Expanding Local Markets Through Evaluating Sensory Characteristics and Agronomic Performance of Flint Corn Varieties.

NORTHEAST SARE
Sustainable Agriculture Research & Education

THE UNIVERSITY OF VERMONT EXTENSION

Northwest Crops and Soils Program

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We have a major project funded by SARE to conduct agronomy and innovative sensory research on varieties of flint corn to help expand their local markets. The key questions we want to answer include:

- Which flint corn varieties are best suited for growing in the Northeast?
- Are the production practices (i.e. populations) for flint corn different than dent corn?
- **What consumer food products are each flint corn variety suitable for producing?**
- **Which flint corn varieties result in food products that best meet consumer aroma and flavor preferences?**
- **What metrics can be used at the farm-level to predict processing performance and suitability in addition to sensory quality of end products?**

We used objective descriptive sensory analysis to answer the questions highlighted in red.

The Flavor Profile Method is the oldest and most widely accepted descriptive method of sensory analysis. It provides a complete description of the sensory attributes of products (e.g., aroma, flavor, texture, mouthfeel, etc.).

FLAVOR PROFILE DEFINITIONS

Balance = degree of harmony
Fullness = degree of complexity
(measured in both aroma and flavor)

1 = None
3 = Slight
5 = Moderate
7 = Strong

CHARACTER NOTES: Aromatics, basic tastes, and feeling factors, which are listed in order of appearance along with a measurement of strength in both aroma (by nose) and flavor (by mouth)

INTENSITY SCALE:
1 = None
3 = Slight
5 = Moderate
7 = Strong

AFTERTASTE: Measurement of all sensation remaining one minute after swallowing.

The primary driver in developing the Flavor Profile Method was the consumer. It was recognized early on that an overall measurement of the sensory experience was critical to understanding consumer preferences.

What is objective Descriptive Sensory Analysis (DSA)?

- Uses trained tasters
- Objective sensory methodology:
  - **The Flavor Profile Method**
  - Total Intensity of Aroma and Flavor
  - Profile Attribute Analysis
- Appropriate experimental design (good science)

The UVM Extension Northwest Crops and Soils Program has a properly trained DSA group that was used to objectively assess the flint corn samples and products included in this study.

We used the sensory directed product development process to generate data to answer the project questions.

- Ingredient screening (flint corn samples) using modified flavor profile – Profile Attribute Analysis (PAA)
- Final product sensory testing using PAA:
  - Corn Tortillas
  - Corn Chips

The corn products were produced by All Souls Tortilleria using a standard recipe and process.

Arthur D. Little, the pioneer in developing DSA methods, also developed the Flavor Leadership Criteria.

Flavor Leadership Criteria	
1 **Aromatic Identity**	◆ Immediate impact of identifying flavor
2 **Amplitude**	◆ Rapid development of balanced, full flavor
3 **Mouthfeel**	◆ Compatible mouthfeel factors
4 **Off-notes**	◆ No “off” flavors.
5 **Aftertaste**	◆ Short clean aftertaste

These criteria help us predict market leadership by measuring sensory attributes known to drive consumer acceptance.

Corn Tortilla Profile Attribute Analysis (PAA) Scoresheet for flavor:

ATTRIBUTES	*Intensity Scale* 1 2 3 4 5 6 7	
Total Intensity of Aroma (TIA)	None	Strong
Balance	Unblended	Blended
Fullness	Thin	Full
Toasted corn	None	Strong
Other corn	None	Strong
Other grain	None	Strong
Green, grassy	None	Strong
Sweet	None	Strong
Sour	None	Strong
Salty	None	Strong
Mouthfeel	None	Strong
Others	None	Strong
Aftertaste	None	Strong

1 = None
2 = Very Slight
3 = Slight
4 = Slight-to-Moderate
5 = Moderate
6 = Moderate-to-Strong
7 = Strong

Corn Tortilla Profile Attribute Analysis (PAA) Scoresheet for texture:

ATTRIBUTES	*SCALE* 1 2 3 4 5 6 7	
Hardness	Soft ⟷	Hard
Crumble	Not Crumbly ⟷	Crumbly
Grain size	Small ⟷	Large
Moistness	Not Moist ⟷	Very Moist

Corn Chip Profile Attribute Analysis (PAA) Scoresheet for flavor:

ATTRIBUTES	*Intensity Scale* 1 2 3 4 5 6 7	
Total Intensity of Aroma (TIA)	None	Strong
Balance	Unblended	Blended
Fullness	Thin	Full
Toasted corn	None	Strong
Other corn	None	Strong
Other grain	None	Strong
Fresh Fried Oil	None	Strong
Oxidized, Rancid Oil	None	Strong
Sweet	None	Strong
Sour	None	Strong
Salty	None	Strong

1 = None
2 = Very Slight
3 = Slight
4 = Slight-to-Moderate
5 = Moderate
6 = Moderate-to-Strong
7 = Strong

Corn Chip Profile Attribute Analysis (PAA) Scoresheet for flavor: (continued)

Intensity Scale

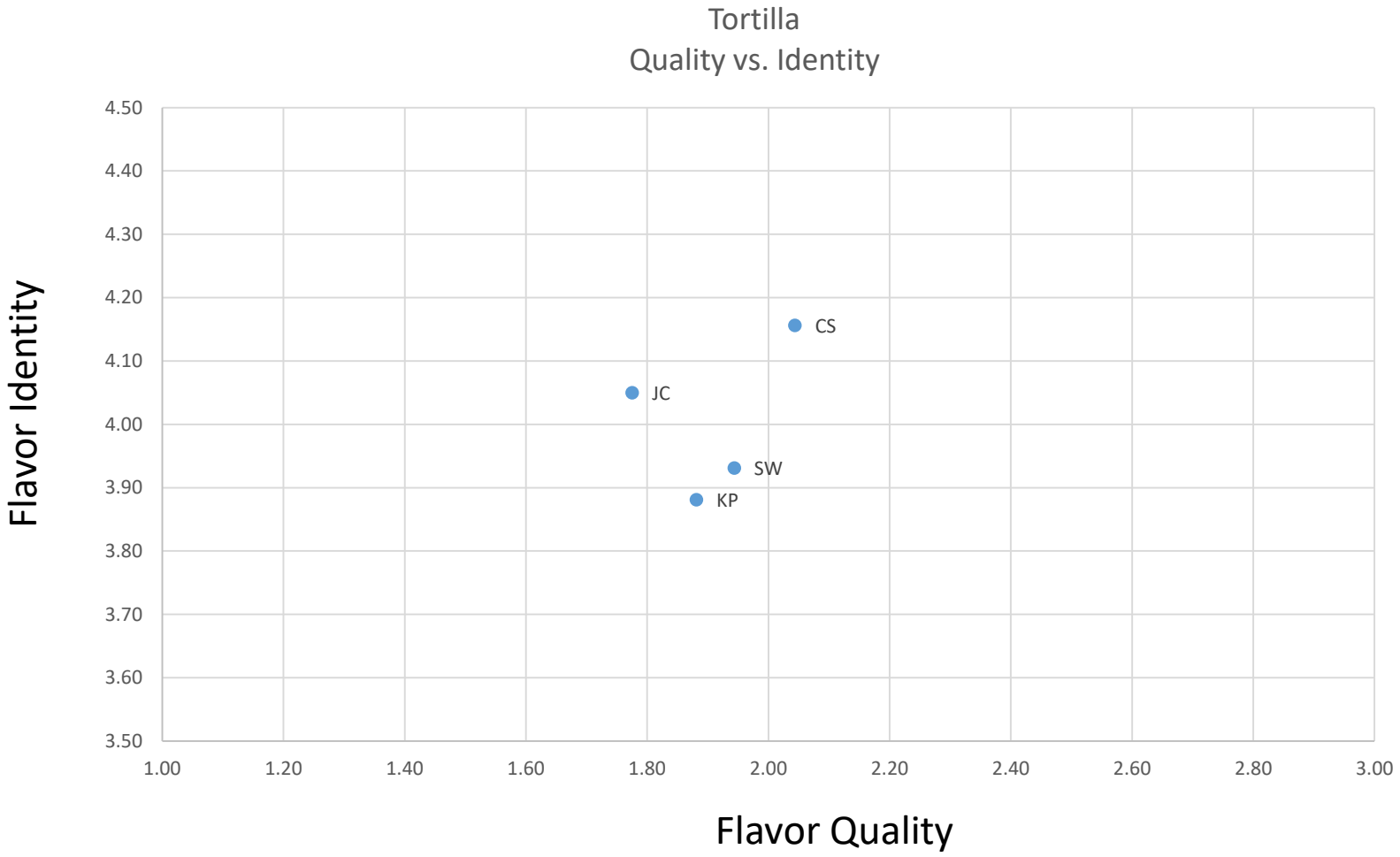
ATTRIBUTES	1	2	3	4	5	6	7
Oily/greasy Mouthfeel	None						Strong
Dry Mouthfeel	None						Strong
Astringent Mouthfeel	None						Strong
Others	None						Strong
Aftertaste	None						Strong

1 = None
2 = Very Slight
3 = Slight
4 = Slight-to-Moderate
5 = Moderate
6 = Moderate-to-Strong
7 = Strong

Corn Chip Profile Attribute Analysis (PAA) Scoresheet for texture:

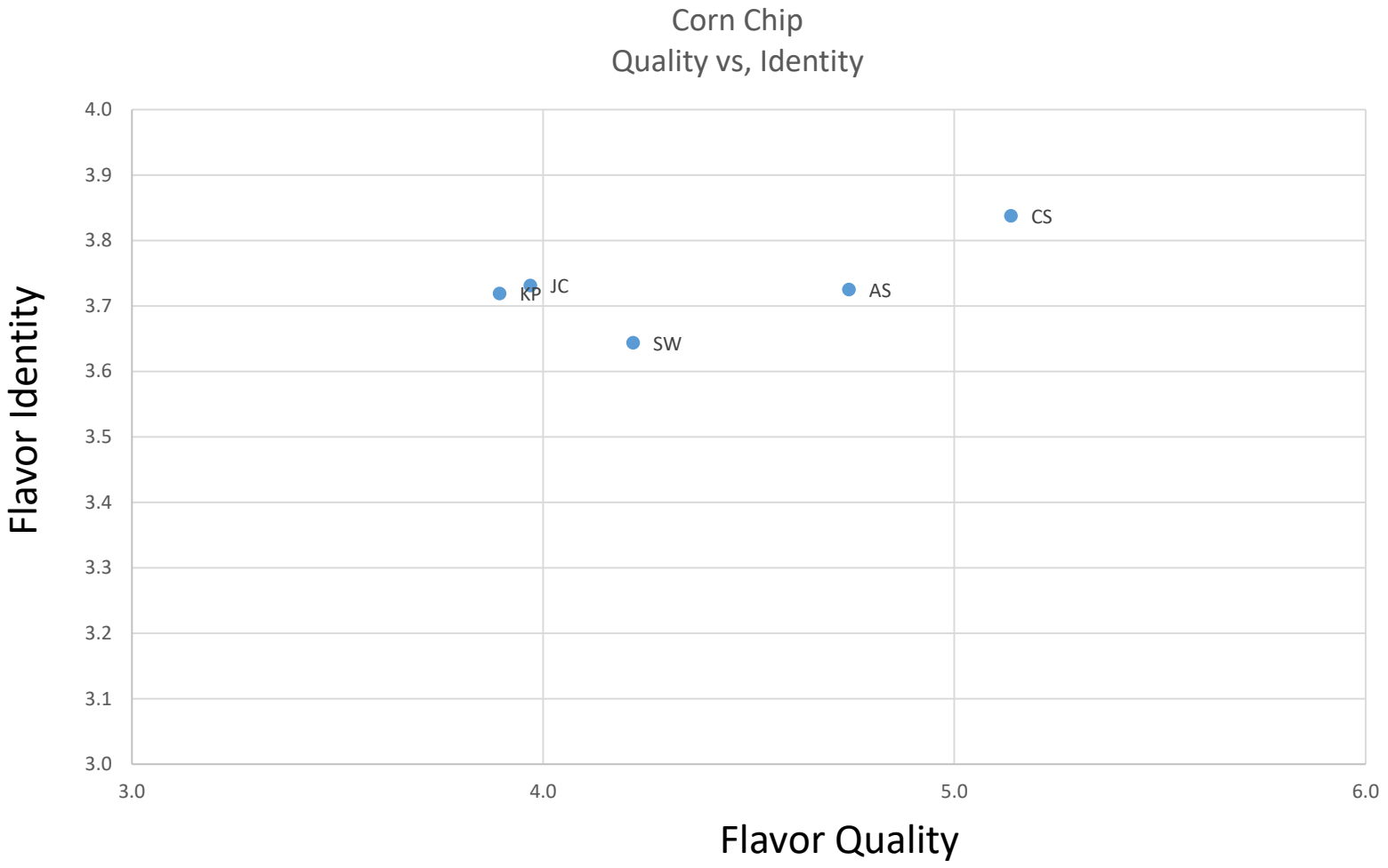
ATTRIBUTES	*SCALE* 1 2 3 4 5 6 7	
Hardness	Soft ⟷	Hard
Crispiness	Not Crispy ⟷	Crispy
Crumble	Not Crumbly ⟷	Crumbly
Grain size	Small ⟷	Large
Oily/greasy	Not Oily ⟷	Greasy

