HortScience 38(3):357–360. 2003.

Planting Date Effects on Stand Establishment and Yield of Chile Pepper

Robert F. Bevacqua[1] and Dawn M. VanLeeuwen[2]
Extension Plant Sciences Department, New Mexico State University, P.O. Box 30003, Department 3AE, Las Cruces, NM 88003-8003

Additional index words. direct seeding, fungicide treatment, fertilizer banding, disease, beet curly top virus, *Capsicum annuum*

Abstract. **Chile pepper (*Capsicum annuum* L.) yields are highly variable and are strongly influenced by disease and weather. The goal of two field experiments was to evaluate crop management factors, especially planting date, that could contribute to improved and more consistent crop production. Current practice in New Mexico is to direct seed the crop from 13 to 27 Mar. In the first experiment, chile pepper was direct seeded on three planting dates, 13, 20, and 27 Mar. 2000, without or with a fungicide treatment of pentachloronitrobenzene and mefenoxam for the control of damping off. The results indicate planting date had no effect on stand establishment or yield. Fungicide treatment, significantly reduced stand, but had no effect on yield. In the second experiment, chile pepper was direct seeded on six planting dates, 13, 20, 27 Mar. and 3, 10, 17, Apr. 2001, with or without an application of phosphorus fertilizer, P at 29.4 kg·ha^{-1}, banded beneath the seed row. During the growing season, this experimental planting suffered, as did commercial plantings in New Mexico, from high mortality and stunting due to beet curly top virus, a disease transmitted by the beet leafhopper. The results indicate planting date had a significant effect on crop performance. The best stand establishment and highest yield were associated with the earliest planting date, 13 Mar. This date also resulted in the least viral disease damage. Phosphorus fertilizer had no effect on stand establishment or yield. Chemical names used: pentachloronitrobenzene (PCNB); (*R*)-2-[(2,6-dimethylphenyl)-methoxyacetylamino]-propionic acid methyl ester (mefenoxam).**

Chile pepper (*Capsicum annuum* L.) has been produced in New Mexico for four centuries (Bosland et al., 1999). It is the dominant vegetable crop in the state at present (New Mexico Dept. of Agriculture, 1999) and is highly valued for its economic, cultural, and historical contributions to New Mexican society.

Chile pepper production in New Mexico is highly variable and is strongly influenced by disease and weather (Skaggs et al., 2000). Harvest statistics from recent years demonstrate the unstable nature of chile production in the state. For example, harvested area decreased from 9315 ha in 1997 to 8708 ha in 1998, while the value of the crop decreased from $62 to $58 million (New Mexico Dept. of Agriculture, 1999). From 1998 to 1999, harvested area further decreased 25% to 6585 ha, and the crop's value declined to $31 million (New Mexico Dept. Agr., 2000). A task force of producers, processors, and researchers (Phillips, 2000) identified poor stand establishment as a major contributing factor to the fluctuations in production. In 1999, the task force, more specifically, identified damping off or seedling disease as the main cause of the stand problem in that year. This soil-borne disease is caused by fungi, such as *Rhizontonia solani, Phytophthora casici, Pythium* sp., and *Fusarium* sp. (Goldberg, 1999). The task force, furthermore, cited early planting dates, when soils are unfavorably cold for seed germination, and a lack of fungicides and preplant phosphorus (P) fertilizer as predisposing the crop to seedling disease (Phillips, 2000).

At present, growers typically direct seed the chile pepper crop during a 2-week period from 13 to 27 Mar. (Skaggs et al., 2000). The costs and benefits of direct seeded versus transplants was evaluated by the chile pepper task force in 2001. This unpublished study concluded that the use of transplants was not economically justified at this time.

Stand establishment can be improved by adopting cultural practices that encourage rapid germination, quick emergence, and vigorous seedling growth. Three of these cultural practices are seeding on planting dates with favorably warm soil temperatures (Harrington and Minges, 1997) the use of protective fungicides and applying P fertilizer to the seedbed (Ludwick, 1995).

There is little previous research on the effect of planting date on chile pepper. Russo (1996) evaluated, among other factors, two planting dates in Oklahoma: one in April and the other in July. Higher yields were produced from the July planting. He also found crop response to fertilizer differed for the two planting dates.

