K-STATE Research and Extension

Spatial Characterization of Soybean Yield and Quality

Department of Agronomy | MF3455 | Crop Production

Introduction

Harvested U.S. soybean acres increased from 72 to 89 million acres from 2000 to 2017. Primary factors are the growing trend in soybean production is its versatile end uses, serving as an oil seed crop, feed for animals, protein source, and biofuel feedstock.

Seed amino acid composition is one of the main factors determining overall soybean quality, leading to this study of the variation in seed amino acid concentration across the country. The study confirmed the correlation between the concentration of protein and oil with latitude. It also found some correlation between essential amino acids and latitude. This geographical analysis reflects overall amino acid concentrations for soybean sourced from northern regions are lower than southern areas.

Objective

This study assessed the spatial association in amino acids concentration for the major U.S. soybean producing regions; and investigated relationships between seed quality indicators, from amino acids, protein, and oil for soybeans.

Methodology

Data is collected from soybean testing programs in 14 states (Figure 1) from 2012 to 2016. Annual measurements of yield, oil, protein, and amino acid concentrations were all determined for each site. As a part of the overall evaluation amino acids measured include arginine, cysteine, isoleucine, leucine, lysine, methionine, threonine, tryptophan, and valine.

In addition to yield and seed quality, the concentration of sulfur-containing essential amino acids (cysteine and methionine) is presented as TSAA, and the sum of the concentration of oil and protein is referred as 'oil + protein.' The sum of total essential amino acids refers to the sum of the concentration of nine listed amino acids.

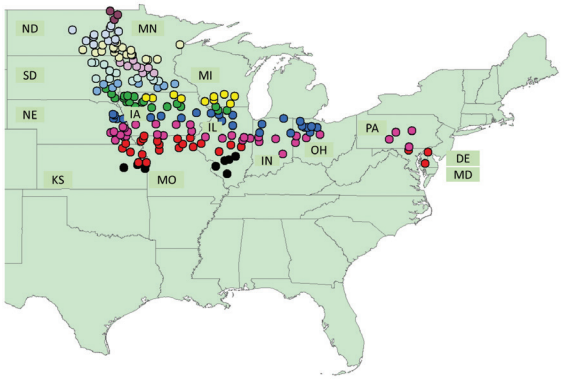


Figure 1. *Soybean testing trial locations. Circles represent locations and colors represent regions with similar maturity groups.*

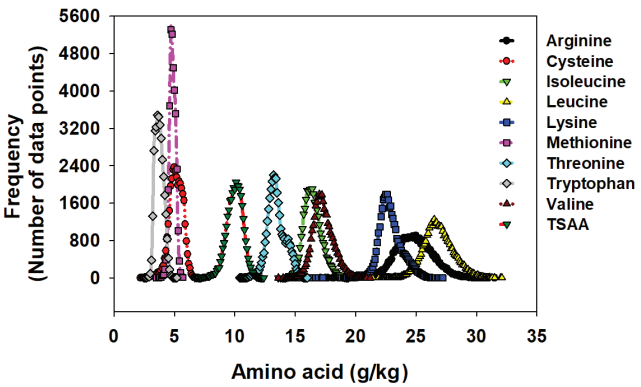
Results

The concentration of each amino acid was below 35 grams per kilogram (Figure 2). The overall mean concentration of leucine, arginine, and lysine (26.8, 24.8, and 22.9 grams per kilogram, respectively) was greater than concentration for valine, isoleucine, and threonine (17.3, 16.4, 13.4 grams per kilogram, respectively).

The concentration of the last three amino acids was greater than the overall concentration of cysteine, methionine, and tryptophan (5.1, 4.8, 3.7 grams per kilogram, respectively).

The concentration of the TSAA (cysteine and methionine) was about 9.9 grams per kilogram but also was presenting a narrow variation (max. – min.) and standard deviation from this mean value.

Overall, a narrow to mild variation (ranges between the maximum and minimum values) on individual amino acid concentration of soybeans had been reported when pooling this large and regional database.



Amino Acid	Mean	SD	Min	Max	Median
	..... g/kg				
Arginine	24.8	1.5	17.1	31.5	24.8
Cysteine	5.1	0.6	2.2	7.0	5.1
Isoleucine	16.4	0.7	13.6	19.4	16.4
Leucine	26.8	1.2	21.4	32.1	26.8
Lysine	22.9	1.0	14.5	27.2	22.7
Methionine	4.8	0.2	3.5	5.7	4.8
Threonine	13.4	0.7	10.4	16.0	13.3
Tryptophan	3.7	0.3	2.5	5.2	3.7
Valine	17.3	0.9	13.6	21.2	17.2
TSAA	9.9	0.7	6.7	12.4	10.0

Figure 2. *Distribution of amino acid concentrations, expressed in grams per kilogram, in soybeans grown across 14 major soybean producing states from 2012 to 2016. Upper panel, data points per amino acid, and lower panel, descriptive statistics for all amino acids, including TSAA-(cysteine+ methionine).*