Corn Tortilla: Flavor Quality vs. Flavor Identity



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Flavor Identity



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White
AS	=	All Souls

Flint Corn Grits Data

Profile Attribute Analysis (PAA) average data for corn grits – Flavor:

	Corn Type					
Sample	TIA	Raw Corn	Cooked Corn	Canned	Creamed Corn	Sweet Corn
CS	3.8	1.9	3.1	2.1	2.4	2.0
JC	3.5	1.9	2.4	1.8	2.2	1.6
KP	3.7	2.2	3.3	2.2	2.1	1.8
SW	3.4	2.2	2.8	2.0	2.2	1.7

Legend

CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

	Grain Type				Sulfidy			
Sample	Starchy Grain	Cooked Grain	Cream of Wheat	Flour	Paper/cdb dy/woody	Vegetable/ Peas	Odd/Rubb ery	Brothy
CS	3.4	3.0	3.0	2.1	2.5	2.4	1.3	2.7
JC	3.5	2.8	2.8	1.8	2.9	2.2	1.5	2.5
KP	3.2	2.8	2.5	2.1	2.8	2.5	1.5	2.7
SW	3.4	2.7	3.3	2.0	2.6	2.5	1.6	2.7

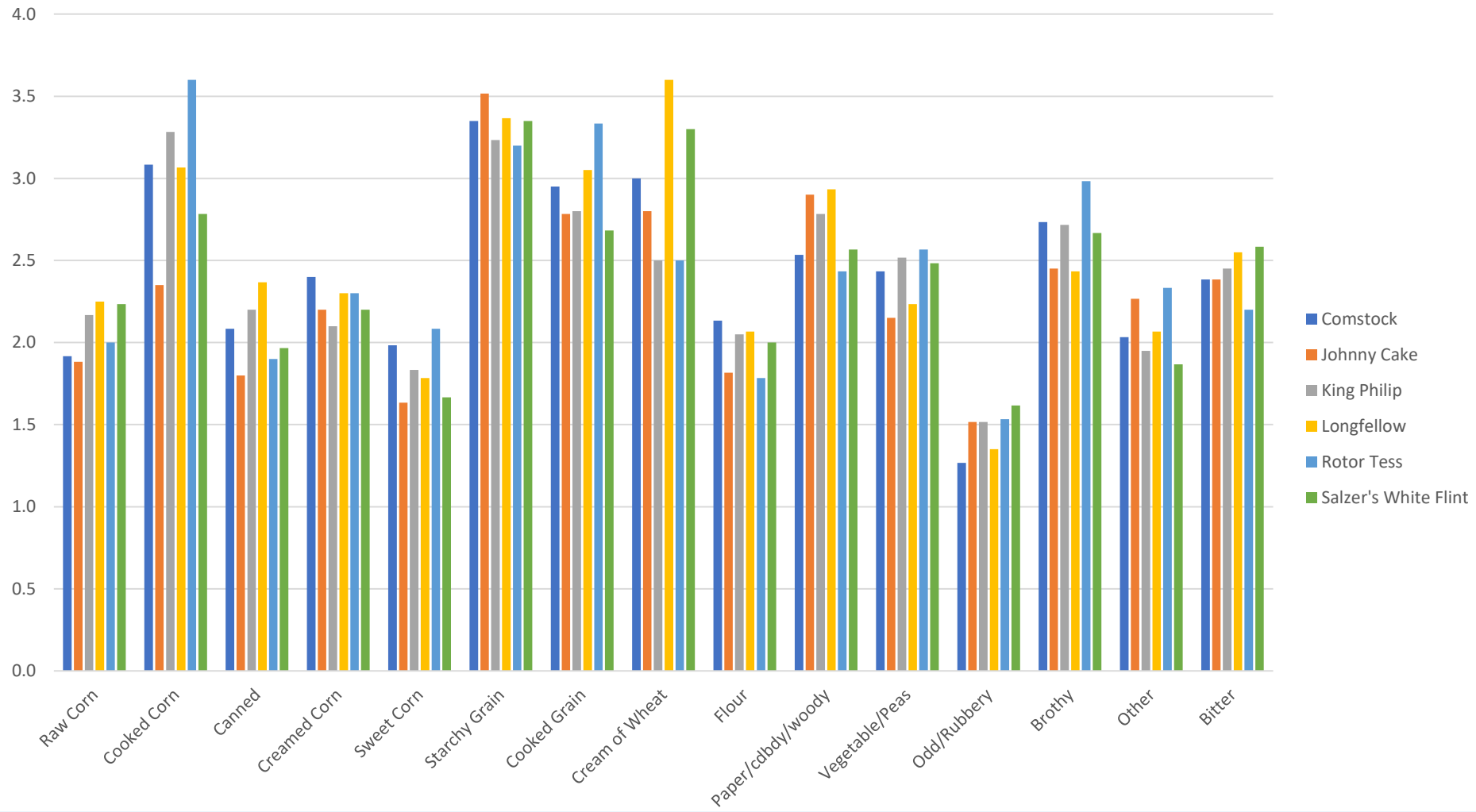
Sample	Other	Bitter
CS	2.0	2.4
JC	2.3	2.4
KP	2.0	2.5
SW	1.9	2.6

Profile Attribute Analysis (PAA) average data for corn grits – Texture:

	Texture	
Sample	P1	P2
CS	5.0	4.3
JC	4.4	4.4
KP	4.9	4.4
SW	4.3	3.7

Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn grits descriptive comparison.



Flint Corn Tortilla Data

Profile Attribute Analysis (PAA) average data for corn tortillas – Flavor:

Sample	Total Intensity of Aroma	Balance	Fullness	Toasted Corn	Other Corn	Other Grain	Green Grassy	Sweet	Sour	Salt	Mouthfeel	Others	Aftertaste
CS	3.5	3.4	3.6	3.3	3.5	3.0	3.1	2.6	2.4	1.8	3.9	2.5	3.6
JC	3.8	3.6	3.3	3.4	3.8	2.8	2.8	2.6	2.9	2.0	3.4	3.0	3.0
KP	3.8	3.3	3.1	3.3	3.0	3.5	2.6	2.8	2.6	2.0	3.5	2.9	3.0
SW	3.9	3.5	2.9	3.5	3.6	2.9	2.5	2.8	2.4	2.0	4.1	2.5	3.0

Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White
AS	=	All Souls

Profile Attribute Analysis (PAA) average data for corn tortillas – Texture:

Sample	Hardness	Crumbly	Grain Size	Moisture
CS	3.3	2.3	3.1	3.1
JC	2.9	1.9	3.5	3.1
KP	3.4	2.3	2.8	3.0
SW	3.4	2.4	2.9	2.8

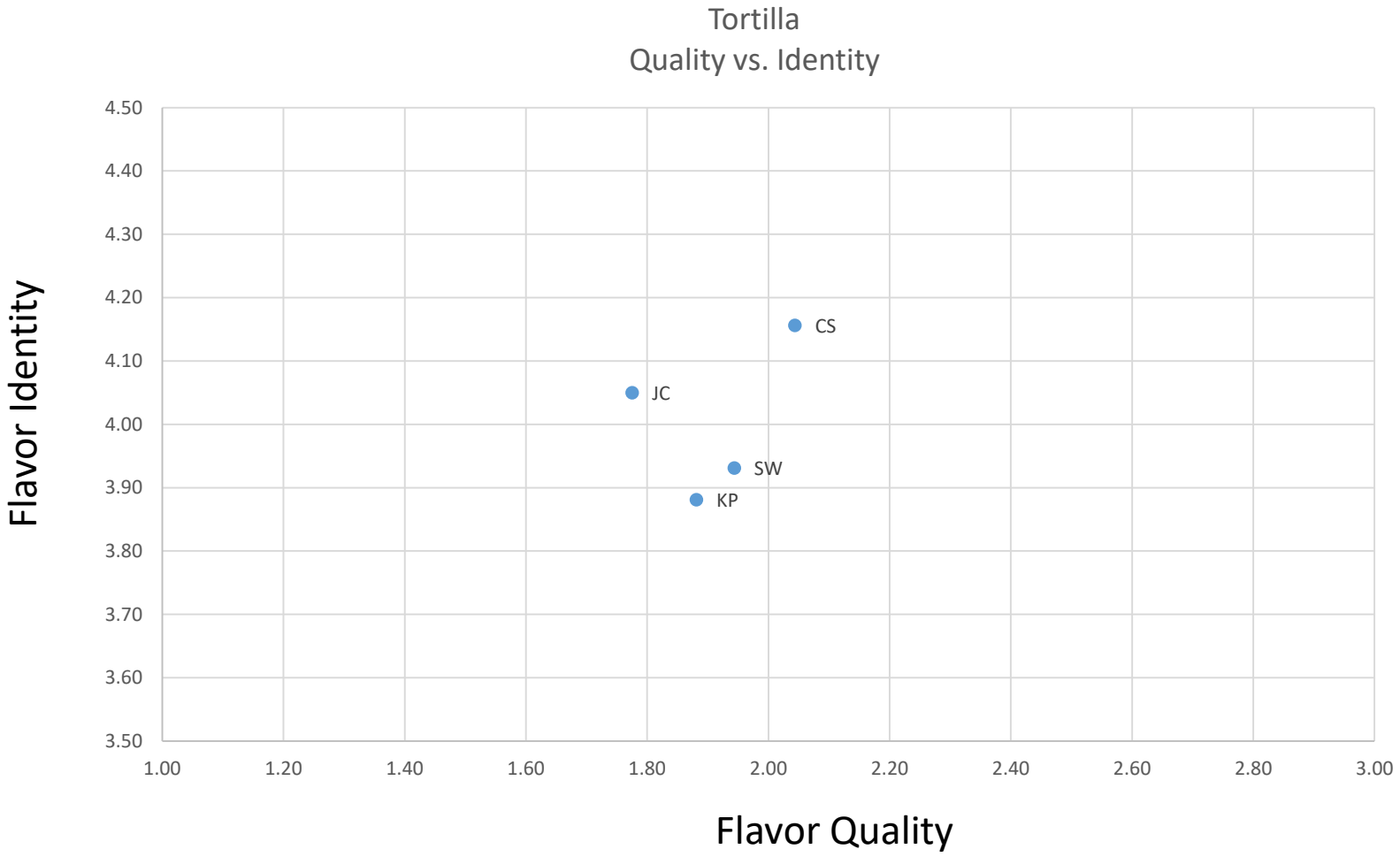
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White
AS	=	All Souls

