

Genetic Variation and Stability of Agronomic and Quality Traits in Soybean Varieties Grown in Western Canada Between 2013 and 2018

Ketema Daba, Gene Arganosa and Thomas D. Warkentin

Crop Development Centre, University of Saskatchewan,
Department of Plant Sciences

Soils and Crops Conference
March 5-6, 2019



Soybean *Glycine max* (L.) Merr. $2n=40$

- **Manifold benefits:**
 - One of the major legume crops grown worldwide
 - **Crop farmer:** Improved soil fertility
 - **Livestock farmer:** Soybean meal, quality animal feed of livestock, fish and poultry
 - **Industries:** All processed products
 - **Truck driver:** pricing of transporting large quantities of the crop
 - **Merchant:** profit from the grain
 - **Nutritionist:** Essential amino acids

Composition of Soybean Seed

- **Soybean oil**

Margarine, salad dressings and cooking oils, and industrial products such as plastics and biodiesel fuel

- **Soy protein**

various edible products

- **Soybean meal**

to produce animal feeds

- **Soy flour**

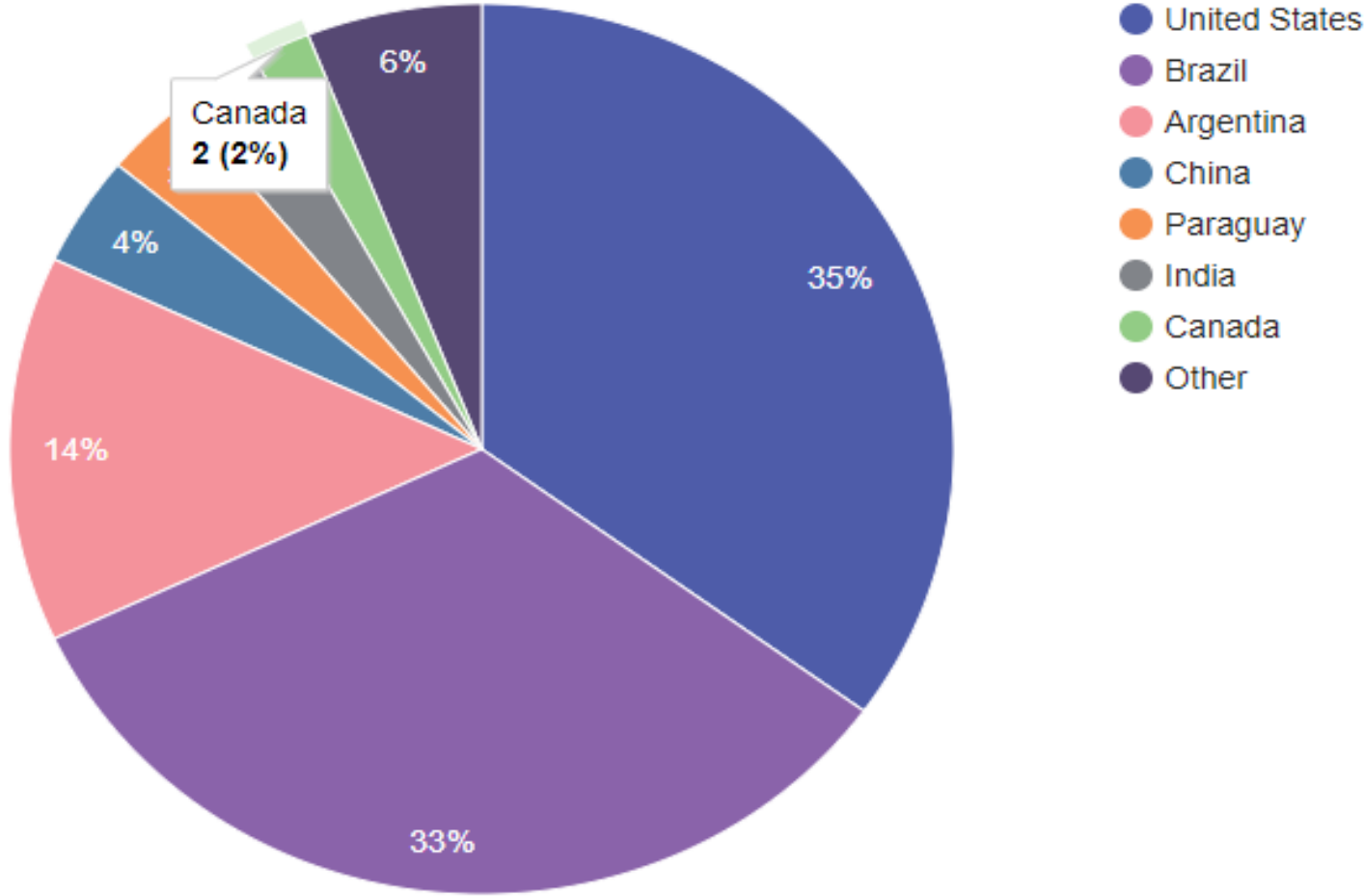
used in the commercial baking industry.

