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Abstract

7KH FRPELQHG LPSDFW RI KHUELYRU\ DQG GHIROLDWLRQ VWUHVV QHHGV IXUWKHU L JURZWK UHVSRQVHV RI SODQWV 8QIRUWXQDWHO\ IHZ VWXGLHV LQYHVWLJDWH HQYLURQPHQW $GGLWLRQDOO\ D VPDOOHU QXPEHU RI WKHVH VWXGLHV GHDOW ZLWK WUHDWPHQWV ZHUH WHVWHG LQ D FRPELQHG GHVLJQ $PELHQW DQG HOHYDWHG &2 FRQFHQWUDWLRQ ZDV WHVWHG WR VHH KRZ FDQ D Cenchrus ciliaris UHVSRQG WR GHIROLDWLRQ VWUHVV XQGHU HO &2 DQG ZKHWKHU WKH &2 FDQ DOWHU JURZWK DOORFDWLRQ WR WKH GLIIHUHQW C. ciliaris WKDW ZHUH JURZQ XQGHU HOHYDWHG &2 KDG ODUJHU OHDI DUHD WKDQ XQGHU WKH VDPH FRQFHQWUDWLRQ EHLQJ UHGXFHG ZKHQ GHIROLDWHG

Keywords: Defoliation stress; CO_2 Enrichment; C. ciliaris

Introduction

Grazing-induced defoliation has caused serious challenges to natural and semi- natural grasslands worldwide. Especially with the anticipated increase in green-house gases such as carbon dioxide and the global impact on species growth. Simply because plants respond di erently when subjected to environmental stresses. Unfortunately, attention had been given to the change in the atmospheric CO_2 concentration and most of the published studies on plant response to elevated CO_2 focus on response under environmental stresses such as drought, high soil salinity, nutrient limitations and high and low temperatures. Very few studies [1], however, assessed plant responses under defoliation conditions coupled with CO_2 enrichment. Additionally, a smaller number of these studies dealt with C4 non-crop species. Defoliation, de ned as the removal of photosynthetic organs of the plant [2] could be caused by many factors such as insect attack, wind or hail damage, or feeding by livestock, is to be studies in combination with the impact of CO_2 increase. e direct e ect of elevated CO_2 on plants is mainly increasing its biomass [3] by increasing photosynthesis. e concern about defoliated plants' response to elevated CO_2 comes from the fact that defoliated plants have reduced photo- synthetic organs. Defoliation stress caused an improvement in tree blade quality [4], and decrease in blade size and weight [5]. During defoliation stages, plants require remobilization of the stored and accumulated N and C in plant organs [3]. Defoliation stress gradually reduces N uptake and photosynthesis. is leads to plant growth being highly a ected by the extra CO_2 supply and plant storage status [2]. Elevated CO_2 have the ability to improve mineralization and plant uptake of N [4]. In addition, elevated CO_2 increased the carbon content in the soil [1]. Soil carbon content may lead to increased concentration of the non structural carbohydrate in crown and roots [2]. Photosynthetic processes are therefore a ected [6] which may impact the plant's regrowth a er defoliation events. e combination of stresses such as defoliation with atmospheric CO_2 enrichment wills very likely lead to di erent growth responses as compared to one of the factors alone. is di erence in responses may also be dependent on the photosynthetic pathway (i.e. C3 vs. C4 species). Elevated CO_2 by itself stimulated the regrowth of C3 plants but inhibited that of C4 plants a er defoliation [2]. Consequently, in this study the aim was to nd out how can a C4 grass like Cenchrus ciliaris responds to defoliation stress under enriched atmospheric CO_2, and whether the CO_2 elevation can alter growth allocation to the di erent vegetative and reproductive parts.

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The average number of dry blades under defoliation was highest for ACO_2 before the clipping treatment was applied (P 0. 05). No significant differences were observed after the clipping was performed at P>0.05 (Figure 4). There was an increasing trend in the number of dry blades similarly for the three treatments (P>0.05). Defoliation, however, seemed to boost the overall average of dry blades for all three treatments. The average number of dry blades did exceed 15 blades for defoliated plants, while the highest average did not exceed 15 dry blades for non-defoliated plants.

Although defoliated plants in the three treatments started with the similar number of stomata, ACO_2

All defoliated plants had similar chlorophyll/b pigment during the whole trial at P>0.05 (Figure 7). A Non-defoliated plant under ACO_2, however, was lowest on 23 March and highest on 16 May (P 0.05).

Growth partitioning

tiller numbers and decreasing tillers weight and size [5]. Published data concluded that atmospheric CO_2 elevation can speed up plant growth and development by a ecting plant cells division and elongation [13]. e di erence in response between young and mature blades comes from the di erence in sugar content and hormone concentration, which reduces the stomata conductance under ECO_2 [13]. Chlorophyll/a and chlorophyll/b increased under $ALCO_2$ condition. It is believed that the plants under $ALCO_2$ may have considered the alternating supply of CO_2 as an additional stress, which led to a di erent response by C. ciliaris. Defoliation stress seems to prevent the long term decline in plant pigment specially chlorophyll/a. Even with lower chlorophyll content, some plants had higher photosynthetic activities [14]. As expected, defoliation stress decreased the weight of C. ciliaris sheath even under elevated CO_2. Frequently defoliated plants under elevated CO_2 changed their growth partitioning. Under defoliation stress, plants adapted by altering the carbon allocation to non harvestable yield [5]. e inhibition for vegetative growth did not lead to the reduction of photosynthesis, but it is a consequence to the rapid conversion of photosynthetic to structural dry matter [2]. Most of the non-structural carbohydrates that are re-mobilized are used for root respiration a er defoliation [2]. e results of the present study showed that defoliation stress seems to bene t C. ciliaris by increasing the root system. Since plants lose their photosynthetic organs by defoliation, the regrowth a er defoliation depends on the remobilization of nitrogen and non-structured minerals from the roots and crowns to the growing shoot [2]. Percent growth allocation was more pronounced under ACO_2 than under the other two treatments. But for both defoliated and non-defoliated plants, most measured variables were a ected under all three treatments. Allocation to root growth, for instance, could have a bene t to the plant as roots are the main respiration organ that supports the remaining plant parts a er the loss of the main respiration organs by defoliation stress [3]. e results of this study suggest that the elevation of CO_2 bene ted some parts of C. ciliaris a er defoliation. Enrichment of atmospheric CO_2 did encourage a fast growth of green blades, especially biomass a er defoliation. is could be explained by the fast reallocation and compensation of C and N in the plant derived by the root meristematic activity [15]. ECO_2 increased the concentration of the non-soluble carbohydrates and carbohydrate remobilization in the plant [2], which is needed for plant regrowth. Soil moisture, salinity and carbon content were not a ected by the defoliation under the three CO_2 treatments (P>0.05). Soil pH, however, was highest for both defoliated and non-defoliated plants under ECO_2 at P=0.05. pH was not a ected by CO_2 concentration in oak dominated soils [16]. Over all, when comparing defoliated and non-defoliated plants, under the same conditions of CO_2 concentration, we found that the e ect of CO_2 enrichment was more pronounced on the non-defoliated plants. Controlled condition of stress positively improved the response in of plants biomass [9]. Defoliated plants under elevated CO_2 had a positive e ect on the regrowth of C. ciliaris a er defoliation [2]. ere is a need for more studies to explore the e ect of defoliation stress on plants' interactions under natural conditions.

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References

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