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Interference Effects of Weed-Infested Bands in or Between Crop Rows on Field Corn (*Zea mays*) Yield[1]

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Abstract: The effect of season-long interference by bands of weeds growing only between rows (BR) on field corn yields has not been reported before or compared with weedy and weed-free (i.e., weeded) plots or bands of weeds growing only in row (IR). The null hypothesis of this research was that field corn yields would be ranked as weed-free > BR weedy only > IR weedy only > weedy (IR + BR weedy) in response to season-long weed interference by these four treatments. Weeds growing as bands closest to field corn were expected to reduce field corn yields more than those growing as bands further away between field corn rows. Field corn yield response to these four weed interference treatments was studied in Missouri for 4 yr. In late summer, most weed ground cover consisted of giant foxtail, the chief weed present, and common waterhemp, a lesser weed. Observed field corn yields averaged for 4 yr were ranked as weed-free > IR weedy only > BR weedy only > weedy. Field corn yields of the IR weedy only, BR weedy only, and weedy treatments averaged 76, 63, and 41%, respectively, of the weed-free treatment (=7,820 kg/ha). In two of the 4 yr, field corn yield of the IR weedy treatment exceeded that of the BR weedy treatment, whereas these treatments could not be statistically distinguished from one another in the other 2 yr. These research results refute the null hypothesis and demonstrate that it may be more critical to control BR than IR weeds, although controlling both BR and IR weeds maximized field corn yields.
Nomenclature: Common waterhemp, *Amaranthus rudus* Sauer #[3] AMATA; giant foxtail, *Setaria faberii* Herrm. SETFA; corn, *Zea mays* L. 'Pioneer 3379' and 'Pioneer 33G28'.
Additional index words: Banding, competition, interference.
Abbreviations: BR, between row; IR, in row.

INTRODUCTION

Weed scientists who wish to reduce the amount of broadcast herbicide applied per unit area in row crops can reduce herbicide rate, decrease treated area, or combine both methods. Currently, herbicides are usually broadcast-applied in field crops independently of rows to manage weeds growing both in and between crop rows (i.e., both row positions are treated with the same herbicide rate). However, to reduce total herbicide amount applied per unit area, weeds can be managed either in or between crop rows using other nonpolluting weed management methods. For example, weeds growing in crop rows can be managed with band-applied herbicides (Mulder and Doll 1993; Padgitt et al. 2000; Rikoon et al. 1996) or flaming (Ascard 1994, 1995, 1997). In the past, between row (BR) weeds were managed with field cultivation (Mulder and Doll 1993; Padgitt et al. 2000; Rikoon et al. 1996), but other methods could be substituted, such as flaming, brush weeding (Fogelberg 1999; Fogelberg and Gustavsson 1999; Fogelberg and Kritz 1999), mowing (Donald 2000a, 2000b, 2000c), and banding different herbicides or varying BR herbicide rates (Donald et al. 2003).

Extension personnel have used descriptive research on field corn–weed interference to justify to farmers that control of both in row (IR) and BR weeds is needed to prevent yield loss by weeds. Knowledge of the relative extent to which IR or BR weeds reduce field corn yields would help fine-tune weed management, in which different methods are used in these row positions. It also might help better understand and improve weed management methods which have failed in field corn, such as living mulches (Echtenkamp and Moomaw 1989; Martin et al. 1999; Mohler 1991; Zemenchik et al. 2000).

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[3] Letters following this symbol are a WSSA-approved computer code from *Composite List of Weeds,* Revised 1989. Available only on computer disk from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

In past field corn–weed interference research, weeds infested field corn in one of two patterns relative to crop rows: (1) weeds were controlled between rows with either field cultivation or hand-hoeing and allowed to grow in crop rows (Rajcan and Swanton 2001; Zimdahl 1980) or (2) weeds were allowed to grow both IR and BR. Method 1 was first introduced when weeds were still widely managed in field corn using BR field cultivation either alone or after IR-banded soil-residual herbicide. Using method 1, the influence of varying individual weed species, weed density, and emergence times on field corn yield loss was studied most often. Method 2 has not been as widely used as method 1 in field corn, although it applies to widely used broadcast-applied herbicides.