Soy hulls

are processed into fiber bran breads, cereal and snacks

World soybean production

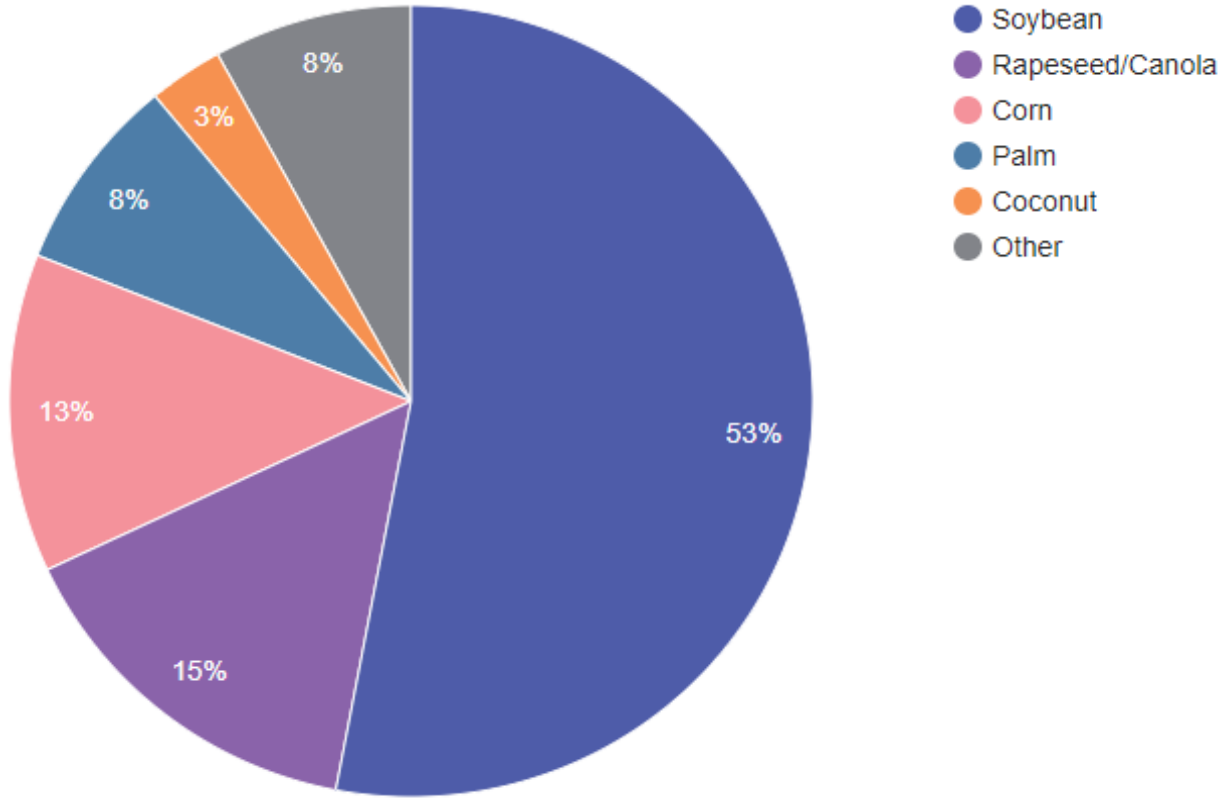
Source: USDA, FAS



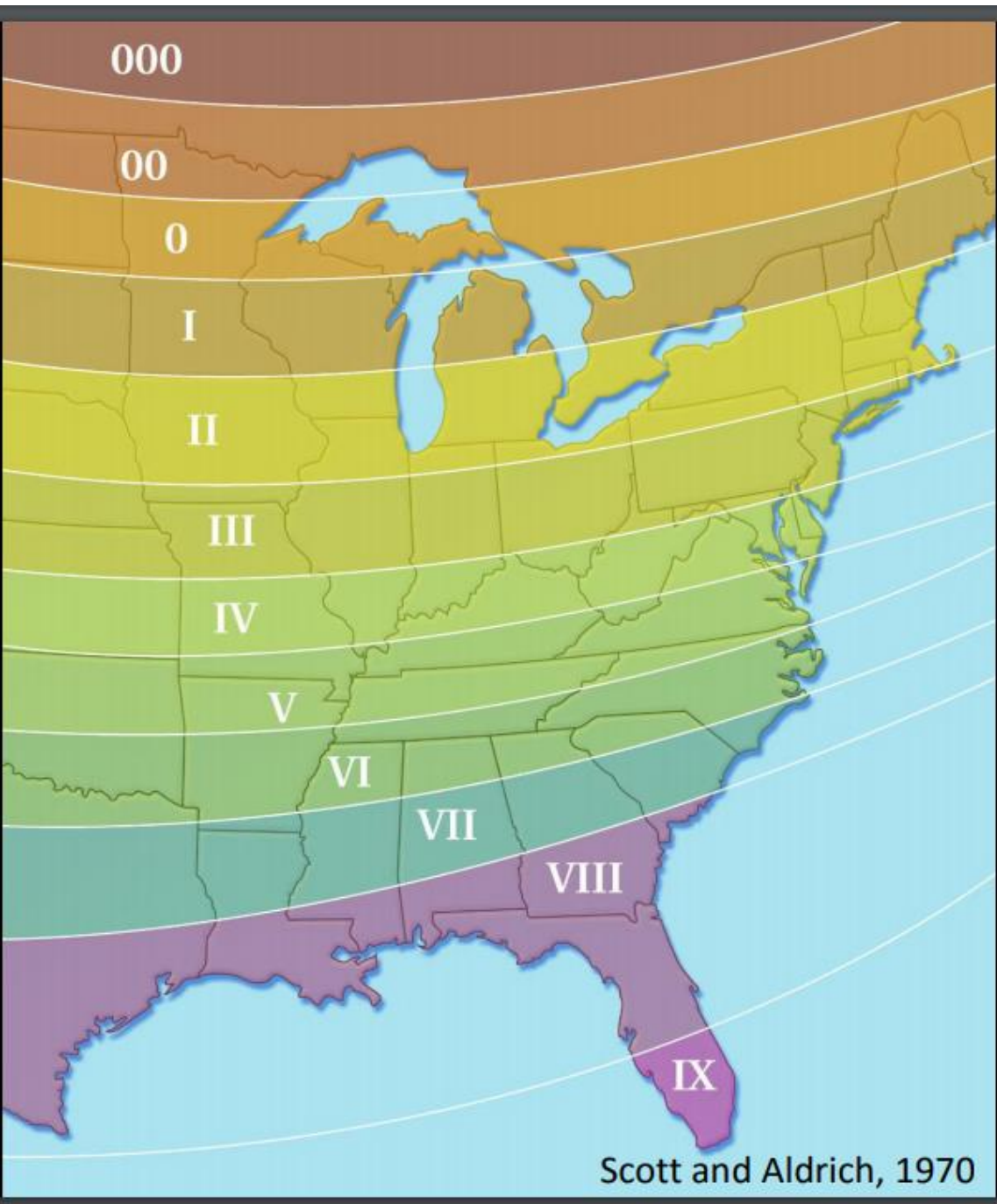
World Soybean Production 2017

Vegetable Oils consumption

Source: ERS, USDA



U.S. **Vegetable Oil Consumption** 2017



Maturity Groups: MGs

- A MG system to classify soybean genotypes is an efficient method for describing relative maturity on a broad environmental basis
- MG zones were developed to define adaptation of a soybean cultivar
- The MG is determined by abiotic factors:
 - Photoperiod
 - Temperature and
 - Other environmental factors

