

Soybean Production

(Research Experience in southern Alberta)

Irrigated Crop Production Update- 2014
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Research Projects of the Pulse and Special Crops Program , CDCS, Brooks

1. Variety/cultivar development/selections

Variety Development : Red lentil, Kabuli chickpea, Faba bean
Mungbean, Black gram, Moth bean
Cowpea

Cultivar/variety selection : Winter lentil and Field peas, Field peas
Soybean, Fenugreek,
Coriander, and
Grain and Silage corn

2. Agronomic/Physiological Studies

- **Agronomic studies : 'CLEARFIELD' type lentils and dry beans**
- **Regulation of crop growth and development: Chickpeas**

3. Production system studies

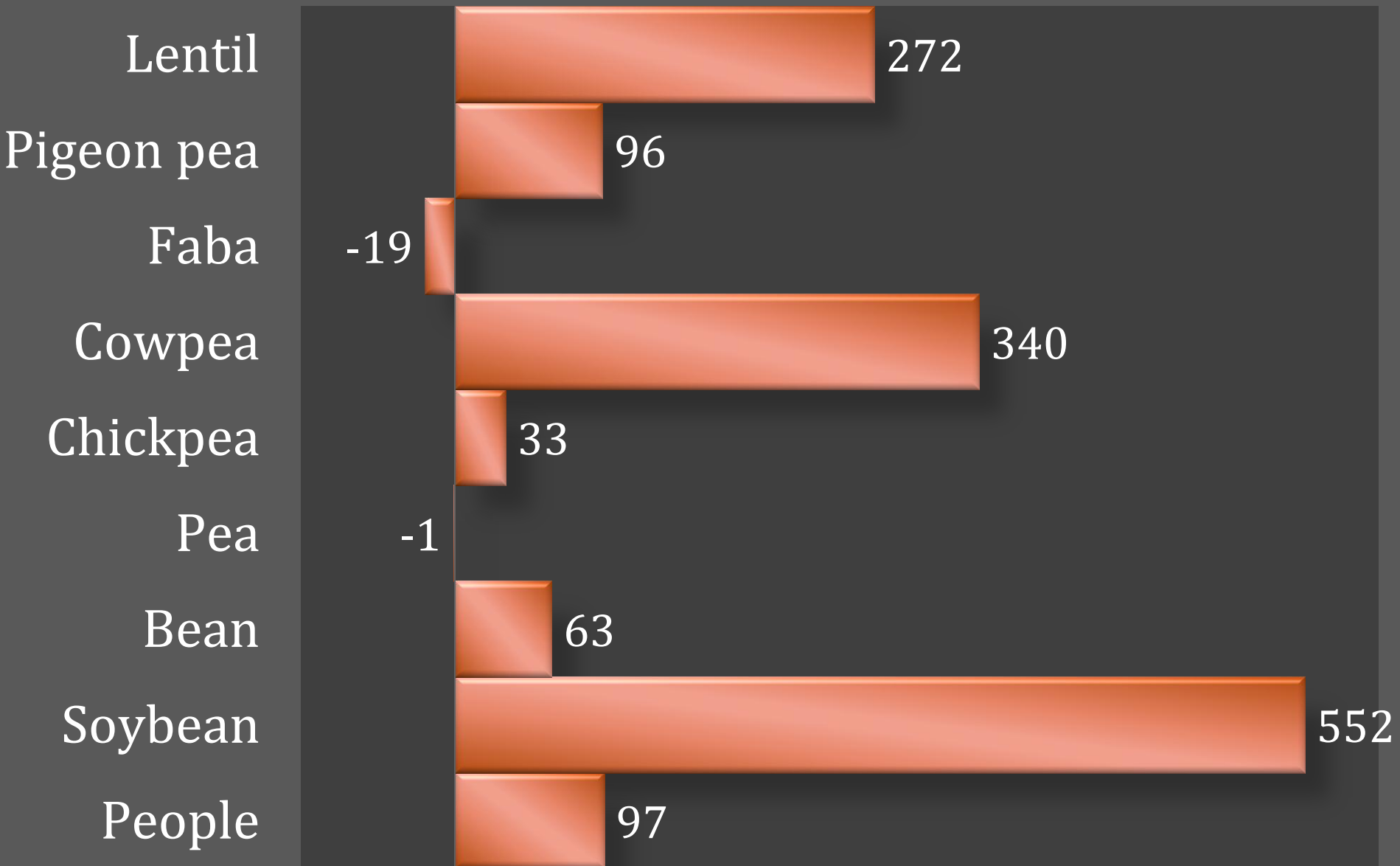
- Optimizing frequency and sequence of annual pulses in crop rotation of cereal-based rain-fed cropping system in southern AB and SK.

Pulse crops : Chickpea, lentil, field pea

Cereal : Spring wheat

Oilseed : Mustard

Growth percentage (%) since 1960s



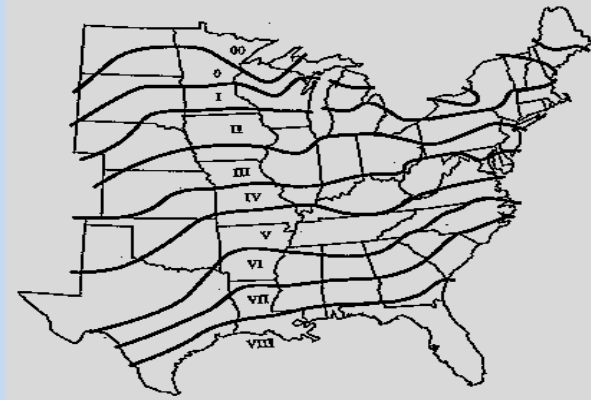
Soybean [*Glycine max* (L.) Merr.]

- Cultivated soybean**
- is a member of the legume family ($2n=40$)
 - is an erect, bushy herbaceous annual
 - can reach a height of 1.5 m

Soybean type (based on growth habit)

- **Determinate:** Ceases vegetative activity of the terminal bud when it becomes an inflorescence at both axillary and terminal racemes
- **Semi-determinate:** have indeterminate stems that terminate vegetative growth abruptly after the flowering period
- **Indeterminate:** Indeterminate genotypes continue vegetative activity throughout the flowering period

