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INFLUENCE OF DIFFERENT CO_2 LEVELS ON THE GROWTH AND COMPETITION OF SOME IMPORTANT WEEDS IN WHEAT (*Triticum aestivum* L.)

SUMMARY

Pot experiments were conducted to investigate the effects of different CO_2 levels on the growth and competition of *Avena sterilis*, *Phalaris minor*, *Galium tricornatum* and *Sinapis arvensis* which are important weed species in wheat (*Triticum aestivum*) growing areas. Two CO_2 levels (500 ppm as ambient, 750-800 ppm as elevated) were used in the study. Weeds or wheat plants were sown to pots alone or in competition with each other. Six weeks after emergence above ground fresh and dry biomasses of all plants were determined and compared. Results showed that biomasses of all plants were significantly increased by elevated $CO_2$when grown in monoculture. Under competition CO_2 showed no significant effect on weed biomasses. Weeds reduced wheat biomass at both CO_2 level but only significantly under elevated CO_2. Wheat suppressed weeds also to higher degrees under elevated CO_2 levels. *S. arvensis* suppression by wheat was 50% at ambient but about 95% at elevated CO_2 conditions. These results show that elevated CO_2 improve the growth of weeds under non-competitive conditions significantly. Although weed growth was not directly affected by elevated CO_2 under competitive conditions, they caused higher biomass reduction of wheat. However, the growth of wheat plants was so improved by elevated CO_2, that they still produced as much biomass as of those grown without competition at ambient CO_2. These results suggest that global CO_2 increase might cause increase in wheat growth, but weed control will still be important issue to maintain maximum yield.

Keywords: Wheat, weed, CO_2, competition, herbicide

INTRODUCTION

Recent increases in atmospheric CO_2 concentrations due to climate change has been popular research topic in the last 20 years and keep its actuality still nowadays. Hitherto studies concerned the effect of increased CO_2 on the growth and yields of some crops. In most studies it was concluded that yields of some crops such as maize, soybean, wheat and rice are increased in response to elevated CO_2 (Alberto et al., 1996; Ziska and Bunce 1997; Ziska and Goins 2006;

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Patel et al. 2008; Erbs et al., 2009). Some other studies concerned however, the effects of CO_2 increase on the growth and competition ability of weeds and their results showed that weed growth can be improved by elevated CO_2 as well (Ziska and Bunce 1997; Ziska 2002; Pandey et al., 2003). Wheat is an important crop grown in Turkey as in most parts of the world. Weeds reduce crop yield, worsen the quality and interfere with harvest. Therefore an effective weed control is required to obtain maximum yields. Since wheat is grown on narrow inter and intra row spacing, mechanical weed control methods are not applied. So, cultural control and chemical control gain importance. Crop vigor is an important factor in competition with weeds. Plants grown under poor growing conditions cannot be good competitor with weeds, while under suitable conditions concurrence ability of crops against weeds can be improved.

Since results of previous studies showed that increasing CO_2 could improve the growth of crops and weeds vigor, competition between them would also be affected (Ziska, 2000). Therefore it was aimed in this study to compare the growths of wheat and four common weed species under ambient and elevated CO_2 levels under competition and non-competition conditions.

MATERIAL AND METHODS

A pot experiment was conducted at the research greenhouse of Weed Science laboratory at Agricultural Faculty of Adnan Menderes University, Aydin, Turkey. Growths of four weed species i.e. wild oat (*Avena sterilis*, AVEST), canary grass (*Phalaris minor*), bedstraw (*Galium tricornatum*) and wild mustard (*Sinapis arvensis*) were investigated under two CO_2 conditions when grown with or without competition. These weed species were chosen for this research because they are important and abundant weed species in wheat growing areas in Aydin region of Turkey (Boz, 2000).

The growth of wheat and weeds alone or in competition with each other was evaluated under two CO_2 conditions, where plants were grown in two different greenhouse rooms (each in 25 m^2 size) with different CO_2 levels. In one room, CO_2 level was kept as normal 500 PPM (ambient), while in the other room, CO_2 was increased within the range of 750-800 ppm. Desired (elevated) CO_2 levels were maintained within the greenhouse with CO_2 supply from cylinders fixed outside of the greenhouse. Plastic pipes containing solenoid valves were fixed in the greenhouse for continuous supply CO_2 from cylinders. Through this control system, CO_2 level in room was determined every minute and CO_2 was released by opening the solenoid valve, when the level was below the lower limit. The CO_2 level, temperature and relative humidity in both ambient and elevated CO_2 rooms were recorded per hour by using data logger throughout the experiment duration. Mean night/day temperature, relative humidity in greenhouse during the experiment was 12/20 ^{0}C and 77/64 %.

