A1718 (Revised January 2019)

Selected Management Factors for Economically Increasing Soybean Yield

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Photos by Greg Endres and Hans Kandel

About 3.8 million acres of soybeans were planted in North Dakota in 2008. That number reached 6.9 million acres in 2018. The growth in acreage can be attributed to the relative ease in producing the crop and its profitability.

Fluctuating weather, with varied rainfall amounts and stored soil moisture levels, requires soybean growers to make careful decisions on the tillage system, fertility management, variety selection, seedbed preparation, weed control strategies, rotations and soybean pest management practices.

Opportunities exist for farmers to increase soybean yield and profitability by improving plant establishment practices. Also, numerous special inputs that may add to soybean profits are being marketed.

A study was conducted by NDSU with selected intensive management practices and inputs to examine potential increases in yield and profit.

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Fargo, North Dakota

Materials and Methods

Nine research trials were conducted during a four year period at the NDSU Carrington Research Extension Center and research sites in Prosper and Fargo to examine inputs that potentially could increase soybean seed yield and profitability. The trials at Carrington were conducted on dryland conditions during year one and under irrigation during the entire study period. Trials were conducted at Prosper during year two and three, and in untiled and tiled environments at Fargo during the fourth year of the study.

The agronomic response of early and late-maturing varieties was examined using the production factors of planting rates, row spacings and special foliar inputs. Two Roundup Ready varieties, with maturity group ranges of 0.0 to 0.2 and 0.6 to 0.8, were planted each year (Table 1). Also, two planting dates were examined at Carrington in year one.

Planting rates were 150,000 and 200,000 pure live seeds (pls)/acre. Row spacings were 14 and 28 inches. Special foliar inputs included: 1) TJ Technologies micronutrient mix "Sunflower/Canola/Soybean" at 48 fluid ounces (fl oz)/acre plus Novozyme LCO Promoter (experimental product used in the first year and "Ratchet" at 4 fl oz/acre during the rest of the study) during second- to third-trifoliate (V2 to V3) growth stages and 2) BASF fungicide "Headline" at 6 fl oz/acre + NIS at 0.125 percent volume/volume during flowering to early pod development (R2 to R3) growth stages.

Other best management practices were used for soybean production during the study. Seed was inoculated with *Bradyrhizobium japonicum*.

Results and Discussion

The study's average early season (two to four weeks after planting) established soybean plant density was 130,500 plants/acre with the planting rate of 150,000 pls/acre and 163,800 plants/acre with 200,000 pls/acre (Table 2). The percentage of established plants compared with planting rate was 87 percent with the low planting rate and 82 percent with the high planting rate.

Table 3 indicates soybean seed yield with row spacings, planting rates and special foliar inputs for each trial. Averaged across the nine trials, the study indicates the following yield advantages:

- 1.4 bushels (bu)/acre with 14-inch versus 28-inch rows

Table 1. Varieties and planting dates in soybean intensive management study, North Dakota, during the four year study.

	Soybean Variety			
	Maturity		Planting Date	
Trial	early	late	1st	2nd
Carrington year one – dryland	DSR0401	NKS08C3	May 16	May 24
Carrington year one – irrigated	DSR0401	NKS08C3	May 16	May 24
Carrington year two – irrigated	RT0268	RT0669	May 22	x
Prosper year two	RT0268	RT0669	May 28	x
Carrington year three – irrigated	PFS1000	PFS0806	May 14	x
Prosper year three	PFS1000	PFS0806	May 20	x
Carrington year four – irrigated	PFS1002	DSR0747R2Y	May 23	x
Fargo year four – untiled	PFS1002	DSR0747R2Y	May 19	x
Fargo year four – tiled	PFS1002	DSR0747R2Y	May 19	x

Table 2. Planting rate and established stand in soybean intensive management study, North Dakota, during the four year study.

	Planting Rate (pls/acre)	
	150,000	200,000
	plants/acre[1]	
Carrington year one – dryland	143,500[b]	163,100[a]
Carrington year one – irrigated	141,700[b]	182,300[a]
Carrington year two – irrigated	151,800[b]	194,200[a]
Prosper year two	119,000[b]	155,600[a]
Carrington year three – irrigated	132,900[b]	167,200[a]
Prosper year three	137,200[b]	177,900[a]
Carrington year four – irrigated	147,700[b]	182,600[a]
Fargo year four – untiled	94,100[b]	119,200[a]
Fargo year four – tiled	103,400[b]	135,200[a]
Study average	130,500[b]	163,800[a]

[1] Different letters in the same row indicate statistical differences (LSD=0.05).

Table 3. Yield and net return with main factors in soybean intensive management study, North Dakota, during the four year study.

