# Soil Fertility Research with Corn Grown on Northeast USA Soils

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COOPERATIVE RESEARCH & EXTENSION

# Soil Survey – Land Capability and Yields

| Soil Series | Bu/acre |
|---|---|
| Aura | 80 – 100 |
| Califon | 110 – 120 |
| Chalfont | 90 – 120 |
| Freehold | 110 – 130 |
| Hazen | 90 – 120 |
| Quakertown | 110 – 140 |
| Sassafras | 100 – 130 |
| Washington | 120 – 140 |

# Dry Land Corn 1990-1994 NJ Economic Optimum Grain Yields

| Soil Series | 1991 | 1992 | 1993 | 1994 | Mean |
|---|---|---|---|---|---|
| | ----------Bu/acre---------- | | | | |
| Califon | | | 170 | | 170 |
| Chalfont | 152 | 126 | | | 139 |
| Freehold | 115 | 226 | 180 | 214 | |
| | | 238 | 163 | 200 | 186 |
| | | | 156 | | |
| Hazen | 146 | | | | 146 |
| Quakertown | 160 | 178 | 150 | 118 | |
| | 181 | 219 | | 200 | 178 |
| | | 222 | | | |
| Sassafras | 201 | | | | 186 |
| | 172 | | | | |
| Washington | | 162 | | | 142 |
| | | 122 | | | |
| | | | | Coastal Plain | 186 |
| | | | | Piedmont | 164 |

# Irrigated Corn 1998-1999 NJ

| Soil Series | 1998 | 1999 |
|---|---|---|
| | Bu/acre | |
| Aura | | 234 |
| Freehold | 242 | |
| Quakertown | 231 | 282 |

# Factors Limiting Irrigated Corn Yield

1. Failing to irrigate early and often enough
2. Plant population too low
3. Lack of uniform stand
4. Low pH
5. Nutrient deficiencies
6. Failing to employ optimum levels of all production factors

# Maximum Corn Yield Research in NJ
# Dr. Roy Flannery, 1980

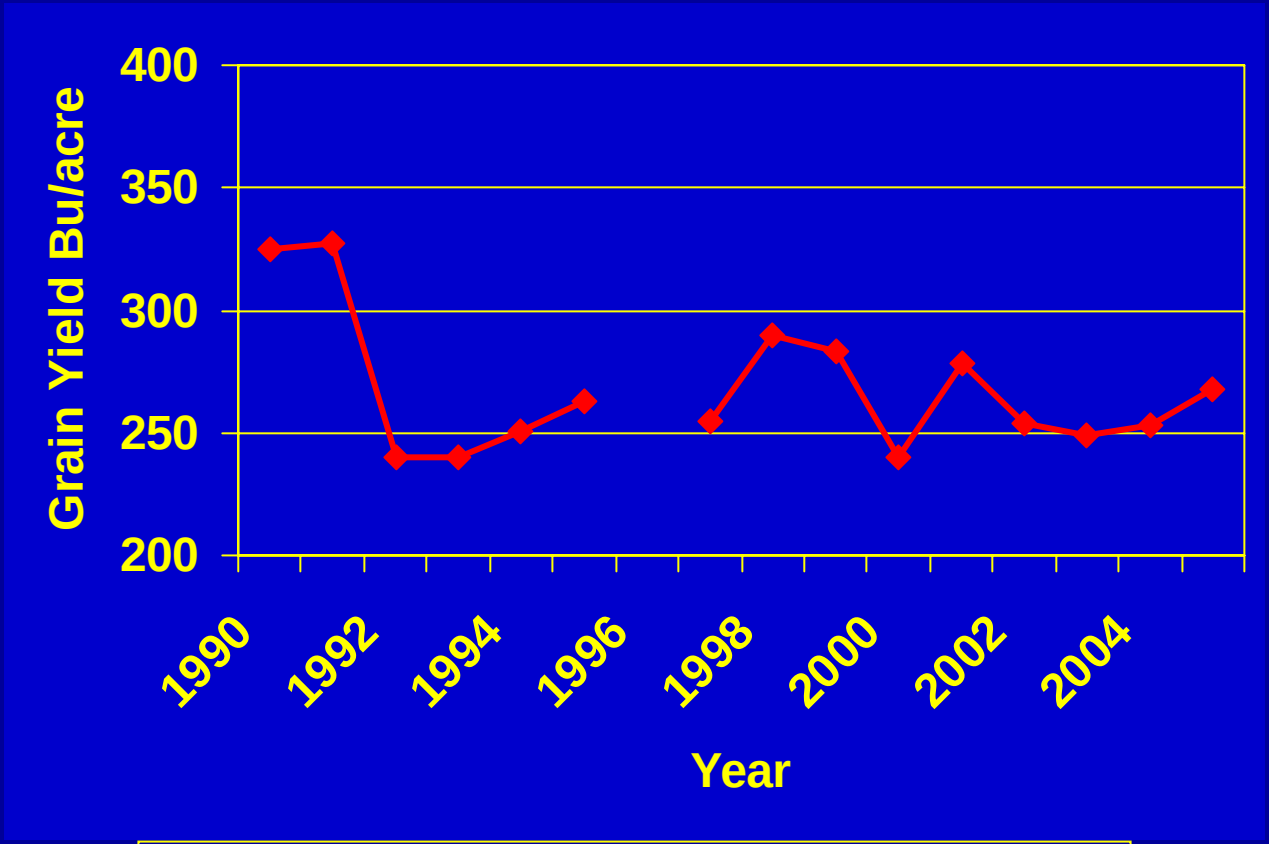
## Fertilizers applied to achieve 312 bu/acre

| | lbs/acre |
|---|---|
| Nitrogen (N) | 500 |
| Phosphate ($P_2O_5$) | 300 |
| Potash ($K_2O$) | 300 |
| Boron (B) | 1.5 |
| Copper (Cu) | 5 |
| Manganese (Mn) | 25 |
| Zinc (Zn) | 10 |

# Maximum Yield Research Objective:

- Identify yield limiting factors
- Develop technology to increase yield

# High Yield Corn Research Adelphia, NJ 1990-2005 Freehold Sandy Loam Soil




Yield (excluding 1996):
Max: **327 Bu/acre**
Min: **240 Bu/acre**
Mean **267 Bu/acre**

# Agronomic Factors in Relation to Corn Yield

| Factor | Ability to Control | | | | |
|---|---|---|---|---|---|
| Hybrid selection | ★ | ★ | ★ | ★ | ★ |
| Soil Fertility | ★ | ★ | ★ | ★ | ★ |
| Irrigation | ★ | ★ | ★ | ★ | |
| Pest control | ★ | ★ | ★ | ★ | |
| Plant spacing | ★ | ★ | ★ | ★ | |
| Planting date | ★ | ★ | ★ | | |
| Soil quality | ★ | ★ | ★ | | |
| Ambient $CO_2$ | ★ | | | | |
| Solar radiation | ★ | | | | |
| Weather | | | | | |

# Soil Quality and Maximum Corn Yield

- Consider total soil profile
- Soil volume per plant
- Eliminate Stress of root restriction
- Subsoil pH, Fertility
- Aeration
- Water infiltration
- Drainage

**Table 1. Current soil test P critical levels used to guide P fertilization of corn in each of the twelve states. The number of experimental sites testing below the critical level and the number of sites with yield increases below the critical level.**

| Soil test | Current critical level | | Maximum soil test P level for which broadcast P is recommended‡ | Sites below critical level | Sites below critical level with yield increase (P<0.10) | |
|---|---|---|---|---|---|---|
| | state | P, mg kg-1 | P, mg kg-1 | ---------- number ---------- | | % |
| Morgan-Colormetric | NY | 4.5 | 20 | 23 | 4 | 17 |
| | RI | 4.5 | 20 | 23 | 4 | 17 |
| | MA | 7 | 20 | 29 | 7 | 24 |
| Mod. Morgan-Colormetric | VT | 4 | 7§ | 26 | 6 | 23 |
| | ME | 5 | 20 | 29 | 7 | 24 |
| | CT | 7 | 10 | 33 | 7 | 21 |
| | RI | 7 | 10 | 33 | 7 | 21 |
| Bray-1-ICP | PA† | 30 | 45 | 7 | 3 | 43 |
| Mehlich-1-ICP | NJ | 23 | 45 | 13 | 4 | 31 |
| | MD | 25 | 50 | 15 | 4 | 27 |
| | WV | 25 | 100 | 15 | 4 | 27 |
| Mehlich-3-ICP | PA | 30 | 50 | 9 | 3 | 33 |
| | NJ | 36 | 69 | 11 | 3 | 27 |
| | DE | NA | 50 | | | |
| | NH | 30 | 50 | 9 | 3 | 33 |
| | MD | 50 | 100 | 17 | 3 | 18 |

† Bray-1 critical level that was used in Pennsylvania prior to changing over to the Mehlich-3 soil test in 1 August 1991.

‡ A starter fertilizer containing some P may be applied at higher than these soil test P levels.

§ A low rate of starter fertilizer P is recommended for soil test P up to 20 mg $kg^{-1}$, higher under adverse conditions.