Profile Attribute Analysis (PAA) summary Indices for corn tortillas:

Sample	"Quality"	"Identify"	"Texture"
CS	2.0	4.2	0.2
JC	1.8	4.1	0.2
KP	1.9	3.9	0.2
SW	1.9	3.9	0.1

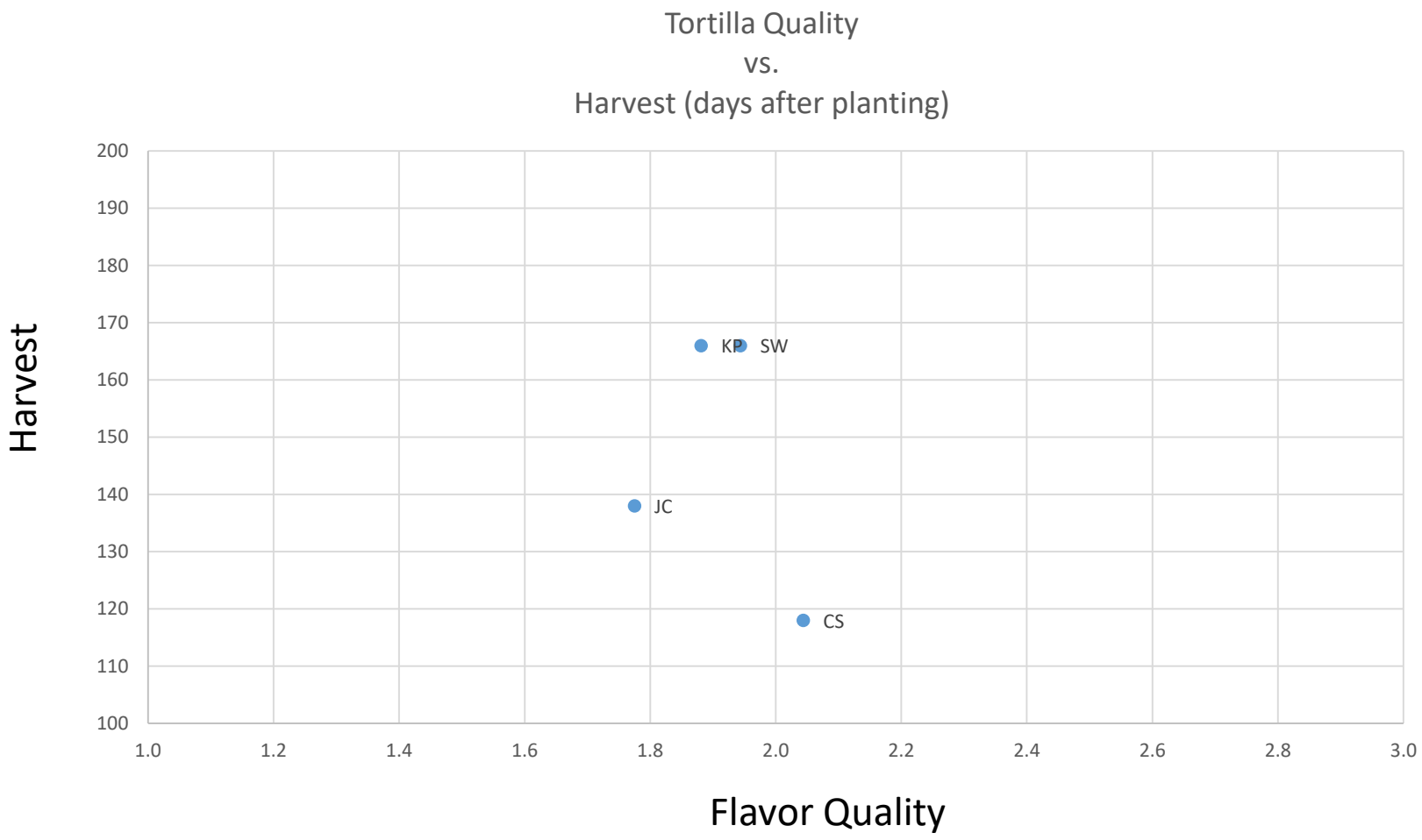
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Flavor Identity



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Harvest (days after planting)



Legend		
CS	=	Comstock Family
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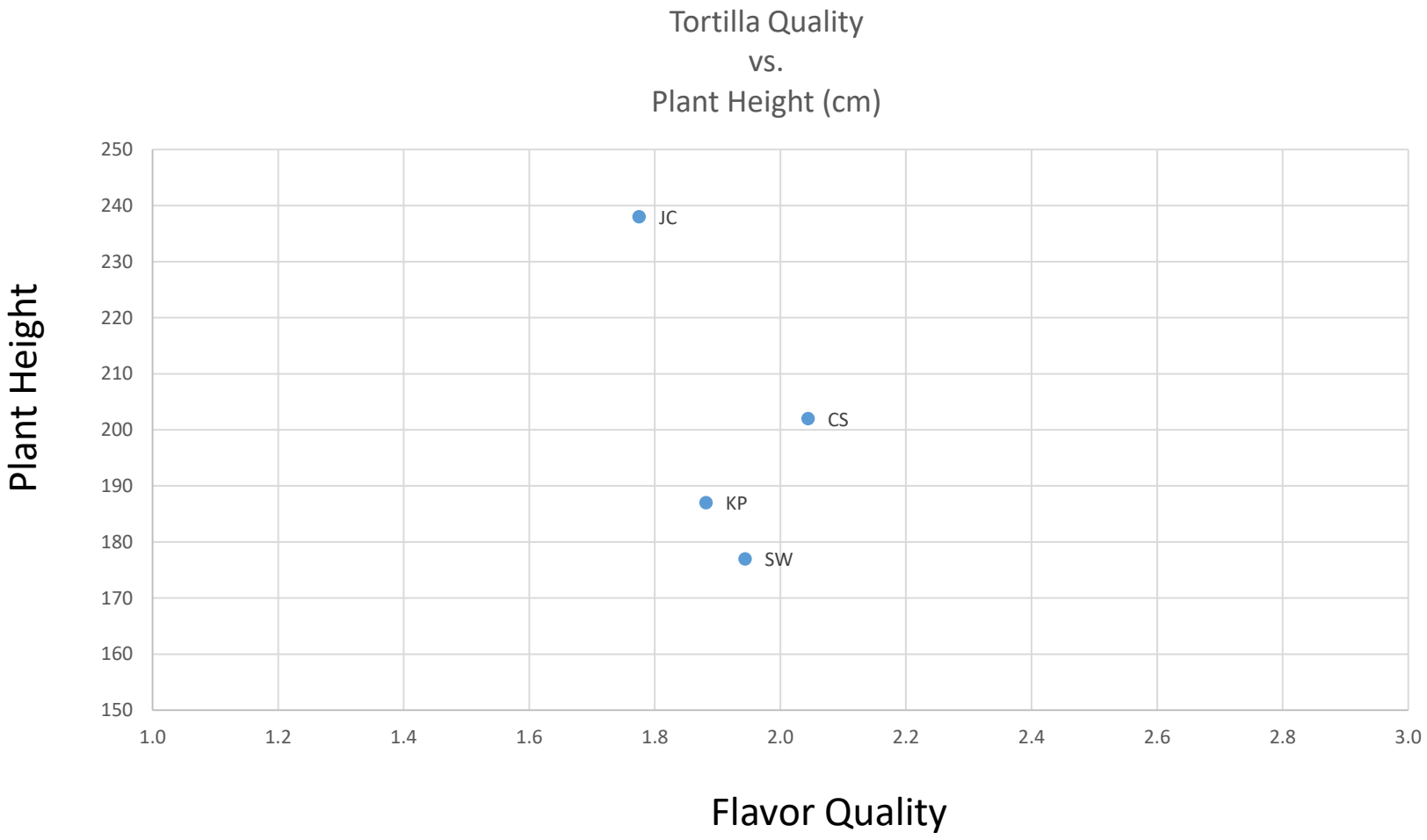
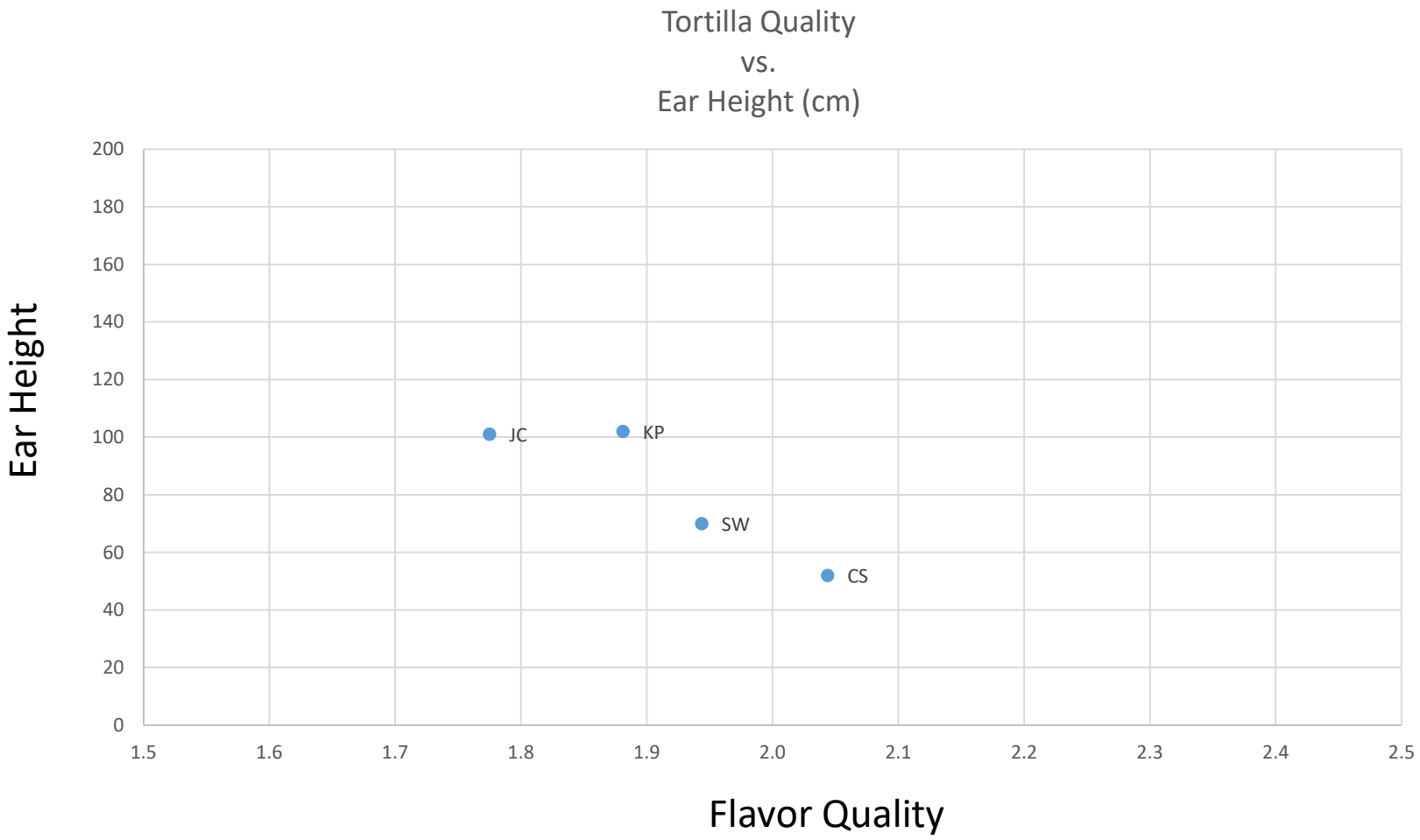
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Plant Height (measured in cm)



