

The Effect Of Row Spacing On Soybean Yields

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Higher yields of soybeans are possible in North Dakota if current varieties are grown in 12- or 18-inch row spacings. Yield responses varied with location, year, variety, and planting date. "Narrow rows" (12- or 18-inch) produced equal to or better than wider rows at Oakes (sprinkler irrigation), Casselton (dryland), and Fargo (dryland).

Soybeans (*Glycine max.* (L.) Merr.) are sensitive to day length and their production is influenced strongly by latitude. Although North Dakota has been considered as the northern fringe area for commercial soybean production, soybeans are of economic importance to the state. The Crop and Livestock Reporting Service, United States Department of Agriculture, estimated the 1976 soybean crop to be worth more than \$15,000,000.

Additional research on soybean production in North Dakota is needed to determine the best management conditions for maximum profit to the grower. Most cultural practices used now by North Dakota farmers have either been developed in the "Soybean Belt" or have been adapted from experience with growing corn. Many of these practices are appropriate, but some are not conducive to producing optimum yields in soybeans. Another factor considered by the grower is the economic and conservation desire to reduce the energy input for crop production. Herbicides now are available which may increase yields while reducing the energy input. However, minimum tillage practices need to be developed in conjunction with these herbicides to obtain maximum effectiveness.

Chemical or mechanical weed control in row spacings of 12 inches or less may be more effective than in 30 inch rows because the herbicide needs to be effective only for a shorter duration before the soybean canopy inhibits weed growth by shading. Row spacings of at least 20 inches have an advantage from the practical viewpoint, because they can be cultivated or receive postemergence herbicides if preemergence herbicide fails (7).

Yield response to different row spacings has varied with variety and environmental influence. Soybean yields in the primary growing region of the Midwest generally were 10-30% greater in the narrow rows (4, 5, 6, 8, 12, 13, 14). The yield increase for narrow rows generally was greater with early maturing varieties and when planting was delayed. Swallers (11) studied the response to row spacings ranging from 18 inches to 42 inches at Fargo, North Dakota in 1956 and found narrow rows did not increase yields unless planting was delayed and early maturing varieties were planted. Berglund (2) found that row spacings did not affect yield with either the 60 lb/A or

120 lb/A planting rate at Casselton, North Dakota. However, at Fargo, the 40 inch row spacing at a 120 lb/A planting rate resulted in the highest yields. Both studies in North Dakota had relatively late planting dates and dry August weather.

The purpose of this study was to determine if changed cultural practices could increase with the current varieties.

MATERIALS AND METHODS

Yield trials were conducted at three locations in southeastern North Dakota. Experiments were grown under sprinkler irrigation at Oakes and on dryland at Casselton and Fargo, North Dakota.

Oakes

Four cultivars of soybeans, 'Chippewa-64', 'Anoka', 'SRF-100', 'Morsoy', were grown in a randomized complete block design at Oakes, North Dakota, to determine the effect of cultivar, row spacing, and planting date. The experimental unit consisted of four 18-foot rows with spacings of 12, 24, and 36 inches.

All cultivars were planted in May and early June. The planting dates were May 1 and June 5 in 1971 and May 16 and June 6 in 1972.

The plant population was 150,000 plants/acre in 1971. However, poor emergence of one cultivar in 1972 required a thinning of all plants to 90,000 plants/acre to maintain plant population uniformity.

Fertilizer was plowed down to bring soil nutrient levels to 119 lb/A of P, and 282 lb/A of K on the basis of prior soil testing. Trifluralin (Treflan)¹ herbicide was applied preplant, soil incorporated at 1 lb/A as a liquid in 1971 and as granules in 1972 to control weeds. Weeds that were not controlled by Treflan were removed by hand.

Rhizobium inoculum was sprinkled on the seed in the planter "box" in 1971. In 1972, the inoculum was applied on seed that had been wetted with condensed milk as an adhesive and dried prior to planting.

