

Plant Population Effects on the Performance of Natto Soybean Varieties 2008
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Natto

Natto soybeans are small (maximum of 5.5 mm diameter), clear hilum soybeans with thin seed coats and high carbohydrate content. The soybean plants usually have a narrow or lanceolate leaflet shape. These specialty soybeans are typically grown for fermented soybean foods called 'Natto' in Japan, thus the name Natto Soybeans. The process of fermentation breaks down the soybeans' proteins, making them easier to digest than whole soybeans.

Natto is a traditional Japanese food. It is prepared by soaking and steaming Natto soybean seeds, followed by a short fermentation with the bacteria *Bacillus Natto*. After fermentation the Natto product has to be kept refrigerated until used. Natto has a short shelf life of approximately 1 week. Japanese consumers eat Natto at breakfast often with addition of soya sauce or mustard. It is a nutritious food.

Research Goals

To evaluate Natto soybean varieties seeded with different plant populations and row spacings, for: stand after complete emergence, any disease, lodging, plant height, yield, oil and protein content, seed weight, and test weight.

Research Objectives:

The hypothesis of this study was that there is an optimum plant spacing and population to achieve maximum net return when Natto soybeans are planted in ND (and NW MN).

To achieve the goal, this study;

1. Compared narrow vs. wider Natto row spacings.
2. Determined plant population for optimum soybean yield.
3. Compared different genotypes of Natto soybean.

Benefit of the research to the ND soybean farmer

Soybean growers in ND have the opportunity to grow identity preserved soybeans. This project was directed toward increasing the per acre profitability of Natto soybean production by adopting the best row spacing and seeding rate. Natto bean size is related to the number of plants per area and the market is very sensitive to seed size, where smaller seeds are desirable. A true Natto soybean will have ≥ 4200 seeds per pound. Trade missions, for instance from Korea and Japan, visit ND regularly to obtain production information and establish contacts with producers and processors. There is an increasing opportunity for ND growers to export identity preserved soybeans to Asian countries. The research results of this project will provide producers production information for identity preserved production systems.

Description of the research

Experiments were seeded at Prosper and at the Carrington Research and Extension Center. The experimental design was a split-plot in a randomized complete block with four replications. Row spacings were treated as whole plots and sub-plot factors were a variety x population factorial arrangement.

The research had three row spacing; solid seeded, narrow rows and wide rows (7, 14 and

28 inch row spacing, respectively), two Natto varieties (SB4020 = "Prematto" and MK0649), and five populations (100,000; 200,000; 250,000 300,000; and 400,000 live seeds per acre).

Characteristics evaluated included plant stand, plant height and lodging, seed yield, protein and oil content, and seed weight. Visual observations included days to emergence, initial and final stands, general staging of plant growth and leaf canopy development, crop competing ability, and pest incidence. Unfortunately the research site at Prosper was flooded after seeding and the site had to be abandoned.

Analysis of variance was conducted. Treatment means separation was performed by application of a *F*-protected LSD at $P \leq 0.05$ level of significance for each evaluated characteristic. This document reports the 2008 results. The project will be repeated in 2009.

Results

There were no significant differences between the varieties therefore data presented in this report is averaged over the two tested varieties. An early season vigor score for the whole plot was given on a scale of 1 to 9 where 1 would be no plants and 9 would be a perfect stand and vigorous growth. Plants in the narrow row spacing were farther apart within the row. Visually plants in the wider rows looked more vigorous early in the season with a score of 7.7 compared with the narrow rows with a score of 6.3. The mean live seeds planted averaged across all row spacings was 250,000. The established stand was 82, 74, and 63% of the live seeds planted for the 7, 14, and 28 inch row spacing respectively (Table 1). This indicates that as the amount of seeds in the row is increased the percent of seed making it to established plants is decreased. The pods per plant were similar for all rowspacings but the number of plants differed significantly. The plants in the wider rows were significantly taller, most likely due to the in-row competition. Two staff members of **Sinner Bros. & Bresnahan** in Casselton evaluated the seed quality of each treatment on a scale of 1 to 5 in which 5 represents the best possible seed quality. Seed quality was similar for the 7 and 14 inch row spacing but significantly lower with the 28 inch row spacing.

Photos: Left 7 inch, middle 14 inch and right 28 inch row spacing, Carrington, 2008.



Table 1. Vigor, plants per acre, pods per plant, plant height, and visual seed score.

Row	Vigor	Plants/ acre 7/28	Pods/ Plant	Height	SBB seed score
Spacing	(1-9)	(Plants)	(Pods)	(Inch)	(1-5)
7	6.3c	205,121a	28.6a	26.1b	3.34ab
14	6.8b	183,855b	28.7a	26.2b	3.50a
28	7.7d	157,895c	30.1a	28.3a	3.26b

Treatments in the same column with at least one similar letter are not significantly different.

The Natto yield showed significant increases from the 28 to 14 and from 14 to 7 inch row spacing (Table 2). The protein content was significantly lower with the 7 and 14 inch compared with the 28 inch row spacing, however the oil content of the Natto in the 28 inch row spacing was significantly lower than the two other row spacings. Seeds were smaller in the 7 inch compared with the 28 inch row spacing.

