

BREEDING AND ROOT MORPHOLOGY OF VEGETABLE SOYBEAN IN CHINA

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Vegetable soybeans (*Glycine max* (L.) Merr.) differ from field soybeans by being larger-seeded, milder-tasting, tender, more digestible with a relatively higher percentage of sucrose. As early as 1620, the Chinese people started to plant vegetable soybean. Although China has a long history of vegetable soybean production, its production was in a state of farmer's subsistence before the 1970s. Since the 1980s, Chinese scientists started to pay more attention to breeding vegetable soybean cultivars suited to different ecological regions. This paper summarizes the achievements in breeding and root morphology from the Chinese researchers' perspective. 50 vegetable soybean cultivars have been released over the past 20 years, and selection standards, i.e. fresh pod weight, length and width and sucrose content, in particular, have been determined. Nitrogen and potassium are the main factors influencing yield and quality in vegetable soybean. The rate of nitrogen application has significant effects on root morphology of vegetable soybean. Compared to 100 mg/kg, the application of 200 mg/kg and 300 mg/kg nitrogen reduced root dry weight, root length and root surface area as well. However, root volume during the reproductive stage increased with a 200 mg/kg and 300 mg/kg nitrogen application compared to a 100 mg/kg application. An increase in finer roots and larger root nodules but lower yields was observed without nitrogen application. The application of certain rates of K is an approach for enhanced sucrose content and fresh pod yield in vegetable soybean production. Three issues, including enzymes, in regulating amino acid and sucrose synthesis, translocation and partitioning, are addressed.

Breeding and Physiological Research of Vegetable Soybean in China

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Outline

- ◆ Brief Introduction
- ◆ Quality and breeding
- ◆ Minerals and yield physiology
- ◆ Issues to be addressed

Brief introduction

Vegetable soybeans (*Glycine max* (L.) Merr.), translated as "beans on branches," are the immature, green form of edible soybeans collected at R6-R7 stages (Konovsky, 1994).

Edamame is the Japanese name for green vegetable soybeans.



Brief introduction

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Vegetable soybeans differ from field soybeans by being larger-seeded, milder-tasting, more tender, more digestible, relatively higher percentage of sucrose.

Vegetable soybean is also a rich source of vitamin A, carbohydrates, protein and iron.

It is more nutritious than vegetable green peas.



Brief introduction

Edamame is a traditional food popular in Asia.

In Japan, it is served boiled in salt water as a snack or appetizer.

In China and other areas, the shelled, raw edible soybeans are cooked with meat or mixed with other vegetables for various dishes.

Edamame is becoming increasingly popular in the United States as consumers become more interested in Asian cuisine.



Brief introduction

As early as 1620, the Chinese people started to plant vegetable soybean.

Traditionally, vegetable soybeans were planted in the coastal regions of South China, including Zhejiang, Jiangsu, and Fujian Provinces.



Brief introduction

Although we have a long history of vegetable soybean production, its production was in a state of farmer's subsistence before 1970s.

Since 1980s, vegetable soybean cultivars were introduced from Taiwan, and Japan, and scientists started to pay more attention to breeding cultivars suited to different ecological regions.



Brief introduction

China is the largest production, consumption and export country of vegetable soybean in the world.

The average annual sowing acreage is 150,000ha , with average yield of 5 t/ha.