Research background

- Soybean production in Canada:
 - Eastern and Northern Québec and Ontario
 - The Canadian Prairies are suitable
- Slow expansion of the crop to these areas due to a lack of adapted very-early cultivars
- Western Canadian agriculture is in desperate need of nitrogen fixing crops
- The current rotation is highly focused on canola and wheat whose sustainability is massively compromised by
 - Blackleg/clubroot
 - Fusarium head blight

Background

- Variety trial coordinated by Saskatchewan Pulse Growers
- Evaluation for earliness and grain yield was conducted by CDC
- The varieties were derived from several companies
- Composed of Roundup Ready or Roundup Ready Extend types and maturity groups of 00 and 000
 - Evaluated over a total of 22 site-years in Saskatchewan
 - Between 2013 and 2018

Table 1: Locations and years of SB-WC variety trials conducted by CDC in 2013 to 2018

	Year					
Locations	2013	2014	2015	2016	2017	2018
Investigation						X
Kamsack			X	X	X	X
Preston	X	X	X	X	X	
Rosthern	X	X	X	X	X	X
SPG	X	X	X	X		
Yorkton	X	X				

Parameters measured

- Plant Height
- Days to flowering
- Days to maturity
- Percent leaf drop
- Percent lodging
- Percent stand
- Yield: Kg/ha

Quality: Protein and Oil content using NIT infratec nova

Hilum colour



Variability in: Days to flowering
Days to maturity
Plant Stand

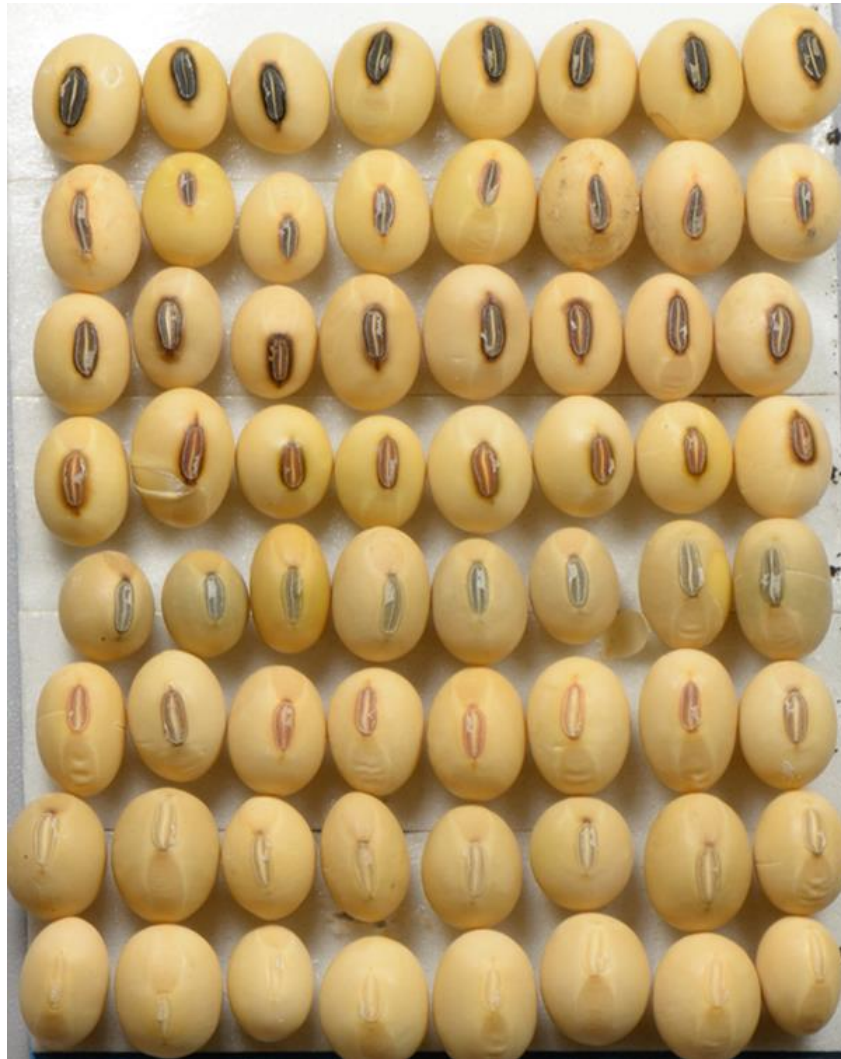
Single plant selection in the field



Selection based on percent green seed



Selection based on Hilum color



Black

Imperfect black

Dark brown

Brown

Grey

Light brown

Imperfect yellow

Yellow



NIT infratec nova



Dry weight basis:

