Cultivar and Planting Date Effects on Soybean Stand, Yield, and *Phomopsis* sp. Seed Infection

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ABSTRACT

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Experiments were conducted in a field near Portageville, MO, from 1992 to 1994 to determine cultivar and planting date effects on soybean stand, yield, and seed infection with fungi. Soybean cultivars Asgrow 3733 (maturity group III), Ring Around 452 (maturity group IV), Hutcheson (maturity group V), and Asgrow 6785 (maturity group VI) were each planted in 75-cm-wide rows in tilled soil. The planting dates were mid-April, mid-May, and mid-June. In 1992, stands of Hutcheson and Asgrow 6785 were greater than stands of Asgrow 3733 and Ring Around 452 for mid-April plantings. Stands were similar among all cultivars and planting dates in 1993 and 1994. Yields of Hutcheson and Asgrow 6785 were similar for all planting dates and were greater than yields of Asgrow 3733 for all planting dates. Yields of Hutcheson and Asgrow 6785 were greater than those of Ring Around 452 for mid-April and mid-May plantings. The percentage of seed infected with *Phomopsis* sp. was greater in Asgrow 3733 than for the other cultivars in mid-April and mid-May plantings. The percentage of seed infected with *Phomopsis* sp. was low in Asgrow 6785 each year and was similar for all planting dates. Low yields and problems of seed infection with *Phomopsis* must be resolved for early planting of Asgrow 3733 to be a practical production system in the upper mid-south. Mid-April planting of Hutcheson and Asgrow 6785 may be a practical cropping system for the upper mid-south because yields, stands, and seed infection with *Phomopsis* sp. were similar to those of mid-May plantings and harvest was earlier.

A major factor limiting soybean, *Glycine max* (L.) Merr., production in the southern United States is drought stress. Drought is a common problem in the south during the late-July to early-September period. In this area, maturity group V to VIII soybean cultivars are normally planted from mid-May to mid-June, and the plants flower and produce seed in late-July to early-September. The DowElanco Southeastern U.S. Crop Advisory Board designed the Early Soybean Production System (ESPS) to time soybean flowering and seed production before the typical periods of drought in the south (10). The success of this system depends on planting early maturing cultivars (maturity groups III and IV cultivars in the south) earlier than normal (April rather than May) so they flower and produce seed during early-July when soil moisture is likely to be more abundant. Yield and management advantages to this system were observed in Arkansas (8), Florida (1), and Texas (11). However, seed infection with *Phomopsis* sp. was high in some maturity group III and IV cultivars planted during mid-April in Arkansas (9).

The value of the Early Soybean Production System in the upper mid-south (southeast Missouri, west Tennessee, west Kentucky, and northeast Arkansas) is unclear. Mid-April soil temperatures in southeast Missouri are usually much cooler than in mid-May, and soil moisture is more abundant. Seedling diseases such as Pythium rot (13) may be more severe in soybean planted in mid-April because of the cool, wet soil conditions, and stands may be reduced by diseases. Early planting dates also can result in greater incidence and severity of diseases such as sudden death syndrome in both tilled (3) and no-till production systems (17). Planting date may also influence the population dynamics of *Heterodera glycines* Ichinohe (6). In addition, early planting will result in early maturity dates, which may enhance seed infection with *Phomopsis* sp. (5).

Phomopsis seed decay is endemic throughout all soybean-growing areas in the U.S. (12). The soybean yield loss due to *Phomopsis* in the southern U. S. during 1995 was estimated to be worth $5.4 million (16). The objective of this research was to determine the effects of early planting of soybean cultivars in maturity groups III, IV, V, and VI on soybean stands, yield, and seed infection by fungi.