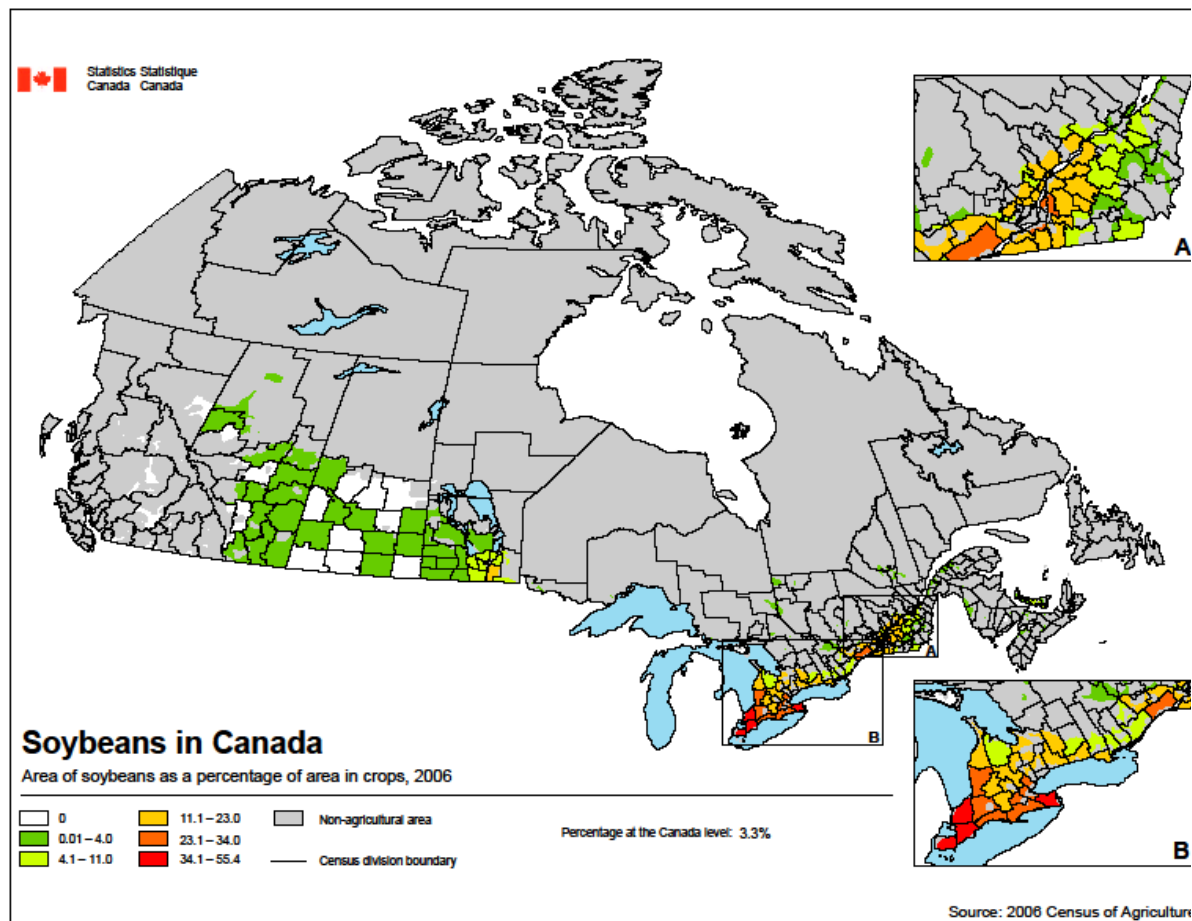
- is a quantitative short day warm season annual plant
- flowers more quickly under short days.
- Thus, photo-periodism and temperature response are important in determining areas of cultivar adaptation.
- Cultivars are identified based on bands of adaptation that run east-west, determined by latitude and day length.
- There are thirteen maturity groups (MG), from MG 000 in the north (45° latitude) to MG X near the equator.
- Within each maturity group, cultivars are described as early, medium or late maturing.



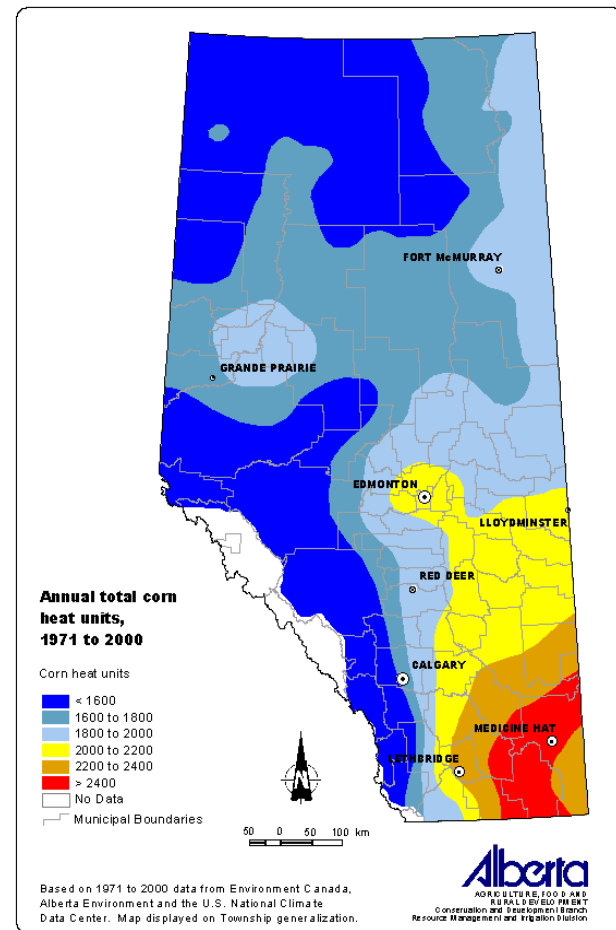
Soybean in Canada

- has been grown in Ontario since 1893
- The crop change: Forage -> oilseed status
- early maturity and tolerance to cooler climates
- It was estimated that Canada had 1,576,000 ha of soybean with an average yield of 2,600 kg ha⁻¹
- In 2013, soybean seeded area
 - Manitoba : 433,600 ha
 - Saskatchewan: 68,000 ha
 - Alberta : 4,000 ha





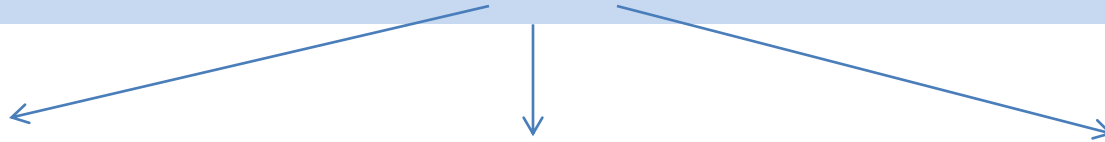
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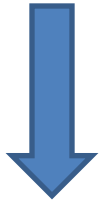
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Fig. 1. Soybean production areas in Canada (a) and Alberta (b)

Soybean Productivity (Economic yield unit area)

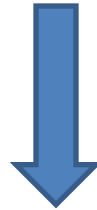


Variety



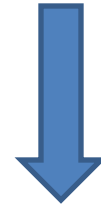
- High yielding
- Early and even maturity
- Acceptable food quality
- Pest and disease resistance

Growing Environment



- Soil temperatures ($> 10^{\circ}\text{C}$ at seeding)
- Frost-free days (at least >100 days)
- $\text{CHU} > 2300$
- Photoperiod (day neutral)
- Precipitation/ irrigation

Crop Management



- Plant population
- Soil fertility
- Inoculant/N fixation
- Pests and disease control
- Weed control
- Soil moisture
- Harvest

Soybean studies in southern Alberta

Genotype evaluations

Objectives

To evaluate newly released soybean genotypes for productivity in AB

- Genotypes were obtained through the Western Canadian Soybean variety Program and Regional Variety testing
- Genotypes were early maturing and roundup- ready (RR) types

Agronomic studies

Objectives

- To optimize seeding density for higher seed yield
- Impact of irrigation amount on crop productivity

