Effect of Phosphorus Fertilization of Soybeans at Three Planting Dates

Jasper M. Teboh, Szilvia Yuja, Kelly Cooper, Heidi Eslinger, and Mike Ostlie

Objective

- Evaluate soybean P fertility management based on planting date in different environments

Materials and methods

Two soybean planting date trials were conducted in 2019 at the NDSU Carrington Research Extension Center under irrigation and dryland conditions, and a third trial was conducted at Oakes, under irrigation. Yields were evaluated in response to soybeans planted on three dates that received three phosphorus (P) fertilizer rate treatments at 0, 20, and 40 lbs P_2O_5. Composite soil samples were taken at the top 6 inches and analyzed for P and reported with the planting dates for each site as described in Table 1. Normal planting date, as referenced in these studies, reflects an approximate period between mid-May to May 25, when the majority of farmers start and conclude their soybean planting in eastern North Dakota. However, the majority of the farmers would typically start planting within the first two weeks of May if conditions were adequate, and after their early-season crops would have been planted.

Table 1. Soil analysis and soybean planting date by site.

	Carrington		Oakes
	Dryland	Irrigated	Irrigated
	Soil test P		
	7 ppm	9 ppm	18 ppm
Planting Date	Dates planted		
Early	7-May	7-May	7-May
Normal	21-May	21-May	24-May
Late	3-Jun	3-Jun	31-May

Results

At Carrington, yields at the dryland site (58 bu/ac) were about 12 bushels greater than averages for the area. P fertilization had significant impact on yields (Table 2). Application of 40 lbs P improved yields by three bushels from the control. At 20 lbs P, soybean yield (58 bushels) improved by two bushels, but was not significantly different from yields at either 0 or 40 lbs P (Table 2). Planting dates had significant effects on yields. Planting early and during the normal planting date resulted in 8 and 9-bushel increases, respectively, compared to late planting (52 bushels). Seed protein significantly improved by 0.3% from P application, but was significantly less at early planting compared to either normal or late planting. Even though grain protein tends to be relatively less when yields are greater, the lower protein from early planting could not necessarily be attributed to higher yields from early planting because the normal planting date produced similar yields; yet, the grain protein was significantly greater than for early planting. Results from a similar dryland study, conducted in 2018, showed that normal and late planted soybean yields (37 bushels each) were significantly lower than from early planting (46 bushels), but their protein content was significantly greater (36.5 and 37.5%, respectively) than for early planting (35.4%).

Mid-September maturity status of soybeans planted at three different dates, with the earliest date on the left.

Table 2. Effects of planting date and P fertilization on seed yield, protein, test weight (TWT), and oil content of dryland soybean at Carrington (2019).

P Rate (P)	Yield	Protein	TWT	Oil
lb/ac	bu/ac	%	lb/bu	%
0	56b	34.2b	57.3	17.4a
20	58ab	34.5a	57.3	17.2b
40	59a	34.5a	57.4	17.3b
Date				
Early	60a	34.0b	57.4	17.5a
Normal	61a	34.6a	57.3	17.4b
Late	52b	34.5a	57.3	17.0c
Effects	----------*p > F*----------			
P Rate	0.0624	0.0022	0.8331	0.0099
Date	0.0079	0.008	0.2926	<0.0001
P x Date	0.6851	0.1644	0.9581	0.68

[ab] Means separated by different letters within a column are significantly different (p<0.1).

At the Carrington irrigation site, yields were about average, at 62 bushels. Yields responded significantly to planting date and P fertilization (Table 3). Yields from late planting were at least 10 bushels less than from earlier planting dates. A two-bushel improvement in yield from 20 lbs P was statistically significant in comparison to the control; meanwhile, a bushel increase by 40 lbs P over the control was not statistically significant. Planting late resulted in significantly greater seed protein content than from the two earlier dates, but also produced significantly lower TWT and oil.