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Ear Height (measured in cm)

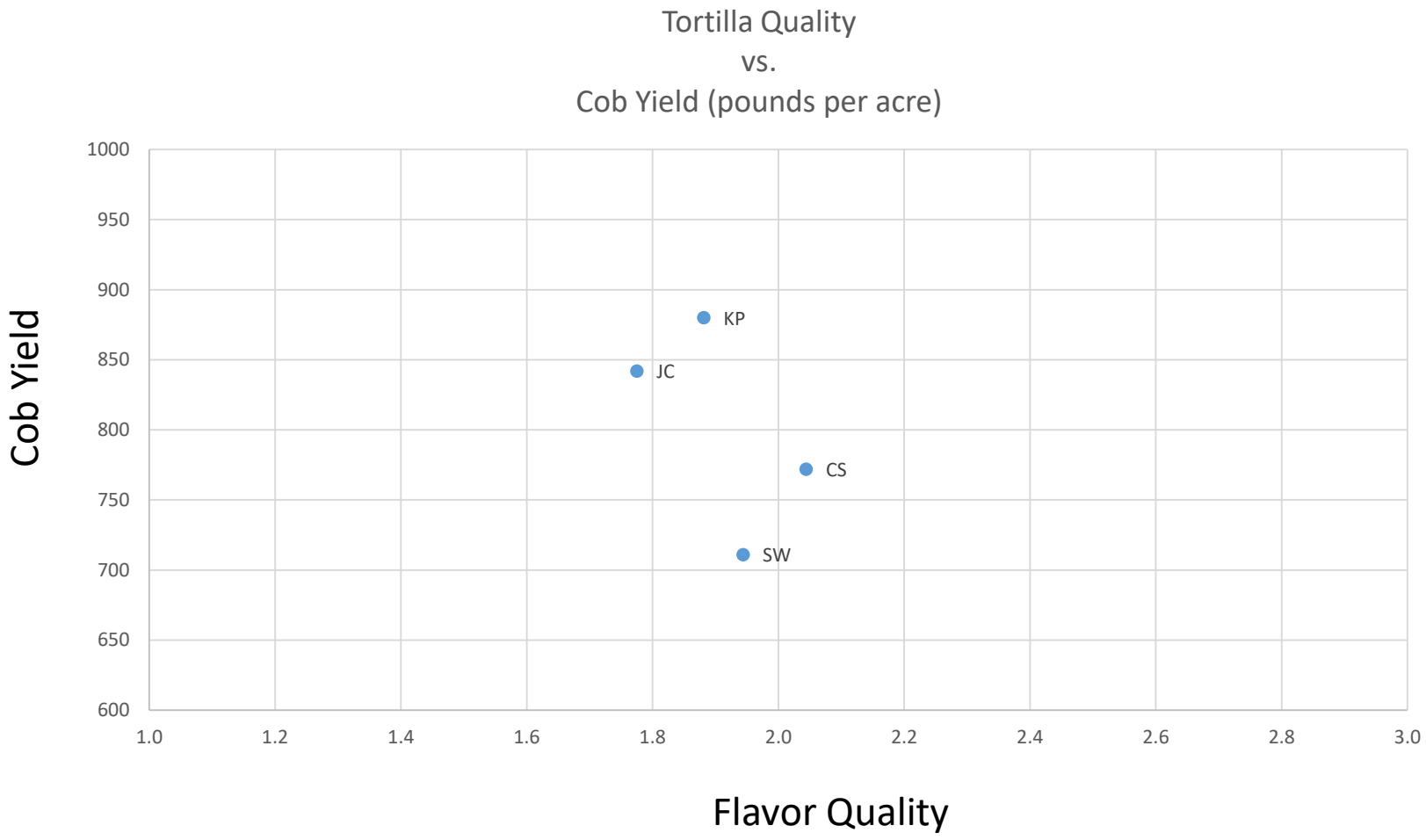


Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Population (plants per acre)

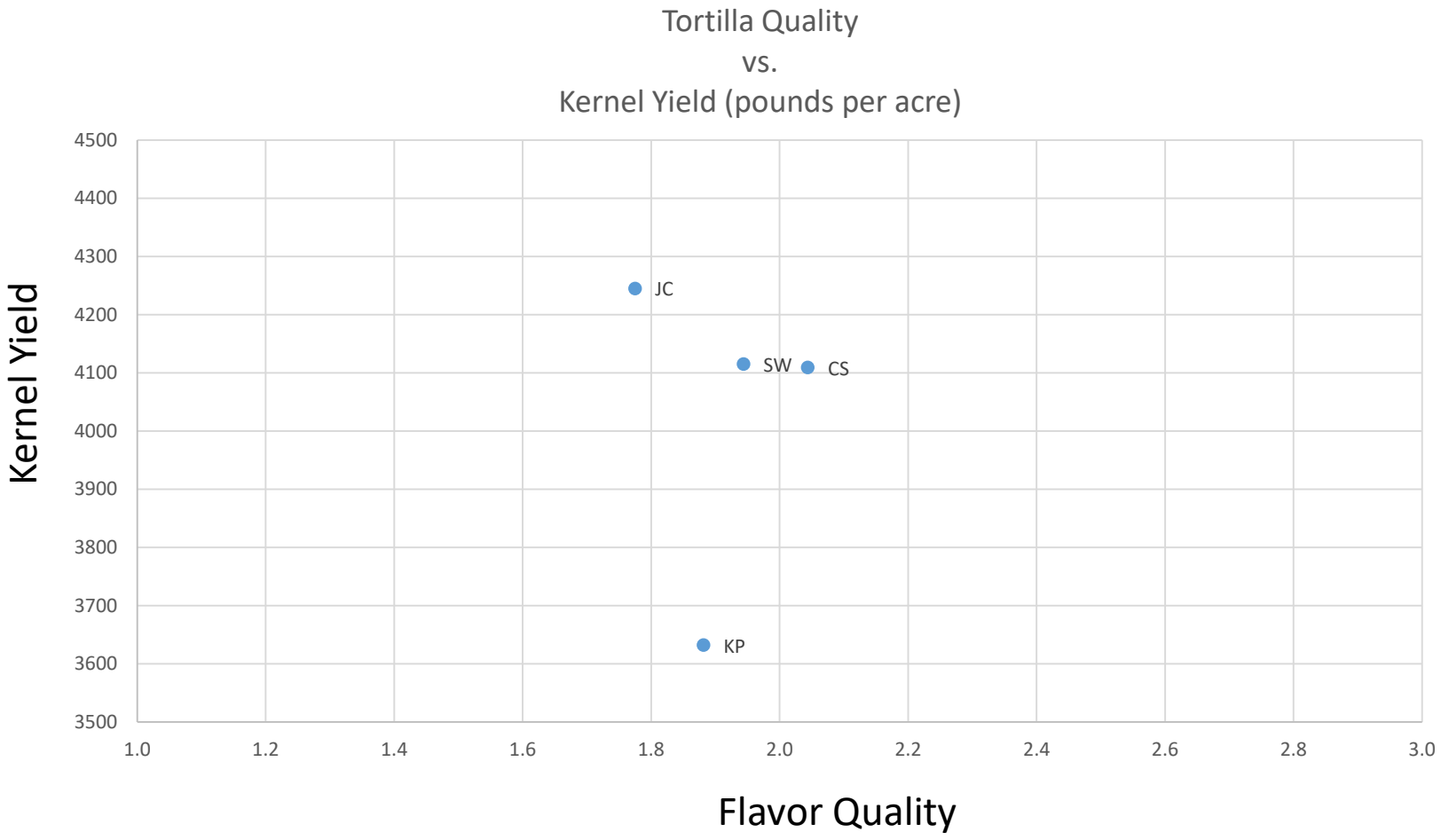
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Cob Yield (pounds per acre)



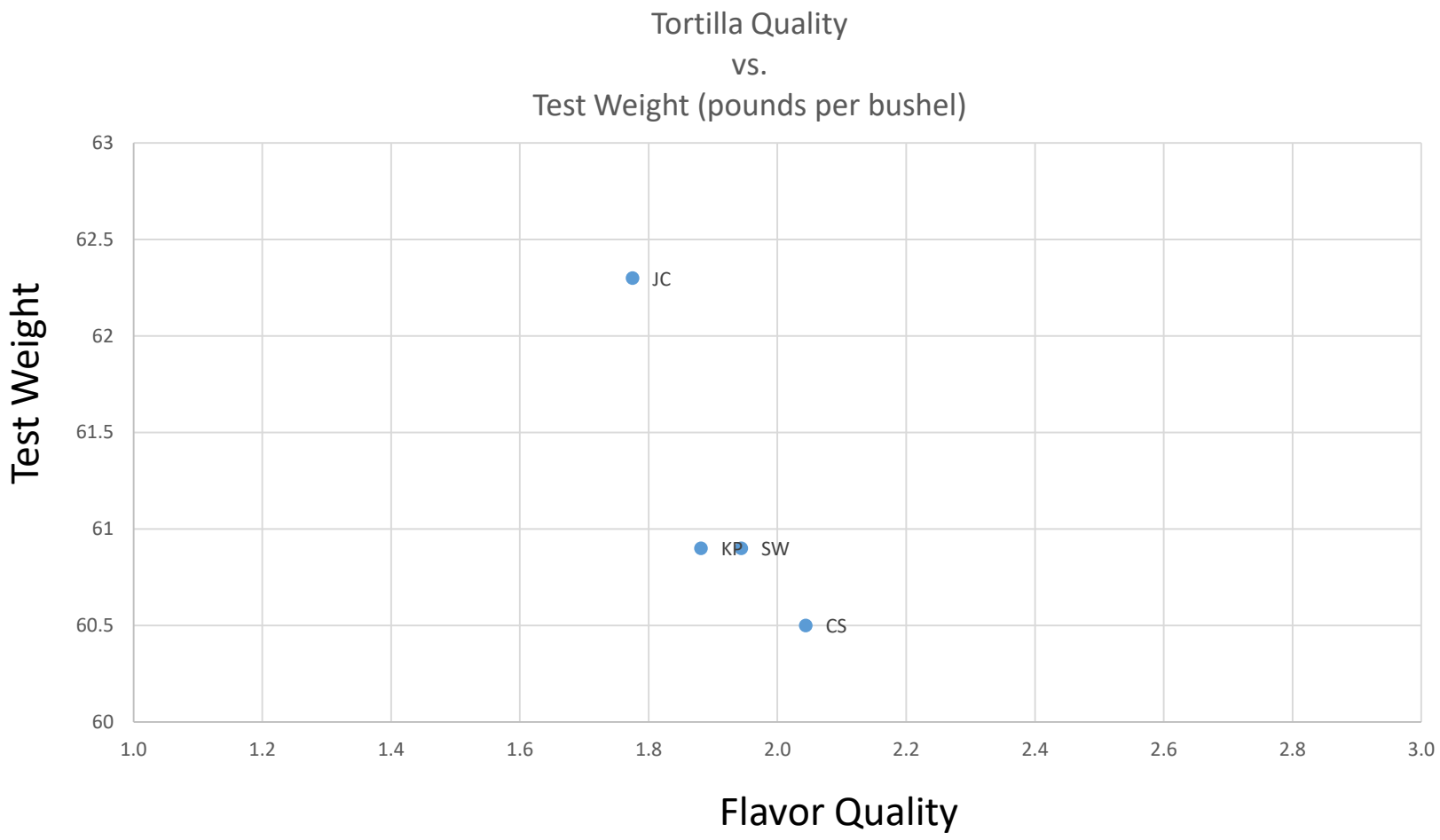
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Kernel Yield (pounds per acre)