Brief introduction

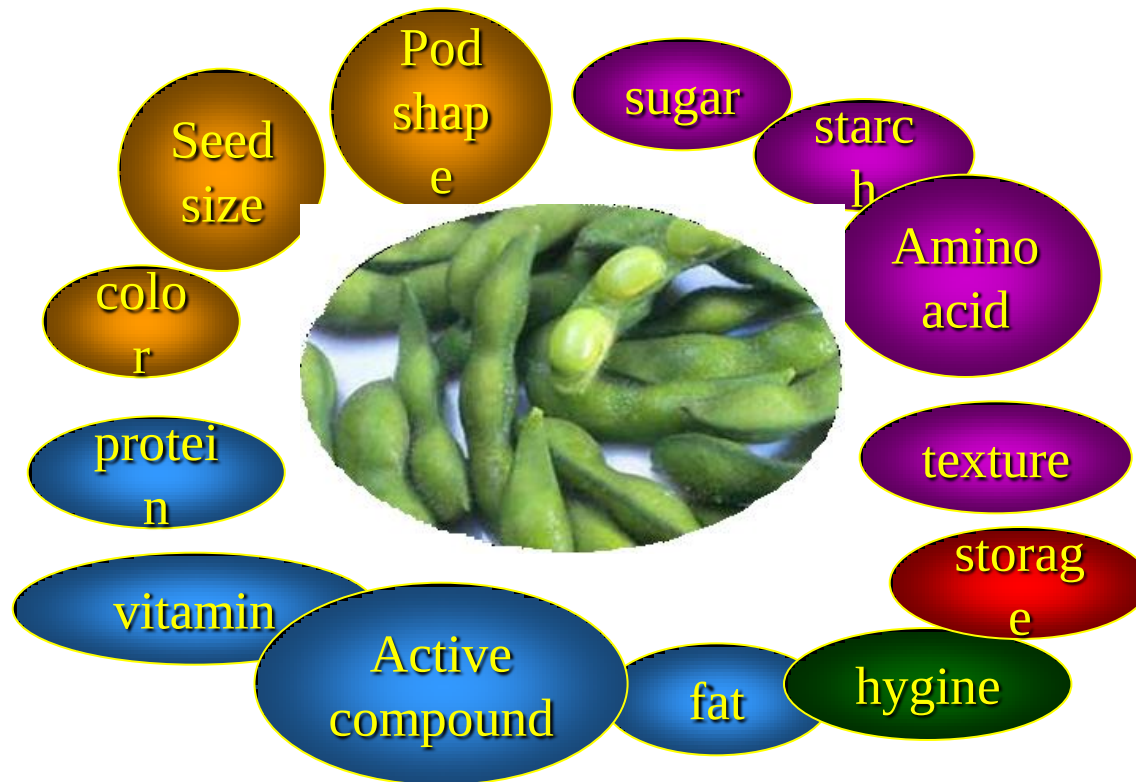
In addition to domestic consumption, vegetable soybean also is exported to Japan, Taiwan, Korea, Australia and USA. As I know very little frozen edamame is produced in your country.

China's export of frozen vegetable soybeans accounted for 52% of the world's total frozen vegetable soybean export in 2008



Quality and breeding

General components of quality



Commodity Quality

Export market requirements:

Hundred seed weight (dry): 30 g or more

Number of seeds per pod: 2 or more

Pubescence on pod: gray

Flavor: good

Pod texture after cooking: easy to squeeze

Taste: slightly sweet

Cooking time: short

less than 175 fresh pods per 500 gram package

-----AVRDC



Commodity Quality

Selection standards

fresh seed weight: 0.61-0.70 g

fresh pod wall weight: 1.36-1.61 g

fresh pod weight: 2.6-3.0 g

fresh pod length: 5.2-6.0 cm

fresh pod width: 1.45-1.62 cm

15- 20 pod per plant in early generation

-----Wu Tian-long et al., 2000,

Soybean Science, 19(2): 184-188



Taste Quality

Taste quality involves sweetness, flavor, texture, and freshness.

Sweetness is the major concern in China, which is mainly dependent on sucrose content.

Our investigation showed that

(1) sucrose content of vegetable soybean should not be less than 3.3%,

(2) sucrose content is negatively correlated with oil content,

thus we proposed that lower oil content could be an indirect index in selecting higher sucrose variety.



Taste Quality

Flavor and taste are not only determined by sucrose content but also determined by glutamic acid and alanine content (Masuda, 1992).

Our investigation showed that the total amino acid content was one fold greater than grain soybean, and the research on differences in specific amino acid content is ongoing.



Breeding

For the past 20 years, China has released 50 vegetable soybean cultivars

25 cultivars were selected in Jiangsu,
Zhajiang and Fujian Province (South
China)

12 cultivars in Anhui and Hunan Province
(Central China)

10 cultivars in Shangdong and Shanxi
Province (North China)

2 cultivars in Liaoning Province

1 cultivar in Heilongjiang Province,
I am the breeder



Nitrogen and yield

Nitrogen is the main factor influencing yield and quality in crops, however less information is available to the root morphology of vegetable soybean in responses to different nitrogen rates during reproductive stages.