**Table 2. Soil classification, soil test P with each of five extractants and Modified Morgan and Mehlich-3 extractable Al at 51 experimental sites in 1998 and 1999. Soil test extractable P and extractable Al were measured either colormetrically or with an inductively coupled plasma instrument (ICP), as indicated. Data were organized by ranking Mehlich-3 soil test P values from lowest to highest. All data are from the 0 to 15 cm soil sampling depth.**

| Experimental site - state | Soil series and taxonomy | Organic Carbon | pH | Soil test extractable P† | | | | | | | Soil test extractable Al | | % M3 P/Al |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | M-COL | MM-COL | M-ICP | MM-ICP | B-ICP | M1-ICP | M3-ICP | MM-ICP | M3-ICP | |
| | | | | mg kg$^{-1}$ | | | | | | | | | |
| 27-VT | Vergennes; Glossaquic Hapludult; clay; very-fine, mixed, mesic | 2.0 | 6.44 | 1.2 | 3.1 | 4.2 | 4.4 | 13 | 8 | 7 | 23 | 808 | 1 |
| 19-NJ | Freehold; Typic Hapludult; sandy loam; fine-loamy, mixed, mesic | 1.2 | 5.36 | 0.8 | 1.2 | 2.4 | 2.2 | 20 | 9 | 16 | 48 | 712 | 2 |
| 48-VT | Vergennes; Glossaquic Hapludult; clay; very-fine, mixed, mesic | 2.4 | 6.23 | 2.5 | 1.0 | 6.0 | 4.6 | 14 | 17 | 18 | 9 | 964 | 2 |
| 50-WV | Lindside; Fluvaquentic Eutrudept; silt loam; fine-silty, mixed, mesic | 0.9 | 5.45 | 1.9 | 1.1 | 2.8 | 2.8 | 21 | 11 | 19 | 30 | 905 | 2 |
| 23-PA | Berks; Typic Dystrudept; shale silt loam; loamy-skeletal, mixed, mesic | 1.6 | 6.30 | 2.2 | 2.4 | 5.1 | 3.8 | 24 | 14 | 21 | 22 | 681 | 3 |
| 51-WV | Monongahela; Typic Fragiudult; silt loam; fine-loamy, mixed, mesic | 0.9 | 5.63 | 2.4 | 1.4 | 3.3 | 3.1 | 20 | 12 | 23 | 23 | 846 | 3 |
| 10-MD | Hagerstown; Typic Hapludalf; silt loam; fine, mixed, mesic | 1.1 | 6.14 | 2.5 | 2.2 | 4.2 | 2.9 | 29 | 9 | 23 | 28 | 660 | 4 |
| 1-CT | Woodbridge; Aquic Dystrudept; sandy loam; coarse-loamy, mixed, mesic | 2.2 | 5.56 | 1.4 | 3.2 | 5.6 | 5.0 | 78 | 32 | 28 | 234 | 1549 | 2 |
| 16-NH | Occum; Fluventic Dystrudept; coarse-loam, mixed, mesic | 1.5 | 5.81 | 0.8 | 2.1 | 2.4 | 2.4 | 68 | 27 | 29 | 166 | 1331 | 2 |
| 29-CT | Paxton; Oxyaquic Dystrudept; sandy loam; coarse-loamy, mixed, mesic | 2.1 | 5.80 | 1.1 | 0.9 | 3.5 | 3.2 | 42 | 20 | 34 | 161 | 1830 | 2 |
| 9-MD | Mattapex; Aquic Hapludult; silt loam; fine-silty, mixed, mesic | 1.2 | 5.93 | 3.6 | 2.9 | 5.8 | 4.5 | 42 | 14 | 36 | 34 | 731 | 5 |
| 14-ME | Nicholville; Aquic Haplorthod; sandy loam; coarse-silty, isotic, frigid | 1.8 | 6.00 | 1.8 | 2.8 | 4.1 | 3.4 | 75 | 32 | 38 | 116 | 1401 | 3 |
| 2-CT | Woodbridge; Aquic Dystrudept; sandy loam; coarse-loamy, mixed, mesic | 2.6 | 5.92 | 1.5 | 3.2 | 4.8 | 4.1 | 99 | 36 | 43 | 170 | 1554 | 3 |
| 36-MD | Bertie; Aeric Endoaquult; silt loam; fine-loamy, mixed, mesic | 1.0 | 6.20 | 3.1 | 1.7 | 4.9 | 3.7 | 34 | 17 | 44 | 37 | 856 | 5 |
| 3-DE | Evesboro; Typic Quartzipsamment; mesic; coated | 1.0 | 6.03 | 2.7 | 1.8 | 4.3 | 2.9 | 47 | 12 | 45 | 34 | 639 | 7 |
| 22-PA | Allenwood; Typic Hapludult; silty clay loam; fine-loamy, mixed, mesic | 1.2 | 6.82 | 5.7 | 4.5 | 7.9 | 5.1 | 53 | 27 | 46 | 13 | 681 | 7 |
| 20-NJ | Quakertown; Typic Hapludult; silt laom; fine-loamy, mixed, mesic | 1.1 | 6.44 | 4.8 | 4.4 | 6.3 | 4.8 | 69 | 35 | 49 | 24 | 776 | 6 |
| 24-PA | Linden; Fluventic Dystrudept; sandy loam; coarse-loamy, mixed, mesic | 1.5 | 6.14 | 6.0 | 5.0 | 8.1 | 5.6 | 67 | 27 | 51 | 17 | 673 | 8 |
| 13-ME | Nicholville; Aquic Haplorthod; sandy loam; coarse-silty, isotic, frigid | 2.4 | 6.10 | 2.9 | 3.7 | 5.6 | 4.4 | 124 | 51 | 56 | 100 | 1418 | 4 |
| 15-NH | Occum; Fluventic Dystrudept; coarse-loam, mixed, mesic | 1.8 | 5.49 | 2.3 | 2.5 | 5.9 | 4.5 | 72 | 25 | 58 | 142 | 1130 | 5 |
| 39-NH | Occum; Fluventic Dystrudept; coarse-loam, mixed, mesic | 2.2 | 6.20 | 1.6 | 0.7 | 4.0 | 2.7 | 63 | 19 | 62 | 67 | 1542 | 4 |
| 32-DE | Rumford; Typic Hapludult; loam; coarse-loamy, siliceous, thermic | 0.6 | 5.43 | 3.7 | 2.6 | 5.2 | 3.9 | 55 | 20 | 64 | 48 | 754 | 9 |
| 33-DE | Matapeake; Typic Hapludult; silt; fine-silty, mixed, mesic | 1.0 | 5.48 | 3.9 | 2.4 | 6.0 | 4.4 | 56 | 70 | 65 | 40 | 1180 | 5 |
| 42-NJ | Quakertown; Typic Hapludult; silt loam; fine-loamy, mixed, mesic | 1.5 | 6.38 | 4.7 | 2.6 | 7.1 | 4.7 | 72 | 30 | 69 | 31 | 1105 | 6 |
| 4-DE | Evesboro; Typic Quartzipsamment; mesic; coated | 1.0 | 6.53 | 4.5 | 3.1 | 5.8 | 4.0 | 80 | 24 | 79 | 25 | 699 | 11 |
| 41-NJ | Aura; Typic Fragiudult; sandy loam; coarse-loamy, mixed, mesic | 0.7 | 6.18 | 6.3 | 3.7 | 7.7 | 4.9 | 67 | 42 | 81 | 16 | 662 | 12 |
| 43-PA | Hublersburg; Typic Hapludult; silty clay loam; clayey, illitic, mesic | 1.6 | 5.90 | 5.5 | 3.5 | 8.0 | 5.6 | 83 | 36 | 83 | 26 | 1172 | 7 |
| 26-VT | Hadley; Typic Udifluvent; sandy loam; coarse-silty, mixed, mesic | 1.5 | 6.47 | 8.4 | 8.4 | 10.6 | 7.7 | 105 | 50 | 84 | 20 | 761 | 11 |
| 38-ME | Nicholville; Aquic Haplorthod; sandy loam; coarse-silty, isotic, frigid | 1.7 | 5.30 | 3.6 | 2.8 | 5.2 | 4.1 | 125 | 58 | 87 | 63 | 1623 | 5 |
| 28-CT | Woodbridge; Aquic Dystrudept; sandy loam; coarse-loamy, mixed, mesic | 2.1 | 5.98 | 3.0 | 2.3 | 5.5 | 4.6 | 89 | 43 | 88 | 56 | 1639 | 5 |
| 37-MD | Mattapex; Aquic Hapludult; silt loam; fine-silty, mixed, mesic | 1.0 | 6.38 | 9.2 | 5.9 | 11.3 | 7.6 | 90 | 45 | 98 | 25 | 928 | 11 |
| 5-DE | Kenansville; Arenic Hapludult; loam; loamy, siliceous, thermic | 0.9 | 6.13 | 7.8 | 5.5 | 9.4 | 6.2 | 122 | 46 | 111 | 35 | 735 | 15 |
| 45-PA | Linden; Fluventic Dystrudept; sandy loam; coarse-loamy, mixed, mesic | 0.6 | 5.78 | 9.3 | 7.2 | 12.2 | 8.5 | 71 | 58 | 123 | 20 | 607 | 20 |
| 18-NJ | Freehold; Typic Hapludult; sandy loam; fine-loamy, mixed, mesic | 0.9 | 5.57 | 8.5 | 6.8 | 11.2 | 8.3 | 147 | 72 | 123 | 69 | 714 | 17 |
| 31-DE | Kenansville; Arenic Hapludult; loam; loamy, siliceous, thermic | 1.1 | 5.88 | 11.3 | 8.4 | 13.1 | 9.6 | 123 | 60 | 138 | 23 | 548 | 25 |
| 30-DE | Sassafras; Typic Hapludult; loam; fine-loamy, siliceous, mesic | 0.9 | 5.83 | 9.8 | 7.1 | 11.9 | 8.2 | 114 | 53 | 144 | 24 | 539 | 27 |
| 46-RI | Bridgehampton; Typic Dystrudept; silt loam; coarse-silty, mixed, mesic | 1.6 | 5.58 | 7.6 | 6.3 | 11.8 | 9.8 | 268 | 94 | 160 | 131 | 1647 | 10 |
| 6-DE | Matapeake; Typic Hapludult; silt; fine-silty, mixed, mesic | 0.9 | 6.44 | 17.6 | 14.9 | 19.2 | 14.1 | 208 | 84 | 176 | 25 | 837 | 21 |
| 49-VT | Nellis; Typic Eutrudept; ; coarse-loamy, mixed, mesic | 1.7 | 6.03 | 38.3 | 28.7 | 41.6 | 28.1 | 148 | 114 | 197 | 7 | 817 | 24 |
| 25-RI | Merrimac; Typic Dystrudept; sandy loam; sandy, mixed, mesic | 1.2 | 5.32 | 12.4 | 9.1 | 16.1 | 10.7 | 294 | 76 | 225 | 68 | 913 | 25 |
| 8-MA | Merrimac; Typic Dystrudept; sandy loam; sandy, mixed, mesic | 1.2 | 6.20 | 9.8 | 7.1 | 11.7 | 7.9 | 346 | 135 | 235 | 40 | 962 | 24 |
| 17-NH | Hollis-Charlton; Lithic-Typic Dystrudept; sandy loam; loamy-coarse loamy, mixed, mesic | 3.1 | 5.52 | 9.6 | 9.4 | 14.0 | 10.4 | 374 | 116 | 238 | 83 | 1378 | 17 |
| 44-PA | Hagerstown; Typic Hapludalf; silt loam; fine, mixed, mesic | 1.5 | 6.30 | 39.0 | 27.6 | 42.5 | 29.8 | 239 | 150 | 248 | 12 | 1054 | 24 |
| 47-RI | Hinckley; Typic Udorthent; sandy loam; sandy-skeletal, mixed, mesic | 1.2 | 5.86 | 11.2 | 8.8 | 15.1 | 11.3 | 261 | 89 | 255 | 81 | 1412 | 18 |
| 7-MA | Hadley; Typic Udifluvent; sandy loam; coarse-silty, mixed, mesic | 1.4 | 6.90 | 19.0 | 16.2 | 20.7 | 15.9 | 427 | 202 | 259 | 27 | 1092 | 24 |
| 40-NH | Hollis-Charlton; Lithic/Typic Dystrudept; sandy loam; loamy/coarse loamy, mixed, mesic | 2.2 | 5.33 | 10.5 | 7.3 | 13.4 | 9.3 | 279 | 95 | 295 | 66 | 1665 | 18 |
| 12-ME | Caribou; Typic Haplorthod; loam; fine-loamy, isotic, frigid | 1.2 | 6.63 | 20.0 | 17.3 | 22.4 | 18.6 | 420 | 247 | 307 | 49 | 1292 | 24 |
| 35-MA | Merrimac; Typic Dystrudept; sandy loam; sandy, mixed, mesic | 1.2 | 5.58 | 12.2 | 8.4 | 15.1 | 10.3 | 285 | 132 | 319 | 48 | 1147 | 28 |
| 21-PA | Braceville; Typic Fragiudept; loam; coarse-loamy, mixed, mesic | 2.5 | 6.30 | 24.3 | 19.8 | 29.1 | 21.0 | 505 | 226 | 326 | 39 | 1149 | 28 |
| 11-ME | Bangor; Typic Haplorthod; silt loam; coarse-loamy, isotic, frigid | 2.3 | 5.41 | 16.1 | 14.7 | 21.3 | 16.7 | 508 | 209 | 338 | 70 | 1342 | 25 |
| 34-MA | Hadley; Typic Udifluvent; sandy loam; coarse-silty, mixed, mesic | 1.8 | 5.58 | 22.3 | 15.5 | 24.7 | 17.6 | 514 | 238 | 418 | 28 | 1525 | 27 |