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Tortilla: Flavor Quality vs. Test Weight (pounds per bushel)



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Flint Corn Chip Data

Profile Attribute Analysis (PAA) average data for corn chips – Flavor:

Sample	Total Intensity of Aroma	Balance	Fullness	Toasted Corn	Other Corn	Other Grain	Fresh Fried Oil	Oxidized Oil	Sweet
AS	3.8	3.4	3.5	3.9	2.6	2.8	3.5	3.0	2.6
CS	3.4	3.4	3.5	3.4	3.4	3.0	3.1	3.1	2.6
JC	3.6	3.6	3.1	3.3	3.5	2.9	3.3	2.6	2.8
KP	3.9	3.5	2.9	3.4	3.8	2.8	3.5	2.4	2.8
SW	3.4	3.8	3.4	3.6	2.5	3.1	3.3	2.8	3.0

Sample	Sour	Salty	Oily/Greasy Mouthfeel	Dry Mouthfeel	Astringent Mouthfeel	Others	Aftertaste
AS	2.4	3.5	4.0	3.6	2.4	2.9	3.8
CS	2.9	3.4	4.4	3.8	2.6	2.9	4.3
JC	2.6	3.5	3.5	3.9	2.9	2.5	3.4
KP	2.4	3.1	3.0	4.0	2.5	2.6	3.8
SW	2.6	3.4	3.4	3.6	2.9	2.8	3.5

Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White
AS	=	All Souls

Profile Attribute Analysis (PAA) average data for corn chips – Texture:

Sample	Hardness	Crispiness	Crumbly	Grain Size	Oily/Greasy
AS	3.6	4.6	3.8	3.3	3.9
CS	5.0	3.9	4.0	3.4	4.0
JC	4.8	4.0	3.4	3.6	3.4
KP	4.6	4.1	3.0	3.5	3.0
SW	4.9	3.9	3.6	3.6	3.1

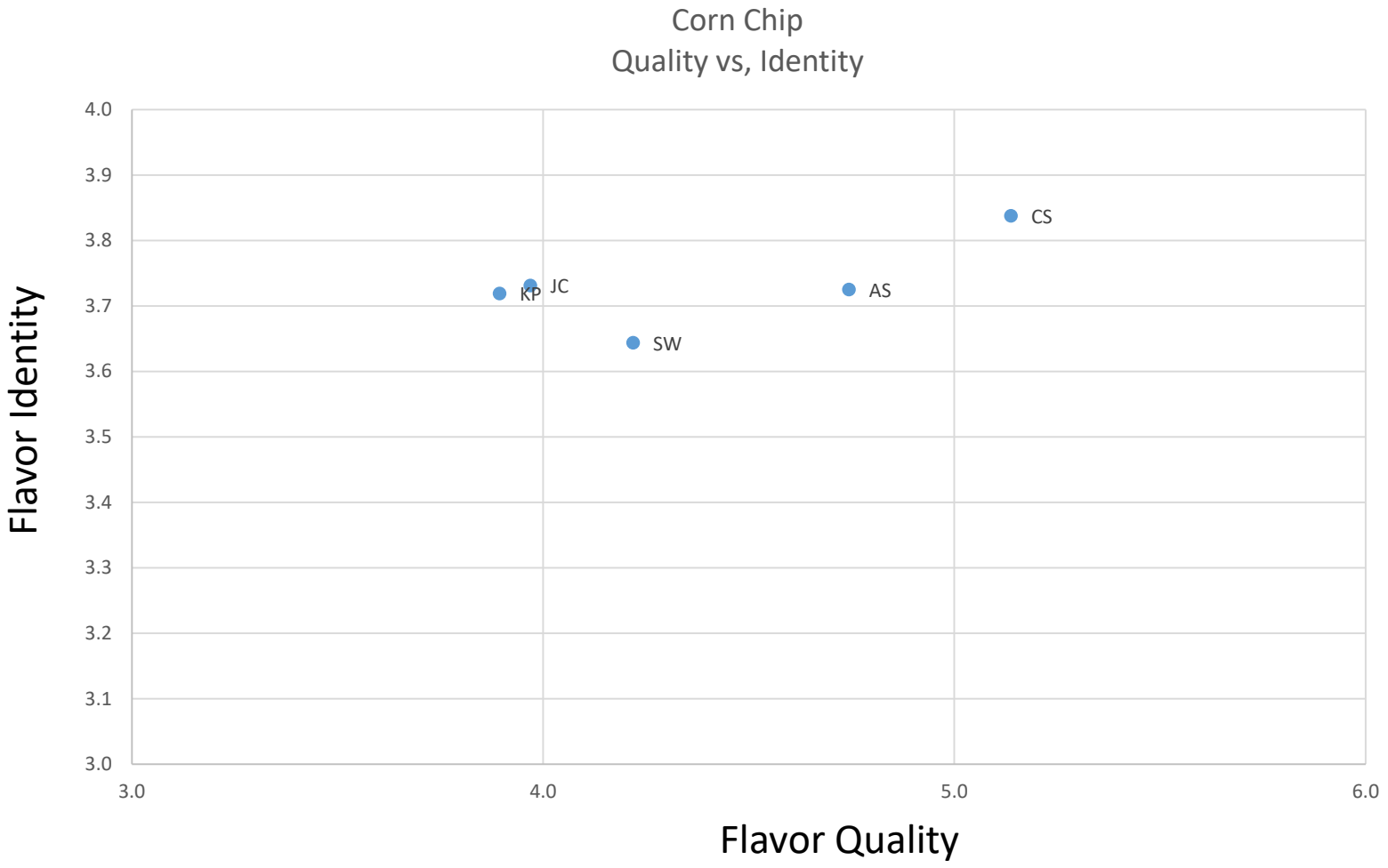
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White
AS	=	All Souls

Profile Attribute Analysis (PAA) summary Indices for corn chips:

Sample	"Quality"	"Identity"	"Texture"
AS	4.7	3.7	0.5
CS	5.1	3.8	0.2
JC	4.0	3.7	0.4
KP	3.9	3.7	0.5
SW	4.2	3.6	0.4

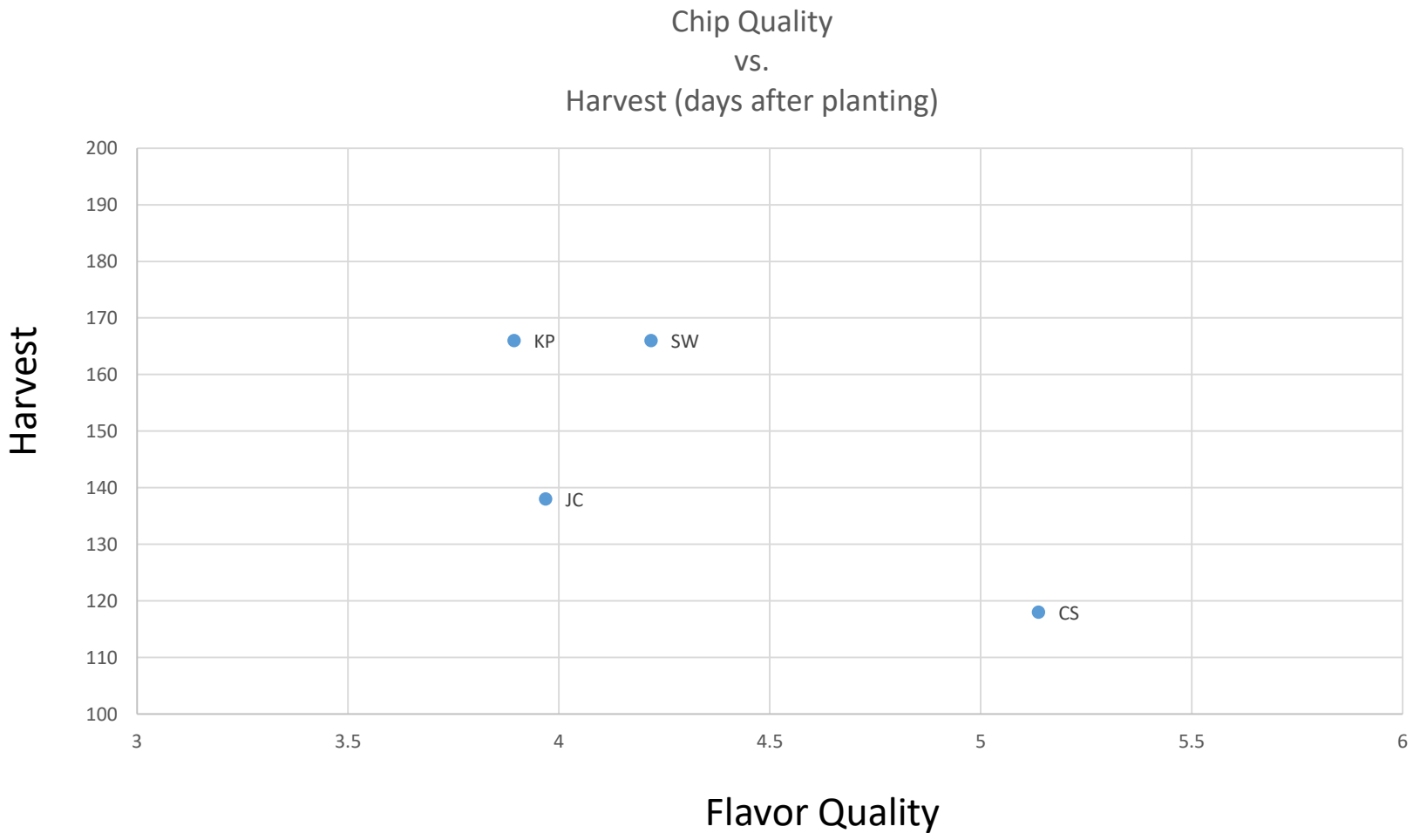
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White
AS	=	All Souls

