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Management practices for improving the performance of canola

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Canada

GROWING GREAT 2015

- CCC anticipates a higher demand for canola/rapeseed
- ambitious plan to expand production (9-15 MMT)
- **2006 – 13 million acres x 30 bu./acre = 9 MMT**
- **2015 – 17 million acres x 40 bu./acre = 15 MMT**
- more acres - non-traditional areas (3%)
 - shorter rotations (25%)
- higher yield - hybrid adoption (10%), genetic gain (15%)
 - insect / disease resistance (5%)
 - stress tolerance (5%)

MANAGEMENT PRACTICES FOR IMPROVING YIELD AND LOWERING PRODUCTION RISKS

- seeding date
- seed quality and vigour
- new hybrid cultivars
- seeding rate

SEEDING DATE EVALUATIONS

- small-plot tests at Saskatoon in 2003-2007
- op cultivar (SP Banner)
- hybrid cultivars (InVigor 2663 or 5020)
- seed treated with Helix[®] and planted into tilled wheat stubble (MT) with a hoe drill
- land tilled the previous fall to facilitate early seeding
- seeded early (May 11-16) soil temp. 7-17° C
- seeded late (May 24-June 2) soil temp. 14-21° C

SEEDING DATE EVALUATIONS

- fertilizer inputs based on yearly soil tests
- 50-60 lb/acre N, 25 lb/acre P, no K, 15 lb/acre S
- herbicides (Roundup™, Select™ and/or Muster™)
- agronomic assessments
 - seedling establishment (14, 21 DAS)
 - shoot fresh weight (14, 21, 28, 35 DAS)
 - shoot biomass (seedlings/m-row x shoot fresh weight)
 - seed yield

Effect of seeding date on yield of op and hybrid Argentine cultivars in MT in 2003-2007.¹

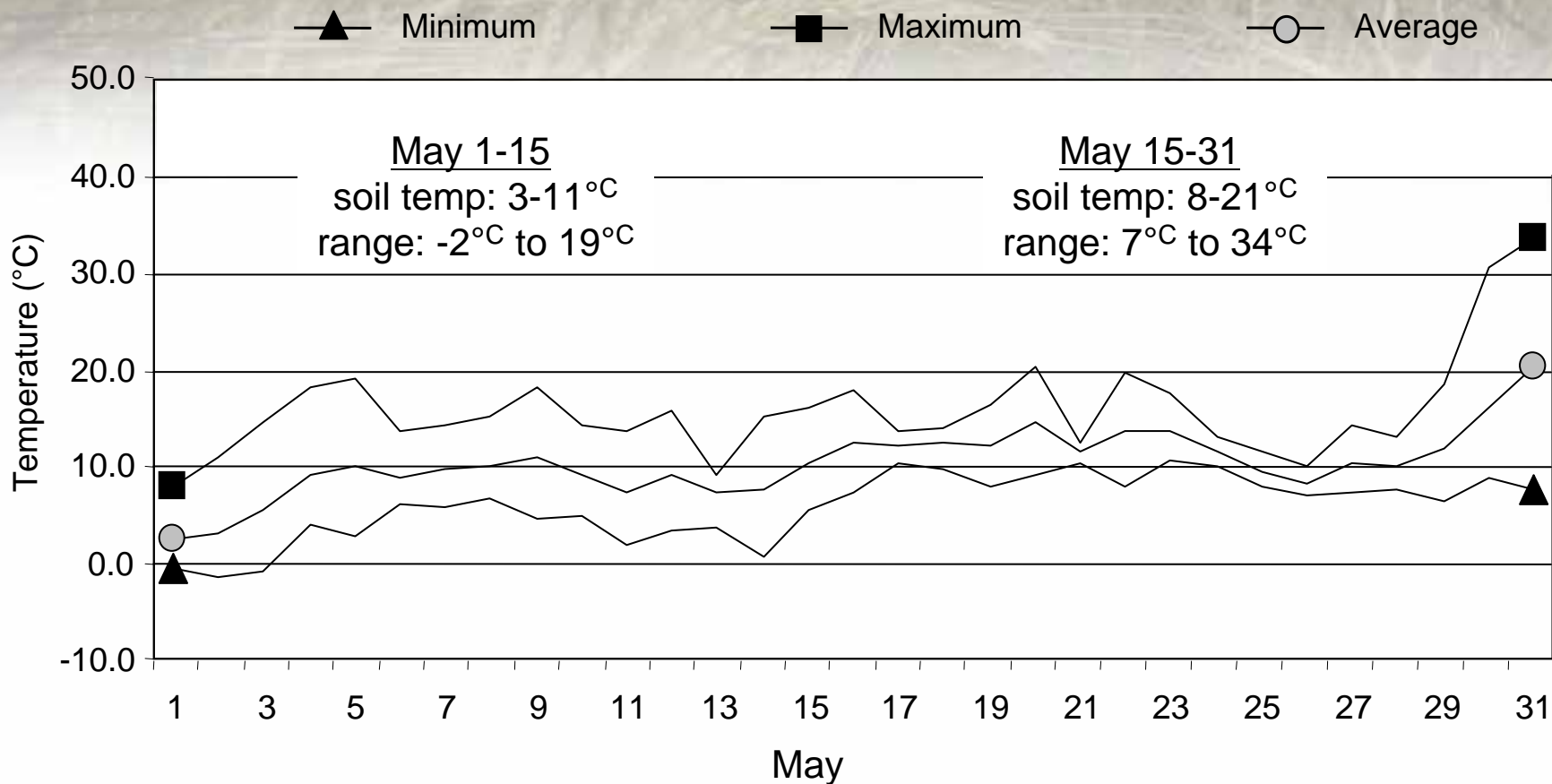
| Cultivar | Seeding date | Yield (bu./acre) | | | | | mean |
|----------|--------------|------------------|-------------|-------------|-------------|-------------|-------------|
| | | 2003 | 2004 | 2005 | 2006 | 2007 | |
| op | early | 35.0 | 43.2 | 53.3 | 38.5 | 38.1 | 41.6 |
| | late | 26.6 | 43.3 | 46.2 | 31.9 | 36.2 | 36.8 |
| | | +8.4 | -0.1 | +7.1 | +6.6 | +1.9 | +4.8 |
| hybrid | early | 39.0 | 55.1 | 60.8 | 48.6 | 43.2 | 49.3 |
| | late | 28.6 | 51.9 | 53.7 | 39.7 | 40.6 | 42.9 |
| | | +10.4 | +3.2 | +7.1 | +8.9 | +2.6 | +6.4 |

¹ early (May 11-16), late (May 24-June 2).

Effect of seeding date on flea beetle emergence in August-September.¹

| Seeding date | Flea beetles/plant | | | mean |
|------------------|--------------------|------------|------------|------------|
| | 2005 | 2006 | 2007 | |
| early | 1.5 | 6.4 | 3.1 | 3.7 |
| late | 16.2 | 21.8 | 19.3 | 19.1 |
| reduction | 91% | 71% | 84% | 81% |

¹ early (May 11-14), late (May 25-June 1).



Minimum, maximum and average soil temperatures at planting depth at Saskatoon during May in 2005.

Effect of seeding date on establishment of op and hybrid canola with MT in 2003-2007.¹

| Cultivar | Seeding date | Stand establishment – 21 DAS (%) | | | | | |
|----------|--------------|----------------------------------|----------|-----------|-----------|----------|----------|
| | | 2003 | 2004 | 2005 | 2006 | 2007 | mean |
| op | early | 50 | 56 | 57 | 66 | 66 | 59 |
| | late | 54 | 58 | 71 | 76 | 68 | 65 |
| hybrid | | 4 | 2 | 14 | 10 | 2 | 6 |
| | early | 50 | 62 | 64 | 66 | 66 | 62 |
| | late | 54 | 69 | 76 | 76 | 70 | 69 |
| | | 4 | 7 | 12 | 10 | 4 | 7 |

¹ early (May 11-16), late (May 24-June 2). DAS - days after seeding.