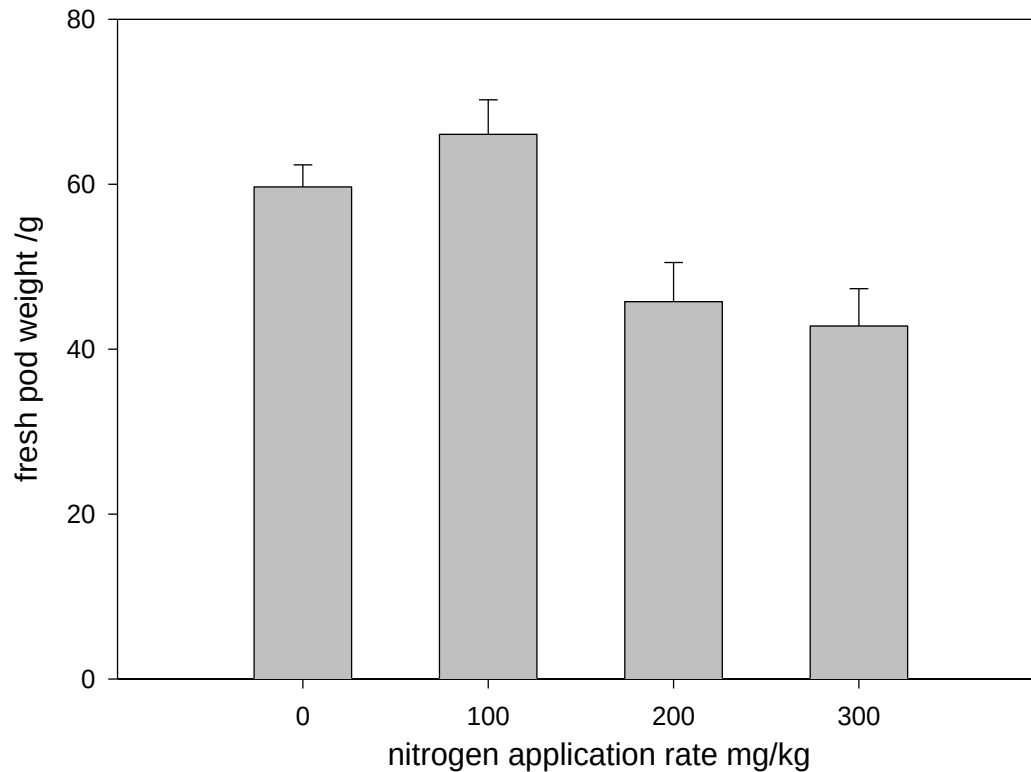


Nitrogen and yield

Using root analysis system , we investigated the variation characteristics of vegetable soybean root morphology during reproductive stages and fresh pod yield under different nitrogen rate.



