

Osmotic adjustment of winter wheat leaves under different soil water stress

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Summary Two varieties of winter wheat, Bei Nong 2(B. N. 2) and Jing 411(J. 411), were selected for osmotic adjustment study. At wheat growing stages, from recovery period to mature period, leaf relative water content(LRWC), water potential(LWP) and saturated osmotic potential(LSOP) were positively correlated to soil relative water content(SRWC) and decreased as SRWC descended at each growth stage, and the decreasing range exhibited B. N. 2 < J. 411. The turgor pressure(TP) of both the varieties decreased less than LRWC and LWP. It was shown that both varieties had a osmotic adjustment ability(OAA), and the decreasing range presented B. N. 2 < J. 411. Both the varieties had a TP tubercle in TP vs SRWC graph at heading and filling stages, and their OAA was the strongest at these two stages.

Key words osmotic adjustment, winter wheat, soil water stress

Introduction

For researching wheat drought-resistant mechanism, stronger drought-resistant cultivar B. N. 2 and weaker one J. 411 were selected, and some physiological parameters related to wheat physiological metabolism like photosynthesis, such as LRWC, LWP, TP and OAA were chosen to study and a series of control researches was done to expose the variant regularity and difference in physiological parameters of drought-resistant varieties.

Materials and Methods

Experimental materials

Varieties used in this study included a stronger drought-resistant cultivar B. N. 2 and a weaker drought-resistant cultivar J. 411. Experiments were conducted in a cement basin (1.50 m × 1.20 m × 1.60 m) located at the Crop Institute of Beijing Academy of Agricultural and Forestry Sciences. The soil was loam with a maximum moisture capacity of 30%.

Field management

In all growing period, only basal dressing consisting of 225.0 kg/ha of ammonium di-hydrogen phosphate and 150.0 kg/ha of urea was applied. After recovery period no fertilizer was applied. Irrigation was given in Nov. before winter. There were precipitations in all growing period only three times, the amount of each was less than 8mm. Seeding was done in Oct. 7, 1992 with a density of 3000000 plants/ha.

Experiment treatments

The experiment was designed as 5 treatments with 3 replications. The treatments included no water supply (Treatment I), water supply at jointing stage (Treatment II), at jointing and heading stages (Treatment III), at jointing and filling stages (Treatment IV), at jointing, heading and filling stages (Treatment V). Supplying water each time made the soil

maximum moisture capacity up to 30%.

Methods for measuring

LRWC: By Wang Wanli's method of measuring physiological water.

LWP: With 3005-type pressure room made in U. S. A.

LSOP and LOP: By freezing-point method.

TP: $TP = LWP - LOP$.

OAA: $OAA = LSOP \text{ of Treatment} - LSOP \text{ of Control}$.

Measurements were carried out from jointing stage. A top developing leaf of wheat was used for measuring. The averages of 3 replications were the measuring results. Sampling depth of measuring SRWC was 0–40 cm.

Results

Variant regularity pattern of LRWC and LWP

Both the varieties' LRWC and LWP decreased as SRWC descended, and the range of decrease at each growth stage was: $B. N. 2 < J. 411$. As $SRWC > 60\%$, $B. N. 2$'s LRWC and LWP were less than $J. 411$'s; as SRWC descended until below 50%, $B. N. 2$'s LRWC and LWP were greater than $J. 411$'s. It was shown that under medium or severe water stress, $B. N. 2$ had the physiological basis that made it to have a adaptive faculty stronger than that of $J. 411$ (Fig. 1–5).

