Effect of Planting Dates on Yield and Other Agronomic Traits of Dry Bean.

K.F. Grafton and A.A. Schneiter

Dry edible bean (*Phaseolus vulgaris* L.) has become an important cash crop in eastern North Dakota, but limited information is available concerning production practices to achieve optimum yields. An important production component of yield is date of planting (Quinones, 1968). Early plantings may expose the bean seedlings to a late frost, while delayed plantings may reduce the yield potential of the crop. Yield reductions due to delayed planting also occur in soybean, maize, and other crops grown in North Dakota (Berglund and Whited, 1979; Berglund et al., 1984). The objective of this study was to determine the effect of planting dates on yield and other agronomic traits of pinto and navy beans.

Procedures

A known number of germinable seed of the navy bean cultivar Seafarer and the pinto bean cultivar UI-114 were sown at approximate two-week intervals: May 1, May 15, May 31, and June 14 during 1977, 1978, and 1980 at Fargo. Data were collected in 1977 and 1978 on days to emergence, the number of seeds per pod, harvest index (percent of total above-ground biological yield as seed), maturity (expressed as days from planting to harvest), and the number of pods per plant. Data for percent emergence of live seed, yield, and seed weight were collected for each year of this study. Plots were overplanted and thinned to a recommended uniform population of 4.5 plants per foot (90,000 plants per acre) for navy and 3.5 plants per foot (70,000 plants per acre) for pinto beans. All data obtained from this study except percent emergence are based on equal plant populations.

Plots consisted of three rows, 21.5 feet long, spaced 30 inches apart. The experimental design was a split-plot design with cultivars as main plots and planting dates as sub-plots. At maturity, the center row of each plot was harvested as an estimate of yield, and five plants per plot were obtained at random from border rows for an estimate of yield components.

Grafton is assistant professor and Schneiter is professor, Department of Agronomy.

Results and Discussion

A summary of the weather data for the 1977, 1978, and 1980 growing seasons is presented in Table 1. The first year of this study was characterized by higher-than-average temperatures from May to July, with higher-than-average precipitation occurring in both May and July. The 1978 growing season had higher-than-average temperatures in May and September with temperatures near normal in June, July, and August. Precipitation during this period was near normal. The 1980 growing season had above normal temperatures in May with near normal temperatures from June through September. Precipitation during the 1980 growing season was below normal early, resulting in a drought stress condition for the remainder of the season.

Yield, percent emergence, and seed weight increased significantly from the May 1 to May 15 planting dates in 1977 (Table 2). Maturity, expressed as days from planting to harvest, was reduced significantly when planting was delayed from May 1 to May 15. By contrast, planting delayed to May 15 in 1978 resulted in slightly decreased yield and seed weight and an increase in the number of days to reach maturity. Delays in planting beyond May 15 resulted in decreased yield in both 1977 and 1978, increases in seed weight in 1977 and 1980, and an increase in the number of days required to reach maturity in both 1977 and 1978. Percent live seed emergence was greater for the May 15 and May 31 planting dates than for the May 1 planting date in 1977 due to excessive precipitation and lower soil temperatures occurring in early May. Reduced emergence observed for the June 14 planting date in 1978 was due to moisture stress at planting followed by high precipitation. By contrast, planting on June 14 in both 1977 and 1980 had no effect on percent emergence. Since all plots were oversown, reduced emergence had no effect on final plant populations required for optimum yield. The number of seeds per pod was reduced as planting date was delayed in 1977 and 1980. Although this yield component is stable over environments, stresses during flowering may cause reductions in the number of seeds per pod.

Growing degree days (GDD), expressed as the average daily temperature over 50°F accumulated during the growing season, are presented in Table 1. GDD values in 1977 are very similar despite delays in planting. The

Table 1. Summary of temperature and precipitation data and deviations from normal for the 1977, 1978, and 1980 growing seasons.

