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Seeding Rate, Irrigation, and Cultivar Effects on Tomato Spotted Wilt, Rust, and Southern Blight Diseases of Peanut[1]

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ABSTRACT

Tomato spotted wilt virus has been the cause of an important peanut disease in southwestern Texas since the mid-1980s. Following observations of elevated disease incidence associated with poor stands, high seeding rates were recommended to reduce risks of spotted wilt. The primary objective of this study was to determine the relationship of spotted wilt incidence to seeding rate and irrigation. Whether the management of rust (*Puccinia arachidis* Speg.) and southern blight (*Sclerotium rolfsii* Sacc.) would be affected by seeding rate and irrigation was a secondary objective. Two runner peanut cultivars, GK-7 and Southern Runner, were planted in 1992 and 1993 in single rows with a precision planter at 8, 12, and 22 seeds m^{-2} and irrigated with amounts ranging from a season total of 0 to 760 mm. Spotted wilt (30.5-cm-loci with symptoms) at digging differed significantly for GK-7 and Southern Runner in 1992 (29 vs. 20%) and 1993 (23 vs. 16%). The seeding rate of either cultivar did not significantly affect spotted wilt in either year. Spotted wilt increased as irrigation increased to a peak of 535 mm total water in 1992 and 587 mm in 1993, and decreased slightly at higher irrigation levels. Rust was significantly affected by seeding rate only in 1992, with lowest rust ratings at 8 seeds m^{-2}. GK-7 had significantly higher rust ratings than Southern Runner in 1992 and 1993. Southern blight in 1993 was lowest with below-optimum irrigation. Reduced seeding rate in irrigated peanut production did not increase risk of spotted wilt under conditions of this study and may have potential to enhance management efforts for rust and southern blight.

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Key Words: *Arachis hypogaea*, plant population, *Puccinia arachidis*, *Sclerotium rolfsii*, TSWV.

This study was part of an effort to assess the potential of reducing both production inputs and disease risks in irrigated peanuts in southwestern Texas. The first reported observation in the U.S. of spotted wilt, caused by tomato spotted wilt virus (TSWV), in peanut (*Arachis hypogaea* L.) was from southeastern Texas in 1971 (14). A high incidence of the disease was observed in some southwestern Texas fields in 1983 (J. W. Demski, pers. commun.) and 1985 (2). Subsequently, the disease has occurred annually in the region. Spotted wilt has become a concern throughout the USA in peanuts (7, 10, 13), tobacco (6), tomatoes (16), peppers (15), and lettuce (4) but, relative to southeastern states, the disease has been generally low in southwestern Texas since the early 1990s (unpubl. data).

Cultivar differences for TSWV reaction have been documented in several studies with moderate resistance in GK-7 and higher resistance in Southern Runner (1, 3, 9) compared to Florunner. Southern Runner, initially released as a cultivar resistant to late leaf spot caused by *Cercosporidium personatum* (Berk. & M.A. Curtis) Deighton, was found to have partial resistance to rust caused by *Puccinia arachidis* Speg. (3) and southern blight caused by *Sclerotium rolfsii* Sacc. (12). GK-7 was a predominant cultivar grown in southwestern Texas in the early 1990s. Information on cultural practices needed to optimize production of GK-7, Southern Runner, and other peanut cultivars with partial resistance to TSWV was lacking.

Traditionally irrigated peanuts have been planted at high seed rates in order to minimize risks of low yield from erratic plant spacing and low plant populations.

Following observations of elevated tospovirus disease incidence associated with poor peanut stands, high seeding rates were recommended to reduce yield losses (8, 11, 17).

Precision planters that place seeds more uniformly in depth and spacing than conventional planters reduce the need to overplant as a means of preventing large skips between seedlings. At seeding rates as high as 17 to 22 seeds m^{-2}, seed costs are 15 to 20% of the total irrigated peanut production cost. An opportunity may exist to increase net return by reducing seeding rates, but the extent of seeding rate reduction without increasing disease risks and sacrificing yield is not known for southwestern Texas.

The effect of reduced seeding rate on spotted wilt had not been confirmed experimentally under southwestern Texas conditions with low disease incidence and cultivars partially resistant to TSWV. An inverse relationship between peanut seeding rate and spotted wilt has been reported for susceptible Florunner under conditions of low disease incidence and of moderately resistant Georgia Green under high disease incidence (8, 11, 20). Our hypothesis was that uniform seeding at the rates used in this study would have little, if any, effect on yield of cultivars with resistance similar to or greater than that of GK-7 grown under low to moderate disease incidence.