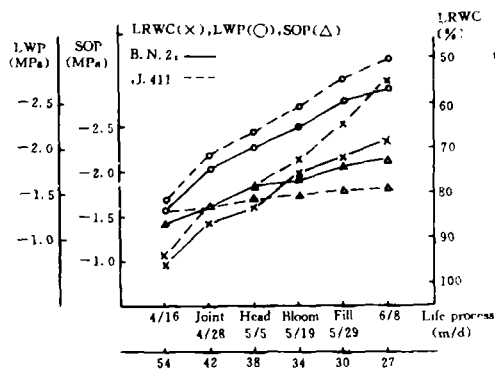


Fig. 1 Treatment I LRWC, LWP and SOP with SRWC

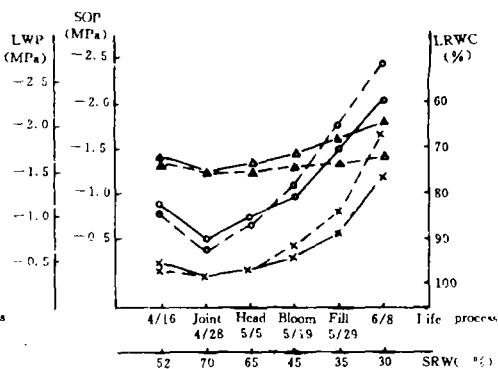


Fig. 2 Treatment II LRWC, LWP and SOP with SRWC

Variant regularity pattern of TP

Both the varieties' TP decreased as SRWC descended, and the variation of TP for $B. N. 2$ in these treatments was the smallest. In Treatment I the variation of TP was the greatest relatively from prejointing to filling anaphase, its TP decreased by 0.25 MPa, but $J. 411$'s TP varied greater as SRWC descended at each growth stage, the decrease of TP reached 0.56 MPa. It was shown that the stronger dry-resistant cultivar $B. N. 2$ had the ability to maintain cell's TP.

In addition, both the varieties' TP at each growth stage had a fluctuation. The common feature was that the TP curve had two tubercles at heading and filling stages. In Treatment I, as SRWC decreased from 42% at jointing stage to 38% at heading stage, the TP in $B. N.$