† Soil P determined by five extractants: M-COL=Morgan-Colorometric, MM-COL=Modified Morgan-Colorometric, M-ICP=Morgan-ICP, MM-ICP=Modified Morgan-ICP, B-ICP=Bray-1-ICP, M1-ICP=Mehlich-1-ICP, and M3-ICP=Mehlich-3-ICP; soil Al determined by Modified Morgan and Mehlich-3.

**Table 3. Corn grain and silage yield response to band and broadcast applied P at 51 experimental sites in 1998 and 1999.**

| | Grain | | | Statistics (P > F) | | | |
|---|---|---|---|---|---|---|---|
| Exp. site - state | Control | Band | Broadcast | Treatment | Control vs BN | Control vs BC | BN vs BC† |
| | ---------- Mg ha$^{-1}$ ---------- | | | | | | |
| 19-NJ | 11.5 | 11.1 | 11.4 | 0.79 | 0.53 | 0.85 | 0.65 |
| 50-WV | 7.0 | 7.3 | 8.4 | 0.02 | 0.38 | 0.01 | 0.02 |
| 23-PA | 9.3 | 9.9 | 9.8 | 0.52 | 0.32 | 0.36 | 0.92 |
| 51-WV | 4.0 | 4.1 | 4.7 | 0.16 | 0.80 | 0.08 | 0.12 |
| 10-MD | 6.8 | 6.5 | 6.9 | 0.74 | 0.57 | 0.89 | 0.48 |
| 9-MD | 5.6 | 6.6 | 6.6 | 0.34 | 0.21 | 0.21 | 1.00 |
| 36-MD | 1.5 | 1.5 | 1.4 | 0.41 | 0.57 | 0.44 | 0.20 |
| 3-DE | 8.6 | 9.4 | 9.1 | 0.31 | 0.14 | 0.35 | 0.53 |
| 22-PA | 7.3 | 7.9 | 7.9 | 0.25 | 0.16 | 0.16 | 1.00 |
| 20-NJ | 14.3 | 14.5 | 14.6 | 0.50 | 0.54 | 0.26 | 0.56 |
| 24-PA | 9.4 | 11.1 | 11.5 | 0.08 | 0.07 | 0.04 | 0.70 |
| 32-DE | 6.8 | 6.8 | 7.2 | 0.16 | 0.75 | 0.08 | 0.13 |
| 33-DE | 4.3 | 5.1 | 5.3 | 0.37 | 0.26 | 0.21 | 0.87 |
| 42-NJ | 17.4 | 17.7 | 17.7 | 0.34 | 0.21 | 0.20 | 0.97 |
| 4-DE | 8.2 | 7.1 | 7.2 | 0.21 | 0.11 | 0.16 | 0.79 |
| 41-NJ | 15.0 | 15.1 | 15.5 | 0.05 | 0.94 | 0.03 | 0.03 |
| 43-PA | 6.4 | 6.2 | 7.7 | 0.04 | 0.64 | 0.04 | 0.02 |
| 37-MD | 2.1 | 2.1 | 1.9 | 0.32 | 0.94 | 0.21 | 0.19 |
| 5-DE | 5.6 | 5.6 | 5.3 | 0.95 | 0.98 | 0.78 | 0.79 |
| 45-PA | 12.3 | 12.9 | 13.1 | 0.36 | 0.28 | 0.19 | 0.77 |
| 18-NJ | 14.9 | 15.6 | 15.0 | 0.15 | 0.07 | 0.69 | 0.13 |
| 31-DE | 11.3 | 9.4 | 10.7 | 0.26 | 0.13 | 0.64 | 0.25 |
| 30-DE | 9.5 | 10.0 | 9.4 | 0.83 | 0.62 | 0.97 | 0.59 |
| 46-RI | 7.2 | 6.4 | 8.4 | 0.06 | 0.28 | 0.14 | 0.02 |
| 6-DE | 5.6 | 5.5 | 6.6 | 0.20 | 0.95 | 0.13 | 0.12 |
| 25-RI | 5.0 | 4.7 | 5.7 | 0.73 | 0.72 | 0.39 | 0.26 |
| 8-MA | 11.5 | 11.7 | 9.8 | 0.25 | 0.82 | 0.19 | 0.14 |
| 44-PA | 2.5 | 3.7 | 3.1 | 0.53 | 0.29 | 0.56 | 0.59 |
| 47-RI | 5.3 | 6.9 | 6.3 | 0.28 | 0.13 | 0.31 | 0.56 |
| 7-MA | 14.6 | 14.9 | 16.4 | 0.06 | 0.63 | 0.03 | 0.05 |
| 35-MA | 9.0 | 11.0 | 11.8 | 0.14 | 0.16 | 0.06 | 0.53 |
| 21-PA | 7.4 | 7.7 | 7.7 | 0.91 | 0.73 | 0.71 | 0.98 |
| 11-ME | 5.3 | 5.0 | 5.3 | 0.51 | 0.44 | 0.73 | 0.28 |
| 34-MA | 16.8 | 16.1 | 15.0 | 0.18 | 0.43 | 0.07 | 0.24 |
| | | Silage | | | | | |
| | ---------- Mg ha$^{-1}$ ---------- | | | | | | |
| 27-VT | 7.92 | 9.43 | 11.28 | 0.04 | 0.17 | 0.01 | 0.10 |
| 48-VT | 10.81 | 11.03 | 11.52 | 0.36 | 0.66 | 0.18 | 0.34 |
| 1-CT | 17.73 | 16.51 | 17.93 | 0.33 | 0.24 | 0.84 | 0.18 |
| 16-NH | 14.62 | 16.02 | 17.81 | 0.46 | 0.58 | 0.24 | 0.49 |
| 29-CT | 64.08 | 66.05 | 64.63 | 0.88 | 0.77 | 0.84 | 0.63 |
| 14-ME | 55.55 | 54.88 | 60.87 | 0.55 | 0.47 | 0.30 | 0.74 |
| 2-CT | 18.63 | 18.75 | 18.97 | 0.94 | 0.91 | 0.75 | 0.83 |
| 13-ME | 53.26 | 52.70 | 58.74 | 0.67 | 0.93 | 0.43 | 0.48 |
| 15-NH | 18.07 | 16.95 | 15.53 | 0.67 | 0.51 | 0.85 | 0.41 |
| 39-NH | 20.13 | 21.82 | 20.74 | 0.36 | 0.17 | 0.60 | 0.36 |
| 26-VT | 18.25 | 16.16 | 18.64 | 0.001 | 0.002 | 0.33 | 0.001 |
| 38-ME | 13.56 | 12.84 | 13.46 | 0.61 | 0.39 | 0.96 | 0.42 |
| 28-CT | 37.20 | 53.13 | 45.43 | 0.18 | 0.08 | 0.31 | 0.34 |
| 49-VT | 11.04 | 12.62 | 11.38 | 0.31 | 0.16 | 0.74 | 0.25 |
| 17-NH | 22.74 | 20.10 | 23.46 | 0.17 | 0.16 | 0.67 | 0.08 |
| 40-NH | 17.29 | 16.98 | 16.80 | 0.98 | 0.91 | 0.86 | 0.95 |
| 12-ME | 41.78 | 47.38 | 45.47 | 0.15 | 0.07 | 0.51 | 0.17 |

