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PHYSIOLOGICAL DETECTION OF WATER AND NITROGEN DEPRIVATION

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Abstract. *Water and nitrogen are crucial environmental factors, which are modifiable by farmers and main in controlling plant growth and development. The supply of nitrogen is crucial for vegetative growth and the role of nitrogen in agricultural production is intimately connected with photosynthesis. Photosynthetic rate correlates closely with leaf nitrogen content and water status of plants. The main goal of this research was to investigate some physiological parameters of barley genotypes under nitrogen and water deprivation conditions at anthesis growth stage. Dry weight of plants was determined with thermo-gravimetric method. Relative chlorophyll content as SPAD unit measurement was applied to follow the relative chlorophyll contents of leaves. The water status of plants was established by measuring relative water content (RWC) of leaves. Chlorophyll fluorescence induction method was used to examine potential photochemical activity (Fv/Fm). Based on the measured parameters, genotypes showed differences. Some parameters are useful for choosing more photosynthetically active barley genotypes in the double-haploid populations to be used in breeding barley lines with increased productivity under relatively low nitrogen and water supply.*

Keywords: nitrogen, drought, barley, SPAD, Fv/Fm

1. Introduction

Water and nitrogen (N) are the main limiting factors in agricultural production in most parts of the world. During its life cycle, a plant may be subjected to a water deficit, a N deficit or a combination of both, thus co-limiting [1] its productivity.

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The interaction between carbon and nitrogen assimilation and their efficiency are key importance for plant production. Applying optimal nitrogen amount at total genetic potential, more carbon assimilation per unit nitrogen would increase biomass. The supply of nitrogen is crucial for leaf growth and the role of nitrogen in agricultural production is intimately connected with photosynthesis. Photosynthetic rate correlates closely with leaf nitrogen content in several plants. At the same time low photosynthetic potential per gram of leaf does not directly cause the slow growth of nitrogen deficient plants. The effect of water deficit on N nutrition has been the subject of considerable research at plants [2, 3, 4]. The main effect of water restriction is certainly a reduction in N demand due to the marked sensitivity of leaf area expansion [5]. Investigations are mainly focused on measuring the intensity and products of dark reaction of the photosynthetic pathway. Less result have about light reaction affected by genotypic and nitrogen supply variations, mainly under stress conditions. The physiological or genetic mechanisms that underlie such natural variation in species or cultivars are largely untapped resources that may provide not only valuable information on the capacity and performance of different cultivars under different environmental conditions but also an invaluable genetic resource that can be used to improve yield [6, 7]. Based on Pepó [8] results the dry weight production was mainly influenced by environmental factors and modified by fertilizers and genotypes. Measuring parameters, which are useful for characterizing plant condition is a good tool for getting information about stress plasticity of plants under non-optimal conditions.

2. Materials and Methods

Two barley (*Hordeum vulgare* L.) – Vlamingh (VLA) and Buloke (BUL) – genotypes from the double haploid population were investigated under two different nitrogen supply (optimal and ¼ amount of optimal) and under optimal and 50% soil water capacity (*Tab 1*) from tillering stage till anthesis. All of the presented results were measured in anthesis (GS 69) stage. Plants were grown on real soil from Katanning (Australia) (2kg topsoil and 2kg subsoil) in columns. 3 columns per treatment and 3 plants per columns were set up. Experiments were established in glasshouse of University of Western Australia. All of the measurements were taken on flag leaves of plants. Dry weight of plants (spike, stem, leaves, root) was determined with thermo-gravimetric method. Relative chlorophyll contents (SPAD unit) were measured by SPAD 502 relative chlorophyll meter (Minolta, Japan). Chlorophyll fluorescence parameter, as potential photochemical activity (Fv/Fm) was detected by PAM-2000 chlorophyll fluorometer (Walz, Germany) as described by Schreiber *et al.* (1986) [9]. Fv/Fm was measured early in the morning and at noon as well. Relative water content

(RWC) measurement of leaves was made by Barrs *et al.* (1962) [10] method at noon.