"Starter" fertilizer is the name for a preplant application of banded fertilizer to the seedbed. The purpose of a starter fertilizer is to stimulate rapid emergence and stand establishment by providing a fertilizer source that is immediately available to the germinating plants (Ludwick, 1995). It does this by promoting early growth and root formation (Ludwick, 1995). Starter fertilizers are especially recommended for direct seeding into cold soils (Ludwick, 1995).

There is conflicting evidence for using P fertilizer in chile pepper production in New Mexico. Positive, but anecdotal evidence comes from a task force survey that identified preplant P as a common factor among farms that enjoyed good stands in 1999 (Phillips, 2000). On the negative side, Cotter (1986) conducted 2 years of testing to evaluate the response of chile pepper to phosphorus fertilizer. Seedling emergence increased in the first year, but not in the second. Yields were not increased in either year and, in some instances, were reduced. Panpruik et al. (1982) found no yield response to P applied through the drip irrigation system.

Materials and Methods

The methodology for the two experiments was similar. The cultivar employed was 'Sonora', an open-pollinated, chile pepper with a long, mildly pungent, fruit that can be picked green for the fresh or canning market or red for the processing market (Petoseed Co., Saticoy, Calif.). Seed was applied at a rate of 6.4 kg·ha^{-1}. Recording thermometers (Hobo data loggers from Spectrum Technologies, Plainfield, Ill.) were installed at three locations in the seed bed. Tensiometers (Irrometer Co., Riverside, Calif.) were used to monitor soil moisture. The crop was managed according to guidelines offered by Bosland and Votava (2000). Scouting for insect pests and diseases was done weekly. Once-over harvests were conducted in all plots on 15 Aug. These were considered, in the commercial sense, "green harvest", where the fruit would go the fresh market. All fruit was stripped off all the plants in a plot, put into a bag, and transported to a nearby laboratory where the total weight of the fruit was recorded and then the fruit were sorted by length into three sizes: small or <8.9 cm long, medium or 8.9 cm to 16.5 cm long, and large or >16.5 cm long. The number of fruit and the total weight of fruit in each size category were recorded. The weight of fruit in each size category was used to calculate the percentages of small, medium, and large sizes. Data were analyzed using SAS Proc Mixed (SAS Institute, 1996: Littell et al., 1996).

Expt. 1. This experiment was conducted in 2000 at the Leyendecker Plant Science Center near the New Mexico State Univ. campus in Las Cruces. The experiment extended across two soils, a Harkey clay loam [coarse-silty, mixed, superactive, calcareous, thermic Typic Torrifluvents] and an Agua loam [coarse-loamy over sandy or sandy skeletal, mixed, calcareous, thermic Typic Torrifluvents] (U.S. Dept. of Agriculture, 1980). Soil analysis revealed a pH of 8.0; organic matter of 6 g·kg^{-1}; soluble salts of 1.7 dS·m^{-1}; and a CEC of 32.8 cmol·kg^{-1}. The land was fallow the previous year. A split-plot design was employed with planting date as the main plot and fungicide treatment as the subplot. The main plots included three

Received for publication 20 Nov. 2001. Accepted for publication 24 June 2002.
[1]Extension Vegetable Specialist.
[2]Statistician.

planting dates: 13, 20, and 27 Mar. 2000. The subplots were with or without a fungicide treatment at planting. There were two blocks with two complete replications within each block. Each subplot was 30.4 m long and 4.04 m or four beds wide.

Soil preparation included plowing, deep chiseling, disking, smoothing, and listing into beds spaced 102 cm apart. A preplant fertilizer of 65 kg·ha^{-1} N and 20 kg·ha^{-1} P was broadcast and incorporated 45 d before the first planting. Furrow irrigation was applied 30 d prior to the first planting. Ten days after the irrigation, a soil mulch was applied to the top of the beds to retain moisture. This mulch was removed one hour before planting. A precision planter of the vacuum type (John Deere maxi-merge plus vacuumeter; Deere & Co., Moline, Ill.) was used to plant four beds at one time at a seeding rate of 4.5 kg·ha^{-1}. The implement was calibrated for a spacing of 2.54 cm between seeds in the row. Cover disks on the planter were used to create a cap of 10.2 cm of soil over the seed to conserve soil moisture.

