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# The Effect of Johnsongrass (*Sorghum halepense* (L.) Pers.) Densities on Cotton Yield

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**Abstract:** Cotton is an important crop in Turkey. Johnsongrass is one of the worst weeds in cotton fields worldwide. Field experiments were carried out in 1992, 1997 and 2002 to show the effect of johnsongrass densities on cotton yield. Johnsongrass densities were 0, 1, 2, 4, 8, 16 and 32 plants per 8 m and 0, 3, 6, 8, 11, 14 and 22 plants per 4 m of cotton row. Data were fitted to equations $Y = 1/(a+b*X_8)$ in 1997 and 2002 for the number of johnsongrass in 8 m of row length and $Y = 1/(a+b*X_4^{-1/2})$ in 1992 and 1997 for the number of johnsongrass in 4 m of row length. Cotton yield was affected by all johnsongrass densities. One johnsongrass plant in 8 m of cotton row decreased cotton yield 4.82 and 9.42% in 1997 and 2002, respectively.

**Key words:** Cotton, johnsongrass, inference, competition

## INTRODUCTION

Johnsongrass (*Sorghum halepense* (L.) Pers.) is among the world's worst weeds. It has been problem in many crops including cotton (Holm *et al*., 1991). It is a Mediterranean plant where Turkey is located (Holm *et al*., 1991).

Cotton is an important crop in Turkey, which is sown over 600 000 ha area (FAO, 2006). Although total cotton sown area have not changed much in Turkey; cotton sown areas shifted after initiation of Southeast Anatolia Irrigation Project (GAP) where the cotton areas have expanded in parallel to increasing irrigation possibilities and become main crop in the irrigated fields. Johnsongrass is one of the worst weeds in cotton fields in the GAP Region as well as other regions of Turkey (Uludag and Uremis, 2000).

The interference of johnsongrass with cotton has been already studied. Keeley and Thullen (1981), found that 20 shoots of johnsongrass per square meter could reduce seed cotton yield 20% and densities exceeding 75 shoots $m^{-2}$ caused over 75% loss. In addition, cotton stands and height were reduced by johnsongrass competition. Bridges and Chandler (1987), reported that 2 johnsongrass plants in 9.8 m row length of cotton was critical observed density. The average loss was 1% when 1 johnsongrass plant was established, it reached to 70% when density was 32 plants/9.8 m. Intraspecific competition was clearly evident at high johnsongrass densities, which the total number of panicles and johnsongrass fresh weight were the parameters measured. Cotton yield was differently affected by various johnsongrass densities but cotton cultivars with different height had similar competitiveness (Bridges and Chandler, 1988).

Although herbicides and mechanical control methods applied intensively, johnsongrass stays as a problem in the cotton fields in Turkey (Uludag and Uremis, 2000). There are examples of differential effect of weeds on crops depending on regional difference (Zimdahl, 2004). The aim of the current study was to quantify the effects of johnsongrass on cotton in the Southeast Anatolia Region where johnsongrass is native.

## MATERIALS AND METHODS

Four field experiments were carried out in three locations, which were Diyarbakir, Sanliurfa and Kahramanmaras provinces in 1992, 1997 and 2002, respectively, in the Southeast Anatolia Region of Turkey with natural johnsongrass densities in order to show the effect of johnsongrass densities on cotton yield. Fields had different soil characteristics (Table 1).

Each year different cotton varieties, which were KAT 64, St 250/1 and Maras 92 in 1992, 1997 and 2002,

Table 1: Soil type and properties of experiments

| | Year | | |
|---|---|---|---|
| Soil property | 1992 | 1997 | 2002 |
| Texture | Clay loam | Loam | Loamy sand |
| pH | 7.6 | 7.8 | 7.7 |
| Organic matter (%) | 1.53 | 1.85 | 0.89 |

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respectively, were sown before mid May. The competitiveness of cotton cultivars was not different in previous experiments (Bridges and Chandler, 1988). Before planting trifluralin at 2 kg $ha^{-1}$ were applied and incorporated into soil. Fertilizers were applied at planting and in June. Two different types of experiments were set in the first week of June. One was based on 4 m of cotton row length with 0, 3, 6, 8, 11, 14 and 22 johnsongrass densities in 1992 and 0, 3, 6, 8, 14 and 22 plant densities in 1997. The other was with 0, 1, 2, 4, 8, 16 and 32 johnsongrass densities per 8 m cotton row length, which were carried out in 1997 and 2002. Plots included 6 rows of cotton, which were 0.70 m apart from each other. The length of plots was either 4 or 8 m depending on experiment type. Undesired plants were removed by hand pulling and hand hoeing every 10 days until the end of the August. Inter row cultivation were applied twice, before experiments were set and at the end of the June except in 1992, experiment. Cotton was irrigated as recommended for the region.

All experiments were conducted in a randomized complete block design with four replications except the experiment in 1992 with three replications. Cotton was harvested by hand in October and seed cotton was weighed. Data were subjected to ANOVA and regression analysis.

## RESULTS AND DISCUSSION

Observed mean cotton yield at weed free plots was 3281, 2506 and 3182 kg $ha^{-1}$ in 1992, 1997 and 2002, respectively. Cotton yield was significantly affected by johnsongrass densities. The effect of johnsongrass depended on the effect of years. Due to the effect of years and differences in plot sizes, each experiment again underwent to ANOVA and regression analyses were run separately.

