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Short Communication

ASSESSMENT OF MORPHOLOGICAL CHANGES AMONG WHEAT AND ASSOCIATED WEEDS UNDER HIGH CARBON DI-OXIDE ENVIRONMENT

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ABSTRACT

Climate change and rising CO_2 levels as well as weed control is disrupted in both natural and traditional biological ways. The effectiveness of bio-control agents will be compromised as a result of this CO_2 -induced morphological, phenological, and physiological alterations. The present study was conducted for the assessment of the effects of elevated CO_2 on morphology of wheat crop as well as two commonly associated weeds *Phalaris minor* and *Avena ludoviciana*. The plant height of wheat was found to be increased in wheat under elevated CO_2 conditions in comparison to ambient environment at 30 DAS and 60 DAS. However, both of the weed species had opposite effect of elevated environment in terms of plant height trait. While taking observation on mean numbers of tillers in wheat crop, it was found to be reduced under elevated environment in comparison to ambient environment. However, both weeds had increment in mean numbers of tillers under elevated CO_2 conditions at both 30 DAS and 60 DAS. Results of the present study confirm the effects of elevated CO_2 on morphology of crop as well as weed species and indicate the need of research in this field because of alarming situations in the future due to expected increase in CO_2 level in the environment.

Keywords: Crop, Weed, Phonological traits, Morphology, Environment.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop for the majority of world's populations being staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally [1] and being cultivated over a wide range of climatic conditions. Wheat belongs to family *Poaceae* (*Gramineae*) which includes major crops plants such as Wheat, barley (*Hordeum vulgare* L.), Oat (*Avena sativa* L.), Rye (*Secale cereal* L.), Maize (*Zea mays* L.) and Rice (*Oryza sativa* L.).

Weeds are known to exhibit allelopathy by releasing water- soluble allelochemicals from leaves, stems, roots, rhizomes, flowers, fruits and seeds [2]. Weeds are a major problem in both crops grown under this system. Many weeds have been reported in association with wheat crop. Among them *Phalaris minor* and wild oat (*Avena ludoviciana*) are consistently prevalent at all sites in increasing trend. Changes in the *P. minor* populations, biotypes, and the flora of weeds in wheat in the intensively cultivated rice-wheat cropping system of South Asia have been alarming. Reports of high populations (>500 plants/m^2) of *P. minor* in wheat fields of Northern India and Pakistan, have led to partial or complete crop failure has been a matter of concern for the last ten years [3].

Wheat occupies prime position among the food crops of the world. In India, it contributes 30-35 percent to total food grain basket of the country. It is infested by multifarious weed flora comprising both grassy as well as broad-leaf weeds causing yield reduction of 15-40 percent depending upon type and intensity of their infestation. *P. minor* is the most dominant weed in wheat crop and it alone affects grain yield upto 40 percent. However, Walia and Brar [4] have reported yield reduction in wheat to the level of 30-80% percent due to *P. minor* alone.

Wild oat (*Avena ludoviciana* L.) is one of the most widespread and harmful grass weeds in wheat

worldwide. It is also one of the most troublesome weeds which constrain wheat production because of the continuous monocropping of wheat and barley in the large and small scale farming systems of the high lands [5]. Tanner *et al.* [6] have reported grain yield reductions of 26-63% across four bread wheat cultivars at 90 weed seedlings m^{-2} in Ethiopia.

Direct effects of climate change influence not only the performance of individual organism but also impact interaction with other organisms at various stages in their life history via changes in physiology, morphology and chemistry. Rapid global industrialization resulted in production of greenhouse gases and continues at its alarming pace. Carbon dioxide is one of the major contributors of greenhouse gases which can have a significant impact on plant metabolism. Although, there is broad agreement that higher atmospheric CO_2 levels stimulate photosynthesis in C_3 crop plants, yet, no such consensus exists on how rising CO_2 levels will affect the physiology of associated weeds, which provide a tough competition to the crop plants. The present study was conducted to assess the variations in morphological traits of wheat crop with associated weeds *P. minor* and *A. ludoviciana* under high CO_2 environment.