† BN=Band 15 kg ha$^{-1}$ of P, BC=Broadcast 60 kg ha$^{-1}$ of P.

**Corn plant height at 35 days after planting combined over experimental sites and years.**

| Year | 1998 | 1999 | 1998-1999 |
|---|---|---|---|
| ---------- Plant Height, cm ---------- | | | |
| Control | 60 | 49 | 55 |
| Band | 64 | 52 | 59 |
| Broadcast | 64 | 54 | 59 |
| | | *P > F* | |
| Treatment | 0.0001 | 0.0001 | 0.0001 |
| Control vs BN | 0.0001 | 0.003 | 0.0001 |
| Control vs BC | 0.0004 | 0.0001 | 0.0001 |
| BN vs BC† | 0.65 | 0.24 | 0.88 |
| n | 26 | 22 | 48 |

BN=Band 15 kg/ha of P, BC=Broadcast 60 kg/ha of P.

## Corn grain yield responses combined over experimental sites and years.

| Year | 1998 | 1999 | 1998-1999 |
|---|---|---|---|
| | ---------- Grain, Bu/ac | ---------- | |
| Control | 140 | 145 | 142 |
| Band | 143 | 150 | 146 |
| Broadcast | 148 | 153 | 151 |
| | | *P > F* | |
| Treatment | 0.10 | 0.05 | 0.005 |
| Control vs BN | 0.44 | 0.42 | 0.18 |
| Control vs BC | 0.09 | 0.04 | 0.003 |
| BN vs BC | 0.62 | 0.43 | 0.27 |
| n | 17 | 17 | 34 |

BN=Band 15 kg/ha of P, BC=Broadcast 60 kg/ha of P.

## Corn silage yield responses combined over experimental sites and years.

| Year | 1998 | 1999 | 1998-1999 |
|---|---|---|---|
| | ---------- Silage, Mg/ha | ---------- | |
| Control | 15.68 | 14.75 | 15.29 |
| Band | 15.38 | 15.75 | 15.53 |
| Broadcast | 16.39 | 15.28 | 15.93 |
| | | *P > F* | |
| Treatment | 0.06 | 0.20 | 0.18 |
| Control vs BN | 0.77 | 0.17 | 0.76 |
| Control vs BC | 0.24 | 0.60 | 0.16 |
| BN vs BC | 0.06 | 0.68 | 0.49 |
| n | 10 | 7 | 17 |

BN=Band 15 kg/ha of P, BC=Broadcast 60 kg/ha of P.

## Corn grain moisture combined over experimental sites and years.

| Year | 1998 | 1999 | 1998-1999 |
|---|---|---|---|
| | ----------Grain Moisture, g/kg---------- | | |
| Control | 238 | 249 | 244 |
| Band | 238 | 248 | 243 |
| Broadcast | 239 | 242 | 241 |
| | | *P > F* | |
| Treatment | 0.93 | 0.03 | 0.02 |
| Control vs BN | 0.99 | 0.96 | 0.99 |
| Control vs BC | 0.93 | 0.04 | 0.19 |
| BN vs BC | 0.97 | 0.07 | 0.24 |
| n | 16 | 15 | 31 |

BN=Band 15 kg/ha of P, BC=Broadcast 60 kg/ha of P.

# Corn Response to P in Starter

Fig. 2a. Relationships between soil P extracted by five soil test extractants and relative plant height at 35 days after planting as calculated based on the broadcast treatment. Triangle symbols are statistically significant at the P>F 0.05 level; circle symbols are not significant. Vertical lines indicate current soil test P critical levels for individual states.