% Oil

% Protein



Table 2. ANOVA for yield and phenology traits of soybean varieties grown in eleven locations in SK combined over three years 2015 to 2017. The experiments were conducted in RCBD with three replications.

Sources	Yield (kg/ha)	DTF	DTM	LD	LODG	YL
Genotype	***	***	***	***	***	***
Gen x Env	ns	ns	*	ns	**	ns
<u>Variance</u>						
Genotype	16,915.8	6.8	22.3	221.8	0.1	299.9
Gen x Loc	1,635.0	0.0	2.5	6.8	0.0	17.7
Residual	42,652.7	12.6	29.9	293.1	0.2	293.8
H²	0.84	0.76	0.90	0.89	0.73	0.89
Grand Mean	1,160.0	51.9	119.8	56.9	1.3	45.8
LSD	345.9	2.2	3.7	20.6	0.1	12.9
CV	17.8	6.9	4.6	30.1	32.7	37.4
Reps	3	3	3	3	3	3
Environments	5	2	5	4	4	3

***, ** and * represent significant difference at $P \leq 0.001$, 0.01 and 0.05 respectively and ns = non-significant. H^2 = Broad sense heritability

Table 3. Anova for yield and phenology traits of soybean varieties grown in multiple locations in Saskatchewan combined over three years 2013, 14 and 18. The experiments were conducted in 12 x 5 rectangular lattice design with three replications.

Sources	Yield (kg/ha)	DTF	PLHT	DTM	LD	LODG	YL	%Oil	%Protein
Genotype	***	**	***	ns	***	***	***	***	***
Gen x Env	***	***	ns	***	***	***	***	***	*
<u>Variance</u>									
Genotype	80,865.9	7.9	32.2	2.1	233.7	0.0	112.6	0.6	0.2
Gen x Loc	35,253.3	2.5	0.0	9.9	105.1	0.0	63.0	0.1	0.1
Residual	52,409.8	3.9	31.4	42.3	193.0	0.1	219.9	0.1	0.8
H²	0.90	0.80	0.90	0.30	0.89	0.63	0.77	0.96	0.71
Grand Mean	1,752.4	49.0	68.7	115.6	47.7	1.2	56.1	15.7	31.8
LSD	1,866.6	3.5	7.5	3.0	51.3	0.1	6.6	0.6	0.9
CV	13.1	4.0	8.2	5.6	29.1	26.4	26.4	2.3	2.8
Reps	3	3	3	3	3	3	3	3	3
Environments	6	2	3	5	6	5	4	4	4

Figure 1. Genetic correlations among the variables in location in 2013. In the figure, Percent of yellow leaves (YL) and percent leaf drop (LD) overlapped

- **The inverse relationship between:**

YL, LD and DTF and DTM.

- **Strong and positive correlation between**

DTF and DTM

Percent leaf drop (LD) and percent yellow leaf (YL)