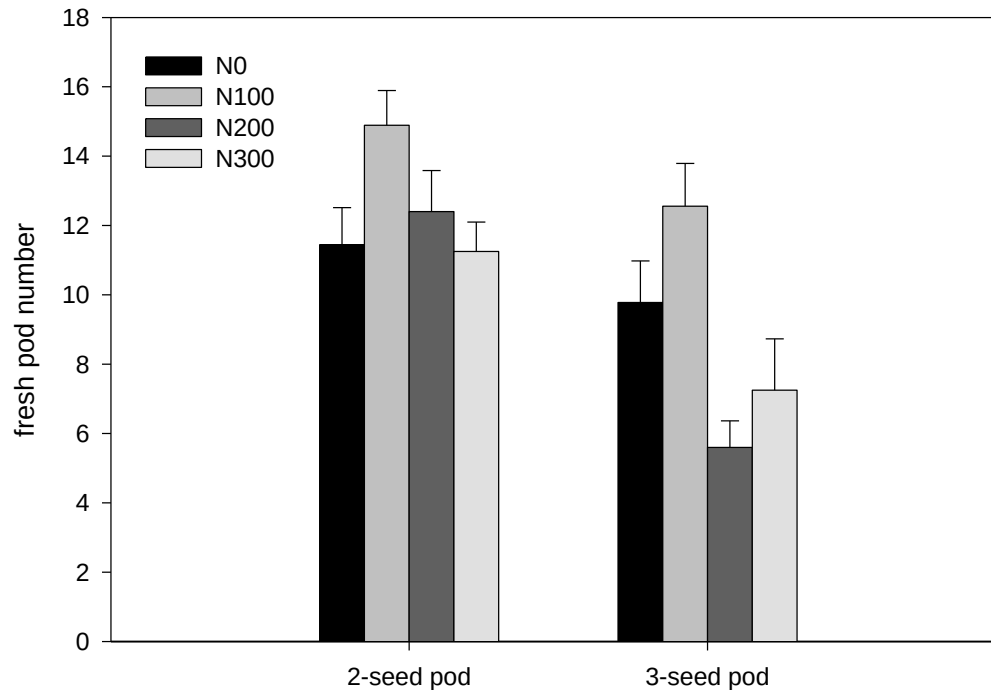
Nitrogen rate and yield



The maximum fresh pod yield was found at 100 mg/kg nitrogen application rate

Fig.1 Effect of different nitrogen rate on the fresh pod yield of vegetable soybean

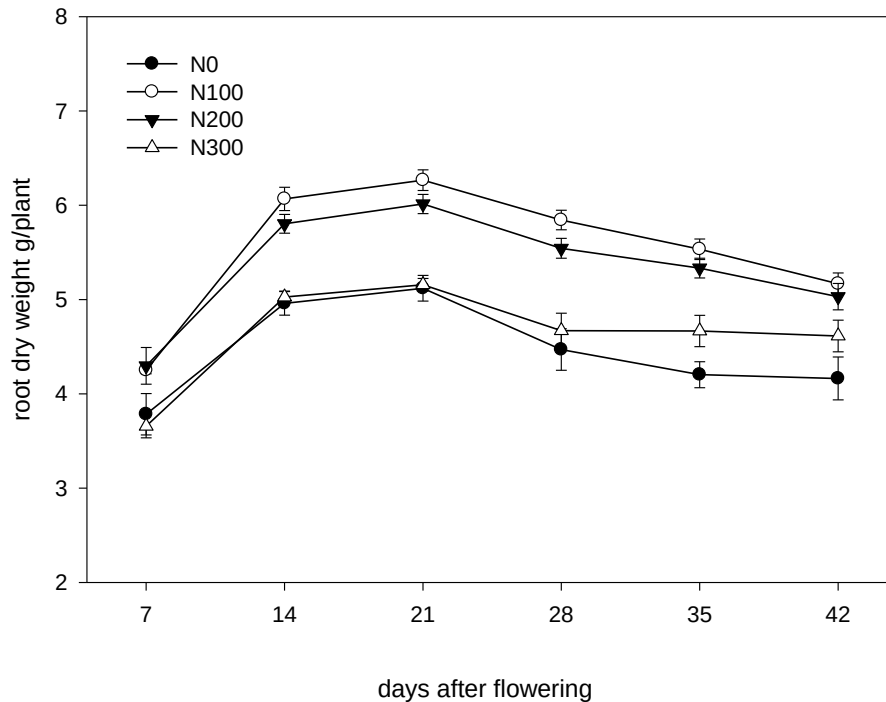
Nitrogen rate and yield



100 mg/kg
nitrogen
application rate
had the highest
2-seeded and 3-
seeded pod
number

Fig.2 Effect of different nitrogen rate on different type pod number of vegetable soybean

