Vascular patterns in grape berries

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Background

Vascular bundles in the pedicel and berry contain the conduits for transport of water, sugar, nutrients and signals into and through the grape berries, and play a very important role in fruit development and quality. They are composed of xylem, phloem and meristematic tissues. Differentiation from cambium results in growth of xylem inwards (periclinally) and phloem outwards. The phloem is particularly important for sugar transport. With the onset of ripening, water flow through the xylem declines. The phloem then becomes the main contributor of water for berry growth and transpiration. Xylem may serve as the conduit for recycling of excess phloem-derived water (water backflow). The balance of water dynamics dictates yield and fruit quality.

Objective

Examine vascular patterns within the proximal region of Shiraz, Sauvignon Blanc, Ruby Seedless and Flame Seedless berries. This region is a critical branching point for vascular tissues that supply either the peripheral network under the skin or the central bundles that lead to the seeds and berry interior.

Key findings

A distinctive change in vascular arrangement from the pedicel into the grape brush zone was apparent in all examined cultivars.

1. At the junction of the receptacle (berry stem) and the berry pericarp, the vascular bundles exhibited the arrangement where xylem was surrounded by phloem (amphicribral-like arrangement).
2. In the brush zone, the vascular bundles reoriented so that the phloem was situated on the inner side of the vascular bundles. This was already apparent at the pre-veraison stage.

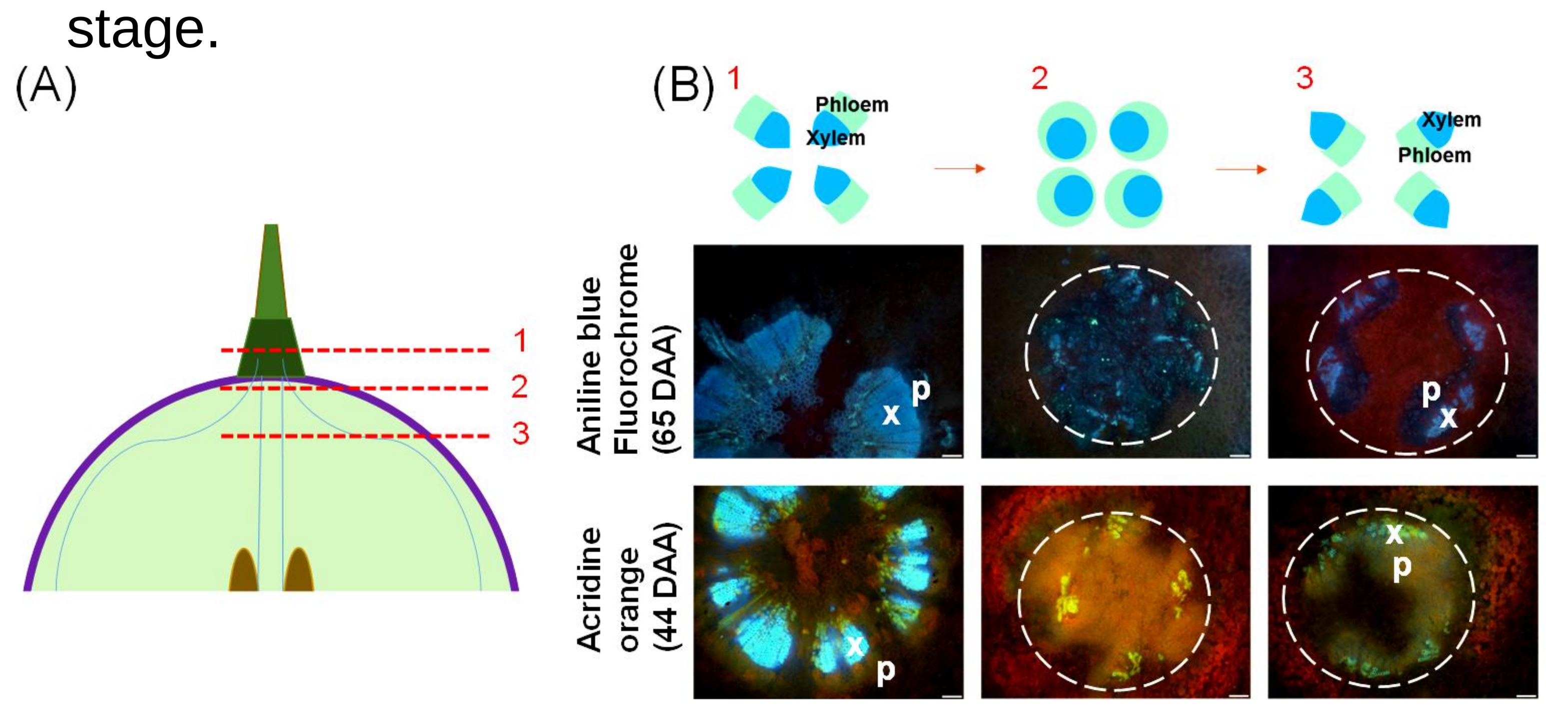

Figure 1 Arrangement of vascular tissues at three points along the proximal (pedicel end) region of a Sauvignon Blanc grape berry. Free-hand section positions in the grape (A) and images (B) of vascular patterning along these three positions after staining with aniline blue fluorochrome or acridine orange. The vascular patterns were imaged at 1. the receptacle, 2. receptacle/grape junction and 3. brush zone. (White dished circles indicate central vascular bundles; x, xylem; p, phloem).