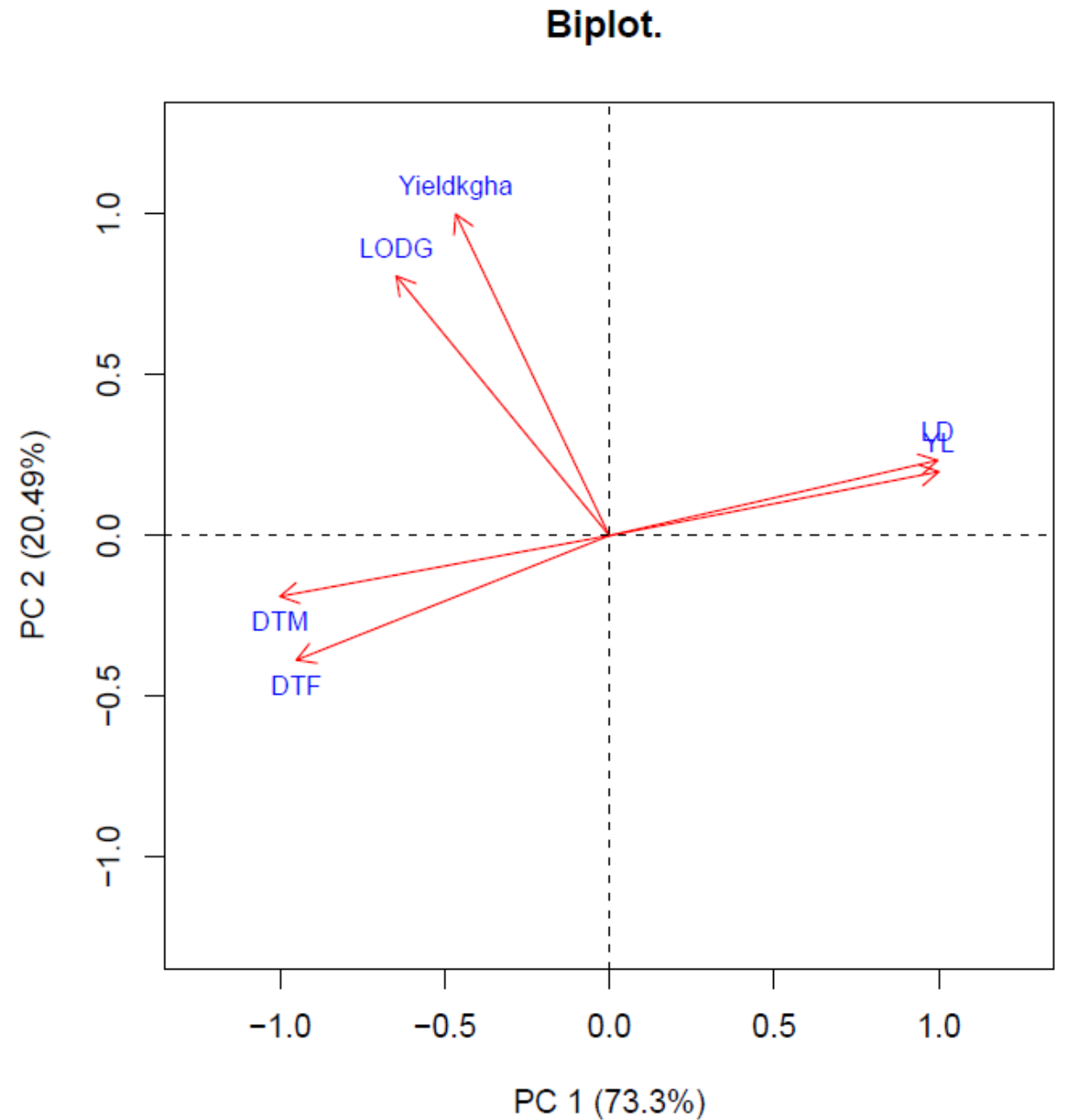


Figure 2. Genetic correlations among the variables location in 2018

