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BRIEF COMMUNICATION

Nitrate Reductase, Nitrite Reductase Activities and Leaf Diffusive Resistance in Wheat under Water Deficit

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Abstract. The flag and second leaves of wheat showed physiological and biochemical differences in the normal and water stressed plants. Although the flag leaf had lower enzyme activities in the control plants, in stressed plants it could continue nitrate assimilation better than the second and other leaves. The flag leaf also exhibited a higher tendency to resume normal metabolic activity after the release of stress as is indicated by higher NRA, NiRa, lower r_{ad} and r_{ab}.

When water stress develops gradually, the first change most likely is a slowing down of plant growth. This is probably followed by reduction in protein synthesis, a decline in levels of some enzymes and a rise in others even at mild water stress (SHARMA 1980). Stomata may begin to close with a concomitant reduction in transpiration and photosynthesis. All this leads to an overall reduction in yield because of the water stress effects on a whole range of plant processes.

The importance of flag leaf contribution towards grain filling has been well documented (ASANA and MANI 1950, WARDLAW 1967 *etc.*). HSIAO (1973) noted that the studies of stress effects on harvestable yield often give inadequate attention to distinguishing which leaves on the plant supply most of the assimilates to the harvestable organ. This study was undertaken to understand the physiological and biochemical behaviour of the flag and other leaves under gradually increasing water deficits.

Wheat (*Triticum aestivum* L.) cv. WH-157 was grown in earthenware pots filled with 5 kg riversand. It was irrigated with Arnon and Hoagland nutrient

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TABLE 1
Effect of withholding irrigation on flag and second leaves of wheat

	Flag leaf					Second leaf				
	NRA	NiRA	r_{ad}	r_{ab}	RWC	NRA	NiRA	r_{ad}	r_{ab}	RWC
Control	65.5	23.5	0.8	2.1	93.3	70.7	22.0	0.9	2.7	95.2
2 days of withholding irrigation	58.1	22.7	2.9	11.0	78.0	48.5	17.3	2.1	7.8	85.4
5 days of withholding irrigation	47.1	18.8	5.7	10.6	73.4	27.4	14.1	27.1	33.5	80.6
Permanent wilting	29.0	15.0	38.0	80.6	48.6	20.0	11.0	47.2	85.0	48.2
Recovery (4 days after irrigation	45.0	25.8	10.2	19.0	89.1	26.7	28.0	14.2	33.0	91.8

NRA (nitrate reductase activity) μg NO_2^- produced g^{-1} (fresh matter) h^{-4}; NiRA (nitrite reductase activity) μg NO_2^- reduced g^{-1} (fresh matter) h^{-2}. r_{ad} : r_{ab} [s cm^{-1}]; RWC [%].

solution at fortnightly intervals. When the flag leaf was fully expanded, the plants were subjected to gradually increasing water deficits. Irrigation was withheld and the estimations were conducted on 2 days, 5 days after no irrigation, permanent wilting and then on recovery, *i.e.* 4 days after irrigation of the permanently wilting plants. Leaf diffusive resistances of the surfaces, adaxial (r_{ad}) and abaxial (r_{ab}), were measured by Lambda LI-60 Diffusive Resistance Meter. Nitrate reductase (NR) and nitrite reductase (NiR) activities were estimated by the intact tissue assay methods of JAWORSKI (1971)and FERARI and VARNER (1971), respectively, and relative water content (RWC) according to WEATHERLEY (1950).

The flag leaf and second leaf showed physiological and biochemical differences in normal as well as stressed plants. The flag leaf of the control plants had lower activities of the enzymes of nitrate assimilation as compared to the second and other leaves (Table 1), similarly to the earlier report of ABROL and NAIR (1976). However, on being subjected to gradually increasing water deficits it showed less reduction in activities of the enzymes and thus could continue its nitrate assimilation to a greater extent. Moreover it also showed a higher tendency to resume normal metabolic activity after the relaxation of the imposed stress.

In normally growing plants, the second leaf had higher r_{ad} and r_{ab} as compared to the flag leaf. During wilting r_{ad} and r_{ab} increased sharply in the leaves. Both the surfaces had different resistances. r_{ab} was higher than r_{ad} in the control as well as stressed plants. The diffusive resistances (r_{ad} and r_{ab}) decreased when plants were allowed to recover (*i.e.* 4 days after irrigation) but even then the values were much higher as compared to the control plants, which shows that the stressed plants were still unable to recover from stress. Here also the second leaf had relatively higher r_{ad} and r_{ab} than the flag leaf although there was not much difference in their RWC values.

Moreover, when the plants were allowed to recover, the flag leaf resumed normal metabolic activities faster than the second leaf as indicated by higher NRA, NiRA, lower r_{ad} and r_{ab}. This indicates that the flag leaf faces water deficit conditions better than the second leaf and fares better physiologically as well as biochemically. These effects are also due to the slight differences in

the age of the leaves although the blades of both leaves had reached their maximal area. Thus flag leaf contribution to grain yield would increase still further under water deficit, and this study points in that direction.

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