moisture

| Treatment | Soil mulch treatment Asphalt | Humusite | No mulch | Mean |
|---|---|---|---|---|
| | T/A | T/A | T/A | T/A |
| F (Flat) | 3.86 | 3.84 | 3.69 | 3.79 |
| R (Ridged) | 4.10 | 4.07 | 3.37 | 3.84 |
| Mean | 3.98 | 3.95 | 3.53 | 3.82 |

Table 5. Average Kernel Moisture of Field Corn for Grain

| Treatment | Soil mulch treatment Asphalt | Humusite | No mulch | Mean |
|---|---|---|---|---|
| | % | % | % | % |
| F (Flat) | 24.1 | 24.6 | 25.6 | 24.8 |
| R (Ridged) | 24.7 | 24.9 | 27.8 | 25.8 |
| Mean | 24.4 | 24.8 | 26.7 | 25.3 |

Discussion

The objective of this experiment was to obtain information on the effect of ridging and mulches on the yield and maturity of field corn. A similar experiment was conducted in 1965. In that experiment planting field corn on ridges significantly increased yields, particularly if no mulch was used, and mulching had very little effect on yield. In 1966, opposite results were obtained. Ridging did not significantly increase yields. Part of this lack of yield increase can be attributed to the lower yields on the ridged, nonmulched plots. Yields on the ridged, nonmulched plots were consistently low in all four replications. Some bird damage occurred on these plots and transplanting was necessary, which may account for the lower yields.

The petroleum mulch as well as the humusite increased the corn yields. On the ridged plots the yield increase was 0.70 tons per acre and on the nonridged plots the yield increase was 0.15 tons per acre. In this application, the Humusite acted strictly as a mulch and not as a fertilizer. It is therefore not surprising to find the yields on the plots with Humusite and asphalt mulch to be the same. The plants on the mulched plots tasseled approximately four days earlier than the plants on the other plots.

The mechanism by which the mulch increases the corn yields is still not clear. Under the proper conditions, yield increases of about 20% are easily obtained. The proper conditions seem to be a loose, moist, fine seedbed. This will be evaluated in more detail in future experiments, conducted in the laboratory as well as in the field.

## EXPERIMENT II

W. E. Kronstad and G. O. Klock

In 1964 a program was initiated to find corn varieties for the Willamette Valley which mature early with satisfactory yields. In 1964, 10 varieties were tested and this was increased to 39 varieties in 1965. Encouraging results were obtained. In 1966 the program included 58 varieties which were planted on both the Woodburn soil (Hyslop Farm) and Dayton soil (Jackson Farm). These varieties were planted May 5 and 6 on the Dayton soil and May 7 on the Woodburn soil. The seed was planted at a rate of 25,000 plants per acre and thinned to 20,000 plants per acre. Some nonuniformity of stand resulted from bird damage at both locations. Four replications were planted in a randomized block design. On the Dayton soil, 150 pounds per acre of muriate of potash were broadcast after planting. Atrazine at the rate of 2 pounds per acre was used for weed control. During the growing season, 14.5 inches of water were applied on the Dayton plots and 18.5 inches on the Woodburn plots by sprinkler irrigation. The Dayton plots were harvested October 17 and 18 and the Woodburn plots October 29. The average yields and percent kernel moisture at harvest of the 58 varieties are shown in Table 6.

Table 6. Average Yield of Grain Corn Varieties Adjusted to 15.5 Percent Moisture and Percent Kernel Moisture at Harvest

| | | Woodburn soil | | Dayton soil | |
|---|---|---|---|---|---|
| No. | Variety | Yield* | Kernel moisture* | Yield* | Kernel moisture* |
| | | T/A | % | T/A | % |
| 1 | Oregon 355 | 3.29 | 30.1 | 3.44 | 34.7 |
| 2 | W-263 | 3.16 | 32.6 | 3.62 | 34.0 |
| 3 | W-1694 | 3.50 | 23.4 | 3.35 | 29.7 |
| 4 | W-1702 | 4.43 | 29.4 | 3.40 | 34.3 |
| 5 | W-260 | 3.26 | 24.1 | 3.12 | 30.4 |
| 6 | W-346 | 3.99 | 30.1 | 3.56 | 33.5 |
| 7 | KE-497 | 3.68 | 34.0 | 3.14 | 37.4 |
| 8 | KM-567 | 3.22 | 38.0 | 2.99 | 46.0 |
| 9 | KE-477 | 3.51 | 32.2 | 3.58 | 37.4 |
| 10 | PX-481 | 3.35 | 31.8 | 3.11 | 37.9 |
| 11 | KE-449 | 3.97 | 30.5 | 3.92 | 35.0 |
| 12 | KE-435 | 4.06 | 25.6 | 3.77 | 30.3 |
| 13 | PX-52 | 3.25 | 36.5 | 3.56 | 40.7 |
| 14 | X-5528 | 3.74 | 34.6 | 3.32 | 38.9 |
| 15 | PX-527 | 3.61 | 34.8 | 3.25 | 36.8 |
| 16 | PX-66 | 3.34 | 35.7 | 3.37 | 44.4 |
| 17 | W-243 | 3.08 | 26.3 | 3.20 | 28.0 |
| 18 | P-232 | 3.80 | 32.5 | 3.76 | 34.3 |
| 19 | P-11 | 3.40 | 28.5 | 3.42 | 32.7 |
| 20 | P-49 | 3.76 | 35.9 | 3.19 | 41.7 |
| 21 | P-22 | 3.67 | 31.9 | 4.52 | 36.5 |
| 22 | R-2 | 4.36 | 30.3 | 4.05 | 34.2 |
| 23 | P-432 | 4.05 | 35.0 | 3.85 | 37.6 |
| 24 | P-5 | 3.63 | 27.8 | 4.25 | 28.9 |
| 25 | R-100 | 3.71 | 22.9 | 3.70 | 26.3 |
| 26 | P-495 | 3.84 | 37.3 | 3.27 | 37.1 |
| 27 | P-132 | 3.60 | 28.4 | 3.18 | 34.6 |
| 28 | PAG-70 | 3.64 | 34.6 | 3.45 | 38.3 |
| 29 | PAG-5X-48 | 3.93 | 28.0 | 3.80 | 31.7 |
| 30 | PAG-26 | 3.05 | 30.1 | 2.87 | 33.6 |
| 31 | PAG-24 | 3.12 | 27.2 | 2.86 | 31.2 |
| 32 | PAG-45 | 3.97 | 32.6 | 3.54 | 35.7 |
| 33 | PAG-62 | 4.14 | 33.3 | 3.12 | 37.3 |
| 34 | PAG-36 | 3.90 | 35.7 | 3.10 | 39.0 |
| 35 | Growmaster | 3.35 | 38.1 | 2.76 | 43.7 |

Table 6. (Continued)

| No. | Variety | Woodburn soil Yield* | Woodburn soil Kernel moisture* | Dayton soil Yield* | Dayton soil Kernel moisture* |
|---|---|---|---|---|---|
| | | T/A | % | T/A | % |
| 36 | Profitmaker | 4.24 | 30.3 | 3.32 | 36.5 |
| 37 | Surimaker | 3.57 | 32.1 | 3.52 | 36.0 |
| 38 | Hastymaker | 3.72 | 31.9 | 3.68 | 35.9 |
| 39 | DC-368 | 4.09 | 34.2 | 3.31 | 40.7 |
| 40 | DC-352 | 3.70 | 38.4 | 2.56 | 43.4 |
| 41 | DC-3862 | 3.67 | 27.6 | 3.10 | 33.4 |
| 42 | SC-3558 | 3.70 | 39.0 | 2.86 | 46.7 |
| 43 | G-43 | 3.67 | 27.3 | 3.72 | 30.1 |
| 44 | G-4170 | 3.42 | 27.1 | 3.43 | 30.8 |
| 45 | H-2204 | 3.16 | 31.1 | 3.29 | 35.1 |
| 46 | H-339 | 3.47 | 24.5 | 3.45 | 31.3 |
| 47 | G-43-SS-7842 | 3.63 | 39.7 | 3.54 | 34.0 |
| 48 | G-11A | 3.98 | 30.5 | 3.20 | 33.4 |
| 49 | H-83 | 3.35 | 26.1 | 3.15 | 30.5 |
| 50 | H-2210 | 3.61 | 27.6 | 3.90 | 33.4 |
| 51 | H-316 | 3.38 | 29.6 | 3.32 | 34.4 |
| 52 | Pick of Pack 3 | 2.45 | 28.0 | 3.28 | 31.9 |
| 53 | H-88 | 3.99 | 25.3 | 3.61 | 31.8 |
| 54 | 5X-203-10 | -- | -- | 3.23 | 32.9 |
| 55 | G-10A | 3.52 | 32.5 | 3.02 | 35.7 |
| 56 | H-85 | -- | -- | 3.69 | 30.1 |
| 57 | H-230 | -- | -- | 3.80 | 29.6 |
| 58 | H-305 | 3.74 | 24.8 | 3.53 | 30.9 |

* Average of four replications.

Discussion

From the data presented in Table 6 it can be noted that several hybrids look promising both in terms of yielding capacity and moisture percentage. The corn harvested on the Woodburn soil was consistently drier than corn harvested on the Dayton soil; however, no consistent differences were found for grain yield between the two locations. When the entries are compared with Oregon 355, many are superior at both locations for yield and moisture percentage. Several of the early maturing hybrids obtained from the University of Wisconsin continued to look good; particularly W-1702 on the Woodburn soil. Pride 22 and Pride 5 had the highest yield on the Dayton soil; however, Pride 22 had a high moisture percentage at harvest. In addition to the yield and moisture data, twelve 2-pound samples of the most promising hybrids are being analyzed for their potential starch content. There is currently considerable interest in the possibility of the Willamette Valley being a source of corn for corn starch production.

On September 16 and September 28, one replication on the Woodburn soil (Hyslop Farm) was sampled for moisture content of the grain. On each plot, 10 ears were picked from the guard rows and shelled for a moisture content determination. Results are shown in Table 7. These restuls are shown in a summarized form in Figure 3. Each line represents an average of five or more varieties. The varieties included in a certain group were chosen on the basis of the grain water-content at the time of harvest. All varieties were ranked according to the water content at harvest time and then grouped. The range of the final water content in one group was never more than 2%, except for the group which had twenty varieties included in it. In this group the range was about 4%.