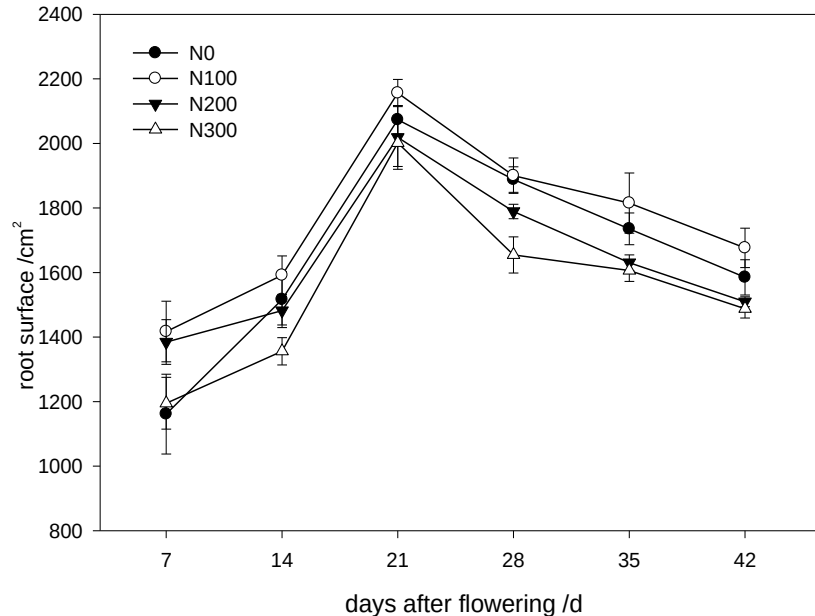
Nitrogen and physiology



The changes of root dry weight during reproductive stages under different nitrogen rates were similar, the highest value was reached at 21d after flowering. Compared to 100 mg/kg, the application of 200 mg/kg and 300 mg/kg nitrogen reduced root dry weight.

Fig.3 The changes of root dry weight under different nitrogen rate during reproductive stages in vegetable soybean

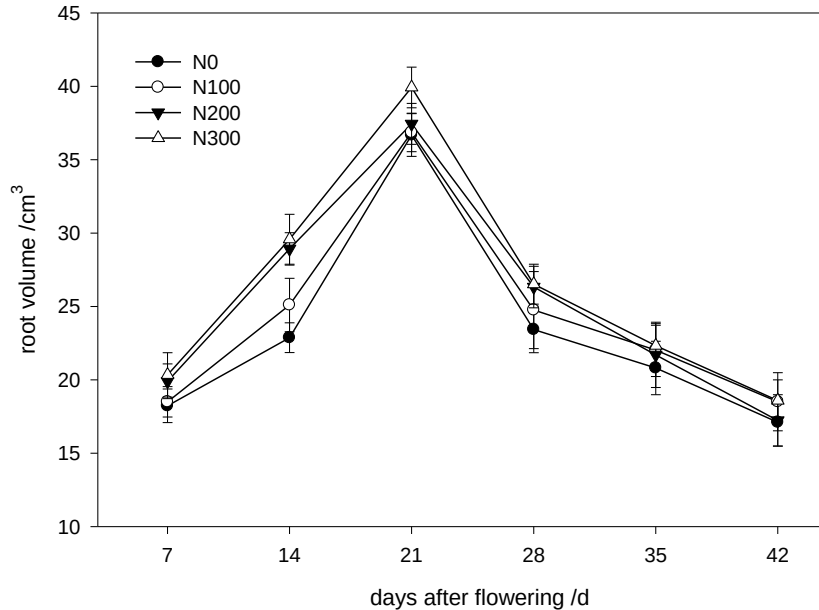
Nitrogen and physiology



The changes of root surface during reproductive stages under different nitrogen rates were similar, the highest value was also reached at 21d after flowering. The application of 200 mg/kg and 300 mg/kg nitrogen also reduced root surface.

Fig.4 The changes of root surface under different nitrogen rate during reproductive stages in vegetable soybean

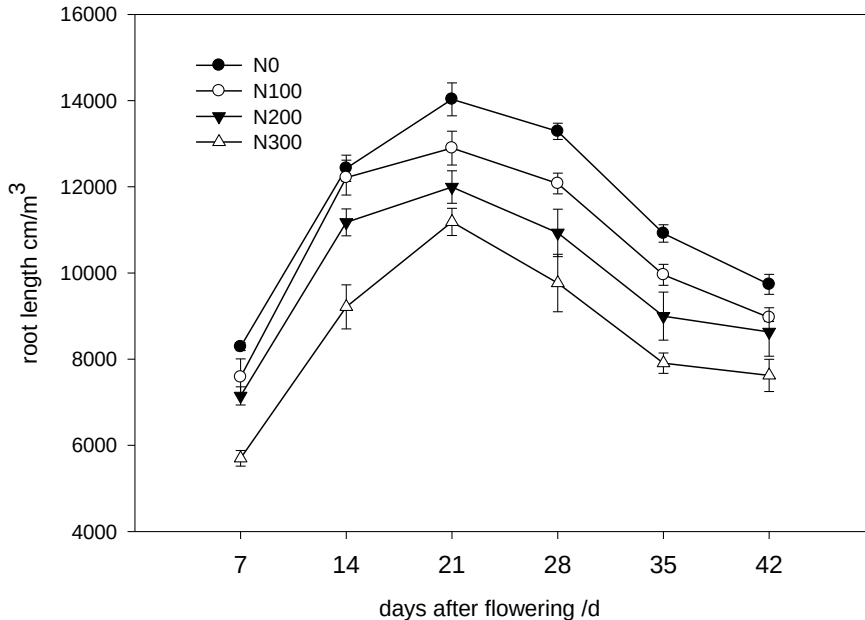
Nitrogen and physiology



However, the root volumes during reproductive stages were increased under 200 mg/kg and 300 mg/kg nitrogen rate compared to 100 mg/kg.

