

Appendix figure 1. Experimental layout

| | | | | | | | | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| V3 P2 | V2 P1 | V3 P0 | V4 P1 | V3 P1 | V1 P2 | V2 P2 | V1 P0 | V2 P3 | V4 P3 | V1 P3 | V4 P2 | V3 P3 | V2 P0 | V4 P0 | V1 P1 |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

R1

| | | | | | | | | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| V2 P2 | V4 P3 | V3 P0 | V1 P3 | V4 P2 | V4 P0 | V2 P1 | V3 P3 | V3 P1 | V3 P0 | V1 P1 | V4 P0 | V2 P2 | V1 P3 | V2 P1 | V1 P2 |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

R2

| | | | | | | | | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| V1 P2 | V4 P3 | V2 P3 | V3 P3 | V4 P2 | V3 P1 | V3 P2 | V2 P0 | V4 P0 | V4 P1 | V1 P1 | V3 P0 | V1 P3 | V1 P0 | V2 P1 | V2 P2 |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

R3

Plot size = 2×6 m; R1, R2, and R3 = Replication 1,2,3; V0 = Lang, V1 = V 41-52, V2 = V 87-13, V3 = VC 27-68A; P0 = 0, P1 = 56, P2 = 75 and P3 = 112 kg P₂O₅ ha⁻¹

Appendix table 2. Climatic characteristics of the study site

A) The climatic characteristics of the study site (average data for nine years 1989-1997)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|------|------|-----|------|-------|------|-------|-------|------|------|------|------|
| R | 112 | 112 | 39 | 79 | 132 | 55 | 82 | 126 | 580 | 580 | 540 | 376 |
| E | 366 | 20.2 | 55 | 66.6 | 103.1 | 22.9 | 109.3 | 149.6 | 69 | 15.8 | 43.9 | 34.8 |
| T | 16.9 | 19.8 | 24 | 25.1 | 27.8 | 29 | 28.7 | 28 | 25.6 | 24.9 | 22.8 | 20.4 |
| H | 90 | 94 | 88 | 85 | 78 | 76 | 78 | 72 | 86 | 90 | 91 | 91 |

Source: Hue Meteorological Station, 1998

Note: R= Rainfall (mm), E= Evaporation (mm), T= Temperature ($^{\circ}$ C), H= Humidity (%)

B) The climatic characteristics of the study site (during the time of experiment)

| | Jan | Feb | Mar | Apr | May | Jun |
|---|------|------|------|------|-------|------|
| R | 80.4 | 31.7 | 18.6 | 47.6 | 269.1 | 109 |
| E | 39.6 | 38.3 | 58.7 | 82.1 | 94 | 37.1 |
| T | 21.7 | 22.3 | 24.5 | 27.2 | 28.6 | 30.5 |
| H | 91 | 90 | 89 | 84 | 81 | 77 |

Source: Hue Meteorological Station, 1998

Appendix table 3. Above ground dry matter at different growth stages and ANOVA table

3.1 30 days after sowing (V4)

A/ Origin data of above ground dry matter for analysis of variation (mg/plant)

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|-----|------|--------|
| | | I | II | III | |
| Lang | 0 | 360 | 670 | 652 | 560.67 |
| Lang | 56 | 410 | 698 | 720 | 609.33 |
| Lang | 75 | 590 | 756 | 810 | 718.67 |
| Lang | 112 | 660 | 796 | 846 | 767.33 |
| V 87-13 | 0 | 420 | 620 | 608 | 549.33 |
| V 87-13 | 56 | 482 | 756 | 750 | 662.67 |
| V 87-13 | 75 | 602 | 820 | 880 | 767.33 |
| V 87-13 | 112 | 646 | 900 | 960 | 835.33 |
| VC 27-68A | 0 | 620 | 600 | 692 | 637.33 |
| VC 27-68A | 56 | 650 | 640 | 806 | 698.67 |
| VC 27-68A | 75 | 860 | 848 | 936 | 881.33 |
| VC 27-68A | 112 | 920 | 846 | 1150 | 972.00 |
| V 41-52 | 0 | 526 | 598 | 548 | 557.33 |
| V 41-52 | 56 | 788 | 770 | 804 | 787.33 |
| V 41-52 | 75 | 890 | 900 | 960 | 916.67 |
| V 41-52 | 112 | 940 | 980 | 1050 | 990.00 |

B/ Analysis of variance of above ground dry matter at V4

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|-------|--------|
| Replication | 2 | 254106 | 127053 | 22.05 | 0.0000 |
| Treatment | 15 | 952965 | 63531.0 | 11.03 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 187301 | 62433.6 | 10.84 | 0.0001 |
| <i>Variety (V)</i> | 3 | 704694 | 234898 | 40.77 | 0.0000 |
| <i>P×V</i> | 9 | 60970.1 | 6774.45 | 1.18 | 0.3451 |
| Error | 30 | 172835 | 5761.17 | | |
| Total | 47 | 1379906 | | | |

3.2 56 days after sowing (R4)

A/ Origin data of above ground dry matter for analysis of variation (mg/plant)

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|-------|-------|---------|
| | | I | II | III | |
| Lang | 0 | 3375 | 3825 | 6253 | 4484.3 |
| Lang | 56 | 4387 | 4483 | 7395 | 5421.7 |
| Lang | 75 | 6570 | 6870 | 8557 | 7332.3 |
| Lang | 112 | 6980 | 7491 | 9350 | 7940.3 |
| V 87-13 | 0 | 3221 | 4890 | 5600 | 4570.3 |
| V 87-13 | 56 | 5159 | 5558 | 6800 | 5839.0 |
| V 87-13 | 75 | 5850 | 7550 | 8922 | 7440.7 |
| V 87-13 | 112 | 7465 | 8644 | 9679 | 8596.0 |
| VC 27-68A | 0 | 5930 | 5570 | 5840 | 5780.0 |
| VC 27-68A | 56 | 6885 | 6400 | 6756 | 6680.3 |
| VC 27-68A | 75 | 9778 | 9660 | 10240 | 9892.7 |
| VC 27-68A | 112 | 10500 | 10900 | 11500 | 10967.0 |
| V 41-52 | 0 | 5553 | 5600 | 5990 | 5714.3 |
| V 41-52 | 56 | 7459 | 7221 | 7850 | 7510.0 |
| V 41-52 | 75 | 8927 | 9512 | 9880 | 9439.7 |
| V 41-52 | 112 | 9510 | 10700 | 10520 | 10243.0 |

B/ Analysis of variance of above ground dry matter at R4

| Source | DF | SS | MS | F | P |
|-----------------------|----|-----------|-----------|--------|--------|
| Replication | 2 | 1.821E+07 | 9105584 | 22.83 | 0.0000 |
| Treatment | 15 | 1.852E+08 | 1.235E+07 | 30.96 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 4.065E+07 | 1.355E+07 | 33.97 | 0.0000 |
| <i>Variety (V)</i> | 3 | 1.393E+08 | 4.643E+07 | 116.41 | 0.0000 |
| <i>P×V</i> | 9 | 5294283 | 588254 | 1.47 | 0.2023 |
| Error | 30 | 1.197E+07 | 398851 | | |
| Total | 47 | 2.154E+07 | | | |

3.3 65 days after sowing (R6)