Table 7. Percent of Kernel Moisture of Corn Grown on Woodburn Soil

| Variety no. | Sampling date Sept. 16 | Sept. 23 | Oct. 29 | Variety No. | Sampling date Sept. 16 | Sept. 23 | Oct. 29 |
|---|---|---|---|---|---|---|---|
| | % | % | % | | % | % | % |
| 25 | 40.2 | 34.5 | 22.9 | 11 | 50.2 | 42.5 | 30.5 |
| 3 | 44.1 | 32.7 | 23.4 | 48 | 51.1 | 43.9 | 30.5 |
| 5 | 47.0 | 39.1 | 24.1 | 45 | 54.3 | 46.1 | 31.1 |
| 46 | 47.3 | 36.8 | 24.5 | 10 | 67.2 | 58.6 | 31.8 |
| 58 | 42.0 | 35.7 | 24.8 | 38 | 56.9 | 43.2 | 31.9 |
| 53 | 46.8 | 35.5 | 25.3 | 21 | 62.2 | 45.0 | 31.9 |
| 12 | 41.5 | 35.5 | 25.6 | 37 | 56.0 | 42.6 | 32.1 |
| 49 | 51.2 | 53.8 | 26.1 | 9 | 54.3 | 42.1 | 32.2 |
| 17 | 41.4 | 32.3 | 26.3 | 55 | 54.9 | 40.5 | 32.5 |
| 44 | 47.8 | 34.9 | 27.1 | 18 | 52.8 | 44.9 | 32.5 |
| 31 | 46.4 | 36.4 | 27.2 | 32 | 55.0 | 42.3 | 32.6 |
| 43 | 49.9 | 36.0 | 27.3 | 2 | 51.8 | 48.4 | 32.6 |
| 41 | 50.1 | 40.9 | 27.6 | 33 | 59.6 | 41.7 | 33.3 |
| 50 | 52.3 | 38.2 | 27.6 | 7 | 56.0 | 40.1 | 34.0 |
| 24 | 49.0 | 36.2 | 27.8 | 39 | 55.2 | 50.8 | 34.2 |
| 52 | 44.9 | 35.3 | 28.0 | 14 | 55.6 | 43.4 | 34.6 |
| 29 | 48.5 | 45.5 | 28.0 | 28 | 63.4 | 46.6 | 34.6 |
| 27 | 57.9 | 43.3 | 28.4 | 15 | 54.4 | 44.1 | 34.8 |
| 19 | 44.9 | 48.9 | 28.5 | 23 | 65.0 | 48.9 | 35.0 |
| 4 | 46.3 | 42.0 | 29.4 | 34 | 62.8 | 56.1 | 35.7 |
| 51 | 61.5 | 49.8 | 29.6 | 16 | 74.6 | 52.1 | 35.7 |
| 47 | 49.5 | 38.8 | 29.7 | 20 | 72.3 | 75.6 | 35.9 |
| 1 | 58.1 | 47.1 | 30.1 | 13 | 61.7 | 55.7 | 36.5 |
| 6 | 52.0 | 37.7 | 30.1 | 26 | 68.7 | 57.2 | 37.3 |
| 30 | 49.4 | 40.8 | 30.1 | 8 | 64.4 | 56.7 | 38.0 |
| 36 | 53.6 | 49.8 | 30.3 | 35 | 59.6 | 57.9 | 38.1 |
| 22 | 52.6 | 43.2 | 30.3 | 40 | 75.4 | 57.2 | 38.4 |
| | | | | 42 | 78.9 | 68.6 | 39.0 |

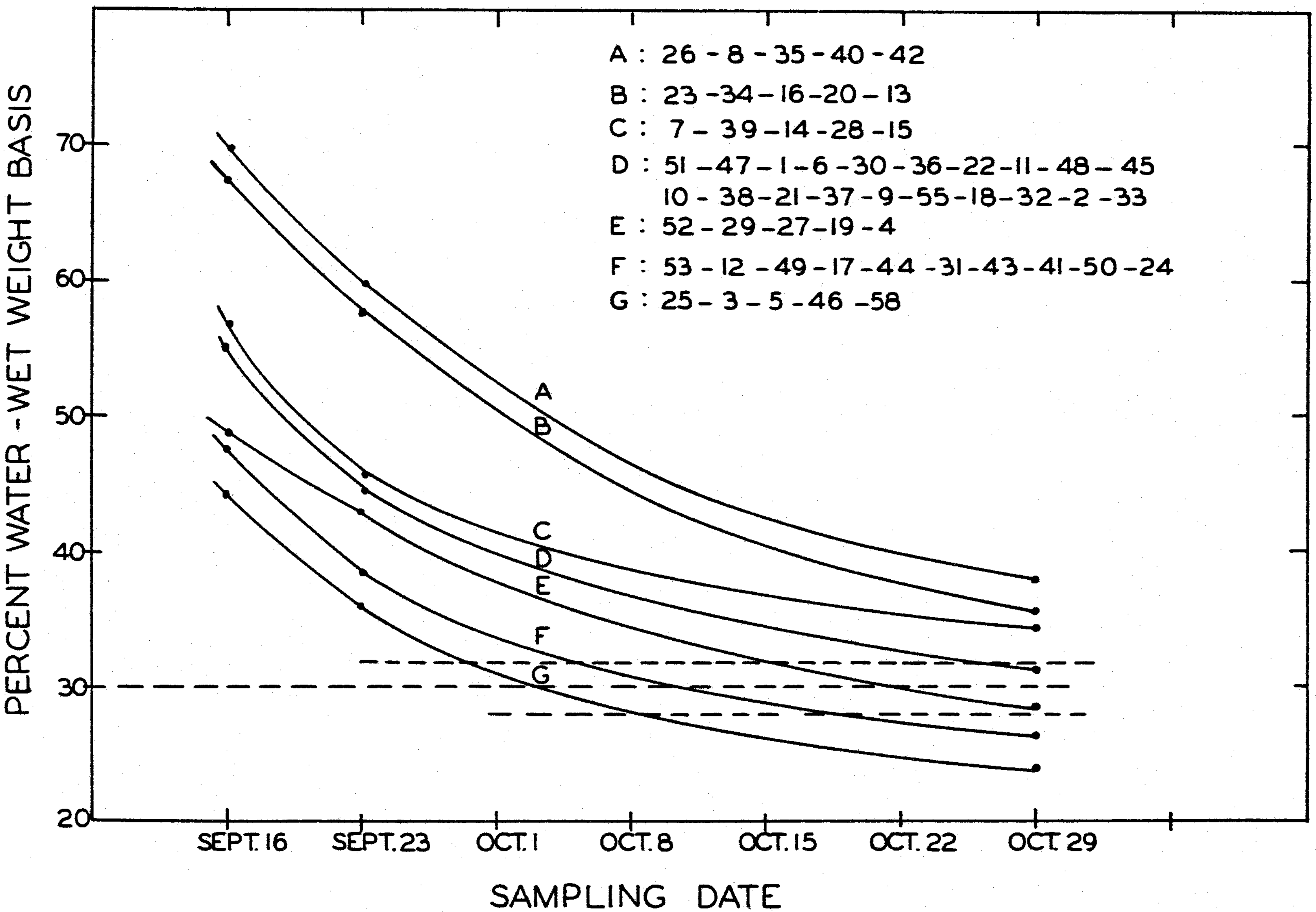


Figure 3. The drying rates of several corn varieties, grown on the Hyslop Farm. Samples were taken on September 16, 23, and October 29. The numbers identify different varieties and are the same as those used in Table 6.

# CORN SILAGE VARIETY TRIAL

W. E. Kronstad and G. O. Klock

Ten varieties of corn grown for silage were planted on Dayton soil (Jackson Farm) and Woodburn soil (Hyslop Farm). The planting dates were May 4 for the Dayton soil and May 7 for the Woodburn soil. All varieties were planted with 18-inch row spacing to give a plant population of 80,000 plants per acre. On the Dayton soil plots, 150 pounds per acre of muriate of potash were broadcast before planting, 750 pounds per acre of 16-48-0 were banded at planting and 200 pounds per acre of 33.5-0-0 were broadcast after planting. On the Woodburn soil, 750 pounds per acre of 16-20-0 were banded at planting and 110 pounds per acre of urea were broadcast after planting. The Dayton soil plots received 15.25 inches of irrigation water, and the Woodburn plots received 18.5 inches of irrigation water. On the Hyslop Farm, the silage was cut on September 27; and, on the Jackson Farm, the silage was cut September 28. Both wet-weight and dry-weight yields for the two soils are given in Table 8.

Table 8. Yield of Corn Silage in Tons per Acre

| Variety | Woodburn soil Yield* Wet weight | Woodburn soil Yield* Dry weight | Dayton soil Yield* Wet weight | Dayton soil Yield* Dry weight |
|---|---|---|---|---|
| | T/A | T/A | T/A | T/A |
| ORE 355 | 24.18 | 9.57 | 21.63 | 8.05 |
| ORE 150 | 28.60 | 9.36 | 23.96 | 7.61 |
| KE 497 | 28.80 | 9.97 | 27.15 | 9.68 |
| KM 567 | 33.25 | 10.59 | 25.12 | 7.74 |
| RX 481 | 24.25 | 7.95 | 21.20 | 8.42 |
| KE 449 | 21.92 | 8.65 | 20.76 | 8.03 |
| Pride 232 | 28.68 | 9.37 | 21.20 | 7.47 |
| Pride 132 | 23.09 | 8.92 | 20.18 | 7.63 |
| Pride 432 | 26.72 | 8.38 | 25.55 | 8.52 |
| Pride 5 | 18.82 | 8.56 | 17.42 | 7.47 |

* Average of four replications.

# USE OF MULCHES ON BUSH BEANS

G. O. Klock and H. J. Mack

The objective of this experiment was to determine the effects of mulches on bush beans planted on several dates throughout the season. A significant increase in yield of bush beans with the use of petroleum mulch was shown in 1965 for one planting date on Amity soil. It was postulated that the mulch should be more effective on the earlier planting dates.

Bush beans were planted on Amity soil (Jackson Farm) on four different dates and three mulching treatments were used on each planting date. The treatments are as follows:

(1) Four planting dates.

D1 - May 10.

D2 - May 26.

D3 - June 10.

D4 - June 17.

(2) Three mulch treatments.

A - petroleum soil mulch.

B - humusite.

C - check.

All treatments received 150 pounds of muriate of potash per acre, broadcast before planting, and 425 pounds of 16-48-0 per acre, banded at the time of planting. The experimental area had received 2.5 tons of lime per acre in 1963 and 75 pounds of borated gypsum per acre in 1964. The Gallatin 50 variety of bush beans was planted at a rate of 8 to 9 seeds per foot with row spacing of 30 inches. The sprinkler method of irrigation was used to apply 14.0 inches of irrigation water during the growing season.