Fungicide treatment was applied as an in-furrow treatment at the time of planting. The fungicide mixture was sprayed on the soil around the seed and on the covering soil that filled the seed furrow. The mixture contained two fungicides: pentachloronitrobenzene (Terraclor Flowable, Crompton Corp., Middlebury, Conn.) at a rate of 3.5 L·ha^{-1} and mefenoxam (Ridomil Gold EC; Syngenta Crop Protection, Greensboro, N.C.) at a rate of 0.15 L·ha^{-1}. They were mixed with water at a rate of 76 L·ha^{-1}. No surfactants or adjuvants were used.

The soil cap was removed on 10 Apr., when the radicle had emerged from the seed, with a dragging harrow. Furrow irrigations were applied every 2 weeks beginning 31 Mar. and once a month nitrogen fertilizer at a rate of 25.8 kg·ha^{-1} was applied in the irrigation water. Seedlings were blocked or thinned to a clump of 2–3 plants every 25.4 cm by hand-held hoes on 17 May. Two weeks later, on 31 May, the seedlings were further thinned by hand to one plant per 25.4 cm.

Stand was measured as the number of emerged seedlings in 1.22 m of row in the center of the treated plot. Stand measurements were recorded on 14, 15, 16, 17, and 24 Apr. and 1, 5, and 9 May.

Expt. 2. This experiment was conducted in 2001 at Fabian Garcia Research Center on the campus of New Mexico State Univ.in Las Cruces. The soil was a Harkey clay loam [coarse-silty, mixed, superactive, calcareous, thermic Typic Torrifluvents] (U.S. Dept. of Agriculture, 1980). Soil analysis revealed a pH of 8.0; organic matter of 7 g·kg^{-1}; soluble salts of 4.3 dS·m^{-1}; and a CEC of 25.2 cmol·kg^{-1}. Phosphorus levels were estimated to be 20 mg·kg^{-1}, an interpretation of moderate, with the Olsen sodium bicarbonate method of extraction. The previous crop was onion. The experimental design was a two-way factorial treatment structure in a randomized complete-block design with four replications. The first factor, planting date, had six levels: 13, 20, and 27 Mar. and 3, 10, and 17 Apr. The second factor, application of P fertilizer, had two levels: 0 and 29.4 kg·ha^{-1}. The experimental layout consisted of 48 plots located on five raised beds that covered an area of 30.4 × 5.0 m or 0.016 ha. Guard rows of chile pepper surrounded the plots. An individual plot measured 1.0 × 3.04 m and was imposed on a raised bed with a subsurface drip irrigation tape running down the middle. Two rows of plants, measuring 0.23 m apart, were direct-seeded in each plot. Treatments were applied to the entire length, 3.04 m of both rows.

Phosphorus was applied in the form of monoammonium phosphate (MAP) at a rate of 129 kg·ha^{-1}. This granular fertilizer had an analysis of 11N–23P–0K. The application rate per plot was 40 g. Hand-held tools were used to plant the seed and apply P. A garden trowel was used to make two V-shaped furrows on the top of the bed, 0.23 m apart and 0.063 m deep. A band of P was applied in the bottom of the furrow. The furrow was partially filled in with soil and the seed planted 5.08 cm above the band of P or 1.27 cm beneath the soil surface. Seedlings were thinned by hand on 10 May to one plant per 0.152 m. Stand was measured as the number of emerged seedlings in 1.22 m of row in the center of the plot. Stand counts were recorded on 16 dates: 2, 3, 4, 5, 7, 10, 12, 14, 17, 19, 21, 24, 26, 28 Apr. and 1, 10 May. The number of plants after thinning was recorded for each plot. Plant mortality was measured on May 30 as the percentage of plants that died since thinning on 10 May. The plots were irrigated with a drip system with the scheduling goal of maintaining soil moisture in the root zone at field capacity or 25 cbr as measured with a tensiometer at a depth of 0.304 m. This goal was achieved by watering, on average, for 4.5 h, twice a week, at a rate of 166,019 L·ha^{-1} for each application. A total of 244 kg·ha^{-1} N was applied through the drip irrigation system at a concentration of 263 ppm N. This total was applied in four, split, unequal injections of 44 kg·ha^{-1} on 29 June, 95 kg·ha^{-1} on 3 July, 81 kg·ha^{-1} on 6 July, and 25 kg·ha^{-1} on 11 July. The fertilizer was a liquid formulation with an analysis of 26N–0P–0K–6S and a density of ≈1.44 kg·L^{-1}. No pesticides were applied to the plots. Weeds were controlled by hand.