Because broadcast-applied herbicides are now widely used, managing IR and BR weeds differently to reduce herbicide use is not often considered in field corn. Yet, because IR and BR weeds can be managed differently, it makes sense to describe and understand how weeds reduce crop yields when weeds grow in these positions. One would expect the publication of more corn–weed interference research that includes the following four treatments: (1) weedy, (2) BR weedy only, (3) IR weedy only, and (4) weed-free. On the basis of research in other crops (Fiebig et al. 1991; Henry and Bauman 1989; Pike et al. 1990; Stoller et al. 1987; Zimdahl 1980), IR weeds growing closest to the crop would be expected to reduce yields more than BR weeds growing further away. In soybean [*Glycine max* (L.) Merr.], weeds growing further away from soybean plants reduced soybean yields less than weeds growing close to soybean plants (Pike et al. 1990; Stoller et al. 1987). Individual soybean plant yields were inversely related to the distance from individual weeds. Neither previous reviewers (Rajcan and Swanton 2001; Zimdahl 1980) nor the authors found published material on field corn–weed interference research, which either included a BR weedy only treatment or compared it with the other three treatments. Thus, the impact of season-long interference by BR bands of naturally occurring, mixed populations of weeds on field corn yields has not been reported before. The null hypothesis of the present research was that field corn yields would be ranked as weed-free > BR weedy only > IR weedy only > weedy in response to season-long weed interference by these four treatments.

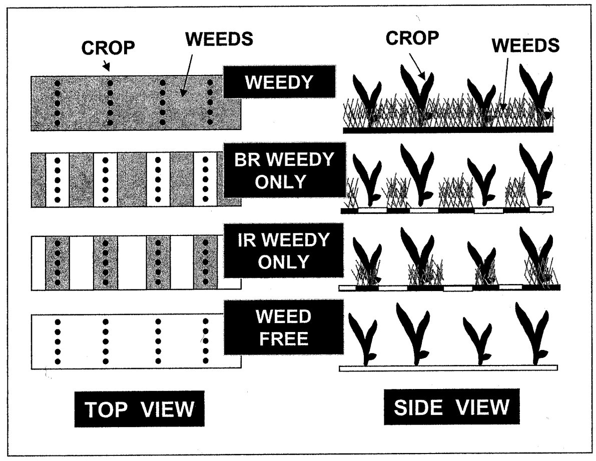

Figure 1. Four weed interference treatments are presented schematically in top and side views: weedy (in row [IR] + between row [BR] weedy), BR weedy only, IR weedy only, and weed-free (IR + BR weeded). IR and BR weed bands were 50% of the crop row width, 76 cm, and centered either on the row or the row middle.

MATERIALS AND METHODS

Treatments. The treatments were (1) IR + BR weedy ("weedy" hereafter), (2) BR weedy only (i.e., IR weeded), (3) IR weedy only (i.e., BR weeded), and (4) IR + BR weeded ("weed-free" hereafter), where the IR and BR band widths were 50% of field corn row width, 76 cm, and centered either on the row or the row middle (Figure 1). Treatments were arranged in a randomized complete block design with four, five, six, and five blocks in 1994, 1995, 2001, and 2002, respectively (Hoshmand 1994). Individual plots measured 3 by 9.1 m in 1994, 1995, and 2002 and 3 by 13.7 m in 2001.

In 1994 and 1995, weed-free zones were created by shallow hoeing, which cut weed shoots off at or slightly below the soil surface, followed by hand-pulling in the row (Table 1). Care was taken not to disturb developing field corn brace roots. Hoeing followed by hand-pulling for weed control was repeated until after canopy closure and the end of silking. In 2001 and 2002, weed-free zones were initially created by applying glufosinate[4] at 0.28 kg ai/ha in glufosinate-resistant field corn varieties, which were unaffected by treatment. Depending on weed interference treatment, glufosinate was either broadcast-applied or banded in 38-cm-wide bands of either IR or BR. A backpack sprayer was used to apply a spray volume of 168 or 166 L/ha, using standard flat spray tips[5] for broadcast application or flat spray tips[6] for band application, with compressed CO_2 at 193 kPa, at a ground

[4] Names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the products, and the use of the name by the USDA implies no approval of the product to the exclusion of others that may also be suitable.

[5] Teejet 6501 standard flat spray tips for broadcast application, Spraying Systems Co., Al Buhl Association, 6124 Enright Avenue, St. Louis, MO 63112.

[6] Teejet 4001E even flat spray tips for banded application, Spraying Systems Co., Al Buhl Association, 6124 Enright Avenue, St. Louis, MO 63112.

Table 1. Dates of field operations, treatments, and measurements.