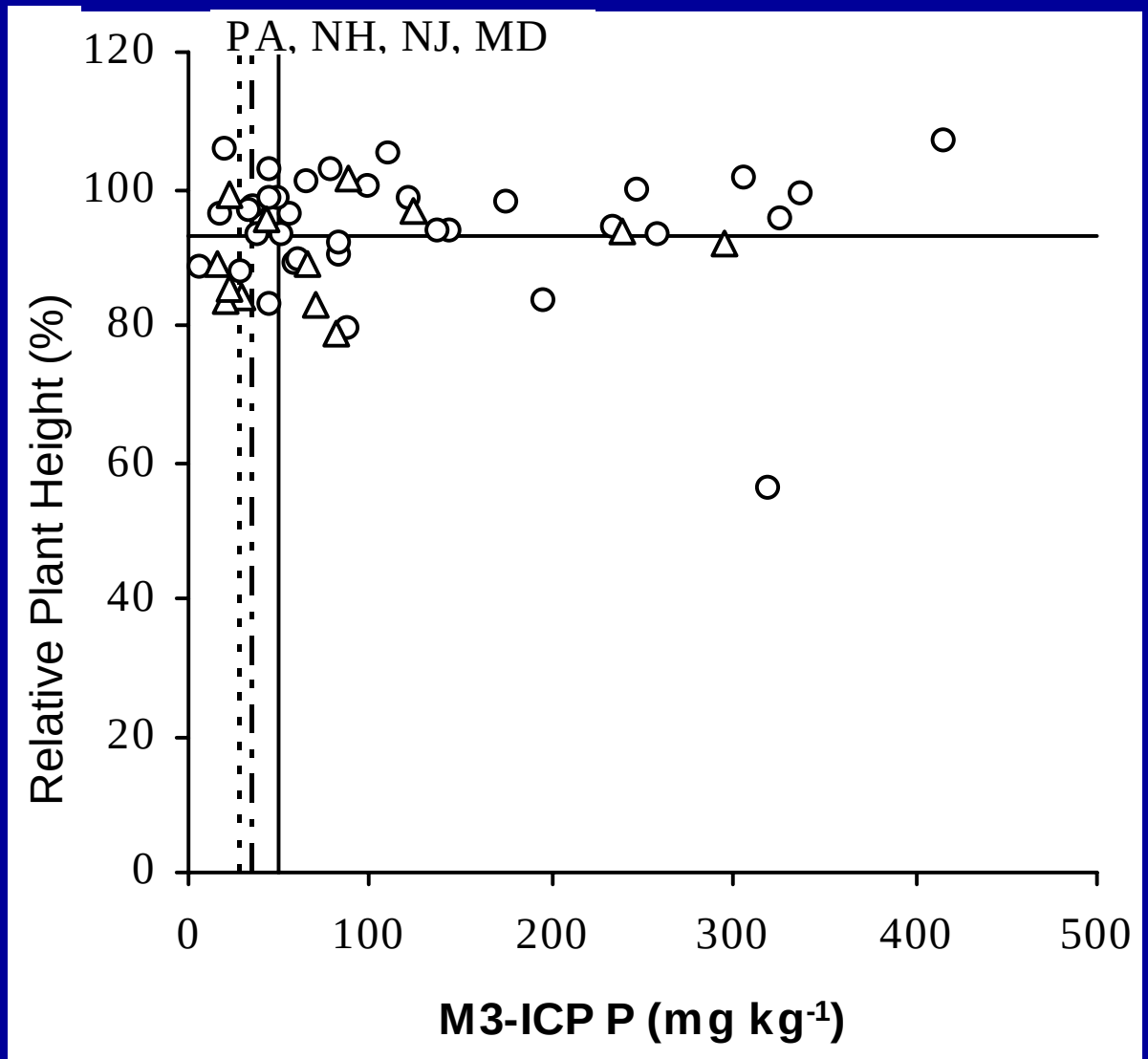
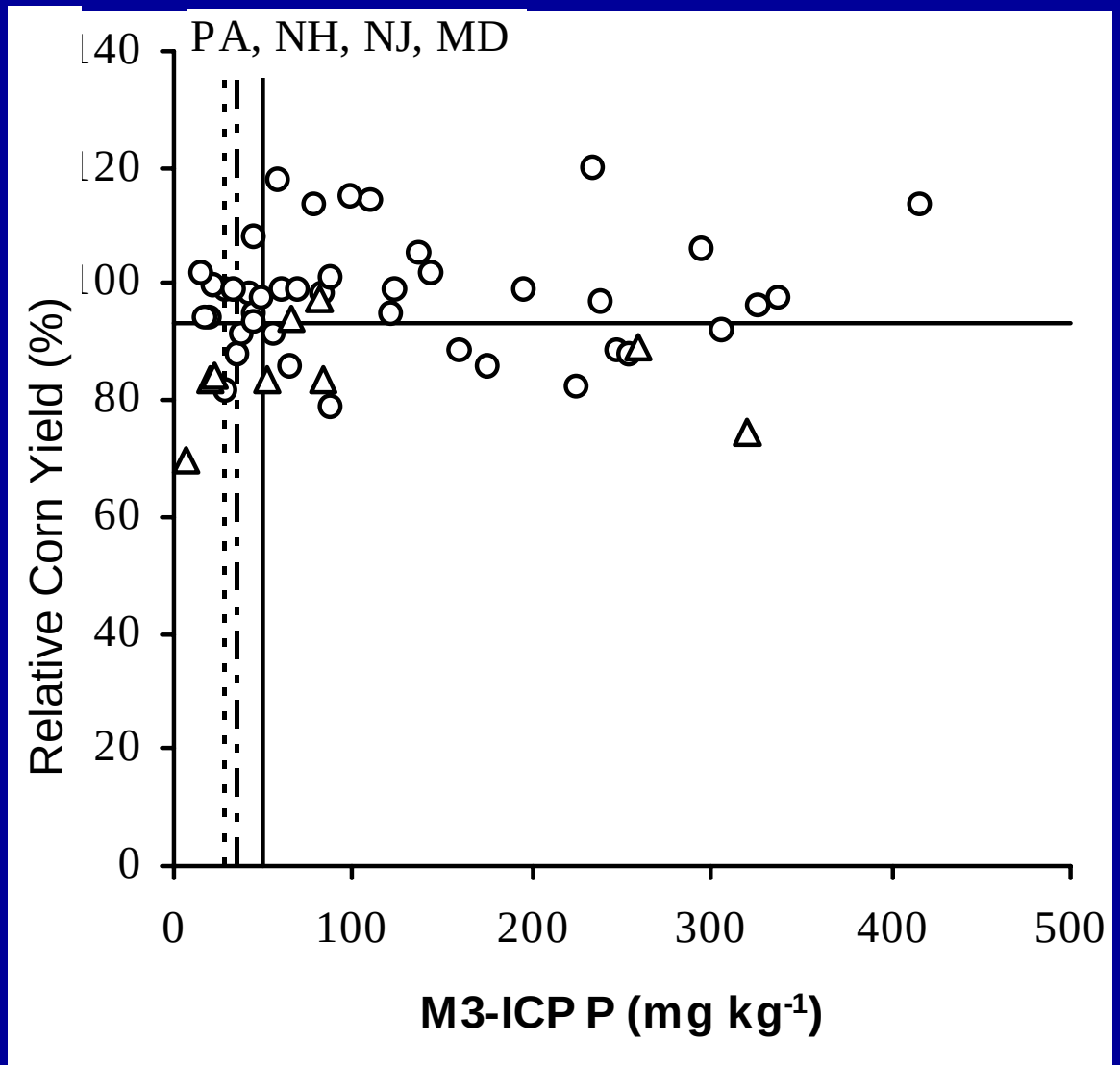
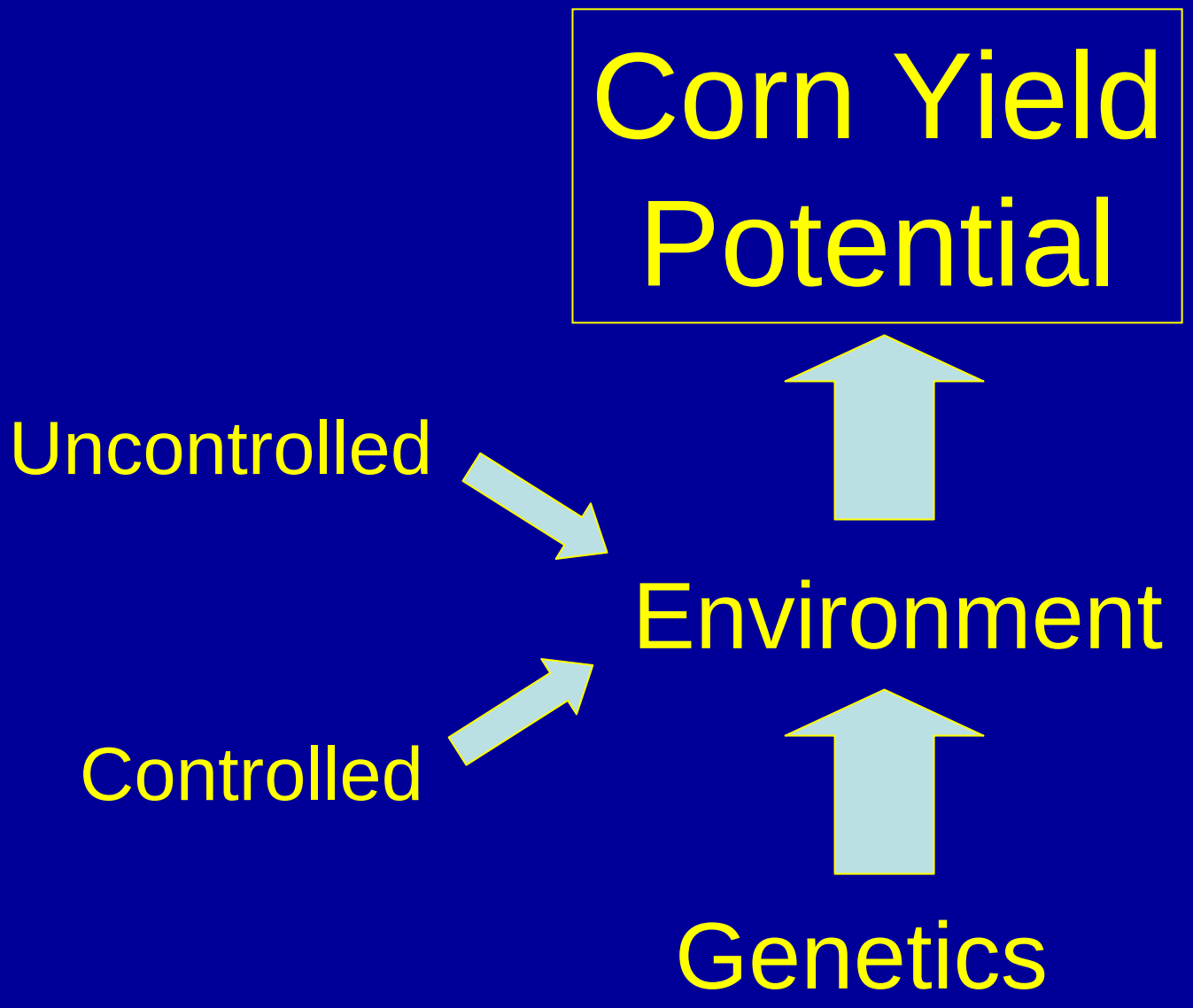
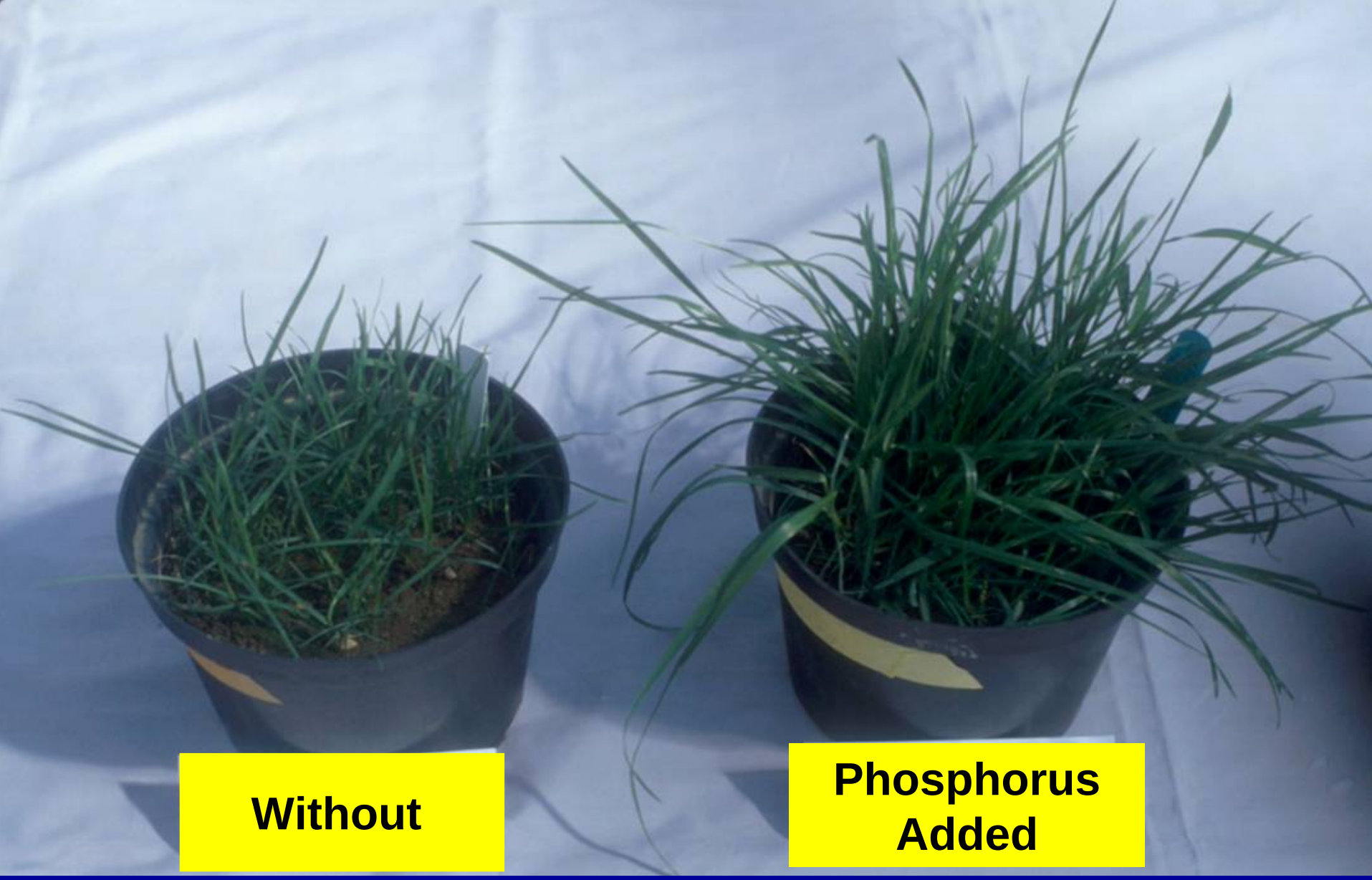