Results

Weather. Weather patterns for the spring planting season in 2000 and 2001 were representative of recent years in southern New Mexico. In 2001 there were four especially salient events. The first three were windstorms on 6, 10, and 20 Apr. The last produced gusts up to 33.4 m·s^{-1}. The fourth event was a heavy, localized rainstorm of 38 mm on May 15.

Seedling stand. In Expt. 1, planting date on no effect on seedling stand (Table 1). Fungicide treatment, however, had a significant effect on stand (Table 1). On 14 Apr., a striking qualitative difference existed between fungicide treated plots and those not treated with fungicide (Table 1). For plots treated with fungicide, no emergence was observed on 14 Apr.. Untreated plots averaged 7.75 seedlings per plot. .Fungicide treatment had the effect of delaying emergence and reducing the number of seedlings per plot (Table 1). No damping off disease was observed in any of the plots. In Expt. 2, planting date had a significant effect on seedling stand; P fertilizer had no effect (Table 2). The first planting date, 13 Mar., produced the best stand or the highest number of seedlings per 122 cm of row. The high number of seedlings was apparent at the first stand count on 2 Apr. and remained higher than the other planting dates for all 16 stand counts until data recording ceased on 10 May (Table 2). On 1 May, for example, the first planting date had 29 emerged seedlings and all other planting dates averaged 12 seedlings. The first planting date, thus, had more than twice the number of seedlings of any subsequent planting date. This consistent and significant difference in stand between the first and later planting dates may be due to the windstorms that occurred on 6, 10, and 20 Apr. Recording thermometers documented wide fluctuations (data not shown) in seedbed soil temperatures during these storms. These fluctuations may have hampered germi-

Table 1. Expt. 1, least squares means for seedling stand at weekly intervals, emergence, and total fruit weight for chile pepper at Leyendecker Plant Science Center during the 2000 growing season.

Planting date	Fungicide treatment	Seedling stand[z] 2 Apr.	14 Apr.	17 Apr.	24 Apr.	1 May	9 May	Emergence (days)[y]	Total fruit wt (kg)[x]
13 Mar.	Without	0[w]	4	25	42 ab[v]	38	42	33 a	31.92
	With	0	0	2	37 b	36	32	34 b	33.28
20 Mar.	Without	0	15	37	54 a	46	46	25 c	36.41
	With	0	0	7	29 c	24	26	26 c	35.55
27 Mar.	Without	0	4	18	37 bc	38	37	18 d	34.23
	With	0	0	0	15 d	25	18	24 e	34.05
SE of means	Without	0	4.2	7.1	4.3	5.3	6.5	0.30	---
	With	0	0.0	1.4	2.6	5.3	6.5	0.30	---
				Significance					
Planting date		NS	v	NS	*	NS	NS	***	NS
Fungicide treatment		NS	*	*	*	*	*	***	NS
Plant date × fung. treat.		NS	NS	NS	*	NS	NS	***	NS

[z]Stand is the number of emerged seedlings in 122 cm of row in the center of the plot.
[y]Emergence is the number of days from seeding to the appearance of the first seedlings in the plot.
[x]Fruit weight is the total weight of all fruit from all plants in a plot at harvest on 15 Aug.
[w]Mean of eight measurements.
[v]Means separated within columns by LSD, $P \leq 0.05$. Means with common letter do not differ significantly.
[NS, *, **, ***]Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

Table 2. Expt. 2, least squares means for seedling stand at weekly intervals, emergence, and total fruit weight for chile pepper at Fabian Garcia Research Center during 2001 growing season.