TSWV induces various combinations of ring spots, line patterns, mottling, distortion, and chlorosis of leaflets during active vine growth. Symptoms late in the season when vine growth is limited include yellowing, wilting, internal browning of taproots, and plant death (7). Yield loss involves limited pod production on plants infected early and loss of maturing pods from degenerating plants that develop symptoms late in the season.

Circumstantial evidence suggests that development of systemic late season peanut symptoms in southwestern Texas is enhanced by saturated soil conditions and by poor internal soil drainage. Saturated soil increased severity of spotted wilt in tomato (5). Thus, we hypothesized that plots receiving the greatest amount of irrigation would have the greatest spotted wilt-related losses. An additional spotted wilt management strategy would exist if the irrigation and seeding rate treatment producing the highest yield, quality, and maximum water use efficiency were different from the treatment with the greatest spotted wilt. Because of the importance of high humidity and leaf wetness in the epidemiology of early leaf spot (caused by *Cercospora arachidicola* S. Hori), late leaf spot, and rust (19), we also expected these foliar diseases to increase with increasing irrigation.

The objectives of this study were to determine (a) if variation in seeding rate within a range unlikely to have large effects on yield would increase risk of spotted wilt disease in moderately resistant cultivars, (b) the relationship between irrigation level and spotted wilt symptoms, and (c) whether rust and southern blight would be affected by seeding rates. Yield, grade, and plant growth responses of these cultivars to seeding rate and irrigation will be reported separately (H. Tewolde, M. C. Black, C. J. Fernandez, and A. M. Schubert, unpubl. data, 1997).

Materials and Methods

The study was conducted in 1992 and 1993 in a commercial field south of Bigfoot, TX in Frio County [H. Tewolde, M. C. Black, C. J. Fernandez, and A. M. Schubert (unpubl. data, 1997]. A randomized complete block design with a split-plot arrangement of treatments was used with four replications in 1992 and six replications in 1993. The cultivars GK-7 and Southern Runner were planted to main plots and seeding rates to subplots. Each subplot consisted of 18 beds spaced at 0.91 m with a length of 9.1 m. Seeding rates consisted of 8, 12, and 22 seeds m^{-2}. A line-source sprinkler irrigation system was used to supply continuously increasing amount of water from none at the driest end to as high as 760 mm in 1992 and 699 mm in 1993 at the wettest end. Total rainfall amounts received during the growing seasons were 261 mm in 1992 and 338 mm in 1993.

Spotted wilt (percentage 30.5-cm loci with symptoms or percentage row-feet), rust (ICRISAT 1-9 scale) (19), a combined rating for early leaf spot and the more prevalent late leaf spot (Florida 1-10 scale), and southern blight (percentage 30.5-cm loci or percentage row-feet) (12) were determined at the end of each season. Data were recorded for each subplot 1.83, 5.49, 9.14, 12.80, and 14.63 m from the line down-wind from the system and 1.83, 3.66, 5.49, 7.32, and 10.97 m up-wind from the system. These sampling distances were chosen so that applied water on one side of the line would be approximately equal to the corresponding positions on the other side of the line. Two 4.57-m-long rows were dug at each distance on 25 Sept. 1992 (136 d after planting) and 27 Oct. 1993 (161 d after planting) with a four-row commercial digger.

All data were subjected to analysis of variance within each irrigation level to test cultivar and seeding rate effects. Main effects of seeding rate and cultivar were tested also. Since irrigation levels were systematically arranged, the test for the main effect of irrigation is not valid statistically.

Results

Results from the 2 yr of this study were largely in agreement. The superior yields in 1992 were attributed to more favorable growing conditions than in 1993 (H. Tewolde, M. C. Black, C. J. Fernandez, and A. M. Schubert, unpubl. data, 1997).

Southern blight, early and late leaf spot affected peanuts minimally in 1992. Late and early leaf spot, in particular, were at very low levels in 1992. A combined leaf spot rating in 1993 was significantly ($P \leq 0.02$) affected only by cultivar, with 2.4 for GK-7 and 2.1 for Southern Runner.

Spotted Wilt. Spotted wilt increased with irrigation to a peak at 535 mm total water in 1992 and 587 mm in 1993 (Fig. 1). At higher irrigation levels, the incidence of spotted wilt decreased slightly.