Fig. 1a. Relationships between soil P extracted by five soil test extractants and relative yield as calculated based on the broadcast treatment. Triangle symbols are statistically significant at the P>F 0.10 level; circle symbols are not significant. Vertical lines indicate current soil test P critical levels for individual states.




Corn Yield Potential
Uncontrolled
Environment
Controlled
Genetics

# Turfgrass Establishment Response to Fertilizer


Without
Phosphorus Added

## Silking percentage combined over experimental sites and years.

| Year | 1998 | 1999 | 1998-1999 |
|---|---|---|---|
| ---------- Silking, % ---------- | | | |
| Control | 53 | 57 | 55 |
| Band | 61 | 62 | 62 |
| Broadcast | 62 | 67 | 65 |
| | | *P > F* | |
| Treatment | 0.0002 | 0.0001 | 0.0001 |
| Control vs BN | 0.003 | 0.04 | 0.0002 |
| Control vs BC | 0.0003 | 0.0001 | 0.0001 |
| BN vs BC | 0.85 | 0.06 | 0.10 |
| n | 20 | 22 | 42 |

BN=Band 15 kg/ha of P, BC=Broadcast 60 kg/ha of P.

# Soil Test P Calibration for Kentucky Bluegrass, Tall Fescue, and Perennial Rye

**Table 1. Soil classification, soil test P with each of three extractants and Mehlich-3 extractable Al on 23 experimental soils from NJ. Soil test extractable P and extractable Al were measured with an ICP instrument. All soils were collected from the 0 to 20-cm surface layer.**

| Experimental Soil | Soil series and taxonomy | Organic C | Initial pH | Soil test Extractable P (ICP) mg kg$^{-1}$ Bray P | Mehlich-1 P | Mehlich-3 P | Soil test Extractable Al (ICP) Mehlich-3 Al | Mehlich-3 P/Al |
|---|---|---|---|---|---|---|---|---|
| | | % | | mg kg$^{-1}$ | | | | % |
| 1 | Washington;loam, mixed mesic, Ultic Hapludalf | 1.2 | 6.9 | 480 | 619 | 680 | 661 | 103 |
| 2 | Nassau;silt loam, mixed, mesic, Lithic Dystrochrept | 1.5 | 7.0 | 905 | 1174 | 1238 | 621 | 199 |
| 3 | Annandale;gravelly loam, mixed, mesic Typic Fragiudult | 1.3 | 5.6 | 37 | 19 | 48 | 1046 | 5 |
| 6 | Bucks;silt loam, mixed, mesic, Typic Hapludult | 1.5 | 7.2 | 259 | 203 | 409 | 1081 | 38 |
| 7 | Quakertown;silt loam, mixed, mesic Typic Hapludult | 1.1 | 6.5 | 73 | 37 | 74 | 891 | 8 |
| 8 | Downer;loamy sand, siliceous, mesic, Typic Hapludult | 0.6 | 7.0 | 365 | 289 | 383 | 579 | 66 |
| 9 | Sassafras;sandy loam, siliceous, mesic Typic Hapludult | 0.7 | 6.3 | 114 | 109 | 239 | 745 | 32 |
| 10 | Sassafras;sandy loam, siliceous, mesic Typic Hapludult | 0.4 | 6.1 | 112 | 90 | 209 | 672 | 31 |
| 11 | Sassafras;sandy loam, siliceous, mesic Typic Hapludult | 1.5 | 4.5 | 7 | 4 | 25 | 1009 | 3 |
| 13 | Freehold;sandy loam, mixed, mesic Typic Hapludult | 0.9 | 6.0 | 152 | 90 | 196 | 954 | 21 |
| 14 | Freehold;sandy loam, mixed mesic Typic Hapludult | 0.5 | 5.5 | 89 | 35 | 101 | 758 | 13 |
| 15 | Freehold;sandy loam, mixed mesic Typic Hapludult | 0.4 | 5.7 | 124 | 59 | 142 | 859 | 17 |
| 16 | Woodstown;loam, siliceous, mesic Aquic Hapludult | 1.4 | 4.1 | 13 | 4 | 6 | 2206 | 0.3 |
| 17 | Adelphia;loam, mixed, mesic Aquic Hapludult | 2.2 | 4.0 | 34 | 10 | 40 | 1258 | 3 |
| 18 | Nixon;loam, mixed, mesic Typic Hapludult | 1.0 | 4.8 | 35 | 10 | 40 | 1074 | 4 |
| 19 | Keyport modified; loam, | 1.8 | 6.4 | 20 | 28 | 19 | 491 | 4 |
| 20 | Downer;loamy sand, siliceous, mesic, Typic Hapludult | 0.6 | 6.5 | 358 | 278 | 371 | 431 | 86 |
| 22 | Quakertown;silt loam, mixed, mesic Typic Hapludult | 1.5 | 6.3 | 86 | 39 | 83 | 589 | 14 |
| 23 | Quakertown;silt loam, mixed, mesic Typic Hapludult | 1.4 | 6.1 | 142 | 75 | 134 | 597 | 22 |
| 24 | Holmdel;sandy loam, mixed, mesic Aquic Hapludult | 1.2 | 6.6 | 123 | 98 | 145 | 515 | 28 |
| 25 | Freehold;loam, mixed, mesic Typic Hapludult | 0.9 | 6.5 | 49 | 28 | 51 | 431 | 12 |
| 26 | Nixon;loam, mixed, mesic Typic Hapludult | 0.6 | 6.7 | 127 | 73 | 129 | 431 | 30 |
| 27 | Sassafras;sandy loam, siliceous, mesic Typic Hapludult | 3.2 | 5.9 | 100 | 24 | 120 | 748 | 16 |

