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Interference of Common Lambsquarters (*Chenopodium album* L.) With Sugar Beet

[1]*Gholamreza Heidari*, [1]*Yousef Sohrabi*, [2]*Khosro Mohammadi*,
[3]*Abdolmajid Heidari* and [2]*Mohammad Majidi*

[1]Department of Agronomy and Plant Breeding,
Faculty of Agriculture, University of Kurdistan, Sanandaj, Iran
[2]Department of Agronomy and Plant Breeding,
Sanandaj Branch, Islamic Azad University, Sanandaj, Iran
[3]Urmia University, Iran

Abstract: Field studies were conducted in 2006 and 2007 growing seasons to examine the competitive effects of common lambsquarters on sugar beet. The experiments were established as a randomized complete block design in a factorial arrangement of four common lambsquarters emergence times (0, 15, 30 and 45 days after sugar beet) and four common lambsquarters densities (0, 5, 10 and 15 plants m^{-1} per row). Sugar beet LAI, biomass and white sugar yield were reduced with increasing common lambsquarters density and decreasing relative time of common lambsquarters emergence. The lack of an affect of late emerging common lambsquarters (45 days after sugar beet emergence) on sugar beet LAI and yield might be due to the common lambsquarters plants being smaller and their not growing above sugar beets until harvest. Seed production of common lambsquarters per m^2 was increased with increasing density and decreasing relative time of emergence of common lambsquarters. Common lambsquarters produced greater biomass when it emerged with or 15 days after sugar beet than at later emergence times at all densities. This indicates the importance of time of emergence of common lambsquarters relative to sugar beet in affecting competition between them. These results suggest that sugar beet producer should implement common lambsquarters management strategies earlier than 45 days after sugar beet emergence in order to reduce negative effects of common lambsquarters on sugar beet yield.

Key words: Biomass · Competition · Emergence time · LAI · Weed density

INTRODUCTION

Weed control in sugar beet adds greatly to total production cost [1]. Sugar beet crop develops slowly, so weeds can compete easily in the early stages of growth [2]. Competition from uncontrolled annual weeds can result in sugar yield reductions of 25-100% andworld-wide, approximately 70% of weed species occurring in sugar beet are broad leaf annuals of which common lambsquarters (*Amaranthus retroflexus* L.) is one of the most frequently occurring [3].

Weed density and time of emergence of the weed relative to the crop are two of the most critical factors affecting weed interference [4, 5]. Weeds emerging before or with the crop cause greater yield losses than weeds of same species emerging later [6, 7]. Baghestani *et al*. [8] reported that simultaneous emergence of common lambsquarters and maize resulted in the highest maize LAI and yield losses, but delaying common lambsquarters emergence reduced its competitive ability against maize. Besides the emergence time, the number of weeds per area (density) is a determinant of crop quality and yield loss [9]. Willenborg *et al*. [10] reported that wild oat at a density of 320 plants m^{-2} reduced cultivated oat yield by 70%. Common lambsquarters (*Chenopodium album* L.) in sugar beet reduced biomass linearly as the density increased from 0 to 8 weeds m^{-2} of row. Horak and Loughin [11] found that early emerging redroot pigweed was taller with greater biomass than late emerging redroot pigweed. Mickelson and Harvey [12] showed that woolly cupgrass emerging at the V5 stage of corn only produced about 40 seeds per plant as compared to 550 to 1760 seeds per plant for early emerging cupgrass.

Corresponding Author: Gholamreza Heidari, Department of Agronomy and Plant Breeding, Faculty of Agriculture, University of Kurdistan, Sanandaj, Iran. Tel: +989141667406.

The objectives of this study were to determine of the effects of common lambsquarters density and time of emergence on LAI, biomass and white sugar yield of sugar beet and on height, seed production and biomass of common lambsquarters when grown in competition with sugar beet.

MATERIALS AND METHODS

Field experiments were conducted during 2006 and 2007 growing seasons at the Mokrian Agricultural Extension Center near Mahabad, Western Azerbaijan of Iran. The experiments were organized as factorial experiments with two factors based on randomized complete block design with three replications. Factors include four common lambsquarters emergence times (0, 15, 30 and 45 days after sugar beet emergence) and four weed densities (0, 5, 10 and 15 plants m^{-1} of row).