The petroleum mulch was sprayed in bands 6 to 8 inches wide and 1 to 2 millimeters thick across the row immediately after planting. The Humusite, a granulated "coal" type material with a chemical analysis of 3-0-0, was spread over the surface of the soil in a 6 to 8 inch wide band centered over the row of seeds immediately after planting, at a rate of about 5,000 pounds per acre. In this application the humusite acts as a mulch, which is not its intended use.

Eptam was used for weed control. The harvest dates are shown in Table 9. The average yield for all treatments is shown in Table 10.

Table 9. Planting Dates and Harvest Dates

| Treatment | Planting dates | Harvest dates |
|---|---|---|
| D1 | May 10 | July 25 |
| D2 | May 26 | August 8 |
| D3 | June 10 | August 18 |
| D4 | June 27 | August 24 |

Table 10. Yield of Bush Beans on Amity Soil in Tons per Acre and Percent of Beans Passing a Number 4 Sieve

| Treatment | Yield* | Percent* of 4's |
|---|---|---|
| | T/A | % |
| D1A | 4.84 | 78.5 |
| D1B | 4.61 | 77.7 |
| D1C | 4.24 | 76.0 |
| D2A | 5.77 | 55.2 |
| D2B | 6.13 | 64.2 |
| D2C | 4.82 | 60.1 |
| D3A | 7.02 | 64.8 |
| D3B | 6.88 | 58.4 |
| D3C | 6.92 | 54.1 |
| D4A | 5.84 | 73.9 |
| D4B | 5.43 | 79.9 |
| D4C | 5.17 | 75.8 |

* Average of four replications.

Table 11. Average Yield of Bush Beans in Tons per Acre

| Treatment | Planting dates D1 | D2 | D3 | D4 | Mean |
|---|---|---|---|---|---|
| | T/A | T/A | T/A | T/A | T/A |
| A (asphalt) | 4.82 | 5.78 | 7.02 | 5.85 | 5.87 |
| B (humusite) | 4.61 | 6.13 | 6.88 | 5.43 | 5.76 |
| C (no mulch) | 4.24 | 4.82 | 6.92 | 5.17 | 5.29 |
| Mean | 4.56 | 5.58 | 6.94 | 5.48 | 5.51 |

The objective of this experiment was to determine the relative effectiveness of the mulches used when applied at different planting dates. In order to make this comparison, yield adjustments were made to take differences in grade into account. All yields were adjusted to a standard of 50% beans passing a No. 4 sieve. The adjustment was made by allowing 100 pounds of beans for each percent deviation from the standard of 50%. The adjusted yields are shown in Table 12.

Table 12. Average Yields of Bush Beans Adjusted to 50 Percent Passing a Number 4 Sieve

| Treatment | Planting dates D1 | D2 | D3 | D4 | Mean |
|---|---|---|---|---|---|
| | T/A | T/A | T/A | T/A | T/A |
| A (asphalt) | 6.26 | 6.03 | 7.76 | 7.03 | 6.77 |
| B (humusite) | 5.99 | 6.84 | 7.30 | 6.92 | 6.76 |
| C (no mulch) | 5.54 | 5.33 | 7.12 | 6.46 | 6.07 |
| Mean | 5.93 | 6.07 | 7.39 | 6.80 | 6.53 |

The June 10 planting date gave the highest yield. On the first three planting dates, the yield increase resulting from the application of asphalt mulch was 0.7 tons per acre. This amounts to an increase of approximately 15% on the first two planting dates and 10% on the third planting date. On the fourth planting date, the increase obtained from the application of asphalt mulch was less than 10%. Yield increases resulting from the use of the humusite were about 5% smaller than those obtained from the use of asphalt mulch. Mulches appear to be most effective on the early planting dates, particularly on the early June planting dates. The seeds emerged several days earlier on the mulched plots than on the check treatment for both types of mulches used.

## BUSH BEANS ON FALL-RIDGED PLOTS

G. O. Klock and H. J. Mack

An experiment established in 1964 and repeated in 1965 to compare yields of bush beans grown on fall-ridged plots with those grown on flat land was again repeated in 1966. The soil was ridged in the fall to obtain drainage with 18-inch high "ridges" spaced 6 feet from center to center. These ridges were prepared with contour border discs in the fall of 1965. The ridges were constructed on randomly selected plots with four replications.

The two experimental treatments were:

(1) Two soil surface conditions maintained through the 1965-1966 winter.

R - ridged in fall.

F - flat throughout the winter.

(2) Two lime levels on each soil surface condition.

$L_0$ - no lime.

$L_1$ - limed at the rate of 3 tons per acre, fall 1963, and

1 ton per acre, fall 1965.

The sprinkler method of irrigation was used on this experiment to apply 11.5 inches of water during the growing season. One hundred and fifty pounds of muriate of potash per acre were broadcast before planting and 400 pounds of 16-48-0 per acre were banded at planting time. The row spacing was 36 inches on all treatments. The seed was planted May 26 and the beans were picked August 7.

Table 13. Average Yield of Bush Beans in Tons per Acre

| Lime | Fall treatment Ridged | Flat | Mean |
|---|---|---|---|
| | T/A | T/A | T/A |
| $L_0$ | 4.10 | 4.09 | 4.09 |
| $L_1$ | 5.12 | 6.03 | 5.57 |
| Mean | 4.51 | 5.06 | 4.84 |

## Discussion

In 1964 and 1965, bush beans planted in the area which had been ridged in the fall gave higher yields. In 1966 the opposite results were obtained. Just as in 1965, the spring was very dry. Therefore, little difference in yield should be expected between fall-ridged plots and the flat plots as a result of the drainage treatment. Thus, the large differences in yields cannot easily be explained.

In the fall of 1965, an additional one ton per acre of lime was applied on the $L_1$ treatment. This may account for the increased response to lime on these plots above that shown in 1964 and 1965. Total yields on all plots were much higher than those obtained in 1964 and 1965. In the previous two years, halo blight had infected the field, but it was not evident in 1966.

## BUSH BEAN FERTILITY EXPERIMENT

D. T. Westermann and T. L. Jackson

Fertility research with bush beans has been conducted for four years on the Dayton soil series under this project. Bush bean production has shown a marked response from liming when potassium was applied and a response from potassium when applied with lime. Responses from both phosphorus and nitrogen were also evident. These studies have indicated that manganese toxicity is a major factor affecting the growth and yield of bush beans on Dayton soils. Major factors affecting the availability of manganese on this soil are the inherent poor drainage condition existing during the winter and early spring months and its acidic nature. In this respect, drainage and liming have both been shown to help correct this unfavorable situation. Banding chloride, containing fertilizer, close to the seed at planting has also been shown to increase the amount of manganese taken up by the plant. The role of the chloride ion is not clearly understood at this time.

Past experiments were all conducted in the summer, following an application of lime in the preceding fall or spring. One of the objectives of this experiment was to test the residual effect of liming during the second year of bush bean production. For this reason the experiment of 1965 was repeated in 1966.

An attempt was also made to improve evaluation of the maturity differences that have existed in the previous experiments. Thus, the plots were split and harvested at two different dates. The first half was harvested when the beans on the limed plots had reached maturity and the second half when the beans on the unlimed plots had reached maturity.

Plant samples of the most recently mature trifoliate leaves were taken at early bloom to evaluate the effect of treatments on chemical composition and the effect of chemical composition on yields.

The soil test results applicable to this experiment are given in Table 14. Corresponding data are also given for the sweet corn fertility experiment and for the experiment to evaluate the source of potassium by placement reported elsewhere in this publication.

All treatments in this experiment received 90 pounds per acre of $P_2O_5$ as concentrated superphosphate banded at planting. Thirty-five pounds of nitrogen per acre as ammonium sulfate were broadcast prior to planting, while 35 pounds of nitrogen per acre as ammonium nitrate were banded at planting time on all treatments except those receiving other sources of nitrogen. Potassium was applied at the rate of 50 pounds of potassium per acre. Respective sources of potassium also supplied 20 pounds of sulfur and 45 pounds of chloride. Applications of chloride were also made with calcium chloride at the same level of chloride supplied by the potassium chloride treatment. The experiment was planted on May 19th. The first harvest date was on August 5th and the second harvest date was on August 23rd.

Table 14. Results of Soil Test Values for the Experimental Areas, 1966

| Experiment | Lime rate | pH | P | K | Ca | Mg | Mn |
|---|---|---|---|---|---|---|---|
| | T/A | | ppm | me/100g | me/100g | me/100g | me/100g |
| Bush beans* & sweet corn fertility experiments | 0 | 4.8 | 10.0** | 0.24 | 2.5 | 0.9 | 0.23 |
| | 3 | 6.1 | 11.0** | 0.25 | 6.4 | 1.1 | 0.11 |
| Source of K* by placement | 0 | 4.8 | 10.0 | 0.20 | 3.0 | 1.3 | 0.41 |

* Averages of six and four replications, respectively.

** 1965 phosphorus soil test.

Table 15. Average Yield, Percent of Beans Passing a Number 4 Sieve, and Managanese Concentrations in the Plant Tissue

| Treatment* | Lime rate | Harvest date: August 5, 1966 Yield | August 5, 1966 Grade | August 23, 1966 Yield | August 23, 1966 Grade | Manganese** |
|---|---|---|---|---|---|---|
| | T/A | T/A | % | T/A | % | ppm |
| 0 | 0 | - | - | 3.0 | 34.7 | 1236 |
| | 3 | 4.7 | 43.5 | 5.1 | 24.6 | 270 |
| KCl | 0 | - | - | 1.1 | 48.5 | 1364 |
| | 3 | 5.1 | 39.6 | 6.0 | 21.1 | 397 |
| $K_2SO_4$ | 0 | - | - | 1.7 | 36.4 | 1337 |
| | 3 | 5.0 | 37.4 | 5.8 | 26.9 | 338 |
| $K_2SO_4$+$CaCl_2$ | 0 | - | - | 0.5 | 45.2 | 1368 |
| | 3 | 4.5 | 46.6 | 5.4 | 16.8 | 452 |
| $KNO_3$ | 0 | - | - | 2.4 | 43.2 | 1195 |
| | 3 | 4.3 | 48.6 | 5.6 | 16.2 | 195 |
| $KNO_3$+$CaCl_2$ | 0 | - | - | 1.8 | 43.5 | 1323 |
| | 3 | 4.4 | 46.0 | 5.4 | 19.3 | 206 |
| $K_2CO_3$ | 0 | - | - | 2.1 | 41.4 | 1310 |
| | 3 | 5.3 | 33.6 | 6.0 | 13.2 | 261 |
| $K_2CO_3$+$CaCl_2$ | 0 | - | - | 1.1 | 50.4 | 1386 |
| | 3 | 4.7 | 43.4 | 6.2 | 15.0 | 399 |
| KCl (broadcast) | 0 | - | - | 1.6 | 47.0 | -- |
| | 3 | 5.4 | 34.7 | 5.2 | 14.7 | -- |

* All fertilizer materials banded at planting time unless otherwise indicated.