Field operation, treatment, and measurement	Date 1994	1995	2001	2002
Field operations				
Previous crop	Fallow	Soybean	Soybean	Soybean
Fertilized crop	5/11	6/14	4/26	4/18
Planted crop	5/19	6/19	4/26	5/22
Crop emergence	5/25	6/26	5/3	6/2
Treatments				
Postemergence glufosinate application	—	—	5/29	6/4
Hoeing and hand pulling weeds	6/20	7/5–7	6/13–14	6/14
	7/12–13	7/19	7/6	6/25
	—	8/14	7/18	7/16
	—	—	—	8/9
Measurements				
Crop stand	6/8	6/30	5/23	6/14
Photographed weed cover	8/9	8/16	7/16–17	7/2–3
Harvested crop	10/21	11/7	9/27	9/25

speed of 2.2 km/h. Glufosinate was applied only once, and later emerging weeds were controlled by hoeing and hand-pulling, as described.

Some summer annual weeds emerged after each soil disturbance by hoeing and after field corn canopy closure and silking, but late emerging weeds were mostly shade-suppressed, low-growing winter annual weeds. Giant foxtail, the major weed present, emerges from May to August in the Midwest (Raynal and Bazzaz 1975; Santelmann et al. 1963; Schrieber 1965), and flushes of giant foxtail frequently emerge after rainfall (Raynal and Bazzaz 1975) or soil disturbance (Buhler 1997). Although weeds emerge throughout the growing season, they do not have to be controlled before or after a limited "critical period" early in the growing season to prevent yield loss (Anderson 1997; Bosnic and Swanton 1997; Ghosheh et al. 1996; Halford et al. 2001; Hall et al. 1992; Knezevic et al. 1994, 1995, 2002; Mickelson and Harvey 1999). Although weeds continue to emerge after crop canopy closure, they do not reduce field corn yields (Knake and Slife 1965; Zimdahl 1980). Consequently, weeding can be stopped after silking, without changing the impact of interference treatments on field corn yields even if some limited weed emergence and crop shade-suppressed weed growth occurs after weeding ends. Moreover, walking through field corn after the canopy closes can damage and break brittle field corn leaves, and hoeing can cut brace roots; this disturbance can limit potential yield. Consequently, hoeing was ended after canopy closure.

Agronomic Practices. The experiment was conducted on conventional tillage (1994 and 1995) and reduced tillage sites (2001) after fallow or soybean at the University of Missouri's Bradford Experimental Farm, near Columbia in central Missouri (lat 38°53′43.5″N, long 92°12′37.9″W; 883 m altitude) and at a reduced tillage site (2002) after soybean at the University of Missouri's Greenley Memorial Research Center, near Novelty in northern Missouri (lat 40°0′45″N, long 92°12′29″W; 832 m altitude). Bradford had a Mexico silty clay loam (fine, smectitic, mesic Aeric Vertic Epiaqualfs), and Greenley had a Putnam silt loam (fine, montmorillonitic, mesic Vertic Albaqualfs). The Bradford soil had 18 to 20% sand, 46 to 48% silt, 34% clay, 2.9 to 3.4% organic matter, and pHs[7] values of 5.5 to 5.7, and the Greenley soil had 12 to 16% sand, 52 to 54% silt, 30 to 36% clay, 3 to 3.4% organic matter, and pHs of 6.

Dates for field operations, treatments, and measurements are summarized in Table 1. Weather data were collected at Bradford in 1994, but data from the Sanborn Experimental Field (1995) and the University of Missouri's South Farm (2001) near Columbia were substituted because the Bradford weather data were incomplete in those years. Greenley weather data from 1996 to 2002 were used. Heat sums for field corn were calculated using a base temperature of 10 C (Ruiz et al. 1998).

After being fallowed in 1993, the Bradford plot was chisel-plowed and the field cultivated for seedbed preparation and winter annual weed control in 1994 and 1995. In spring of 2001, the site was shallowly disked for seedbed preparation. Field corn was fertilized with nitrogen, phosphorus, and potassium for a yield goal of 7,520 kg/ha in 1994 and 1995 and 10,000 kg/ha in 2001 and 2002, based on soil tests and recommendations of

[7] pHs values are salt pH values that run approximately 0.5 units lower than the customary water pH values.