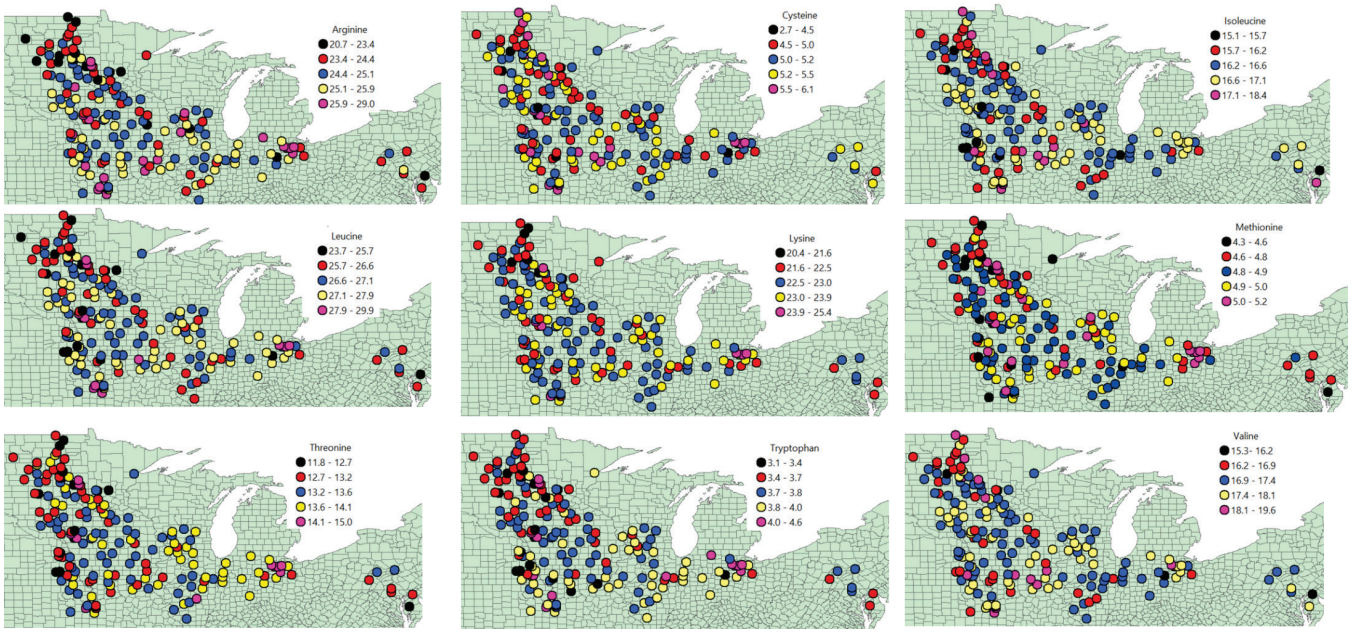


Figure 3. *Spatial classification of the average concentration of amino acid in soybeans for the trial across 14 states from 2012 to 2016.*

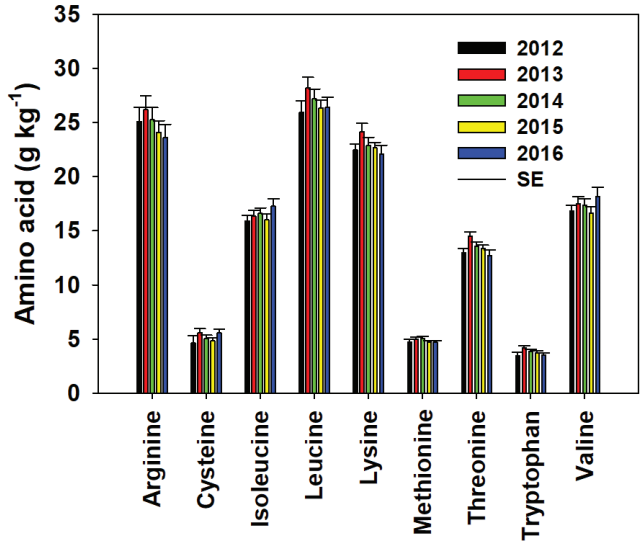


Figure 4. *Mean annual amino acid concentration in soybeans for the trial across 14 states from 2012 to 2016.*

In a spatial-scale, for all seed quality traits there was a relative trend of greater amino acid concentrations in southern soybean-producing U.S. latitudes than in northern U.S. latitudes (Figure 3).

All amino acids concentrations portrayed a negative correlation with latitude (Figure 3). These results suggest a significant impact of geographical location, with relatively lower amino acid concentration in the northwest than in the southeast U.S. major soybean-producing region.

Changes in latitudes also include modifications of soybean variety-maturity group as an additional factor. This spatial analysis reflects that overall amino acid concentrations for soybeans sourced from northern regions are lower than in southern areas.

A significant annual variation for amino acid concentration was observed, with the lowest in 2012 (Figure 4), and attaining its maximum concentration in 2013. Over the years, concentration of arginine, leucine, lysine, methionine, threonine, and tryptophan tended to decrease but cysteine, isoleucine, and valine tended to increase.

Summary

Essential amino acids exhibit a delayed spatial correlation, and there was a negative relationship between concentration of amino acids, protein, and oil, with latitude.

There was a positive interrelationship among all amino acids, and the correlation between isoleucine and valine was the strongest (r=0.93) followed by the correlation among arginine, leucine, lysine, and threonine (0.71< r <0.88).

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