Seeds of wheat and weeds were sown to pots (74x24x20) containing soil/sand/turf/perlite (each 25% volume) on 05.02.2013. Wheat seeds (2 rows, total 60 seeds) were sown in each pot. In the case of weeds 20 seeds were sown

and then thinned to 5 weeds per pot. Pots were placed in two different rooms in greenhouse with two different CO_2 levels as described above. Experiments were done with three replications for each CO_2 and competition condition. After 6-8 weeks exposure to different CO_2 levels all plants were harvested and their above ground fresh and dry weights were determined. Since results from both dry and fresh biomass parameter were similar, only results with fresh weights were given in this paper.

General Linear Model (GLM) was used for data analysis and standard errors (SE) were used for separation of means for significance.

RESULTS AND DISCUSSION

Fresh weights of wheat and weeds grown in monoculture or in competition at two CO_2 levels are shown in Table 1. Elevated CO_2increased wheat biomass significantly by 1.6 fold in monoculture. Although wheat biomass was increased by elevated CO_2 also under competition by about 20 %, this increase was not significant. Weed competition caused insignificant biomass reduction (by about 11 %) under ambient CO_2, while weeds reduced wheat biomass significantly under elevated CO_2 (by 35 %).

Similar to wheat, growth of all weeds was significantly improved by elevated CO_2 when grown in monoculture. Fresh biomass increase was 1,7 fold for wild oat, 3,2 fold for canary grass, 3,7 fold for bed straw and 2,7 fold for wild mustard. Under competition conditions however weed biomass was not significantly affected by CO_2 level, but reduced in most cases under elevated CO_2 (by 40-60%).

Wheat suppressed weeds to higher degrees under elevated as compared to ambient CO_2 levels. Wild oat and bed straw biomasses were reduced by competition with wheat by 80-85% under ambient, but over 95% under elevated CO_2 conditions. In the case of *S. arvensis* differences between CO_2 conditions were more pronounced so that this weed was suppressed at ambient CO_2 by about 50% by wheat competition, while this was about 95% at elevated CO_2 conditions. In the case of canary grass wheat suppressed this weed by over 90 % regardless of the CO_2 condition.

Table 1. Fresh weight of wheat and weeds as affected by CO_2 and competition

Fresh weight (g/pot)	Monoculture		In competition		
	Ambient CO_2	Elevated CO_2	Ambient CO_2	Elevated CO_2	S.E
Wheat	93,2	152,7*	82,6	98,7 ns	9,6
Wild oat	8,3	14,5*	1,6	0,7 ns	1,44
Canary grass	2,10	6,65*	0,16	0,17 ns	1,12
Bedstraw	3,20	11,70*	0,54	0,27 ns	3,52
Wild mustard	2,84	7,78*	1,29	0,39 ns	1,22

Results recorded with all plants show that plants utilize increased CO_2 mostly under no stress conditions. Under competition increasing CO_2 has no significant effects on plant growth. CO_2 is only one factor required for plant growth, therefore positive effect of the CO_2 on plant growth is also associated with the availability of other resources, such as light, water and nutrients (Cure, 1996). Since under non-competition condition all these factors were available for just one plant species, positive effects of increased CO_2 was clearly observed for all plants.

The effect of CO_2 levels on wheat-weed competition remain still unclear based on the results recorded here. Since weeds suppressed wheat biomass significantly at elevated CO_2, it can be concluded that weeds will be important problems in future climate scenarios. But growth of wheat grown in competition under elevated CO_2 was still higher than the growth of wheat plants grown in pure stand under ambient CO_2. This shows that wheat growth would still be improved by elevated CO_2 despite the increase in weed concurrence severity. Although there are some studies concerning the effect of CO_2 on interspecific concurrence, there are no consistent results. Also no studies were found concerning directly the effect of CO_2 on competition between wheat and weeds. Erbs et al. (2009) evaluated the growth of wheat and weeds under ambient and elevated CO_2 and suggested that wheat growth would be improved by elevated CO2, but weed population and competition could also be variable.

CONCLUSIONS

From the results of this study it can be concluded that elevated CO_2 increase the growth of wheat and weeds under no competition, but not under competition. Wheat-weed interactions would be changed by CO_2 condition. Wheat yield would be positively affected by CO_2 increase in future, but weeds would remain still as an important factors threatening yield. To make more clear conclusions, further studies are needed.

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