# Soil Test P Calibration for Kentucky Bluegrass, Tall Fescue, and Perennial Rye

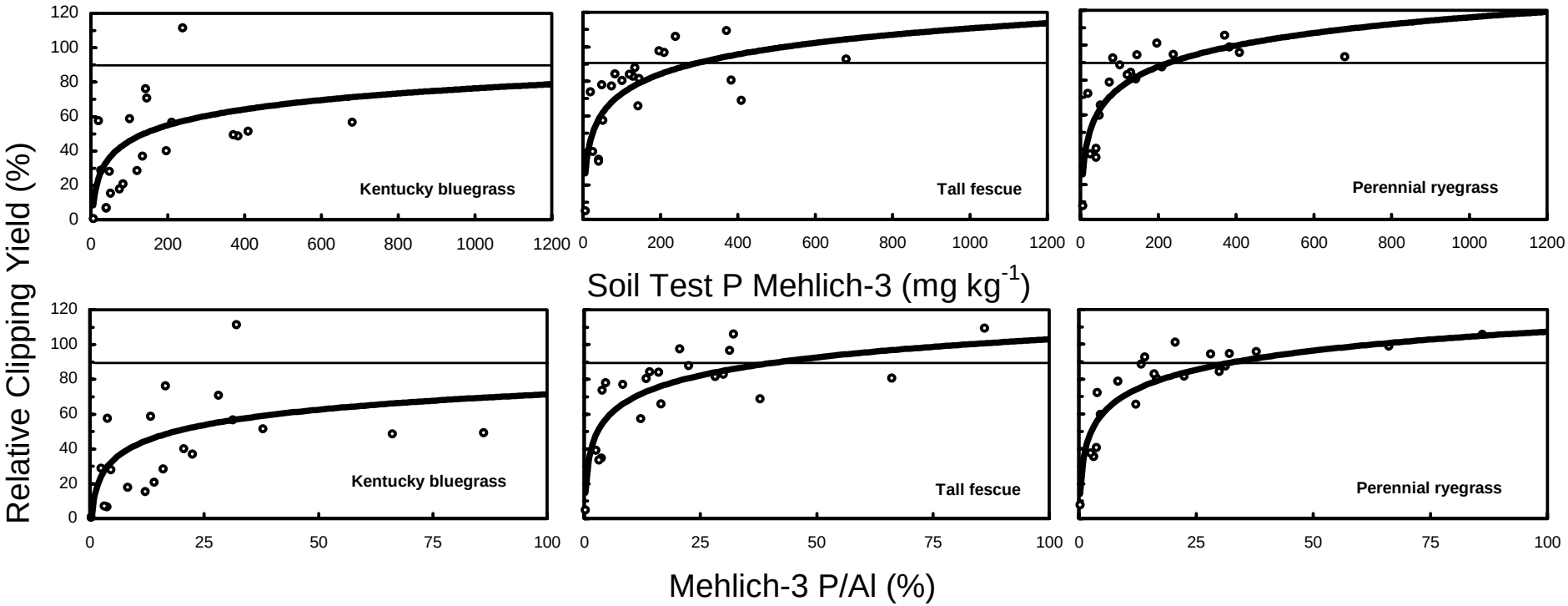



Fig. 1. Relationship between relative clipping yield of three turfgrass species at 42 days after seeding and soil test P with each of three extractants and Mehlich-3 extractable P to Al ratio, expressed as a percentage, on 23 experimental soils from NJ. Soil test extractable P and extractable Al were measured with an ICP instrument.

# Soil Test P Calibration for Kentucky Bluegrass, Tall Fescue, and Perennial Rye

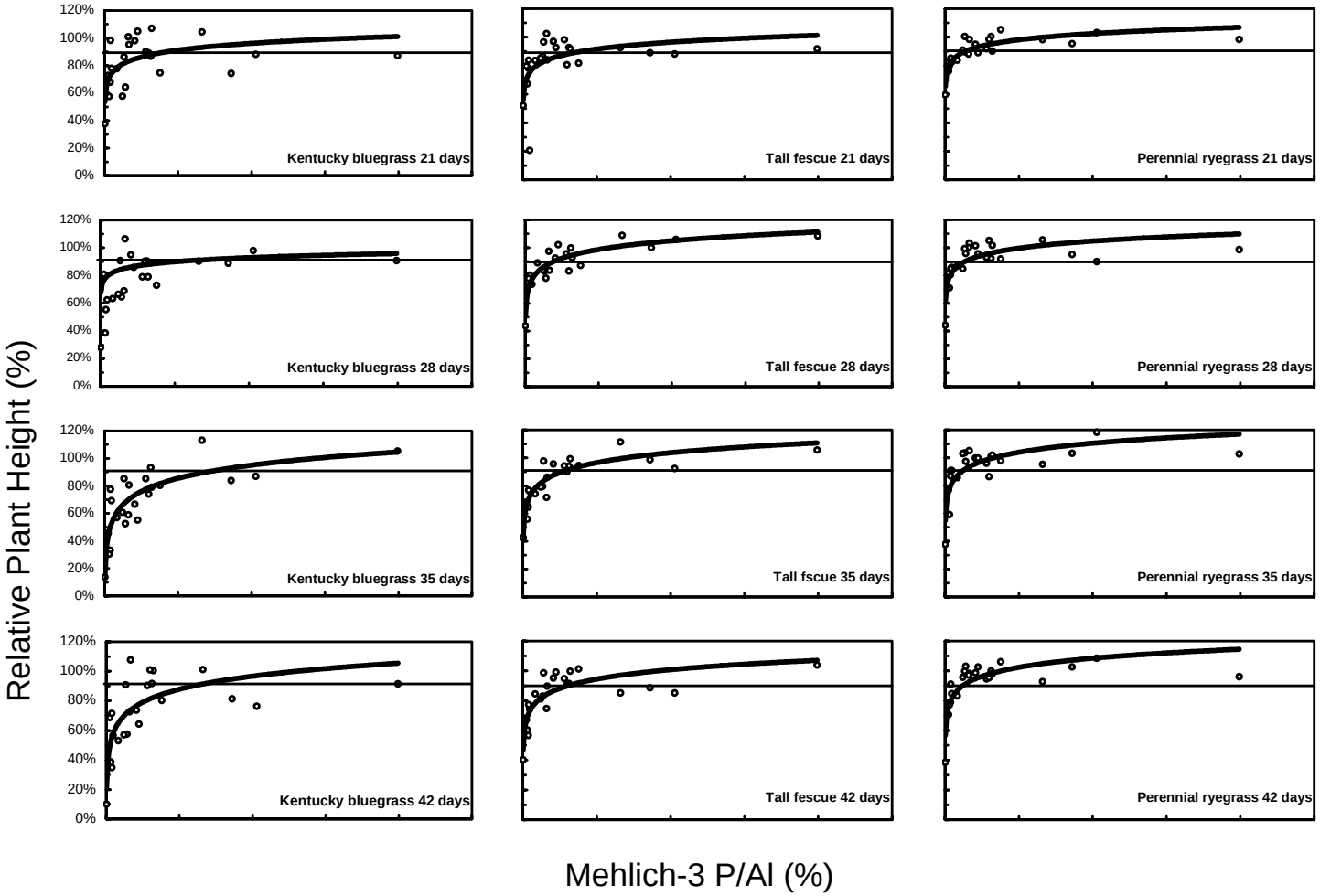



Fig 3. Relationship between relative plant height of three grass species at 21 to 42 days after seeding and Mehlich-3 extractable P to Al ratio, expressed as a percentage on 23 experimental soils. Soil test extractable P and extractable Al were measured with an ICP instrument.

## Earleaf P concentration combined over experimental sites and years.

| Year | 1998 | 1999 | 1998-1999 |
|---|---|---|---|
| ---------- Earleaf P, g/kg ---------- | | | |
| Control | 28 | 25 | 26 |
| Band | 28 | 25 | 26 |
| Broadcast | 28 | 24 | 27 |
| | | *P > F* | |
| Treatment | 0.09 | 0.58 | 0.60 |
| Control vs BN | 0.95 | 0.97 | 1.00 |
| Control vs BC | 0.20 | 0.74 | 0.68 |
| BN vs BC | 0.11 | 0.58 | 0.64 |
| n | 23 | 14 | 37 |

BN=Band 15 kg/ha of P, BC=Broadcast 60 kg/ha of P.

Fig. 1b. Relationships between soil P extracted by five soil test extractants and relative yield as calculated based on the broadcast treatment. Triangle symbols are statistically significant at the P>F 0.10 level; circle symbols are not significant. Vertical lines indicate current soil test P critical levels for individual states.