MATERIALS AND METHODS

Plots were established in 1992 near Portageville, MO, on a silt loam soil consisting of 34% sand, 50% silt, and 16% clay. The field was precision graded, 1% slope, to provide good surface drainage. Prior to soybean planting each year the field was disked twice and row beds (75-cm spacing) were formed with a disk-bedding implement. The top 10 cm of the beds was pushed off just prior to planting to form a flat-top ridge. The soybean cultivars Asgrow 3733 (maturity group III), Ring Around 452 (maturity group IV), Hutcheson (maturity group V), and Asgrow 6785 (maturity group VI) were planted on three dates each year: 15 April, 19 May, and 15 June in 1992; 22 April, 17 May, and 15 June in 1993; and 15 April, 17 May, and 14 June in 1994. Seeds were purchased each spring from Asgrow Seed Company, Matthews, MO, Northrup King, Bay, AR, and The Missouri Foundation Seed Program (MFSP), and each germinated greater than 80%, according to the company or MFSP. Seeds from the same bag were planted on each of the three dates to reduce variation in stand due to different germination rates of the seed lots. Each four-row soybean plot was 3 m wide and 7.6 m long, and 26 seeds were planted per meter of row. All plots received a pre-emergence application of Scepter (American Cyanamid Co., Agriculture Division, Wayne, NJ) at 0.14 kg a.i./ha and Lasso (Monsanto Co., Agriculture Group, St. Louis, MO) at 0.4 kg a.i./ a and a postemergence application of Basagran (BASF Corporation, Agricultural Products, Research Triangle Park, NC) at 0.181 kg a.i./ha. Plots were cultivated once and hand-weeded as necessary.

The plots were located in a different area of the same field each year to avoid problems caused by repeated planting in the same area. The plot area each year had been planted to corn, *Zea mays* (L.), 2 years before and soybean 1 year before. This corn/soybean rotation is common for soybean farmers in the region.

Thirty days after emergence, plants were counted in two arbitrarily selected 1-m-

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long sections of row from the middle two rows of each plot. The counts in the two sections were added to determine plants per two meters of row.

The middle two rows of each plot were harvested at maturity and yield was adjusted to 13% moisture (Table 1). A 500 g sample of harvested seed was stored in a paper bag at 25°C. One hundred seeds (taken randomly from each bag) were surface sterilized by soaking in 0.5% sodium hypochlorite for 5 min, rinsed in sterile distilled water, and placed on acidified (pH 4.5) potato dextrose agar in petri dishes (15). Five seeds were placed on each culture dish and the dishes were incubated under fluorescent lights at 25°C. Seed-borne fungi were identified based on morphological characteristics at 14 days after plating.

A split plot design with four replications included three planting dates as main plots and soybean cultivars, randomized within the main plots, as subplots. Stand, yield, and the percentage of seed infected with fungi were subjected to analysis of variance (7). Fisher's protected least significant difference test was used for mean comparison. Analyses were conducted by SAS procedures (SAS Institute, Cary, NC).

RESULTS AND DISCUSSION

Stands 30 days after emergence varied among cultivars and planting dates only in 1992 (Table 2). In 1992, stands of Asgrow 3733 and Ring Around 452 were better in the mid-May planting than in either mid-April or mid-June plantings. At the same time, stands of Hutcheson and Asgrow 6785 were better in mid-April than in mid-June plantings. The variation in stands between cultivars and planting dates in 1992 may be due to the weather. The soil was cool in mid-April and soil moisture after planting was abundant. This condition may have enhanced seedling diseases. Stands of Hutcheson and Asgrow 6785 planted in mid-April were greater than those of Asgrow 3733 and Ring Around 452, which may indicate differences in resistance to seedling disease among the cultivars. The soil was warm and moist after planting in mid-May and hot and dry after planting in mid-June, 1992. These conditions were probably responsible for the greater stands for mid-May than for mid-June plantings.

Yields of Asgrow 3733 planted in April were lower than those of any cultivar planted in May or June and lower than those of the other cultivars planted in April (Table 3). Asgrow 3733 planted in May and June had similar yields but these were lower than those for any of the other cultivars planted on any date. Hutcheson and Asgrow 6785 had similar yields when planted in April, May. or June. Each one planted in April yielded more than either planted in June but not May (Table 3). Asgrow 6785 planted in May yielded more than when it was planted in June.