** All chemical analyses reported here are based on dry-matter weight.

## Discussion

The following yield, maturity effects, and manganese contents were observed in this experiment:

1. The application of lime increased the yield and the rate at which the beans reached maturity. The greatest effect of liming occurred on the treatments receiving potassium, although this comparison is made on the second harvest date where the limed plots were greatly over mature. Also note that the unlimed treatments had no harvestable beans on the first harvest date.

2. The application of potassium, independent of source, decreased yields when lime was not applied and generally increased yields where lime was applied. Maturity was either advanced slightly or not affected by potassium on the first harvest date. It was delayed at the second harvest date on the plots receiving no lime.

3. Yield was reduced by a source of chloride in absence of lime on the second harvest date, and no apparent trend is observable where lime was applied on either of the two harvest dates.

4. Manganese contents were greatly reduced by the application of lime and increased slightly by a source of chloride in lime and non-limed comparisons.

Results of chemical analyses of interest were the following:

1. Variation of potassium content was from 1.18% to 2.56%. All treatments receiving potassium had above 1.90% potassium. No visual symptoms of potassium deficiency occurred in this experiment.

2. Calcium content varied from 1.3% to 2.21%. Average increase in calcium content from liming was 0.70%.

3. Zinc, magnesium, and iron contents appeared to be adequate and not in excess for bush beans grown under these conditions.

Careful consideration should be given to the interpretations of the treatment effects on yield in this experiment because of the wide degree of maturities present, even though some of the maturity effects were related to the treatment responses. Management no doubt played a part in influencing the results obtained, since part of the experiment was unavoidably flooded during the growing season.

Greater responses of bush beans to potassium fertilization have been observed in previous experiments on the Dayton soil. These responses were measured when the exchangeable potassium was 0.15 me/100 gms or less. Liming without an application of potassium generally has been shown to result in a severe potassium deficiency. Liming also reduces the possibility of manganese toxicity when a source of chloride is used as a fertilizer material and banded close to the seed at planting.

# SWEET CORN FERTILITY EXPERIMENT

D. T. Westermann and T. L. Jackson

The sweet corn experiment of 1965 was repeated in 1966 with the additional objective of evaluating the residual effect of liming. The original objectives were to evaluate the effect of source of potassium, the effect of lime, and the method of application of potassium chloride on the yield and chemical composition of sweet corn. Experimental data from 1965 indicated that an increase in yield is obtained from an application of lime and from an application of a nonchloride source of potassium in the absence of lime. No yield increases were observed from an application of potassium in the presence of lime.

The soil test results are given in Table 14. All sources of potassium were applied at the rate of 75 pounds of K per acre. All treatments received 105 pounds of N broadcast as ammonium nitrate prior to planting and 68 pounds of N per acre as ammonium sulfate banded at the time of planting. Concentrated superphosphate was banded at the rate of 160 pounds of $P_2O_5$ per acre at planting. The amount of chloride (68 pounds per acre) supplied by the calcium chloride was equivalent to the amount of chloride supplied by potassium chloride. The experiment was planted on May 19 and harvested by hand and graded on September 12. Results are shown in Table 16.

Table 16. Yield of Sweet Corn in Tons of Number 1 Ears per Acre *

| Lime rate | Check | KCl | $K_2SO_4$ | $K_2SO_4$ $CaCl_2$ | $KNO_3$ | $K_2CO_3$ | KCl (bc) |
|---|---|---|---|---|---|---|---|
| T/A | T/A | T/A | T/A | T/A | T/A | T/A | T/A |
| 0 | 4.05 | 4.59 | 4.86 | 4.08 | 5.56 | 5.59 | 4.38 |
| 3 | 5.19 | 4.41 | 6.82 | 5.80 | 5.65 | 6.34 | 5.56 |

* Averages of three replications. Harvesting done by hand.

## Discussion

The following effects were evident in this experiment:

1. The application of lime increased yields in every fertilizer treatment except when potassium chloride was banded. In the latter treatment, there was a slight nonsignificant yield reduction.

2. In general, there was an increase in yield from the application of potassium. This increase was the greatest on treatments that did not receive a source of chloride.

3. There appears to be some reduction in yield from an application of chloride, either banded or broadcast, in both the absence and presence of lime when compared to the nonchloride sources of potassium. Yield data from the 1965 experiment showed the yields on plots with broadcast potassium chloride to be equal to the yields on plots with other sources of potassium applied by banding.

The experimental area was accidentally flooded during the growing season, and the regular irrigations were not uniform over the experimental site. Due to these irregularities, no attempt is made to evaluate the residual lime effect and little can be said with certainty regarding treatment effects on yields.

## SOURCE OF POTASSIUM BY PLACEMENT

D. T. Westermann and T. L. Jackson

Previous experiments have shown a marked increase in the uptake of manganese by bush beans on the Dayton soil when a source of chloride was banded at planting time on unlimed soils. In all cases, the source of chloride was banded with concentrated superphosphate and ammonium nitrate. Other workers have shown that both of these chemicals have an acidifying effect on the soil. Since the availability of manganese is also increased by low pH values, it was postulated that some of the effect of the chloride ion may be associated with the pH effect. It was the purpose of this experiment to ascertain whether the presence of concentrated superphosphate and ammonium nitrate was influencing the amount of manganese taken up by bush beans when banded with chloride.

The experiment was designed as follows: Three sources of potassium were banded at the rate of 70 pounds of K per acre. One-half of the treatments had the potassium banded in the same fertilizer band (combined) with 90 pounds of $P_2O_5$ per acre as concentrated superphosphate and 48 pounds of N per acre as ammonium nitrate. On the other half the potassium was banded separately (split) on the other side of the seed row opposite the phosphorus and nitrogen band. Thirty-five pounds of N per acre were broadcast prior to planting. The experimental area was not limed.

The soil test results are given in Table 14. The soil test indicates a large amount of "plant available" manganese at planting time (0.41 me/100 gms). In previous experiments it has been found that manganese toxicity occurs on all bush bean plants when the manganese level is approximately 0.10 me/100 gms. This would indicate that manganese toxicity should be very severe on this site, as was later found to be the case. The manganese content in the trifoliate leaves at early bloom is reported in Table 17.

Table 17. Manganese Content in Trifoliate Leaves at Early Bloom

| Method of placement | 0 | KCl | $K_2SO_4$ | $KNO_3$ |
|---|---|---|---|---|
| | ppm | ppm | ppm | ppm |
| Split | ---- | 1320 | 1247 | 1138 |
| Combined | 1115 | 1220 | 1255 | 1258 |
| Broadcast | ---- | 1247 | ---- | ---- |

In all treatments the level of manganese found in the plant tissue was more than adequate to explain the manganese toxicity observed. The plants remained stunted and very chlorotic throughout the growing season. The bean set was very small or nonexistent on all plots. For this reason, no evaluation of treatment effect on yield was made. No attempt was made to evaluate the effect of treatment on manganese uptake because of the excessive levels of available manganese originally present and the poor physical condition of the plants throughout the growing season.

## DRY BEANS

G. O. Klock

The objectives of this experiment were to determine yields from several varieties of dry beans on Woodburn soil (Hyslop Farm) and Dayton soil (Jackson Farm). A petroleum mulch treatment was also used on each variety to determine its influence on yield and maturity.

All varieties on the Woodburn and Dayton soils were planted May 21 and harvested by hand the first week in September. If the beans had been harvested by machine, they would have had to be cut earlier than this date to prevent shattering. All varieties on the Dayton soil received 150 pounds of 16-48-0 per acre, banded at planting time. The varieties on the Woodburn soil received 400 pounds of 16-20-0 per acre, banded at planting. Eptam at the rate of 2.5 pounds per acre was used for weed control. Sixteen inches of irrigation water were applied on the Woodburn soil plots and 13.75 inches on the Dayton soil plots. The petroleum mulch was applied in a 6 to 8 inch wide bande covering the seed row immediately after planting. The row spacing was 22 inches on all treatments. Yields are reported in Tables 18 and 19.

The treatments used were:

(1) Seven varieties.

V1 - Red Mex. 37.
V2 - Red Mex. 36.
V3 - Pinto 114.
V4 - Seaway (small white beans).
V5 - Charlevoix.
V6 - Black Turtle.
V7 - Sutter Pink Pinto.

(2) Two levels of petroleum.

A - check.
B - petroleum mulch.

Table 18. Average Yield in Pounds per Acre of Dry Beans on Woodburn Soil

| Treatment | Variety: Red Mex. 37 | Red Mex. 36 | Pinto 114 | Seaway | Charle-voix | Black Turtle | Mean |
|---|---|---|---|---|---|---|---|
| | lbs/A | lbs/A | lbs/A | lbs/A | lbs/A | lbs/A | lbs/A |
| Check | 2975 | 3088 | 3012 | 2346 | 2718 | 1631 | 2628 |
| Mulch | 2989 | 3030 | 2907 | 2431 | 2849 | 2032 | 2706 |
| Mean | 2982 | 3059 | 2960 | 2388 | 2784 | 1832 | 2667 |

Table 19. Average Yield in Pounds per Acre of Dry Beans on Dayton Soil

| Treatment | Variety: Red Mex. 37 | Red Mex. 36 | Pinto 114 | Seaway | Charle-voix | Black Turtle | Sutters Pink | Mean |
|---|---|---|---|---|---|---|---|---|
| | lbs/A | lbs/A | lbs/A | lbs/A | lbs/A | lbs/A | lbs/A | lbs/A |
| Check | 2508 | 2499 | 2669 | 2527 | 2349 | 2401 | 2699 | 2522 |
| Mulch | 2776 | 2750 | 2868 | 2664 | 2296 | 2669 | 3099 | 2717 |
| Mean | 2642 | 2625 | 2768 | 2546 | 2323 | 2535 | 2899 | 2620 |

Discussion

The average yields of all varieties tested were quite close to the mean for the entire experiment. Only the yield of the Black Turtle beans on the Woodburn soil was substantially below the other varieties. Some blight was evident in this variety which may have accounted for the suppression in yield.

All varieties matured within 100 days except the Black Turtle beans. These required approximately 110 days. Petroleum mulch increased the yields approximately 8% on the Dayton soil, but only increased the yields 3% on the Woodburn soil. The mulching could not be considered significantly different from the check on the Woodburn soil. The petroleum mulching may be more effective on the Dayton soil.