Planting	Seedling stand[z]						Emergence	Total fruit
date	2 Apr.	10 Apr.	17 Apr.	24 Apr.	1 May	10 May	(days)[y]	wt (kg)
13 Mar.	24[w]a[v]	36 a	34 a	31 a	29 a	28 a	20 a	9.14 a
20 Mar.	0 b	15 b	14 b	11 b	11 b	11 bc	16 bc	5.82 bc
27 Mar.	0 b	0 c	4 c	8 bc	9 b	8 b	20 a	3.71 d
3 Apr.	---	0 c	0 c	12 b	14 b	14 bc	17 b	5.94 b
10 Apr.	---	---	0 c	2 cd	12 b	17 bc	15 cd	4.87 b–d
17 Apr.	---	---	---	0 d	14 b	17 c	14 d	4.24 cd
SE of means	1.8	2.8	2.6	2.5	3.1	3.1	0.5	0.56
			Significance					
Planting date	***	***	***	***	***	**	***	***
Fertilizer treatment	NS	NS	NS	NS	NS	NS	NS	NS
Plant date × fert.treat.	NS	NS	NS	NS	NS	NS	NS	NS

[z]Stand is the number of emerged seedlings in 122 cm of row in the center of the plot.
[y]Emergence is the number of days from seeding to the appearance of the first seedlings in the plot.
[x]Fruit weight is the total weight of all fruit from all plants in a plot at harvest on Aug 15.
[w]Mean of eight measurements.
[v]Means separated within columns by LSD, $P \leq 0.05$. Means with common letter do not differ significantly.
--- Treatments where seeding has not occurred yet.
NS, *, **, ***Nonsignificant or significant at $P \leq 0.0$, 0.01, or 0.001, respectively.

nation and emergence and could explain the poor stand of the later planting dates. Also, the storms can cause mechanical damage to the seedling by damaging the base of the stem or removing the leaves. It is important to note these reduced stands of the second through sixth planting dates occurred before disease or insects were detected in the plots.

Emergence. In Expt. 1, the number of days from seeding to emergence was 34, 26, and 21 for the three planting dates 13, 20, and 27 Mar, respectively (Table 1). Seedlings from the three planting dates all emerged on the same day, 14 Apr. In Expt. 2, the days to emergence was 20, 16, 20, 17, 15, and 14 for the six planting dates, respectively. (Table 2). Planting date had a significant effect on emergence and P fertilizer had no effect (Table 2.). It is generally assumed that the later planting dates, when warmer soil temperatures prevail, will have progressively shorter emergence times and, thus, offer less exposure to damping off. Seeds from the first planting date of 13 Mar. emerged after 20 d, while seeds planted on the last planting date, 17 Apr., emerged after 14 d, a significant difference of 6 d. While this difference was consistent with the anticipated trend, decreasing emergence time was not a consistent pattern for all planting dates. Emergence on the third planting date, 27 Mar., for example, required 20 d, the same as 13 Mar., the first planting date.

Mortality. In Expt. 1, very little seedling mortality was observed. There were no major reductions in stand due to disease, insects, wind, or soluble salts. In Expt. 2, however, the treatments produced dramatic differences in mortality (Table 3). An interaction was noted between planting date and P fertilizer for plant mortality (Table 3). This interaction stems largely from the last three planting dates, but does not produce a clear pattern for interpretation. The effect of planting date was significant. In light of the interaction, all 12 means are reported in Table 3. Weekly pest scouting revealed beet curly top virus as a major cause of seedling mortality. Minor contributors to seedling mortality were, in descending importance, soluble salts movement after the rainstorm of 15 May (Miyamoto et al., 1985), flea beetle (*Phyllotreta* sp.) feeding on apical meristems, and beet armyworm (*Spodoptera exigua*). The first insect pest, beet armyworm, was observed on 10 May. Beet curly top virus is believed to have entered the planting between 17 May and 30 May, when it was formally diagnosed. The observed symptoms included seedling death, stunting, yellowing, and stiff plants with brittle leaves. The disease is transmitted by the beet leafhopper (*Circulifer tenellus*). This insect vector prefers to feed on young plants, which is why they are more susceptible to the disease than more mature plants (Goldberg, 1999). This preference was apparent in our plots. The two earliest planting dates, 13 and 20 Mar., suffered the lowest plant mortality, while the subsequent four plantings dates suffered significantly higher rates of mortality (Table 3). These results clearly illustrate that the two early plantings on 13 and 20 Mar. largely escaped infection by beet curly top virus and that the four later plantings were very vulnerable to the disease.