All cultivars yielded more in 1994 than in 1992 or 1993 (Table 4). Yields of Ring Around 452 were the same in 1992 and 1993, as were yields of Asgrow 6785. However, Hutcheson yielded more in 1992 than in 1993 (Table 4). Within each year Asgrow 3733 had the lowest yield, Ring Around 452 yields were significantly higher than those of Asgrow 3733 each year, and Hutcheson and Asgrow 6785 yields were higher than those of Ring Around 452 in 1992 and 1994. Hutcheson and Asgrow 6785 had similar yields each year (Table 4).

The effect of planting date on the percentage of seed infected by *Phomopsis* sp. was consistent over the 3 years (Table 5). The percentage of seed infected by *Phomopsis* sp. was greater in Asgrow 3733 for mid-April than for mid-May plantings, which in turn was greater than for mid-June plantings. Infection of Asgrow 6785 seed by *Phomopsis* sp. was not significantly different among planting dates over the years. The percentage of Ring Around 452 and Hutcheson seeds infected by this fungus was significantly greater in mid-April plantings than in mid-June plantings in 1992 but not 1993 or 1994. Seeds of all cultivars from all plantings dates were infected by *Cercospora sojina*, *Nigrospora* sp., and *Fusarium* sp. No consistent differences among cultivars or among planting dates were observed for infection of seed by fungi other than *Phomopsis*.

Our data indicate that infection of seed by *Phomopsis* sp. can be a problem when Asgrow 3733, an early maturing cultivar, is planted in mid-April in southeast Missouri. The effect of early maturity date on infection of soybean seed with *Phomopsis* sp. is well documented (5,15). Cultivars that mature early generally have a higher percentage of infection by this fungus than do late maturing cultivars. Early-maturing cultivars fill grain in the summer (late-July to mid-August) when relative humidity is high and dew is heavy. High relative humidity and presence of heavy dew during grain fill results in higher infection of seed by this fungus (12,14). The high percentage of *Phomopsis* sp. seed infection in mid-April-planted Asgrow 3733, which reproduces in the mid-south during humid weather in late-July and early-August, is consistent with earlier work (14). Warm

Table 1. Dates of harvest maturity for four cultivars planted on three dates averaged over 3 years[a]

	Cultivars			
Planting date	Asgrow 3733	Ring Around 452	Hutcheson	Asgrow 6785
1	1 September	18 September	1 October	7 October
2	13 September	30 September	14 October	22 October.
3	25 September	10 October	3 November	10 November

[a] Dates of harvest maturity: When soybean seed first dried to less than 14% moisture. Planting dates: 15 April, 19 May, and 15 June, 1992; 22 April, 17 May, and 15 June, 1993; and 15 April, 17 May, and 14 June, 1994.

Table 2. Mean seedling stand densities (plants/2m row) 30 days after emergence of four soybean cultivars planted at three dates in 1992, 1993, and 1994[a]

		Cultivars			
Year	Planting date	Asgrow 3733	Ring Around 452	Hutcheson	Asgrow 6785
1992	15 April	19.6	21.3	30.1	28.7
	19 May	24.4	29.3	24.8	26.0
	15 June	20.0	19.7	20.9	21.2
1993	22 April	35.3	29.3	37.3	43.7
	17 May	31.3	26.7	30.7	35.1
	15 June	33.1	31.1	36.7	41.7
1994	15 April	39.2	33.4	41.0	45.1
	17 May	41.0	39.9	39.5	44.7
	14 June	43.2	36.5	40.1	41.4

[a] Least significant difference (0.05) to compare any planting date and cultivar combination in 1992 is 3.8. There were no treatment effects for stand in 1993 and 1994.

Table 3. Seed yields (kg/ha) for four soybean cultivars planted at three dates averaged over 3 years[a]

	Planting date		
Cultivars	1 (April)	2 (May)	3 (June)
Asgrow 3733	732	1,114	1,171
Ring Around 452	1,413	1,348	1,308
Hutcheson	1,600	1,504	1,396
Asgrow 6785	1,671	1,552	1,327

[a] Planting dates were 15 April, 19 May, and 15 June in 1992; 22 April, 17 May, and 15 June in 1993; and 15 April, 17 May, and 14 June in 1994. Least significant difference (0.05) to compare any planting date and cultivar combination = 123.

and very humid conditions in July and early-August, 1992, were associated with very high seed infection of Asgrow 3733 by *Phomopsis* (Table 5), especially the mid-April and mid-May plantings. Warm, humid conditions prevailed during July and early August, 1993 and 1994, but were not as extreme as in 1992. Asgrow 3733 flowered and produced seed during that period. Ring Around 452 planted in mid-April also flowered and produced seed during July and early August, but seed infection was not as great as in Asgrow 3733. This may indicate differences in resistance to *Phomopsis* between these two cultivars.