There was an inverse relationship between

DTF and LD

LODG and protein content

Yield and Protein

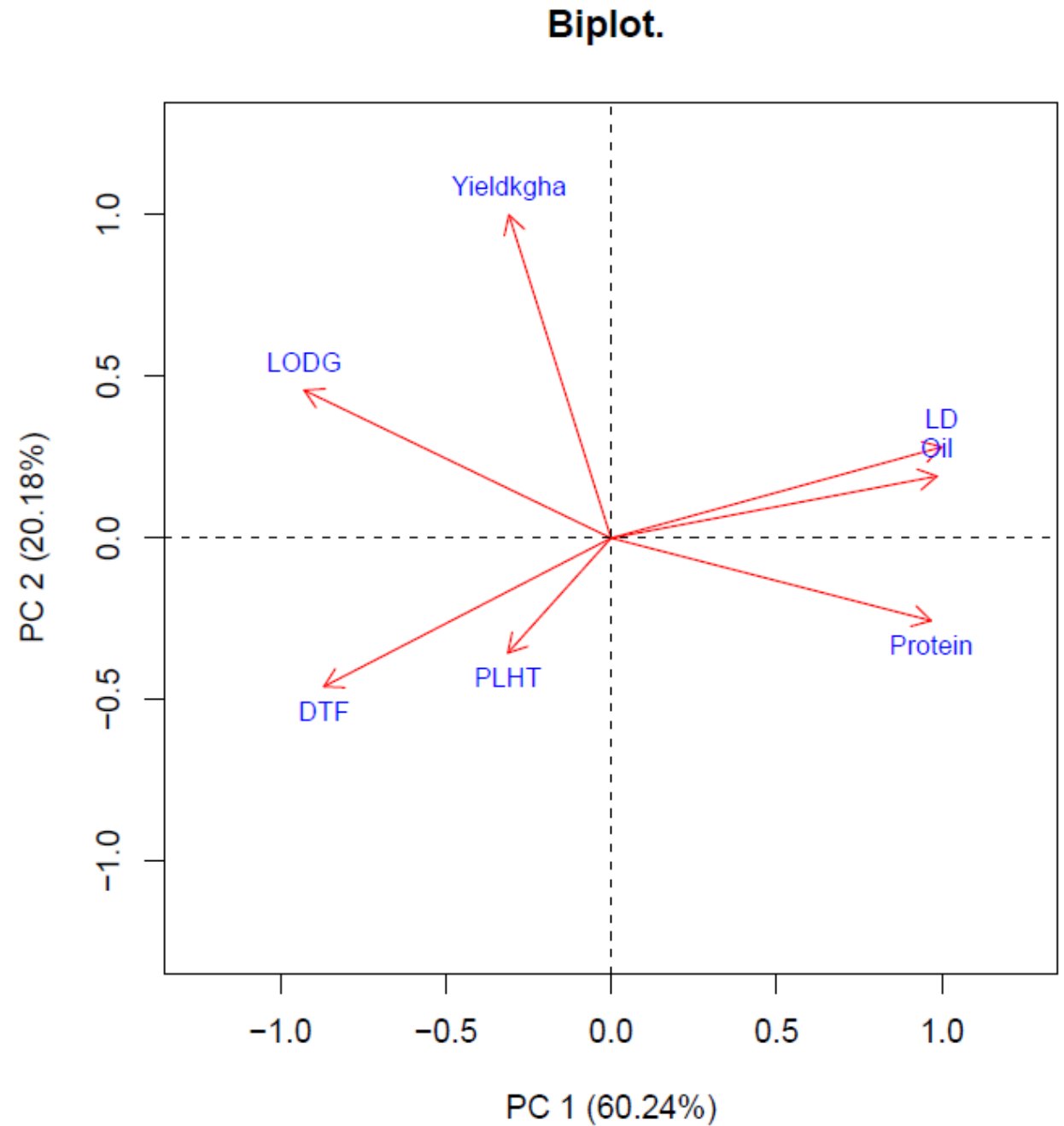
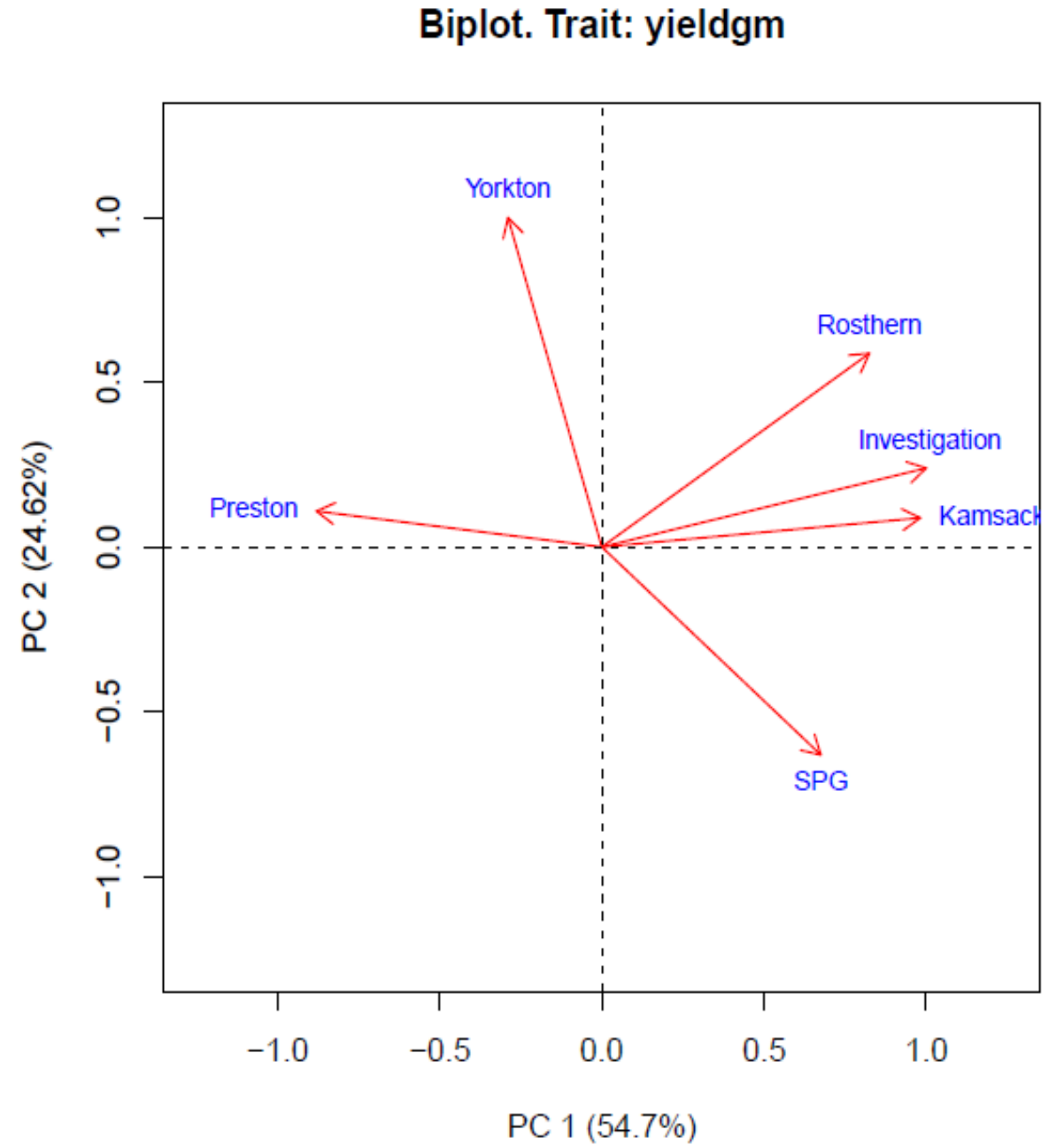