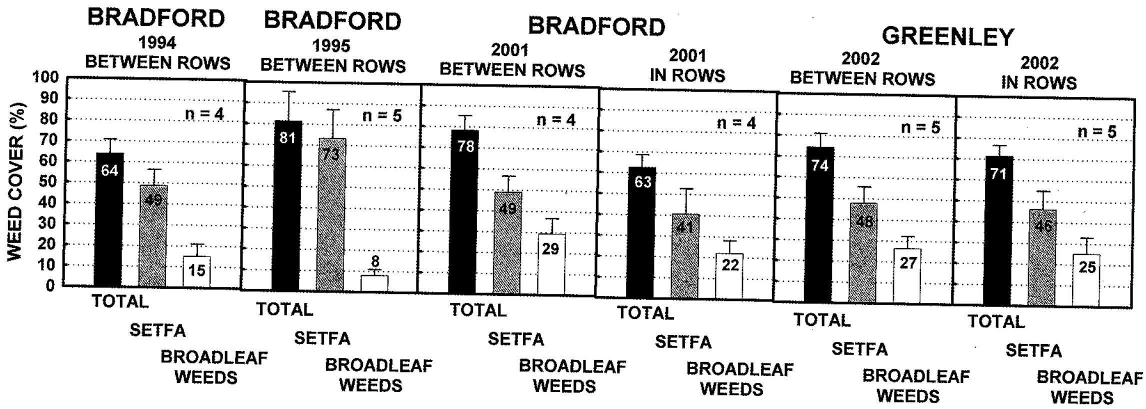

Figure 2. Weed cover (%) for giant foxtail (SETFA), broadleaf weeds, and total weeds (= SETFA + broadleaf weeds) are graphed for the weedy treatment at Bradford in 1994, 1995, and 2001 and at Greenley in 2002. Means ± standard error bars and sample sizes (*n*) are presented.

the University of Missouri's soil testing laboratory. In 1994 and 1995, fertilizers were broadcast before planting and were incorporated by field cultivation or shallow disking for seedbed preparation. NH_2NO_3–N–P_2O_5–K_2O was applied at 140–20–20 kg/ha in 1994, at 140–0–0 kg/ha in 1995, and at 160–69–93 kg/ha in 2001. 'Pioneer 3379' field corn seed were planted 1.3 to 1.9 cm deep in 76-cm rows at 74,000 and 78,000 seed/ha in 1994 and 1995, respectively, and glufosinate-resistant 'Pioneer 33G28' field corn seed were planted at 68,000 seed/ha in 2001.

In the spring of 2002, soybean residue at Greenley was shallowly disked. Field corn was fertilized for a grain yield goal of 10,000 kg/ha, based on soil tests and recommendations of the University of Missouri's soil testing laboratory. NH_2NO_3–N–P_2O_5–K_2O was broadcast-applied at 180–56–112 kg/ha before planting and was incorporated by disking. Glufosinate-resistant Pioneer 33G28 field corn seed were planted 1.3 to 1.9 cm deep in 76-cm rows at 68,000 seed/ha.

Giant foxtail and common waterhemp were the major grass and broadleaf weeds present at both sites in late summer in all the years (Figure 2). Giant foxtail constituted most of the weed cover for most treatments in all years. In 1994, the following sparse weeds were present: common ragweed (*Ambrosia artemisiifolia* L. AMBEL), common lambsquarters (*Chenopodium album* L. CHEAL), ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq. IPOHE], tall morningglory [*Ipomoea purpurea* (L.) Roth PHBPU], ladysthumb (*Polygonum persicaria* L. POLPE), velvetleaf (*Abutilon theophrasti* Medik. ABUTH), and yellow nutsedge (*Cyperus esculentus* L. CYPES). Occasional tall morningglory and yellow nutsedge were present in 1995, and common ragweed and Pennsylvania smartweed (*Polygonum pensylvanicum* L. POLPY) were present in 2001. Sparse common cocklebur (*Xanthium strumarium* L. XANST), ladysthumb smartweed, Pennsylvania smartweed, and velvetleaf were present in 2002.

Measurements. To determine field corn stand, plants were counted after emergence ended in the two center rows of four-row plots, along 1.8-m lengths in 1994 and 1995 and along the entire plots in 2001 and 2002 (Table 1). Field corn was combine-harvested from the two center rows in an area measuring 1.5 by 8.4 m in 1994, 1995, and 2002 and an area measuring 1.5 by 10.6 m in 2001, and yields were reported after adjustment to 15% moisture.