Fig.5 The changes of root volume under different nitrogen rate during reproductive stages in vegetable soybean

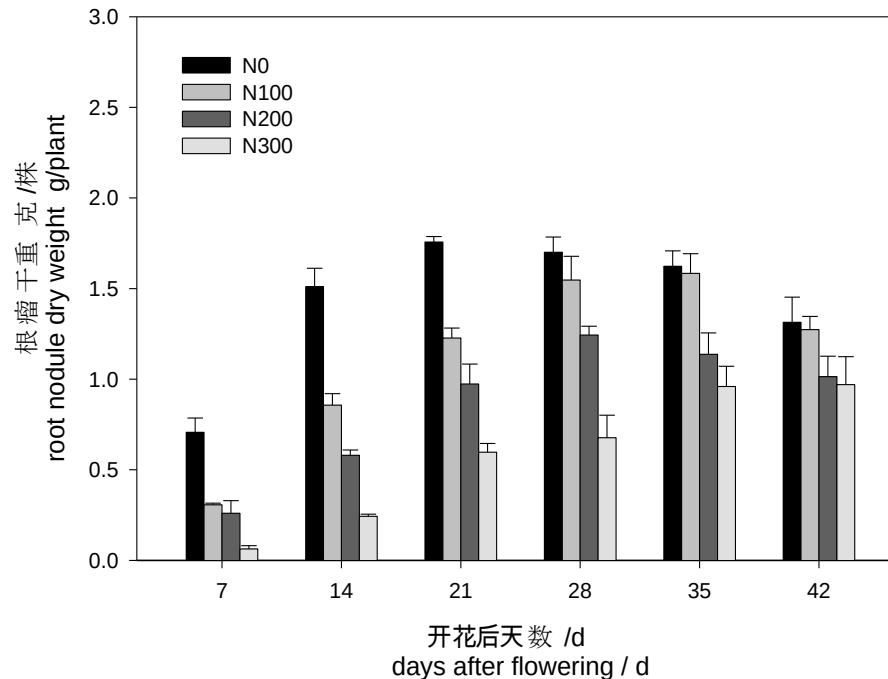
Nitrogen and physiology



While the root length during reproductive stages was significantly reduced under 200 mg/kg and 300 mg/kg nitrogen rate compared to 100 mg/kg.

Fig.6 The changes of root length under different nitrogen rate during reproductive stages in vegetable soybean

Nitrogen and physiology



It was surprised to find that root nodule dry weight without N application was 24%、41% and 61% greater than 100 mg/kg, 200 mg/kg and 300 mg/kg application rate respectively

Fig.7 The changes of root nodule dry weight under different nitrogen rate during reproductive stages in vegetable soybean

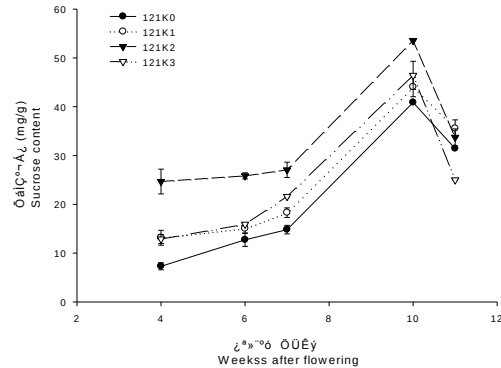
Nitrogen and physiology

We also observed that more finer roots and larger root nodules but lowest yield without nitrogen application.

