

# Time and Method of Fertilizer Application For Potatoes

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In 1977 Dahnke, et al. reported on the results of 17 soil fertility field trials with potatoes. The results of those trials indicated:

1. A yield response by potatoes to added fertilizer nitrogen is very probable when the amount of nitrate-nitrogen in the top 2 feet of soil is less than 60 pounds per acre at or near planting time.
2. When the phosphorus soil test (Olson test) is less than 15 pounds of P per acre, potatoes will very likely respond to added phosphate fertilizer.
3. A response to potassium fertilizer was obtained at only one of 17 sites. That site had a potassium soil test of 162 pounds per acre. The probability of getting a potato yield response to potassium fertilizer is very unlikely in the Red River Valley or any other place in North Dakota.
4. While high rates of nitrogen tend to decrease specific gravity, fertilizer applications did not influence the color of potato chips.

Since these earlier trials, several other soil fertility trials have been conducted at the Red River Valley Potato Growers Research Farm near Grand Forks. These trials compared time and method of applying several rates of nitrogen and phosphorus.

## PROCEDURE

The site locations, cooperators, varieties, planting dates and harvest dates are given in Table 1.

Norchip potatoes were planted in 38-inch rows with a two-row planter. Except as otherwise noted, fertilizer was placed in bands 2 inches on each side and 2 inches below the seed pieces. The other methods of application were bands 7 to 8 inches below the soil surface or broadcast onto the soil surface and worked into the soil before planting. The source of nitrogen fertilizer was ammonium nitrate (34-0-0) and the source of phosphorus was 0-46-0. Spacing between seed pieces was approximately 12 inches. Plants were sprayed and cultivated as needed during the growing season to control insects, diseases and weeds. Potatoes were harvested for yield and other tests from 40 feet of one of the center rows of the four-row plots. Each treatment was replicated 10 times. Soil samples were taken before planting.

**Table 1. Soil test data and planting and harvest dates for potato soil fertility trials conducted from 1976 thru 1982 at the Potato Research Farm, Grand Forks, N.D.**

Soil Test	1976	1977	1978	1979	1980	1981	1982
pH	8.1	8.0	7.7	7.9	8.0	7.6	8.2
Nitrate-nitrogen, lb/acre-2'	46	44	16	22	19	22	46
Phosphorus, lb/acre-6"	16	14	12	16	10	13	11
Potassium, lb/acre-6"	180	251	303	270	176	312	317
Electrical conductivity, mmhos/cm	0.59	0.43	0.85	0.92	0.83	0.29	0.46
Organic matter, %	5.8	5.8	4.9	5.4	5.3	5.6	5.1
Planting date	May 13	May 9	May 18	June 1	May 16	May 14	May 26
Harvest date	Sept. 20	Sept. 2	Sept. 25	Sept. 20	Sept. 23	Sept. 22	Sept. 23

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The soil test results are in Table 1. The nitrogen and phosphorus levels in these soils were low enough so that yield responses to the applications of these nutrients would be expected most years. Yield response to the application of potassium would not be expected.

## RESULTS AND DISCUSSION

The two trials in 1976 and 1977 were set up to compare spring vs. fall and band vs. broadcast applications of nitrogen and phosphorus fertilizer. Total and marketable yields are shown in Table 2. Percent marketable yield (U.S. No. 1 yield 2 to 3½ inches in diameter) averaged 75 and 80 percent in 1976 and 1977, respectively. There was no significant difference among treatments in the percentage of marketable tubers. There were significant yield responses to nitrogen and phosphorus fertilizer combinations as would be expected based on the soil tests. The differences due to time and method of application were not significantly different in 1976, however.

In 1977 there was a significant response to nitrogen and phosphorus, and also to time and method of application. A combined application of nitrogen and phosphorus was significantly better when broadcast in the fall or banded in the spring than when broadcast in the spring. A fall broadcast application of phosphorus fertilizer alone was significantly

better than a spring band application. There were no significant differences in yield due to time or method of application when only nitrogen was applied. Specific gravity of the tubers ranged from 1.097 to 1.100 but was not affected by fertilizer rates or application methods.

Starting in 1978 a series of treatments were applied at the request of growers to determine the influence of the timing of a deep tillage operation (in this case, plowing) and method and time of nitrogen application on the yield of potatoes (Table 3). In each of the three years there was a significant yield response to 50 pounds of nitrogen per acre. In 1978 there was a further significant potato yield response to 100 pounds of N per acre. Also in 1978 there was a significant yield increase from fall plowing in comparison to spring plowing. In the other two years fall plowing resulted in a higher yield, although not statistically significant. Marketable yield for each year is also shown in Table 3. Marketable yields reflect the differences of treatments on total yield. There was no significant treatment effect on the percentage of marketable tubers.