Effect of seeding date on shoot growth of op and hybrid canola with MT in 2003-2007.¹

| Cultivar | Seeding date | Shoot fresh weight – 21 DAS (mg) | | | | | |
|----------|--------------|----------------------------------|-------------|-------------|-------------|-------------|-------------|
| | | 2003 | 2004 | 2005 | 2006 | 2007 | mean |
| op | early | 436 | 129 | 191 | 442 | 207 | 281 |
| | late | 641 | 254 | 771 | 650 | 653 | 594 |
| | | 1.5x | 2.0x | 4.0x | 1.5x | 3.2x | 2.1x |
| hybrid | early | 476 | 210 | 289 | 813 | 233 | 404 |
| | late | 674 | 424 | 1274 | 994 | 820 | 837 |
| | | 1.4x | 2.0x | 4.4x | 1.2x | 3.5x | 2.1x |

¹ early (May 11-16), late (May 24-June 2). DAS – days after seeding.

Effect of seeding date on shoot biomass of op and hybrid canola with MT in 2003-2007.¹

| Cultivar | Seeding date | Shoot biomass – 21 DAS (g/m-row) | | | | | |
|----------|--------------|----------------------------------|-------------|-------------|-------------|-------------|-------------|
| | | 2003 | 2004 | 2005 | 2006 | 2007 | mean |
| op | early | 7.1 | 2.5 | 3.5 | 9.6 | 4.5 | 5.4 |
| | late | 11.0 | 5.0 | 18.3 | 16.3 | 14.6 | 13.0 |
| | | 1.5x | 2.0x | 5.2x | 1.7x | 3.2x | 2.4x |
| hybrid | early | 7.7 | 4.5 | 6.1 | 17.8 | 5.1 | 8.2 |
| | late | 12.3 | 9.3 | 30.7 | 24.8 | 19.0 | 19.2 |
| | | 1.6x | 2.1x | 5.0x | 1.4x | 3.7x | 2.3x |

¹ early (May 11-16), late (May 24-June 2). DAS – days after seeding.

SEED QUALITY AND VIGOUR

- substantial differences in the quality and vigour of Certified No. 1 canola
- differences between op and hybrid cultivars
- also differences in quality and vigour of seed lots within varieties or cultivars

Range in quality and vigour of Certified No. 1 seed lots of op and hybrid Argentine canola.

| Quality and vigour attributes | op cultivar | op cultivar | hybrid cultivar |
|-------------------------------|----------------------|----------------------|---------------------|
| 1000–seed weight (TSW) | 1.8-3.6 g | 2.1-3.1 g | 3.1-5.5 g |
| conductivity (EC) | 55-140 μS | 63-137 μS | 57-86 μS |
| germination - SGT | 87-99 % | 89-99 % | 88-99 % |
| - PCT | 71-96 % | 88-99 % | 90-99 % |
| - CDT | 74-99 % | 88-99 % | 60-98 % |
| vigour index - SGT, PCT | 1.5-3.5 | 1.5-3.0 | 3.1-5.1 |

¹ vigour index = TSW x final % germination/100. Conductivity ($\mu\text{S cm}^{-1} \text{ g}^{-1}$).

CERTIFIED NO.1 SEED

low vigour

high vigour



Effect of seed vigour on the performance of an op cultivar CT, MT and ZT in 2004.¹

| Tillage | Seeding date | Vigour | Stand est. (%) | Shoot wt.(mg) | Biomass (g/m-row) | Yield bu/acre |
|---------|--------------|--------|----------------|---------------|-------------------|---------------|
| CT | May 11 | low | 62 | 53 | 1.1 | 39.7 |
| | | high | 84 | 120 | 3.1 | 50.0 |
| | | | 22 | 2.3x | 2.8x | 10.3 |
| MT | May 12 | low | 31 | 44 | 0.5 | 43.9 |
| | | high | 64 | 120 | 2.3 | 49.9 |
| | | | 33 | 2.7x | 4.6x | 6.0 |
| ZT | May 14 | low | 14 | 403 | 2.2 | 19.9 |
| | | high | 56 | 906 | 16.7 | 39.2 |
| | | | 42 | 2.2x | 7.6x | 19.3 |

¹ seed lots met the germination requirement for Certified No.1 canola.

Effect of seed vigour on the performance of a hybrid cultivar in CT and MT in 2005.¹

| Tillage | Seeding date | Vigour | Stand est. (%) | Shoot wt. (mg) | Biomass (g/m-row) | Yield bu/acre |
|---------|--------------|--------|----------------|----------------|-------------------|---------------|
| CT | May 11 | low | 83 | 139 | 3.8 | 62.5 |
| | | high | 96 | 280 | 7.6 | 70.8 |
| | | | 13 | 2.0x | 2.0x | 8.3 |
| MT | May 12 | low | 58 | 147 | 2.9 | 42.5 |
| | | high | 78 | 247 | 6.3 | 54.0 |
| | | | 20 | 1.7x | 2.2x | 11.5 |

¹ seed lots met the germination requirement for Certified No.1 canola.

SEED QUALITY AND VIGOUR TESTS IN CANOLA

- since 2002, we have used five main laboratory tests to assess the vigour of canola seed lots
- standard germination test (SGT)
- tolerance to low temperatures in the pre-chill test (PCT) and high temperatures in the controlled deterioration test (CDT)
- membrane integrity in the electrical conductivity test (ECT)
- 1000-seed weight (TSW)
- vigour index = $TSW \times \text{final \% germination} / 100$

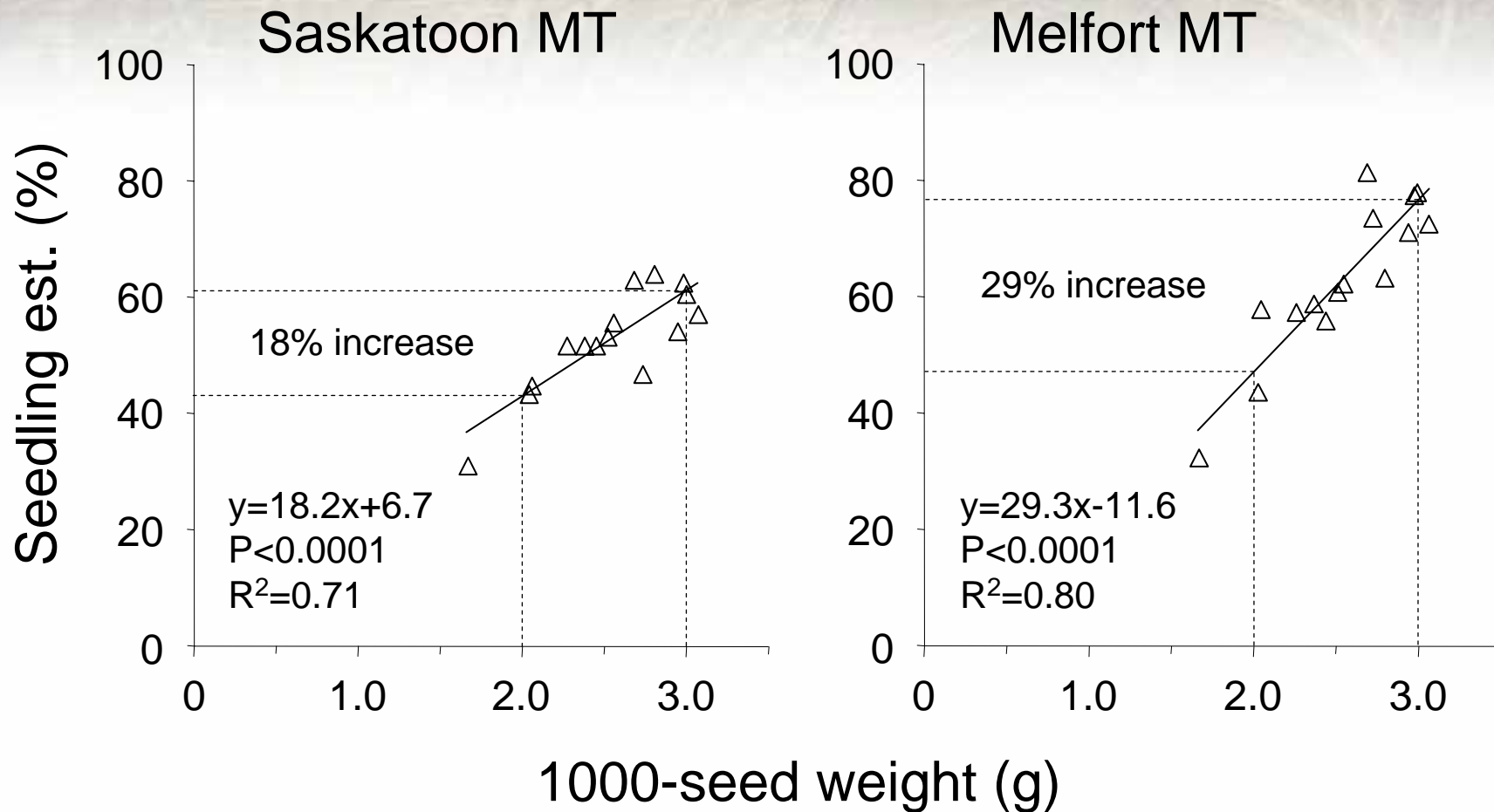
SEED QUALITY, VIGOUR AND PERFORMANCE

- seed lots evaluated at multiple sites in 2003-2007
- CT (Saskatoon, Scott, Loon Lake)
- MT (Saskatoon, Melfort) and ZT (Indian Head)
- lab data correlated with field data to identify tests that provide the best indication of stand establishment, shoot growth, biomass accumulation and seed yield

