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SHORT COMMUNICATION

The critical period of weed control in corn in Birjand region, Iran

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Abstract

The critical period for weed control (CPWC) is the period in the crop growth cycle during which weeds must be controlled to prevent unacceptable yield losses. Field studies were conducted in 2005 and 2006 in the University of Birjand at the south east of Iran to determine CPWC of corn using a randomized complete block design with 14 treatments and three replications. The treatments consisted of two different periods of weed interference, a critical weed-free period and a critical time of weed removal, were imposed at V_3, V_6, V_9, V_{12}, V_{15}, and R_1 (based on phonological stages of corn development) with a weedy check and a weed-free check. The CPWC was determined with the use of 2.5, 5, 10, 15 and 20% acceptable yield loss levels by non-linear regression method and fitting Logistic and Gompertz nonlinear equations to relative yield data. The CPWC of corn was from 5- to 15-leaf stage (19-55 DAE) to prevent yield losses of 5%. This period to prevent yield losses of 2.5, 10 and 20% was 4- to 17-leaf stage (14-59 DAE), 6- to 12-leaf stage (25-47 DAE) and 8- to 9-leaf stage (31-36 DAE) respectively.

Keywords: Gompertz, Logistic; Weed control

Introduction

The critical period for weed control (CPWC) is a period in the crop growth cycle during which weeds must be controlled to prevent yield losses. It is useful for making decisions on the need for and timing of weed control. Determining the CPWC could help reduce yield losses due to weed interference (Knezevic et al., 2002). The CPWC is determined by calculating the time interval between two components of weed interference. These are (1) the critical weed interference period or the maximum length of time during which weeds emerging soon after crop planting can coexist with the crop without causing unacceptable yield loss, and (2) the critical weed-free period or the minimum length of time required for the crop to be maintained weed-free before yield loss caused by late emerging weeds is no longer a concern (Evans et al., 2003; Hall et al., 1992).

Corn (*Zea mays* L.) is an important crop for Iran and weeds are one of the most important reducing factors in its production in Iran. Therefore, weed control is an important management practice for corn production that should be carried out to ensure optimum grain and forage yield. Studies have been conducted around the world to determine the CPWC in corn, with a range of environmental conditions. Hejazi et al., (2000) reported this period for silage corn in Varamin region, Iran from 5-leaf stage (21 DAP) to 12-leaf stage (38 DAP) at the 5% yield loss. Asghari et al., (2002) showed that CPWC for corn in west of Iran is 5- to 9-leaf stage (26-37 DAE) at the 5% grain yield loss.

To provide more precise information for growers, CPWC should be determined specifically for a particular region by considering the weed composition and climatic conditions (Knezevic et al., 2002; Heshmati, 2007; Wu et al., 2008). Therefore, this study aimed to estimate the optimum timing for weed control in corn and to determine the effect of the timing of weed removal and the duration of weed interference on corn yield under the growing conditions of southern Khorasan province at Birjand region (south east of Iran), an area for which this type of information is lacking.

Materials and Methods

Field experiments were conducted in 2005 and 2006 at the Birjand University Experiment Station in the southern east of Iran (32° 56′ North latitude, 59° 13′ East longitude, 1480 m). Corn seeds, cultivar SC704, sown at a spacing of 20 cm within the row spaced 75 cm apart at a population density of 66,600 plants ha^{-1}. Sowing dates were 14 May 2005 and 20 May 2006. Plot size was five rows each 7 m long, and plots were separated by two border rows. The middle three rows of each plot were used for data collection. Fertilizers and irrigation were applied according to local practices for corn production. Experiments were conducted on the same site within the research station in successive years. Naturally occurring weed populations were used in trials. The experimental design was a randomized complete block with three replications. Two sets of treatments were imposed. The first set of treatments established six levels of increasing duration of weed interference by delaying weed control from the time of crop emergence up to predetermined crop growth stages (weedy up to V_3, V_6, V_9, V_{12}, V_{15}, and R_1) at which weed control was initiated and maintained for the remainder of the growing season. The second set of treatments established six levels of increasing length of the weed-free period by maintaining weed control from the time of crop planting up to the above-presented crop growth stages before subsequently emerging weeds were left uncontrolled for the remainder of the season. In addition, season long weedy and weed-free controls were included.

Two days before each weed removal, weeds were harvested from three 1-m^2 quadrats staggered on each side of the three middles corn rows within each experimental plot. At each harvest weeds were clipped at the soil surface, sorted by species, counted, and dried at 70 °C to constant moisture content to obtain a measure of aboveground dry weed biomass.

Final corn harvest dates were September 21, 2005 and September 27, 2006. Ears were threshed and subsequently dried at 70 °C to constant moisture content. All yields are presented and analyzed on a dry weight basis to eliminate the error associated with adjusting moisture content. Yield data of individual plots were calculated as the percentage of their corresponding weed-free plot yields. Nonlinear regression analyses were used to estimate the relative yield of corn as a function of increasing duration of weed interference or as a function of the length of the weed-free period, according to the procedure outlined by Knezevic et al., (2002). The logistic equation was used to determine the beginning of the CPWC, and the Gompertz equation was used to determine the end of the CPWC for acceptable yield loss levels of 2.5%, 5%, 10%, 15% and 20%. Goodness of fit was studied in terms of minimum mean square error (MSE) and maximum R^2.