Table 1. Agronomic performance of soybean genotypes at Bow Island in 2011- WS

Genotype	Rain-fed			Supplementary irrigated		
	DTM	TSW (g)	SY (kg ha ⁻¹) (bu/ac)	DTM	TSW (g)	SY (kg ha ⁻¹) (bu/ac)
23-10RY	106	147	2119 (31)	120	172	4083 (60)
24-10RY	113	137	2569 (38)	126	150	3497 (51)
29002	102	108	1656 (24)	120	132	3255 (48)
32004R2Y	109	128	2425 (36)	122	140	3830 (56)
900Y61	109	142	2233 (33)	122	162	3846 (56)
900Y71	109	133	2328 (34)	120	158	3952 (58)
CFS11.1.01R2	108	127	2399 (35)	124	158	4426 (65)
CFS11.3.01R2	113	136	2631 (39)	124	151	3645 (53)
EXP 006RY 524	110	142	2429 (36)	122	164	4025 (59)
LS 0036RR	108	93	2038 (30)	119	117	4581 (67)
LS 004R21	110	135	2396 (35)	122	152	4106 (60)
NSC Warren RR	107	100	2172 (32)	117	122	4144 (61)

Seeded: May 31/2011 ; Harvested: Sept 27, 2011

Precipitation: April 01- Oct. 30 = 237 mm (9.5") ; Irrigated : 93 mm (3.7")

Table 2. Highest yielding soybean genotypes at Bow Island in 2012 (WS)

Genotype	Rain-fed			Supplementary irrigated			
	DTM	TSW (g)	SY (kg ha ⁻¹) (bu/ac)	Genotype	DTM	TSW (g)	SY (kg ha ⁻¹) (bu/ac)
G 10 R2	112	143	2690 (40)	G10 R2	126	151	4758 (70)
SC2375R2	113	155	2573 (38)	TH 33003R2Y	124	141	4548 (67)
NSM EXP 1225 R2	110	131	2568 (38)	TH 32004R2Y	126	153	4496 (66)
PEKKO R2	115	136	2565 (38)	23-10RY	123	162	4462 (65)
HX 007RY 32	112	153	2551 (37)	HX 007RY32	128	167	4451 (65)
TH 33003R2Y	112	136	2522 (37)	HS 006RYS24	127	156	4410 (64)
LS 002R23	112	135	2521 (37)	SC 2375R2	125	157	4302 (63)
24-10RY	115	153	2475 (36)	PEKKO R2	125	152	4280 (63)
NSC LiBau RR2Y	114	145	2467 (36)	NSM EXP 1225 R2	122	142	4249 (62)
SAMPA R2	113	159	2430 (35)	BISHOP R2	127	146	4214 (62)

Seeded: May 16 ; Harvested: Rain-fed Sept. 17; Irrigated Sept. 28;
Precipitation: April 01-Oct 31 = 305 mm (12.2") ; Irrigated amount : 127 (5.1")

Table 3. Highest yielding soybean genotypes at Bow Island in 2013 (ws)

Rain-fed				Supplementary Irrigated			
Genotype	DTM	TSW (g)	SY (kg ha ⁻¹) (bu/ac)	Genotype	DTM	TSW (g)	SY(kg ha ⁻¹) (bu/ac)
23-60RY	128	134	3390 (50)	PRO 2525R2	120	166	3636 (53)
PRO 2525R2	116	148	3214 (47)	NSC Libau RR2Y	120	155	3611 (53)
EXP00313R2	112	143	3131 (46)	23-60RY	128	152	3548 (52)
TH 32004R2Y	115	123	3044 (45)	TH 32005R2Y	120	154	3472 (51)
MCLEOD R2	113	143	3039 (45)	NSC TILSTON RR2Y	117	144	3343 (49)
TH 33005R2Y	119	133	3018 (44)	LS 002R24N	116	162	3247 (48)
LS 002R24N	111	133	2970 (44)	EXP00313R2	117	171	3235 (48)
NSC TILSTON RR2Y	111	126	2933 (43)	MCLEOD R2	116	167	3153 (46)
SAMPA R2	116	127	2905 (42)	TH 33003R2Y	116	145	3149 (46)
LS 002R23	113	125	2902 (42)	900Y71	120	155	3145 (46)
Mean	104	134	3055 (44)	Mean	119	157	3354 (49)

24 genotypes tested; Precipitation (April 01 – Oct. 31) = 293.3 mm (11.6"); irrigated amount = 165 mm (6.6"); heavy rain/wind damage occurred on July 08/2013.

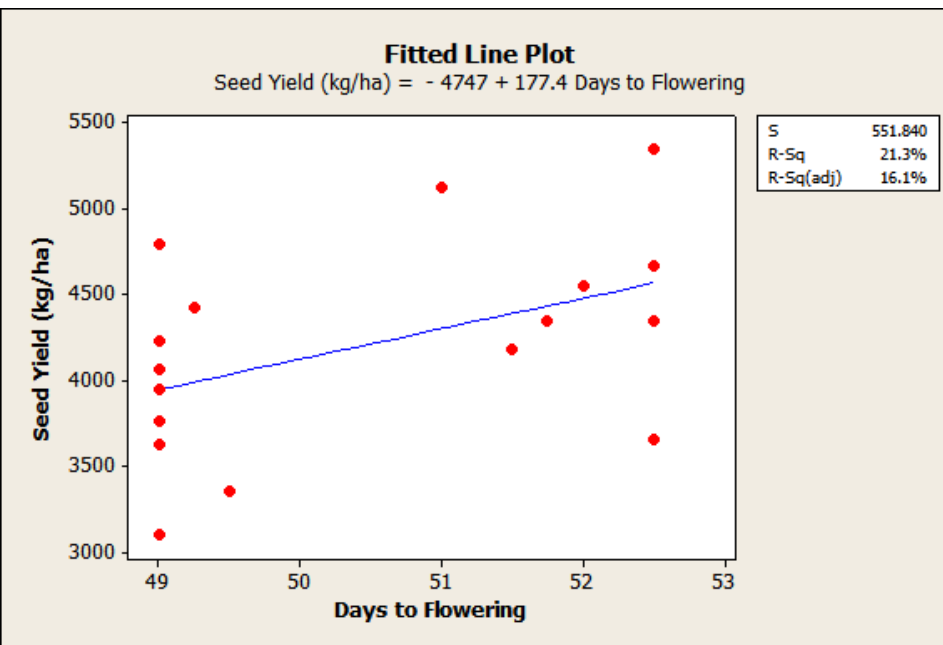
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Table 4. Highest yielding soybean genotypes at Brooks and BISS in 2013 (RVT)