# FORAGE LEGUMES

T. L. Jackson

The forage experiment was initiated in the summer of 1963 to evaluate the effect of lime and fertilizer treatments and irrigation on the production and species stabilization of Granger lotus and New Zealand white clover.

The experiment was designed as a multiple-split block with each replication having two irrigation treatments as the main blocks. Each of these blocks was split into two blocks for species and each species block was split for the two lime variables. The treatments applied on the sub-plots within each of the four replications are shown in Table 20.

Table 20. Treatments Used in the Forage Legume Experiment

| 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. | $P_2K_2Mo_1$ |
| 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. $P_2O_5$ per acre respectively; $K_1$, $K_2$ = 60, 120 lbs. $K_2O$ per acre; $Mo_1$, $Mo_2$ = 0.4, 0.8 lbs. Mo per acre; 40 lbs. S per acre and 2 lbs. B per acre on all plots.

All of the phosphorus and one-half of the potassium was applied in the fall of 1964. The other one-half of the potassium was applied after the first cutting and harvested in mid-May. Irrigation treatments were applied with a sprinkler system, using part-circle sprinklers. A total of 14.5 inches of water was applied on the irrigated plots.

Table 21. Yields* of New Zealand White Clover and Granger Lotus in Tons per Acre, Dry Weight

| Treatment | | Lime rate | White clover Nonirrigated | White clover Irrigated | Lotus Nonirrigated | Lotus Irrigated |
|---|---|---|---|---|---|---|
| | | | T/A | T/A | T/A | T/A |
| 1. | $P_0K_2Mo_1$ | 0 | 3.74 | 5.40 | 3.15 | 6.41 |
| | | 1 | 3.63 | 4.90 | 3.74 | 7.18 |
| 2. | $P_1K_2Mo_1$ | 0 | -- | 5.99 | -- | 6.22 |
| | | 1 | -- | 5.26 | -- | 6.82 |
| 3. | $P_2K_2Mo_1$ | 0 | 3.65 | 5.85 | 3.15 | 6.55 |
| | | 1 | 3.59 | 5.96 | 3.73 | 7.21 |
| 4. | $P_2K_1Mo_1$ | 0 | 3.42 | 5.01 | 3.22 | 6.13 |
| | | 1 | 3.16 | 5.04 | 3.46 | 6.71 |
| 5. | $P_2K_0Mo_1$ | 0 | 2.87 | 5.06 | 2.90 | 4.81 |
| | | 1 | 2.72 | 3.91 | 3.05 | 5.14 |
| 6. | $P_0K_0Mo_1$ | 0 | 3.10 | 4.82 | 2.56 | 6.20 |
| | | 1 | 2.91 | 4.13 | 2.86 | 6.27 |
| 7. | $P_2K_2Mo_0$ | 0 | -- | 5.31 | -- | 5.64 |
| | | 1 | -- | 5.42 | -- | 6.46 |
| 8. | $P_2K_2Mo_2$ | 0 | -- | 5.82 | -- | 6.04 |
| | | 1 | -- | 5.56 | -- | 7.04 |

* Average of four replications. Plot yields are frequently a little higher than field yields.

The New Zealand white clover plots were harvested on May 15, June 2, July 7, and September 17. The Granger lotus plots were harvested on June 2, July 7, and September 17. The nonirrigated plots were not harvested on September 17 because of poor regrowth. The most important yield effects obtained during 1965 from this experiment are shown in table 21 and summarized in table 22.

## Discussion

The yields from the irrigated forage crops were excellent where the proper fertilizer materials were applied and successful nodulation was achieved. The excellent stand and nodulation were undoubtedly the major factors contributing to the high yields of the lotus. Irrigation was necessary to insure adequate yields and species stabilization. Loss of stand in both species has occurred on the nonirrigated treatments.

Table 22. Summary of the Yields of New Zealand White Clover and Granger Lotus

| Treatment | White clover | | | Granger lotus | | |
|---|---|---|---|---|---|---|
| | No lime | Lime | Mean | No lime | Lime | Mean |
| | T/A | T/A | T/A | T/A | T/A | T/A |
| Irrigated | 5.23 | 4.78 | 5.01 | 6.02 | 6.50 | 6.26 |
| Not Irrigated | 3.36 | 3.20 | 3.28 | 3.00 | 3.37 | 3.18 |
| | $K_0$ | $K_2$ | Mean | $K_0$ | $K_2$ | Mean |
| | T/A | T/A | T/A | T/A | T/A | T/A |
| Irrigated | 4.48 | 5.56 | 5.02 | 5.60 | 6.84 | 6.22 |
| Not Irrigated | 2.90 | 3.65 | 3.28 | 2.84 | 3.44 | 3.14 |

The following observations can be made concerning these results:

1. The biggest yield difference is obtained from irrigation.

2. Lotus shows a positive response to lime.

3. Both legume species show a response to potassium with or without irrigation.

4. The response to potassium application is greatest when the legumes are irrigated.

5. The response of white clover to phosphorus under irrigation may be significant.

# WHEAT

W. H. Foote and G. O. Klock

Two experiments involving the use of wheat were conducted in 1966. The first experiment was set up on Dayton soil (Jackson Farm) to determine the effect of surface drainage on the yield of wheat. This was the second planting of wheat in the Jackson Farm program. The second wheat experiment was conducted on Woodburn soil (Hyslop Farm). The objective of this experiment was to measure the response of Druchamp winter wheat to various levels of spring-applied nitrogen fertilizer with and without supplemental irrigation.

## DAYTON SOIL EXPERIMENT

In 1965, wheat was grown on Dayton soil with an improvised surface drainage system. Good yields were obtained (2.5 tons per acre). To examine the influence of surface drainage more closely, an experiment was established in the fall of 1965 to compare surface-drained plots with plots for which no drainage was provided.

The wheat on the surface-drained plots was planted on six-foot-wide beds constructed with a contour disc. The nondrained area was tilled and planted by conventional methods. These plots are shown in Figures 4 and 5 as they appeared early in the spring and again in Figures 6 and 7 as they appeared late in the spring. Two replications were provided. The variety Druchamp was planted October 26, 1965, at the rate of 100 pounds of seed per acre. One hundred pounds per acre of 16-20-0 was banded at the time of planting. In the spring, 375 pounds per acre of 33.5-0-0 was broadcast on all plots. Five inches of irrigation water was applied by the sprinkler method in the spring.

The average yield for the nondrained plots was 1.75 tons per acre (58.4 bu/A) and for the surface-drained plots 2.75 tons per acre (91.8 bu/A).

Thus, by providing a limited amount of drainage which can be accomplished with surface drainage, a yield increase of one ton per acre was obtained. On the nondrained plots, the yield was suppressed by the drowning of many plants during the winter wet period.

## WOODBURN SOIL EXPERIMENT

The objective of this experiment was to determine the effect on yield of Druchamp wheat of different levels of irrigation and spring-applied nitrogen.

Levels of treatments used:

(1) Three irrigation levels.

$W_0$ - no irrigation.

$W_1$ - irrigate shortly before the bootstage.

$W_2$ - irrigate shortly before the bootstage with subsequent irrigations to be applied when the soil water suction exceeds 1 bar, 12 inches below the surface.

(2) Four nitrogen levels.

$N_1$ - 50 pounds of nitrogen per acre.

$N_2$ - 100 pounds of nitrogen per acre.

$N_3$ - 150 pounds of nitrogen per acre.

$N_4$ - 200 pounds of nitrogen per acre.

The Druchamp wheat was seeded in late October 1965, and fertilized uniformly with 40 pounds of nitrogen per acre in the form of ammonium sulfate, after the wheat had emerged. The spring-applied fertilizer was broadcast by hand on April 1, 1966, at the four indicated rates. The source of nitrogen used was ammonium nitrate.

Water was applied with part-circle sprinklers, and the water requirements were determined with the use of electrical resistance units (gypsum blocks) installed at a depth of 12 inches in the soil. The size of the irrigation plots was 40' x 40' and the size of the fertilizer plots was 10' x 40'. The experimental design was a 3 x 3 Latin square with the four fertilizer treatments as a split plot. The plots were harvested by combine; weights were obtained in the field from which later the yields were computed. The amount of water applied was 0 inches on the $W_0$ treatment, 3 inches on the $W_1$ treatment, and 6 inches on the $W_2$ treatment. Yields are reported in Table 23.

Table 23. Yield of Druchamp Wheat in Bushels per Acre

| Treatment | Nitrogen Treatments $N_1$ | $N_2$ | $N_3$ | $N_4$ | Mean |
|---|---|---|---|---|---|
| | Bu/A | Bu/A | Bu/A | Bu/A | Bu/A |
| $W_0$ | 77.4 | 93.5 | 102.5 | 99.7 | 93.3 |
| $W_1$ | 76.4 | 91.3 | 101.0 | 102.8 | 92.9 |
| $W_2$ | 84.9 | 96.1 | 102.7 | 104.3 | 97.0 |
| Mean | 79.6 | 93.6 | 102.1 | 102.3 | |

Discussion

The increase in yield obtained from the supplemental irrigations was small. The increase was about 10% on the plots with the lowest nitrogen rate, and about 5% on the plots with the highest nitrogen rate. The increase in yield obtained from the nitrogen increments is shown in Table 24.

Table 24. Yield Increase Obtained from Nitrogen Fertilizer in Bushels Per Acre

| Treatment | Nitrogen Increment 50 - 100 | 100 - 150 | 150 - 200 | Mean |
|---|---|---|---|---|
| | Bu/A | Bu/A | Bu/A | Bu/A |
| $W_0$ | 16.1 | 9.0 | -2.8 | 7.4 |
| $W_1$ | 14.9 | 9.7 | 1.8 | 8.8 |
| $W_2$ | 11.2 | 6.6 | 1.6 | 6.5 |
| Mean | 14.1 | 8.4 | 0.2 | |

Table 24 indicates that little benefit was obtained from the last 50 pounds per acre nitrogen increment. This was true on all irrigation treatments. The table also indicates that a heavy nitrogen application is a more efficient means of increasing yield than is irrigation.

Figure 4. Druchamp wheat planted on six-foot-wide beds, photographed in early February. Note the good stand of wheat on the ridges as well as in the shallow drainage ways.

Figure 5. Druchamp wheat planted on six-foot-wide beds, photographed in the middle of May. Dr. Foote points to wheat yielding about 92 bushels per acre.

