# Nitrogen and Phosphorus Fertilizer Response on Conquest Barley as Related to Soil Tests for Nitrogen and Phosphorus on Stubble

W. F. Nuttall
Research Station
Melfort, Saskatchewan

Eighteen field experiments were set out in 1969, 1970 and 1971 with Conquest barley on second or third crop after summerfallow on Blaine Lake loam, Nipawin loam, Arborfield clay, Melfort silty clay, Etomami clay and Waitville loam. The field design was a factorial, composite design, (5N x 2P) + (2N x 3P) giving 16 treatment combinations with 5 rates of nitrogen at 0, 22, 45, 67 and 134 kg N/ha and 5 rates of phosphorus at 0, 10, 20, 30 and 39 kg P/ha. Soil tests for exchangeable ammonium-N, nitrate-N and sodium bicarbonate soluble phosphorus were measured at depths of 0-15, 15-30 and 30-60 cm depths in the fall and spring. Yield response to nitrogen and phosphate fertilizer was obtained by subtracting the control with no fertilizer applied from the remaining 15 treatment combinations. Soil tests for nitrogen (spring sampling) and phosphorus were related by multiple regression analyses to yield response (Table 1). In every regression equation with the exception of the 0-20, N-P treatment, the soil test for nitrogen was significant in accounting for among-site variation in yield response. The soil test for phosphorus was not significant in accounting for yield response variation for fertilizer treatments not receiving phosphorus. Also, the soil test for phosphorus was not as consistent as the nitrate test in significantly reducing among-site variation on plots receiving phosphorus. A highly significant relationship between control yields and the soil tests for nitrogen and phosphorus was obtained ($R^2$ = 83.3%). As 1969-71 were average to above average years in precipitation, giving fairly consistent soil moisture reserves, differences in fertility status of the soils accounted for most of the among-site variation. The relationship between 3 soil test for nitrogen and phosphorus and 5 rates of nitrogen and phosphorus fertilizers is shown in Table 2. The table is not complete with 9 missing of the 25 values required to complete the table. An estimation of these missing values can be made by interpolation and in some cases extrapolation. For example, with a soil test of 15 µg N/4g soil (30 lb N/ac) and 6 µg P/g soil (12 lb P/ac), interpolation between 796 and 1553 kg/ha (67-0 and 67-20 treatments) gives an estimate of 1275 kg/ha for the 67-10, N-P treatment or interpolation between 931 and 1599 kg/ha (134-10 and 45-10 treatments) gives 1098. An average of these two values, 1187 kg/ha, would give a reasonable estimate of yield response.

Yield response to nitrogen is shown in the table to be reduced consistently with higher soil test values for nitrogen. This is not so for the phosphorus test as the estimate of yield response for the 45-20, N-P treatment is 1169, 833 and 1127 for 6, 12 and 18 µg P/g soil. Since the phosphorus test on these estimates are related on a curvilinear basis, the upper limit of the phosphorus soil test (18 µg P/g) may not give the best estimate of minimum yield response. By adding control estimates to the yield response values, potential yields could be estimated and would help in giving a better understanding of marginal yield response. (Fig. 1)

Table 1. Regression Coefficients of Soil Tests used to Estimate Yield Response of Conquest Barley from Nitrogen and Phosphorus Fertilizer Application