2. MATERIAL AND METHODS

The study was conducted in Free-Air Carbon dioxide Enrichment (FACE) at Directorate of Weed Research (DWR), Jabalpur, (MP).

2.1. Detail of treatments

Crop: Wheat (*Triticum aestivum* L. em Thell.)
Weeds: *Phalaris minor* and *Avena ludoviciana*
Weed density: 0, 15, 30 plant/m^2
CO_2 levels: Ambient (385± 5 ppm)
Elevated (550 ± 50ppm)
Time of treatment: From emergence up to maturity of wheat
Observations: Plant height and Numbers of tillers at 30 and 60 days respectively

Two FACE rings (Ring A and Ring B) were adopted for the present experiment.

2.2. Data analysis

All observations were recorded at least three times. Obtained data was statistically analyzed with available programmes.

3. RESULTS AND DISCUSSION

According to the Intergovernmental Panel on Climate Change (IPCC), by the end of the twenty-first century, global mean temperature (2.6-4.8°C) and CO_2 atmospheric concentration (730-1000 $molmol^{-1}$) will have increased [7]. The speed with which these changes are occurring is likely to have an impact on a variety of human activities, including agriculture. Weeds have been the most detrimental biotic factor reducing agricultural yield and quality since the dawn of agriculture. Weeds are responsible for up to 34% of crop output losses worldwide [8], making uncontrolled arable weeds a threat to food security.

High CO_2 environment led to increase in plant height in wheat crop however it was not found to be suitable for weed plants (Table 1). At 30 DAS, the mean plant height of wheat was 55.10±2.51 under ambient environment. However, under elevated CO_2 (Ring A), the plant height in wheat was 62.16±1.01 and in Ring B it was 63.23±1.13. This indicates increasing trend in plant height of wheat crop under elevated CO_2 environment.

Table 1: Effect of CO_2 enrichment on plant height at 30 DAS and 60 DAS in wheat and weed species

Time	30 DAS			60DAS		
Treatment	**Wheat**	***P. minor***	**Wild Oat**	**Wheat**	***P. minor***	**Wild Oat**
Ambient	55.10±2.51	42.50±3.61	75.66±2.33	79.83±1.58	86.33±5.84	104.76±2.34
Elevated (Ring A)	62.16±1.01	35.10±1.01	64.50±1.22	92.66±2.84	73.66±4.49	91.50±1.25
Elevated (Ring B)	63.23±1.13	36.20±1.03	66.23±1.32	95.16±1.48	71.33±6.22	95.16±3.01

[Phalaris minor and Avena ludoviciana (L.). Values presented are mean ± SE based on three independent determinations

In contrast to this, *P. minor* attained the mean plant height 42.50±3.61 under ambient environment. While, this weed species reflected reduced plant height (35.10±1.01) in under elevated CO_2 (Ring A) and 36.20±1.03 in Ring B. Similarly, wild oat had attained higher plant height 75.66±2.33 under ambient condition in comparison to elevated CO_2 conditions i.e. 64.50±1.22 (Ring A) and 66.23±1.32 (Ring B). Decreased trend of plant height was observed under elevated CO_2 in both of the weed species at 30 DAS.

Similar trend was followed by wheat crop and both of the associated weed species under study after 60 DAS in plant height. Wheat attained mean plant height 79.83±1.58 under ambient environment at 60 DAS.

The plant height was increased under elevated environment. In Ring A it was 92.66±2.84 while in Ring B 95.16±1.48.

P. minor had plant height 86.33±5.84 under ambient condition at 60 DAS while under elevated condition in Ring A it was 73.66±4.49 and in Ring B 71.33±6.22. Similar to this, wild oat had attained plant height 104.76±2.34 under ambient environment while under elevated condition in Ring A the plant height was 91.50±1.25 and in Ring B it was 95.16±3.01.