A/ Origin data of above ground dry matter for analysis of variation (mg/plant)

| Variety | Treatment | Replication | | | Mean |
|-----------|-------------|-------------|-------|-------|---------|
| | Phosphorous | I | II | III | |
| Lang | 0 | 3756 | 5808 | 4098 | 4554.0 |
| Lang | 56 | 5874 | 6220 | 6030 | 6041.3 |
| Lang | 75 | 7164 | 6718 | 7774 | 7218.7 |
| Lang | 112 | 7422 | 8515 | 8764 | 8233.3 |
| V 87-13 | 0 | 4734 | 5860 | 5895 | 5496.3 |
| V 87-13 | 56 | 4950 | 6862 | 7240 | 6350.7 |
| V 87-13 | 75 | 7164 | 8700 | 8690 | 8184.7 |
| V 87-13 | 112 | 8634 | 9290 | 9320 | 9081.3 |
| VC 27-68A | 0 | 4938 | 6360 | 7290 | 6196.0 |
| VC 27-68A | 56 | 5760 | 7420 | 8120 | 7100.0 |
| VC 27-68A | 75 | 8712 | 8950 | 9870 | 9177.3 |
| VC 27-68A | 112 | 9112 | 9520 | 10938 | 9856.7 |
| V 41-52 | 0 | 6120 | 6032 | 5930 | 6027.3 |
| V 41-52 | 56 | 7890 | 8432 | 8378 | 8233.3 |
| V 41-52 | 75 | 9096 | 9342 | 10250 | 9562.7 |
| V 41-52 | 112 | 9906 | 10230 | 10294 | 10143.0 |

B/ Analysis of variance of above ground dry matter at R6

| Source | DF | SS | MS | F | P |
|-----------------------|----|-----------|-----------|--------|--------|
| Replication | 2 | 1.047E+07 | 5234925 | 18.07 | 0.0000 |
| Treatment | 15 | 1.313E+08 | 8754480 | 30.22 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 2.778E+07 | 9260024 | 31.97 | 0.0000 |
| <i>Variety (V)</i> | 3 | 1.013E+08 | 3.375E+07 | 116.52 | 0.0000 |
| <i>P×V</i> | 9 | 2275272 | 252808 | 0.87 | 0.5593 |
| Error | 30 | 8690244 | 289675 | | |
| Total | 47 | 1.505E+08 | | | |

Appendix table 4. Root dry weight at different growth stages and ANOVA table

4.1 30 days after sowing (V4)

A/ Origin data of root dry weight for analysis of variation (mg/plant)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|-----|-----|--------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 116 | 150 | 118 | 128.00 |
| Lang | 56 | 136 | 140 | 130 | 135.33 |
| Lang | 75 | 120 | 170 | 164 | 151.33 |
| Lang | 112 | 130 | 174 | 184 | 162.67 |
| V 87-13 | 0 | 146 | 120 | 132 | 132.67 |
| V 87-13 | 56 | 166 | 164 | 156 | 162.00 |
| V 87-13 | 75 | 170 | 195 | 170 | 178.33 |
| V 87-13 | 112 | 182 | 205 | 180 | 189.00 |
| VC 27-68A | 0 | 110 | 120 | 148 | 126.00 |
| VC 27-68A | 56 | 150 | 172 | 184 | 168.67 |
| VC 27-68A | 75 | 126 | 180 | 236 | 180.67 |
| VC 27-68A | 112 | 130 | 200 | 240 | 190.00 |
| V 41-52 | 0 | 158 | 160 | 122 | 146.67 |
| V 41-52 | 56 | 172 | 176 | 186 | 178.00 |
| V 41-52 | 75 | 184 | 190 | 190 | 188.00 |
| V 41-52 | 112 | 190 | 210 | 198 | 199.33 |

B/ Analysis of variance of root dry weight at V4

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|-------|--------|
| Replication | 2 | 4992.67 | 2496.33 | 5.00 | 0.0134 |
| Treatment | 15 | 26499.9 | 1766.66 | 3.54 | 0.0016 |
| <i>Phosphorous(P)</i> | 3 | 7075.58 | 2358.53 | 4.72 | 0.0082 |
| <i>Variety (V)</i> | 3 | 18146.1 | 6048.69 | 12.10 | 0.0000 |
| <i>P×V</i> | 9 | 1278.25 | 142.028 | 0.28 | 0.9740 |
| Error | 30 | 14991.3 | 499.711 | | |
| Total | 47 | 46483.9 | | | |

4.2 56 days after sowing (R4)

A/ Origin data of root dry weight for analysis of variation (mg/plant)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|--------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 1111 | 1006 | 1034 | 1050.3 |
| Lang | 56 | 1208 | 1090 | 1137 | 1145.0 |
| Lang | 75 | 1370 | 1258 | 1308 | 1312.0 |
| Lang | 112 | 1420 | 1396 | 1479 | 1431.7 |
| V 87-13 | 0 | 953 | 999 | 1232 | 1061.3 |
| V 87-13 | 56 | 1086 | 1076 | 1423 | 1195.0 |
| V 87-13 | 75 | 1460 | 1100 | 1653 | 1404.3 |
| V 87-13 | 112 | 1579 | 1270 | 1800 | 1549.7 |
| VC 27-68A | 0 | 1162 | 1150 | 1347 | 1219.7 |
| VC 27-68A | 56 | 1274 | 1450 | 1528 | 1417.3 |
| VC 27-68A | 75 | 1485 | 1616 | 1780 | 1627.0 |
| VC 27-68A | 112 | 1562 | 1780 | 1870 | 1737.3 |
| V 41-52 | 0 | 1276 | 1227 | 1300 | 1267.7 |
| V 41-52 | 56 | 1484 | 1490 | 1459 | 1477.7 |
| V 41-52 | 75 | 1723 | 1730 | 1790 | 1747.7 |
| V 41-52 | 112 | 1778 | 1863 | 2005 | 1882.0 |

B/ Analysis of variance of root dry weight at R4

| Source | DF | SS | MS | F | P |
|----------------|----|---------|---------|-------|--------|
| Replication | 2 | 251613 | 125807 | 9.99 | 0.0005 |
| Treatment | 15 | 2847223 | 189815 | 15.07 | 0.0000 |
| Phosphorous(P) | 3 | 1009880 | 336627 | 26.73 | 0.0000 |
| Variety (V) | 3 | 1780270 | 593423 | 47.12 | 0.0000 |
| P×V | 9 | 57073.2 | 6341.47 | 0.50 | 0.8601 |
| Error | 30 | 377806 | 12593.5 | | |
| Total | 47 | 3476642 | | | |

4.3 65 days after sowing (R6)

A/ Origin data of root dry weight for analysis of variation (mg/plant)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|--------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 1479 | 1151 | 1395 | 1341.7 |
| Lang | 56 | 1655 | 1470 | 1476 | 1533.7 |
| Lang | 75 | 1935 | 1756 | 1950 | 1880.3 |
| Lang | 112 | 2150 | 1828 | 1902 | 1960.0 |
| V 87-13 | 0 | 1612 | 1250 | 1349 | 1403.7 |
| V 87-13 | 56 | 1614 | 1610 | 1456 | 1560.0 |
| V 87-13 | 75 | 1934 | 1840 | 1970 | 1889.7 |
| V 87-13 | 112 | 1817 | 1840 | 2012 | 1914.7 |
| VC 27-68A | 0 | 1395 | 1632 | 1633 | 1553.3 |
| VC 27-68A | 56 | 1720 | 1721 | 1717 | 1719.3 |
| VC 27-68A | 75 | 1887 | 2066 | 2419 | 2124.0 |
| VC 27-68A | 112 | 2345 | 1990 | 2583 | 2306.0 |
| V 41-52 | 0 | 1694 | 1928 | 1488 | 1703.3 |
| V 41-52 | 56 | 2262 | 2446 | 2185 | 2297.7 |
| V 41-52 | 75 | 2322 | 2618 | 2695 | 2545.0 |
| V 41-52 | 112 | 2610 | 3038 | 2810 | 2819.3 |

