Above and below-ground interference of soybean (*Glycine max* (L.) Merrille) by shattercane (*Sorghum bicolor* (L.) Moench) and soybean

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Summary A greenhouse experiment was designed to investigate the above- and below-ground interactions of soybean with shattercane and soybean. This experiment included a randomised complete block design with seven treatments and four replications. The treatments included above-ground only, below-ground only, full interaction of soybean–shattercane and soybean–soybean, and no interaction (control) of soybean. The maximum competitive effects on biomass and grain yield of soybean related to full interspecific interference of shattercane. In soybean–shattercane and soybean–soybean associations, no significant difference was observed between full and above-ground interference. Also, soybean biological and economical yield loss due to shoot competition was about two-fold that of root competition. In all interactions, the grain yield of soybean was more sensitive to interference than the biological yield of soybean. The greatest reduction (of about 50%) of number of leaves and pods per soybean plant occurred with full competition with sorghum. At each interaction, inter-specific competition was greater than soybean intra-specific competition.

Keywords Competition, soybean, sorghum, yield, weed.

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is one of the most important oil crops in the world. Successful production of high-yielding soybean depends on the control of weeds and reduction of competition of weeds with soybean. Competition occurs when two plants seek the same resource and begins when one of the factors becomes limiting. Therefore, species that best utilise resources will succeed. Intra-specific and inter-specific competition occurs between plants of the same and different species, respectively (Cowen *et al*. 1998, Stone *et al*. 1998). Belowground competition is for water and nutrients, whereas aboveground competition is for light (Stone *et al*. 1998).

Johnsongrass (*Sorghum halepense* (L.) Pers) and shattercane (*Sorghum bicolor* (L.) Moench) are the two most important weeds in soybean seed production regions in Iran because they compete with soybean for nutrients, light and water and so reduce the yield of this crop (Cowen *et al*. 1998). Fellows and Roeth (1992) observed that shattercane could reduce soybean yield by 80%. Corn yields were decreased 22% by shattercane at 6.6 plants per metre of row (Beckett *et al*. (1988).

The aim of this study was to investigate the effects of above and below ground competition with shattercane (inter-specific) and soybean (intra-specific) on yield, biomass, the number of leaves and pods per plant of soybean.

MATERIALS AND METHODS

A pot experiment was undertaken under glasshouse conditions (day: 25°C, 16 h lighting and night: 18°C) in a randomized complete block design with four replications at the Faculty of Agriculture, University of Kassel, Germany. Shattercane (*Sorghum bicolor*) and Harcur (MG2, 3) a variety of soybean (*Glycine max*), were used in this trial. The treatments included aboveground interactions only with roots separated, belowground interactions only with shoots separated and full interference with no separation of soybean–shattercane and soybean–soybean, and no interaction (control) of soybean. Controls had one soybean plant alone at the center of pot. The treatment of above-ground interference used one large pot and was divided into two parts. The two parts of the pot were of the same volume as the control pot. The treatment of belowground interaction used the same pot size as the control, and the shoots of two plants were separated. The full interference had two plants in the same pot size as the control.

Plants were harvested at physiological maturity of soybean and the yield, biomass, the number of leaves and pods per plant were measured.

Data were subjected to analysis of variance and means were compared by LSD and Duncan's multiple range test.

RESULTS

Different competition regimes showed significant differences in biomass, grain yield, the number of leaves and pods per soybean plant (Table 1 and Figure 1).

The full interaction of soybean, aboveground only competition with sorghum and full interaction with

sorghum caused significant reductions in soybean plant biomass. The highest percentage of biomass loss compared with the control occurred with full competition with sorghum. The lowest percentage biomass loss was in the belowground only soybean-soybean competition treatment (Figure 2).

In all full and aboveground competition treatments the grain yield of soybean decreased significantly compared with the control.

The grain yield of soybean plants subjected to full competition with sorghum showed the highest percentage loss (Figure 2). The biological and grain yield loss of soybean due to shoot competition of sorghum and soybean were estimated to be about two-fold that of root competition (Figure 2).