| Estimate kg/ha | Fertilizer rate, kg/ha N | P | Intercept | Coefficients of soil test values: Nitrate-N µg N/4g soil | (Nitrate-N)$^2$ | $NaHCO_3$-P µg P/g soil | ($NaHCO_3$-P)$^2$ | $R^2$% |
|---|---|---|---|---|---|---|---|---|
| Δ≠ Yield | 22 | 0 | 1233 | -72.9** | .956*+ | | | 75.8 |
| | 45 | 0 | 1910 | -96.2** | 1.149+ | | | 69.9 |
| | 67 | 0 | 2354 | -128.1** | 1.615+ | | | 66.8 |
| | 134 | 0 | 3741 | -215.0** | 2.97* | | | 74.1 |
| | 0 | 20 | 668 | | | -94.7* | 3.38+ | 40.1 |
| | 22 | 20 | 1862 | -27.6* | .259 | -164.2*+ | 6.41* | 62.5 |
| | 45 | 20 | 3055 | -73.6** | .830*+ | -214.0 | 8.77* | 78.4 |
| | 67 | 20 | 3257 | -79.5** | .668+ | -136.7* | 4.39 | 74.5 |
| | 134 | 20 | 4920 | -194.8** | 2.59* | -196.0 | 9.01 | 78.5 |
| | 45 | 10 | 2475 | -93.9** | 1.21* | -91.6 | 3.94 | 75.5 |
| | 45 | 30 | 2616 | -61.4** | .722* | -158.3** | 5.78* | 79.6 |
| | 45 | 39 | 2514 | -96.5** | 1.46* | -57.7 | 1.43 | 60.6 |
| | 134 | 10 | 4056 | -197.7** | 2.67** | -15.4 | | 77.3 |
| | 134 | 30 | 4786 | -204.2** | 2.73** | -72.2*+ | | 82.3 |
| | 134 | 39 | 4519 | -191.8** | 2.48* | -45.0 | | 81.5 |
| Control yield | 0 | 0 | -1700 | 193.4** | -2.74** | 325.6 | -14.69** | 83.3 |

* F test was significant at 5% probability level.
** F test was significant at 1% probability level.
\+ F test was significant at 10% probability level.
≠ Symbol indicates increase in yield over control from application of nitrogen and phosphorus fertilizer.

Table 2. Relationship of Yield Response of Conquest Barley to NP Fertilizers and NP Soil Tests

| Phosphate Fertilizer kg P/ha | Soil N - 15 µg N/4g Fertilizer N (kg/ha) | | | | | Soil N - 30 µg N/4g Fertilizer N (kg/ha) | | | | | Soil N - 45 µg N/4g Fertilizer N (kg/ha) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 22 | 45 | 67 | 134 | 0 | 22 | 45 | 67 | 134 | 0 | 22 | 45 | 67 | 134 |
| **Phosphorus Soil Test - 6 µg P/g Soil** | | | | | | | | | | | | | | | |
| 0 | 0 | 355 | 726 | 796 | 1184 | 0 | -94 | - | - | - | 0 | -112 | - | - | - |
| 10 | | | 931 | | 1599 | | | 339 | | 436 | | | 292 | | 474 314* |
| 20 | 221 | 751 | 1169 | 1553 | 1729 | 221 | 513 | 626 | 811 | 555 | 221 | 390 | 455 | 370 | 547 420 |
| 30 | | | 1116 | | 1904 | | | 682 | | 683 | | | 573 | | 692 550 |
| 39 | | | 1100 | | 1920 | | | 638 | | 727 | | | 833 | | 640 545 |
| **Phosphorus Soil Test - 12 µg P/g Soil** | | | | | | | | | | | | | | | |
| 0 | 0 | 355 | 726 | 796 | 1184 | 0 | -94 | - | - | - | 0 | -112 | - | - | - |
| 10 | | | 807 | | 1506 | | | 215 | | 343 | | | 168 | | 382 222 |
| 20 | 18 | 459 | 833 | 1207 | 1526 | 18 | 219 | 288 | 465 | 352 | 18 | 97 | 119 | 24 | 344 217 |
| 30 | | | 790 | | 1471 | | | 356 | | 251 | | | 247 | | 259 116 |
| 39 | | | 908 | | 1660 | | | 447 | | 457 | | | 641 | | 370 275 |
| **Phosphorus Soil Test - 18 µg P/g Soil** | | | | | | | | | | | | | | | |
| 0 | 0 | 355 | 726 | 796 | 1184 | 0 | -94 | - | - | - | 0 | -112 | - | - | - |
| 10 | | | 967 | | 1414 | | | 375 | | 251 | | | 327 | | 289 130 |
| 20 | - | 628 | 1127 | 1177 | 1972 | - | 388 | 583 | 435 | 798 | - | 266 | 413 | - | 790 663 |
| 30 | | | 881 | | 1038 | | | 447 | | - | | | 338 | | - |
| 39 | | | 819 | | 1390 | | | 358 | | 187 | | | 553 | | 100 5 |