	1977				1978				1980			
	Temp		Precip		Temp		Precip		Temp		Precip	
Month	Ave	Dev	Total	Dev	Ave	Dev	Total	Dev	Ave	Dev	Total	Dev
	°F		in.		°F		in.		°F		in.	
April	49.5	+ 7.2	0.84	−1.24	42.5	+0.2	1.15	−0.93	49.0	+6.7	0.02	−2.06
May	66.5	+11.9	7.30	+5.01	59.1	+4.5	1.78	−0.51	61.4	+6.8	0.64	−1.65
June	66.6	+ 1.9	1.64	−1.56	64.7	0.0	4.40	+1.20	65.7	+1.0	2.68	−0.52
July	72.2	+ 1.5	5.36	+2.20	69.5	−1.2	2.92	−0.24	71.9	+1.2	0.76	−2.90
August	62.5	− 6.7	2.53	−0.32	69.1	−0.1	3.79	+0.94	67.5	−1.7	4.24	+1.39
Sept.	57.9	0.0	3.21	+1.37	63.6	+5.7	0.92	−0.02	56.9	−1.0	2.52	+0.68

Table 2. Effect of four planting dates on yield and agronomic traits averaged over two dry bean cultivars grown in 1977, 1978, and 1980.

Planting date	Yield	Planting to maturity	Live seed emergence	Number seeds/pods	250 g seed wt.	Growing degree days[1]
	lbs/A	days	%		g	
			1977			
May 1	1485.1	96.6	68.0	4.0	66.2	1787
May 15	1819.5	89.2	81.9	4.1	57.7	1677
May 31	1337.0	94.8	84.5	3.8	67.6	1625
June 14	1338.6	109.0	81.3	3.5	66.4	1630
			1978			
May 1	2201.3	122.0	89.2	4.5	69.0	1930
May 15	1921.7	123.0	99.6	4.5	55.9	2213
May 31	1587.8	137.0	86.3	4.4	54.9	1662
June 14	1611.8	135.0	65.2	4.4	54.9	1535
			1980			
May 1	1694.1	—	71.6	3.3	62.4	—
May 15	1608.1	—	80.8	3.4	65.4	—
May 31	1727.5	—	86.7	3.1	69.5	—
June 14	1703.9	—	83.5	3.8	67.8	—
$LSD_{0.05}$	310.4	1.8	8.7	0.45	3.0	

[1] Growing degree days = $\frac{\text{Max. temp (or 86°F)} - \text{min. temp (or 50°F)} - 50}{2}$ summed over the growing season.

delays in maturity observed in late planted material were necessary for the crop to accumulate the required GDD units in order to mature. The large differences in GDD units exhibited in 1978 may be partially explained by the generally cooler temeprature in July and August, followed by slightly warmer weather in September. Such changes in weather patterns during one growing season can influence plant development by delaying maturity of some bean cultivars, especially indeterminate types.

When summarized over the three growing seasons, significant differences in yield, percent emergence, plant weight, seed weight, harvest index, and an increase in the number of days needed to reach maturity were observed (Table 3). Yield, number of pods per plant, and number of seeds per pod were significantly reduced and maturity was delayed when planting was delayed from May 1 to May 31.

Areas with longer growing seasons and greater summer precipitation than in North Dakota may delay palnting until mid-June for most dry bean cultivars without experiencing yield losses (Eidmann and Adams, 1978). Delays in maturity brought about by late planting in North Dakota may allow the crop to be subjected to unfavorable weather during harvest. The short growing season in North Dakota necessitates planting dry beans as early as possible, after the danger of frost has passed in a given area, to achieve maximum yields and better harvest conditions with present cultivars.

Yield and yield components of the pinto and navy cultivars are presented in Table 4. No significant dif-

Table 3. Yield and other traits of dry beans planted at four dates average over years and varieties.