Comparing various methods of nitrogen fertilizer application on fall plowing indicated that the best method was spring band application. The next best application method was spring broadcast. A fall broadcast application was the least effective method of applying nitrogen when the soil was plowed in the fall.

**Table 2. Influence of rate, time and method of fertilizer application on yield of potatoes**

Treatment	Total Yield*			Marketable Yield (2-3½")*		
	1976	1977	Avg.	1976	1977	Avg.
<b>lb/acre and time of application</b>	----- cwt/acre -----			----- cwt/acre -----		
1. Check	140 b	213 f	176 c	105 a	168 e	136 c
2. 50 N, 100 P <sub>2</sub> O <sub>5</sub> ; both Fall B.C.**	159 a	251 bcd	205 ab	116 a	201 bc	158 b
3. 100 N, 100 P <sub>2</sub> O <sub>5</sub> ; both Fall B.C.	169 a	261 b	215 ab	130 a	208 b	169 ab
4. 100 N Fall B.C.; 100 P <sub>2</sub> O <sub>5</sub> Spring band	158 ab	261 b	210 ab	113 a	213 b	163 ab
5. 50 N, 100 P <sub>2</sub> O <sub>5</sub> ; both Spring B.C.	172 a	242 cd	207 ab	132 a	188 cd	160 b
6. 100 N, 100 P <sub>2</sub> O <sub>5</sub> ; both Spring B.C.	161 a	235 de	198 b	120 a	187 cd	154 b
7a. 100 N Spring B.C.; 100 P <sub>2</sub> O <sub>5</sub> Spring band	167 a			122 a		
7b. 0 N, 100 P <sub>2</sub> O <sub>5</sub> ; Spring band		224 ef			179 de	
8. 50 N, 100 P <sub>2</sub> O <sub>5</sub> ; Spring band	155 ab	251 bcd	203 ab	116 a	201 bc	158 b
9. 100 N, 100 P <sub>2</sub> O <sub>5</sub> ; Spring band	160 a	255 bc	206 ab	122 a	208 b	165 ab
10. 100 N Spring band; 100 P <sub>2</sub> O <sub>5</sub> Fall B.C.	156 ab	281 a	218 a	119 a	232 a	176 a
Combinations of above treatments:						
<b>Time and Method of Application (N + P<sub>2</sub>O<sub>5</sub>)</b>						
Fall BC (treatments 2,3)	164 a	256 a	210 a	123 a	204 a	164 a
Spring BC (treatments 5,6)	166 a	239 b	202 a	126 a	188 b	157 a
Spring band (treatments 8,9)	158 a	253 a	206 a	119 a	204 a	162 a
<b>Rate of Nitrogen</b>						
50 N (treatments 2,5,8)	162 a	248 b	205 a	121 a	197 a	159 a
100 N (treatments 3,6,9)	163 a	250 b	206 a	124 a	201 a	162 a
<b>Method of Application of P<sub>2</sub>O<sub>5</sub></b>						
100 P <sub>2</sub> O <sub>5</sub> B.C. (treatments 3,10)	162 a	271 a	216 a	124 a	220 a	172 a
100 P <sub>2</sub> O <sub>5</sub> Spring band (treatments 4,9)	159 a	258 b	208 a	118 a	210 a	164 a
<b>Method of Nitrogen Application</b>						
100 N Fall B.C. (treatments 3,4)	163 a	261 b	212 a	122 a	210 a	166 a
100 N Spring band (treatment 9,10)	158 a	268 b	213 a	120 a	220 a	170 a

\* Yields followed by the same letter are not significantly different.  
 \*\* B.C. = Broadcast.

In 1981 and 1982 a trial was conducted to determine the influence of fertilizer band location on potato yield. A band of fertilizer placed 2 inches below and 2 inches to the side of the seed piece was compared with a preplant band placed 5 to 7 inches below the seed piece. There was a significant increase in total and marketable yield (Table 4) when fertilizer was applied but there was not a significant difference in yield between the two methods of band application or rates of P<sub>2</sub>O<sub>5</sub>. Treatments did not affect the percentage of marketable tubers. Specific gravity of the tubers was not influenced by the method of fertilizer application.

## CONCLUSIONS

This series of trials with potatoes suggest the following:

1. Avoid major tillage in the spring.
2. Broadcast required phosphorus fertilizer in fall.
3. Apply nitrogen in the spring.