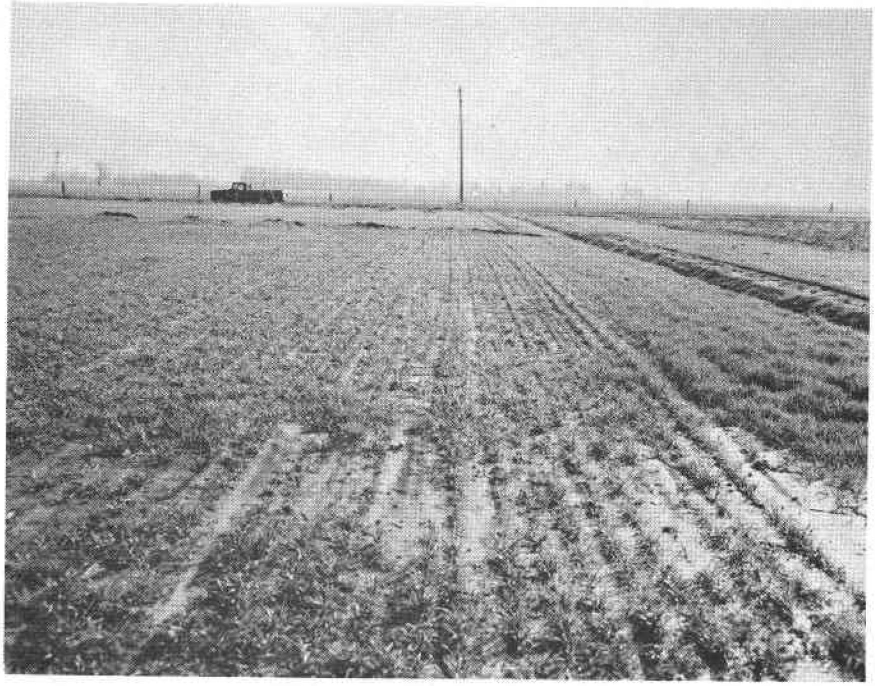

Figure 6. Druchamp wheat planted by conventional methods, photographed in early February. Note the poor stand of wheat. The surface-drained plots can be seen in the background.

Figure 7. Druchamp wheat planted by conventional methods, photographed in the middle of May. The poor stand is the result of water logging and possibly manganese and aluminum toxicity.

# POTATOES

G. O. Klock

The objective of this experiment was to determine the optimum moisture level for potato production on a heavy soil such as the Amity soil (Jackson Farm). Four varieties of potatoes were irrigated at three moisture levels with three replications. Before planting, 150 pounds per acre of muriate of potash were broadcast. At planting time, 400 pounds per acre of 11-48-0 was banded and 200 pounds per acre of 33.5-0-0 was broadcast after planting. Eptam was used for weed control. All varieties were planted June 2 and harvested October 10. Irrigation water was applied with part-circle sprinklers on 40' x 40' experimental blocks. The row spacing was 36 inches for all varieties.

Levels of treatments used:

(1) Three levels of irrigation.

$W_0$ - no irrigation.
$W_1$ - irrigate at a tension of 1.5 bars at the tuber depth.
$W_2$ - irrigate at a tension of 0.5 bars at the tuber depth.

(2) Four varieties.

$V_1$ - Netted Gems.
$V_2$ - Kennebec.
$V_3$ - Red Pontiac.
$V_4$ - Catadin.

The $W_1$ treatment received 10.1 inches of irrigation water and the $W_2$ treatment received 14.5 inches. Yields are reported in Table 25.

Table 25. Average Yield of Potatoes in Tons per Acre

| Treatment | Variety | | | | |
|---|---|---|---|---|---|
| | Netted Gems | Kennebec | Red Pontiac | Catadin | Mean |
| | T/A | T/A | T/A | T/A | T/A |
| $W_0$ | 3.08 | 5.80 | 3.20 | 4.72 | 4.20 |
| $W_1$ | 15.79 | 16.15 | 11.19 | 12.46 | 13.90 |
| $W_2$ | 15.97 | 22.02 | 12.76 | 15.07 | 16.45 |
| Mean | 11.61 | 14.99 | 9.05 | 10.75 | 11.52 |

Discussion

Irrigation increased the potato yields considerably. An additional benefit of the application of irrigation water was the improvement in the quality of the potatoes. Of the yields on the nonirrigated plots only about 10% by weight were number 1 potatoes. On the wettest treatment the percentage of number 1 potatotes was about 75%.

The yields obtained in 1966 were less than those reported for 1965. Yields in 1966 were adversely affected by an occurrence of leaf roll diesease and blight, particularly in the Red Pontiac variety.

## SWEET CORN ON FALL-RIDGED PLOTS

G. O. Klock

In 1964 an experiment was established to compare the yields of field corn for grain grown on soil ridged during the winter with the yields of grain corn grown on normal "flat" land. This experiment was repeated in 1965. Both years there were no significant differences between treatments. In 1966 sweet corn was used as the experimental crop. To obtain the ridged plots, the soil is ridged in the fall with a contour border disc to form 18-inch high "ridges" spaced 6 feet from center to center. The ridges were constructed on randomly selected plots with four replications. To prevent the ridged area from draining the adjacent flat areas, plastic barriers were inserted to a depth of three feet. The ridges were removed in the spring by inverting the contour disc. Then both the ridged area and the flat area were cultivated in the same manner.

The two experimental treatments were:

(1) Two soil surface conditions maintained through the 1965-1966 winter.

R - ridges installed in the fall.

F - flat throughout the winter.

(2) Two lime levels on each soil surface condition.

$L_0$ - no lime.

$L_1$ - limed at the rate of 3 tons per acre, fall 1963 and

1 ton per acre, fall 1965.

The sprinkler method of irrigation was used on this experiment to apply 14.5 inches of water during the growing season. One hundred and fifty pounds of muriate of potash per acre was broadcast before planting. Four hundred pounds of 16-48-0 per acre was banded at planting and 200 pounds of 33.5-0-0 was broadcast after planting. Eptam at the rate of 215 pounds per acre was used for weed control. The row spacing was 36 inches on all treatments. The seed was planted May 4 and the ears were picked August 29. Yields are shown in Table 26.

Table 26. Average Yield of Sweet Corn in Tons per Acre

| Lime | Fall Treatment | | Mean |
|---|---|---|---|
| | Ridged | Flat | |
| | T/A | T/A | T/A |
| $L_0$ | 6.94 | 6.74 | 6.84 |
| $L_1$ | 7.92 | 7.58 | 7.75 |
| Mean | 7.45 | 7.16 | 7.31 |

## Discussion

Even though the spring was quite dry so that poor drainage was no problem in the flat area, a significant increase in yield was obtained both from ridging in the fall and from the use of lime. There was an increase of approximately one ton per acre of corn with the use of lime.

## STRAWBERRIES

G. O. Klock

One thousand strawberry plants (variety:Northwest) were planted on Dayton soil (Jackson Farm). The planting date was May 17, 1966. Approximately one-half of the seedlings were planted in double rows on beds five feet wide and one foot high. The rest of the plants were planted on a conventional seedbed. The beds were conceived as a means to provide the plants with a permanent shallow drainage system. The width of the beds was selected so that the number of plants per acre was equal to that of the conventional seedbed.

During the growing season, 13 inches of irrigation water was applied by the sprinkler method. On September 14, 300 pounds per acre of muriate of potash and 500 pounds per acre of 16-20-0 was broadcast on both treatments.

Yield measurements will be taken in the spring of 1967.

# DRAINAGE EXPERIMENT

D. G. Watts and D. T. Westermann

To investigate the feasibility of improving the drainage conditions of the Dayton soils in the spring, a small experiment was intiated in the summer of 1965. The experimental arrangement is shown in Figure 8. Eight 50' by 60' soil blocks were surrounded with a vertical sheet of heavy plastic. The plastic wall was inserted in trenches three feet deep and penetrating well into the impermeable clay horizon. This arrangement provides essentially 8 "boxes" into which or out of which no water can move from surrounding areas. Several plots or "boxes" were then provided with their own drainage system as shown in the diagram. The efficiency of the several systems as shown in the diagram. The efficiency of the several systems is being evaluated. The criteria used for this evaluation are: control of the water table, water contents of the soil in the spring, and the exchangeable manganese content of the soil throughout the winter.

## Manganese concentrations

During the first year of the program of experimentation on the Jackson Farm, very poor results were obtained with a planting of bush beans. Most of the seedlings died after an initial vigorous growth. T. L. Jackson and co-workers associated the loss of the many plants with a high concentration of exchangeable and water-soluble manganese oxide. The high concentration of this toxic oxide is the result of a chemical conversion which occurs when the soil is poorly aerated. If for no other reason therefore, drainage is a very necessary practice to avoid these poorly aerated conditions.

During the winter of 1965-1966, the change in the concentration of water soluble and exchangeable manganese was followed by means of a systematic sampling. The results of these samplings are shown in Figure 9. Similar results obtained in the spring of 1967 are also shown.

In the drained plots, the concentration did not change much throughout the winter, and remained much lower than the concentrations which are considered toxic for such plants as beans. In the undrained plots, however, the manganese concentrations increased rapildly as soon as the fall rains started. In the soil layer, 0 to 3 inches thick, the manganese concentration reached a maximum value of 0.26 milliequivalents per liter in the early part of February and remained more or less constant at that level until the soil started to dry out during the month of April. Once the evaporation rate increased and the rain storm frequency decreased, the concentration in the surface layers declined rapidly. In the soil layer 3 to 6 inches thick, the manganese concentration continued to increase throughout the winter and early spring, and reached values much higher than those measured in the 0 to 3 inch soil layer. The soil layer at a depth of 3 to 6 inches does not dry out nearly as rapidly as the surface layers in the spring, and, as a result, reduction of manganese continues well into the spring. Measurements were not made below the 6-inch depth.