The plots in 1971 were on a Gardena loam over sand with an available water holding capacity of 7.6 to 8.8 inches in the 4-foot zone. In 1972, the plots were on a Hecla sandy loam and a Maddock sandy loam having water holding capacities of 4.4 to 5.6 and 3.6 to 4.4 inches, respectively.

Soil moisture was determined by tensiometers and by feeling the soil after probing. About nine inches of water was applied during the growing season both years.

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Seed yields were harvested from 16 feet of the center two rows of each plot. The seed samples were dried to a uniform moisture percentage before weighing.

Casselton

Four replications using "solid-seeding" (6-inch) and 12-, 24-, and 36-inch row spacings were planted in a randomized complete block design in "field-size" plot units. The experimental unit was 0.36 acres in 1975 and 1.05 acres in 1976.

'Ada' soybeans were planted on May 29 and 30, 1975. The variety 'Evans' was planted May 13, 1976. Plots were planted at a rate of 16 lb/A using a Kirschmann¹ grain drill and #3 coarse feed rolls.

Fertilizer was broadcast to bring the fertility level to 75 lb/A of P and 400 lb/A of K. The fertilizer was incorporated with a tandem disk and field cultivator.

Herbicides were supplemented with hand weeding for complete weed control. A tank mix combination in the ratio of 0.75 lb/A Treflan and 0.5/A metribuzin (Sencor)¹ was applied preplant soil incorporated in 1975. In 1976, Treflan was preplant incorporated at the rate of 0.75 lb/A and Bentazon (Basagran)¹ was applied aerial, post emergence at 0.75 lb/A.

Plots were harvested at 12-13% seed moisture content with commercial sized combines. Harvest was similar to commercial farm practices used in the Red River Valley of North Dakota.

Fargo

The soybean cultivar, Evans, was planted May 19, 1976, and May 12, 1977, in rows spaced 6-, 12-, 18-, 24-, and 30-inches apart. A plant population of 150,000 plants/acre was established by thinning at the unifoliate stage. This is the expected plant population if a grower planted 60 lb/A at 93% germination of an average seed size cultivar. Treflan soil incorporated at 1 lb/A the previous fall was supplemented with a small amount of hand weeding during the growing season to eradicate weeds.

Four replications were used in a randomized complete block design. The plots were cut with a mower and threshed with a stationary small plot thresher.

RESULTS

Oakes

Average seed yields of four soybean cultivars grown with irrigation at two planting dates and three row widths in 1971 and 1972 at Oakes, North Dakota are shown in Table 1. Yields from narrow rows were significantly higher than the wider rows. When planted early, 12-inch rows yielded 25% and 40% more than 24- and 36-inch rows, respectively. When planted late, the yield advantage for 12-inch narrow rows over 24-, and 36-inch rows was 10% and 21%, respectively.

Yield differences between the 12- and 36-inch row spacings were relatively consistent across cultivars with the advantage for the 12-inch row spacing ranging from

Table 1. Bushels/acre of soybean seed of four soybean cultivars grown with irrigation at two planting dates and three row spacings in 1971-72, Oakes, North Dakota (9).

Cultivar	Row Spacing (in)	1971 Planting		1972 Planting		Average (Bu/A)
		Early (Bu/A)	Late (Bu/A)	Early (Bu/A)	Late (Bu/A)	
Morsoy	12	56.3	40.1	45.4	40.4	45.5
	24	39.4	35.2	38.1	35.9	37.2
	36	36.9	30.5	35.9	34.0	34.3
SRF-100	12	60.7	35.7	41.3	35.7	43.4
	24	50.7	34.1	46.2	33.6	41.1
	36	41.9	31.6	39.2	30.6	35.8
Anoka	12	82.8	33.1	57.0	39.1	53.0
	24	54.9	33.6	43.7	32.2	41.1
	36	49.2	31.1	38.3	29.5	37.0
Chippewa-64	12	55.9	30.8	43.0	33.0	40.7
	24	40.4	28.0	39.6	28.7	34.2
	36	40.6	23.9	32.7	27.7	31.2
Average	12	63.9	34.9	46.7	37.0	45.6
	24	46.3	32.7	41.9	32.6	38.4
	36	42.1	29.3	36.5	30.4	34.6

¹Use of a tradename does not imply a recommendation by North Dakota State University nor the authors.