	Yield (bu/acre)[1]					
	Row Spacing (inches)		Planting Rate (pls/acre)		Special Foliar Inputs	
Trial	14	28	150,000	200,000	Yes	No
Carrington year one – dryland	36.9[a]	35.5	36.2	36.2	37.1[a]	35.4
Carrington year one – irrigated	42.7	42.0	41.9	42.7	43.6[a]	41.0
Carrington year two – irrigated	48.3	48.2	46.5	50.0	48.8	47.7
Prosper year two	53.8	53.7	55.5	51.9	54.7	52.8
Carrington year three – irrigated	63.9	62.5	62.5	63.9	64.7[a]	61.7
Prosper year three	55.2	54.5	53.6	56.0	55.7	54.0
Carrington year four – irrigated	52.4[a]	48.1	49.6	50.9	51.5[a]	49.0
Fargo year four – untiled	44.5	42.5	41.3	45.7[a]	44.7	42.4
Fargo year four – tiled	51.5	49.9	48.6	52.8[a]	52.0	49.4
Study average	49.9[a]	48.5	48.5	49.9[a]	50.3[a]	48.1
Net revenue/acre[2]	$499	$485	$435	$432	$466	$481

[1] 'a' indicates mean within a factor is statistically significant (LSD=0.05) by trial and study average.

[2] Assumptions: $10/bu soybean market price; seed costs: $0.30/1,000 seeds; $5/acre field application cost; $32/acre special foliar input cost.

- 1.4 bu/acre with planting 200,000 pls/acre versus 150,000 pls/acre
- 2.2 bu/acre with special foliar inputs versus untreated check

Assumptions used for determining net revenue after costs of research factors include $10/bu soybean market price; no difference in costs between row spacings; 30 cents/1,000 seeds with 10 percent additional seed used to reach desired pls/acre; total cost of $32/acre for special foliar inputs plus $5/acre for a field application cost. Averaged across the nine trials, the study indicates the following revenue advantages:

- $14/acre with 14-inch vs. 28-inch rows
- $3/acre with the low vs. high planting rate
- $15/acre without special foliar inputs

The Fargo research site compared soybean performance with tiled and untiled conditions using controlled drainage structures **(Table 4)**.

Early vigor was slightly greater, plants were taller and iron chlorosis expression was slightly lower in the tiled treatment. Seed yield with tiled was 13 percent higher than untiled yield.

Table 4. Response to tile versus nontile environments in soybean intensive management study, North Dakota, Fargo, during year four.

	Plant			
Drainage[1]	Vigor[2]	Height	IDC[3]	Yield
	(1-9)	(inch)	(1-5)	(bu/acre)[4]
Tiled	5.5[a]	27.5[a]	2.6[b]	50.7[a]
Untiled	4.9[b]	23.6[b]	2.9[a]	43.9[b]

[1] Two environements: tiled and untiled in Fargo.

[2] Early season vigor; 1 = least vigorous and 9 = most vigorous.

[3] IDC = Iron Chlorosis Deficiency symptoms; 1 = tissue green and 5 = tissue yellow/brown. Scoring conducted on June 30.

[4] Different letters in the same column indicate statistical differences (LSD=0.05).

Soybean yield was 2.6 bu/acre (5 percent) greater with the later maturity group (50.5 bu/acre), compared with the early maturity group (47.9 bu/acre). The highest yield with the combination of maturity groups and row spacing was with the later-maturing varieties grown in 14-inch rows **(Table 5)**.

Fourteen-inch rows and two varieties, Carrington, during year two of the study.

Table 5. Yield with maturity groups and row spacing in soybean intensive management study, North Dakota, averaged over the four year study period.

Maturity Group	Row Spacing	Yield
	(inches)	(bu/acre)[1]
0.6-0.8	14	51.7[a]
0.6-0.8	28	49.4[b]
0.0-0.2	14	48.1[c]
0.0-0.2	28	47.7[c]

[1] Letters indicate statistical differences (LSD = 0.05).

Table 6 displays average date of canopy closure, lowest pod height, and yield with row spacing and planting rates.

Averaged across seven trials, canopy closure with 14-inch rows was 35 days earlier, compared with 28-inch rows. The early canopy closure with the narrow rows provided the opportunity for increased capture of sunlight, increased crop competitiveness with weeds, decreased soil moisture loss from evaporation and ultimately yield increase, compared with the wide rows.

Canopy closure occurred sooner with 14-inch rows but was similar between planting rates. Pod height generally increased slightly with the high planting rate. Yield was highest with 14-inch rows and the high planting rate.