Lb/ac = .9 x kg/ha

* Minimum response which is at a soil test value less than 45 µg N/4g soil

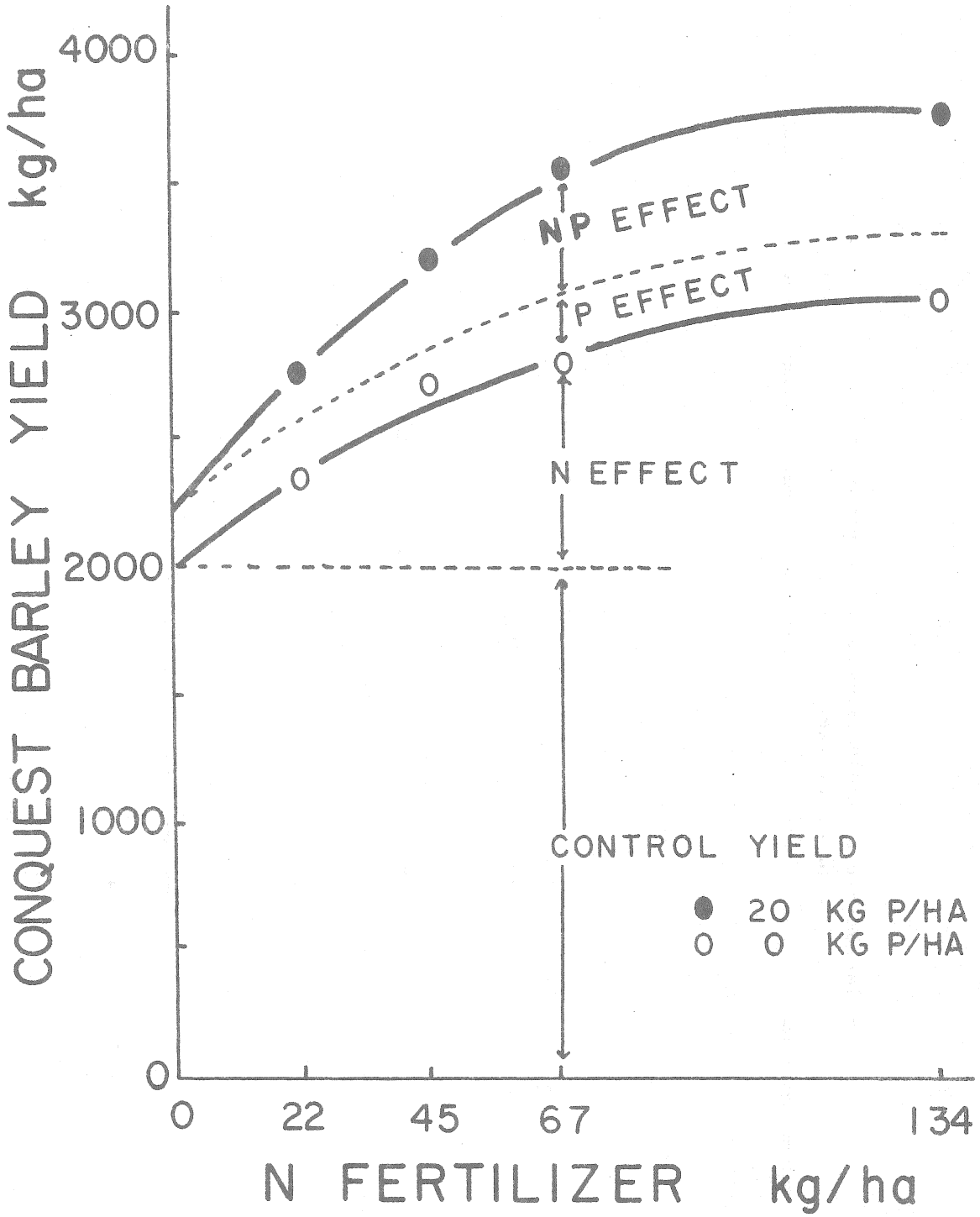


Fig. 1 Conquest barley yield related to nitrogen and phosphorus fertilizer for years 1969-71 at soil tests of 15 µg N/4g soil (30 lb N/ac) and 6 µg P/g soil (12 lb P/ac).