Corn Chip: Flavor Quality vs. Flavor Identity



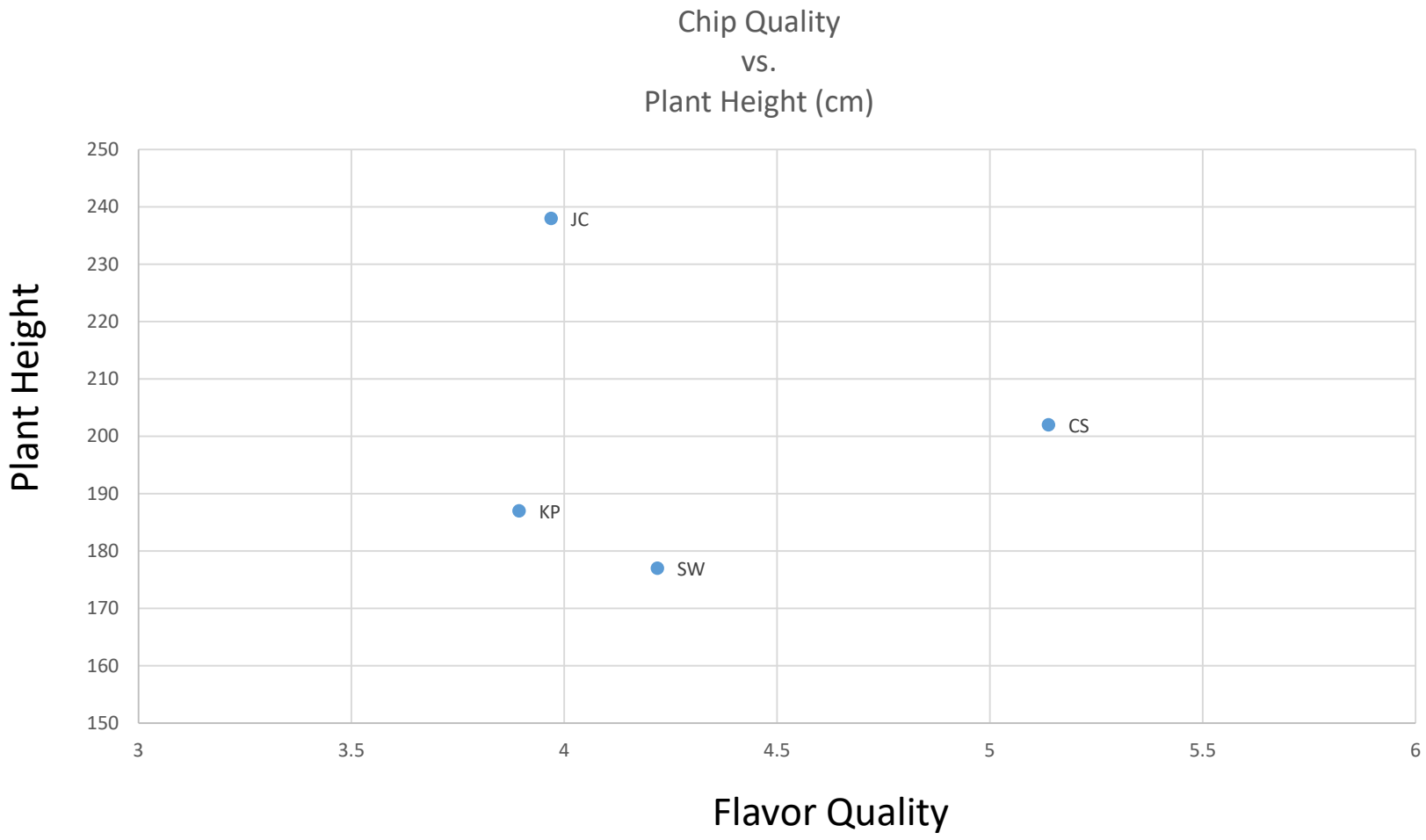
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White
AS	=	All Souls

Corn Chip: Flavor Quality vs. Harvest (days after planting)



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Plant Height (measured in cm)



Legend		
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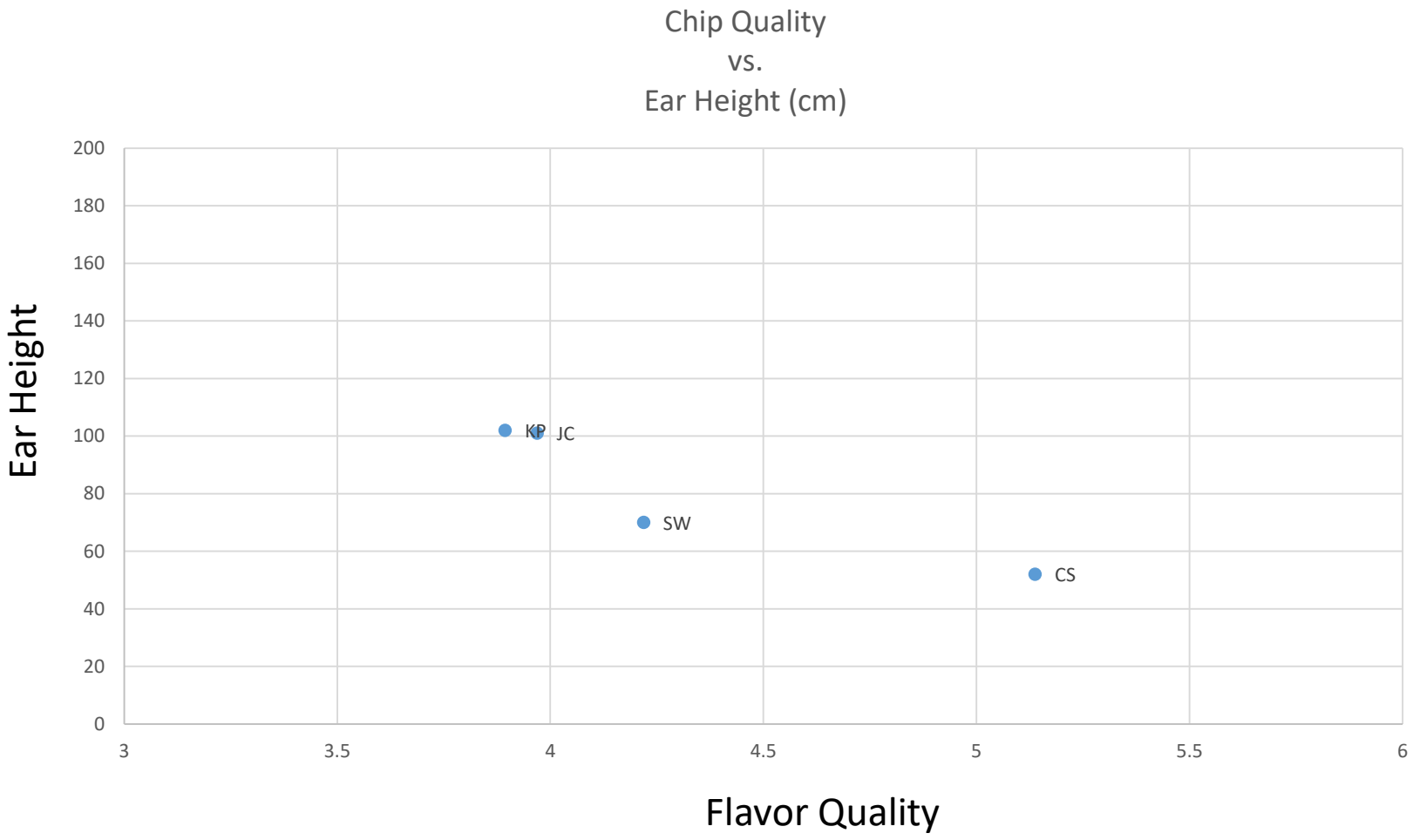
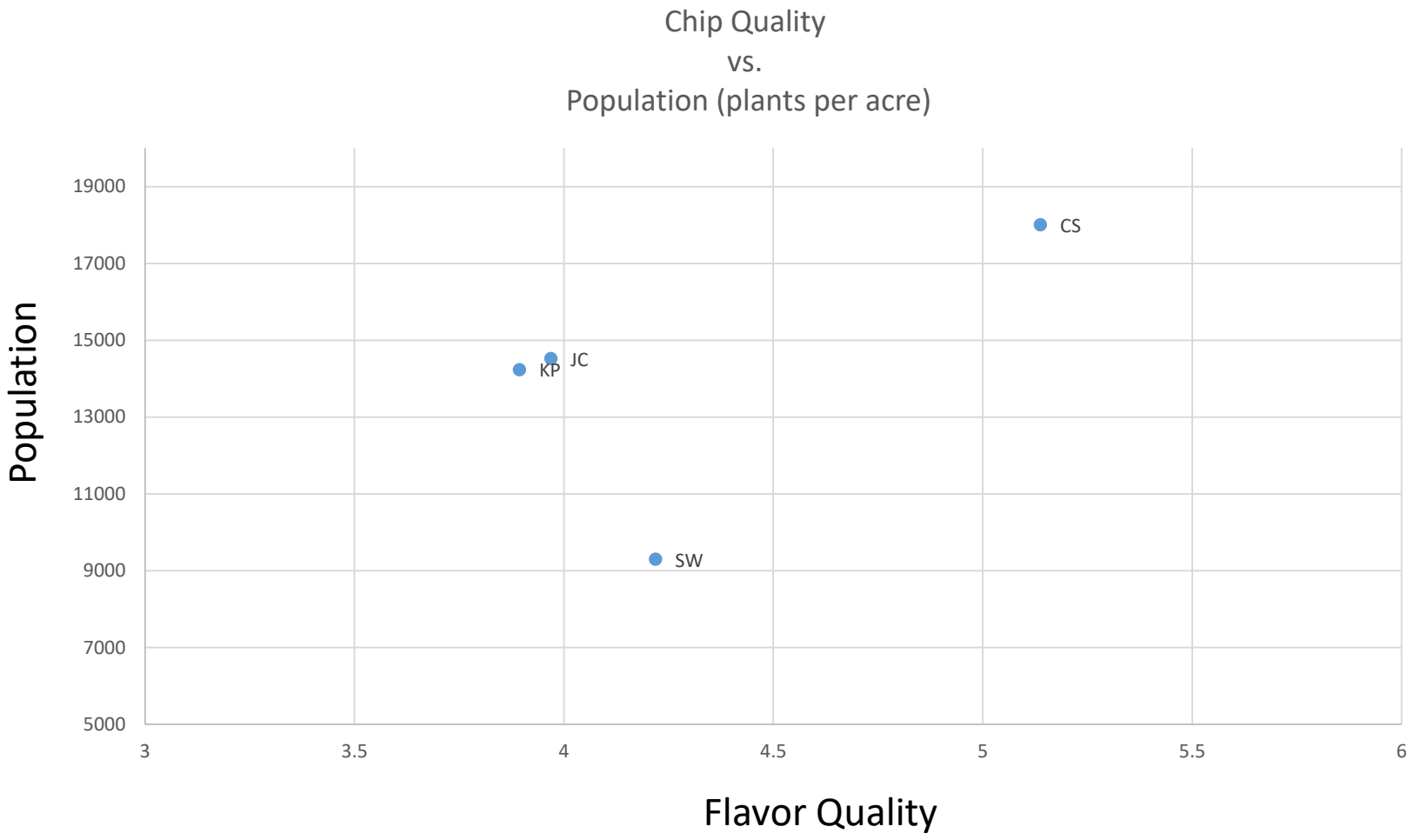
Corn Chip: Flavor Quality vs. Ear Height (measured in cm)