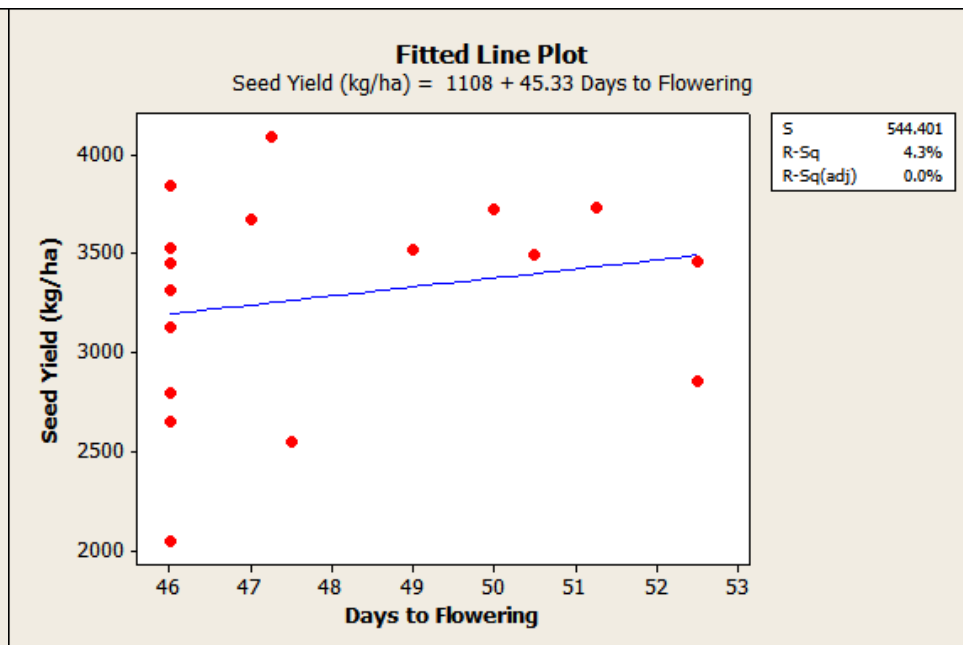
Brooks (Supplementary irrigated)					Bow Island (Supplementary irrigated)				
Genotype	DTM	CHU	TSW (g)	SY (kg ha ⁻¹) (bu/ac)	Genotype	DTM	CHU	TSW (g)	SY (kg ha ⁻¹) (bu/ac)
CFS 12.3.02	119	2295	157	5351 (78)	SC 2380	118	2399	139	4085 (60)
TH 33005	120	2315	159	5126 (75)	TH 33003	115	2336	141	3841 (56)
CFS 13.2.02	118	2278	179	4794 (70)	TH 33005	119	2423	152	3726 (55)
MCLEOD	118	2278	170	4668 (68)	MCLEOD	115	2336	158	3724 (55)
TH 32004	119	2295	146	4550 (67)	CFS 13.2.02	118	2399	165	3670 (54)
PEKKO	120	2315	152	4428 (65)	900Y71	115	2336	150	3524 (52)
900Y71	118	2278	163	4348 (64)	TH 32004	116	2357	132	3520 (52)
TH 33003	117	2258	165	4347 (64)	SAMPSA	118	2399	146	3490 (51)
SAMPSA	118	2278	148	4226 (62)	CFS 12.3.02	118	2399	147	3458 (50)
NSC WARREN	121	2333	159	4184 (61)	900Y61	118	2399	157	3447 (50)
Mean	118	2292	160	4602 (67)	Mean	117	2378	149	3648 (53)

17 genotypes tested; At Brooks, precipitation (April 01-Oct. 31) = 278 mm (11.1") and irrigated amount = 110 mm (4.4"); At BISS, precipitation (April 01– Oct. 31) = 293.3 mm (11.6") and irrigated amount = 165 mm (6.6"); heavy rain/wind damage occurred at BISS on July 08/2013.

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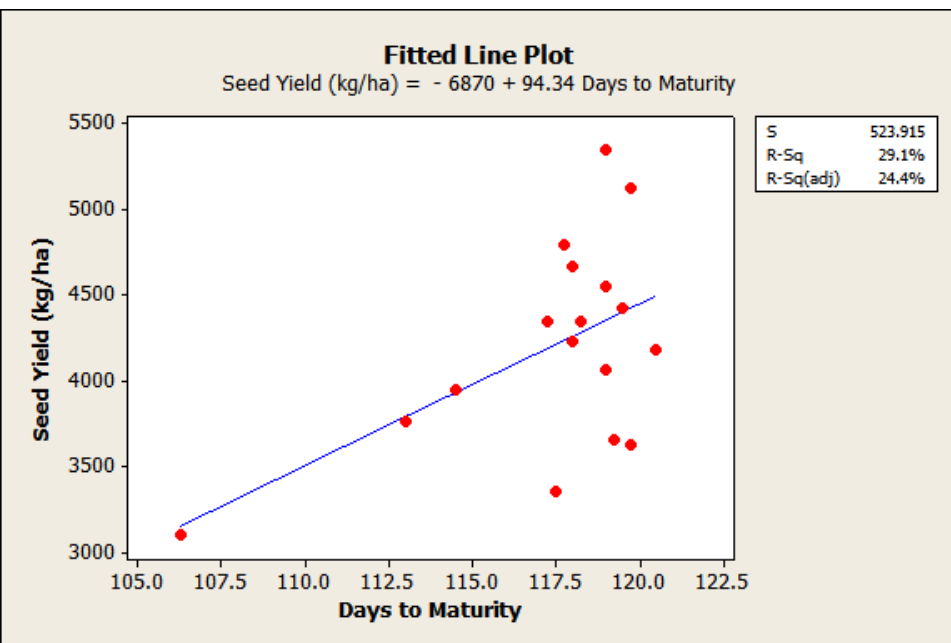


Brooks

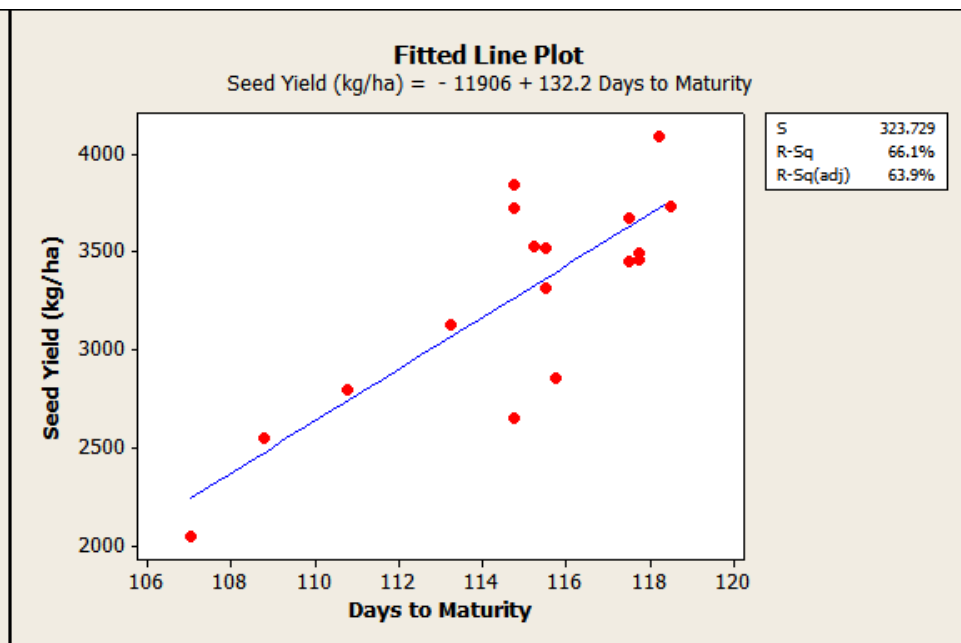


Bow Island

Fig. 1. Relationship between seed yield and number of days to flowering of soybean genotypes at Brooks and Bow Island in 2013.