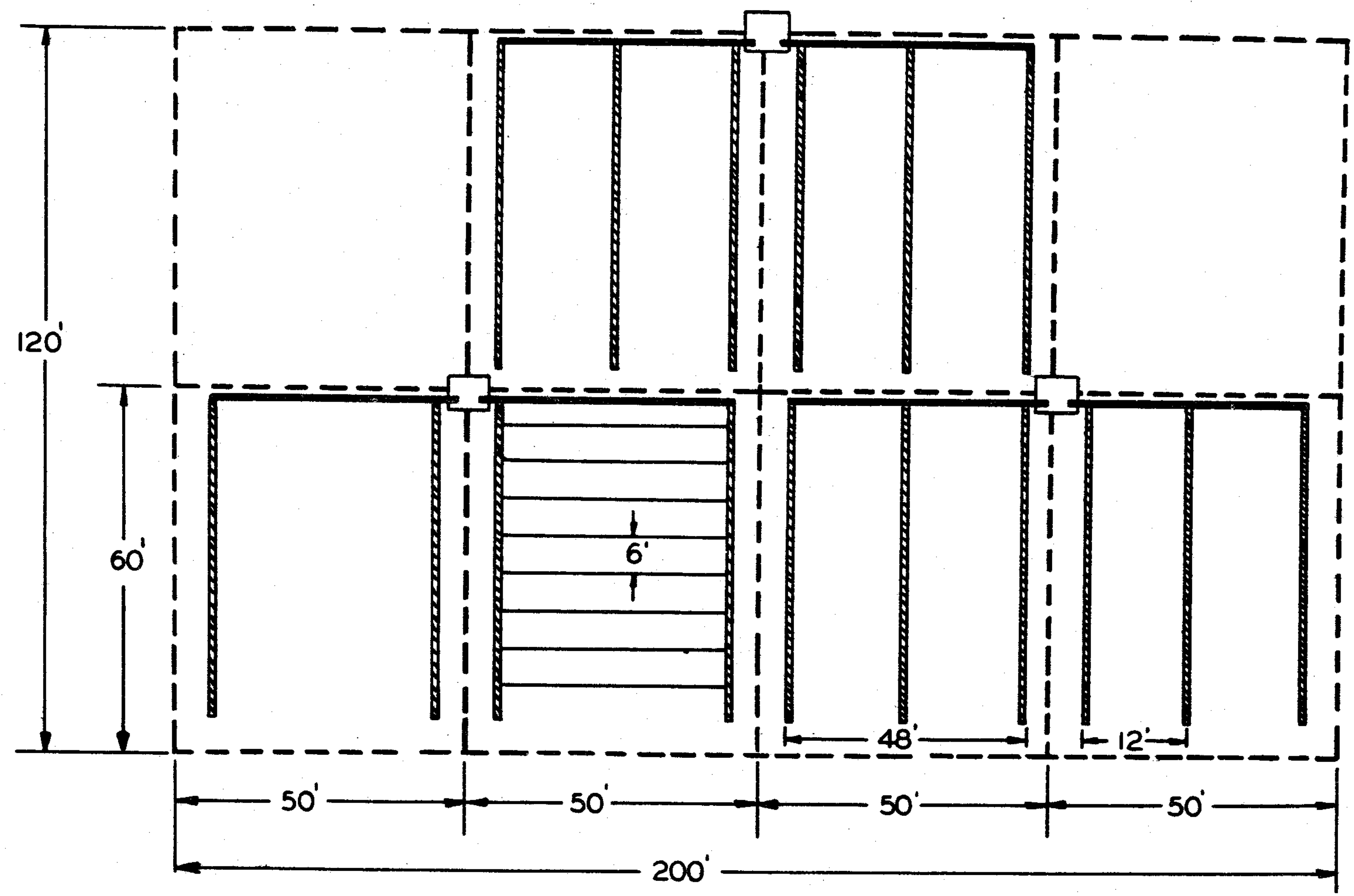


Figure 8. Layout of the drainage experiment on the Jackson Farm. Drainage water is collected in manholes and then pumped outside the experimental area. : closed drain; : plastic drain; : plastic barrier; : mulched channel between drains; : manhole from which water is pumped outside the plots.

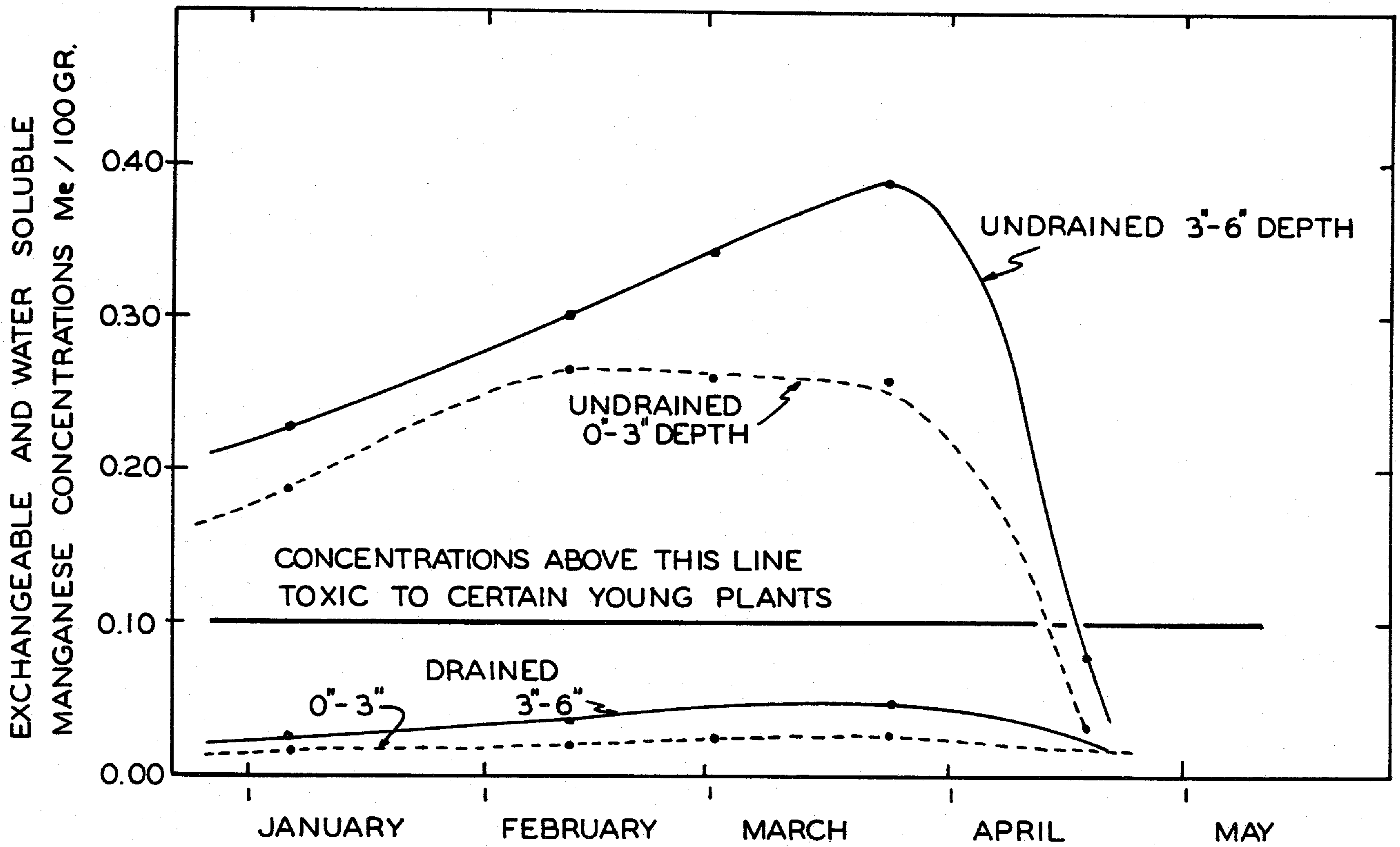


Figure 9. Manganese concentrations determined on drained and undrained plots during the spring of 1966. Samples were taken at a depth of 0 to 3 inches, and a depth of 3 to 6 inches. Note that the concentrations on the drained plots never reached the toxic level.

It is quite clear that manganese toxicity can arise, either because the seeds germinate in the soil from the 0 to 3 inch level which has been plowed up or because the roots of the seedlings very rapidly penetrate the soil below the plow layer, in which the oxidation of the reduced manganese proceeds much more slowly than it does in the upper layers. This latter situation seems to be the reason for the failure of a crop such as beans on these soils.

Performance of the drainage system

To evaluate the performance of the drainage systems, water-stage recorders were installed on observation wells located at the midpoint of the drainage lines. Figure 10 illustrates the water table conditions on the plots without drains. Ponded or near ponded conditions existed almost through the entire winter and early spring. Beginning with March 23 and continuing to the end of the month, the weather was dry and warm with a corresponding increase in evaporation, and the water table declined as a result. Figure 11 shows the fluctuation of the water table at the midpoint between the tiles on two plots drained with the 1.6-inch perforated plastic tile. The figure indicates that there was little difference between the drainage systems with and without organic backfill. The low hydraulic gradients, resulting from the shallow depth of the drains, are much more important in the determination of the flow rates than the permeability of the backfill material. Figure 12 shows a comparison of the water tables with 2-inch drains on a 45-foot spacing, with and without vertical mulch channels. The water table was consistently lower in the vertical mulched treatment throughout the winter months. The more rapid removal of water from the mulched plots shows that organic channels increased the flow rate to the drains.

Results of this study lead to the following observations:

1. Plastic drains installed at shallow depths did a good job of removing water from the "A" horizon of a planosol, particularly the Dayton soil series.

2. Organic backfill seems to have little advantage over top soil backfill in increasing the rate of water removal.

3. Vertical mulch channels appear to hold promise as a means of increasing the effectiveness of drainage. It is, however, necessary to establish the effective life of the mulch.

4. On the drained plots, the manganese concentrations were drastically reduced. It may be that the most important function of drainage on Dayton soil is to maintain a low concentration of reduced manganese.