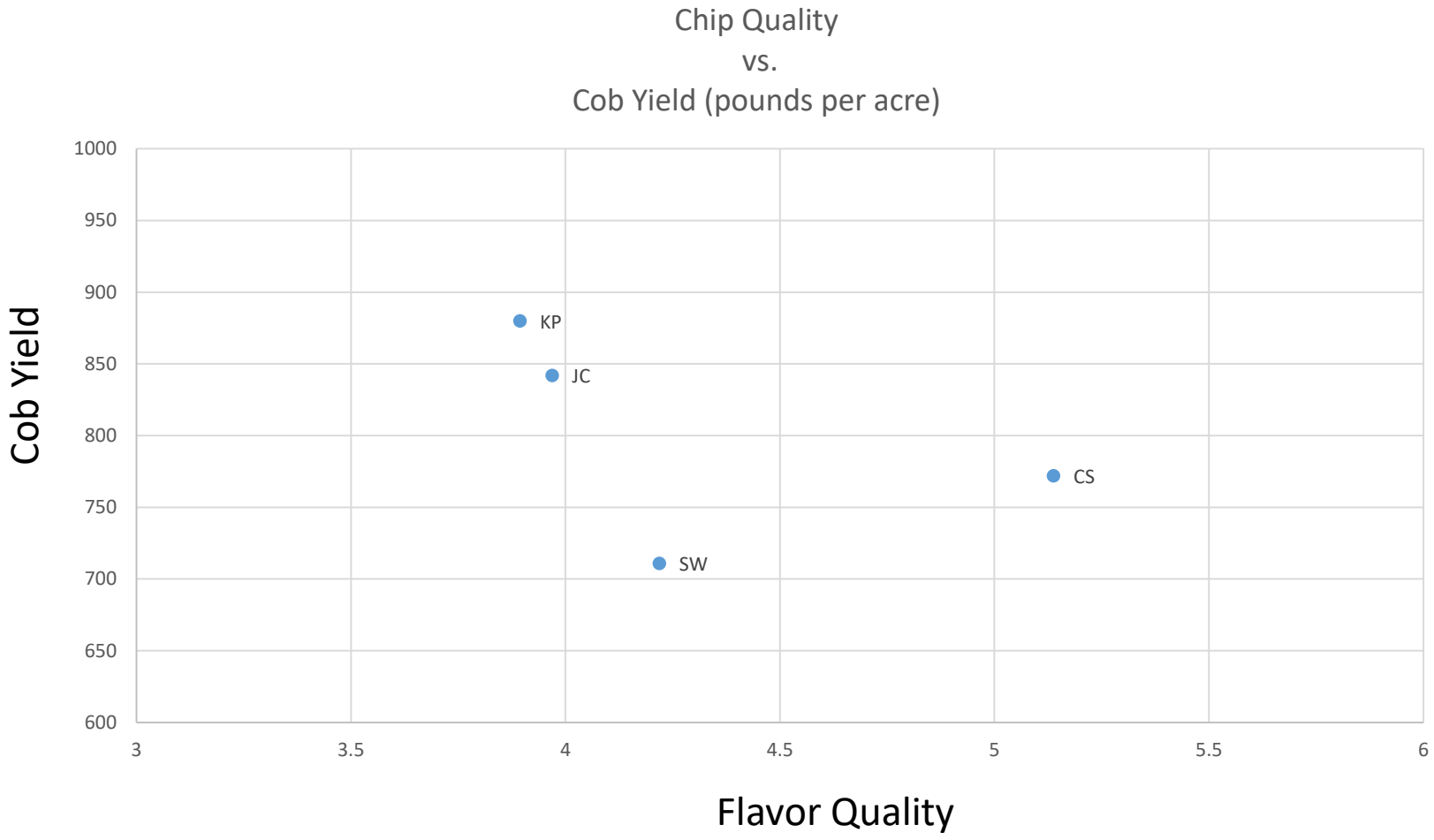
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Population (plants per acre)



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Cob Yield (pounds per acre)



Legend		
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JC	=	Johnny Cake
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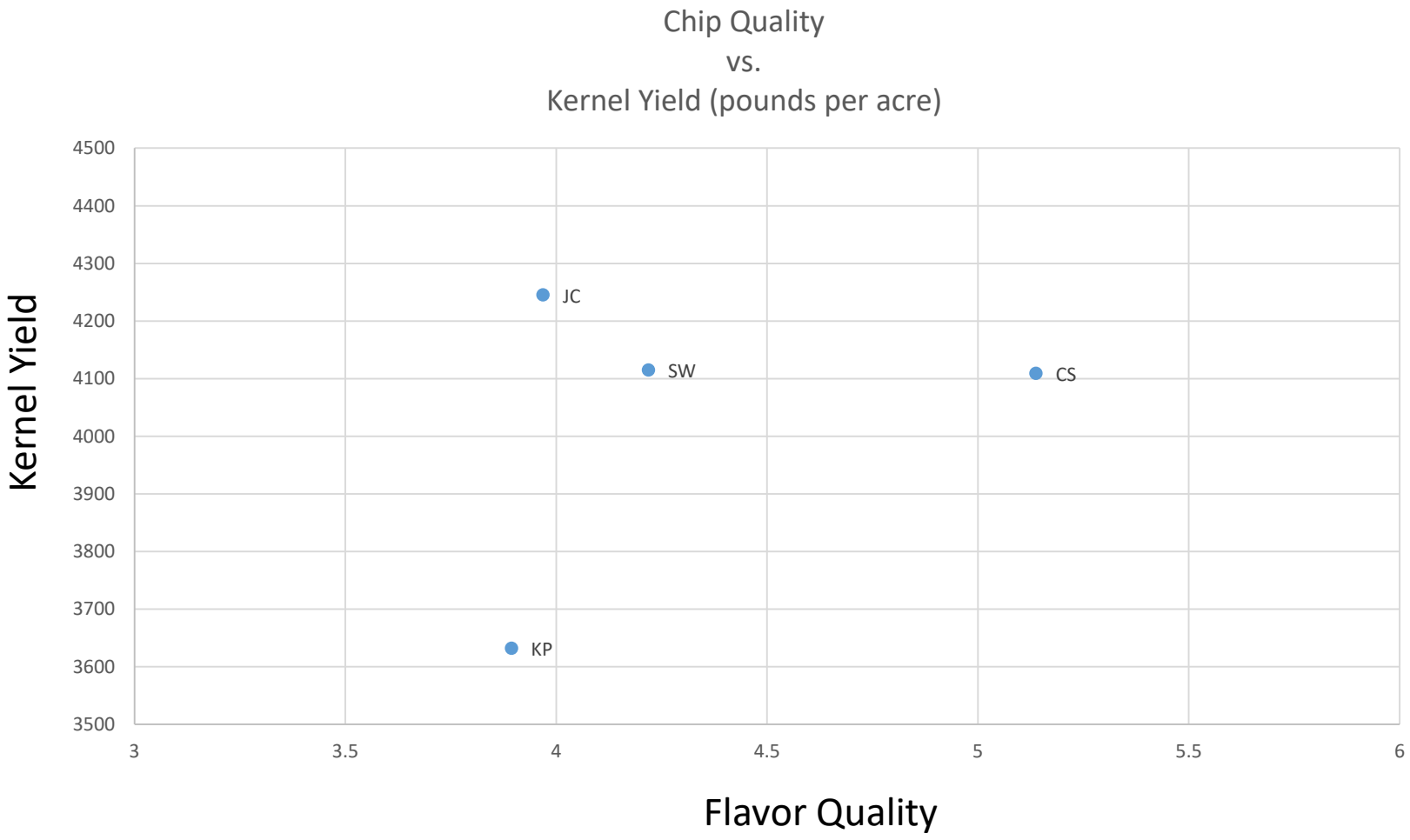
Corn Chip: Flavor Quality vs. Kernel Yield (pounds per acre)



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
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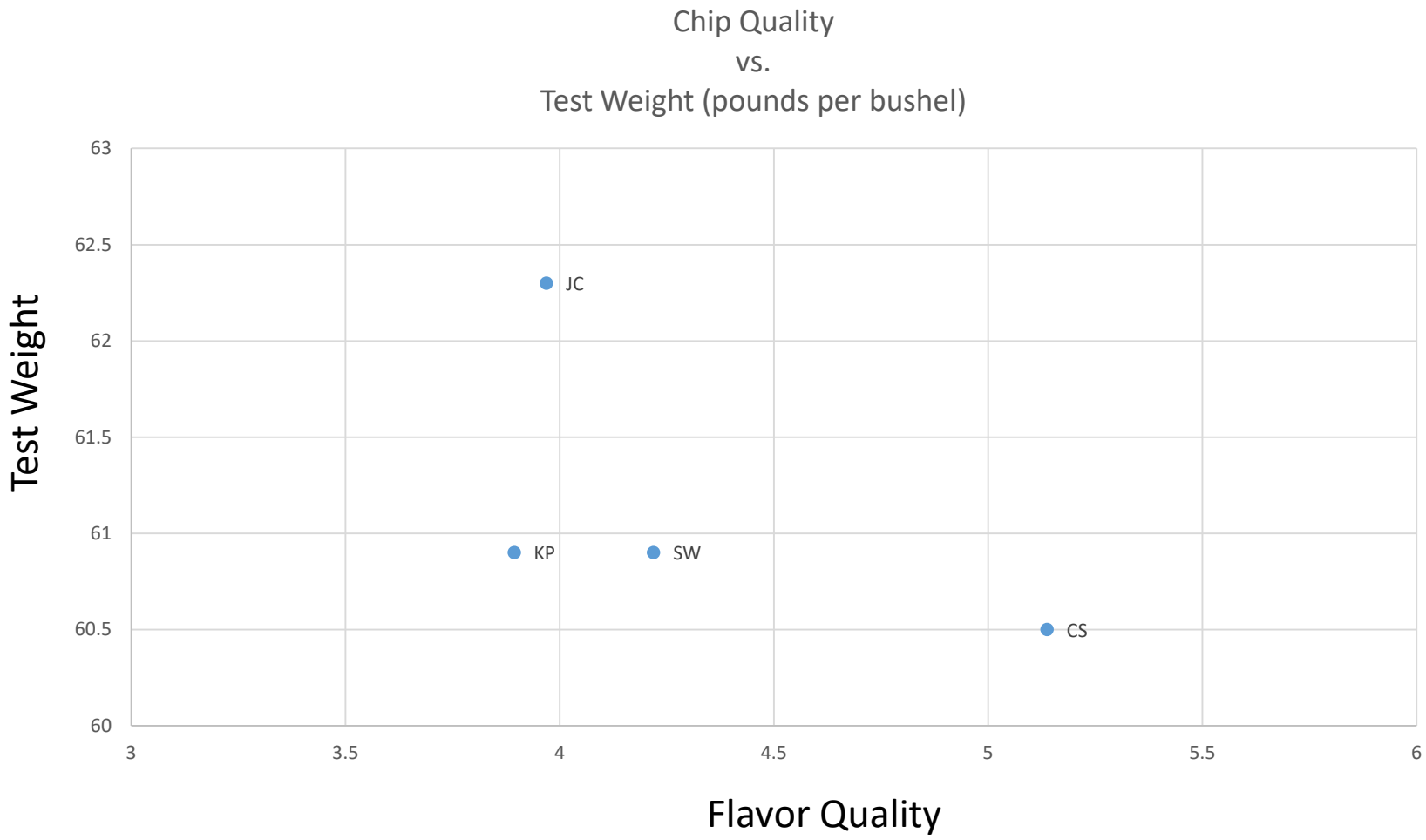
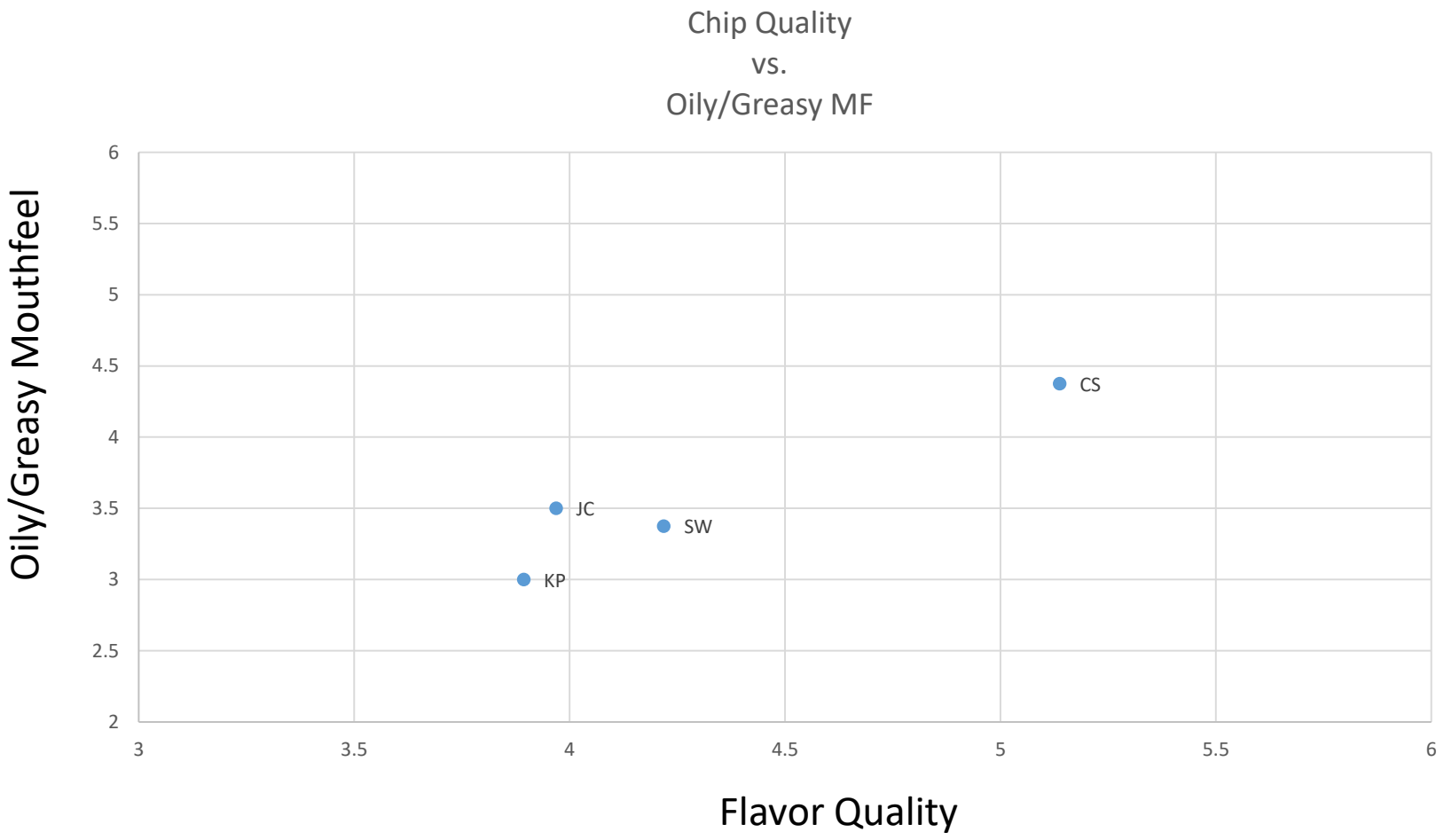
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Test Weight (pounds per bushel)