Brooks



Bow Island

Fig. 2. Relationship between seed yield and number of days to maturity of soybean genotypes at Brooks and Bow Island in 2013.

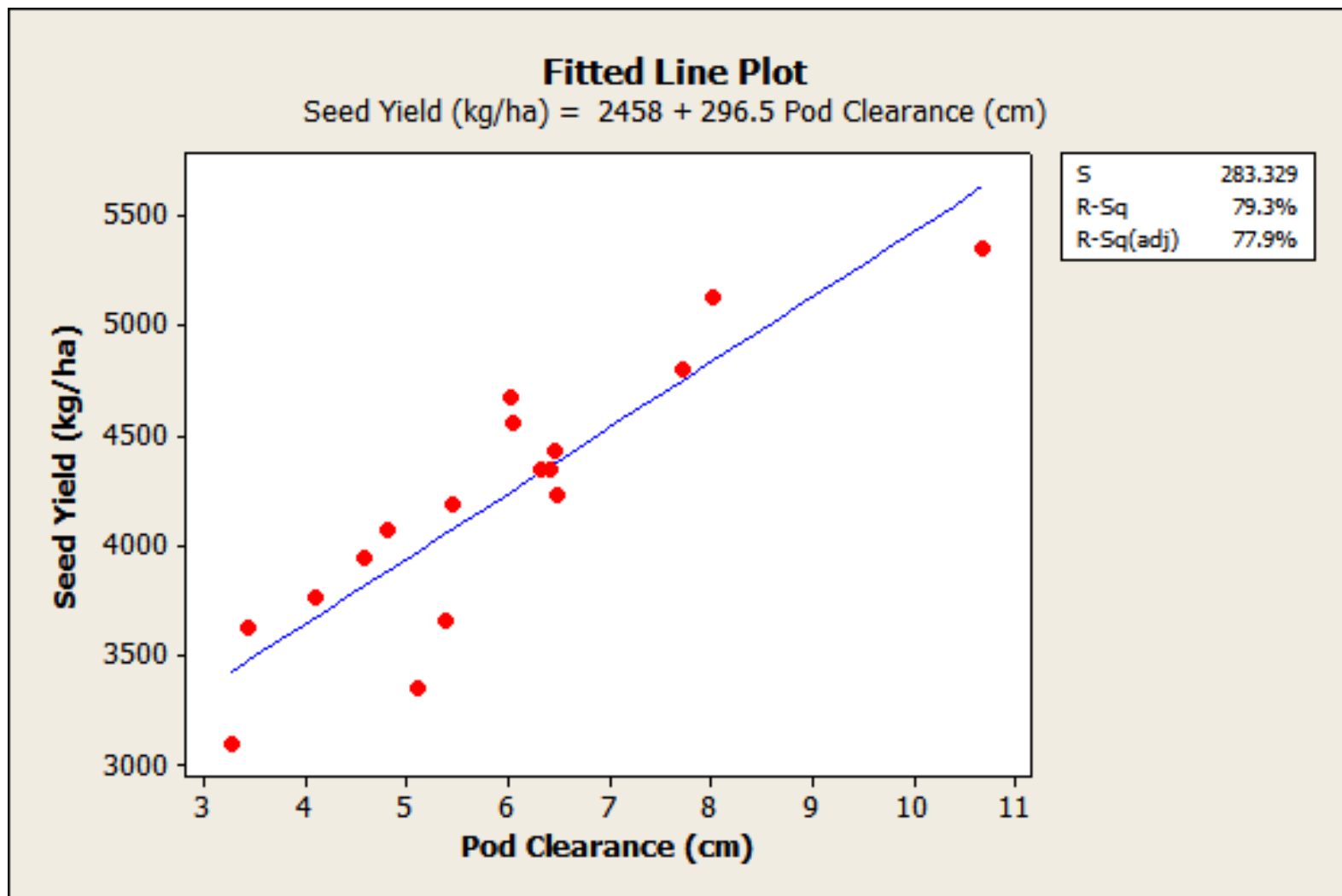
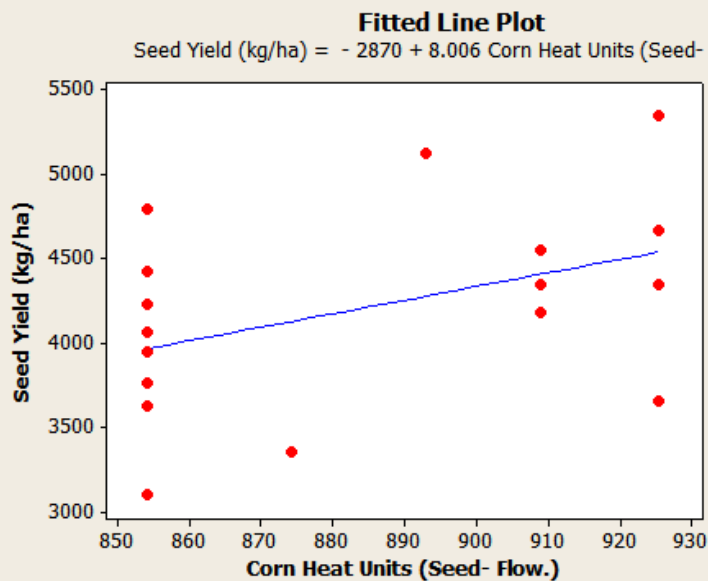
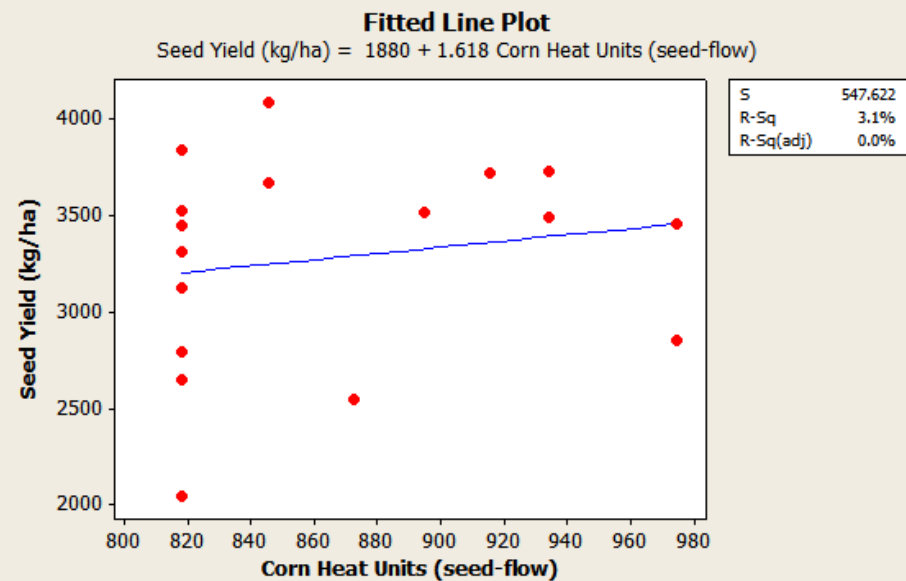


Fig. 3. Relationship between **seed yield** and **pod clearance** of soybean genotypes at Brooks in 2013.