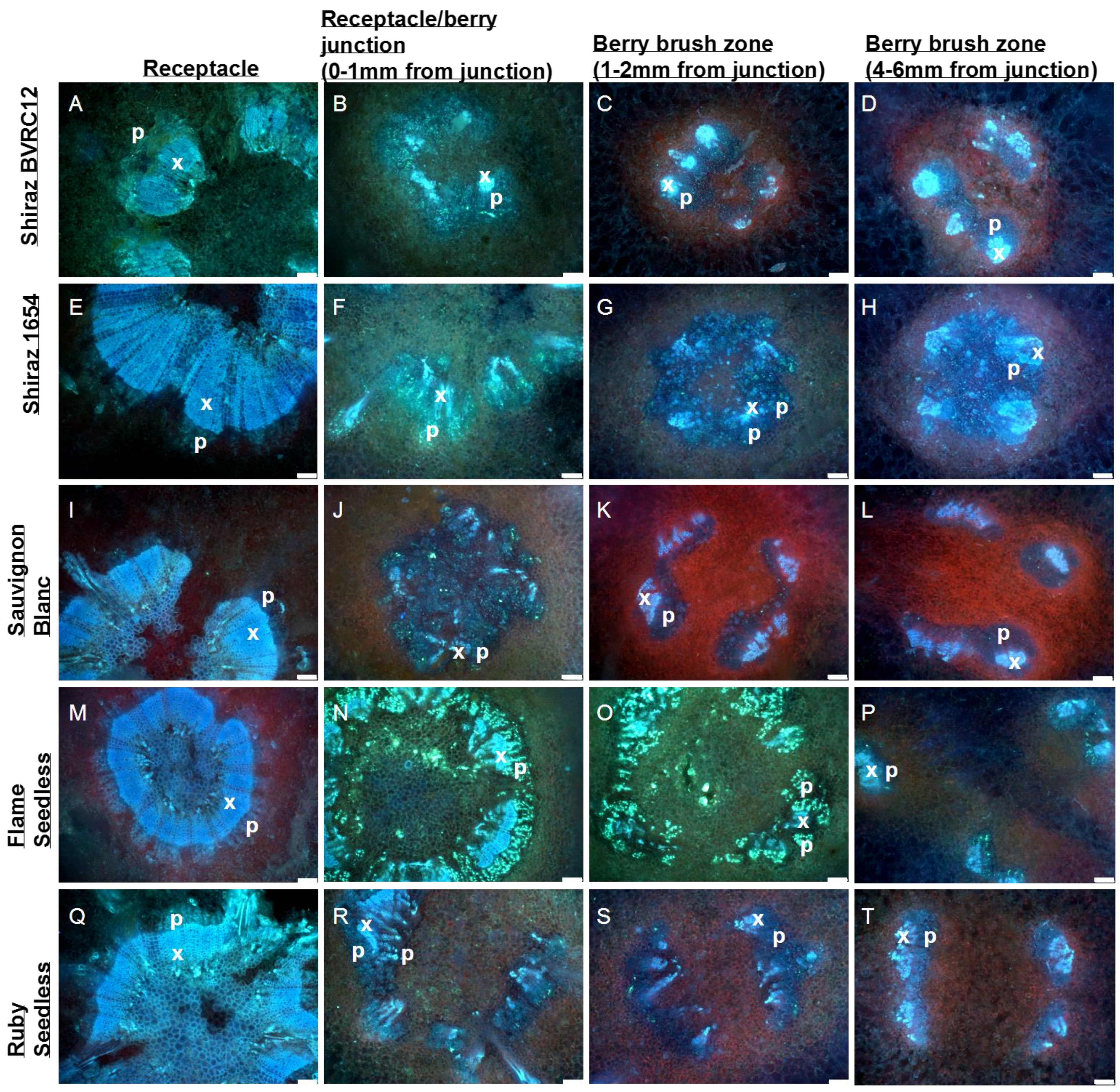

Figure 2 Free-hand sections at four points (receptacle, receptacle/berry junction and berry brush zone at two depths from the junction) along the proximal region (pedicel end) of the berry at around 65 days after anthesis (post-veraison). The fresh samples were stained with aniline blue fluorochrome and viewed under UV. (Scale bar = 100µm; x, xylem; p, phloem)

Methods

1. Grape berries (*Vitis vinifera*) were sampled in 2017 and 2019.
2. Shiraz, Sauvignon Blanc, Ruby Seedless and Flame Seedless were collected in 2017, fixed in 100% methanol and stained with acridine orange, which stains non-lignified cell walls giving a red/orange fluorescence.
3. Fresh berries of same cultivars were sampled in 2019 and stained with aniline blue fluorochrome, which stains callose in phloem giving greenish blue fluorescence.
4. Images were photographed using an Olympus Provis AX70, microscope (excitation 330-385nm, barrier filter 420nm) with an Olympus DP80 digital camera.

Conclusion

All four grape cultivars exhibited an inversion in the vascular arrangement within the central axis of the berry as it traversed from the receptacle into the brush region. It is likely that this inversion has implications on the development of the seeds and the central pericarp tissues.

This is the first time the pattern of vascular growth has been characterized in commercial grape cultivars. It provides the ground work for future studies on material transport into the berry, linked to berry quality for wine making.

FOR MORE INFORMATION

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