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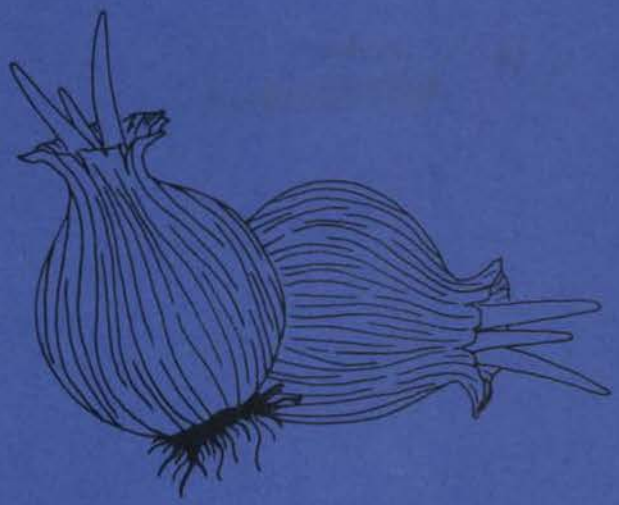

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The Effect of Nitrogen, Phosphorus, Potassium and Micronutrients On Yield, Grade and Storage of Onion Bulbs In Southwestern Idaho

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Introduction

Onion bulb production in southwestern Idaho ranged from about 3,700 to 4,200 acres harvested and about 1,684,000 to 1,978,000 cwt production per year for the years 1969 to 1971. The crops produced a gross income to onion growers of $4,620,000 to $7,163,000 per year. Yields ranged from 455 to 465 cwt per acre (3).

Because climate, soils and available nutrients differ greatly between areas, nutritional studies in onion bulb production in southwestern Idaho were needed to provide onion growers with information to predict and use the correct kind and rate of plant nutrients to improve efficiency in onion bulb production and to improve quality and storage.

The objectives of this study were to determine the kind and rate of fertilizers needed to produce onion bulbs and to obtain soil and plant analysis data for use in predicting need of nutrients in onion production.

Literature Review

Some research in southwest Idaho has shown no benefits from applications of nitrogen, phosphorus and potassium in commercial onion bulb production (5). Other research has indicated that the onion root system is comparatively limited, the feeding zone is rather restricted and that nitrogen and phosphorus fertilizers are needed for commercial bulb production (1, 2, 4).

However, there is some evidence that an increase in the number of plants producing seed stalks followed applications of phosphorus fertilizer for commercial bulb production (4). The use of micronutrients on transplanted bulbs was of doubtful value (1). One investigator stated that onion growers believed that excessive nitrogen prevented proper ripening and resulted in bulbs with poor storage quality. Therefore, the growers have refrained from heavy nitrogen applications on onion bulbs grown for seed production (6).

Procedure

Fertilizer experiments on onion bulb production were conducted at the University of Idaho Research and Extension Center at Parma in 1971 and 1972. Locations were on a Greenleaf silt loam soil having a laminated layer of silt at the 14 to 18 inch soil depth. This layer restricts root penetration but allows slow water penetration. Barley was the preceding crop in the crop rotation.

Soil was bedded in spring before fertilization and rebedded after fertilization before onion bulb seed was planted.

Fertilizer treatments consisted of four nitrogen rates — 0, 80, 160 and 320 pounds per acre — with and without 160 pounds of P_2O_5 and K_2O per acre. In 1972 zinc was included at 10 pounds per acre. All fertilizer was banded 4 to 5 inches deep and 4 inches to the side of each row before seeding.

The fertilizers used were ammonium sulfate for nitrogen and treble super phosphate, potassium chloride and zinc sulfate for the other three elements.

Soil samples were taken before fertilization and analyzed for nutrients. Methods for soil extraction were:

Nitrate-nitrogen — saturated calcium sulfate extractant.

Phosphorus and potassium — sodium bicarbonate, 1-20 extractant.

Micronutrients — zinc, iron, manganese and copper, DTPA extractant; boron, hot water extractant.