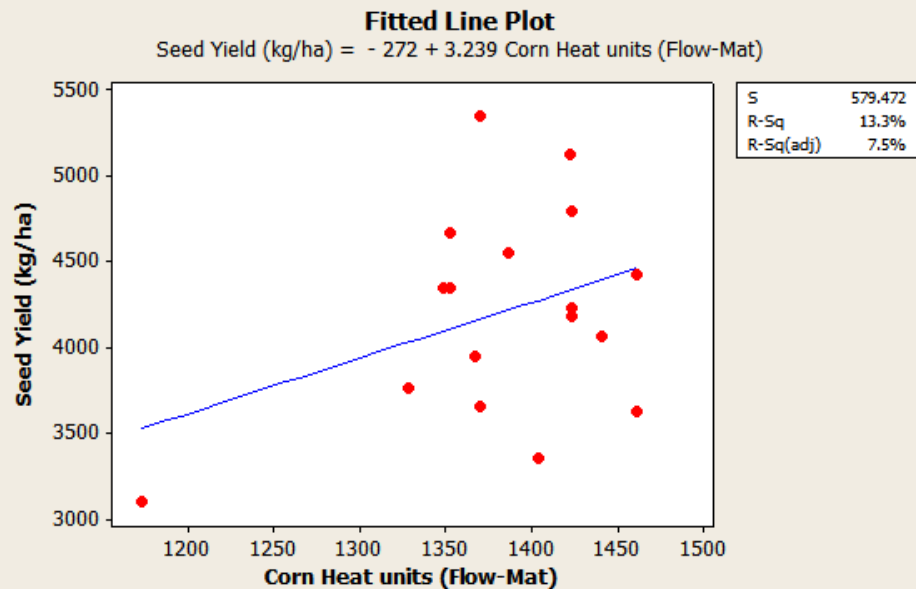


Brooks

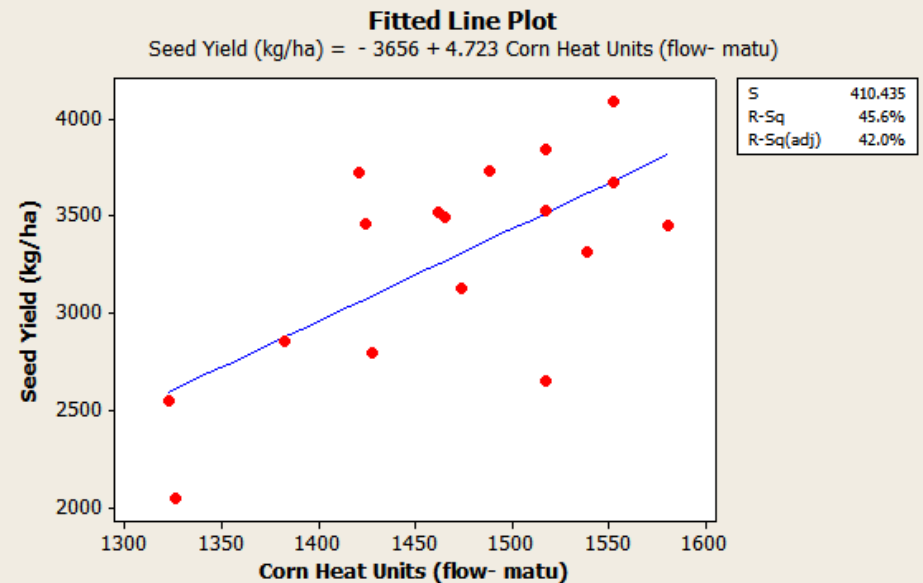


Bow Island

Fig. 4. Relationship between seed yield and **corn heat unit received from **seeding to flowering** of soybean genotypes at Brooks and Bow Island in 2013.**

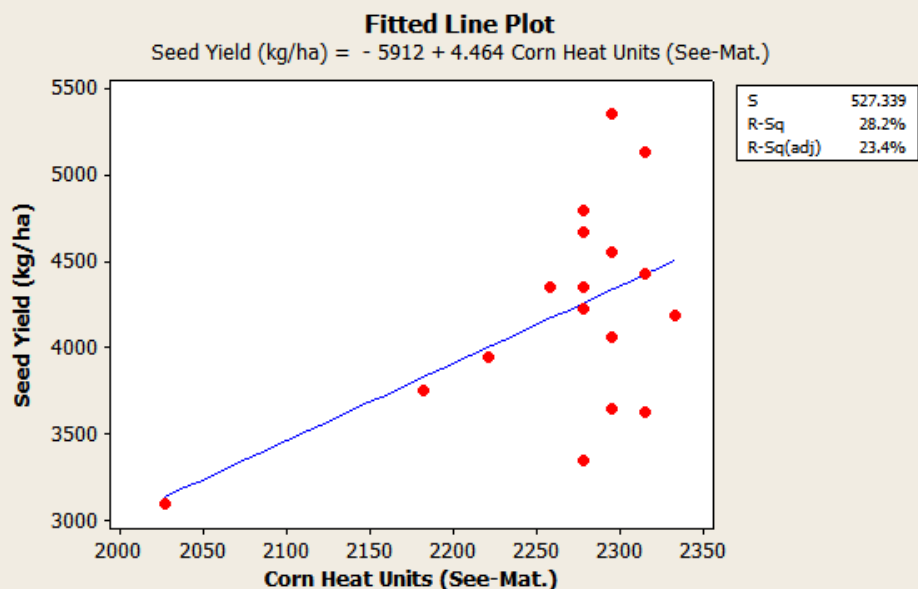


Brooks

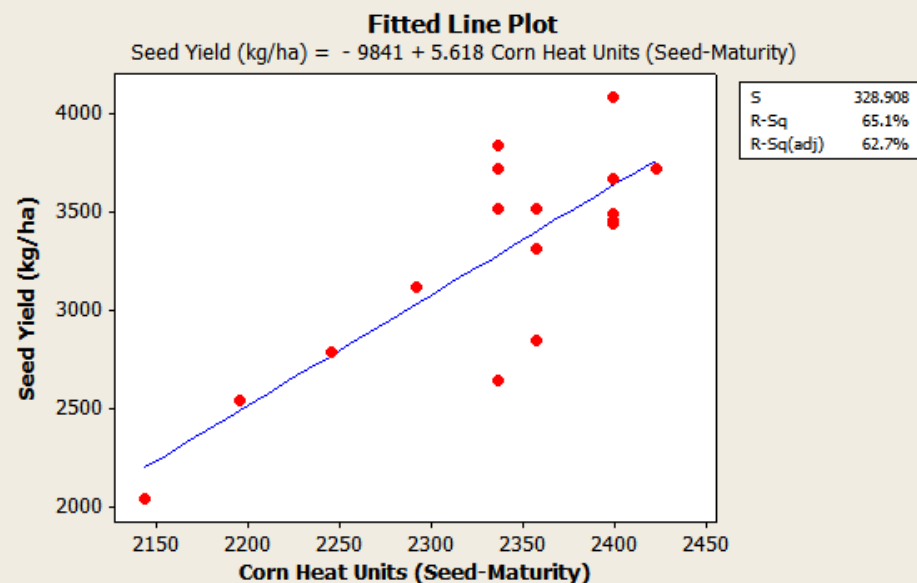


Bow Island

Fig. 5. Relationship between seed yield and **corn heat units received from **flowering to maturity** of soybean genotypes at Brooks and Bow Island in 2013.**

