

UNIQUE NITRATE UPTAKE INDUCTION PATTERN IN COLD TOLERANT WHEAT GENOTYPES

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Nitrate uptake behaviour of cold tolerant and cold sensitive wheat genotypes was examined by analysing the induction of nitrate uptake. The sensitive genotypes when exposed to cold showed delay in induction of nitrate uptake system, whereas, the tolerant genotypes did not show any such delay in the induction of nitrate uptake system. Moreover, the pattern of nitrate uptake in sensitive genotypes (non-acclimated and cold-acclimated) and non-acclimated tolerant genotypes showed a bimodal kind of induction, while, the cold-acclimated tolerant genotypes showed only unimodal induction pattern.

Key words : Cold tolerance, induction, nitrate uptake, wheat.

Wheat is the most important food crop in the world and is grown in many countries. It is exposed to mild to severe cold stress in many parts of the world particularly in the countries of extreme latitudes. Certain wheat genotypes are able to tolerate the cold stress owing to their unique physiological attributes like increase in accumulation of free amino acids especially proline (Charest *et al.* 1990) and their derivatives like quaternary ammonium compounds (glycinebetaine, prolinebetaine, β -alaninebetaine, choline-*o*-sulfate), tertiary sulfonium compound 3-methyl fulfoniopropionate (DMSP) and polyamines (spermidine, spermine and putrescine) (Rhodes 1999) and high molecular weight proteins (Sarhan and Ferras 1987). All these compounds are nitrogenous in nature and nitrate taken up from the soil acts as the primary source of nitrogen for these compounds. Even though the role of these compounds are well studied, the nature of nitrate uptake and its relation to the cold tolerance behaviour is not adequately characterized.

Four genotypes of wheat (*Triticum aestivum* L.) differing in cold tolerance were used as experimental material. Two genotypes (VFW 1350 and HS 240) are cold tolerant and other two genotypes (VL404, HD1949) are cold sensitive. All the four genotypes were obtained from Vivekananda Parvatiya Krishi Anushandan Shala, Almora, India. For the nitrate uptake induction study, wheat seedlings were raised in nitrogen free Hoagland

medium for seven days. The seven days old seedlings were then cold acclimated for 15 day at 4°C/2°C day/night temperature with 12h/12h light/dark period. Another set of seedlings were raised under non-acclimated condition (22°C/18°C day/night temperature). The 22 day old non-acclimated and cold-acclimated wheat seedlings which were grown in Hoagland medium devoid of nitrogen were used for the study of induction of nitrate uptake. The nitrate uptake induction was examined by incubating ten wheat seedlings in 15 ml of ¼ Hoagland medium containing 15 mM KNO₃ for different times. The measurements of nitrate uptake were made from 0 to 15 hours at an interval of 3 hours by measuring the amount of nitrate remaining in the culture solution by the method of Downes (1978).

Nitrate uptake over 0-15 h time intervals reveals an interesting pattern. The cold-sensitive genotypes VL404 and HD1949 under non-acclimated condition showed induction of nitrate uptake at 0-3 and 9-12 h intervals (Fig. 1). Under non-acclimation both the sensitive genotypes, therefore, had a 9 h gap between two successive inductions of nitrate uptake. On the other hand, cold-tolerant genotypes (VFW1350 and HS240) showed a difference in induction pattern. Both the tolerant genotypes under non-acclimated conditions showed induction of nitrate-uptake during 0-3, 3-6 and

9-12 h intervals. However, the cold-acclimated seedlings showed increase in nitrate uptake during 0-3, 3-6 and 6-9 h intervals. The 6h gap between two successive induction of nitrate uptake in the non-acclimated category was not detected in the cold-acclimated category. Thus the cold-acclimated category of tolerant genotypes showed continuous increase in nitrate uptake from 0-9 h.

The results of induction study show that the nitrate uptake system in all the genotypes was induced by the first 0-3 h which is similar to the findings of Goldstein *et al.* (1985). Sensitive genotypes raised under non-acclimated condition had major induction of nitrate uptake at 0-3 h itself followed by another induction peak at 12 h. However, the cold acclimated sensitive seedlings had a small induction at 3 h which continued at 6 h also. The cold acclimated sensitive genotypes showed another induction peak at 12 h. This clearly shows the delay in induction of nitrate uptake system in the sensitive genotype due to cold

acclimation. This fact is evident from the observation that even at 6 h, the cold acclimated sensitive genotypes did not attain the level of nitrate uptake attained by non-acclimated seedlings at 3 h itself. The cold tolerant non-acclimated genotypes had nitrate uptake induction peaks at 6 and 12 h. On cold acclimation, the tolerant genotypes showed higher (than non-acclimated) uptake at 0-3 h itself and the increase continued steadily till 9 h. Unlike the cold-acclimated sensitive genotypes, the cold-acclimated tolerant genotypes had no cold-induced delay in the nitrate uptake.