Sugar beet was planted in a conventional tillage system with 60-cm row spacing and five rows per plot. Plots were 5 m in length. The soil types were fine silt loam at Mokrian site. Sugar beet seeds were planted on 15^{th} and 19^{th} April in 2006 and 2007 growing seasons, respectively. Plots were irrigated immediately after sowing to assure uniform germination. Later on irrigation intervals were determined on the basis of sugar beet need. Common lambsquarters was hand seeded on four different times in each year in the sugar beet rows at densities of 0 (control), 5, 10 and 15 plants m^{-1} of row. The desired weed densities were established by hand removal at the two to four leaf stages. In both years weeds other than common lambsquarters were removed by hand hoeing.

In both years, leaves from six sugar beet plants were removed and passed individually through a leaf area meter every 15 day. Leaf area index (LAI) was calculated by dividing leaf area per plot (cm^2) by the plot area (cm^2). At the end of the experiment, total dry biomass of sugar beet leaves and roots were measured. Also height of six common lambsquarters plants were measured and shoots harvested and their dry biomass was determined. Seed production m^{-2} of common lambsquarters estimated by the procedure of Knezevic *et al*. [13]. Sugar beet plants in each plot were harvested and white sugar yield was obtained multiplying white sugar content by root yield for each plot in each year.

Data were subjected to the combined analysis of variance over years and the chi-square test was used to verify homogeneity of variance before combining data. Analysis of variance was performed using the general linear model procedure to test the significance of common lambsquarters emergence time, density and interaction between emergence time and density [14].

RESULTS AND DISCUSSION

Sugar Beet: None of the interactions between the experimental factors and year were statistically significant for studied variables (data not shown). Therefore, average of data from two years was used for interpretation.

Leaf area index (LAI) can be used to indicate the effect of weed competition on crop yield and quality [15, 16]. Sugar beet leaf area index was reduced with increasing common lambsquarters density and decreasing relative time of common lambsquarters emergence. Sugar beet leaf area index was 4.4 with no common lambsquarters present and reduced by 50% for synchronous emergence time at density of 15 plants m^{-1} of row. Late emerging common lambsquarters (45 days after sugar beet emergence) did not affect LAI of sugar beet at all densities (Fig. 1). The height advantage of common lambsquarters shaded the sugar beet, which contributed to the reductions in sugar beet LAI. Our results are consistent with earlier studies in which a reduction in LAI of crops other than sugar beet is influenced by emergence time and density of a weed [17, 18].

Sugar beet dry biomass was reduced by increasing the density of common lambsquarters emerging synchronous with sugar beet from 45 to 71% in mean of two years. Also common lambsquarters emerging 15 and 30 days after sugar beet reduced sugar beet dry biomass in all densities. The reduction in sugar beet dry biomass due to weed competition might be attributed to decreasing sugar beet LAI (Fig. 2). Common lambsquarters emerging 45 days after sugar beet did not affect sugar beet dry biomass. The lack of an effect of late emerging common lambsquarters (45 days after sugar beet emergence) on sugar beet dry biomass might be due to the common lambsquarters plants being smaller and their not growing above sugar beets until harvest [19].

Sugar beet white sugar yield is determined by multiplying white sugar content by root yield. White sugar yield varied from 9.8 t ha^{-1} for weed free condition (density of 0) to 4.8 t ha^{-1} for synchronous emergence time and density of 15 plants m^{-1} of row (Fig. 3). Decreasing of white sugar yield due to weed competition was the result of effects on the sugar beet root yield, because white sugar content was not affected by common lambsquarters emergence time and density (data not shown). Common lambsquarters that emerged 45 days after sugar beet emergence had no significant effect on white sugar yield at all densities (Fig. 3).