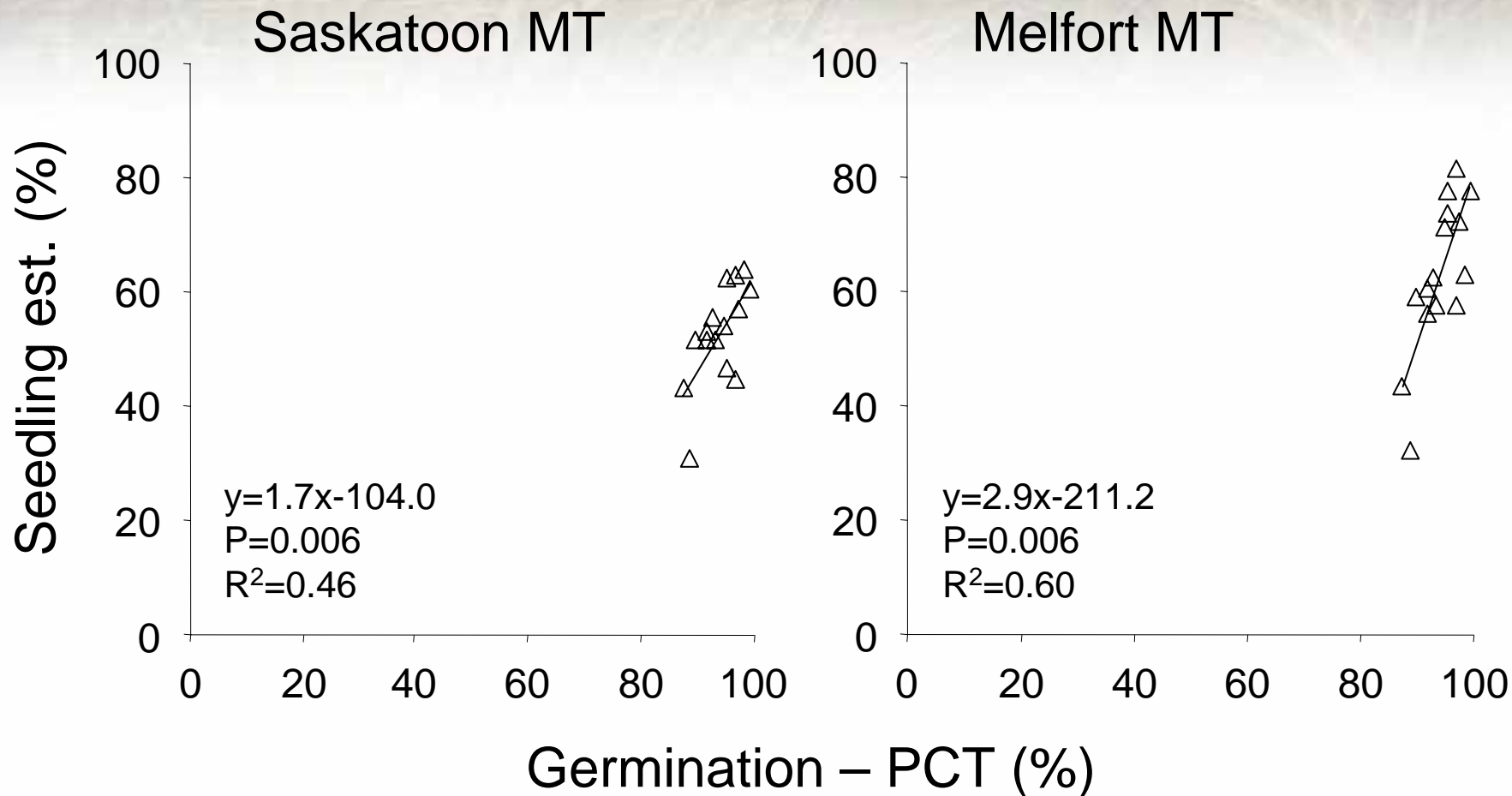
VIGOUR TESTS AND STAND ESTABLISHMENT

- seed lots with high germination in the SGT and PCT provided the best establishment in warm and cool moist soils, respectively
- seed lots with high germination in the CDT provided the best establishment in dry soil
- seed lots with low conductivity in the ECT provided the best establishment with reduced tillage
- seed lots with seed weights above 2.8g provided the best establishment in op cultivars

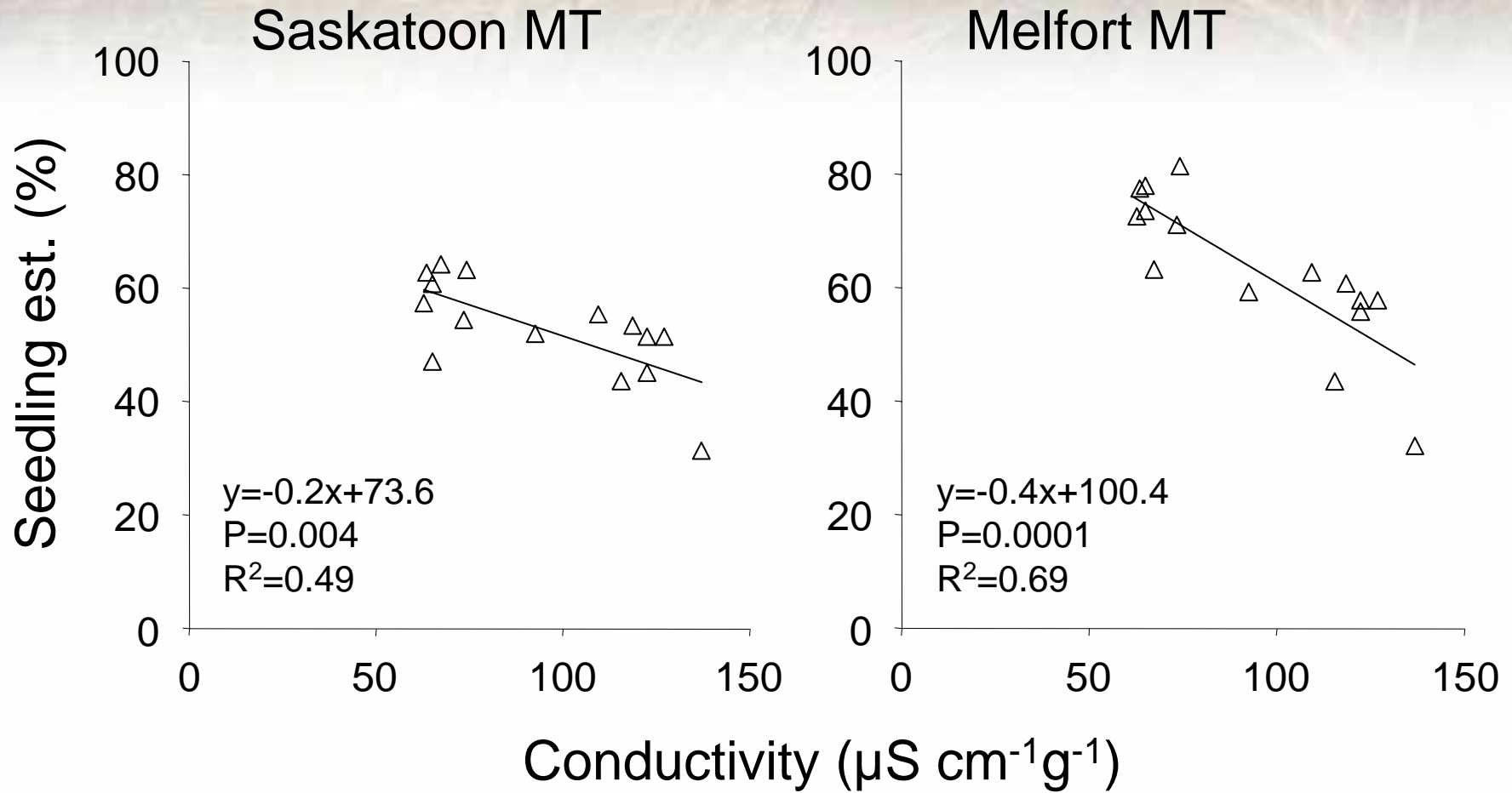
Relationship between 1000-seed weight and establishment of op seed lots in MT in 2004.