Onion leaves were collected at 4 periods in 1971 and 3 periods in 1972 during the growing season and analyzed for nutrients to show levels in plant as related to yield and quality. The most recently matured leaves were collected, usually the third leaf from center of plant. Analyses were made for nitrate-nitrogen and phosphate-phosphorus (soluble in a 2 percent acetic acid solution) and for total nitrogen, phosphorus, potassium, zinc, manganese, iron, copper and boron.

The number of seed heads and broken leaves were counted in 1971 to show effect of nutrients. Onion bulbs were harvested the middle of September. The tops were removed and bulbs counted the last of September and the bulbs were graded for yield and quality the first week of October. One bag of large No. 1's over 3 inches in diameter from each treatment was placed in storage and graded in early March of the following year for physical deterioration, rot and weight loss. In 1971, measurements were also made on total nutrient removal by onion bulbs and tops.

Results and Discussion

Observation showed no great contrast in top growth or color as affected by fertilizer treatments. Some stunting on onion leaves was noted early in the season on plants having nitrogen applied at 320 pounds per acre.

Root growth of onions extended to the 18-inch restrictive soil layer and indicated very little loss from pink root or other diseases.

Yield of onion bulbs ranged from 459 to 717 cwt per acre for the two year study. In 1971, increased nitrogen rates reduced total yield and yield of large bulbs over 3 inches in diameter (Fig. 1). The yield of culls was also increased by the 320-pound nitrogen rate. In 1972, these effects were not apparent. Nitrate-nitrogen in the top 2 feet of soil before fertilization was 21.8 ppm in 1971 and 16.3 ppm in 1972.

In 1971, phosphorus fertilizer increased the number of plants with seed stalks and increased the yield of culls by 32 cwt per acre. This effect has been reported previously (4). No beneficial effects from nitrogen, phosphorus, potassium and zinc fertilizers were shown on yield, grade and storage of onion bulbs. These results agree with past research in this area (5).

The levels of phosphorus, potassium and zinc in the soil before fertilization would appear to be sufficient to produce top yield and quality of bulbs. These were 13.3 to 19.4, 218 to 257 and 1.68 to 2.77 ppm in the 0 to 8 inch soil depth, respectively.

Nitrogen fertilizer reduced bulb yield in 1971, probably because nitrogen was banded too close to the seed at planting. This had a toxic effect on plants during the growing season. This result suggests that most nitrogen fertilizer should be broadcast and worked into the seed bed before seeding.

Percent total nitrogen in onion leaves in 1971 increased with increased nitrogen rates (Fig. 2). Nitrate-nitrogen in leaves, although low in concentration, followed a similar pattern but showed more variation within treatments (Fig. 3). Consequently, total percent nitrogen would appear to be the best method for determining the level of nitrogen fertility for onion bulb production.

In 1972, percent total nitrogen in leaves varied little between nitrogen rates. Residual nitrogen in soil was similar between years but, in 1972, onions followed several years of continuous grain in the crop rotation. This could account for this yearly difference. These data suggest that about 4 percent total nitrogen in leaves taken on July 1, when bulbs were about 1 inch in diameter, is sufficient to produce top onion bulb yields.

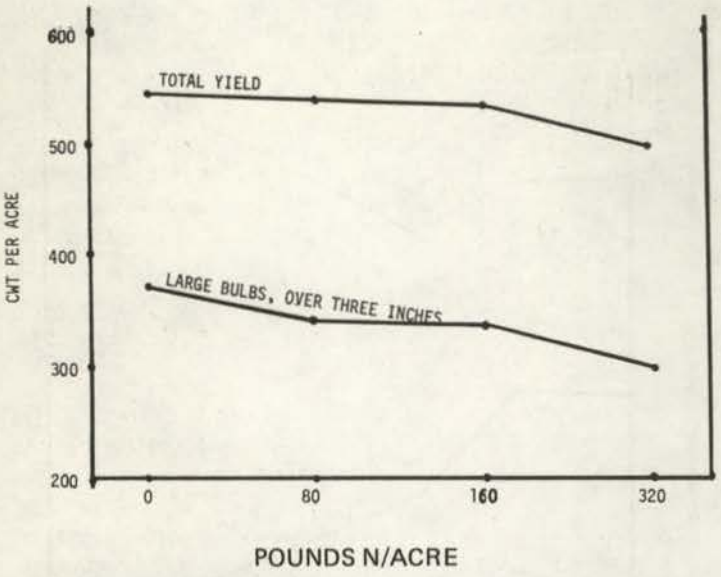

Fig. 1. Effect of nitrogen rates on onion bulb production, 1971.