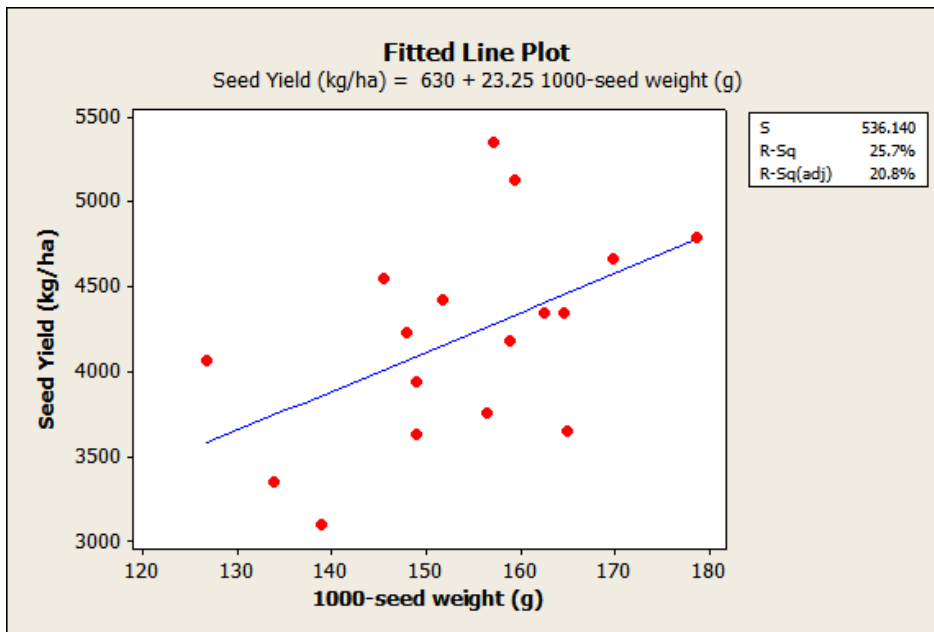


Brooks

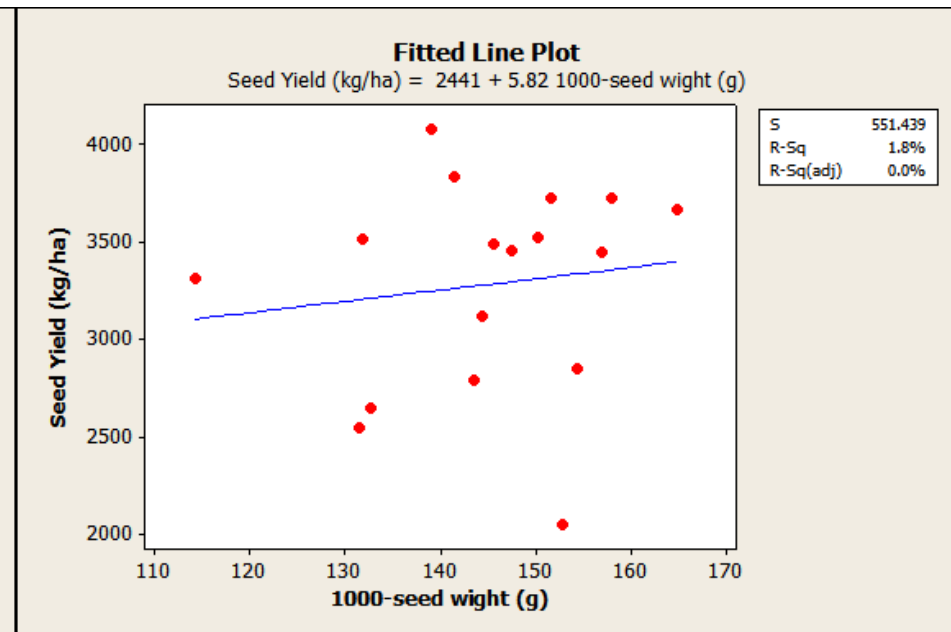


Bow Island

Fig. 6. Relationship between seed yield and corn heat unit received from seeding to maturity of soybean genotypes at Brooks and Bow Island in 2013.



Brooks



Bow Island

Fig. 7. Relationship between seed yield and 1000-seed weight of soybean cultivars at Brooks and Bow Island in 2013

Seeding density studies

Table 5. Effect of seeding density on plant growth and seed yield of 230 RR under supplementary irrigation in Bow Island

Seeding density (Seeds ha ⁻¹)	Plant height (cm)	1000-seed weight (g)	Seed yield (kg ha ⁻¹)
296,600	71	131	2899
494,000	73	127	3516
691,600	77	132	3819
889,200	74	128	4174
Statistical sig.	ns	ns	L ^{**}
^{ns} non-significant at p=0.05; L ^{**} =Linear effect is significant at p=0.01.			

Fitted Line Plot

$$\text{Seed yield (kg ha}^{-1}\text{)} = 584 + 0.01178 \text{ Seeds ha}^{-1} - 0.000000 \text{ Seeds ha}^{-1}{}^2 + 0.000000 \text{ Seeds ha}^{-1}{}^3$$