Relationship between germination (PCT) and establishment of op seed lots in MT in 2004.



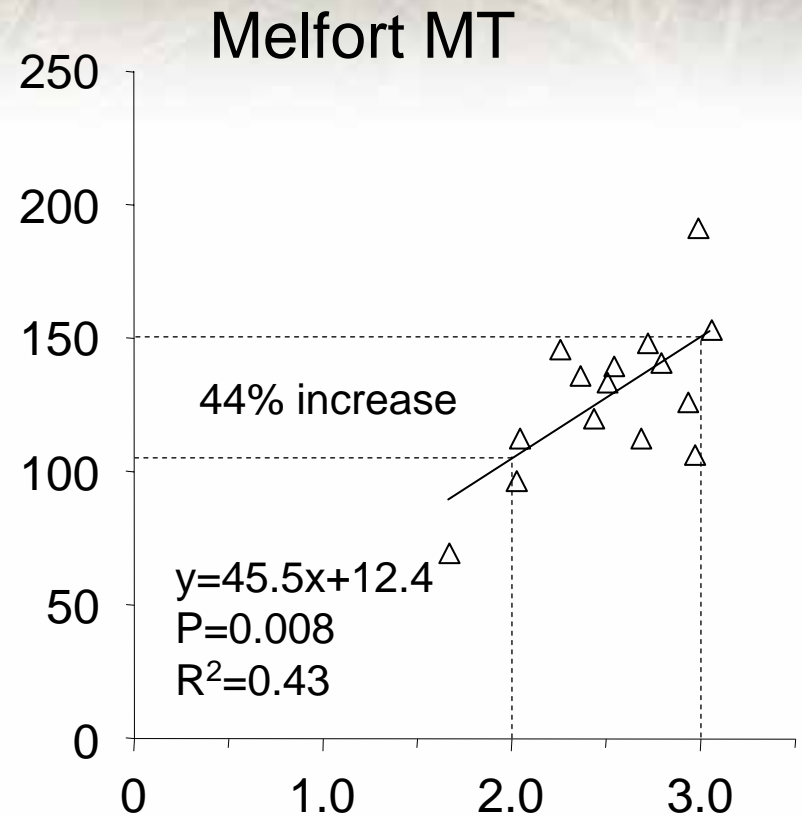
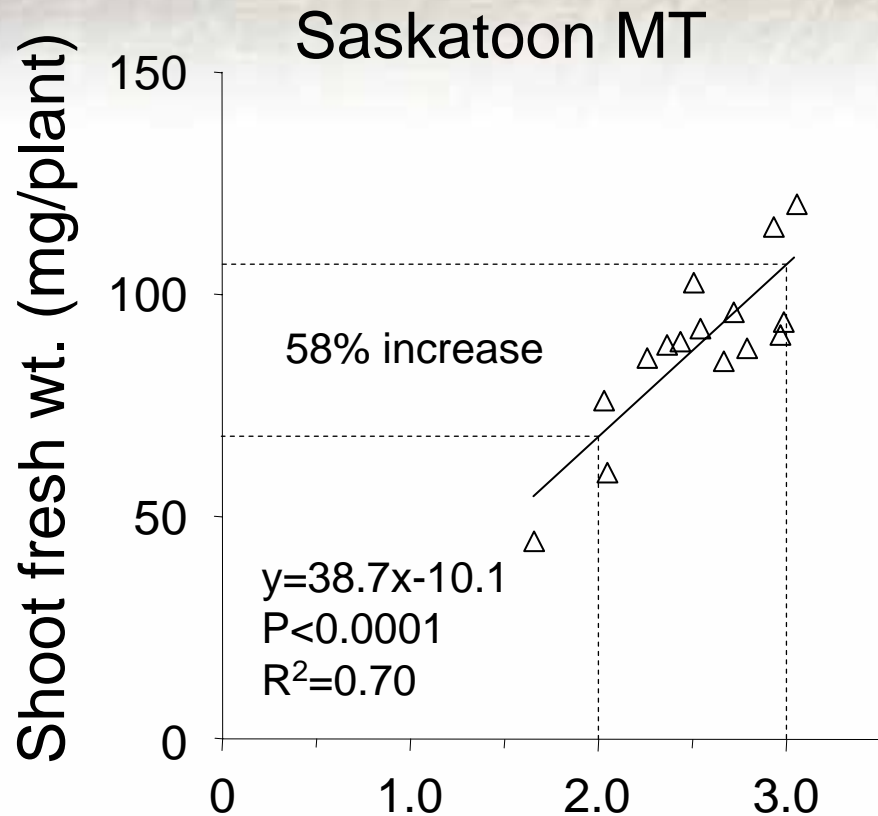
Relationship between conductivity (ECT) and establishment of op seed lots in MT in 2004.