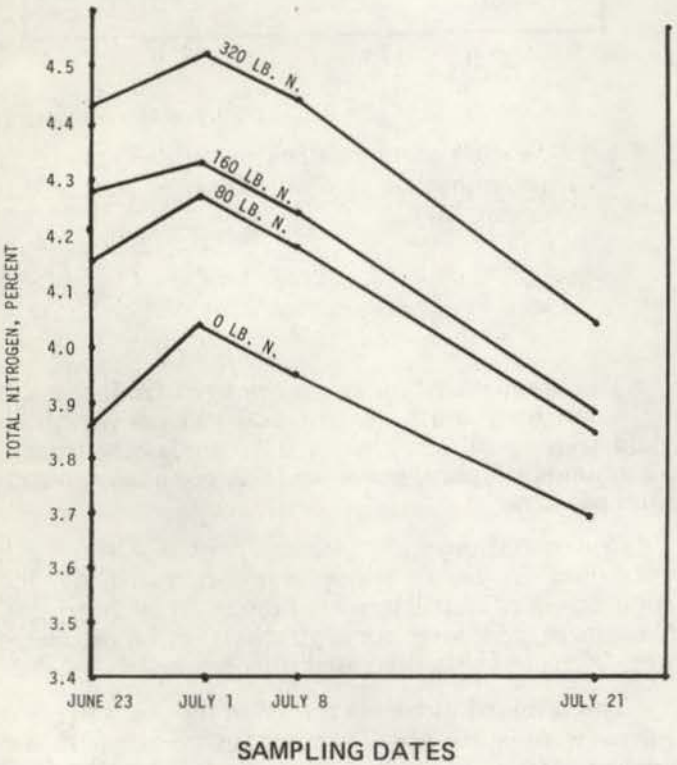

Fig. 2. The effect of nitrogen rate and sampling date on total percent nitrogen in onion leaves for bulb production, 1971.

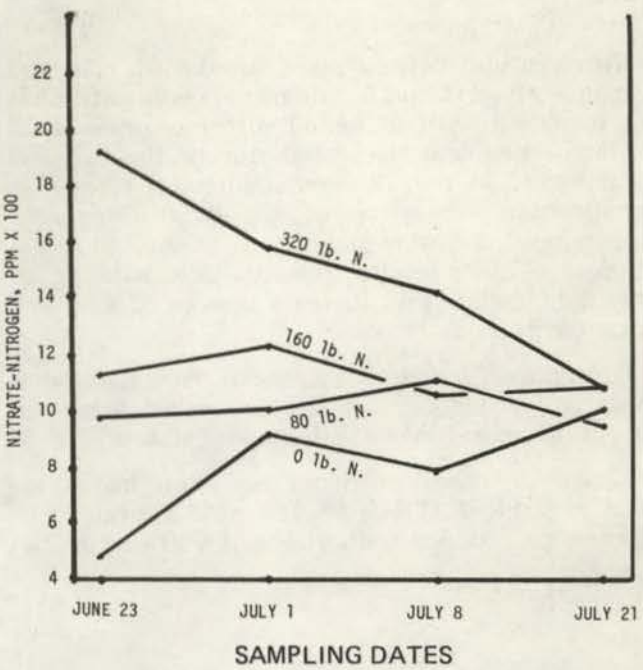

Fig. 3. Effect of nitrogen rate and sampling date on nitrate-nitrogen in onion leaves for bulb production, 1971.

