FERTILIZER RATES VERSUS PLANT AND ROW SPACING

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For best health, it takes a certain amount of the right kind of food to serve a given number of people. It takes a definite amount of the right kind of feed to maintain a heard of cattle. Everyone who serves people or fattens livestock thinks in terms of "so much" per individual. There has been a lot of talk about so many pounds of nitrogen, P_2O_5 and K_2O per acre without taking into consideration the number of potato plants or the expected harvest date. Plants can be killed (matured) by insects and diseases, low temperatures, toxic chemicals, mechanical means, by lack of water, and by starvation - generally, starvation for nitrogen. Most potato plants are killed by something. They don't just die.

Most potato growers have worked out their own cultural practices. Distances between rows vary from 32 inches to 36 inches. Thirty-four inches between rows is common. Plant spacings within the row vary from about 7 inches to 12 inches, with 10 to 11 inches between plants being common. The relationships between distance between plants, distance between rows and amount of nutrients applied is shown in Table 1. It can be seen that almost the same amount of nutrients per plant can be achieved by using different combinations of plant spacing, row spacing and fertilizer rates. Fertilizers must function in conjunction with other factors before the greatest return per dollar invested can be realized.

Many studies have been made to determine the best plant and row spacing and fertilizer rates for a particular area, but the growing conditions of the Columbia Basin are unique. There are upward of 150 frost-free, bright sunny days, irrigation water is plentiful, and most soils are light and well aerated silty loams which are ideal for plant growth. Under these conditions it is not surprising that Washington usually leads the nation in highest potato yields per acre.

Yield per unit of time has often been omitted from discussions of fertilizer recommendations. This becomes especially important when potatoes are intended for early or mid-season harvest. In these cases fertilization for maximum yields is not only wasteful of fertilizer but frequently costly because of low yields.

The potatoes were planted on April 28, 29 and 30 with the WSU press-wheel potato planter. All of the fertilizers were applied in bands about two inches to the side and two inches below the seed piece at planting time. The soil was definitely on the dry side and the potatoes had to be irrigated "up". The first irrigation was applied in alternate furrows on May 18. The water remained in the furrows for 24 hours. Those furrows which were not irrigated on May 18 were irrigated for the first time on May 27. One inch of rain fell on June 7 and 8. The plants were well up on June 17 after having been scorched by frost on May 22.

On July 1 all furrows received water for 12 hours, and on July 2 the experiment was placed on a 5-day water rotation until August 5, at which time a 7-day water rotation was put into effect. On September 10 irrigation was stopped for the season. This turned out to be too early and the soil became too dry, because no rain occurred between that time and October 12 when the potatoes were harvested.

Effect on early growth: The plants fertilized with 938 pounds per acre of triple 16 fertilizer came up first and made the most rapid growth early in the season. As the amount of fertilizer increased from the 938 pound rate to the 3750 pound rate, plants were progressively slower to emerge and the rate of growth early in the season also was slower than at the lower rates of fertilization.

Effect on length of plant life: The amount of fertilizer used had a definite effect on the time of dying of the vines. The experiment was planted on April 30. Plants receiving 938 pounds per acre of triple 16 fertilizer were almost dead by the first of September (120 days). Those receiving the 1875 pound rate were dead by about September 15 (135 days); those receiving the 2813 pound rate were almost dead by October 1 (150 days), and those receiving the 3750 pound per acre rate were dead by October 15 (165 days). There was considerable difference in earliness of death within a given fertilizer rate. The plants at the closer spacing died sooner than those at the wider spacings.

Effect of row spacing and fertilizer rates on total yield: The yields in the tables to a degree reflect the length of life of the plants. Table 2 shows the data for yield. At the 30 and 32 inch row spacings, yields increased as the amount of fertilizer applied increased, but at the 34 and 36 inch row spacings, yields appear to increase and then decrease. The apparent decrease in yield occurred at a lower fertilizer rate at the 36 inch spacing than at the 34 inch row spacing.

Percentage grade: The data for percentage grade are shown in Table 3. As the rate of fertilizer increased and the distance between rows increased, the percentage of No. 1 grade tubers decreased. The decrease in percentage grade become greater as the amount of fertilizer and the distance between rows increased.

The loss of grade resulting from the use of large quantities of fertilizer in this experiment is of particular interest because suce a large decrease in grade did not occur in another experiment on land with a similar crop and fertilizer history, but which had been pre-irrigated (see Table 5 in the article entitled "Results of 1963-1964 Fertilizer Trials With Russet Burbank Potatoes" in these Conference Proceedings). Triple 16 fertilizer was used in both experiments.

Effect of plant spacing and fertilizer rates on total yield: The effect of plant spacing within the row is shown in Table 4. When the plants in the row were 6.6 and 7.8 inches apart, the highest yield was obtained with the highest rate of fertilizer application. When the plants were 9.2 and 11 inches apart in the row, yield increased as rate of fertilization increased, but appeared to reach a maximum and then decreased. The effect was more pronounced at the 11.1 inch spacing than at the 9.2 inch spacing.

