Leaf Vein Density in Rice: Is it regulated by temperature?

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Introduction

Engineering of C_4 rice has been identified as one of the major rice breeding objectives to meet the rising food demand especially in the Asian region. Enhanced vein density is known to be a prerequisite for establishment of biochemical pathways and has laid the foundation for evolution of the C_4 photosynthesis pathway (McKown and Dengler 2007, Smillie et al. 2012). Many approaches have adopted to develop C_4 rice by aiming to increase the yield potential from 1990s. It is essential to identify driving factors of enhanced vein density and to study genetic regulation of vein density in order to design C_4 rice with higher yield.

Material and Methods

Eight rice varieties were studied under two different temperature regimes for variation in vein density in a Completely Randomized Design with three replicates. Light levels in the growth chambers were maintained at 1000 μmol s^{-1} m^{-2} for 12 hours and the two temperature regimes were 26.5 ^{0}C and 31 ^{0}C in light hours and 3 ^{0}C lower during dark hours. Vein density was screened on six week old rice plants using a handheld digital microscope Dino-Lite AM4515ZT. Number of veins on both sides of the midrib was counted manually excluding midrib. Data was statistically analyzed using SAS 9.4.

Results and Discussion

The vein density increased with increased temperature. All rice lines showed a significant increase in vein density (α=0.05) under 31 ^{0}C with different magnitude when compared to 26.5 ^{0}C as shown in Figure 1. Temperature had a strong significant effect on vein density of rice (Pr<0.0001) irrespective of variety. However, interaction effect of temperature and variety on leaf vein density in rice was not significant (Pr =0.226).

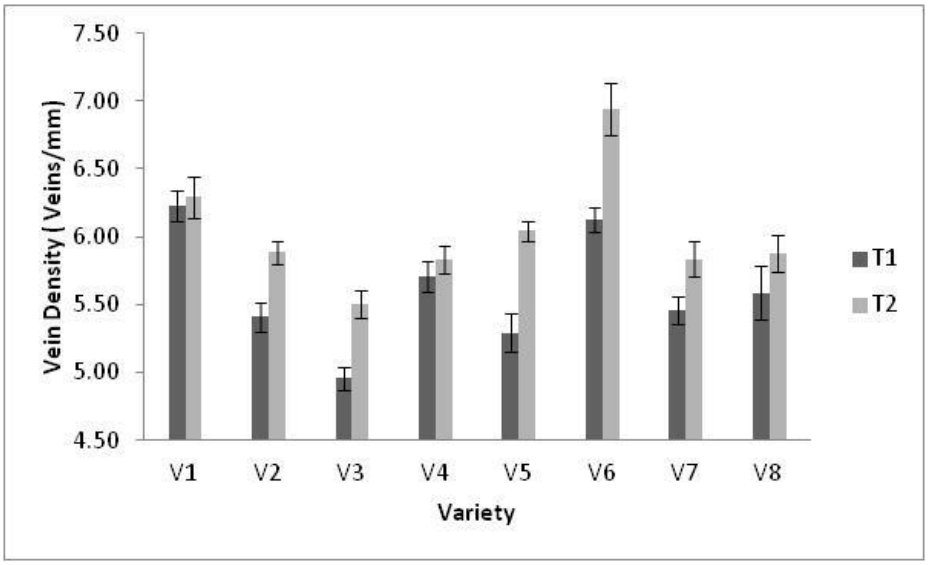

Figure 1. Variation in number of veins per mm of leaf under two treatments (T1=26.5 ^{0}C, T2=31 ^{0}C, V=Variety)

Vein density increased under elevated temperature levels. Variation in vein density under high temperature may be partly due to accelerated cell division and/or cell expansion as observed by Smillie et al. 2012. Further research together with detailed microscopic studies is required to confirm the observations and to identify anatomical variations under high temperature.

Conclusion

Vein density increased under elevated temperature levels. Since the vein density trait appears to be associated with environmental factors such as temperature, environmental effect should taken into consideration in designing of screening trials. The phenotypic plasticity of the genotypes can be used as a breeding approach to identify genetic regulation behind enhanced vein density which has led to the evolution of C_3 into C_4. It is questionable whether we have to select genotypes with high plasticity to adjust under elevated temperature or genotypes with less plasticity to maintain in a constant manner. It is essential to study the variation in vein density coupled with photosynthesis and total soluble sugars to check the association.

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References

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