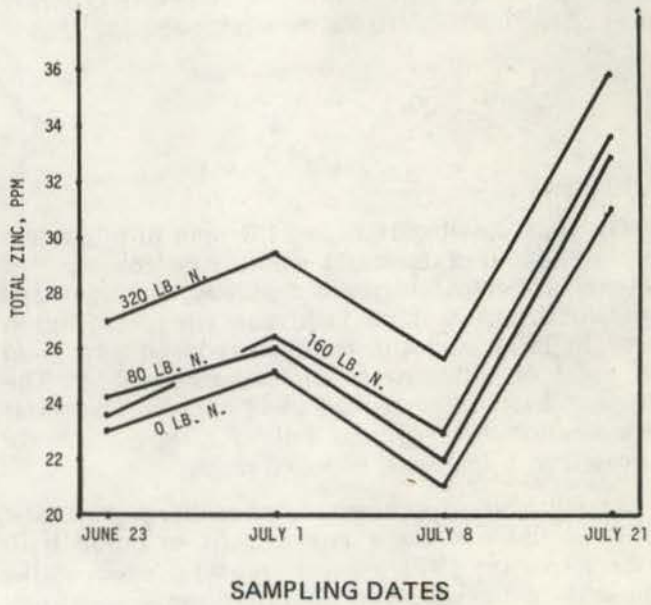

Fig. 4. Effect of nitrogen rate and sampling date on total zinc in onion leaves for bulb production, 1971.

Nitrogen also affects plant uptake of zinc and manganese (Figs. 4 and 5). Manganese concentrations were increased with increased nitrogen rates at all sampling dates and decreased during the growing season except at the 320-pound nitrogen rate. Zinc concentrations were increased slightly with increased nitrogen rates and were the highest at the last sampling date. These results indicate that banding of ammonium sulfate will increase uptake of zinc and manganese in onion leaves.

Phosphorus fertilizer increased phosphate-phosphorus and potassium fertilizer increased total percent potassium in leaves at all sampling dates.

Levels of other nutrients in onion leaves are shown in Table 1. These levels would appear to be sufficient to produce bulb yields of 600 to 700 cwt per acre.

Nutrient Removal by Onions

Yield of onion bulbs and tops and the nutrients removed from the soil are shown in Tables 2 and 3. Since yields were not affected greatly by nitrogen rates, the amount of nutrients removed by an onion crop were based on the average yield of the 4 nitrogen rates. Total pounds of nutrients removed are quite small, only 61, 12 and 72 pounds per acre of nitrogen, phosphorus and potassium, respectively. Total removal of calcium, magnesium and sodium was about 8, 11 and 7 pounds, respectively. Only traces of the micronutrients were removed.

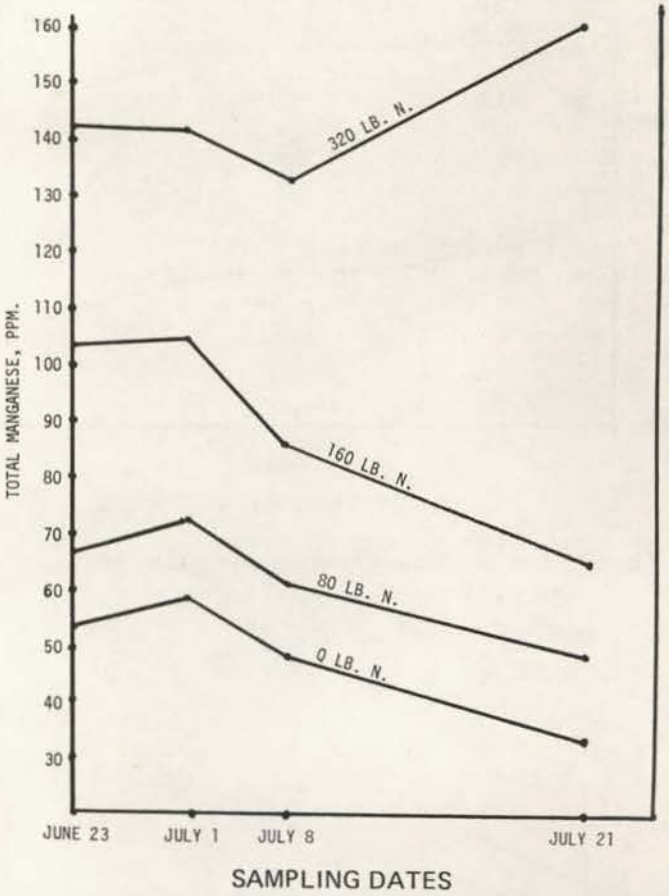

Fig. 5. The effect of nitrogen rate and sampling date on total manganese in onion leaves for bulb production, 1971.