B/ Analysis of variance of root dry weight at R6

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|-------|--------|
| Replication | 2 | 24263 | 12131.5 | 0.40 | 0.6763 |
| Treatment | 15 | 7909799 | 527320 | 17.22 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 3446596 | 1148865 | 37.52 | 0.0000 |
| <i>Variety (V)</i> | 3 | 4068316 | 1356105 | 44.29 | 0.0000 |
| <i>P×V</i> | 9 | 394887 | 43876.3 | 1.43 | 0.2185 |
| Error | 30 | 918502 | 30616.7 | | |
| Total | 47 | 8852564 | | | |

Appendix table 5. Plant height at different growth stages and ANOVA table

5.1 Plant height at 30 days after sowing (V4)

A/ Origin data of plant height for analysis of variation (cm)

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|------|------|--------|
| | | I | II | III | |
| Lang | 0 | 7.5 | 7.9 | 7.6 | 7.667 |
| Lang | 56 | 8.1 | 7.8 | 8.1 | 8.000 |
| Lang | 75 | 8.2 | 7.9 | 8.2 | 8.100 |
| Lang | 112 | 8.5 | 8.1 | 8.5 | 8.367 |
| V 87-13 | 0 | 8.4 | 8.5 | 8.3 | 9.067 |
| V 87-13 | 56 | 8.5 | 8.5 | 8.6 | 9.100 |
| V 87-13 | 75 | 8.7 | 8.7 | 8.8 | 9.133 |
| V 87-13 | 112 | 8.9 | 8.9 | 9 | 9.467 |
| VC 27-68A | 0 | 8.7 | 8.7 | 8.6 | 8.500 |
| VC 27-68A | 56 | 8.8 | 8.8 | 8.9 | 8.767 |
| VC 27-68A | 75 | 9.5 | 9.6 | 9.6 | 8.800 |
| VC 27-68A | 112 | 10.2 | 10.5 | 10.5 | 8.967 |
| V 41-52 | 0 | 10.2 | 11 | 10.5 | 10.567 |
| V 41-52 | 56 | 10.9 | 11.2 | 10.9 | 11.000 |
| V 41-52 | 75 | 10.5 | 11.5 | 11.6 | 11.000 |
| V 41-52 | 112 | 10.5 | 11.2 | 11.3 | 11.200 |

B/ Analysis of variance of plant height at V4

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|--------|--------|
| Replication | 2 | 0.32792 | 0.16396 | 3.05 | 0.0622 |
| Treatment | 15 | 64.1198 | 4.27465 | 79.55 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 4.90563 | 1.63521 | 30.43 | 0.0000 |
| <i>Variety (V)</i> | 3 | 56.5873 | 18.8624 | 351.02 | 0.0000 |
| <i>P×V</i> | 9 | 2.62688 | 0.29188 | 5.43 | 0.0002 |
| Error | 30 | 1.61208 | 0.05374 | | |
| Total | 47 | 66.0598 | | | |

5.2 Plant height at 56 days after sowing (R4)

A/ Origin data of plant height for analysis of variation (cm)

| Treatment Variety | Phosphorous | Replication | | | Mean |
|----------------------|-------------|-------------|------|------|-------|
| | | I | II | III | |
| Lang | 0 | 32.4 | 33.1 | 32.9 | 32.80 |
| Lang | 56 | 33.1 | 33.5 | 33.5 | 33.37 |
| Lang | 75 | 35.2 | 34.9 | 35.6 | 35.23 |
| Lang | 112 | 35.6 | 35.9 | 36.1 | 35.87 |
| V 87-13 | 0 | 31.5 | 32 | 32.1 | 31.87 |
| V 87-13 | 56 | 34.7 | 35.2 | 35.6 | 35.17 |
| V 87-13 | 75 | 35.4 | 36 | 35.5 | 38.20 |
| V 87-13 | 112 | 35.2 | 36 | 36.5 | 38.50 |
| VC 27-68A | 0 | 32.5 | 32.3 | 32.9 | 32.57 |
| VC 27-68A | 56 | 34.7 | 35 | 34.5 | 34.73 |
| VC 27-68A | 75 | 39.7 | 38.5 | 38.2 | 35.63 |
| VC 27-68A | 112 | 38.2 | 38.9 | 38.4 | 35.90 |
| V 41-52 | 0 | 34.8 | 35.7 | 35.2 | 35.23 |
| V 41-52 | 56 | 38.8 | 38.9 | 39.5 | 39.07 |
| V 41-52 | 75 | 39.9 | 40.6 | 41.2 | 40.57 |
| V 41-52 | 112 | 40.8 | 41.2 | 41.7 | 41.23 |

B/ Analysis of plant at R4

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|--------|--------|
| Replication | 2 | 2.65792 | 1.32896 | 16.19 | 0.0000 |
| Treatment | 15 | 355.295 | 23.6839 | 288.58 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 167.834 | 55.9447 | 681.68 | 0.0000 |
| <i>Variety (V)</i> | 3 | 165.951 | 55.3169 | 674.03 | 0.0000 |
| <i>P×V</i> | 9 | 21.4742 | 2.38602 | 29.07 | 0.000 |
| Error | 30 | 2.46208 | 0.08207 | | |
| Total | 47 | 360.379 | | | |

5.3 Plant height at 65 days after sowing (R6)

A/ Origin data of plant height for analysis of variation (cm)

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|------|------|-------|
| | | I | II | III | |
| Lang | 0 | 35.5 | 36.7 | 36.1 | 36.10 |
| Lang | 56 | 37.7 | 36.8 | 36.9 | 37.13 |
| Lang | 75 | 39.8 | 39.9 | 38.9 | 39.53 |
| Lang | 112 | 39.9 | 40.7 | 41.2 | 40.60 |
| V 87-13 | 0 | 38.5 | 38.7 | 38.9 | 38.70 |
| V 87-13 | 56 | 39.6 | 40.9 | 41.2 | 40.57 |
| V 87-13 | 75 | 42.3 | 41.3 | 42.3 | 41.00 |
| V 87-13 | 112 | 41.3 | 41.6 | 40.1 | 41.97 |
| VC 27-68A | 0 | 39.8 | 37.8 | 36.9 | 38.17 |
| VC 27-68A | 56 | 40.6 | 41 | 40.6 | 40.73 |
| VC 27-68A | 75 | 41.5 | 44.3 | 42.7 | 42.83 |
| VC 27-68A | 112 | 41.5 | 43.6 | 41.6 | 42.23 |
| V 41-52 | 0 | 40.5 | 39.5 | 39.8 | 39.93 |
| V 41-52 | 56 | 41.7 | 42.3 | 42.6 | 42.20 |
| V 41-52 | 75 | 42.9 | 42.9 | 44.3 | 43.37 |
| V 41-52 | 112 | 46.5 | 44.8 | 43.5 | 44.93 |