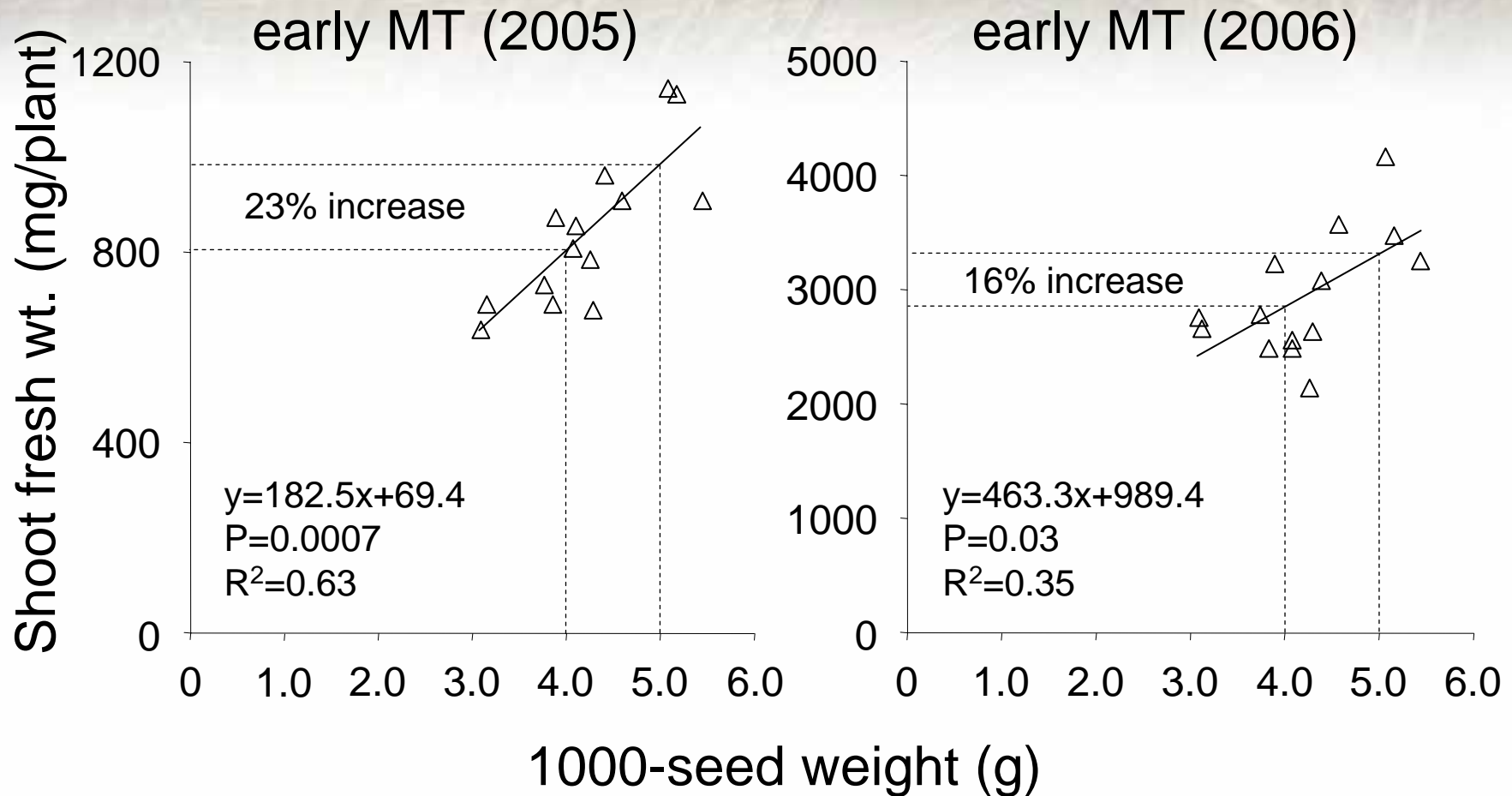
SEED QUALITY AND SHOOT GROWTH

- seed lots with high seed weights had the best shoot growth
- in op cultivars, seed lots with TSW above 2.8 g had the highest shoot weights after 14, 21 and 28 days
- in hybrid cultivars, seed lots with TSW above 4.5 g had the highest shoot weights after 14, 21 and 28 days

Relationship between 1000-seed weight and shoot fresh weight of op seed lots after 21 days in MT in 2004.



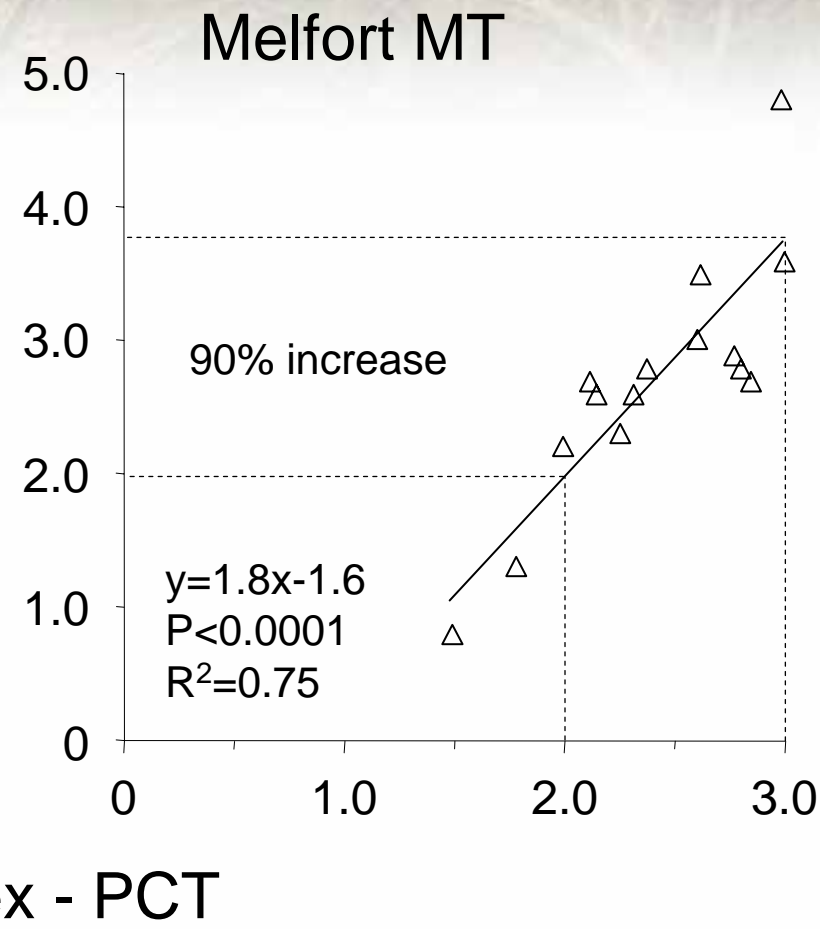
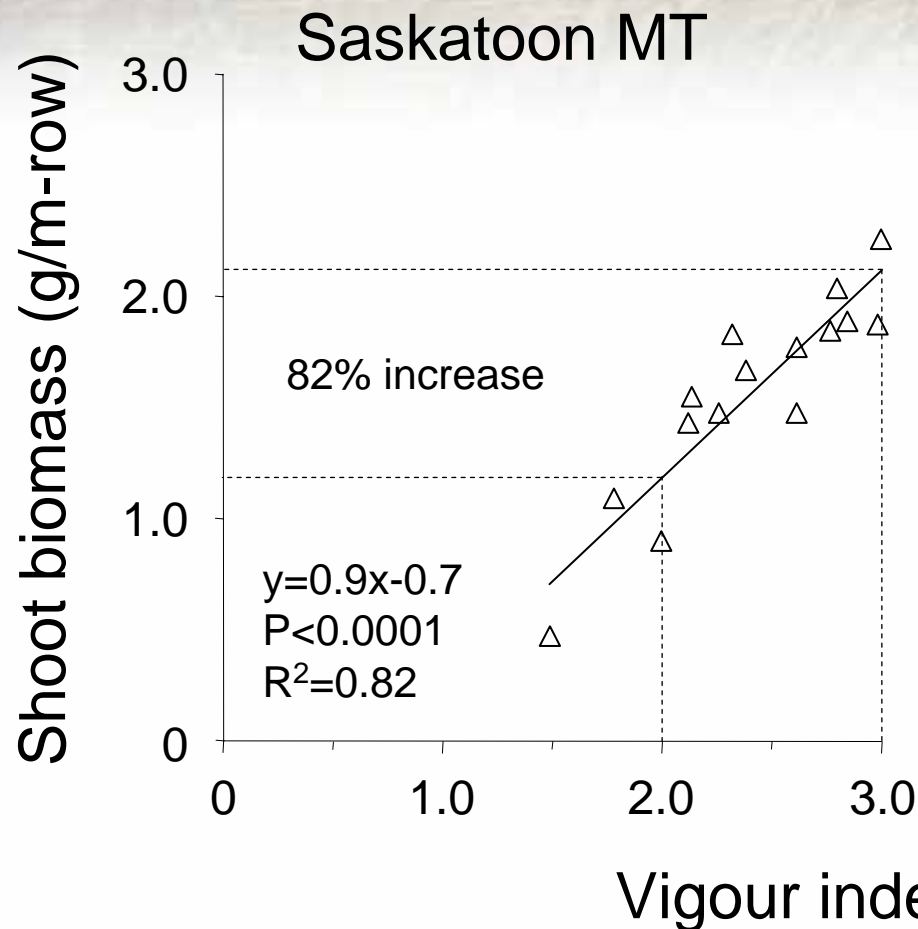
Relationship between 1000-seed weight and shoot fresh weight of hybrid seed lots after 28 days in MT in 2005 and 2006.