Yield. In Expt. 1, yield, as expressed as total fruit weight (kg) per plot, was not affected by planting date or fungicide treatment (Table 1). All plots, regardless of treatment, produced similar numbers and weights of fruit. All plots also produced a similar distribution of percentages of small, medium, and large fruit. In Expt. 2, planting date had a significant effect on yield, P fertilizer had no effect and there was no interaction (Table 2). The date effect, however, did not produce a consistent trend over the six planting dates. The first planting date of Mar. 13 produced a significantly higher mean yield than the mean for any other date. Mean separation by least significant difference (LSD) placed these remaining five means into three overlapping groups (Table 2). Planting date did not have a significant mean effect on the percentage of small, medium, or large fruit at harvest (Table 3), however a planting date × P fertilizer interaction was noted for the percentage of medium and large fruit at harvest (Table 3). The means in Table 3 suggest that this interaction may be due to differences in the P fertilizer treatments on the 3 and 17 Apr. planting dates. These results document how the three planting dates in Expt. 1 produced the same yields, whereas the earliest planting date in Expt. 2 produced a significantly higher yield than the following five planting dates.

Table 3. Expt. 2, least squares means for crop mortality and fruit size distribution for chile pepper at Fabian Garcia Research Center during 2001 growing season.

Planting	P fertilizer	Mortality	Fruit size[y]		
date	treatment	(%)[z]	Small (%)	Medium (%)	Large (%)
13 Mar.	Without	2[x]a[w]	1	52 a–d	47 b–d
	With	7 a	3	53 a–d	44 a–d
20. Mar	Without	18 a–c	4	59 b–d	37 a–c
	With	15 ab	6	54 a–d	40 a–c
27 Mar.	Without	41 c–e	3	61 b–d	36 a–c
	With	47 de	5	58 a–d	37 a–c
3 Apr.	Without	37 b–d	3	73 d	24 a
	With	56 dvf	1	37 a	62 d
10 Apr.	Without	38 b–d	3	67 cd	30 ab
	With	63 ef	2	50 a–c	48 b–d
17 Apr.	Without	78 f	2	43 ab	55 cd
	With	48 de	3	64 b–d	33 ab
SE of means		8.4	1.3	7.8	7.7
		Significance			
Planting date		***	NS	NS	NS
Fertilizer treatment		NS	NS	NS	NS
Plant date × fert. treat.		*	NS	*	*

[z]Mortality is the percentage of plants on 30 May that had died since thinning on 10 May.
[y]Small fruit size is <8.9 cm, medium is 8.9 to 16.5 cm, and large is >16.5 cm.
[x]Mean from four measurements.
[w]Means separated within columns by LSD, $P \leq 0.05$. Means with a common letter do not differ significantly.
NS, *, **, ***Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

Discussion

Expt. 1 evaluated three planting dates, 13, 20, and 27 Mar. 2000. The cropping season enjoyed mild weather and was free of disease and insect pests. The study found that the 3 planting dates produced crops that emerged on the same day and had the same stands and yields (Table 1). Expt. 2 evaluated the same three planting dates, 13, 20, and 27 Mar., and was expanded to include the additional dates of 3, 10, and 17 Apr. in 2001. This was a season marked by storms, insect pests, and disease. Of the six planting dates evaluated, the earliest planting date, 13 Mar., began with the best stand of seedlings and had consistently higher stand counts than all subsequent planting dates (Table 2). This may have been due to the stand being established before the windstorms of mid-April occurred. Plant mortality was lowest for the two earliest planting dates, 13 and 20 Mar., (Table 3) probably because the plants had advanced to a growth stage where they were no longer susceptible to the soluble salts moved by the rain on May 15 and no longer attractive to the leafhopper that transmitted beet curly top virus from 17 May to 30 May. This earliest planting date, most importantly, produced the highest yield. The conclusion of Expt. 2 was that the best stand establishment and highest yield were produced by the earliest planting date, 13 Mar., (Table 2) and this was the preferred planting date because the crop avoided injury from wind, soluble salts, insect pests, and most important, beet curly top disease.

In Expt. 1, no damping off disease was obseved in any of the plots. Thus, this experiment, was not able to assess the effect of a fungicide treatment of pentachloronitrobenzene and mefenoxam on reducing this disease. This experiment did document that the fungicide treatment had a significant effect on stand establishment. Fungicide treatment had the effect of delaying emergence and reducing the number of seedlings in the stand (Table 1). This fungicide effect on stand persisted during the growing season, but had no effect on yield (Table 1). It is not know why the fungicide treatment had a negative effect on stand establishment.