Seeding rate did not significantly affect spotted wilt when ratings were compared within each irrigation level or when averaged across all irrigation levels (Fig. 1A,B). Overall, GK-7 had a higher incidence of spotted wilt than Southern Runner in 1992 ($P \leq 0.01$) and 1993 ($P \leq 0.05$) (Fig. 1C,D). Averaged across all irrigation levels, spotted wilt ratings in 1992 were 29% for GK-7 compared with 20% for Southern Runner. The ratings in 1993 were

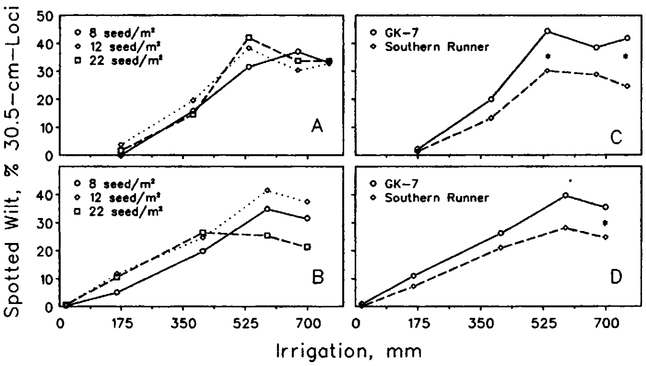

Fig. 1. Incidence of tomato spotted wilt virus symptoms in response to peanut seeding rate in 1992 (A) and 1993 (B) and to cultivars in 1992 (C) and 1993 (D) under an overhead irrigation gradient. Significant differences ($P \leq 0.05$) between cultivars at individual irrigation levels are indicated by an asterisk (*).

23% for GK-7 compared with only 16% for Southern Runner. Cultivar differences tested at individual irrigation levels were significant at two levels in 1992 and one level in 1993 (Fig. 1C,D).

Rust. Averaged across cultivars and irrigation levels in 1992, the eight seeds m^{-2} treatment had significantly ($P \leq 0.05$) less rust than the 12 seeds m^{-2} (Fig. 2A). However, the rust scores of the eight and 22 seeds m^{-2} treatments did not differ significantly. Rust scores of both cultivars increased with irrigation in both years (Fig. 2). Rust ratings averaged across irrigation levels in both 1992 and 1993 were significantly ($P \leq 0.01$) more severe for GK-7 (2.7 in 1992, 2.2 in 1993) than for Southern Runner (1.6 in 1992, 1.9 in 1993) (Fig. 2C,D).

Southern Blight. Southern blight incidence in 1993 peaked (Fig. 3) where irrigation was not limiting to pod yield (406-587 mm) (H. Tewolde, M. C. Black, C. J. Fernandez, and A. M. Schubert, unpubl. data, 1997). Averaged across other effects, southern blight was significantly affected by seeding rate ($P \leq 0.02$) but not by

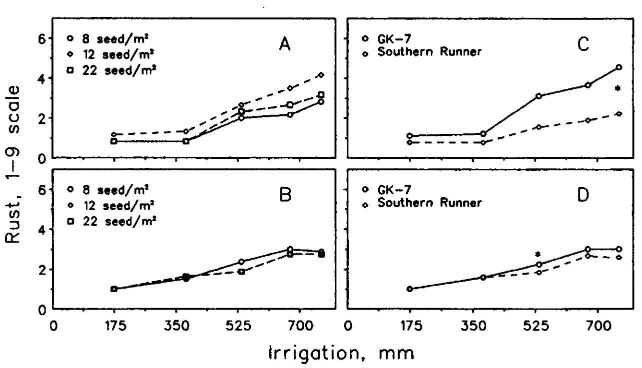

Fig. 2. Incidence of rust, caused by *Puccinia arachidis* Speg., in response to peanut seeding rate in 1992 (A) and 1993 (B) and to cultivars in 1992 (C) and 1993 (D) under an overhead irrigation gradient. ICRISAT scale: 1 = no rust, 9 = 50-100% of foliage destroyed by rust. Significant differences ($P \leq 0.05$) between cultivars at individual irrigation levels are indicated by an asterisk (*).