Phomopsis lowers the quality of seeds used for planting by reducing germination potential and can also reduce the quality of seeds used for processing (12). Seed from Asgrow 3733 planted in mid-April was judged to be poor quality by a local grain dealer. The seeds were off color and shrunken. As a result, the price offered by the dealer was less than for Hutcheson and Asgrow 6785 planted in mid-April, which were judged to be of acceptable quality. The quality of flour and oil derived from seeds infected with *Phomopsis* can be lower than that from healthy seeds (2). The effects of infection by *Phomopsis* sp. on fatty acid and amino acid composition of seed are not clear.

Table 4. Seed yields (kg/ha) of four soybean cultivars during 1992 to 1994 averaged over three planting dates[a]

	Years		
Cultivars	**1992**	**1993**	**1994**
Asgrow 3733	894	825	1,299
Ring Around 452	1,249	1,320	1,501
Hutcheson	1,462	1,315	1,724
Asgrow 6785	1,490	1,421	1,638

[a] Least significant difference (0.05) to compare any cultivar by year = 123.

Yields of Asgrow 3733 and Ring Around 452 might have been greater if planted in narrow rows. The canopy of these cultivars never closed. We did not expect these cultivars to yield well because earlier research indicated that short season cultivars planted early yielded poorly in wide rows (4).

There were differences among cultivars in stand, yield, and infection with *Phomopsis* sp., but the effects of maturity group was difficult to interpret. Further research is needed to evaluate maturity group effects on these variables, and several cultivars within each maturity group must be included.

An alternative to planting early maturing cultivars in April may be the planting of soybean cultivars in maturity groups V and VI in mid-April. Our data demonstrate that the yields and stands of Hutcheson (maturity group V) and Asgrow 6785 (maturity group VI) planted in mid-April were high and similar to mid-May plantings. In addition, the percentage of seed of these two cultivars that was infected by *Phomopsis* sp. was low, and maturity date was 2 weeks earlier than with mid-May plantings. Therefore, harvest may be spread out for more efficient use of labor and machinery. The performance of other maturity group V and VI cultivars may vary.

Planting soybean in April in the upper mid-south may not be practical in clay or other poorly drained soils. Rain is generally more abundant in April than in May or June in this area, and soil temperatures are cool. These conditions are conducive to seedling diseases. These studies were conducted on a well-drained soil that had been precision graded so excess water drained away. The practicality of this system in poorly drained soils and the benefit of fungicide seed treatments for protection of plants in these conditions against seedling disease are not clear.

Table 5. *Phomopsis* sp. infection as percentages of harvested seeds from four soybean cultivars planted on three dates, 1992 to 1994[a]

		Cultivars			
Year	**Planting date**	**Asgrow 3733**	**Ring Around 452**	**Hutcheson**	**Asgrow 6785**
1992	15 April	99.75	15.25	14.25	1.00
	19 May	75.5	19.00	2.50	0.00
	15 June	51.5	0.50	1.00	2.00
1993	22 April	49.00	5.75	11.75	8.00
	17 May	32.25	4.00	3.00	4.50
	15 June	17.25	2.00	7.25	2.25
1994	15 April	56.00	1.75	0.75	0.50
	17 May	15.00	0.75	0.75	1.00
	14 June	3.00	0.25	3.00	0.25

[a] LSD (least significant difference, 0.05) to compare cultivars within the same year and planting date is 8.24. LSD (0.05) to compare planting dates within a cultivar in the same year is 8.22. LSD (0.05) to compare cultivars across years and planting date is 8.50.

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