Data were fitted to equations $Y = 1/(a+b*X_8)$ in 1997 and 2002 for the number of johnsongrass in 8 m of row length and $Y = 1/(a+ b*X_4^{-1/2})$ in 1992 and 1997 for the number of johnsongrass in 4 m of row length, where Y is cotton yield (kg $ha^{-1}$), a and b are constants and $X_8$ is the number of johnsongrass plants in 8 m cotton row and $X_4$ the number of johnsongrass in 4 m of row (Fig. 1 and 2). Parameter estimates were presented at Table 2. Ratkowsky (1990), stated that this model has been used in agricultural research for yield-density studies and is known the reciprocal model.

Cotton yield was affected by all johnsongrass densities (Table 3). One johnsongrass plant in 8 m of cotton row decreased cotton yield 4.82 and 9.41% in 1997 and 2002, respectively. In our conditions crop loss was higher in low densities. Bridges and Chandler (1987) found 1% crop loss when a johnsongrass plant competed in 9.6 m row length. However, similar crop losses were obtained at higher densities with earlier studies. Estimated yield loss for 32 johnsongrass shoots reached to 76.88 and 61.86% in 2002 and 1997, respectively. The relative

Table 2: Parameter estimates and regression coefficient for experiments

| | Parameters and their standard deviations | | | | |
|---|---|---|---|---|---|
| Experiments | a | sd | b | sd | $R^2$ |
| 2002 | 0.000308 | 1.10E-05 | 0.000032 | 3.91E-06 | 98.25 |
| 1997-8 m | 0.000434 | 1.60E-05 | 0.000022 | 3.45E-06 | 98.00 |
| 1997-4 m | 0.000391 | 2.60E-05 | 0.000096 | 1.50E-05 | 96.27 |
| 1992 | 0.000444 | 4.00E-05 | 0.000187 | 3.40E-05 | 93.80 |

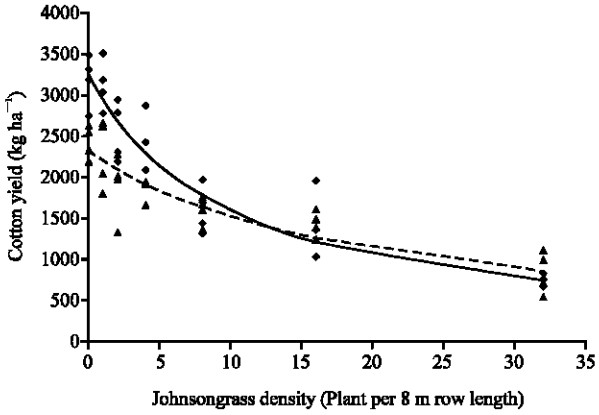


Fig. 1: The effect of johnsongrass densities at 8 m row length on cotton yield (solid line, predicted curve for 2002; dotted line, predicted curve for 1997; ◆, measured cotton yields in 2002; ▲, measured cotton yields in 1997)

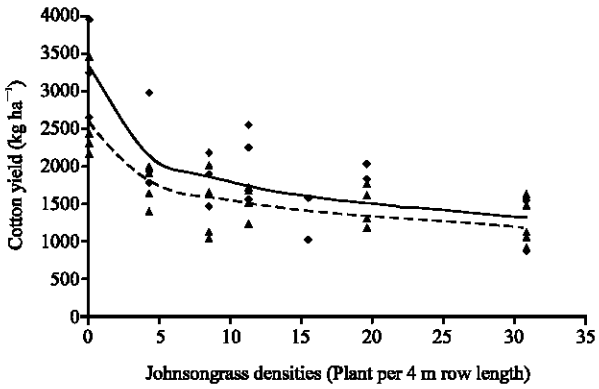


Fig. 2: The effect of johnsongrass densities at 4 m row length on cotton yield (solid line, predicted curve for 1992; dotted line, predicted curve for 1997; ◆, measured cotton yields in 1992; ▲, measured cotton yields in 1997)

Table 3: Estimated crop losses due to johnsongrass densities, which is calculated from predicted regression curves

| Johnsongrass densities | Losses at 8 m experiments (%) | | | Johnsongrass densities | Losses at 4 m experiments (%) | | |
|---|---|---|---|---|---|---|---|
| | 2002 | 1997 | Mean | | 1997 | 1992 | Mean |
| 1 | 9.41 | 4.82 | 7.12 | 3 | 29.84 | 35.51 | 32.67 |
| 2 | 17.20 | 9.21 | 13.20 | 6 | 37.56 | 43.78 | 40.67 |
| 4 | 29.36 | 16.86 | 23.11 | 8 | 40.98 | 47.34 | 44.16 |
| 8 | 45.39 | 28.85 | 37.12 | 11 | 44.88 | 51.32 | 48.10 |
| 16 | 62.44 | 44.78 | 53.61 | 14 | 47.88 | 54.33 | 51.10 |
| 32 | 76.88 | 61.86 | 69.37 | 22 | 53.52 | 59.86 | 56.69 |

yield loss was higher in 1992 and 2002 comparing to 1997. In this region, over 90% of fields were infested by johnsongrass and johnsongrass mean density for overall region after mechanical and herbicidal activities completed in fields was still 2.91 plants $m^{-2}$ (Uludag and Katkat, 1991). Cotton yield loss corresponding to mean regional yield was estimated minimum 40%, which roughly 8 plants per 4 m or 16 plants per 8 m (Table 3). Recent surveys in Kahramanmaras province had showed that 77% of fields were infested and overall regional mean is 0. 65 plants $m^{-2}$ (Gozcu and Uludag, 2006), where 16.86% yield loss would be in the region if there had not been control measures for johnsongrass (corresponding density is in experiments is roughly 4 plants per 8 m).

It is clear that johnsongrass causes huge crop losses. Current techniques applied by farmers are not well enough to eliminate negative effect of johnsongrass. In addition, world wide problem of herbicide resistance requires new and more effective measures for johnsongrass management in cotton.

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