Any deviation from normal environmental condition can be considered as a stress factor for plants. Plants need to adjust themselves to cope-up the changes in climate and such an adjustment can be achieved with changes at various level. Elevated CO_2 have been reported to be an important factor that influences growth and increase above ground biomass [9]. In agreement to our results, stimulation of plant growth in response to high CO_2 has been reported in tomato, summer mungbean, cucumber, soybean and celery and lettuce [10]. Similar to the present study, various responses of biomass to elevated CO_2 under varying growth conditions, such as salinity, low and high temperature, drought, and nutrient deficiencies in general, and nitrogen deficiency in particular, have been reported in the literature [11, 12].

This observation was recorded in wheat and both of the weed species under study at 30 DAS and 60 DAS. Wheat had mean numbers of tillers 6.33±0.88 under ambient environment while under elevated environment in Ring A this value was 5.66±0.33 and in Ring B it was 5.33±0.34 at 30 DAS. This indicates a reduction in mean numbers of tillers in wheat crop under elevated environment in comparison to ambient environment.

Table 2: Effect of CO_2 enrichment on no. of tillers at 30 DAS and 60 DAS in wheat and weed species

Time	30 DAS			60DAS		
Treatment	**Wheat**	***P. minor***	**Wild Oat**	**Wheat**	***P. minor***	**Wild Oat**
Ambient	6.33±0.88	1.33±0.32	2.34±0.33	8.66±0.76	3.64±0.32	2.67±0.67
Elevated (Ring A)	5.66±0.33	3.33±0.38	4.34±0.88	7.67±0.34	5.33±0.30	2.90±0.23
Elevated (Ring B)	5.33±0.34	2.01±0.58	4.35±0.88	7.33±0.33	4.67±0.88	3.34±0.30

[Phalaris minor and Avena ludoviciana (L.). Values presented are mean ± SE based on three independent determinations.

P. minor had mean numbers of tillers 1.33±0.32 under ambient environmental condition at 30 DAS while, this parameter was found to be increased 3.33±0.38 under elevated condition in Ring A. In Ring B mean numbers of tillers was 2.01±0.58 at 30 DAS. Wild oat was also found sensitive under elevated environmental CO_2 conditions in terms of increased numbers of tillers in this weed species. Under ambient condition wild oat had mean numbers of tillers 2.34±0.33 at 30 DAS. Under elevated environmental condition mean numbers of tillers in wild oat was 4.34±0.88 in Ring A while 4.35±0.88 in Ring B (Table 2).

At 60 DAS, under ambient condition, wheat crop had 8.66±0.76 tillers while under elevated CO_2 condition in Ring A mean numbers of tillers were 7.67±0.34 and in Ring B 7.33±0.33. In *P. minor* mean numbers of tillers under ambient were 3.64±0.32. Under elevated condition mean numbers of tillers were found to be increased. In Ring A this value was 5.33±0.30 and in Ring B it was 4.67±0.88. Wild oat also reflected same pattern as in *P. minor*, which means an increment in mean numbers of tillers under elevated CO_2 condition. Wild oat had 2.67±0.67 mean numbers of tillers at 60 DAS under ambient environment. Under elevated environment, mean numbers of tillers were 2.90±0.23 in Ring A while 3.34±0.30 in Ring B.

4. CONCLUSION

The increase in CO_2 content in the atmosphere is almost certain, and it will be a focus of future study efforts. Numerous studies have shown that plant growth will increase in response to increased atmospheric CO_2, but little attention has been paid to how the interaction of a plant species with other species will be changed at raised CO_2. For example, how would crop-weed interactions evolve in a high-CO_2 environment, and who will have the upper hand? Our findings demonstrate that with high CO_2, weed species *P. minor* and wild oat will dominate wheat crop in terms of tiller numbers due to a favourable environment for expanding their tiller numbers. However, elevated CO_2 atmosphere was not found to be appropriate for enhancement in their plant height.

5. ACKNOWLEDGEMENT

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Conflicts of Interests

Authors have no conflicts of interests.

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