Percentage grade: The effect of plant spacing and fertilizer rates on percentage grade is shown in Table 5. As the distance between plants increased and as the fertilizer rate increased, there was a decrease in the per cent of No. 1 grade potatoes.

Summary

From this study it is evident that rate of fertilization, distance between rows, and distance between plants all can influence total yield, percentage grade and longevity of the plants. However, it should also be pointed out that position

in an experiment also can have a large effect on yield and grade (Table 6).

The data show the differences in yield and grade of equal sized areas within an experiment. Position in the experiment made a difference in total yield among the 8 blocks as large as 75 CWT per acre and a difference in percentage grade as large as 8 percent. Individual plots receiving the same treatment differed in total yield by 80 percent.

The closer spacings, both between the plants and between the rows, resulted in higher total yields and a higher percentage of No. 1 grade potatoes than the wider spacings.

The effect of seed and row spacing on yield and grade emphasizes the necessity of having a good stand of plants to obtain high yields with a high percentage grade-out. As area per plant increased, the loss of grade was greater than the loss in total yield.

To make an adequate fertilizer recommendation, one must know the fertility status of the land, the market season for which the crop is intended, and the row and plant spacing used by the grower.

Table 1. The relationship between plant spacing, row spacing, plants per acre and nutrients per plant.

Plant spacing	Row spacing	Plants/acre	Nutrients, pounds per plant *			
			Rate 1	Rate 2	Rate 3	Rate 4
6.6	30	31,680	.014	.028	.043	.057
7.8	30	26,806	.017	.034	.050	.067
9.2	30	22,735	.020	.040	.059	.079
11.1	30	18,841	.024	.048	.072	.096
6.6	32	29,714	.015	.030	.046	.061
7.8	32	25,136	.018	.036	.053	.072
9.2	32	21,311	.021	.042	.063	.085
11.1	32	17,664	.026	.051	.076	.102
6.6	34	27,959	.016	.032	.048	.064
7.8	34	23,648	.019	.038	.057	.076
9.2	34	20,055	.023	.045	.067	.090
11.1	34	16,620	.027	.054	.081	.108
6.6	36	26,400	.017	.034	.050	.068
7.8	36	22,338	.020	.040	.060	.081
9.2	36	18,939	.024	.043	.071	.095
11.1	36	15.697	.029	.057	.086	.115

* Rate 1 was 150 lb/acre of nitrogen P_2O_5 and K_2O.
Rate 2 was 300 " " " " "
Rate 3 was 450 " " " " "
Rate 4 was 600 " " " " "

Table 2. Effect of distance between rows and rate of fertilization on total yield.

Triple 16* lb/acre	Inches between rows 30 CWT/A	32 CWT/A	34 CWT/A	36 CWT/A	Mean CWT/A
938	528	554	549	560	548
1875	626	632	616	653	632
2813	633	635	666	630	641
3750	650	658	653	632	648
Mean CWT/acre	609	619	621	619	

* Average distance between plants, 8.7 inches.

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Table 3. Effect of distance between rows and rate of fertilization on percent No. 1 grade potatoes.

Triple 16* lb/acre	Inches between rows 30 % No. 1	32 % No. 1	34 % No. 1	36 % No. 1	Mean % No. 1
938	70	71	70	70	70
1875	69	67	64	60	65
2813	67	64	56	56	61
3750	64	57	50	48	55
Mean % No. 1	67	65	60	58	

* Average distance between plants, 8.7 inches.

Table 4. Effect of plant spacing and rate of fertilization on total yield.

Triple 16* lb/acre	Distance between plants - inches 6.6 CWT/A	7.8 CWT/A	9.2 CWT/A	11.1 CWT/A	Mean CWT/A
938	565	559	541	526	548
1875	647	659	613	608	632
2813	642	655	643	624	641
3750	695	673	617	608	648
Mean CWT/A	637	636	603	591	

* Average distance between rows, 33 inches.

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Table 5. Effect of plant spacing and rate of fertilization on percentage grade.

Triple 16* lb/acre	Distance between plants - inches 6.6 % No. 1	7.8 % No. 1	9.2 % No. 1	11.1 % No. 1	Mean % No. 1
938	73	73	69	67	70
1875	67	67	61	64	65
2813	63	61	60	60	61
3750	58	57	52	52	55
Mean % No. 1	65	64	60	60	

* Average distance between rows, 33 inches.

Table 6. Effect of location in the field on yield and grade.

Block No.	Total Yield CWT/acre	Per cent No. 1	Block No.	Total Yield CWT/acre	Per cent No. 1
1	625	62	6	617	63
2	601	63	7	662	64
3	590	58	8	665	65
4	635	64	9	611	59
5	629	66			