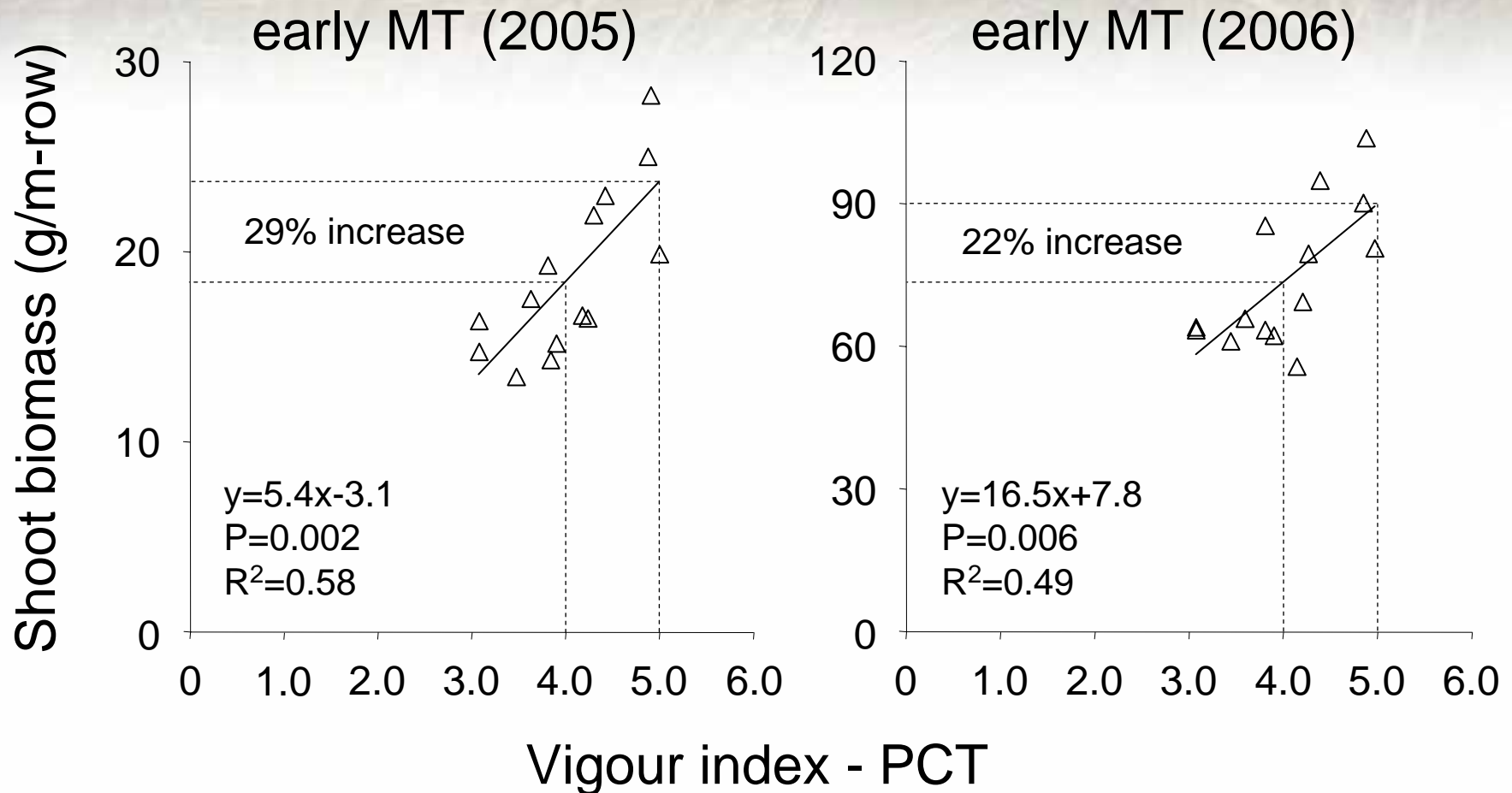
VIGOUR INDEX AND SHOOT BIOMASS

- **Vigour index = TSW x final % germination/100**
- seed lots with a high vigour index (SGT, PCT) had the highest shoot biomass
- in op cultivars, seed lots with a vigour index above 2.5 in the PCT had the highest shoot biomass after 14, 21 and 28 days in cool soils
- in hybrid cultivars, seed lots with a vigour index above 4.5 in the PCT had the highest shoot biomass after 14, 21 and 28 days in cool soils

Relationship between vigour index (PCT) and shoot biomass of op seed lots after 21 days in MT in 2004.



Relationship between vigour index (PCT) and shoot biomass of hybrid seed lots after 28 days in MT in 2005 and 2006.



CONCLUSIONS

- **to improve stand establishment**, plant seed lots with high germination (>95%) in the SGT and PCT, low electrical conductivity (< 80 $\mu\text{S cm}^{-1} \text{g}^{-1}$) in the ECT and op lots with high seed weight (>3.0 g)
- **to improve shoot growth**, plant op seed lots with seed weights above 2.8 g and hybrid seed lots with seed weights above 4.5 g
- **to improve biomass**, plant op seed lots with a vigour index above 2.7 and hybrid seed lots with a vigour index above 4.3

GENETIC GAIN WITH NEW HYBRID CULTIVARS

- small-plot tests at Saskatoon in 2004-2006
- op cultivar (SP Banner) registered in 2002
- older hybrid cultivar (InVigor 2733) registered in 2001
- new hybrid cultivar (InVigor 5020) registered in 2003
- to standardize the comparisons, tests were done on sized seeds (1.8-2.0 mm diameter) of each cultivar

Performance of sized seeds of op and hybrid Argentine cultivars in 2004-2006.¹

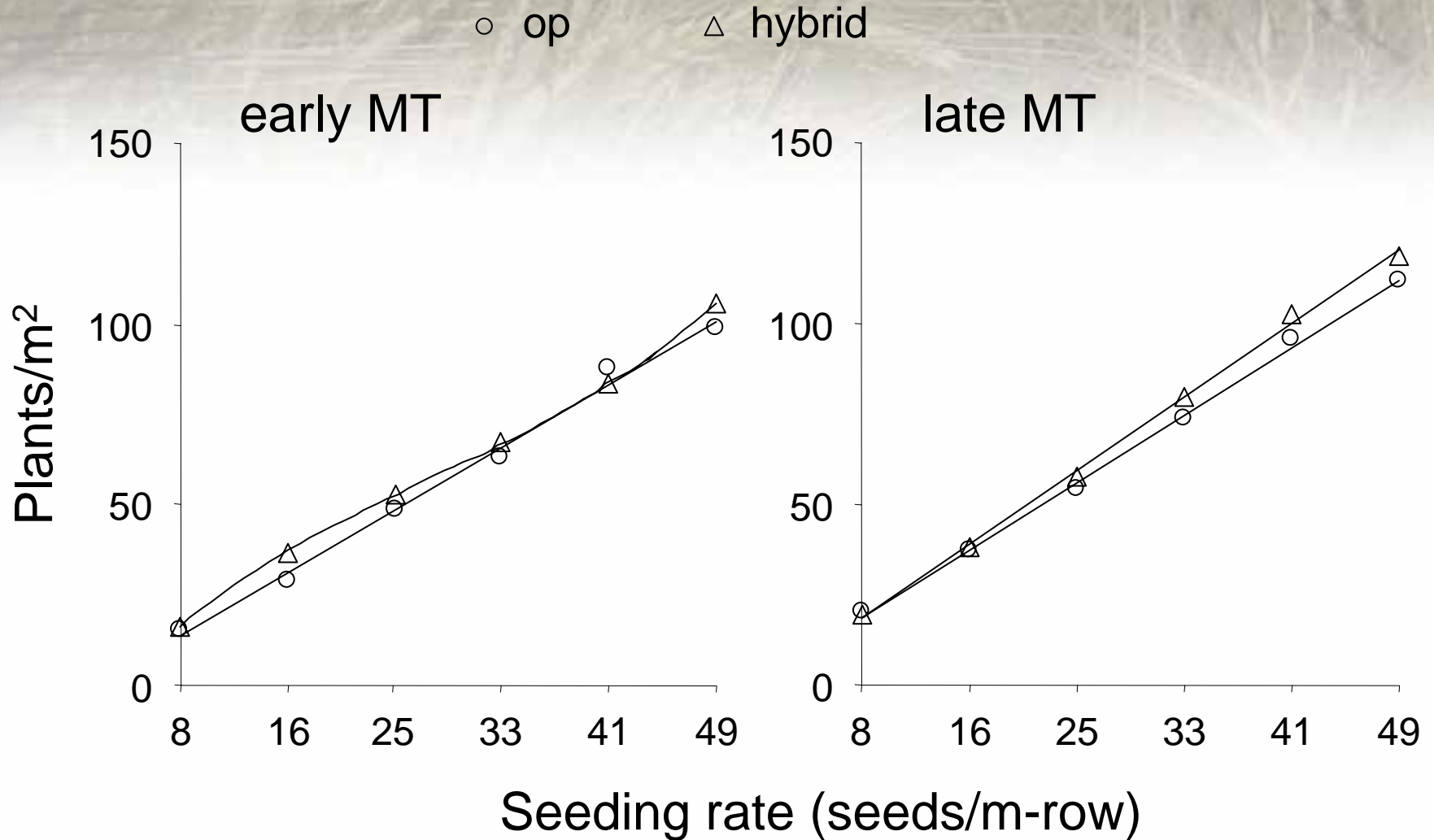
| Cultivar | Stand est. (%) | Biomass (g/m-row) | | | Yield (bu/acre) |
|--------------|-------------------|-------------------|------------|-------------|--------------------|
| | | 21 DAS | 28 DAS | 34 DAS | |
| op | 90 | 9.8 (1.0) | 54.4 (1.0) | 135.9 (1.0) | 50.9 (1.00) |
| older hybrid | 87 | 11.3 (1.1) | 66.9 (1.2) | 167.6 (1.2) | 54.9 (1.08) |
| new hybrid | 89 | 12.1 (1.2) | 75.5 (1.4) | 191.0 (1.4) | 61.0 (1.20) |

¹ tests on sized seeds (1.8-2.0 mm diameter).