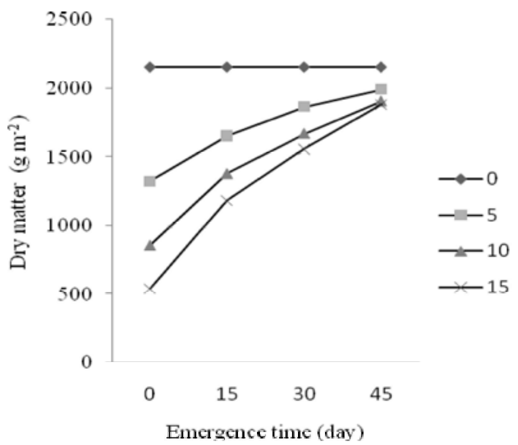

Fig. 1: Effect of emergence time and plant density of common lambsquarters (0-15 plants per meter of row) on sugar beet dry matter.

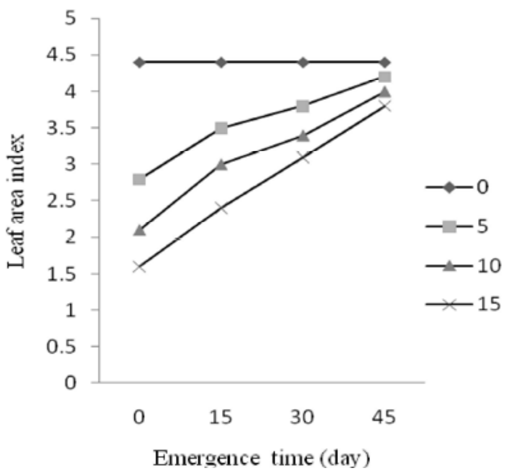

Fig. 2: Effect of emergence time and plant density of common lambsquarters (0-15 plants per meter of row) on sugar beet leaf area index.

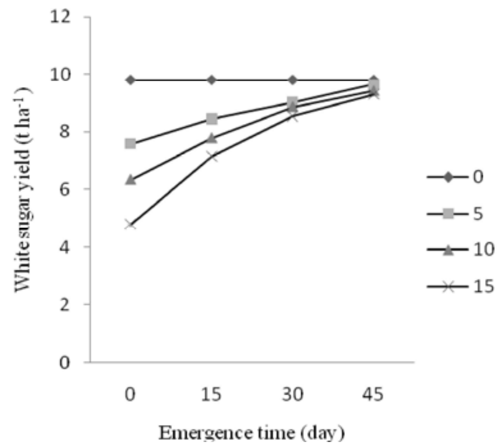

Fig. 3: Effect of emergence time and plant density of common lambsquarters (0-15 plants per meter of row) on white sugar yield.

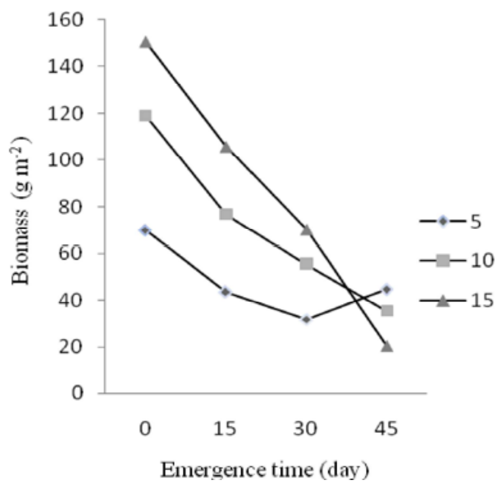

Fig. 4: Effect of emergence time and plant density of common lambsquarters (0-15 plants per meter of row) on biomass of common lambsquarters.

Common Lambsquarters: Height of common lambsquarters at sugar beet harvest ranged from 26.59 to 86.97 cm depending on emergence time and density (Fig. 4). Height of common lambsquarters was increased by decreasing common lambsquarters relative emergence time and increasing its density (Fig. 4). The increase in common lambsquarters height at higher densities for the earlier emergence times likely was due to allocate large portion of it's assimilates to stem to increase its height in order top receive more light. There was no effect of density on the height of late emerging common lambsquarters (45 days after sugar beet emergence) (Fig. 4). It appears that sugar beet ability to effectively shade late emerging common lambsquarters plants had a large negative effect on the competitive ability of common lambsquarters.