In Expt. 2, the banding of P at 29.4 kg·ha^{-1} beneath the seed row had no effect on stand establishment and yield (Table 2). This was an unexpected outcome. Our expectations of improved stand, quicker emergence, lower mortality, and higher yield were not realized. Two plausible and related explanations are offered. First, P levels in the soil may not have been low enough for a response to fertilizer to be observed. Second, the critical soil test levels for P have not been established for chile pepper, but may be as low as 8 mg·kg^{-1} (Robert Flynn, personal communication). This figure may explain why no response to P fertilization was observed in our experiment, where the soil had a P level of 20 mg·kg^{-1}, and why crop response to P has been infrequent in previous research. These results, however, do not necessarily negate the value of a starter fertilizer even when soil test P is above the critical level. It is possible the crop can respond to starter P under cool soil temperatures.

Conclusion

The need for this study on planting dates was triggered by high mortality in commercial fields due to damping off in 1999. A literature search indicated this disease could be minimized by seeding the crop later in the spring than is the current practice. Our experimental plots, however, demonstrated that late planting dates are at risk from other threats, namely wind, salinity, insect vectors, and viral diseases. With these conflicting factors in mind, it is our conclusion that our results verify the current practice of farmers to direct seed during a two-week period from 13 to 27 Mar. as the best time to plant chile pepper in southern New Mexico. More specifically, the earliness of planting on 13 Mar., as documented in our field plots in 2000 and 2001, consistently produced a healthy stand that escaped injury from wind, soluble salts, beet leafhopper, and beet curly top disease. A possible exception to this conclusion, as noted above, is the threat posed by damping off disease.

Literature Cited

Bosland, P.W. and E.J. Votava. 2000. Peppers: Vegetable and spice capsicums. CABI Publ., Oxon, U.K.

Bosland, P.W., A.L. Bailey, and D.J. Cotter. 1999. Growing chiles in New Mexico. N.M. Coop. Ext. Serv. Guide H–230.

Cotter, D.J. 1986. Preplant broadcast and banded phosphorus effects on growth and yield of long, green, mildly pungent chile (*Capsicum Annum* L.) New Mexico Agr. Expt. Sta. Res. Rpt. 580.

Goldberg, N.P. 1999. Chile pepper diseases. New Mexico Agr. Expt. Sta. Circ. 549.

Harrington, J.F. and P.A. Minges. 1997. Days required for seedling emergence at various soil temperatures from seed planted ½ inch deep, p. 95–96. In: D.N. Maynard and G.J. Hochmuth (eds.). Knott's handbook for vegetable growers. 4th ed. Wiley, New York.

Littell, R.C., G.A. Milliken, W.W. Stroup, and R.D. Wolfinger. 1996. SAS system for mixed models. SAS Inst., Cary, N.C.

Ludwick, A.E. (ed.). 1995. Western fertilizer handbook. Calif. Fert. Assn., Interstate Publ., Danville, Ill.

New Mexico Dept. of Agriculture. 1999. Agricultural statistics for 1998. Las Cruces, N.M.

New Mexico Dept. of Agriculture. 2000. Agricultural statistics for 1999. Las Cruces, N.M.

Panpruik, P., B.D. McCaslin, and P.J. Wierenga. 1982. Effects of nitrogen and phosphorus fertilizer on yield and leaf content of trickle irrigated chile peppers. New Mexico Agr. Expt. Sta. Res. Rpt. 480.

Phillips, R. 2000. New Mexico Chile Pepper Task Force Stand Establishment Project 2000. New Mexico Agr. Expt. Sta. manuscript.

Russo, V.M. 1996. Planting date, fertilizer rate, and harvest timing affect yields of jalapeño and banana peppers. HortScience 31:1124–1125.

SAS Institute Inc. 1996. SAS/STAT software: Changes and enhancements through release 6.11. SAS Inst., Cary, N.C.

Skaggs, R., M. Decker, and D. VanLeeuwen. 2000. A survey of southern New Mexico chile producers: Production practices and problems. New Mexico Agr. Expt. Sta. Bul. 782.

U.S. Dept. of Agriculture. 1980. Soil survey of Dona Ana County, New Mexico. Soil Conservation Serv., Washington, D.C.