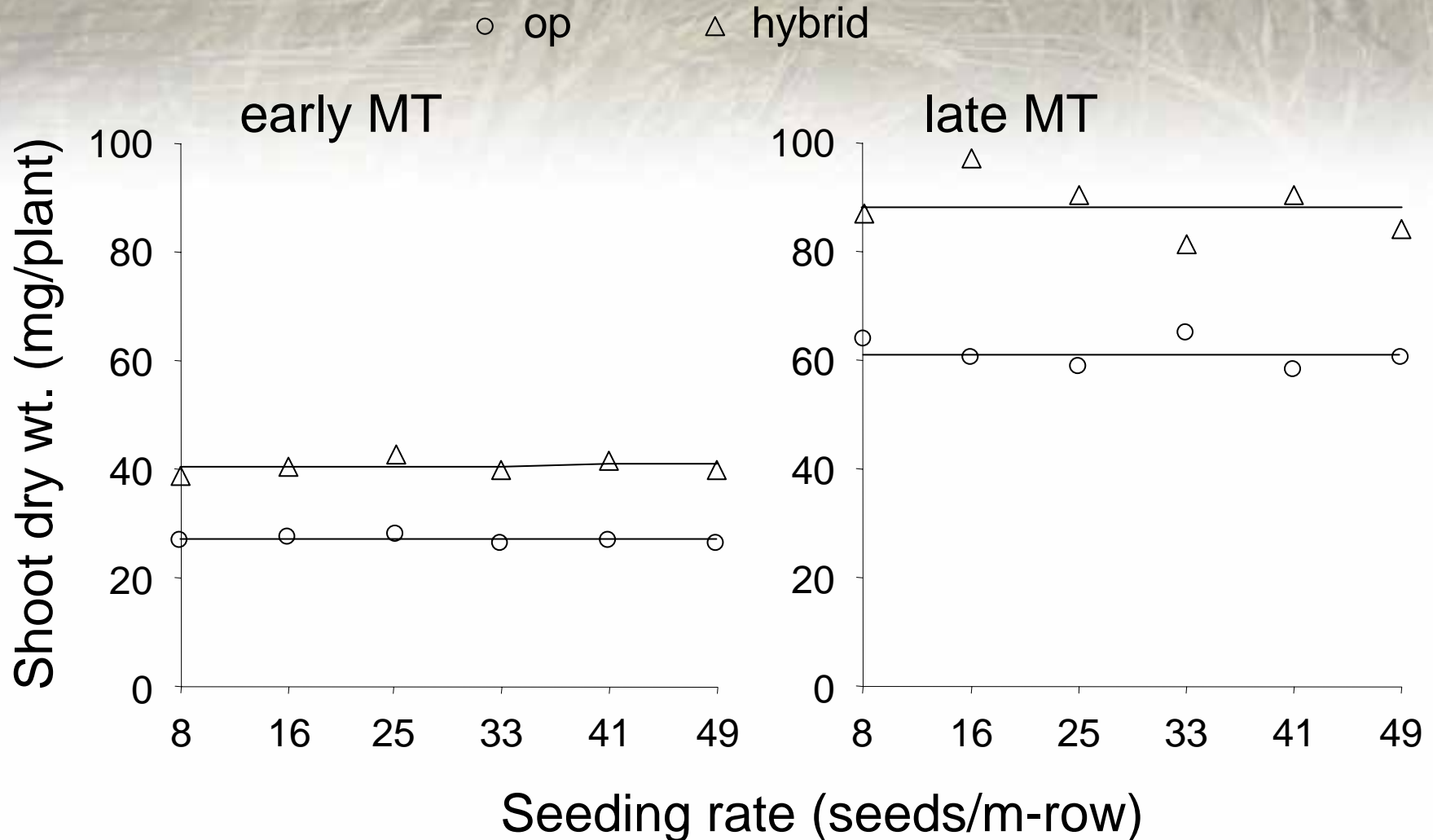
SEEDING RATE EVALUATIONS

- small-plots tests at Saskatoon with MT in 2001-2006
- op cultivars (SW Arrow, SP Banner)
- hybrid cultivars (InVigor 2663 or 5020)
- seeded early (May 11-16) and late (May 24-June 2)
- seeded at six rates (8, 16, 25, 33, 41, 49 seeds/m-row)
- op (0.7-5.8 lb/acre), hybrid (0.9-7.5 lb/acre)
- effects of seeding rate on plants/m², shoot growth, biomass and yield

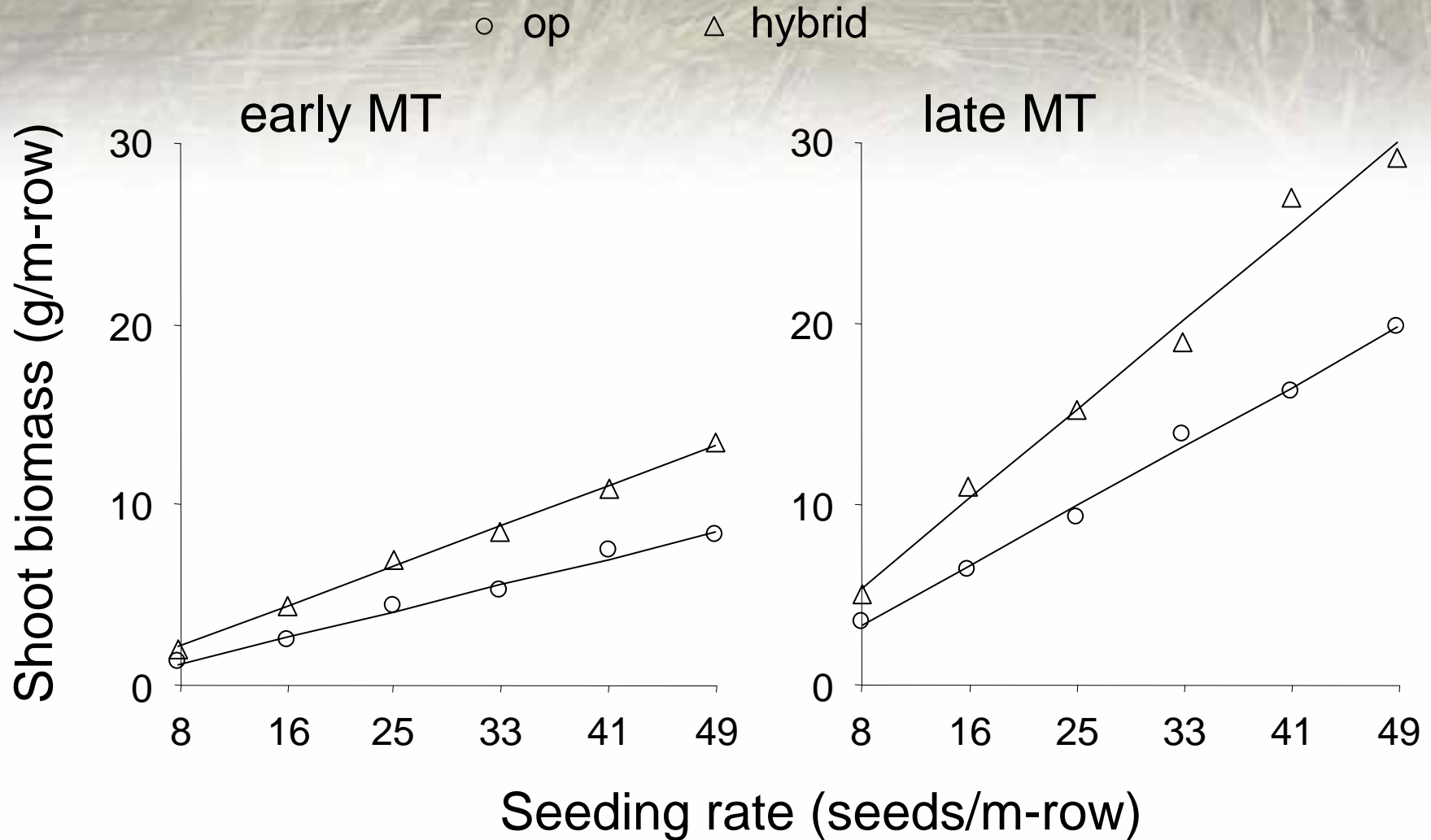
Relationship between seeding rate and plants/m² of op and hybrid cultivars in early and late MT plantings in 2001-2006.



