COMMENT

A note on the report by M. B. Lavigne and M. G. Ryan relating stem maintenance respiration rate to stem growth rate

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Lavigne and Ryan (1997) (hereafter L&R97) used comprehensive measurements of stem respiration and growth in three tree species at several field sites to relate annual growth to annual respiration. An important finding of this analysis is that annual stem maintenance respiration—estimated from dormant-season respiration rate measurements—is positively related to annual sapwood relative growth rate. L&R97 concluded that this result was contrary to present plant respiration dogma and claimed that “although it has been assumed that no relationship exists between maintenance respiration rate and growth rate (Amthor 1989), we consistently observed such relationships at our sites” (p 549). In fact, however, Amthor (1989, p 83) stated that: “The maintenance (respiration) coefficient tends to increase as the growth rate increases.” Thus, the results reported by L&R97 are consistent with previous publications suggesting that maintenance costs increase with increases in growth rate or overall metabolic activity (Amthor 1989, Penning de Vries et al. 1989). Therefore, the conclusion of L&R97 that their “results cast doubt on the assumption that stem maintenance respiration is independent of stem growth rate” (p 550) requires modification. In particular, two aspects of the results presented by L&R97 deserve attention: (1) their data extend previous results relating maintenance respiration rate to growth rate mainly from herbaceous crop species (Amthor 1989, Penning de Vries et al. 1989) to tree stems and (2) their data go beyond previous results showing a positive relationship between instantaneous maintenance costs and growth rate (Amthor 1989) to include maintenance respiration rate even during the “post-growing season.” Hence, the results of L&R97 significantly extend, rather than contradict, previous tenets of higher-plant respiration.


REPLY

Reply to letter by J. S. Amthor

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We thank Amthor for opening a discussion about the current “functional” model of respiration. Our reason for citing Amthor (1989) in support of the assumption that no relationship exists between growth rate and maintenance respiration (Lavigne and Ryan 1997, p 549) was that Respiration and Crop Productivity recognizes and promotes the two component model of plant respiration, and the two component model of respiration includes no dependence of the maintenance coefficient on growth rate. Respiration and Crop Productivity has had a strong influence on the field, and most physiologically based models of forest production use the growth + maintenance model to estimate respiration (e.g., Rastetter et al. 1991, Running and Hunt 1993). Our paper suggests that if the effects of growth rate on maintenance respiration are not considered, estimates of respiration costs will be incorrect.

Given the increasing evidence that maintenance respiration does vary with growth rate, we suggest a search for a new paradigm of plant respiration that incorporates this relationship. Other evidence suggests that the ratio of respiration to photosynthesis remains relatively constant with growth temperature (Gifford 1994, Ryan et al. 1997) and with forest biomass (Ryan et al. 1997). Finding a model that yields these results is a useful goal for those studying plant respiration.