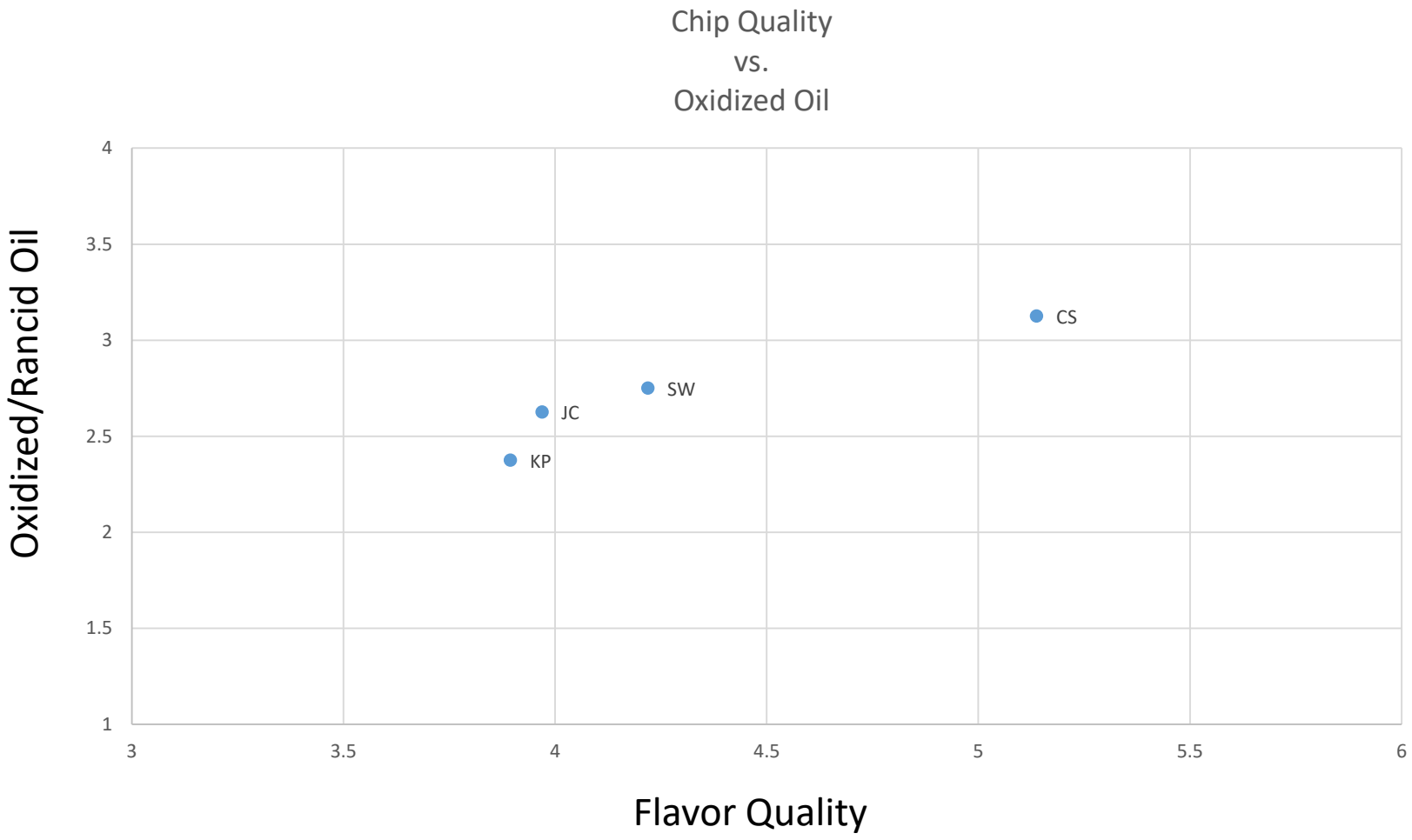
Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Oily/Greasy Mouthfeel



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Oxidized/Rancid Oil



Legend		
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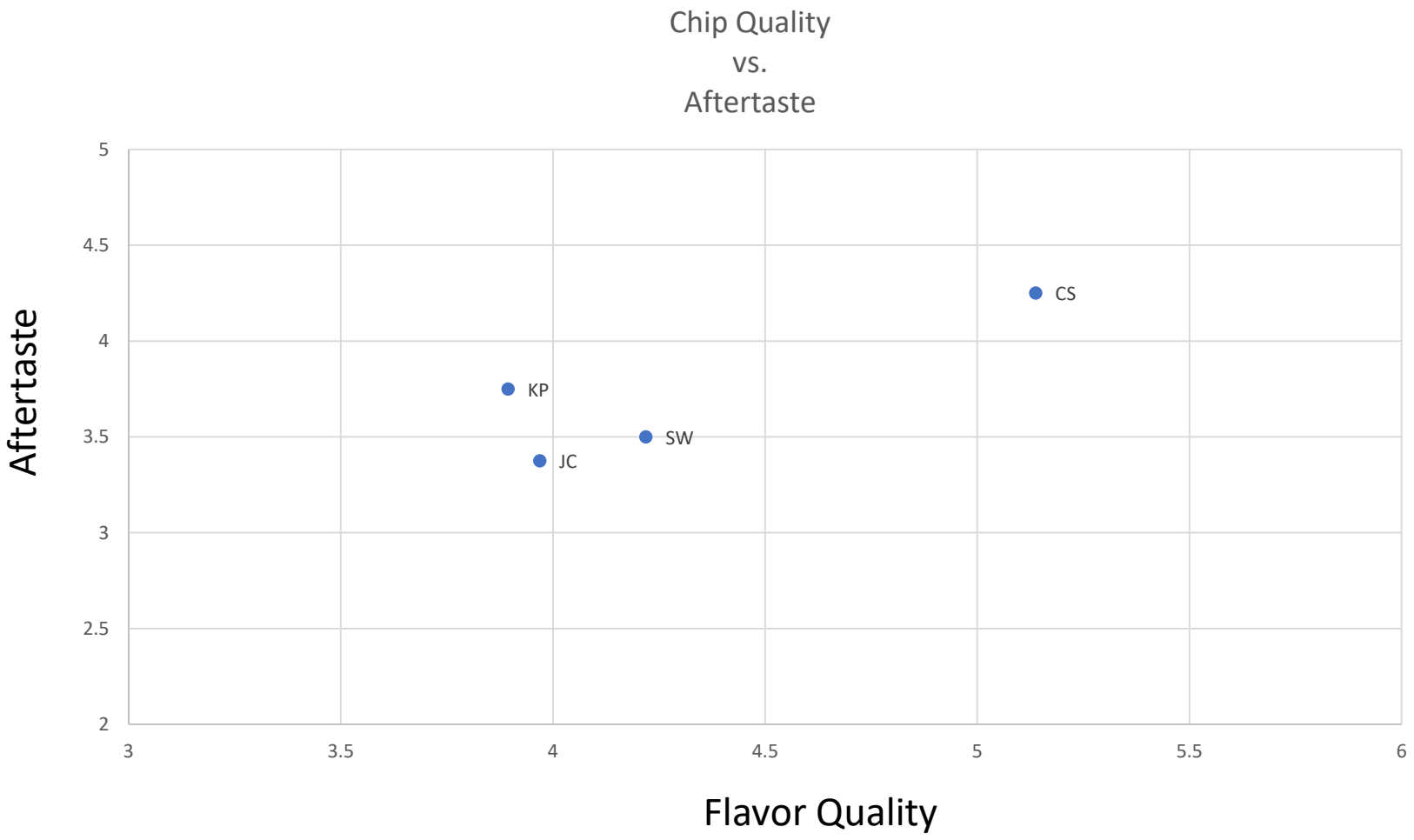
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White

Corn Chip: Flavor Quality vs. Aftertaste



Legend		
CS	=	Comstock Family
JC	=	Johnny Cake
KP	=	King Philip
SW	=	Salzer's White