Summary

On soils showing 16.6 to 21.9 ppm nitrate-nitrogen in the top 2 feet and where root rot was not present, additional nitrogen fertilizer did not have any beneficial effect on yield and storage of onion bulbs. In 1971, nitrogen fertilizer reduced total yield and yield of bulbs over 3 inches in diameter. The 320-pound rate increased the yield of culls. There was an indication that percent bulb rot during storage increased with increased nitrogen rates.

Application of potassium, phosphorus and zinc fertilizers did not show any benefit in onion bulb production. In 1971, plants showing seed stalks increased with addition of phosphorus fertilizers and increased the yield of culls.

The amounts of nutrients removed from the soil by onion tops and bulbs for 500 cwt per acre bulb yield were quite small, only 61 pounds of nitrogen, 12 pounds of phosphorus and 72 pounds of potassium per acre.

Concentrations of nitrogen, phosphorus and potassium in onion leaves were increased by the application of fertilizers containing these nutrients. Manganese and zinc concentrations in onion leaves were increased with increased nitrogen rates.

The levels of nutrients shown in the soil and plant leaves were sufficient to maintain good yield and quality of onion bulbs without the addition of fertilizer.

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Table 1. Effect of nitrogen rates on concentration of nutrients in onion leaves, bulb production.[1]

Sampling dates[2]	Pounds nitrogen per acre			
	0	80	160	320
		Total percent nitrogen, 1971		
June 23	3.86 a	4.15 b	4.29 c	4.44 d
July 1	4.04 a	4.27 b	4.32 b	4.52 c
July 8	3.95 a	4.18 b	4.24 b	4.44 c
July 21	3.69 a	3.85 b	3.88 b	4.04 c
		Total percent nitrogen, 1972		
June 29	3.33 a	3.24 a	3.34 a	3.35 a
July 17	3.12 a	3.11 a	3.11 a	3.17 a
July 28	3.04 a	3.07 a	3.08 a	3.21 b
		Nitrate-nitrogen, ppm, 1971		
June 23	492 a	982 b	1,139 b	1,926 c
July 1	922 a	1,011 ab	1,239 b	1,589 c
July 8	786 a	1,112 b	1,078 b	1,424 c
July 21	1,025 a	954 a	1,090 a	1,062 a
		Phosphate-phosphorus, ppm, 1971		
June 23	3,819 a	3,764 a	3,882 a	3,618 a
July 1	4,264 a	4,493 a	4,504 a	4,340 a
July 8	4,108 a	4,343 a	4,476 a	4,394 a
July 21	4,679	4,797 a	4,656 a	4,761 a
		Phosphate-phosphorus, ppm, 1972		
June 29	2,930 a	3,047 a	3,305 a	3,203 a
		Total percent potassium, 1971		
June 23	4.44 a	4.41 a	4.38 a	4.38 a
July 1	4.55 a	4.59 a	4.53 a	4.56 a
July 8	4.23 a	4.28 a	4.38 a	4.34 a
July 21	3.96 a	3.98 a	3.95 a	4.09 a
		Total percent potassium, 1972		
June 29	3.44 a	3.26 a	3.30 a	3.21 a
		Total zinc, ppm, 1971		
June 23	23.1 a	24.3 a	23.5 a	26.5 a
July 1	25.2 a	26.1 a	26.3 a	29.4 b
July 8	21.1 a	22.0 a	22.9 b	25.6 c
July 21	31.1 a	32.9 ab	33.6 bc	35.8 c
		Total zinc, ppm, 1972		
June 29	15.0 a	14.8 a	14.9 a	14.7 a
		Total manganese, ppm, 1971		
June 23	53.5 a	66.9 a	103.3 b	142.4 c
July 1	58.4 a	72.4 b	104.1 b	141.5 c
July 8	48.7 a	61.6 a	85.7 b	133.0 c
July 21	33.3 a	48.6 ab	64.9 b	160.0 c

Table 1. Continued.