21% in Chippewa 64 to 43% in Anoka. When the average of all cultivars and both planting dates is considered, the 12-inch row spacing exceeded the 24- and 36-inch spacing by 18.7% and 31.8%, respectively.

Soybean cultivars did not respond the same when planted in different row spacings at different planting dates. Early planted soybeans yielded 25% more in 12-inch than in 24-inch rows. At the late planting, the average yield for the 12-inch rows was higher, but too variable to be certain if the differences was due to the narrow row spacing.

Regression analyses of these data are illustrated in Figure 1. These data indicate early planted soybean yields increased 0.69 bu/A with each inch the row spacing decreased from 36-inch to 12-inch spacing. Late planted yields increased 0.25 bu/A with each inch the row decreased.

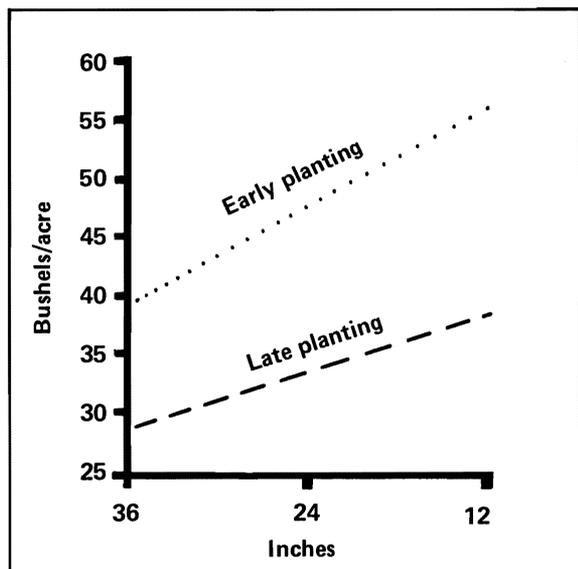


Figure 1. The average effect of row spacing on yields of four soybean varieties at Oakes, North Dakota, 1971-72.

Casselton and Fargo

Average seed yields of soybeans grown at Casselton in 1975 and 1976 are presented in Table 2. In 1975 the highest yields were from 12-inch row spacings. The yields from 24- and 36-inch row spacings were similar to each other. Results from the 1976 trial and 1975-76 average indicate the narrower row spacings exceeded the 24- and 36-inch spacings by an average of 4.6 bu/A.

Table 2. Bushels/acre of soybean seed grown at four row spacings 1975-76, Casselton, North Dakota.

Year	Row widths, inches			
	6	12	24	36
1975	22.7b ¹	24.8a	20.6c	19.2c
1976	21.2a	20.7a	17.6b	15.1b
Average	22.0a	22.7a	19.1b	17.1b

¹ Values followed by the same letter within the same year or the average are not statistically different.

Results from the 1976-77 Fargo trials are presented in Table 3. Narrow row spacings (6- and 12-inch) were significantly higher yielding than the wide rows (24- and 36-inch) in 1976. No yield differences due to row spacing were present in 1977 or when the two-year average was considered. The yield differences were due to factors other than row spacings, in this instance.

Table 3. Bushels/acre of soybean seed at five row spacings 1976-77, Fargo, North Dakota.

Year	Row spacing, inches				
	6	12	18	24	30
1976	21.9a ¹	22.8a	20.8ab	18.8b	19.6b
1977	44.4a	44.5a	42.7a	44.5a	41.8a
Average	33.1a	33.6a	31.7a	31.6a	30.7a

¹ Values followed by the same letter within the same year or the average are not significantly different.