Common lambsquarters produced much more biomass, when it emerged with or 15 days after sugar beet than at later emergence times at all densities. This further indicates the importance of time of emergence of common lambsquarters relative to sugar beet in affecting competition between them. Abdollahian-Noghabi and Froud-Williams [20] reported that depending on weed emergence time and density, total weight of weeds was reduced by 49-97% by the competitive effect of sugar beet.

Seed yield of common lambsquarters per m^2 varied with density, time of emergence (Fig. 6). Seed yield from late emerging common lambsquarters (30 and 45 days after sugar beet) was significantly lower than seed yield from early emerging (0 and 15 days after sugar beet). The decrease in seed production with later emergence

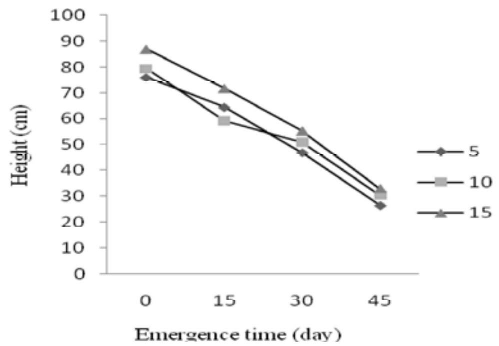

Fig. 5: Effect of emergence time and plant density of common lambsquarters (0-15 plants per meter of row) on plant height of common lambsquarters.

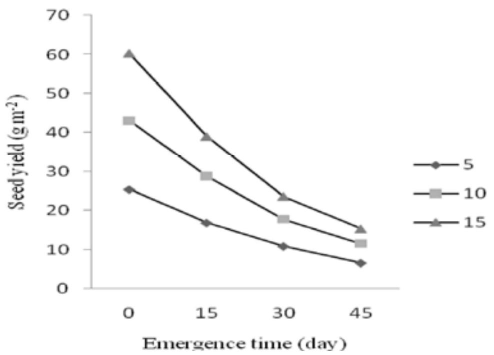

Fig. 6: Effect of emergence time and plant density of common lambsquarters (0-15 plants per meter of row) on seed yield of common lambsquarters.

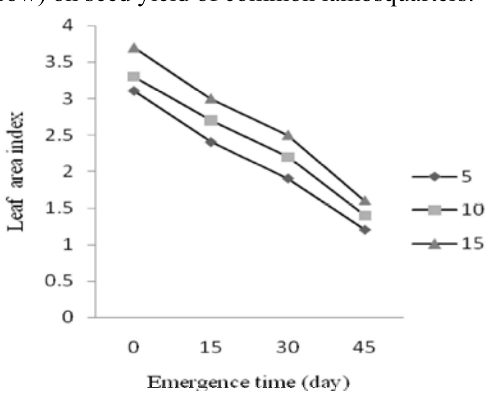

Fig. 7: Effect of emergence time and plant density of common lambsquarters (0-15 plants per meter of row) on leaf area index of common lambsquarters.

was attributed to inter specific competition between crop and weed. Seed yield produced per m^{-1} increased with increasing density in both early and late emerging common lambsquarters. Our results on the relationship of weed density and emergence time on seed yield agree with trends reported in other weeds [17, 21].

CONCLUSIONS

This study showed that earlier emergence times of common lambsquarters can be highly competitive with sugar beet at densities as low as 5 plants m^{-1} of row. Emergence time of common lambsquarters in 45 days after sugar beet did not cause a substantial reduction in biomass, LAI and white sugar yield of the crop. Therefore the time of common lambsquarters emergence relative to sugar beet was fundamental in determining the outcome of common lambsquarters -sugar beet competition. These results suggested that sugar beet producer should implement common lambsquarters management strategies earlier than 45 days after sugar beet emergence in order to reduce negative effects of common lambsquarters on sugar beet yield. Our information will be useful to farmers developing common lambsquarters management plans in sugar beet fields.

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