B/ Analysis of variance of plant height at R6

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|-------|--------|
| Replication | 2 | 0.86000 | 0.43000 | 0.55 | 0.5808 |
| Treatment | 15 | 246.197 | 16.4131 | 21.12 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 111.433 | 37.1444 | 47.80 | 0.0000 |
| <i>Variety (V)</i> | 3 | 121.467 | 40.4889 | 52.10 | 0.0000 |
| <i>P×V</i> | 9 | 13.2967 | 1.47741 | 1.90 | 0.0905 |
| Error | 30 | 23.3133 | 0.77711 | | |
| Total | 47 | 270.370 | | | |

Appendix table 6. Nodule number at different growth stages and ANOVA table

6.1 Number of nodule 30 days after sowing (V4)

A/ Origin data of nodule number for analysis of variation (no./plant)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|-------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 14.4 | 15.6 | 15 | 15.00 |
| Lang | 56 | 16.8 | 17 | 17.2 | 17.00 |
| Lang | 75 | 17 | 17.5 | 17.3 | 17.27 |
| Lang | 112 | 18.6 | 17.9 | 18.5 | 18.33 |
| V 87-13 | 0 | 19 | 19.8 | 20.1 | 19.63 |
| V 87-13 | 56 | 24.2 | 23.8 | 24 | 24.00 |
| V 87-13 | 75 | 26.2 | 25.8 | 25.4 | 25.80 |
| V 87-13 | 112 | 27.6 | 28 | 27.4 | 27.67 |
| VC 27-68A | 0 | 19 | 20.5 | 19.5 | 19.67 |
| VC 27-68A | 56 | 23.5 | 24.4 | 24 | 23.97 |
| VC 27-68A | 75 | 27.5 | 27.4 | 28.6 | 27.83 |
| VC 27-68A | 112 | 31.5 | 32.1 | 31 | 31.53 |
| V 41-52 | 0 | 22.7 | 21.8 | 22.5 | 22.33 |
| V 41-52 | 56 | 25.6 | 25.5 | 26 | 25.70 |
| V 41-52 | 75 | 30 | 29.8 | 30.2 | 30.00 |
| V 41-52 | 112 | 32 | 32 | 31.8 | 31.93 |

B/ Analysis of variance of nodule number at V4

| Source | DF | SS | MS | F | P |
|----------------|----|---------|---------|---------|--------|
| Replication | 2 | 0.40542 | 0.20271 | 1.05 | 0.3630 |
| Treatment | 15 | 1306.57 | 87.1048 | 450.45 | 0.0000 |
| Phosphorous(P) | 3 | 781.357 | 260.452 | 1346.88 | 0.0000 |
| Variety (V) | 3 | 449.134 | 149.711 | 774.20 | 0.0000 |
| P×V | 9 | 76.0808 | 8.45343 | 43.72 | 0.0000 |
| Error | 30 | 5.80125 | 0.19338 | | |
| Total | 47 | 1312.78 | | | |

6.2 56 days after sowing (R4)

A/ Origin data of nodule number for analysis of variation (no./plant)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|-------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 41 | 40.5 | 41 | 40.83 |
| Lang | 56 | 42.6 | 43 | 43 | 42.87 |
| Lang | 75 | 45 | 46 | 46.5 | 45.83 |
| Lang | 112 | 48 | 48.2 | 48.8 | 48.33 |
| V 87-13 | 0 | 44.8 | 43.8 | 44.8 | 44.47 |
| V 87-13 | 56 | 47.8 | 49.2 | 48.5 | 48.50 |
| V 87-13 | 75 | 51.2 | 50.6 | 52 | 51.27 |
| V 87-13 | 112 | 53 | 52 | 52.6 | 52.53 |
| VC 27-68A | 0 | 52 | 53 | 51 | 52.00 |
| VC 27-68A | 56 | 62 | 61.5 | 63 | 62.17 |
| VC 27-68A | 75 | 64.5 | 65.3 | 66.3 | 65.37 |
| VC 27-68A | 112 | 71.5 | 70.8 | 72 | 71.43 |
| V 41-52 | 0 | 60 | 58 | 59 | 59.00 |
| V 41-52 | 56 | 67.5 | 68.7 | 69 | 68.40 |
| V 41-52 | 75 | 73 | 75.5 | 74.5 | 74.33 |
| V 41-52 | 112 | 77.6 | 78.6 | 79 | 78.40 |

B/ Analysis of variance of nodule number at R4

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|---------|--------|
| Replication | 2 | 2.92042 | 1.46021 | 2.92 | 0.0693 |
| Treatment | 15 | 6489.00 | 432.600 | 865.61 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 5043.30 | 1681.10 | 3363.79 | 0.0000 |
| <i>Variety (V)</i> | 3 | 1218.45 | 406.152 | 812.69 | 0.0000 |
| <i>P×V</i> | 9 | 227.243 | 25.2493 | 50.52 | 0.0000 |
| Error | 30 | 14.9929 | 0.49976 | | |
| Total | 47 | 6506.92 | | | |

Appendix table 7. N, P, K concentration of YFEL at V4 and ANOVA table

7.1 N concentration at 30 days after sowing (V4)

A/ Origin data of N concentration for analysis of variation (%)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|-------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 1.56 | 1.49 | 1.59 | 1.547 |
| Lang | 56 | 1.58 | 1.52 | 1.61 | 1.570 |
| Lang | 75 | 1.88 | 1.81 | 1.83 | 1.840 |
| Lang | 112 | 2.11 | 2.05 | 2.08 | 2.080 |
| V 87-13 | 0 | 1.45 | 1.49 | 1.58 | 1.507 |
| V 87-13 | 56 | 1.62 | 1.59 | 1.58 | 1.597 |
| V 87-13 | 75 | 1.93 | 2 | 1.89 | 1.940 |
| V 87-13 | 112 | 2.11 | 2.07 | 2.16 | 2.113 |
| VC 27-68A | 0 | 1.49 | 1.55 | 1.51 | 1.517 |
| VC 27-68A | 56 | 1.71 | 1.68 | 1.74 | 1.710 |
| VC 27-68A | 75 | 2.01 | 1.98 | 2.01 | 2.000 |
| VC 27-68A | 112 | 2.83 | 2.2 | 2.32 | 2.300 |
| V 41-52 | 0 | 1.5 | 1.56 | 1.57 | 1.543 |
| V 41-52 | 56 | 1.72 | 1.67 | 1.76 | 1.717 |
| V 41-52 | 75 | 2.03 | 2.05 | 2.02 | 2.033 |
| V 41-52 | 112 | 2.19 | 2.25 | 2.22 | 2.220 |

B/ Analysis of variance of N concentration at V4

| Source | DF | SS | MS | F | P |
|----------------|----|---------|---------|--------|--------|
| Replication | 2 | 0.00825 | 0.00413 | 2.22 | 0.1266 |
| Treatment | 15 | 3.33766 | 0.22251 | 119.46 | 0.0000 |
| Phosphorous(P) | 3 | 0.13987 | 0.04662 | 25.03 | 0.0000 |
| Variety (V) | 3 | 0.12622 | 1.04207 | 559.46 | 0.0000 |
| P×V | 9 | 0.07156 | 0.00795 | 4.27 | 0.0012 |
| Error | 30 | 0.05588 | 0.00186 | | |
| Total | 47 | 3.40179 | | | |