Sampling dates[2]	Pounds nitrogen per acre			
	0	80	160	320
		Total manganese, ppm, 1972		
June 29	23.0 a	23.6 a	24.7 a	22.9 a
		Total iron, ppm, 1971		
June 23	151.4 b	139.3 a	132.5 a	140.0 a
July 1	211.4 a	202.9 a	183.4 a	202.6 a
July 8	140.6 b	125.0 a	124.3 a	117.7 a
July 21	130.9 a	143.6 a	142.8 a	137.2 a
		Total copper, ppm, 1971		
June 23	7.3 b	7.2 b	7.6 b	6.3 a
July 1	9.3 a	8.7 a	8.2 a	8.6 a
July 8	9.4 a	9.4 a	9.5 a	8.9 a
July 21	9.7 a	9.3 a	8.6 a	8.7 a
		Total boron, ppm, 1971		
June 23	24 a	25 a	24 a	27 a
July 1	16 a	15 a	16 a	14 a
July 8	28 a	31 a	30 a	29 a
July 21	38 a	41 a	40 a	42 a

[1]Means having same letter do not differ at 5 percent level of significance.

[2]Bulbs 1 inch in diameter at time of sampling on July 1, 1971, and June 29, 1972.

Table 2. Nutrient removal by onion tops and bulbs in 1971.

	1971 Pounds per acre[1]		
Nutrients	Tops	Bulbs	Total
Nitrogen	12	49	61
Phosphorus	0.98	11	12
Potassium	26	46	72
Calcium	4.7	3.8	8.5
Magnesium	6.2	5.0	11.2
Sodium	5.1	1.9	7.0
Zinc	0.0364	0.0632	0.0996
Manganese	0.1664	0.1353	0.3017
Iron	0.7004	0.1206	0.8210
Copper	0.0060	0.0127	0.0187
Boron	0.0384	0.0621	0.1005

[1]Based on average yield of the four nitrogen rates.

Table 3. Effect of nitrogen rates on yield of onion tops and bulbs and percent nutrients at harvest in 1971.

Variables measured	Pounds nitrogen per acre				
	0	80	160	320	Average
Tops:					
Oven dry wt., lb./acre	894	929	1,076	867	941
Green wt., lb./acre	2,820	2,965	2,981	2,591	2,839
Percent dry wt.	32.5	32.3	37.4	33.8	34.0
Bulbs:					
Oven dry wt., lb./acre	2,135	1,754	2,334	1,900	2,031
Green wt., lb./acre	51,167	54,300	51,233	48,300	51,250
Percent dry wt.	4.2	3.2	4.5	3.9	3.9
Tops:					
Percent total nitrogen	1.24	1.28	1.29	1.34	1.29
Percent total phosphorus	0.11	0.10	0.10	0.11	0.10
Percent total potassium	2.45	2.50	2.88	3.19	2.76
Percent total zinc	0.0036	0.0042	0.0039	0.0039	0.0039
Percent total manganese	0.0040	0.0099	0.0210	0.0392	0.0185
Percent total iron	0.0800	0.0675	0.0796	0.0700	0.0743
Percent total copper	0.0008	0.0006	0.0006	0.0006	0.0006
Percent total boron	0.0032	0.0047	0.0041	0.0042	0.0040
Percent total calcium	0.49	0.52	0.53	0.46	0.49
Percent total magnesium	0.66	0.70	0.66	0.61	0.66
Percent total sodium	0.67	0.63	0.53	0.40	0.55
Bulbs:					
Percent total nitrogen	2.34	2.83	2.28	2.57	2.50
Percent total phosphorus	0.46	0.64	0.44	0.61	0.53
Percent total potassium	2.32	2.75	1.98	2.33	2.35
Percent total zinc	0.0027	0.0035	0.0033	0.0034	0.0032
Percent total manganese	0.0015	0.0039	0.0081	0.0154	0.0070
Percent total iron	0.0050	0.0071	0.0061	0.0060	0.0060
Percent total copper	0.0006	0.0009	0.0004	0.0006	0.0006
Percent total boron	0.0022	0.0033	0.0029	0.0037	0.0030
Percent total calcium	0.20	0.17	0.18	0.19	0.18
Percent total magnesium	0.26	0.27	0.22	0.25	0.25
Percent total sodium	0.09	0.11	0.08	0.09	0.093

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