Table 1) Symbols of different treatment

VLAMING=VLA	BULOKE=BUL
¼ Nitrogen + 50% Water = VLA00	¼ Nitrogen + 50% Water = BUL00
¼ Nitrogen + optimal Water = VLA0W	¼ Nitrogen + optimal Water = BUL0W
optimal Nitrogen + 50% Water = VLAN0	optimal Nitrogen + 50% Water = BULN0
optimal Nitrogen + optimal Water = VLANW	optimal Nitrogen + optimal Water = BULNW

3. Results and Discussion

The main goal of this research was to investigate some physiological parameters of barley genotypes under two nitrogen contents and water deprivation conditions. It is widely accepted that improved information on the factors controlling the acquisition and utilization of N by crops will help to identify the constraints to developing more effective strategies of N fertilization. Nitrogen nutrition and water supply has significant effects on dry weight of two barley genotypes were compared under two different nitrogen and water supply conditions. Water deprivation means higher strain than nitrogen luck with genotype difference (*Fig 1*).

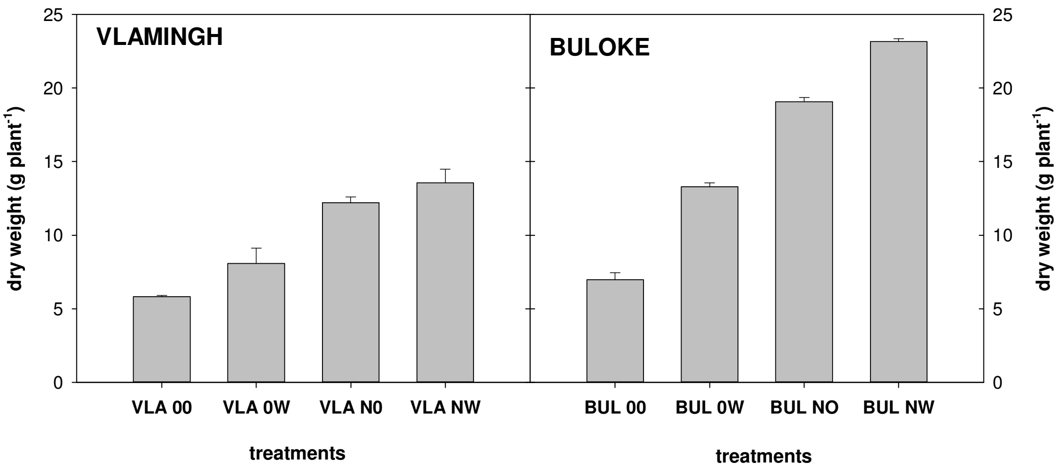

Fig 1) Values of dry weight (g plant^{-1}) of barley genotypes under different N and water supply conditions, n=3±s.e.

The 50% water deprivation after the tillering stage does not caused serous drought problem for plants *(Tab 2)*, but Fv/Fm values were sensitive mainly for ¼ nitrogen supply condition at noon. (*Fig 2*). The chlorophyll fluorescence induction method was used for examining Fv/Fm as one of the most reliable chlorophyll fluorescence parameters for characterising genotypic differences in photochemical activity under various nitrogen and water supplies.

Table 2) Values of relative water content (RWC) (%) in the case of two barley genotypes (VLAMINGH=VLA and BULOKE=BLU) under optimal nitrogen (N) and water (W) supply and deprivation (0), n=3, ±s.e.

%	1/4N+0W	1/4N+optimalW	optimalN+0W	optimalN+optimalW
VLA	81.8±0.3	88.1±0.9	73.8±5.2	84.2±2.1
BUL	81.9±0.7	91.1±0.3	79.5±0.8	86.6±2.1