Projected total weed cover (= giant foxtail + broadleaf weed cover) (%) was measured after field corn canopy closure, from BR photographs to document the weed infestation (Knezevic et al. 1994, 1995; Ngouajio et al. 1999a, 1999b, 1999c). Crop and weed cover are related to yield and have been used to document treatment efficacy and phytotoxicity before (Donald 1998a, 1998b, 2000a, 2000b, 2000c, 2002). The references cited review the literature, describe the methodology, and provide an example of using weed cover to estimate soil erosion in computer models, such as RUSLE (Donald 2002). Four photographs per plot were taken with either a video camera[8] or a digital camera,[9] at a height of 164 cm in 1994 to 1995 and at 132 cm in 2001, respectively. Each photograph corresponded to 1.5 m^2 at the soil surface in 1994 and 1.1 m^2 in the other years, based on photographs of a 30- by 30-cm orange calibration plate. Before photographing BR weed cover, field corn foliage covering the BR zone was pulled back with 1-m^2 wooden frame panels covered with black cloth. Video photographs were

[8] RC-570 still video camera, Canon USA, Inc., Still Video Systems Division, 3 Dakota Drive, Lake Success, NY 11024.

[9] Olympus D-600 or D-620 L digital camera, Olympus America Inc., Two Corporate Center Drive, Melville, NY 11747-3157.

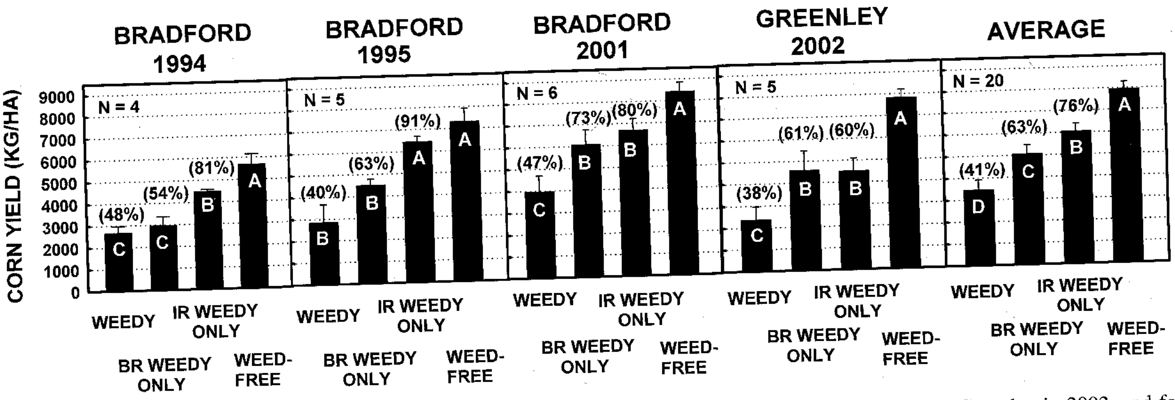

Figure 3. Field corn yield is graphed vs. weed interference treatment (Figure 1) at Bradford in 1994, 1995, and 2001, at Greenley in 2002, and for the average of all four site–years. Treatment means ± standard error bars and sample sizes (n) are presented for each year and for their average. Means followed by the same letter within each panel were not different by Fischer's protected LSD ($P \leq 0.05$). Numbers in parentheses above the vertical bars are treatment means as a percentage of the in row (IR) + between row (BR) weed-free treatment within each panel.

digitized[10] and saved as TARGA (1994 and 1995) or JPEG files (2001 and 2002) for import into Sigma Scan Pro version 5 (SPSS Science 1999). After the BR zones (all years) or IR zones (2001 and 2002) in each photograph were manually "cropped" (i.e., selected), image analysis software was used to automatically superimpose a 20- by 20-pixel square grid of intersecting lines onto each photograph. Projected cover (%) of SETFA, broadleaf, and total (= SETFA + broadleaf) weeds was calculated as follows:

$$C = (n/N) \times 100 \qquad [1]$$

where C = SETFA, broadleaf, or total (= SETFA + broadleaf) weed cover (%), n = number of intersecting lines in each category (SETFA or broadleaf weed), and N = total number of intersections per photograph.

Averages of four IR or BR cover measurements per plots in each category (SETFA or broadleaf weed) and total weed cover (= SETFA + broadleaf weed cover) are presented.