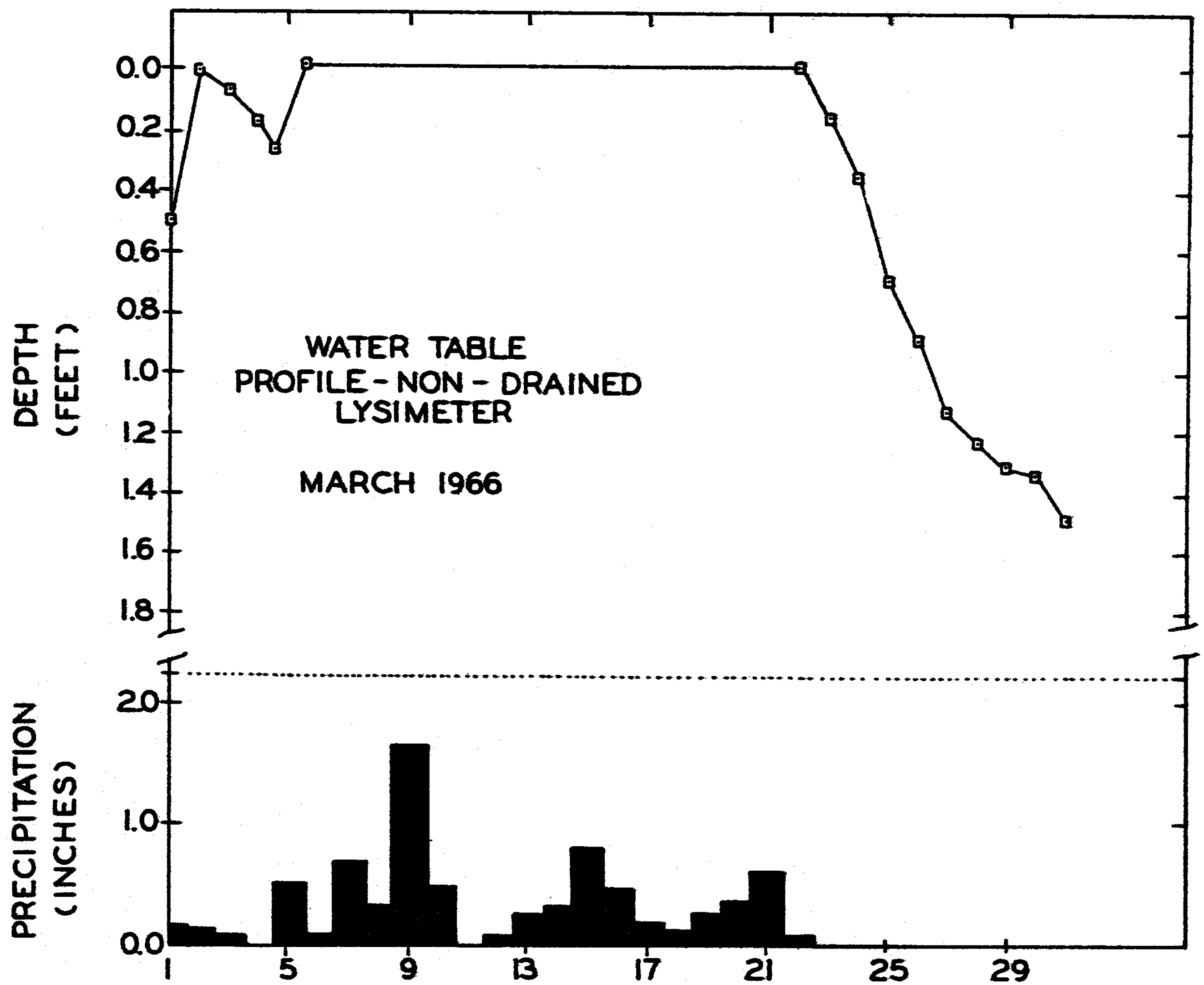


Figure 10. The water table on undrained plots, observed during March 1966. Towards the end of the month the weather was dry and warm and the water table declined rather rapidly as a result of evaporation.

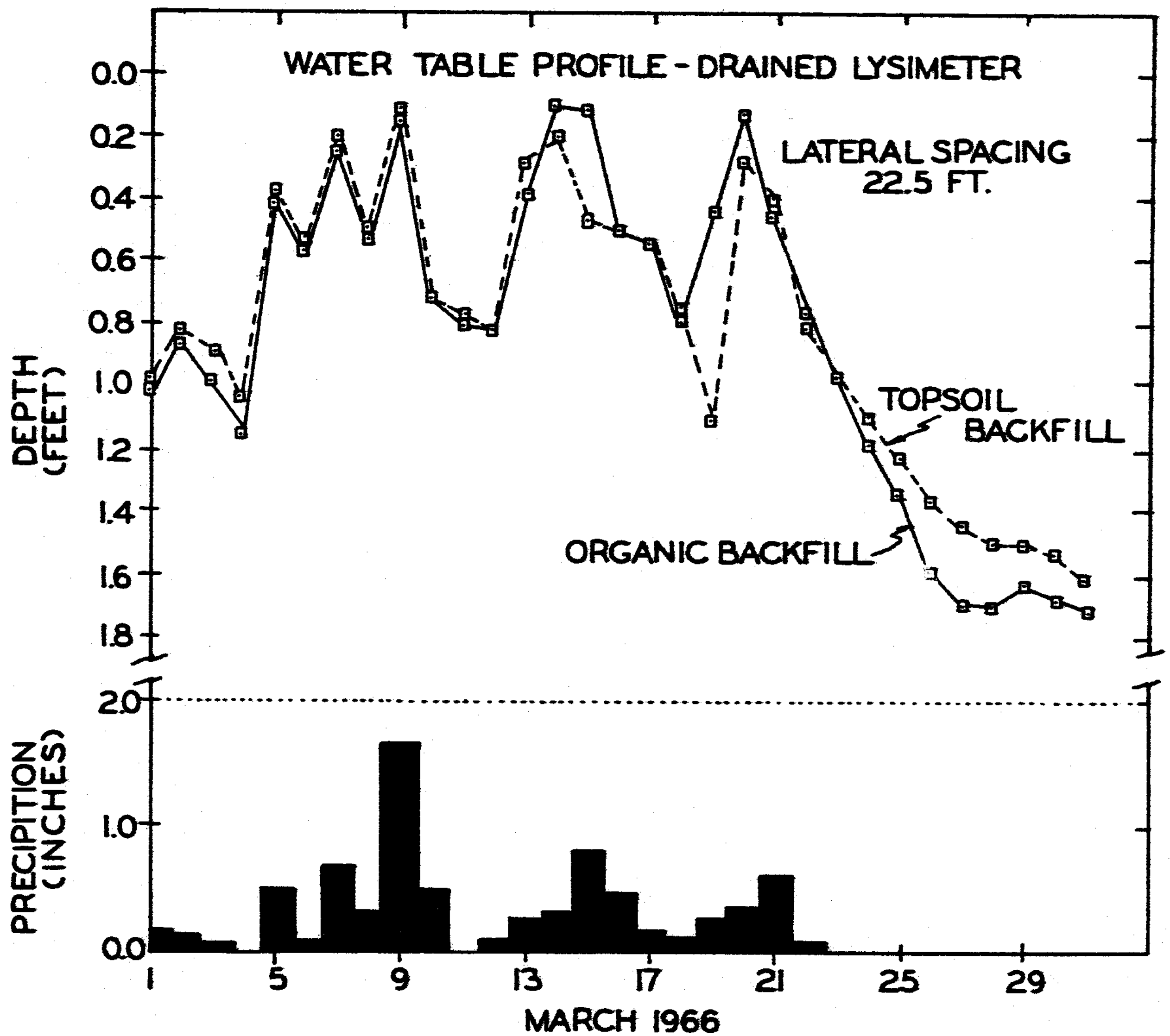


Figure 11. Water table elevations observed on plots, drained with 1.6 inch diameter plastic tile, installed at a depth of 18 inches with a spacing of 22.5 feet. The observations indicated little difference between the drainage systems with and without organic backfill.

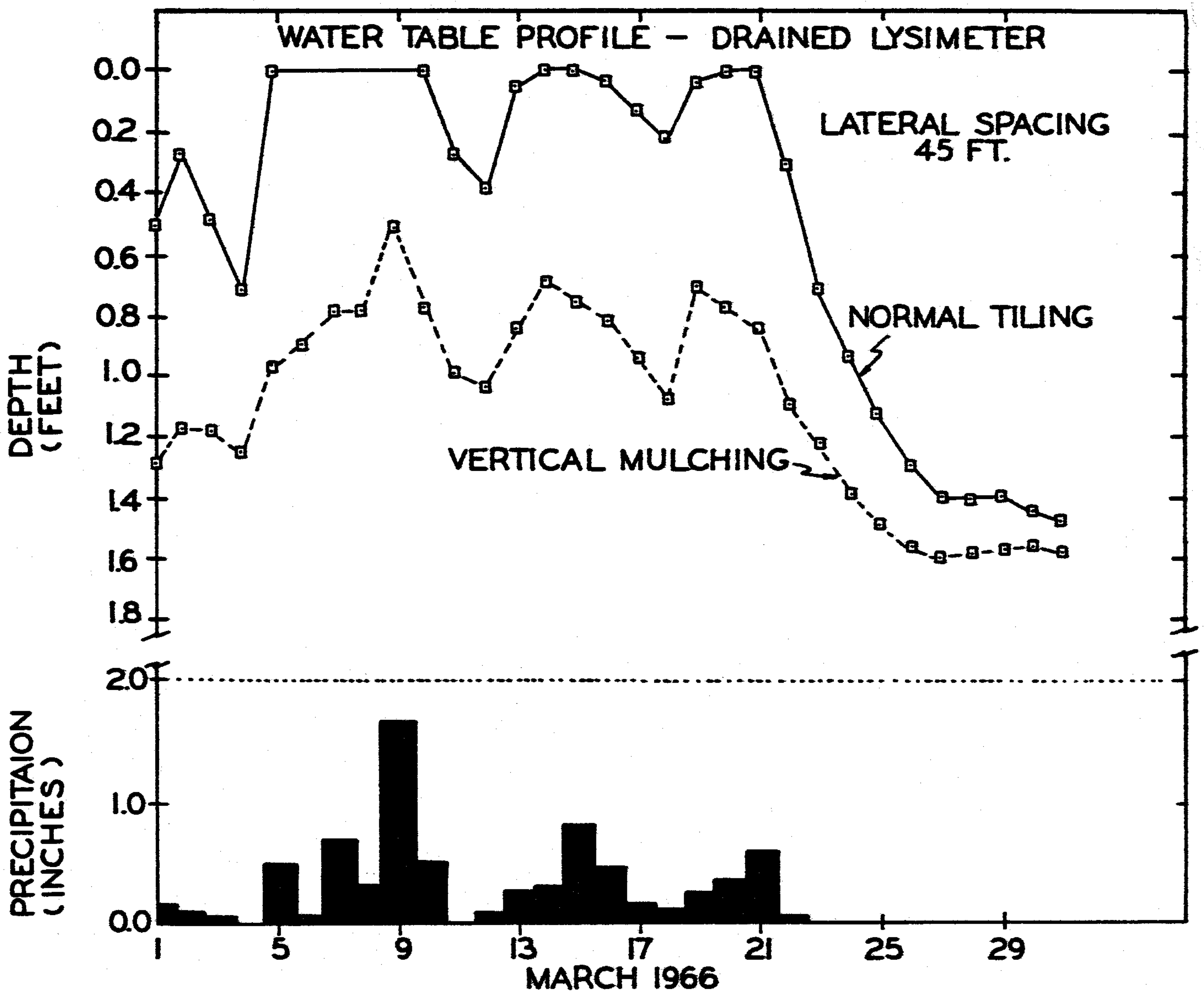


Figure 12. Water table elevations observed on plots drained with 2.0 inch diameter perforated pipe, installed at a depth of 18 inches with a spacing of 45.0 feet. The vertical mulching tratment improved drainage considerably.