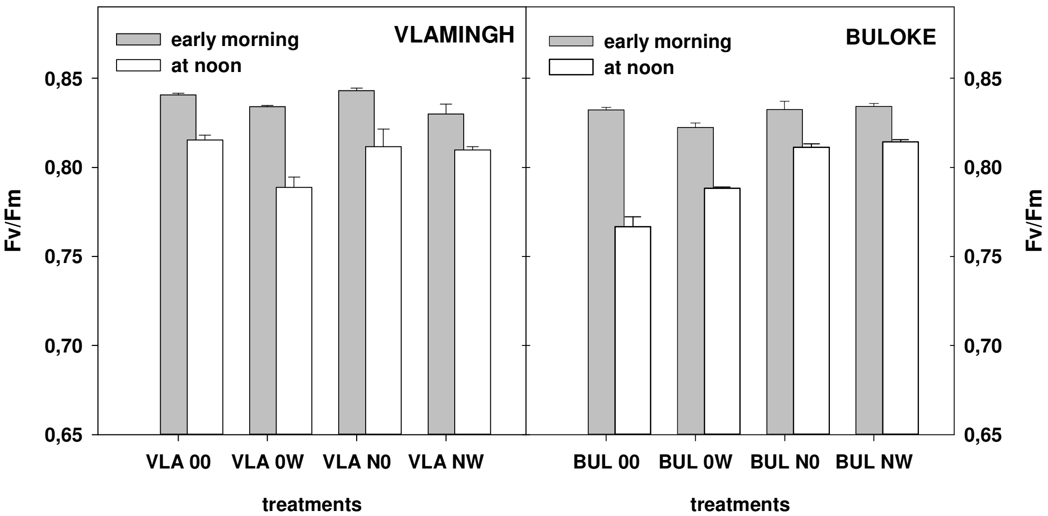

Fig 2) Values of potential photochemical activity (Fv/Fm) of barley genotypes under different nitrogen and water supply conditions, n=9, ±s.e.

BULOKE genotype was more tolerant for water or nitrogen deprivation respectively, than VLAMINGH, but deprivation of both caused higher reduction in Fv/Fm, than in VLAMINGH.

Nondestructive analysis of relative chlorophyll content with chlorophyll meters, for example the SPAD-502, provide a simple, quick, and nondestructive method for estimating leaf chlorophyll content [11].

The relative chlorophyll content values show (*Fig 3*) differences by the effect of nitrogen and water in both barley genotypes.

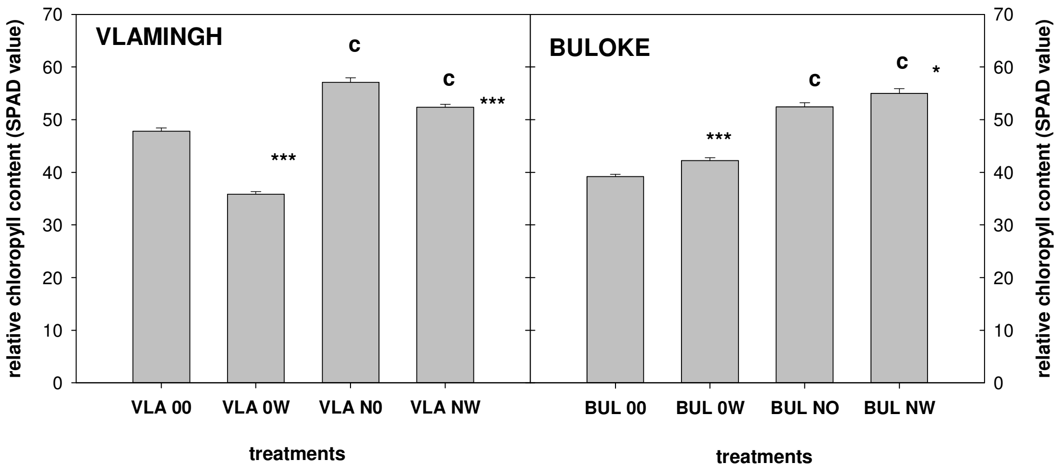

Fig 3) Values of relative chlorophyll content (SPAD value) of barley genotypes under different nitrogen and water supply conditions n=15±s.e. Significant differences p<0.05*; p<0.001*** between water treatment and $p<0.001^{c}$ between nitrogen treatment

Nitrogen luck was more serious in VLAMINGH genotype, SPAD values declined with 25% compared to have nitrogen. In case of BULOKE genotypes this differences were lower.

Conclusions

Water deprivation means higher strain than nitrogen luck with genotype difference based on dry weight value.

The optimal photochemical activity (Fv/Fm) values were sensitive for the investigated two environmental factors, and genotype differences were established in tolerance.

Relative chlorophyll content was more sensitive for nitrogen supply, than water deprivation with genotypes differences as well.

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