7.2 P concentration at 30 days after sowing (V4)

A/ Origin data of P concentration for analysis of variation (%)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|-------|-------|-------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 0.32 | 0.31 | 0.29 | 0.307 |
| Lang | 56 | 0.32 | 0.31 | 0.33 | 0.320 |
| Lang | 75 | 0.34 | 0.36 | 0.36 | 0.353 |
| Lang | 112 | 0.35 | 0.39 | 0.4 | 0.380 |
| V 87-13 | 0 | 0.33 | 0.3 | 0.27 | 0.300 |
| V 87-13 | 56 | 0.31 | 0.32 | 0.3 | 0.310 |
| V 87-13 | 75 | 0.36 | 0.36 | 0.35 | 0.357 |
| V 87-13 | 112 | 0.41 | 0.43 | 0.4 | 0.413 |
| VC 27-68A | 0 | 0.3 | 0.32 | 0.32 | 0.313 |
| VC 27-68A | 56 | 0.32 | 0.35 | 0.37 | 0.347 |
| VC 27-68A | 75 | 0.4 | 0.43 | 0.38 | 0.403 |
| VC 27-68A | 112 | 0.44 | 0.455 | 0.425 | 0.440 |
| V 41-52 | 0 | 0.306 | 0.31 | 0.314 | 0.310 |
| V 41-52 | 56 | 0.34 | 0.37 | 0.36 | 0.357 |
| V 41-52 | 75 | 0.43 | 0.41 | 0.37 | 0.403 |
| V 41-52 | 112 | 0.45 | 0.455 | 0.41 | 0.438 |

B/ Analysis of P concentration at V4

| Source | DF | SS | MS | F | P |
|----------------|----|---------|-----------|-------|--------|
| Replication | 2 | 0.00173 | 8.646E-04 | 2.60 | 0.0908 |
| Treatment | 15 | 0.10500 | 0.00700 | 21.06 | 0.0000 |
| Phosphorous(P) | 3 | 0.01400 | 0.00467 | 14.04 | 0.0000 |
| Variety (V) | 3 | 0.08626 | 0.02875 | 86.52 | 0.0000 |
| P×V | 9 | 0.00474 | 5.269E-04 | 1.59 | 0.1647 |
| Error | 30 | 0.00997 | 3.323E-04 | | |
| Total | 47 | 0.11669 | | | |

7.3 K concentration at 30 days after sowing (V4)

A/ Origin data of K for analysis of variation (%)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|-------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 1.56 | 1.4 | 1.42 | 1.460 |
| Lang | 56 | 1.62 | 1.59 | 1.6 | 1.603 |
| Lang | 75 | 1.66 | 1.59 | 1.7 | 1.650 |
| Lang | 112 | 1.8 | 1.66 | 1.69 | 1.717 |
| V 87-13 | 0 | 1.42 | 1.4 | 1.37 | 1.397 |
| V 87-13 | 56 | 1.64 | 1.63 | 1.62 | 1.630 |
| V 87-13 | 75 | 1.63 | 1.64 | 1.62 | 1.630 |
| V 87-13 | 112 | 1.6 | 1.71 | 1.67 | 1.660 |
| VC 27-68A | 0 | 1.65 | 1.54 | 1.44 | 1.543 |
| VC 27-68A | 56 | 1.63 | 1.63 | 1.65 | 1.607 |
| VC 27-68A | 75 | 1.65 | 1.59 | 1.58 | 1.637 |
| VC 27-68A | 112 | 1.63 | 1.78 | 1.49 | 1.633 |
| V 41-52 | 0 | 1.57 | 1.51 | 1.54 | 1.540 |
| V 41-52 | 56 | 1.64 | 1.59 | 1.67 | 1.633 |
| V 41-52 | 75 | 1.64 | 1.64 | 1.67 | 1.650 |
| V 41-52 | 112 | 1.66 | 1.7 | 1.64 | 1.667 |

B/ Analysis of variance of K at V4

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|-------|--------|
| Replication | 2 | 0.01270 | 0.00635 | 1.86 | 0.1737 |
| Treatment | 15 | 0.29890 | 0.01993 | 5.82 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 0.01166 | 0.00389 | 1.14 | 0.3507 |
| <i>Variety (V)</i> | 3 | 0.23752 | 0.07917 | 23.13 | 0.0000 |
| <i>P×V</i> | 9 | 0.04972 | 0.00552 | 1.61 | 0.1562 |
| Error | 30 | 0.10270 | 0.00342 | | |
| Total | 47 | 0.41430 | | | |

Appendix table 8. Seed yield and yield components at harvesting stages and ANOVA table

8.1 Seed yield (kg/ha)

A/ Origin data of seed yield for analysis of variation (kg/ha)

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|------|------|--------|
| | | I | II | III | |
| Lang | 0 | 1203 | 1263 | 1205 | 1223.7 |
| Lang | 56 | 1251 | 1320 | 1456 | 1342.3 |
| Lang | 75 | 1489 | 1552 | 1564 | 1535.0 |
| Lang | 112 | 1580 | 1533 | 1624 | 1579.0 |
| V 87-13 | 0 | 1265 | 1270 | 1300 | 1278.3 |
| V 87-13 | 56 | 1350 | 1374 | 1411 | 1378.3 |
| V 87-13 | 75 | 1385 | 1560 | 1650 | 1531.7 |
| V 87-13 | 112 | 1522 | 1630 | 1640 | 1597.3 |
| VC 27-68A | 0 | 1327 | 1350 | 1322 | 1333.0 |
| VC 27-68A | 56 | 1619 | 1574 | 1574 | 1589.0 |
| VC 27-68A | 75 | 1683 | 1832 | 1875 | 1796.7 |
| VC 27-68A | 112 | 1729 | 1833 | 1964 | 1842.0 |
| V 41-52 | 0 | 1292 | 1313 | 1375 | 1326.7 |
| V 41-52 | 56 | 1738 | 1548 | 1722 | 1669.3 |
| V 41-52 | 75 | 1843 | 1860 | 1837 | 1846.7 |
| V 41-52 | 112 | 1966 | 1843 | 1929 | 1912.7 |

B/ Analysis of variance of seed yield

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|--------|--------|
| Replication | 2 | 46955.3 | 23477.6 | 6.07 | 0.0061 |
| Treatment | 15 | 2204663 | 146978 | 38.00 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 660348 | 220116 | 56.92 | 0.0000 |
| <i>Variety (V)</i> | 3 | 1441016 | 480339 | 124.20 | 0.0000 |
| <i>P×V</i> | 9 | 103299 | 11477.7 | 2.97 | 0.0120 |
| Error | 30 | 116020 | 3867.33 | | |
| Total | 47 | 2367638 | | | |

8.2 Number of pod per plant (no./plant)

A/ Origin data of number of pod per plant for analysis of variation (no./plant)