Statistical Analysis. Yield data were subjected to ANOVA (Hoshmand 1994; SPSS 2001) with block, treatment, and site–year as main effects, and treatment by site–year interactions. Means ± standard errors are presented, and means were separated using Fisher protected LSD test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Field Corn Yield. IR weeds growing in bands closest to field corn rows were expected to reduce yields more than BR weeds growing further. Consequently, the null hypothesis was that field corn yields would be ranked as weed-free > BR weedy only > IR weedy only > weedy in response to these treatments. Field corn yields are presented by site–year and averaged over four site–years (Figure 3) because weather (Figures 4 and 5) and methodology (see Materials and Methods) varied among site–years. The research results refute the null hypothesis; field corn yields averaged over four site–years were ranked as weed-free > IR weedy only > BR weedy only > weedy (Figure 3). Averaged field corn yields of the IR weedy only, BR weedy only, and weedy treatments were 76, 63, and 41% of the weed-free treatment (=7,820 kg/ha). Under ANOVA, main effects for site–year ($P = 0.0001$) and treatment ($P = 0.0001$) were significant for field corn yield, but block effects ($P = 0.315$) and site–year by treatment interactions ($P = 0.466$) were nonsignificant. In all site–years, the field corn yields of the weed-free treatment exceeded those of either the BR only weedy or weedy treatments, the two lowest yielding treatments. In three of the four site–years, the field corn yield of the weed-free treatment also exceeded that of IR only weedy treatment but could not be distinguished from it in 1 yr. In two of the 4 yr, the field corn yield of the IR weedy treatment exceeded the BR weedy treatment, whereas these treatments could not be distinguished from one another in the other 2 yr.

Weed-free field corn achieved 81, 104, 90, and 82% of the yield goal for which it was fertilized in 1994, 1995, 2001, and 2002, respectively (see Materials and Methods) (Figure 3). In the 2 yr in which the weed-free field corn yields did not achieve at least 90% of the yield goal for which it was fertilized, weather conditions during silking may have limited potential yield. When soil moisture is limited and moisture stress is visible, field corn silking can be delayed and pollination can fail, lead-

[10] SV-PC SV digitizer still video board, Canon USA, Inc., Still Video Systems Division, 3 Dakota Drive, Lake Success, NY 11024.

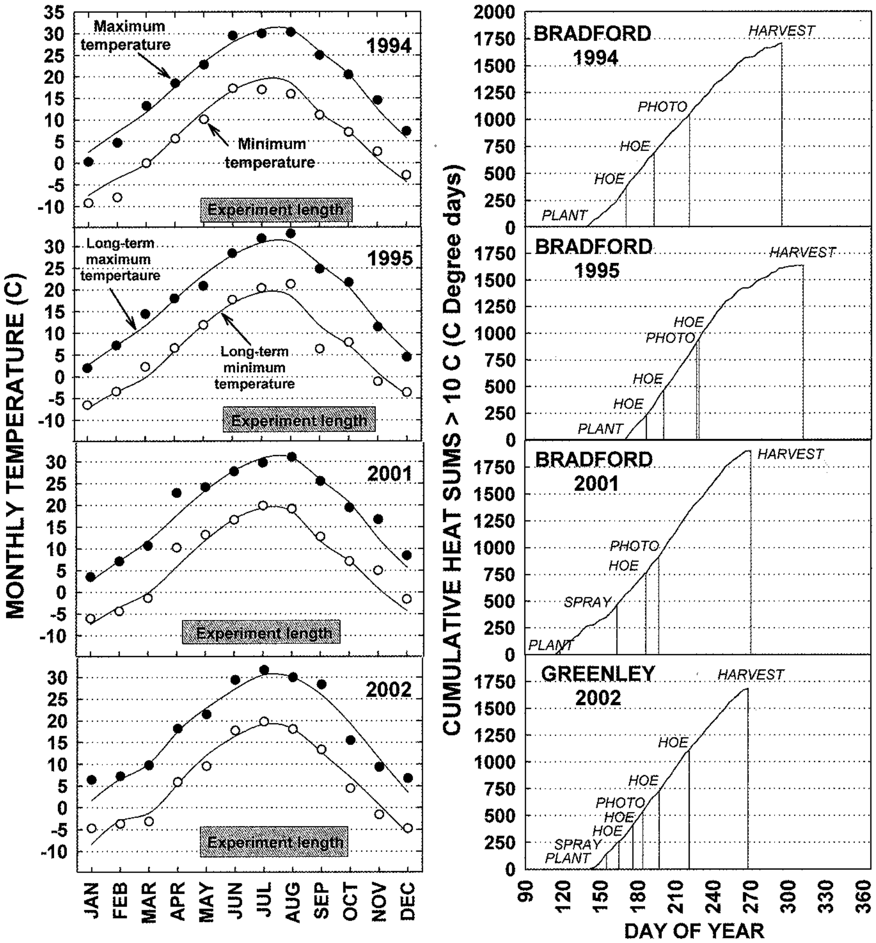

Figure 4. Monthly average maximum (solid circles) and minimum (open circles) temperatures are graphed vs. month at Bradford in 1994, 1995, and 2001 and at Greenley in 2002 in the left panels. Long-term average maximum and minimum temperature (solid lines) are graphed vs. month at Bradford (long-term average from 1993 to 2001) and Greenley (long-term average from 1996 to 2002) in the left panels. The duration of each experiment is indicated by a horizontal gray bar marked "Experiment length." Cumulative heat sums > 10 C (i.e., cumulative C degree days) using a base temperature of 10 C starting after field corn planting are graphed vs. day of the year in the right panels. Field operations or measurements are indicated by vertical lines.