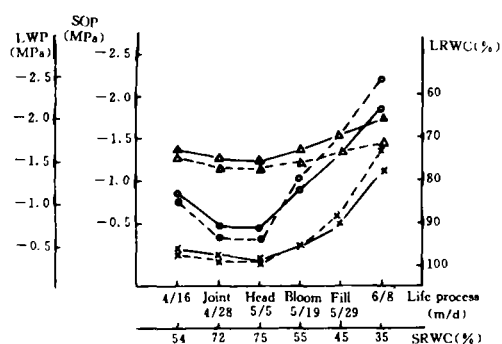


Fig. 3 Treatment III LRWC, LWP and SOP with SRWC

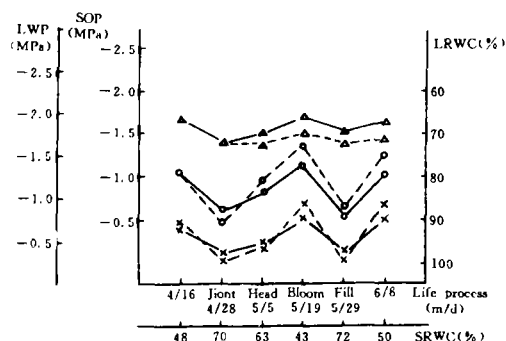


Fig. 4 Treatment IV LRWC, LWP and SOP with SRWC

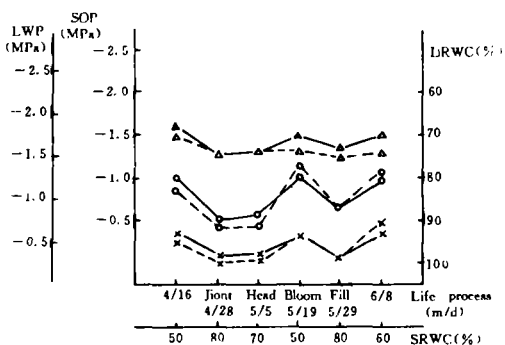


Fig. 5 Treatment V LRWC, LWP and SOP with SRWC

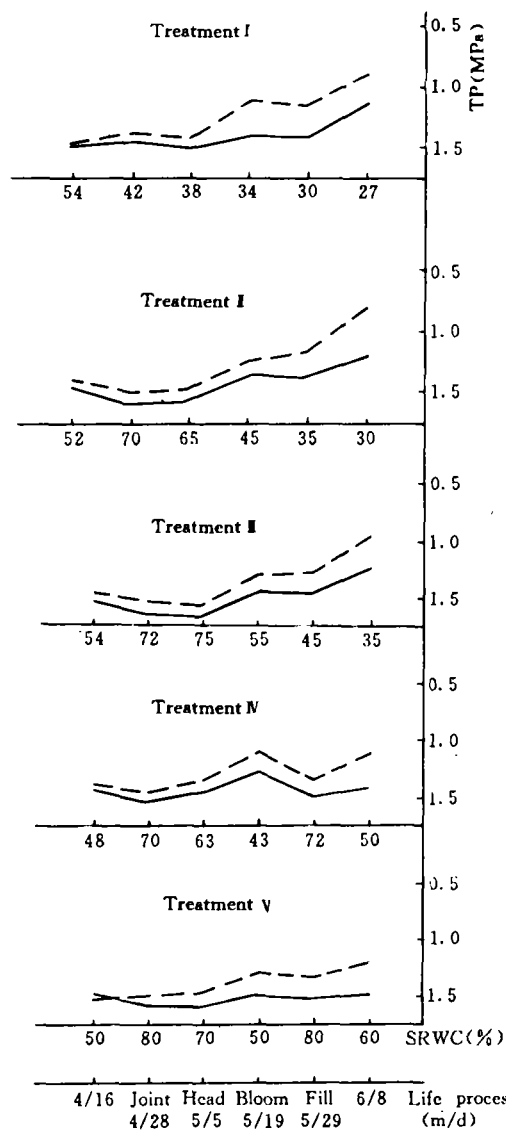


Fig. 6 Treatment I ~ V TP with SRWC

2 rose from 1.45 MPa to 1.50 MPa, and in J. 411, from 1.39 MPa to 1.42 MPa; as SRWC decreased from 34% at blooming stage to 30% at filling stage, the TP in B. N. 2 rose from 1.40 MPa to 1.42 MPa, and that in J. 411 descended from 1.21 MPa to 1.16 MPa, but the descent of TP with unit SRWC's descent was the smallest. The two tubercles can be seen

in Fig. 6. In Treatment II, with effect of jointing water, the tubercle can be seen only at filling stage. This TP's variant regularity showed that there was a higher level of TP in both the varieties at heading and filling stages that could maintain stronger OAA, and stronger dry-resistant B. N. 2 had stronger OAA than J. 411.

Analysis for OAA

In order to describe more clearly the osmotic adjustment effect of both the varieties under soil water stress, Treatment I can be regarded as a process of slow dehydration, and Treatment V can be looked upon as the control at each stage except for blooming stage. The result showed that both the varieties' maximum OAA all appeared at filling stage, next at the heading stage. It tallied with TP's variant regularity (Table 1).

Table 1. OAA of both the varieties under slow dehydration (MPa) and SRWC (%)

	Jointing stage	Heading stage	Blooming stage	Filling stage	Fill anaphase
SRWC	42	38	34	30	28
B. N. 2	0.34	0.55	0.51	0.74	0.59
J. 411	0.33	0.42	0.41	0.55	0.52

Between the two varieties, B. N. 2's OAA was higher than J. 411's, 0.19 MPa higher at filling stage and 0.13 MPa higher at heading stage, respectively. It was shown that under severe soil water stress, B. N. 2 had a higher OAA and drought resistance.

Discussion

Plants LRWC, LWP and OAA are closely relative to water stress. LRWC and LWP, usually as traits of tissue water, were widely used in research of plants OAA. This experimental results showed that LRWC and LWP of both the varieties kept higher positive correlation to SRWC. Under soil water stress the decrease level of LRWC and LWP for a stronger dry-resistant cultivar was less than that for a weaker one, the turgor pressure of both the cultivars showed decreasing tendency also, but was not in direct proportion with the decrease of LRWC and LWP, and demonstrated a slow falling process, and the decreasing range of a stronger dry-resistant cultivar was smaller than that of weaker one. This is identical with results of Li Dequan (1992) and Shangguan Zhouping (1990). In a variant trait of TP and OAA, both the varieties expressed a stronger OAA at heading and filling stages which are just important growing periods of wheat. This is not identical with Li Dequan's view of stronger OAA at boot and filling stages. It may be the difference between varieties. All results showed that the adaptive faculty of wheat to water stress was realized by osmotic adjustment mechanism. Osmotic adjustment showed positive effect on the physiological activities, affected by TP, like cell expansion, stoma opening and closing, and photosynthesis. Under water stress, the OAA of wheat can maintain a higher electron transfer ability, RUBP carboxylase activity and photosynthetic system activity.

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