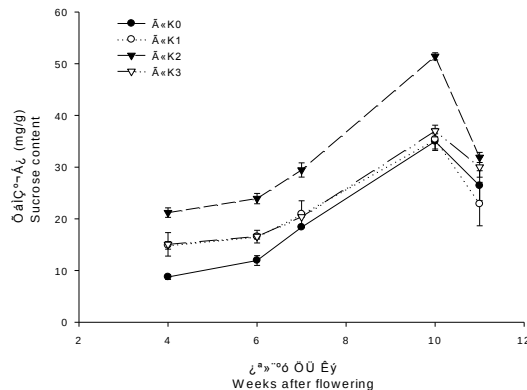
We proposed that the variation of fresh pod yield in vegetable soybean under different nitrogen rates might be related to nutrients uptake, which needs further investigation.

Pottasium and sucrose content

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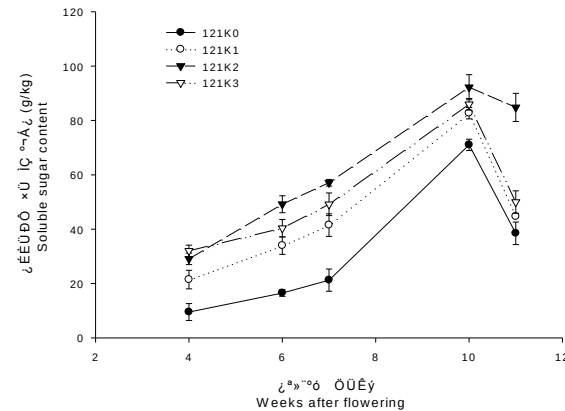
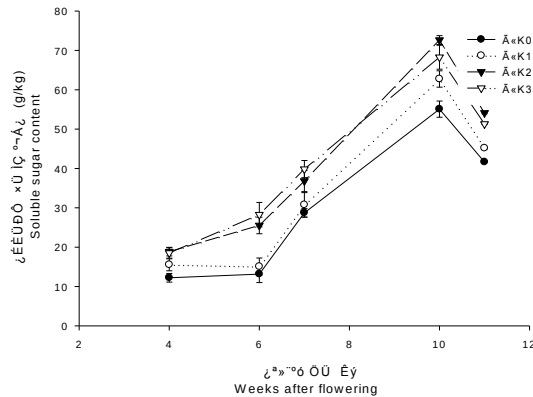
Our investigation with different K application rates indicated K application enhanced sucrose content but highest sucrose content was only achieved at 120 kg K/ha not at 180 kg/ha.