Planting date	Yield	Planting to maturity	Live seed emergence	Plant weight	Number pods	Seeds/ pod	250 seed weight	Harvest index[1]
	lbs/A	days	%	g			g	%
May 1	1793.5	109.3	76.2	39.7	22.6	3.9	65.4	56.2
May 15	1783.1	106.1	87.4	35.2	21.1	4.0	60.4	51.1
May 31	1550.8	115.9	85.8	32.3	18.4	3.8	63.4	51.2
June 14	1551.5	122.0	76.7	30.9	17.5	3.9	59.4	51.5
$LSD_{0.05}$	179.2	1.3	5.0	4.5	2.4	0.2	3.7	2.4

[1] Harvest index = % total above ground biological yield as seed.

Table 4. Yield and yield components of UI-114 pinto (P) and Seafarer navy (N) dry edible beans grown in three years, combined over planting dates and years.

	Yield lb/A		No. Pods		No. Seeds/pod		Seed (250) wt. (g)	
Year	P	N	P	N	P	N	P	N
	----- lb/A -----						----- g ----	
1977	1488.5	1501.6	15.1	25.5	3.7	3.9	83.6	43.4
1978	1931.0	1730.3	15.6	22.3	4.4	4.4	75.0	43.2
1980	1818.1	1548.8	16.0	25.1	3.5	3.3	84.5	45.6
$LSD^{1}_{0.05}$	NS		NS		NS		4.9	
Planting Date								
May 1	1872.7	1714.3	18.0	27.1	3.8	4.0	86.5	44.2
May 15	1791.8	1774.4	15.7	26.5	4.0	4.0	77.0	43.9
May 31	1620.6	1480.9	15.0	21.8	3.8	3.7	81.3	45.6
June 14	1698.4	1404.5	13.4	21.7	3.9	3.8	75.5	43.5
$LSD^{2}_{0.05}$	NS		NS		NS		4.6	

[1] LSD value based on the interaction of years and bean classes.

[2] LSD value based on the interaction of planting dates and bean classes.

ferences were observed for yield, number of pods per plant, or the number of seeds per pod of the pinto or navy cultivars when averaged over planting dates or years. As expected, seed weight of the navy bean cultivar was significantly less than that of the pinto cultivar. The limited response of yield components over years of planting dates is characteristic of the compensatory nature of dry beans (Adams, 1972).

Conclusion

This study indicated that delayed maturity would be obtained from late planting. Yield reductions would also occur. To obtain maximum yields, planting as early as possible is desired. However, dry bean growers should keep in mind that the plants are susceptible to frost at all stages of growth. Planting should be delayed so that seedlings emerge after the last average frost for a given area which, for most areas of North Dakota, would correspond to the May 15-May 31 planting dates. Also, in order to minimize seedling rots, planting should be delayed until the soil temperature reaches 50°F (Schneiter, 1981).

References

Adams, M.W. 1967. Basis of yield component compensation in crop plants with special reference to the field bean *Phaseolus vulgaris*. Crop Sci. 7:505-510.

Berglund, D.R., J.L. Helm, and H.Z. Cross. 1984. Corn production for grain and silage. North Dakota Coop. Ext. Service Circular A-834.

Berglund, D.R, and D.A. Whited. 1979. Soybean production. North Dakota Coop. Ext. Service Circular A-250.

Eidmann, M.H., and M.W. Adams. 1978. Row width, plant spacing, and planting depth. P. 124-133. In L.S. Robertson and R.D. Frazier (eds.) Dry Bean Production - Principles and Practices. Michigan State University - Cooperative Extension Service. Ext. Bulletin E-1251.

Quinones, F.A. 1968. Response of pinto beans to date of planting. New Mexico State University Experiment Station Bulletin 529.

Schneiter, A.A. 1981. Germination, growth and development. p. 4-7. In D.R. Berglund (ed.) Dry Bean Production Handbook. North Dakota Coop. Ext. Service Circular A-602 Revised.