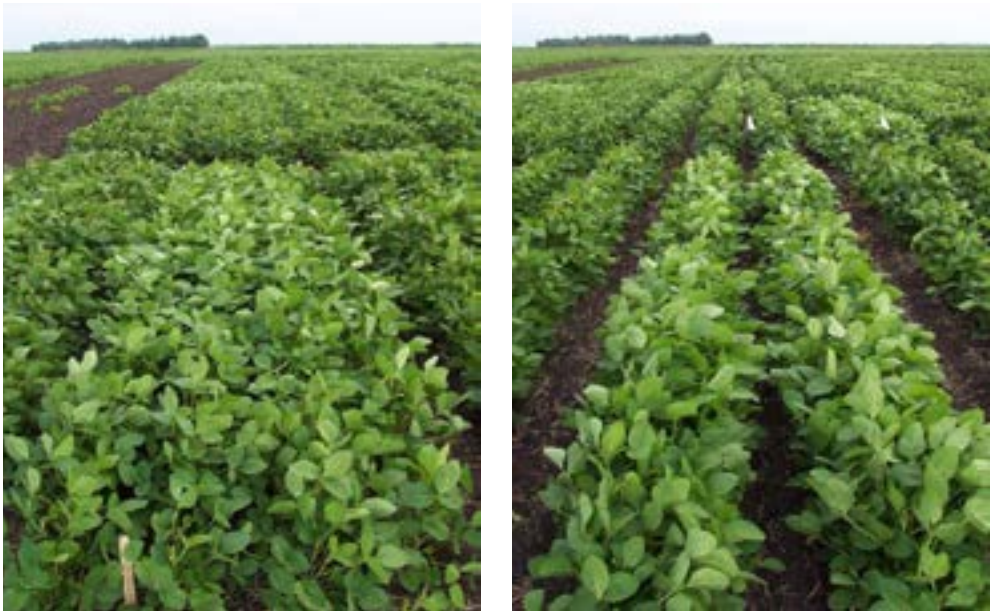
Table 6. Response to row spacing and planting rate in soybean intensive management study, North Dakota, averaged over the four year study period.

Row Spacing	Planting Rate	Canopy Closure	Lowest Pod Height[2]	Yield
(inches)	(pls/acre)	(day of the year)[1]	(cm)	(bu/acre)[3]
14	150,000	205[a]	5.8[ab]	49.3[b]
14	200,000	205[a]	6.2[a]	50.5[a]
28	150,000	241[b]	5.4[b]	47.8[c]
28	200,000	239[b]	6.1[a]	49.3[b]

[1] Seven environments (no data recorded for Fargo).

[2] Six environments (no data recorded for Prosper in year two and Fargo).

[3] Different letters in the same column indicate statistical differences (LSD=0.05).



14-inch rows (left) and 28-inch rows (right) at 150,000 pls/A in late July during the second year at Prosper.

Soybean yield and net revenue after costs of research factors with the combination of row spacing, planting rates and special foliar inputs are listed in **Table 7**. The highest yield was obtained with foliar inputs in 14-inch rows at both planting rates and in 28-inch rows at the high planting rate. However, the combination of 14-inch rows and 150,000 pls/acre planting rate without foliar inputs provided the highest net revenue.

Table 7. Yield and net revenue with three factor interactions in soybean intensive management study, North Dakota, averaged over the four year study period.

Row Spacing	Planting Rate	Special Foliar Inputs	Yield	Net Revenue After Costs of Research Factors/Acre
(inches)	(pls/acre)		(bu/acre)[1]	($)
14	150,000	yes	50.2^{ab}	465
14	150,000	no	48.4^{c}	484
14	200,000	yes	51.7^{a}	463
14	200,000	no	49.3^{bc}	476
28	150,000	yes	48.9^{bc}	452
28	150,000	no	46.7^{d}	467
28	200,000	yes	50.4^{ab}	450
28	200,000	no	48.2^{cd}	465

[1] Different letters in the yield column indicate statistical differences (LSD = 0.05).

[2] Assumptions: $10/bu soybean market price; seed costs: $0.30/1,000 seeds; $5/acre field application cost; $32/acre special foliar input cost.

Summary

- Soybean yield increased with 14-inch versus 28-inch rows, 200,000 versus 150,000 pls/acre planting rate and special foliar inputs. The narrow rows also had higher net revenue than 28-inch rows. However, the low planting rate and no foliar inputs provided higher net revenue after costs of research factors versus the alternative choice for each factor.
- While several combinations of the three main factors in the study provided high yields, the combination of 14-inch rows and the 150,000 pls/acre planting rate without foliar inputs provided the highest net revenue after costs of research factors.
- While using pure live seed as a basis for reaching a targeted plant population is recommended, also consider that an additional 10 to 20 percent seedling loss can occur between planting and emergence.
- Management strategies that reduce the time required from planting to canopy closure will increase yield potential. This study indicated that canopy closure with narrow rows occurred more than a month earlier than with wide rows.

Researched with support from the North Dakota Soybean Council
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web-5-14; web-1-19