Results and Discussion

The weed population was composed of 10 species in 2005 and 9 species in 2006. In both years, the most common weeds in the experiments were Common lambsquarters (*Chenopodium album* L.), Saltwort (*Salsola kali* L.), Heliotrope (*Heliotropium europaeum* L.) and Camel thorn (*Alhagi pseudalhagi* M.B. Desv.). These four species represented 76 and 80% of the total weed population in 2005 and 2006, respectively. Common lambs quarters and Saltwort were the most predominant species and accounted for 51 and 55% of the weed populations in 2005 and 2006, respectively. Corn yield in the weed-free treatment was 8,210 kg ha^{-1} in 2005 and 6,090 kg ha^{-1} in 2006. There was no year by treatment interaction; therefore, relative yield data were combined over years.

The length of the CPWC in corn was 45, 36, 22, 13 and 5 days with 2.5, 5, 10, 15 and 20% acceptable yield loss levels (AYL), respectively. The onset of the CPWC was 19 DAE (fifth leaf stage of corn (CLS) at 5% AYL and 14 DAE (4 CLS), 25 DAE (6 CLS), 28 DAE (7 CLS) and 31 DAE (8 CLS) at 2.5, 10, 15 and 20% AYL, respectively (Figure 1). Weed control should therefore start 2 weeks after crop emergence to avoid a yield loss of more than 2.5%. The CPWC for AYL of 2.5, 5, 10, 15 and 20% ended at 59 DAE (17 CLS), 55 DAE (15 CLS), 47 DAE (12 CLS), 41 DAE (11 CLS) and 36 DAE (9 CLS) (Table 1 and Figure 1).

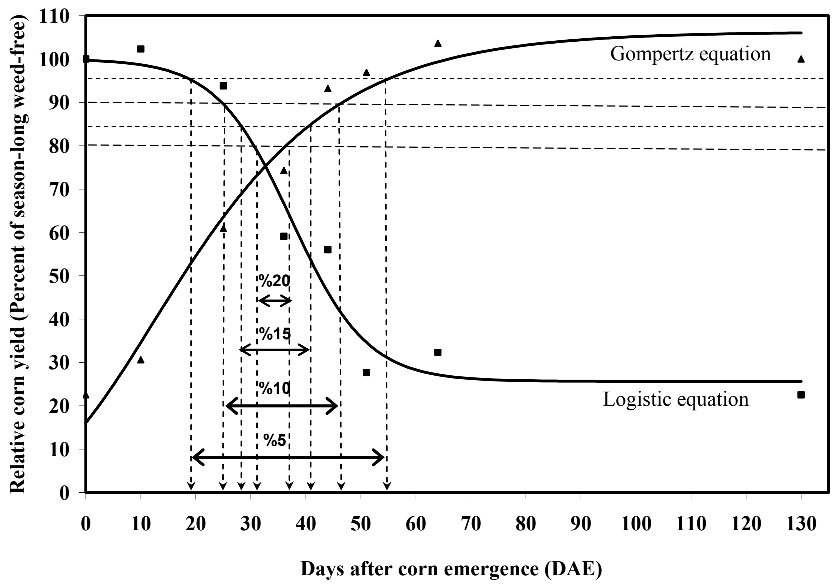

Figure 1. Effect of weed interference on total yield of corn. Increasing duration of weed interference (■) and fitted curves as calculated by the logistic equation; increasing weed-free period (▲) and fitted curves as calculated by the Gompertz equation. Dots represent observed data averaged over 2005 and 2006. Horizontal dashed lines indicate the 5%, 10%, 15% and 20% acceptable yield loss levels used to determine the CPWC, whereas vertical dashed lines indicate the beginning and end of CPWC.

Table 1. The critical period of weed control (CPWC) for corn calculated from Logistic and Gompertz equations at five acceptable yield loss levels (AYL) expressed as days after emergence (DAE) and corn leaf stages (CLS).

ALY	Beginning of CPWC		End of CPWC	
	DAE	CLS	DAE	CLS
2.5%	14	4	59	17
5%	19	5	55	15
10%	25	6	47	12
15%	28	7	41	11
20%	31	8	36	9

Weeds reduced corn yield by approximately 77% when allowed to compete with the crop from planting through harvest. The CPWC determined in our research for the southern east region of Iran is generally similar to that determined by Evans et al., (2003), shorter duration in comparison to that determined by Norsworthy and Oliverira (2004) and longer duration in comparison to that determined by Isik et al., (2006). This variation could be explained by differences in environmental conditions and weed species diversity among research sites. Our results suggest that weed control measures in southern east of Iran can be delayed up to about 20 days after corn emergence. Previous study has reported similar results in northern east region of Iran (Abbaspour and Moghaddam, 2004). Several researchers have indicated that the end of CPWC was not stable but was highly dependent on the density, competitiveness, and emergence periodicity of the weed population (Evans et al., 2003; Norsworthy and Oliveira, 2004).

Based on 5% acceptable yield loss, results of this research suggest that under our experimental conditions corn tolerates weed interference until 19 DAE or 5 CLS, suggesting that control measures should start at that stage. The crop should be kept weed free until 55 DAE or 15 CLS in order to prevent yield loss in excess of 5%. Weeds that emerge after that, grow in a competitive disadvantage in comparison with corn.

In Birjand region, hand weeding and herbicide applications are the major methods of weed control in corn. According to the results of the CPWC, growers could improve timing of post emergence herbicide applications and hand weeding. Further studies should be conducted to determine the CPWC in other areas where weed populations are different from those reported here.

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