Sucrose content under different K application rate

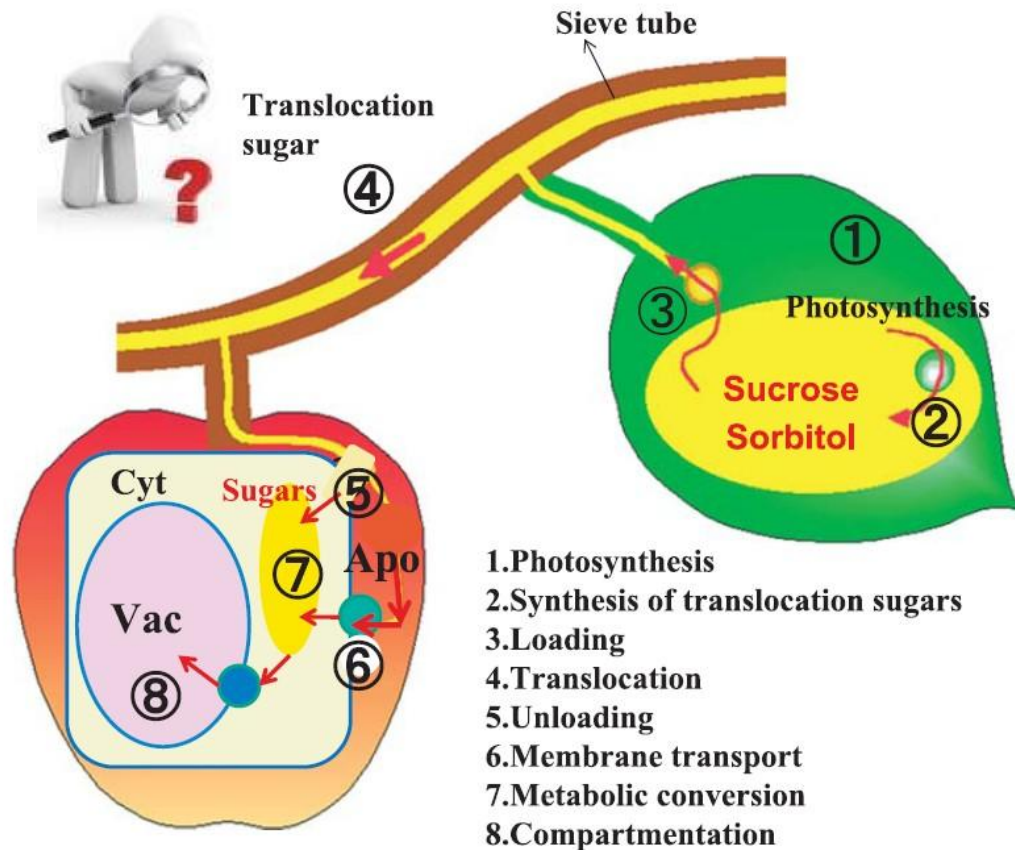
Pottasium and total soluble sugar

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We got the similar results for soluble sugar content with highest content at 120 kg K/ha not at 180 kg/ha. This means that application of certain rate K is an approach for vegetable soybean production

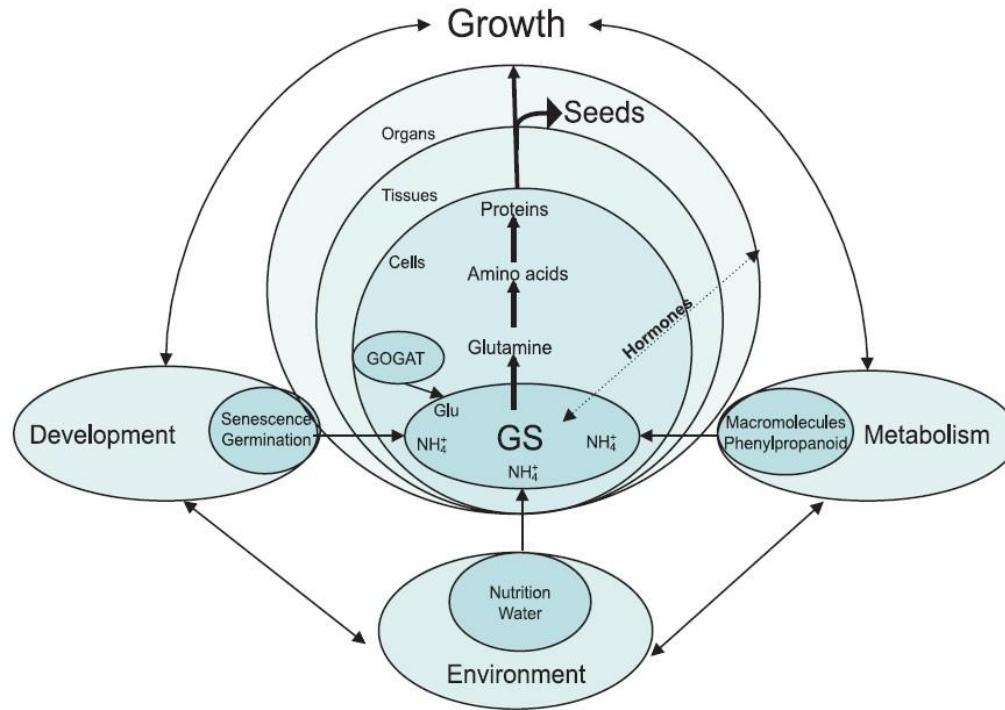
First Issue to be addressed



Three enzymes involved in regulating sucrose synthesis, translocation and partitioning need further investigation, they are invertase, sucrose synthase and sucrose phosphate synthase

S. Yamaki. Soc. Hort. Sci. 2010 , 79 (1): 1–15

Second Issue to be addressed



As the taste of vegetable soybean is determined also by amino acid composition and content, enzymes involved like GS and GOGAT also needs further investigation.

New Phytologist (2009) 182: 608–620

Third Issue to be addressed

Potassium nutrition in relation to yield/quality in vegetable soybean.

This is mainly due to possible and potential roles of potassium in improving yield, especially its quality.



Thank you





Northeast Institute of Geography and Agroecology, CAS

Welcome to Harbin