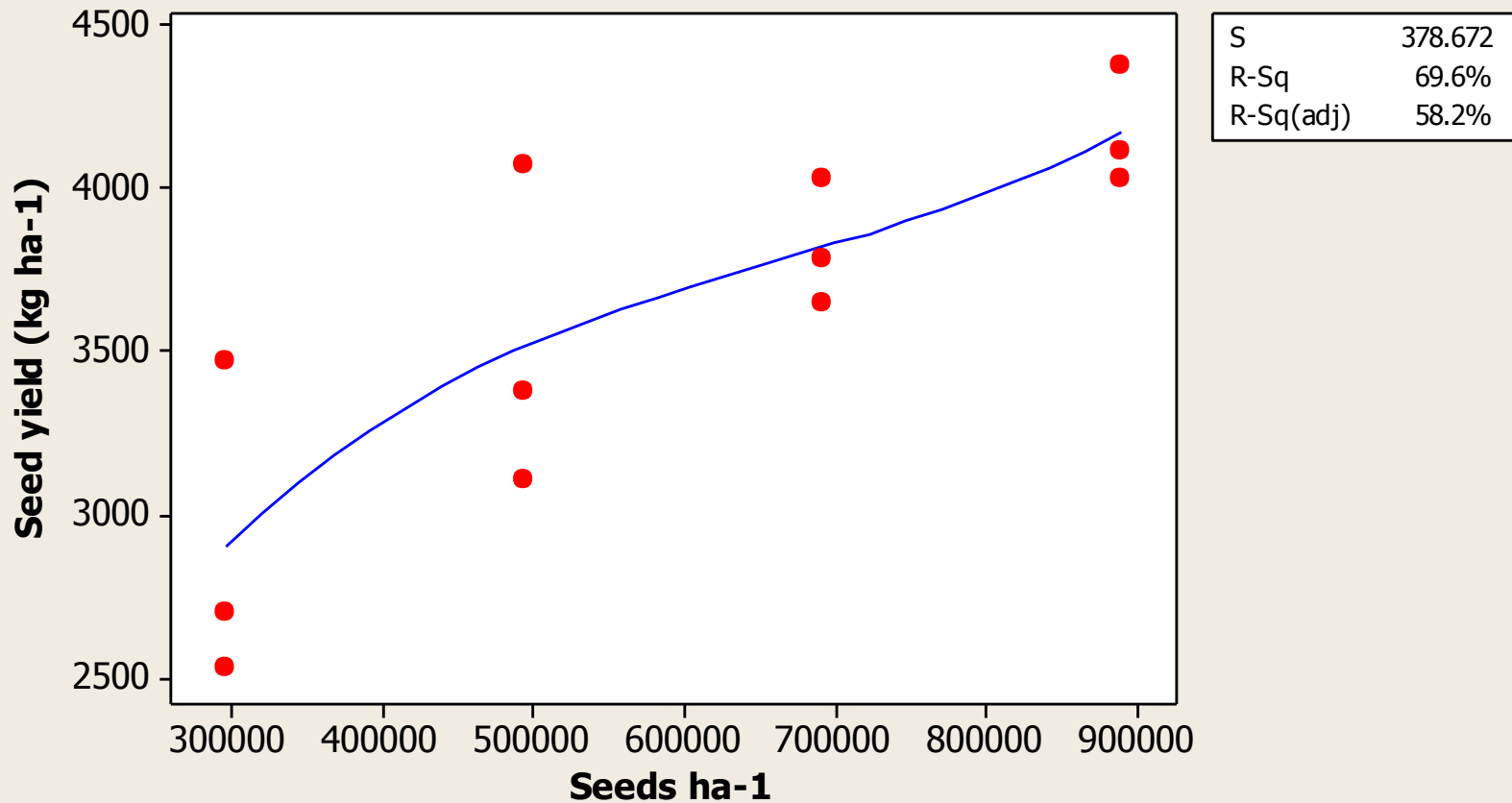


Fig. 8. Relationship between seeding density and seed yield of soybean genotype 230 RR at Bow Island

Large-scale field study

- Was conducted in the Fabian Seed Farms near Brooks
- Soybean genotype LS 0065 (small-seeded) was used.
- Two seeding densities (35 cm row spacing at 48 seeds m^{-2} and 17.5 cm row spacing at 55 seeds m^{-2})
- Each treatment had 17-ha section
- Seed yield components were estimated, using randomly collected 5 replicates (10 plants per replicate)

Large – scale field study at the Fabian Seed Farms in 2010



17.5 cm



35 cm

Fig 2. Soybean crop seeded at 17.5 cm and 35 cm on the Fabian seed farms near Brooks in 2010.

Table 6. Effect of row spacing and seeding rate on plant growth and seed yield of LS 0065 at Fabian Seed Farms near Brooks

Treatment		Ph (cm)	DW (g pl ⁻¹)	SY (g pl ⁻¹)	No. seeds pl ⁻¹	TSW (g)	SY (kg ha ⁻¹)
Spacing (cm)	Density (seeds m ⁻²)						
17.5	55	69	7	2.5	30	86	1673
35.0	48	81	12	4.4	53	85	2005

Irrigation study

Cultivar: NSC Warren RR

Treatments

- 1. Manage a 60-cm root zone, allow to dry to 60% of available before refilling soil water**
- 2. Manage a 30-cm root zone for entire season, allow to dry to 60% before refilling**
- 3. Manage a 30-cm root zone until flower, expand 60-cm root zone to end of season, allow to dry to 60% before refilling**
- 4. Manage a 60-cm root zone, apply 12 cm during each irrigation, maintain soil water above 60% of available**
- 5. Manage a 60-cm root zone, apply 25 mm during each irrigation, maintain soil water above 60% of available**

Seeding density : 80 seeds m⁻²

Table 7. Impact of irrigation schedule on crop growth and seed yield of NSC Warren RR soybean in Bow Island in 2012

Irrigation treatment	1000-seed weight (g)	ET (mm)	Seed Yield (kg ha ⁻¹) (bu/ac)	WUE (kg ha ⁻¹ mm ⁻¹)
1. > 60% FC at 60 cm	110	373	2868 (42)	7.7
2. > 60% FC at 30 cm	114	362	3140 (46)	8.7
3. > 60% FC at 30/60 cm	112	366	3113 (46)	8.5
4. > 60% FC applied 12 mm	107	344	2857 (42)	8.3
6. > 60% FC applied 25 mm	106	365	2732 (40)	7.5

1. Manage a 60-cm root zone, allow to dry to 60% of available before refilling soil water
2. Manage a 30-cm root zone for entire season, allow to dry to 60% before refilling
3. Manage a 30-cm root zone until flower, expand 60-cm root zone to end of season, allow to dry to 60% before refilling
4. Manage a 60-cm root zone, apply 12 cm during each irrigation, maintain soil water above 60% of available
5. Manage a 60-cm root zone, apply 25 mm during each irrigation, maintain soil water above 60% of available

Table 8. Impact of irrigation schedule on crop growth and seed yield of NSC Warren RR soybean in Bow Island in 2013

Irrigation treatment	1000-seed weight (g)	ET (mm)	Seed Yield (kg ha ⁻¹) (bu/a)	WUE (kg ha ⁻¹ mm ⁻¹)
1. > 60% FC at 60 cm	135	408	2130 (31)	5.2
2. > 60% FC at 30 cm	133	427	2168 (32)	5.1
3. > 60% FC at 30/60 cm	138	429	2270 (33)	5.3
4. > 60% FC applied 12 mm	136	380	2315 (34)	6.1
5. > 60% FC applied 25 mm	131	378	1913 (28)	5.1

1. Manage a 60-cm root zone, allow to dry to 60% of available before refilling soil water
2. Manage a 30-cm root zone for entire season, allow to dry to 60% before refilling
3. Manage a 30-cm root zone until flower, expand 60-cm root zone to end of season, allow to dry to 60% before refilling
4. Manage a 60-cm root zone, apply 12 cm during each irrigation, maintain soil water above 60% of available
5. Manage a 60-cm root zone, apply 25 mm during each irrigation, maintain soil water above 60% of available

Conclusions

- Soybean is a **potential new** crop in southern Alberta
- Optimum **irrigation amount and frequency** to be determined by considering the crop growth stage and evapotranspiration rate.
- Optimum **plant population density** to be determined based on within and between row spacing and cultivar, and cost effectiveness.
- Most **vital yield component(s)** affecting seed yield of soybean need to be determined.
- Moderate heat requiring **(2300-2350 CHU)** genotypes appear to be well productive in AB.
- The use of appropriate **genotypes** with optimum **cultural practices** would help reach genetic potential under field conditions in AB

Acknowledgments

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