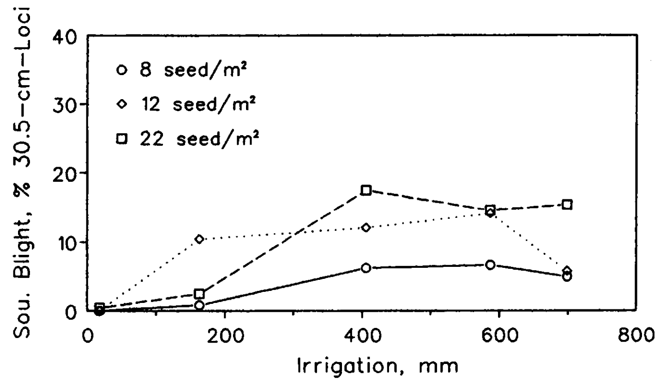

Fig. 3. Incidence of southern blight, caused by *Sclerotium rolfsii* Sacc., in response to peanut seeding rate in 1993 under an overhead irrigation gradient near Bigfoot, TX.

cultivar. Average ratings of the lowest seeding rate (eight seeds m^{-2}) was 3.8% of 30.5-cm-loci compared with 8.5% for the 12 seeds m^{-2} treatment and 10.1% for the 22 seeds m^{-2} treatment. When analyzed at individual irrigation levels, differences were significant only at the highest level of irrigation (Fig. 3).

Discussion

The potential to reduce production inputs and disease risks in irrigated peanuts through reduced seeding rates was assessed in southwestern Texas. Growers have opportunities to reduce seeding rates with the increased use of precision planters but have concerns of increased risks of spotted wilt at low plant populations. We tested two runner cultivars, GK-7 and Southern Runner, for which there was little information on management in southwestern Texas.

Pod yield of both cultivars planted at the lowest seeding rate (eight seeds m^{-2}) was as good as or better than their yield at the highest seeding rate (17 seeds m^{-2}) in this study (H. Tewolde, M. C. Black, C. J. Fernandez, and A. M. Schubert, unpubl. data, 1997). Yield was reduced at greater than optimum irrigation levels, as previously reported (10). Plants of these runner cultivars can compensate for reduced seeding rate when sufficient time is allowed for late formed pods to fully mature, because individual plants grow larger and produce more pods at low plant populations (H. Tewolde, M. C. Black, C. J. Fernandez, and A. M. Schubert, unpubl. data, 1997).

Spotted wilt was not significantly affected by the seeding rates tested in this study on two cultivars with partial resistance.(Fig. 1A,B). This contradicts reports of work with susceptible Florunner and with partially resistant Georgia Green under high incidence conditions (8, 11, 20). Overall, spotted wilt incidence has decreased since the early 1990s in southwestern Texas and increased or remained high in southeastern states. A return to high incidence in the Southwest may preclude use of low seeding rates.

Spotted wilt was affected by cultivar anu irrigation. The greater resistance in Southern Runner compared to GK-7 has been reported (3, 9). Irrigation levels that produced the greatest yield (H. Tewolde, M. C. Black, C. J. Fernandez, and A. M. Schubert, unpubl. data, 1997) were associated with the most severe spotted wilt ratings (Fig. 1). The increase of spotted wilt in peanut with irrigation up to 535 mm in 1992 and 587 mm in 1993 agrees with a greenhouse study on spotted wilt in tomato (5). The decrease of spotted wilt with irrigation in excess of the optimum was unexpected, but this decrease may have been due to physical action of overhead irrigation on thrips (4). More information is needed on the potential benefits of avoiding saturated soil conditions late in the season when spotted wilt becomes a problem. Low spotted wilt ratings in irrigation-deficient plots most likely were due to the lack of new vine growth and poor expression of symptoms.

Rust and leaf spots developed late in the season despite the use of a foliar fungicide program (chlorothalonil + sulfur). Data from seeding rate and irrigation treatments indicated that cultural practices have potential to enhance foliar disease control with fungicides. The increased incidence of rust with increasing water from rain or irrigation has been reported (19). The high seeding rate in 1992 was associated with the highest rust rating (Fig. 2A). The early development of a dense foliar canopy with the highest seeding rate may have been more favorable for infection by early arriving rust spores compared to the less dense canopy at the two lower seeding rates.

The increase in southern blight with increasing irrigation also agrees with previous work (18), but the lack of continued increase with excess irrigation was unexpected and may have been due to more favorable conditions for antagonists of *S. rolfsii*. Southern Runner was reported to be more resistant to southern blight than the cultivar Florunner (12), but no cultivar differences were found in this study.

We have presented evidence that reduced seeding rate in irrigated peanut production, with cultivars partially resistant to TSWV under low to moderate TSWV incidence, does not increase the risk of spotted wilt and may help in the management efforts for control of rust and southern blight.

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