ing to reduced seed set and incompletely filled cobs (Smith and Carter 1997). In 1994 and 2002, average June maximum and minimum temperatures were above normal (Figure 4) and total June rainfall (Figure 5) was below normal during silking. In 1994, July rainfall continued below normal, but maximum and minimum temperatures were below normal. In 2002, July rainfall was close to normal, and maximum and minimum temperatures continued above normal. In 1995 and 2001, weed-free field corn achieved at least 90% of the yield goal for which it was fertilized. In these years, June and July maximum and minimum temperatures and rainfall were closer to normal than in 1994 and 2002.

In 1994, 1995, 2001, and 2002, weedy field corn achieved 48, 40, 47, and 38% (average = 41%), respectively, of the weed-free yield (Figure 3). Field corn yields of the IR weedy only treatment were 81, 91, 80, and 60% (average = 76%) of the weed-free yield in the respective years (Figure 3) and were similar to published reports for giant foxtail, the predominant weed present (Beckett et al. 1988; Fausey et al. 1997; Knake and Slife 1962). Bands of giant foxtail growing only IR (i.e., cultivated BR) decreased field corn yields, but decreases varied between years and locations in the Midwest (Knake and Slife 1962; Lindquist et al. 1999). In Illinois, IR bands of giant foxtail at a density of 178 plants/m of row reduced field corn yields 25% (Knake and Slife 1962), and season-long interference by giant foxtail, which emerged 2 to 3 wk after field corn, at a density of 13.1 clumps/m of row (clump = five to eight plants) decreased field corn yields 18% (Beckett et al. 1988). In Michigan, 10 giant foxtail plants/m of row reduced field corn yields 13 and 14% in 2 yr (Fausey et al. 1997). Field corn yield was reduced 41% when IR weeds grew all season but were field-cultivated between rows (Schroder et al. 1984). In other research, field corn yields