**Table 3. Influence of rate, time and method of nitrogen application on the yield of potatoes**

Treatment	Total Yield*				Marketable Yield (2-3½")*			
	1978	1979	1980	Avg.	1978	1979	1980	Avg.
<b>lb/acre of nitrogen and time of application</b>	----- cwt/acre -----				----- cwt/acre -----			
1. 0 N; Spring plowed	235 f	194 c	153 c	194 e	185 f	139 c	130 b	151 e
2. 0 N; Fall plowed	260 f	190 c	156 c	202 e	214 e	132 c	131 b	159 e
3. 50 N Fall B.C.**; Fall plowed	301 de	251 ab	208 ab	253 c	234 ce	177 ab	175 a	195 cd
4. 100 N Fall B.C.; Fall plowed	317 cd	262 a	208 ab	262 bc	246 bd	191 a	177 a	205 abc
5. 50 N Spring B.C.; Spring plowed	287 e	228 b	199 b	238 d	220 de	165 b	166 a	184 d
6. 100 N Spring B.C.; Spring plowed	327 bd	252 ab	196 b	258 c	247 bd	186 ab	161 a	198 bc
7. 50 N Springs B.C.; Fall plowed	316 cd	241 ab	200 b	252 c	246 bd	172 ab	160 a	193 cd
8. 100 N Spring B.C.; Fall plowed	350 b	253 ab	220 a	274 ab	267 ab	183 ab	175 a	208 ab
9. 50 N Spring Band; Fall plowed	342 bc	253 ab	197 b	264 bc	256 ac	175 ab	160 a	197 bc
10. 100 N Spring Band; Fall plowed	379 a	266 a	194 b	280 a	281 a	190 a	158 a	210 a
<b>Combinations of above treatments:</b>								
<b>Time of Plowing</b>								
Fall plowed (treatments 2,7,8)	309 a	228 a	192 a	243 a	242 a	162 a	155 a	186 a
Spring plowed (treatments 1,5,6)	283 b	225 a	183 a	230 b	217 b	163 a	152 a	177 b
<b>Rate of Nitrogen</b>								
0 N (treatments 1,2)	248 c	192 b	154 b	198 c	199 c	136 c	130 b	155 c
50 N (treatments 5,3)	294 b	240 a	204 a	246 b	227 b	171 b	176 a	191 b
100 N (treatments 6,4)	322 a	257 a	202 a	260 a	246 a	188 a	170 a	201 a
<b>Rate of Nitrogen</b>								
50 N (treatments 3,5,7,9)	312 b	243 b	201 a	252 b	239 a	172 b	165 a	192 b
100 N (treatments 4,6,8,10)	343 a	258 a	205 a	269 a	260 a	187 a	168 a	205 a
<b>Method of Application</b>								
Fall B.C.; Fall plow (treatments 3,4)	309 c	257 ab	208 ab	258 b	240 bc	184 a	176 a	200 a
Spring B.C.; Spring plow (treatments 5,6)	307 c	240 b	198 ab	248 c	234 c	176 a	164 ab	191 b
Spring B.C.; Fall plow (treatments 7,8)	333 b	247 ab	210 a	263 b	256 ab	177 a	168 ab	200 a
Spring Band; Fall plow (treatments 9,10)	360 a	260 a	196 b	272 a	268 a	182 a	159 b	203 a

\* Yield followed by the same letter are not significantly different.

\*\* B.C. = Broadcast

**Table 4. Influence of band placement of nitrogen and phosphorus fertilizer on the yield of potatoes**

Fertilizer Placement	Rate of N + P <sub>2</sub> O <sub>5</sub> + K <sub>2</sub> O lb/acre	Total Yield*			Marketable Yield (2-3½")*		
		1981	1982	Avg.	1981	1982	Avg.
1. Check	None	195 b	246 b	220 b	149 b	197 b	173 b
2. 2" by 2" band	100 + 30 + 0	238 a	302 a	270 a	194 a	237 a	216 a
3. 2" by 2" band	100 + 60 + 0	222 a	300 a	261 a	182 a	239 a	210 a
4. Deep band (8-10")	100 + 30 + 0	223 a	299 a	261 a	180 a	234 a	207 a
5. Deep band (8-10")	100 + 60 + 0	227 a	308 a	268 a	179 a	242 a	210 a
Combinations of above treatments:							
<b>Band Location</b>							
2" by 2" band (treatments 2,3)		230 a	301 a	266 a	188 a	238 a	213 a
Deep band (treatments 4,5)		225 a	304 a	265 a	179 a	268 a	208 a
<b>Rate of P<sub>2</sub>O<sub>5</sub></b>							
100 + 30 + 0 (treatments 2,4)		230 a	301 a	266 a	187 a	235 a	211 a
100 + 60 + 0 (treatments 3,5)		225 a	303 a	264 a	180 a	240 a	210 a

\* Yields followed by the same letter are not significantly different.