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|-------|-------|--------|
| | | I | II | III | |
| Lang | 0 | 15.25 | 15.42 | 15.58 | 15.417 |
| Lang | 56 | 17.67 | 17.08 | 17.28 | 17.333 |
| Lang | 75 | 19.58 | 19.58 | 19.83 | 19.707 |
| Lang | 112 | 19.83 | 19.67 | 19.62 | 19.663 |
| V 87-13 | 0 | 17.08 | 16.08 | 17.25 | 16.803 |
| V 87-13 | 56 | 19.58 | 19.92 | 19.92 | 19.807 |
| V 87-13 | 75 | 20.17 | 20.25 | 21.17 | 20.530 |
| V 87-13 | 112 | 22.08 | 22.17 | 22.75 | 22.333 |
| VC 27-68A | 0 | 17.12 | 17.67 | 17.42 | 17.403 |
| VC 27-68A | 56 | 20.22 | 20.25 | 20.67 | 20.380 |
| VC 27-68A | 75 | 22.42 | 22.33 | 21.58 | 21.943 |
| VC 27-68A | 112 | 21.75 | 22.33 | 21.75 | 22.110 |
| V 41-52 | 0 | 19.92 | 18 | 18.25 | 18.723 |
| V 41-52 | 56 | 20.67 | 20.33 | 20.42 | 20.473 |
| V 41-52 | 75 | 22.42 | 23.12 | 23.08 | 23.040 |
| V 41-52 | 112 | 23.08 | 23.33 | 23.08 | 23.163 |

B/ Analysis of variance of number of pod per plant

| Source | DF | SS | MS | F | P |
|----------------|----|---------|---------|--------|--------|
| Replication | 2 | 0.16089 | 0.08044 | 0.47 | 0.6296 |
| Treatment | 15 | 38.3815 | 12.7938 | 303.39 | 0.0000 |
| Phosphorous(P) | 3 | 164.333 | 54.7777 | 319.99 | 0.0000 |
| Variety (V) | 3 | 70.9222 | 23.6407 | 138.10 | 0.0000 |
| P×V | 9 | 6.03842 | 0.67094 | 3.92 | 0.0022 |
| Error | 30 | 5.13551 | 0.17118 | | |
| Total | 47 | 246.590 | | | |

8.3 Number of seed per pod (no./pod)

A/ Origin data of number of seed per pod for analysis of variation (no./pod)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|--------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 7.8 | 6.5 | 6.9 | 7.067 |
| Lang | 56 | 7.5 | 7.7 | 7.8 | 7.667 |
| Lang | 75 | 7.8 | 7.8 | 7.9 | 7.833 |
| Lang | 112 | 8.1 | 8.2 | 7.9 | 8.067 |
| V 87-13 | 0 | 9.7 | 9.7 | 9.3 | 9.567 |
| V 87-13 | 56 | 9.8 | 10.9 | 10.5 | 10.400 |
| V 87-13 | 75 | 10.9 | 10.4 | 10.8 | 10.700 |
| V 87-13 | 112 | 11.2 | 12.3 | 11.6 | 11.700 |
| VC 27-68A | 0 | 9.8 | 9.9 | 9 | 9.567 |
| VC 27-68A | 56 | 10.5 | 10.2 | 10.6 | 9.967 |
| VC 27-68A | 75 | 11.2 | 12.3 | 11.9 | 11.800 |
| VC 27-68A | 112 | 12 | 11.9 | 11.9 | 11.933 |
| V 41-52 | 0 | 10.5 | 10.1 | 9.8 | 10.133 |
| V 41-52 | 56 | 11.6 | 11.4 | 11.3 | 11.433 |
| V 41-52 | 75 | 12.1 | 11.9 | 11.7 | 11.900 |
| V 41-52 | 112 | 12.1 | 11.7 | 11.8 | 11.867 |

B/ Analysis of variance of number of seed per pod

| Source | DF | SS | MS | F | P |
|----------------|----|---------|---------|--------|--------|
| Replication | 2 | 0.17792 | 0.08896 | 0.67 | 0.5169 |
| Treatment | 15 | 127.386 | 8.49239 | 64.41 | 0.0000 |
| Phosphorous(P) | 3 | 22.5675 | 7.52250 | 57.05 | 0.0000 |
| Variety (V) | 3 | 100.988 | 33.6625 | 255.31 | 0.0000 |
| P×V | 9 | 3.83083 | 0.42565 | 3.23 | 0.0074 |
| Error | 30 | 3.95542 | 0.13185 | | |
| Total | 47 | 131.519 | | | |

8.4 100-seed weight

A/ Origin data of 100-seed weight for analysis of variation (g)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|-------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 5.15 | 4.95 | 5.12 | 5.073 |
| Lang | 56 | 5.41 | 5.45 | 5.5 | 5.453 |
| Lang | 75 | 5.6 | 5.65 | 5.7 | 5.650 |
| Lang | 112 | 5.82 | 5.86 | 5.78 | 5.820 |
| V 87-13 | 0 | 5.45 | 5.47 | 5.36 | 5.267 |
| V 87-13 | 56 | 5.82 | 5.83 | 5.74 | 5.797 |
| V 87-13 | 75 | 6.1 | 5.9 | 6.1 | 6.033 |
| V 87-13 | 112 | 6.1 | 6.15 | 6.2 | 6.150 |
| VC 27-68A | 0 | 5.99 | 5.9 | 6 | 5.963 |
| VC 27-68A | 56 | 6.6 | 6.6 | 6.5 | 6.567 |
| VC 27-68A | 75 | 7.1 | 6.9 | 7.1 | 7.033 |
| VC 27-68A | 112 | 7.2 | 7.1 | 7.1 | 7.133 |
| V 41-52 | 0 | 5.85 | 5.83 | 5.82 | 5.833 |
| V 41-52 | 56 | 6.76 | 6.65 | 6.72 | 6.710 |
| V 41-52 | 75 | 7.1 | 7.15 | 7.11 | 7.120 |
| V 41-52 | 112 | 7.25 | 7.2 | 7.2 | 7.217 |

B/ Analysis of variance of 100-seed weight

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|---------|--------|
| Replication | 2 | 0.01621 | 0.00811 | 2.05 | 0.1461 |
| Treatment | 15 | 21.2770 | 1.41847 | 359.04 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 13.2838 | 4.42792 | 1120.80 | 0.0000 |
| <i>Variety (V)</i> | 3 | 7.28577 | 2.42859 | 614.73 | 0.0000 |
| <i>P×V</i> | 9 | 0.70744 | 0.07860 | 19.90 | 0.0000 |
| Error | 30 | 0.11852 | 0.00395 | | |
| Total | 47 | 21.4117 | | | |

Appendix table 9. Available phosphorous, exchangeable Aluminum, and pH in the experimental soil after liming and phosphorous fertilizer application

9.1 Available phosphorous

A/ Origin data of available phosphorous for analysis of variation (ppm)

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|-------|-------|-------|
| | | I | II | III | |
| Lang | 0 | 4.12 | 3.99 | 4.10 | 4.07 |
| Lang | 56 | 6.30 | 6.40 | 6.70 | 6.47 |
| Lang | 75 | 15.80 | 16.20 | 16.10 | 16.03 |
| Lang | 112 | 16.60 | 16.60 | 16.90 | 16.70 |
| V 87-13 | 0 | 3.78 | 4.10 | 3.90 | 3.93 |
| V 87-13 | 56 | 6.62 | 6.54 | 6.20 | 6.45 |
| V 87-13 | 75 | 15.90 | 16.30 | 15.70 | 15.97 |
| V 87-13 | 112 | 16.90 | 17.10 | 16.53 | 16.84 |
| VC 27-68A | 0 | 3.75 | 3.41 | 3.89 | 3.68 |
| VC 27-68A | 56 | 6.72 | 6.53 | 6.83 | 6.69 |
| VC 27-68A | 75 | 16.40 | 15.80 | 16.2 | 16.13 |
| VC 27-68A | 112 | 17.06 | 16.95 | 16.7 | 16.90 |
| V 41-52 | 0 | 4.22 | 3.68 | 3.40 | 3.77 |
| V 41-52 | 56 | 6.00 | 6.45 | 6.70 | 6.38 |
| V 41-52 | 75 | 15.30 | 16.50 | 16.10 | 15.97 |
| V 41-52 | 112 | 16.30 | 17.00 | 16.90 | 16.73 |

