THE DROUGHT RESISTANCE MECHANISM OF *PHALARIS ARUNDINACEA* L.

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ABSTRACT

The measurement of morphological and physiological indices of *Phalaris arundinacea* to drying and irrigation treatments and in natural field conditions (ck) were conducted in tillering stage and stem elongation stage. Results show that plants in the drying treatment, compared with plants in the irrigation treatment and control, that their single plant leaf area, plant height, chlorophyll content, intensity of photosynthesis, stomatal area and plant yields were decreased, but the intensity of respiration increased. Through statistic analysis, none of those indices, except stomatal area, were significantly different. It indicates that the species of *Phalaris arundinacea* is strongly drought resistant and could ensure stable yields under drought conditions. It provides a promising hay crop for semi-arid regions.

KEYWORDS

Phalaris arundinacea L., drought resistance mechanism, intensity of photosynthesis, intensity of respiration, leaf area of single plant, stomatal area.

INTRODUCTION

Drought is one of the important factors affecting hay crop yields and quality. It causes plant water stress and physiological changes. In order to learn the drought resistance mechanism of *Ph. arundinacea* plants for establishing man-made pastures in arid region, some morphological and physiological indices were measured.

EXPERIMENTAL MATERIALS AND MEASUREMENTS

Wild plant of *Ph. arundinacea* from the Keerqing grassland of China were acclimatized and selected clones were established separately in a greenhouse and on the field. The surviving plants were watered once on June 8 and then transferred to drying and irrigation experimental plots (1 x 3 m) and some to natural field (ck) with three replications. Physiological indices were measured separately on June 29 (in tillering stage) and August 2 (in stem elongation stage). The indices measured were single plant leaf area, chlorophyll content, intensity of photosynthesis, intensity of respiration, water potential, stomatal status and their area, and the determination of yields.

RESULTS

Drought can affect the biological activities of plants and the cell division. For *Ph. arundinacea*, the tillering stage and stem elongation stage are most sensitive to water stress. Therefore drought would slow down the elongation of stem and leaf. Results of the study showed that the height (cm) of the irrigated plants was 76 cm, it was 34.7 cm higher than plants of the drying treatment and 23.2 cm higher than the control. The single plant leaf area (cm) of irrigated plant was 122.6 cm^2, it was 30.5 cm^2 and 20.1 cm^2 more than plants in drying and control plots respectively. By statistical analysis, there were no significant differences found at P=0.01 level in single plant leaf area. In plant height, there was no significant difference between irrigation and drying, but a significant difference was found between irrigation and control, and between drying and control at the same level. It shows that drought affects plant height and leaf area to some extent but not severely.

Water stress causes a decrease of protein synthesis and a decrease of chlorophyll content. The chlorophyll G content (mg/g fresh weight) of irrigation was 14.6, 3.5 higher than that of drying and 2.6 higher than control, but between them no significant differences were found in both tillering and stem elongation stages. It shows that water stress affects the chlorophyll G content, but only reaches a certain degree.

Drought can decline the rate of photosynthesis. The photosynthetic rate (mg/d.m^2.hr) of plants under irrigation was 82.37. It was 18.88 higher than drying and 1.07 higher than the control. No significant differences were found at 0.05 level. It indicates that drought does not have great influence on the photosynthetic rate.

As the respiratory rate rises, with increasing of tissue water content, limited water stress results in an increase in the respiratory rate. The maximum respiratory rate (mg/CO_2/g.hr) was 41.38 of drying treatment; it was 17.62 higher than irrigation and 20.39 higher than control. No significant differences were found between them. It says that water stress affects photosynthetic rate and organic matter production; hence it causes drought injury.

Water is transpired through leaf blade by cuticle and stomata. On the drying treated plant leaf, a white colour cuticle was found to prevent water loss, the stomata were closed and the total stomatal area of upper and lower epidermis was 744.8 µ. The stomata of irrigation treated plants were opened and with an area of 144.2 µ more than that of former; the stomata of control plants were half-opened with a total area of 862.9 µ. At the 0.05 level, there were significant differences between them. This expressed that the *Ph. arundinacea* plant under water stress condition could reduce water content to strengthen drought hardiness. It found that in the tillering stage, the water potential of drying treated plants was -5.29 bar, it was 5.03 bar lower than that of irrigation and 4.23 bar lower than control. In the stem elongation stage, drying plants had a water potential of -7.3 bar; 2.5 bar lower than irrigation and 2.3 bar lower than control. Drought could reduce plant water content to promote the water absorbability of roots for resisting the drought injury.

Water stress also affects the accumulation of dry matter. In the stage of stem elongation, crop yields (fresh weight) of irrigation treatment was 19 t/ha with 12.75 t/ha higher than that of drying treatment and 11.6 t/ha higher than the control. It indicates that although drought causes the yields of *Ph. arundinacea* to decrease, but it still maintains a minimal level. After 56 days, the drying treatment plots were irrigated. It was found that plants soon recovered from the effects of drought injury. This indicates that *Phalaris arundinacea* is a fine drought resistant hay crop. Drought resistant is through their thickening cuticle, closing stomata, reducing stomata area, decreasing water potential and transpiration rate and improving the absorbability of roots.

CONCLUSION

1. When *Phalaris arundinacea* is under water stress condition, there are some influences on plant height, single plant leaf area, chlorophyll content, photosynthetic rate and yields, but the intensity of respiration increases. The drying treated plants have no significant differences with irrigation and control. It shows the *Ph. arundinacea* is a strong drought resistant hay crop species.

2. The drought resistance mechanism is through the reduction of body water loss, thickening cuticle, closing stomata, reducing stomatal area, to lower water potential and transpiration, and promoting the root absorb ability in soil.

Table 1
The morphologic and physiological indices of *Ph. arunainacea*

Growth periods	Tillering stage			Jointing stage		
Treatments	Irrigation	Drought	Ck	Irrigation	Drought	Ck
Leaf area/ plant (cm^2)	86.40	65.40	49.71	122.60	92.12	92.50
Plant height (cm)	52.00	47.13	23.14	76.00	52.75	41.26
Content of Chlorophyll (mg/g .F.W)						
CA	6.275	6.099	6.945	6.252	5.064	5.365
CB	6.595	6.516	8.615	8.322	6.021	8.689
G	12.87	12.58	15.56	14.57	11.08	11.93
Photosynthetic Intensity ($mg/d.m.^2.h$)	54.00	31.00	22.94	82.37	64.29	81.30
Respiration intensity ($mg\ CO_2/g.h$)	3.776	10.45	4.855	23.76	41.382	20.99
Stoma area (u)				888.47	744.32	862.9
Water Potential (Psi)	-0.26	-5.29	-1.06	-4.8	-7.3	-5
Yield (ton/hm)				19	6.25	7.40