The two-year average effect of row spacing on dryland soybean yields at Casselton and Fargo is presented graphically in Figure 2. These lines illustrate similar trends at each location, yields increasing as the row spacings decreased to 12 inches. Yields from solid-seeding (6-inch spacing) were slightly lower than the 12-inch row spacing at both locations.

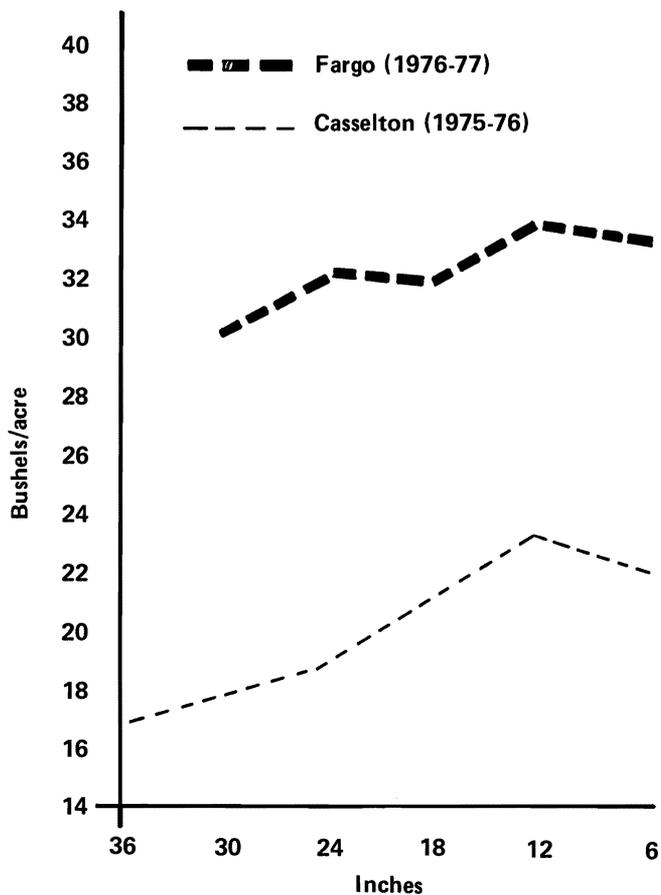


Figure 2. The effect of row spacing on soybean yields at Casselton and Fargo, North Dakota.

DISCUSSION

These results are in general agreement with studies (1, 3, 4, 6, 8, 14) conducted in other states, which reported that soybeans in narrow rows produce the highest yields. Results from the Oakes study suggest that soybean yields can be increased substantially by reducing the row spacings to 12 inches under irrigated conditions. Optimum growth conditions and variety selection apparently accentuate this yield differential. When yields were averaged over seasons and varieties, the early planted 12-inch rows exceeded the 36-inch rows by 41% as compared to a 20% increase with the late planting. Average yields for the variety Anoka increased by 43% when the row width was decreased to 12 inches, while Morsoy, SRF-100, and Chippewa-64 yields increased 28%. These data substantiate results reported by Cooper (3) that some varieties show a greater response to narrow rows, particularly under irrigated conditions.

The yield response for narrow rows was less evident on dryland conditions at Casselton and Fargo. Narrow rows were significantly higher yielding than wide rows at Casselton, 1975-76, and Fargo in 1976. However, the 24-inch row spacing at Fargo was identical in yield to the 12-inch spacing in 1977. These results lead to the conclusion that a 12-inch row spacing may produce the highest soybean seed yield. A producer probably would not reduce the yield by going from wide rows to narrow rows and may, in some years, increase productivity.

The availability of soil moisture and planting date appear to be the most critical environmental factors in determining anticipated soybean seed yield responses to variable row spacings. Studies in Missouri, Kansas, and Iowa (9) point to an advantage for early maturing varieties at the wider row spacings if planted late during dry years. These results are most prevalent in soils that have hardpans or low water holding capacity. In these conditions, some soil water was available between the rows when the plants were in the pod-stage. The full season cultivar, i.e., Anoka, produced the highest yields under narrow row spacing at Oakes where water was not as much a limiting factor as for the cultivars in the dryland studies at Casselton and Fargo where soil moisture availability was a factor. Precipitation amounts during the critical pod-setting period of development in late July and early August was unusually low during each of the three seasons, including an all-time seasonal drought in 1976. The advantage for narrow row spacings at Casselton and Fargo may have been minimized under these dryland environmental conditions.