B/ Analysis of variance of available phosphorous

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|---------|--------|
| Replication | 2 | 0.10052 | 0.05026 | 0.56 | 0.5783 |
| Treatment | 15 | 1559.10 | 103.940 | 1153.43 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 0.12866 | 0.04289 | 0.48 | 0.7014 |
| <i>Variety (V)</i> | 3 | 1558.54 | 519.513 | 5765.07 | 0.0000 |
| <i>P×V</i> | 9 | 0.43607 | 0.04845 | 0.54 | 0.8353 |
| Error | 30 | 2.70342 | 0.09011 | | |
| Total | 47 | 1561.91 | | | |

9.2 Exchangeable aluminum (meq/100 g)

A/ Origin data of exchangeable aluminum for analysis of variation (meq/100 g)

| Treatment | | Replication | | | Mean |
|-----------|-------------|-------------|------|------|-------|
| Variety | Phosphorous | I | II | III | |
| Lang | 0 | 0.36 | 0.37 | 0.45 | 0.393 |
| Lang | 56 | 0.25 | 0.24 | 0.28 | 0.257 |
| Lang | 75 | 0.2 | 0.2 | 0.15 | 0.183 |
| Lang | 112 | 0.05 | 0.07 | 0.08 | 0.067 |
| V 87-13 | 0 | 0.38 | 0.43 | 0.34 | 0.383 |
| V 87-13 | 56 | 0.32 | 0.34 | 0.25 | 0.303 |
| V 87-13 | 75 | 0.07 | 0.22 | 0.1 | 0.130 |
| V 87-13 | 112 | 0.04 | 0.09 | 0.05 | 0.060 |
| VC 27-68A | 0 | 0.51 | 0.36 | 0.28 | 0.383 |
| VC 27-68A | 56 | 0.42 | 0.28 | 0.22 | 0.307 |
| VC 27-68A | 75 | 0.27 | 0.2 | 0.17 | 0.213 |
| VC 27-68A | 112 | 0.17 | 0.15 | 0.08 | 0.133 |
| V 41-52 | 0 | 0.38 | 0.39 | 0.37 | 0.380 |
| V 41-52 | 56 | 0.24 | 0.26 | 0.24 | 0.247 |
| V 41-52 | 75 | 0.16 | 0.14 | 0.16 | 0.153 |
| V 41-52 | 112 | 0.14 | 0.06 | 0.13 | 0.110 |

B/ Analysis of variance of exchangeable aluminum

| Source | DF | SS | MS | F | P |
|----------------|----|---------|---------|-------|--------|
| Replication | 2 | 0.01250 | 0.00625 | 2.33 | 0.1146 |
| Treatment | 15 | 0.61820 | 0.04121 | 15.36 | 0.0000 |
| Phosphorous(P) | 3 | 0.01249 | 0.00416 | 1.55 | 0.2216 |
| Variety (V) | 3 | 0.58631 | 0.19544 | 72.84 | 0.0000 |
| P×V | 9 | 0.01940 | 0.00216 | 0.80 | 0.6163 |
| Error | 30 | 0.08050 | 0.00268 | | |
| Total | 47 | 0.71120 | | | |

9.3 pH

A/ Origin data of pH for analysis of variation

| Variety | Treatment Phosphorous | Replication | | | Mean |
|-----------|--------------------------|-------------|------|------|------|
| | | I | II | III | |
| Lang | 0 | 5.6 | 5.5 | 5.49 | 5.53 |
| Lang | 56 | 5.88 | 5.8 | 5.78 | 5.82 |
| Lang | 75 | 5.93 | 5.9 | 5.87 | 5.90 |
| Lang | 112 | 6.01 | 5.98 | 5.96 | 5.98 |
| V 87-13 | 0 | 5.68 | 5.4 | 5.54 | 5.54 |
| V 87-13 | 56 | 5.8 | 5.8 | 5.8 | 5.80 |
| V 87-13 | 75 | 5.84 | 5.9 | 5.92 | 5.89 |
| V 87-13 | 112 | 5.9 | 6 | 5.99 | 5.96 |
| VC 27-68A | 0 | 5.7 | 5.57 | 5.59 | 5.62 |
| VC 27-68A | 56 | 5.8 | 5.85 | 5.84 | 5.83 |
| VC 27-68A | 75 | 5.91 | 5.93 | 5.89 | 5.91 |
| VC 27-68A | 112 | 5.96 | 5.99 | 6.1 | 6.02 |
| V 41-52 | 0 | 5.59 | 5.4 | 5.55 | 5.51 |
| V 41-52 | 56 | 5.82 | 5.83 | 5.85 | 5.83 |
| V 41-52 | 75 | 5.86 | 5.96 | 5.88 | 5.90 |
| V 41-52 | 112 | 5.9 | 6.02 | 5.91 | 5.94 |

B/ Analysis of variance of pH

| Source | DF | SS | MS | F | P |
|-----------------------|----|---------|---------|--------|--------|
| Replication | 2 | 0.00391 | 0.00196 | 0.49 | 0.6149 |
| Treatment | 15 | 1.26786 | 0.08452 | 21.35 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 0.01762 | 0.00587 | 1.48 | 0.2388 |
| <i>Variety (V)</i> | 3 | 0.23599 | 0.41200 | 104.08 | 0.0000 |
| <i>P×V</i> | 9 | 0.01425 | 0.00158 | 0.40 | 0.9251 |
| Error | 30 | 0.11875 | 0.00396 | | |
| Total | 47 | 1.39053 | | | |

Appendix table 10. Chemical properties of soils in the farmers' fields

| No. Field | Binh Dien | | | Huong Ho | | |
|--------------|-----------|------------------------------|----------|----------|------------------------------|----------|
| | pH | Al ³⁺ meq/100g | P ppm | pH | Al ³⁺ meq/100g | P ppm |
| 1 | 4.39 | 0.76 | 2.36 | 4.08 | 0.42 | 3.75 |
| 2 | 3.91 | 0.52 | 3.56 | 4.63 | 0.28 | 3.42 |
| 3 | 5.38 | 0.42 | 3.82 | 4.38 | 0.52 | 3.41 |
| 4 | 4.37 | 0.28 | 4.01 | 4.32 | 0.21 | 3.54 |
| 5 | 4.88 | 0.12 | 3.65 | 4.79 | 0.08 | 3.82 |
| 6 | 4.18 | 0.62 | 3.47 | 4.76 | 0.12 | 3.34 |
| 7 | 4.27 | 0.28 | 2.99 | 4.39 | 0.22 | 3.95 |
| 8 | 3.98 | 0.22 | 3.67 | 3.91 | 0.62 | 2.34 |
| 9 | 4.03 | 0.12 | 4.92 | 5.38 | 0.12 | 2.56 |
| 10 | 4.22 | 0.21 | 5.21 | 4.37 | 0.08 | 4.01 |