The pattern of nitrate uptake in sensitive genotypes (non-acclimated and cold-acclimated) and non-acclimated tolerant genotypes showed a bimodal kind of induction peaks. The bimodal induction suggests a possible temporally separated expression of low affinity nitrate transport system (LATS) and high affinity nitrate transport system (HATS). In the case of cold-acclimated tolerant

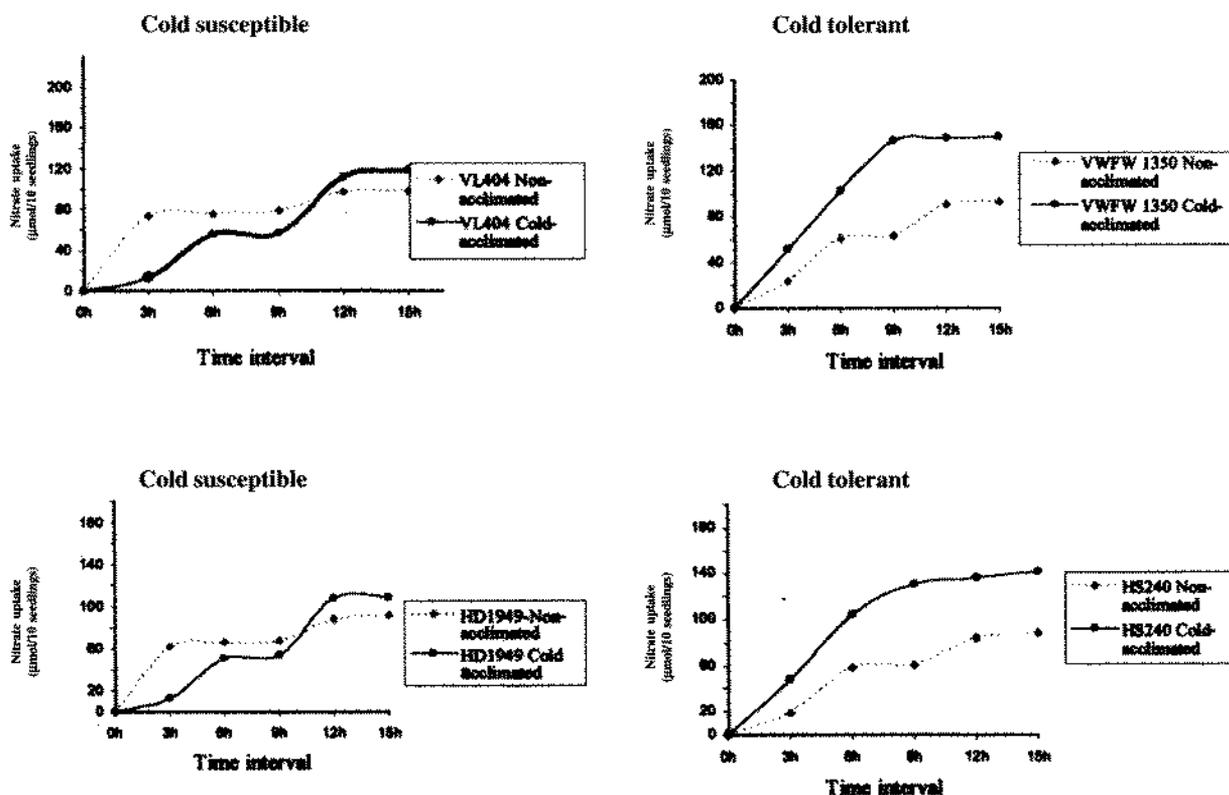


Fig. 1. Nitrate uptake induction in cold tolerant and cold susceptible wheat genotypes under cold-acclimated and non-acclimated conditions

NITRATE UPTAKE INDUCTION IN COLD TOLERANT WHEAT

genotypes only unimodal induction is observed, and it may be due to the concurrent expression of LATS and HATS without any time gap. The quantum of nitrate uptake in cold-acclimated tolerant genotypes is higher than in the cold-acclimated sensitive genotypes, as observed by Bloom and Chapin (1981) in barley.

The presence or absence of cold induced delay in the nitrate uptake induction and reduction in nitrate uptake correlates well with the ability of wheat genotypes to tolerate cold temperature. This suggests a key role of nitrate uptake behaviour in cold tolerance ability of wheat genotypes.

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