Fig 1. Soybean yield response to P rates and planting dates under dryland and irrigated conditions at Carrington (2019)

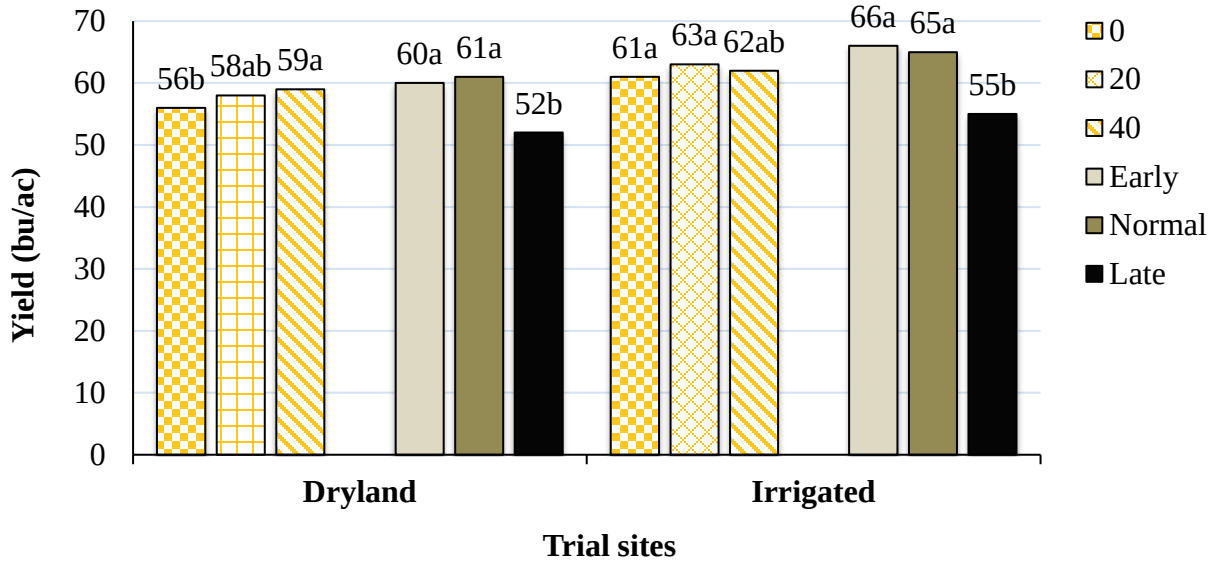

Table 3. Effects of planting date and P fertilization on seed yield, protein, test weight (TWT), and oil content of irrigated soybean at Carrington (2019).

P Rate (P)	Yield	Protein	TWT	Oil
lb/ac	bu/ac	%	lb/bu	%
0	61b	35.3	57.6	17.1
20	63a	35.3	57.6	17.1
40	62ab	35.3	57.6	17.0
Date				
Early	66a	35.2b	57.8a	17.3a
Normal	65a	35.2b	57.6a	17.1b
Late	55b	35.5a	57.3b	16.8c
Effects	----------*p > F*----------			
P Rate	0.0606	0.5061	0.9354	0.4138
Date	<.0001	0.0251	0.0053	<0.0001
P x Date	0.1322	0.1514	0.6069	0.2250

[ab] Means separated by different letters within a column are significantly different (p<0.1).

At Oakes, planting date significantly affected yields. Yields from late planting were significantly greater than from early or normal planting dates (Table 4). This was probably due to hail damage in early June to young growing plants from the two earlier planting dates. Grain protein was significantly greater from late planting. The TWT from early planting was significantly less than from the normal planting date.

Table 4. Effects of planting date and P fertilization on seed yield, protein, test weight (TWT), and oil content of irrigated soybean at Oakes (2019).

P Rate (P)	Yield	Protein	TWT	Oil
lb/ac	bu/ac	%	lb/bu	%
0	62.3	34.5	56.5	17.8
20	61.0	34.6	56.3	17.7
40	59.9	34.5	56.6	17.7
Date				
Early	59.3b	34.3b	56.2b	17.8
Normal	59.4b	34.5b	56.6a	17.7
Late	64.3a	34.9a	56.5ab	17.6
Effects	----------*p > F*----------			
P Rate	0.3456	0.6533	0.211	0.7676
Date	0.0184	0.0001	0.0564	0.3041
P x Date	0.3329	0.9895	0.3192	0.3036

[ab] Means separated by different letters within a column are significantly different ($p<0.1$).

Conclusion

From these studies, the effects that P fertilization had on yields were not dependent on the date of planting. Compared to the unfertilized control, P fertilization improved yields at Carrington by an average of 2.5 bushels under dryland, where soil P was low, by 1.5 bushels under irrigation where P was medium, but did not improve yields where P was very high (Oakes). Even though P improved yields, the yield gains were neither high enough, nor consistent enough to economically justify recommending that farmers fertilize soybeans with P in North Dakota. Yields from early and normal planting dates were not different, but were significantly greater than planting late. Therefore, farmers are better off planting during the early to normal planting window, when the risk of yield loss is relatively low.