Is time to flowering in wheat and barley influenced by nitrogen?: A critical appraisal of recent published reports

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Timing of flowering is critically important in determining yield of grain crops because it defines crop adaptation (best match between the seasonal dynamics of environmental conditions and crop requirements for yield formation and realization). Shifts in timing can alter both the number of grains set per unit area and their average weight. These effects can arise, even under irrigated conditions, through the crops being exposed to more or less favorable combinations of radiation and temperature during the windows of development for grain number and grain weight determination, respectively. If grain number determination and grain filling take place under increasingly stressful conditions (e.g., terminal drought, increasing seasonal temperatures) and if flowering is delayed, impacts on yield can be even greater than under non-stressed conditions.
The literature includes a number of reports, relating to both crop and non-crop species, showing conflicting responses of developmental plasticity to nitrogen availability. However, there has not been any systematic attempt to analyse the occurrence and importance of these effects across a broad spectrum of reports. We reviewed 1130 papers published from 1990 to 2010 drawn from 14 agriculture-themed journals and conducted a critical appraisal of the effects of fertiliser nitrogen on time to heading or anthesis in barley and wheat, species for which there is a good deal of data. Features of the analysis were the use of relative responses (respect to unfertilized controls) of yield and time to flowering to nitrogen as a proxy for crop nitrogen status and developmental differences, respectively, and the standardisation of the start point for calculating time (in both calendar and thermal units) to flowering in autumn-sown winter cultivars to March 1 (N Hemisphere). The resulting database (180 cases) covered a broad range of unfertilised crop yields (1–8 Mg ha^{-1}), and times to flowering (47–168 days). In very few cases (19 out of 118), the relative time to flowering in fertilised crops differed by more than 5% from those of unfertilised crops across a range of yield responses to fertilizer nitrogen from negligible to three-fold. Currently available evidence does not provide solid support to a plastic response of time to flowering to nitrogen in these two species. The implication for agronomists both in research or management is that nitrogen availability (within agronomic usual ranges) is not related to changes in crop development. This is consistent with the decision of modellers interested in these crops who have not included a response of phenology to nitrogen in their models.

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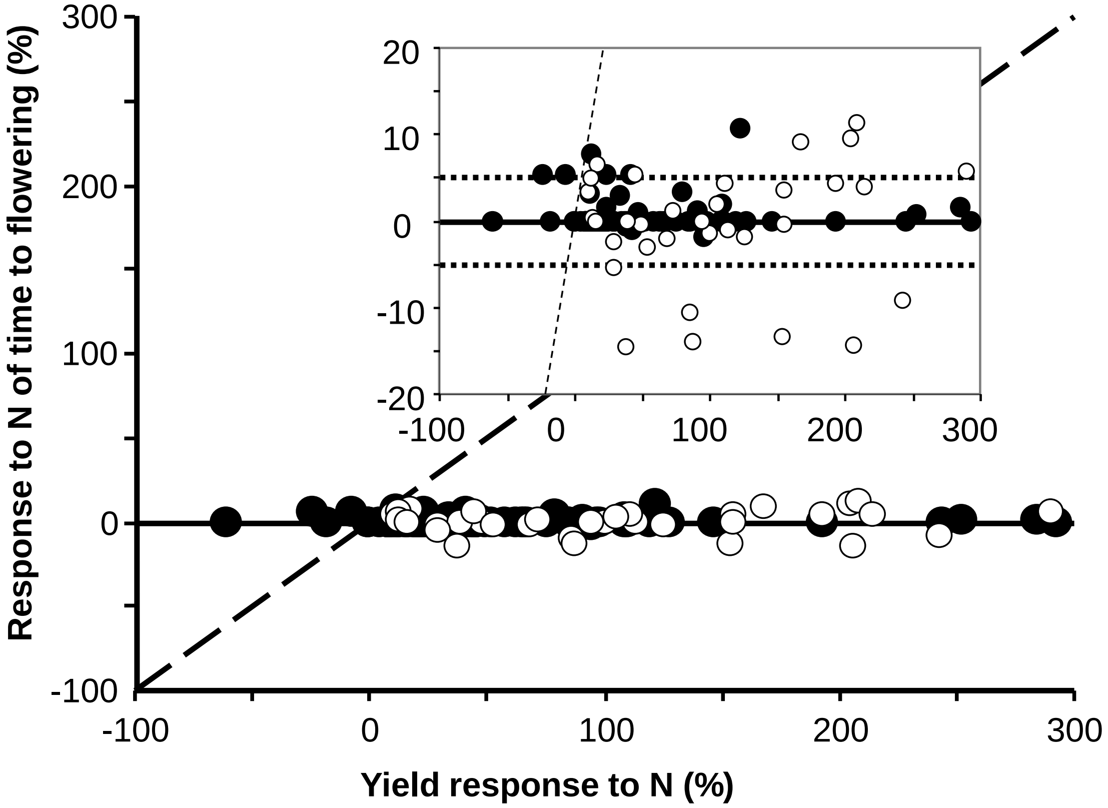

Time to heading or anthesis in fertilised *vs*. unfertilised treatments and grain yield with the same scale for both variables (*b*). Inset in (*b*) shows a detail of the main panel with an expanded "y" axis scale, and horizontal lines (thin dashes, thick continuous, and thin continuous) indicate +5%, 0 % and -5% responses, respectively. Results for wheat (closed symbols) and barley (open symbols). In panel *a*, time is in calendar (circles) or thermal units (squares). In all cases, times are days or degree-days from March 1 for winter types sown in autumn in the Northern hemisphere and from sowing in all other cases. Dashed lines stand for the 1:1 ratio. Many data-points (n=118) are not visible as they overlap. The Model II regression function in panel *a* is y=5.84 (± 1.82) + 0.94 (± 0.01x), r^2=0.97, P < 0.01)