Figure 3. Correlations among the test locations for yield (gm/plot) of soybean varieties evaluated over multiple site-years 2013, 2014 and 2018



Selection criteria

- Early flowering and maturing under field conditions
- Stand percent (vigor)
- Lodging resistance
- Yield (kg/ha)
- Seed quality traits: hilum color, percent green seeds
- Quality traits: dry weight basis
 - Protein
 - Oil content

Stable (yield) varieties identified in the study

- TH33003R2Y*
- NSC LEROY RR2Y* provide genetic basis for soybean adaptation and expansion in SK
- NSC RESTON RR2Y*
- NSC WATSON RR2Y

*Are being used as checks in soybean breeding program

- Are also popular varieties in Western MB and Eastern SK
- Stable yield under a wide range of environmental conditions.
- Semi-bush growth habit for good canopy closure and consistent and competitive yields

Germplasm source for future research breeding work

- Targeting promising early maturing and/or high yielding
- Publicly available soybean germplasm from public breeding programs:
 - University of Guelph
 - AAFC-Ottawa
 - University of Minnesota
 - USDA, and other international seed banks

Germplasm accessions

- Plant Gene Resources of Canada Agriculture and Agri-Food Canada, Saskatoon
 - 10 -20 lines based on earliness and non-shattering
 - Summer crossing block



Thank You!