Table 2. Yield, protein and oil content, and seeds per lb.

Row	Yield	Protein	Oil	Seeds/lb
Spacing	(Lb/a)	(%)	(%)	(Seeds)
7	1589a	32.1b	19.1a	6909a
14	1406b	32.3b	19.1a	6865ab
28	1304c	33.7a	18.6b	6800b

Treatments in the same column with at least one similar letter are not significantly different.

Table 3. Vigor, plants per acre, pods per plant and plant height.

Seeding	Vigor	Plants/a	Pods/Plt	Height
X 1000	(1-9)	(Plants)	(Pods)	(Inch)
100	4.5d	87,956e	49.2a	26.2b
200	6.5c	152,146d	31.4b	27.1a
250	7.4b	186,759c	24.8c	27.1a
300	7.8b	222,618b	22.6c	26.9ab
400	8.5a	264,973a	17.6d	26.9ab

Treatments in the same column with at least one similar letter are not significantly different.

The established stand was 88, 76, 75, 74, and 66% for the 100,000; 200,000; 250,000; 300,000; and 400,000 live seeds planted, respectively (Table 3). As expected the established plants increased with the increased seeding rate. The vigor score increased with the increased seeding rate. The number of pods per plant decreased with increased seeding rate. The height of the plants with the 100,000 live seeds seeding rate was significantly less than plants seeded at the 200,000 or 250,000 live seeds seeding rate.

The yield with the lowest seeding rate was significantly lower than any of the other seeding rates (Table 4). There was no significant yield difference between 200,000 through 400,000 live seeds per acre seeding rate. Protein content tended to increase with higher seeding rates and oil content to decrease. The two lower seeding rates (100,000 and 200,000 live seeds) had significantly fewer seeds (larger) per lb compared with the highest seeding rate.

Table 5 provides the yield for the different combinations of row spacing and seeding rate. The numbers are grouped from highest to lowest yielding. The 7 inch row spacing group had the highest yield. The lowest seeding rates (100,000) of the 7 inch spacing was significantly lower yielding than the other seeding rates of the 7 inch row spacing.

Conclusions

The 7 inch row spacing provided the highest yield level compared with 14 and 28 inch. The 14 inch row spacing provided higher yields than the 28 inch row spacing. Seeding rates of 200,000 – 400,000 live seeds per acre did not significantly differ in yield. With increasing seeding rates the percent of the live seeds surviving to established plants decreased. This data would indicate that 7 inch x 200,000 live seeds per acre would be the best for yield and economic return.

Table 4. Yield, protein and oil content, and seeds per lb.

Seeding	Yield	Protein	Oil	Seeds/lb	SBB seed score
X 1000	(Lb/a)	(%)	(%)	(Seeds)	(1-5)
100	1352b	31.6d	19.5a	6765b	3.40a
200	1469a	32.5c	19.0b	6826b	3.33a
250	1466a	32.8bc	18.9b	6869ab	3.31a
300	1431a	33.1b	18.7c	6872ab	3.31a
400	1474a	33.6a	18.6c	6957a	3.48a

Treatments with at least one similar letter are not significantly different.

Photos: Carrington end of the season 2008.

7 inch

14 inch

28 inch

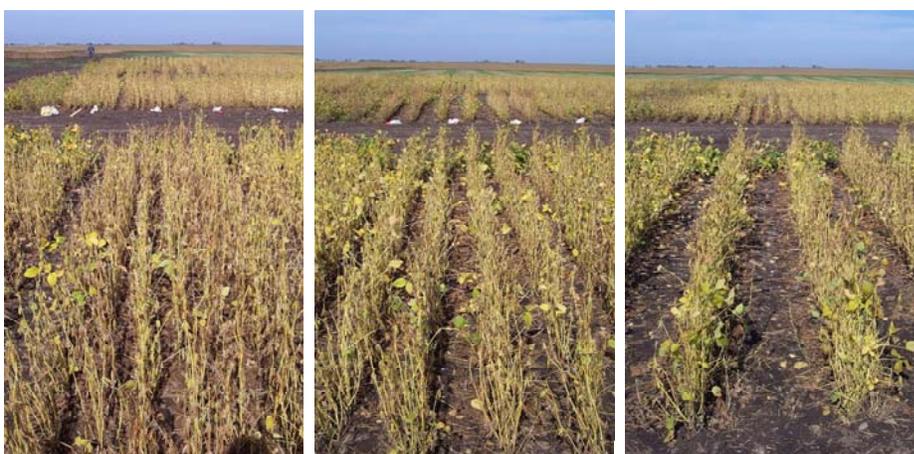


Table 5. Yield per acre for row spacing and seeding rate.

Row spacing in inch	Seeding rate x 1000	Yield in lb per acre
7	250	1698a
7	200	1660a
7	400	1586ab
7	300	1576ab
14	300	1488bc
14	400	1471bcd
14	200	1432cde
7	100	1424cdef
14	250	1369cdefg
28	400	1365cdefg
28	250	1331defg
28	200	1315efg
28	100	1282fg
14	100	1270g
28	300	1229g

Treatments with at least one similar letter are not significantly different.