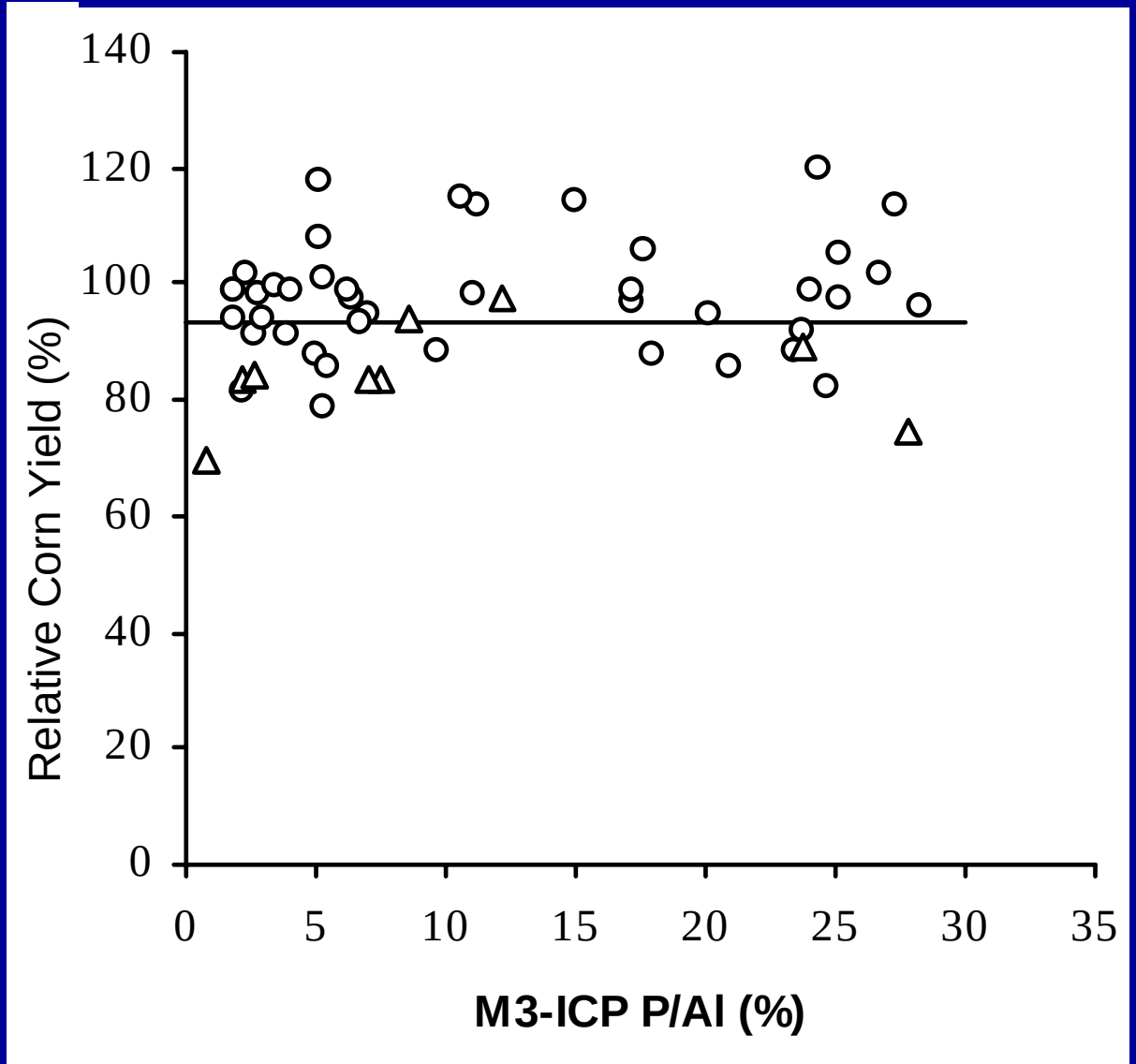
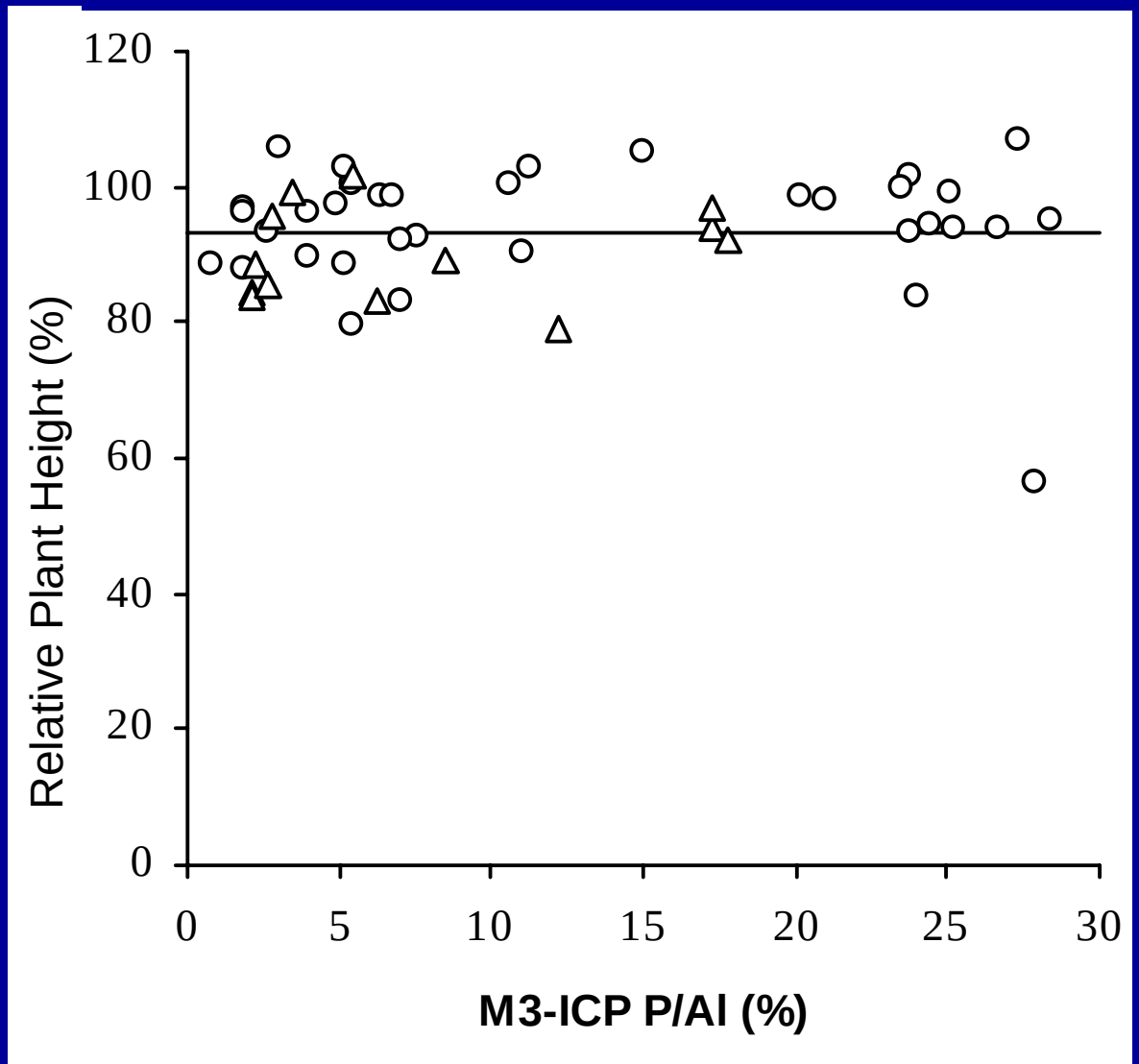


Fig. 2b. Relationships between soil P extracted by five soil test extractants and relative plant height at 35 days after planting as calculated based on the broadcast treatment. Triangle symbols are statistically significant at the P>F 0.05 level; circle symbols are not significant. Vertical lines indicate current soil test P critical levels for individual states.



# Hybrid Selection For Maximum Corn Yield

1. High yield potential; proven with on-farm trials
2. Tolerance for high populations
3. Full-season hybrid
4. Extended canopy duration
5. Slow rate of leaf senescence
6. High rates of nutrient uptake during grain fill
7. Cross pollination of matched hybrids
8. Disease and insect resistance

# Crop Rotation for Maximum Corn Yield

- Corn should follow forage legumes, grass sod, or soybean.
- Corn following corn suppresses yield potential.

# Planting Practices for Maximum Corn Yield

1. Plant early for maximum harvest of sunlight
2. Use a starter fertilizer (MAP, 11-52-0)
3. Equal Plant Spacing
4. Optimum seed depth and placement

# Ambient $CO_2$ Concentration

- Soil organic matter releases $CO_2$ to the atmosphere
- Supply manure or compost
- Grow cover crops
- Wind and crop row orientation

# Practices that Make More Efficient Use of Sunlight

1. Early planting
2. High seeding rates
3. Narrow rows
4. Improved hybrids
5. Better pest control
6. Improved soil fertility
7. Tassel removal
8. Leaf orientation

# Maximum Corn Yield Research in NJ
# Cultural Practices

| | |
|---|---|
| Tillage: | Plow & disk |
| Hybrids: | Pioneer 3245 & 33Y09 |
| Planting date: | April 24 to May 1 |
| Seeding rate: | 90,000 seeds per acre |
| Thinned to: | 43,460 plants per acre |
| Equidistant: | 12 X 12 inch spacing |
| Irrigation: | 60 to 80% field capacity |
| Preplant & Sidedress: | N, P, K, Cl, S, & B |

# Maximum Corn Yield Research in NJ Fertilizer Practice

- Satisfy crop nutrient accumulation requirements
- Match soil supply with crop demand
- Timeliness and placement
- Nitrogen form, $NH_4^+/NO_3^-$ ratio
- Preplant broadcast, multiple sidedressings, & foliar applications

# Maximum Corn Yield Research in NJ
# Fertilizer Application

| Nutrient | Total Applied lbs/acre | Major Source |
|---|---|---|
| N | 400-500 | $(NH_4)_2SO_4$, $NH_4NO_3$ |
| $P_2O_5$ | 100 | DAP, Super Phosphate |
| $K_2O$ | 400 | $K_2SO_4$, KOH, KCl |
| S | 200-300 | $(NH_4)_2SO_4$, $K_2SO_4$ |
| Ca | 500 | Limestone |
| Mg | 200 | Dolomite |
| Mn | 25 | $MnSO_4$ |
| Zn | 10 | $ZnSO_4$ |
| Cu | 5 | $CuSO_4$ |
| B | 3 | $Na_2B_4O$ |

# Maximum Corn Yield Research in NJ
# Dr. Roy Flannery, 1980

**Nutrients Removed with 312 bu/acre grain**

| | N | P ($P_2O_5$) | K ($K_2O$) |
|---|---|---|---|
| | | Pounds per acre | |
| Ear | 245 | 62 (140) | 71 (85) |
| Stover | 211 | 16 (37) | 283 (341) |
| Ear + Stover | 366 | 78 (177) | 354 (426) |

# What Does it Take?

## Summary

- Hybrid, soil, and weather
- Optimum levels of all production factors
- Watchful attention to detail