Weed control is another major consideration. Chemical or mechanical weed control may be more effective in narrow rows than in 40-inch rows because the herbicide needs to be effective only for a short time before the soybean canopy shades out weeds between and within the rows (7). However, narrow rows do not eliminate the need for good weed control measures. Instead, initial good weed control may be more important in narrow rows because of the inability to cultivate after soybean emergence. From the practical viewpoint 24-inch rows have an advantage over solid-seeded (6-inch) or 12-inch rows in that they can be cultivated once or receive a post-

emergence herbicide without reducing the soybean plant population when a preemergence type has failed. Another consideration might be to provide for a 24-inch spacing for the tractor track with 12-inch spacings between the other rows.

Some herbicides provide broad-spectrum weed control, either singly or in combination, in soybeans. Results at Casselton (unpublished data) have indicated chemical weed control has been inconsistent. However, continued research may reveal a system utilizing herbicides to provide nearly "weed-free" soybeans in the future which would increase the probability of obtaining maximum yields with narrow rows.

REFERENCES

1. Auckland, A. K. 1974. **Inheritance and interrelationship of canopy characteristics and specific leaf weight in soybeans (*Glycine max. (L.) Merr.*)**.
2. Berglund, D. R., and J. D. Nalewaja. 1969. **Wild mustard competition in soybeans**. Proceedings, North Central Weed Control Conference Vol. 24:83.
3. Cooper, R. L. 1977. **Response of soybean cultivars to narrow rows and planting rates under weed-free conditions**. Agron. J. 69:89-92.
4. Cooper, R. L., and J. W. Lambert. 1965. **Narrow rows and soybean yields in Minnesota**. Farm Home Sci. 22 (4):5-7.
5. Mader, E. L. 1963. **Producing soybeans in Kansas**. Kansas Agr. Expt. Sta. Bulletin 458. 16 p.
6. Pendleton, J. W., R. L. Bernard, and H. H. Hadley. 1960. **Grow soybeans in narrow rows**. Illinois Res. 2 (1):3-4.
7. Pendleton, J. W., and E. E. Hartwig. 1973. Management. p. 214-216. In B. E. Caldwell (ed.) **Soybeans: improvement, production, and uses**. Am. Soc. Agronomy, Inc., Madison, Wisconsin.
8. Reiss, W. D., and L. V. Sherwood. 1965. **Effect of row spacing, seeding rate and potassium and calcium hydroxide additions on soybean yields on soils of Southern Illinois**. Agron. J. 57: 431-33.
9. Searle, L. 1976. **Dry years are different...management strategies**. Soybean Digest, Nov.:8.
10. Sletteland, R. L. 1974. **Variety, planting date, and row width effects of irrigated soybeans at Oakes, North Dakota**. MS thesis, North Dakota State University, Fargo, North Dakota. 67 p.
11. Swallers, C. M. 1957. **The effect of dates and rates of planting and row width upon certain characters of four soybean varieties**. MS thesis. North Dakota State University, Fargo, North Dakota. 59 p.
12. Thompson, H. S., and J. C. Herman. 1968. **Guidelines for profitable soybean productions**. Iowa Agr. Expt. Sta. pp.441.
13. Wax, L. M., and J. W. Pendleton. 1968. **Nodulating and non-nodulating soybean isolines: II. Response to applied nitrogen and modified soil conditions**. Agron. J. 58:46-49.
14. Weber, C. R., R. M. Shibles, and D. E. Byth. 1966. **Effect of plant population and row spacing on soybean development and production**. Agron. J. 58:99-102.