ABSTRACT OF THE THESIS

Evaluation of advanced and elite lines of wheat (*Triticum aestivum* L.) from northern Iran to pre-harvest sprouting

Wheat (*Triticum aestivum* L.) is one of the most important staple crops worldwide, with total production of over 690 million tons of grains annually, and occupying 220 million ha of cultivable land. It is exposed to several biotic and abiotic factors which contribute to loss in grain yield and quality. Pre-harvest sprouting is a serious problem in various countries, where the rainy season coincides with the harvesting time of wheat. Therefore, pre-harvest sprouting (PHS) tolerance in wheat genotypes is the most important goal in breeding programs of these countries. PHS reduces the grain yield, nutritional quality and end product quality of wheat flour, for which high α-amylase activity is mainly responsible. The tolerance to PHS is a complex trait, influenced by genotypes, environment and plant morphology. Humid and warm climate that exists at the time of harvesting in some part of northern Iran such as Sari, Gorgan, Gonbad are very prone to PHS.

Screening of wheat genotypes under mist irrigation for PHS tolerance

The field experiments were conducted in randomized complete block design, with three replications, using mist irrigation (MI), for twenty one days at Bayekola Agricultural Research Station (Sari) to screen the response of forty wheat genotypes to PHS. The mist irrigation treatment was applied at physiological maturity stage for 21 days and parameters such as plant height, days for heading and maturity, kernel color, kernel weight as well as yield before and after MI, days to PHS etc. were recorded.

The results indicated significant diversity for PHS tolerance among the selected genotypes. The genotypes in the first cluster N-87-2, N-87-6, N-87-9, N-87-18, N-86-22, N-86-25, N-86-32 showed more tolerance to PHS after 21 days of mist irrigation, without any remarkable reduction in kernel weight.
The findings of present study revealed that kernel colour is not a reliable marker to select the wheat genotypes tolerant to PHS, because various morphological traits such as lemma and palea, spike type (vertical, horizontal, and curved), open and close spikelets and their density, awns, lodging as well as α-amylase activity in grains are also involved in tolerance to PHS.

After primary screening, five genotypes from all the three clusters were selected for field evaluation and the experiments were conducted in split plot based randomized complete block design, with three replications at the same research station. Main plots were given seven, fourteen, and twenty one days of MI. For simulating natural conditions mist irrigation was applied daily at physiological maturity stage of wheat (rainfall 30-50 mm) and humidity (50-70%) was maintained. Five genotypes such as Nai60, N-80-19, N-86-12, N-87-12 and N-87-8 were grown in sub plots.

The results indicated that there was significant interaction between all the characters, except spike length and number as well as kernel number per spike. The selected traits like kernel weight (r=0.84; P<0.01), kernel size (r=0.77; P<0.01) and harvest index (r=0.74; P<0.01) had shown positive correlation with grain yield. However percentage loss (r=-0.740) and damage severity (r=-0.91;P<0.01) as well as days to PHS (r=-0.42; P<0.01) had shown negative correlation with grain yield. Mean comparison showed that during 21 days of MI, PHS sensitive genotypes such as N-87-12 (600 kg ha$^{-1}$) and N-87-8 (400 kg ha$^{-1}$) showed lowest grain yield as compared to other treatments of MI (7 and 14 days).

On the other hand PHS tolerant genotypes like N-86-12 had the highest grain yield (5000 kg ha$^{-1}$) as compared to other genotypes. The results of path analysis revealed that the biological yield (-0.315), harvest index (-0.908), and damage percentage (-0.357) had the maximum direct effects on grain yield. While days to PHS (-0.684), damage severity (-5.594), and kernel weight (-1.489) had indirect effects on grain yield. The genotype N-86-12 had shown minimum PHS during MI conditions; hence this genotype is suitable for cultivation during high rainfall and humidity in Mazandaran province of Iran as it showed PHST.
Physiological and biochemical evaluation:

The results on physiological and biochemical analysis of wheat genotypes during MI indicated that the selected genotypes significantly differed on the basis of carbohydrates, starch, phenols, proline, sugars, proteins, total chlorophylls, chlorophyll a, chlorophyll b, activities of total amylases, α-amylase, β-amylase and yield. After 21 days of MI starch, carbohydrates, phenols, proline and protein contents as well as yield was reduced highly as compared to seven and fourteen days of MI. However sugars, total amylases, α-amylase, and β-amylase increased as compared to other MI treatments. The results of simple correlation coefficient analysis showed that starch, protein, total chlorophylls, chlorophyll a, b, carbohydrates, phenols and proline had positive correlation with grain yield after MI. While sugars, total amylase, α-amylase and β-amylase activity had negative correlation with grain yield.

The results of regression analysis indicated that there was significant difference between genotypes in terms of values of carbohydrates, starch, protein, phenol, protein, yield, sugars, α-amylase, β-amylase and total amylase under different conditions of MI. Estimated values for genotypes such as N-80-19, N-87-12, N-87-8, N-86-12 and Nai60 using the segmented model were decreased linearly for carbohydrates, starch, protein, phenol, protein and yield with 7, 14 and 21 days however values of sugars, α-amylase, β-amylase and total amylase were increased linearly with days up to 21 days of MI, except N-86-12 genotype, which was due to its high tolerance to PHS.

The results of path analysis revealed that sugars, protein, duration MI, starch and carbohydrates had negative direct effect on grain yield. While total amylases had negative impact on grain yield, indicating that this may be considered as the useful parameter for selecting genotypes tolerant to PHS. The highest indirect effect on grain yield was due to protein, duration MI, total chlorophylls, and chlorophyll a. While phenols showed negative correlation with total amylases, which indirectly controls accumulation of starch. The PHS tolerant genotypes had shown increase in carbohydrates, phenol, starch, proline, protein and yield. However the carbohydrates,
phenol, starch, proline, protein and yield in highly PHS sensitive genotypes such as N-87-8 were decreased after 21 days of MI.

**Molecular expression of α-amylase activity:**

The molecular expression of α-amylase activity in wheat grains of different genotypes during PHS indicated that the variety N-87-8 showed very high level of gene expression and subsequently stimulated level of enzyme activity, indicating its very high sensitiveness to PHS. The sensitiveness of this variety was also supported by morphological characters such as lemma, palea, spike type, awns, etc. In contrast to this the variety Nai60 showed low expression of genes for α-amylase and low level of enzyme activity, indicating its very high tolerance to PHS. The other two varieties N-87-8 and N-87-12 had shown medium level of gene expression of α-amylase activity indicating their medium tolerance to PHS.

From the results of present investigation it can be concluded that not only the level of gene expression for α-amylase but some other traits such as morphological, physiological and biochemical are also contributing to tolerance or sensitiveness of wheat genotypes to PHS. The findings of present study also confirmed that the genotype N-86-12 was highly tolerant to PSH on the basis of morphological and physiological analysis in field condition. While the genotype Nai60 was tolerant to PHS on basis of molecular analysis. Finally on the basis of results of present investigation these two genotypes such as N-86-12 and Nai60 which showed tolerance to PHS may be recommended to the farmers of northern part of Iran for cultivation, as promising varieties and these can be released after further research and multi location trials.

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<th>Candidate Name</th>
<th>Co-Guide</th>
<th>Co-Guide</th>
<th>Research Guide</th>
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<tr>
<td>Mr. Ahmad ahmad pour Malakshah</td>
<td>Prof. Dr. Hemmatollah Pirdashti (Iran)</td>
<td>Prof. Dr. Praveen G. Saptashi Pune</td>
<td>Professor K. N. Dhumal Pune</td>
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