In all interference treatments except below-ground only interference with shoot separation of soybean, the number of leaves per soybean plant was significantly different to the control ($P < 0.05$, Figure 1). The aboveground only interference with root separation and full competition of soybean and sorghum showed significant differences with controls related to the number of pods per soybean plant ($P < 0.05$). The greatest reduction (about 50%) of number of leaves and pods per soybean occurred at full competition of sorghum (Figure 1).

DISCUSSION

For plant communities where soybean–soybean or soybean–sorghum interactions occur (sorghum as a crop or weed), an understanding of competition regimes (full, below and above-ground competition) can help to develop management strategies that minimize the soybean yield loss.

In this study, the different competition regimes had a range of competitive effects on measured soybean attributes. Soybean grain yield was more sensitive to different competition regimes than biomass. Also, shoot competition had an approximately two-fold greater effect on biological and grain yield than root competition. This is in contrast to the study of Stone *et al*. (1998), who found that plant height, leaf number, tillering, leaf area, dry weight of leaves, stems and roots of wheat were reduced by full or belowground-only interaction with ryegrass (*Lolium multiflorum*). Semere *et al*. (2001) also found that root competition decreased the shoot dry weights, plant height of maize and pea, while shoot competition had no significant effect on these attributes. Kunelius *et al*. (1992) observed that

Table 1. Influence of different interference regimes on biological and grain yield of soybean.

Treatment	Individual soybean biomass (g)	Individual soybean grain yield (g)
Control	12.0 a[A]	4.4 a
Soy-soy-root	11.7 ab	3.9 ab
Soy-soy-shoot	11.0 abc	3.4 bc
Soy-soy-full	10.6 bc	3.3 bc
Soy-sorg-root	11.1 ab	3.7 ab
Soy-sorg-shoot	10.3 c	3.1 bc
Soy-sorg-full	9.9 c	2.7 c

[A] Means with different letters in each column were significantly different ($P < 0.05$).

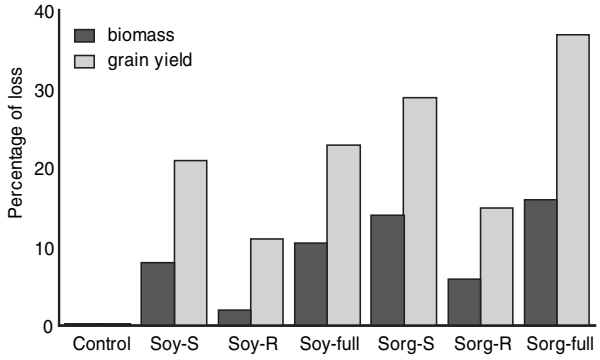

Figure 1. The number of leaves and pods per soybean plant at different competition regimes. The numbers above the columns indicate percent loss compared with the control.

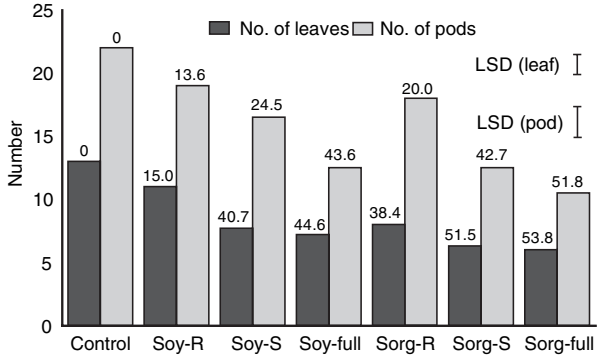

Figure 2. Percentage of biological and grain yield loss of soybean at different competition treatments (S = shoot competition, R = root competition, full = full competition).

plots with ryegrass under-sown with barley (*Hordeum vulgare* L.) produced substantially more belowground biomass and reduced grain yield compared with pure barley stands. Other research showed that sorghum was dominated by pigeon pea (*Cajanus cajan*) at full interaction (Holker and Jagtap 1992).

The all inter-specific interference regimes (soybean–sorghum) had greater competitive effects on soybean than intra-specific interference treatments (Table 1 and Figure 2). The results of all competition regimes showed that the soybean grain yield was more sensitive to competition compared with soybean biomass.

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