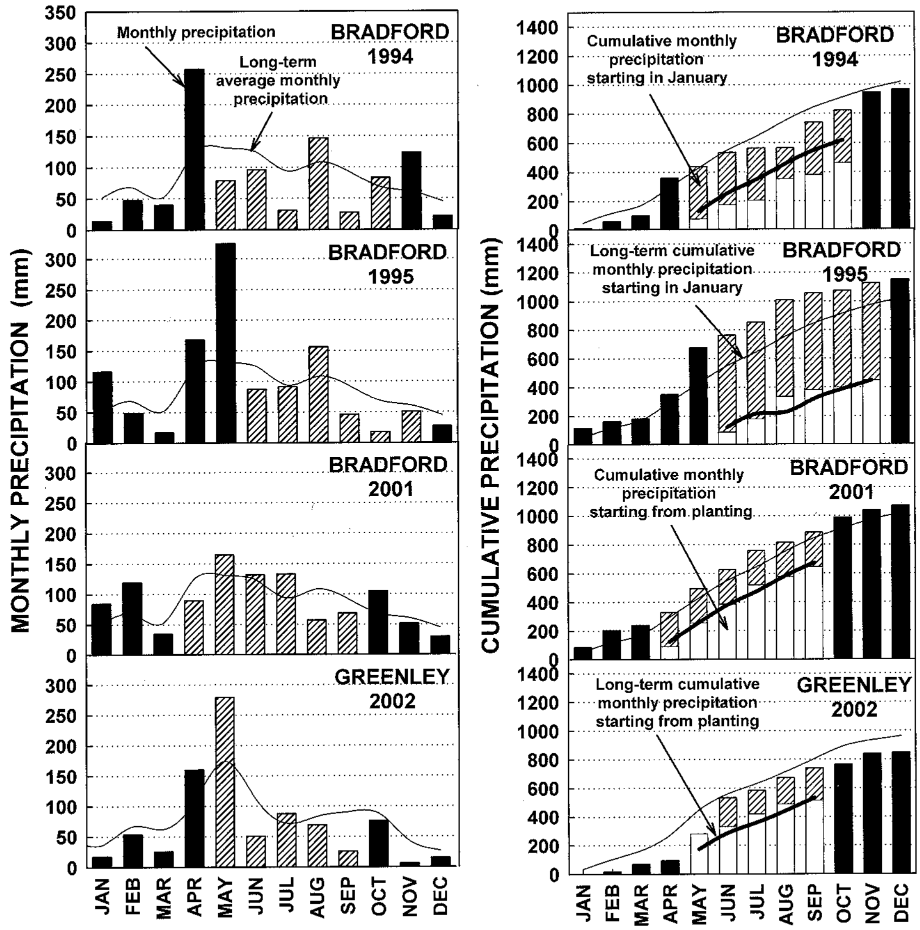

Figure 5. Average monthly precipitation (vertical bars) is graphed vs. month of the year at Bradford in 1994, 1995, and 2001 and at Greenley in 2002 in the left panels. Long-term average precipitation (solid lines) is graphed vs. month of the year at Bradford (long-term average from 1993 to 2001) and at Greenley (long-term average from 1996 to 2002) in the left panels. Cumulative average monthly precipitation starting in January (black and hatched bars) and starting after planting (white bars) are graphed vs. month of the year in the right panels. Long-term cumulative precipitation starting in January (solid thin lines) and starting after planting (solid thick lines) are graphed vs. month of the year in the right panels. Hatched bars indicate the duration of each experiment, and black bars indicate the nongrowing season months.

after treatment with IR band-applied herbicide + BR field cultivation exceeded those after BR cultivation alone (Drew and Van Arsdall 1966). In New York, field corn yields were ranked as follows: broadcast herbicide or band herbicide + cultivation > cultivation alone > weedy treatment (Ford and Pleasant 1994).

In 1994, 1995, 2001, and 2002, field corn yields of the BR weedy only treatment were 54, 63, 73, and 61% (average = 63%), respectively, of the weed-free yield (Figure 3). This response has not been reported before and was greater than the field corn yield decrease observed for the IR weedy only treatment, as noted.

Weed Ground Cover. In the weedy treatment, BR total weed cover (= SETFA + broadleaf weed cover) after canopy closure was 64, 81, 78, and 74% in 1994, 1995, 2001, and 2002, respectively (Figure 2). Most of the BR total weed cover was giant foxtail cover (77, 90, 63, and 65%, respectively, of total weed cover), as was the IR total weed cover in 2001 and 2002. In 1995, May rainfall (Figure 5) delayed seedbed preparation and planting, which killed most early emerging summer annual broadleaf weeds, allowing later emerging giant foxtail to predominate more than in the other years.

Research Significance. This research establishes that bands of BR weeds can reduce field corn yields as much as or more than bands of IR weeds (Figure 3). This research suggests that BR weeds experience less crop interference than IR weeds for a period before late field corn canopy closure, and interference eventually suppresses them. Reduced and delayed crop interference may give BR weeds a "head start" to acquire more resources and compete better with field corn than IR weeds, which experience earlier, more severe crop interference. If this prediction is correct, then IR weed cover should be less than BR weed cover late in the growing season after crop canopy closure. This prediction was observed to be true in 2001 but not in 2002 (Figure 2) and requires additional research for confirmation. Likewise, greater crop suppression of IR than BR weeds should enhance IR soil-residual herbicide efficacy compared with BR herbicide efficacy, as measured by both corn yield and IR and BR weed cover after crop canopy closure. This prediction was confirmed for IR– and BR–banded zone treatments with soil-residual herbicide in field corn at two sites in Missouri (Donald et al. 2003). The relative contribution of allelopathy vs. competition to total giant foxtail–field corn interference (Bhowmik and Doll 1984) also is hard to reconcile with the observed results (Figure 3) and needs to be reevaluated in field research.

A better understanding of BR and IR weed–field corn interference may contribute to better weed management strategies, requiring less herbicide per unit area because field corn interference causes weeds growing in IR and BR zones to respond differently to treatment. When farm labor was more plentiful and less costly in the 1950s and 1960s and farmers wished to reduce herbicide input costs, relatively expensive soil-residual herbicides were banded in crop rows, and BR weeds were controlled with field cultivation. As noted in the Introduction, there are now more options for managing weeds both IR and BR (Bowman 1997). If weeds growing in competitive crops, like field corn, are controlled BR by cultivation, brush rolling, mowing, or herbicide application, then band-applied IR herbicides rate may be reduced without decreasing yields relative to broadcast-applied reduced rate herbicide application (Donald et al. 2003). Although this research suggests that it may be more critical to control BR than IR weeds, controlling both BR and IR weeds maximized yields.

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