Appendix table 11. How to calculate variable cost, gross return, net benefit, return to seed, return to phosphorous fertilizer

1. Variable cost = labor cost + fertilizer cost + lime cost + seed cost + plough (machine)

1.1 Plough cost = 520,000 VND ha⁻¹

1.2 Labor cost = Liming + land preparation + sowing + harvesting

1.2.1 Land preparation with phosphorous fertilizer application

= 20 labor days * 12,000 = 240,000 VND ha⁻¹

1.2.2 Land preparation without phosphorous fertilizer application

= 16 labor days * 12,000 = 192,000 VND ha⁻¹

1.2.3 Liming = 2 labor days * 12,000 = 24,000 VND ha⁻¹

1.2.4 Sowing = 5 labor day * 12,000 = 60,000 VND ha⁻¹

1.2.5 Harvesting cost

1.2.5.1 Harvesting with control yield (no P fertilizer) = 12 labor days * 12,000 = 144,000 VND ha⁻¹

1.2.5.2 Harvesting with yield which is 10% higher than control yield

= 13.2 labor days * 12,000 = 173,000 VND ha⁻¹

1.2.5.3 Harvesting with yield which is 20% higher than control yield = 14.4 labor day * 12,000 = 185,000 VND ha⁻¹

1.2.5.4 Harvesting with yield which is 30% higher than control yield = 15.6 labor days * 12,000 = 192,000 VND ha⁻¹

1.3 Seed cost = 25kg ha⁻¹ * 7,000 VND = 200,000 VND ha⁻¹

1.4 Fertilizer cost: 1 kg Urea = 2,200 VND, 1 kg phosphorous fertilizer (NINH BINH) = 950 VND, 1 kg potassium = 2,000 VND and 1kg lime = 150 VND

2. Gross return = output (seed yield) * price of one kg of seed (7,000 VND/kg)

3. Gross margin (GM) = Gross revenue – variable cost

4. Fix cost (FC) = Tax charge + Land charge + Interest charge

5. Return to Capital = (GM – FC + Cash input)/Cash input

6. Return to Labor = (GM – FC + Labor cost)/ total labor days

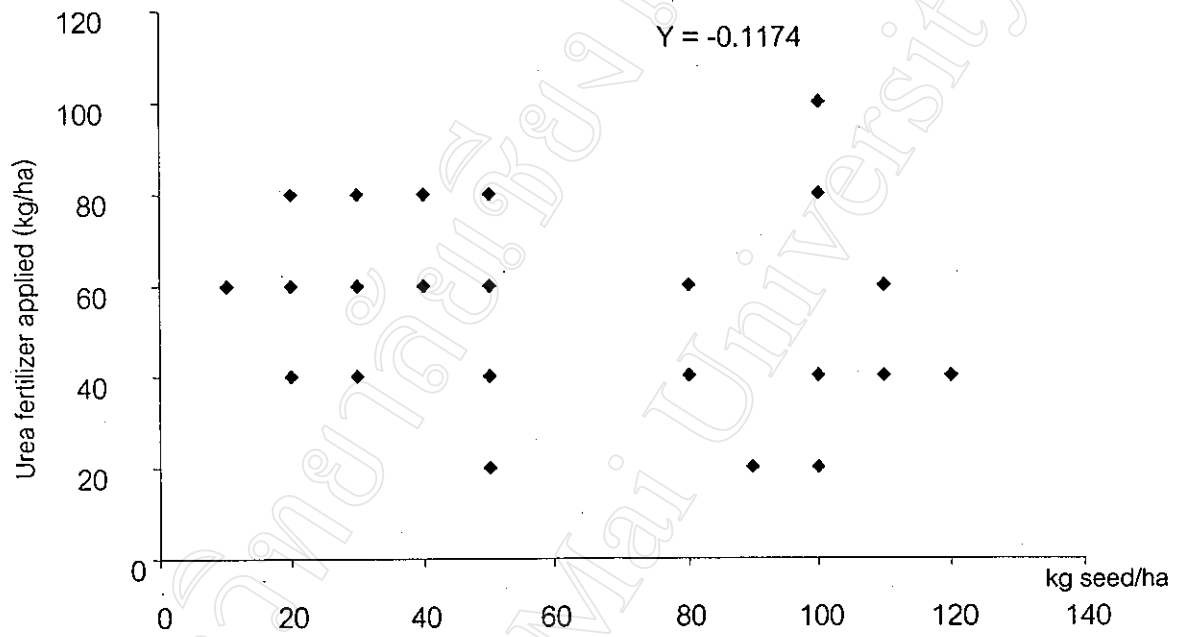
Appendix table 12. Gross margin from mungbean production (1,000 VN dong ha⁻¹) and ANOVA

| Variety | Treatment | Replication | | | Mean |
|-----------|-------------|-------------|-------|-------|---------|
| | Phosphorous | I | II | III | |
| Lang | 0 | 6672 | 7092 | 6686 | 6816.7 |
| Lang | 56 | 6492 | 6975 | 7927 | 7131.3 |
| Lang | 75 | 7979 | 8420 | 8504 | 7982.7 |
| Lang | 112 | 8323 | 7994 | 7631 | 8301.0 |
| V 87-13 | 0 | 7106 | 7141 | 7351 | 7199.3 |
| V 87-13 | 56 | 7171 | 7339 | 7598 | 7369.3 |
| V 87-13 | 75 | 7251 | 8476 | 9106 | 8277.7 |
| V 87-13 | 112 | 7905 | 8661 | 8731 | 8432.3 |
| VC 27-68A | 0 | 7540 | 7701 | 7501 | 7580.7 |
| VC 27-68A | 56 | 8889 | 8574 | 8574 | 8679.0 |
| VC 27-68A | 75 | 9318 | 10361 | 10662 | 10114.0 |
| VC 27-68A | 112 | 9347 | 10075 | 10992 | 10138.0 |
| V 41-52 | 0 | 7295 | 7442 | 7876 | 7537.7 |
| V 41-52 | 56 | 9710 | 8380 | 9598 | 9562.7 |
| V 41-52 | 75 | 10438 | 10557 | 10396 | 10464.0 |
| V 41-52 | 112 | 11006 | 10145 | 10747 | 10633.0 |

B/ Analysis of variance of gross margin

| Source | DF | SS | MS | F | P |
|-----------------------|----|-----------|-----------|-------|--------|
| Replication | 2 | 1730103 | 865051 | 4.93 | 0.0141 |
| Treatment | 15 | 7.398E+07 | 4931809 | 28.12 | 0.0000 |
| <i>Phosphorous(P)</i> | 3 | 3.401E+07 | 1.134E+07 | 64.66 | 0.0000 |
| <i>Variety (V)</i> | 3 | 3.413E+07 | 1.138E+07 | 64.88 | 0.0000 |
| <i>P×V</i> | 9 | 5827480 | 647498 | 3.69 | 0.0033 |
| Error | 30 | 5260982 | 175366 | | |
| Total | 47 | 8.097E+07 | | | |

Appendix Figure 13. Correlation between amount of Urea farmer applied and mungbean yield in the field



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