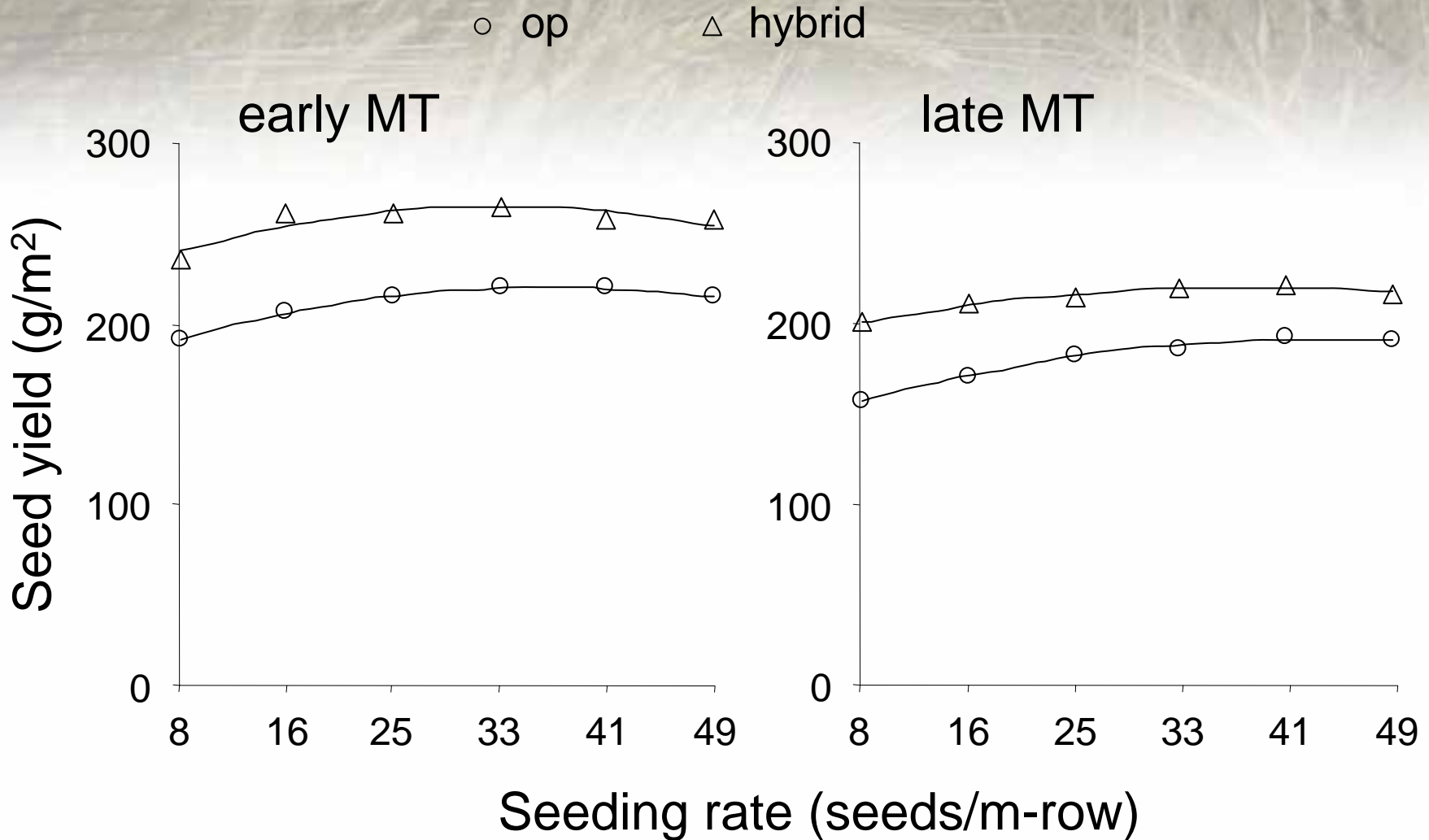
Relationship between seeding rate and shoot dry weight of op and hybrid cultivars after 22 days in early and late MT plantings in 2001-2006.



Relationship between seeding rate and shoot biomass of op and hybrid cultivars after 22 days in early and late MT plantings in 2001-2006.



Relationship between seeding rate and yield of op and hybrid cultivars in early and late MT plantings in 2001-2006.



Relationship between seeding rate, performance and net return of op cultivars in early and late MT plantings in 2001-2006.¹

| Seeding rate | | Plants/m ² | | Yield (bu/acre) | | Net return (\$/acre) | |
|--------------|---------|-----------------------|-----------|-----------------|-------------|----------------------|-----------------|
| seeds/m-row | lb/acre | early | late | early | late | early | late |
| 8 | <0.9 | 15 | 20 | 34.0 | 27.9 | \$251.40 | \$205.70 |
| 16 | 1.8 | 29 | 38 | 36.7 | 30.6 | \$268.10 | \$222.30 |
| 25 | 2.6 | 49 | 55 | 38.1 | 32.8 | \$275.40 | \$235.60 |
| 33 | 3.5 | 63 | 74 | 39.0 | 33.1 | \$278.50 | \$234.30 |
| 41 | 4.4 | 87 | 96 | 39.0 | 34.5 | \$274.90 | \$241.20 |
| 49 | 5.3 | 99 | 112 | 38.1 | 34.0 | \$264.60 | \$233.80 |

¹ Net returns based on a canola price of \$7.50/bu and seed cost of \$4.00/lb.

CONCLUSIONS

- recommended seeding rates for canola are 5-8 lb/acre
- a seeding rate of 3.5 lb/acre and plant density of 60-65 plants/m² provided the highest net return from op cultivars in early MT plantings
- a 1.5-4.5 lb/acre reduction in seeding rate would reduce seed costs by \$6-18/acre and reduce seed treatment use by 30-55%

Relationship between seeding rate, performance and net return of hybrid cultivars in early and late MT plantings in 2001-2006.¹

| Seeding rate | | Plants/m ² | | Yield (bu/acre) | | Net return (\$/acre) | |
|--------------|---------|-----------------------|-----------|-----------------|-------------|----------------------|-----------------|
| seeds/m-row | lb/acre | early | late | early | late | early | late |
| 8 | <1.1 | 17 | 20 | 42.0 | 35.8 | \$306.70 | \$260.20 |
| 16 | 2.1 | 36 | 38 | 46.5 | 37.7 | \$333.00 | \$267.00 |
| 25 | 3.2 | 53 | 58 | 46.6 | 38.3 | \$325.50 | \$263.30 |
| 33 | 4.3 | 67 | 79 | 47.0 | 39.2 | \$320.20 | \$261.70 |
| 41 | 5.4 | 83 | 103 | 45.7 | 39.7 | \$302.30 | \$257.30 |
| 49 | 6.4 | 106 | 118 | 45.7 | 38.6 | \$294.80 | \$241.50 |

¹ Net returns based on a canola price of \$7.50/bu and seed cost of \$7.50/lb.

CONCLUSIONS

- a seeding rate of 2.1 lb/acre and plant density of 35-40 plants/m² provided the highest net return from hybrid cultivars in early MT plantings.
- a 2.9-5.9 lb/acre reduction in seeding rate would reduce seed costs by \$21.75-44.25/acre and reduce seed treatment use by 55-70%.

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