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CORRECTION

Correction to: Allometric approach to crop nutrition and implications for crop diagnosis and phenotyping. A review

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Correction to: Agronomy for Sustainable Development https://doi.org/10.1007/s13593-019-0570-6

Due to a different interpretation of a query about figure numbering during proof stage, figures and captions in above mentioned article got mixed-up in the final version. The publisher and typesetter regret this occurrence and apologize for the inconvenience caused.

In this correction note you will find figures 4 - 8 with correct numbers and captions, as well as the correct version of Box 2.

The online version of the original article can be found at https://doi.org/10.1007/s13593-019-0570-6

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Box 2 Consequences for assessing N use efficiency by crops

Derivative of Eq. (7) with time allows the expression of the rate of crop N uptake (dN_{upt}/dt) in relation with the crop growth rate (dW_{sh}/dt) and the shoot mass (W_{sh}):

$$dN_{upt}/dt = abW_{sh}^{b-1} \times dW_{sh}/dt \quad \text{Eq. } (7')$$

Under non-limiting N supply, the crop N uptake rate (dN_{upt}/dt) depends on the potential crop mass accumulation rate (dW_{sh}/dt), but it declines as crop mass increases. Devienne-Barret et al. (2000) showed that the rate of crop N uptake is dependent on both crop growth rate and soil N availability leading to a family of N_{upt}-W_{sh} trajectories for each steady state condition of soil N supply as represented in Fig. 4. This dual dependency of N uptake is well explained by physiological evidence on feed-back regulation of root absorption capacity of mineral N (nitrate and ammonium) by shoot growth through C and N signals (Gastal and Saugier 1989; Lejay et al. 1999).

If N_f represents the rate of N fertilizer application, the Nitrogen Use Efficiency ($NUE = dW_{sh}/dN_f$) for crop mass production is a function of two components: (i) the N Absorption Efficiency ($NAE = dN_{upt}/dN_f$) and (ii) the N Conversion Efficiency ($NCE = dW_{sh}/dN_{upt}$), so that:

$$NUE = NAE \times NCE \quad (8)$$

dN_f being the increment in N fertilization rate. Then the N_{upt}-W_{sh} allometry has two important consequences for analyzing variations in NUE due to genotype-environment-management interactions as underlined by Sadras and Lemaire (2014):

(i) NAE is partly determined by crop growth rate so that genotypes having a higher crop mass should have a higher NAE than slow growing genotypes. This effect is shown on Fig. 4 where any increment in W_{sh} is associated with a corresponding increment of N_{upt} for each N supply. So genotypic variation in NAE has to be compared at a similar shoot mass otherwise the difference would be trivial.

(ii) The N dilution process implies that dN_{upt}/dW_{sh} decreases as shoot mass increases, so that NCE (dW_{sh}/dN_{upt}) increases as shoot mass increases. Consequently, the NCE of different genotypes has also to be compared at a similar shoot mass otherwise the difference observed would be obvious with a larger crop having always a higher NCE than a smaller one.

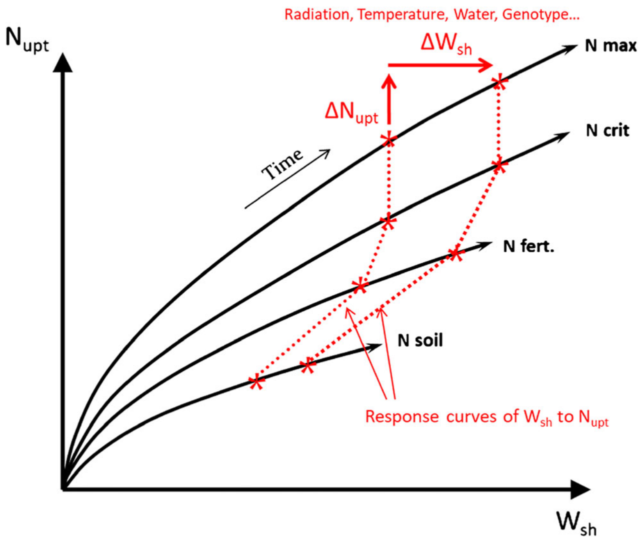

Fig. 4 Trajectories of N uptake as a function of shoot mass accumulation (Wsh) for different steady-state levels of N supply: N soil (N supply only from the soil without any N fertilizer application), N fert (N supply with a limiting N fertilization rate); N crit. (N supply with a minimum N application for achieving maximum shoot mass accumulation); and N max (N supply with a supra-optimum N fertilizer rate). Adapted from Gastal et al. (2014)

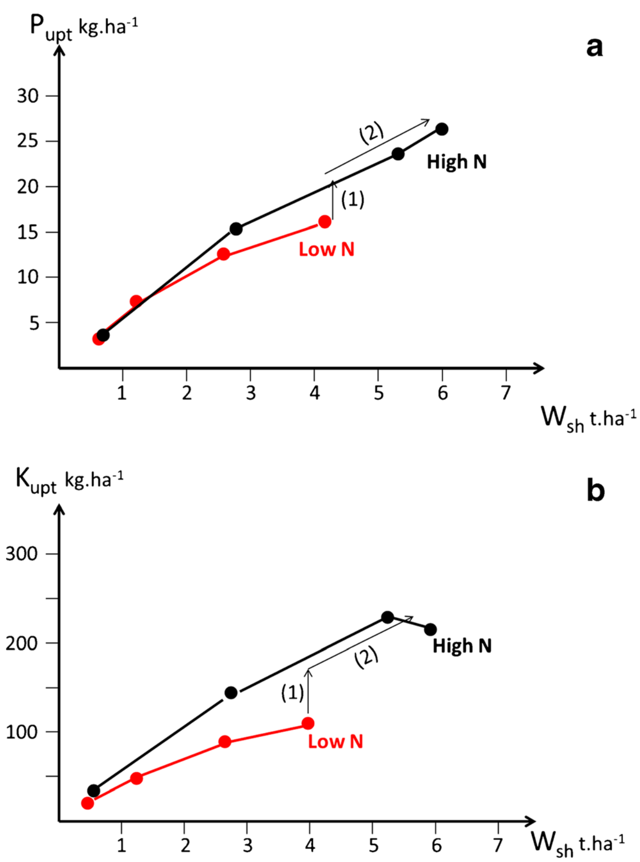

Fig. 5 Illustration of the effect of N supply on the allometry between P uptake (a) and K uptake (b) and shoot mass for natural grasslands. This effect can be decomposed into two parts: (1) an increase in P or K uptake at a similar shootmass and (2) an increase in P and K uptake associated to the increment in shoot mass. Adapted from Duru et al. (1992)

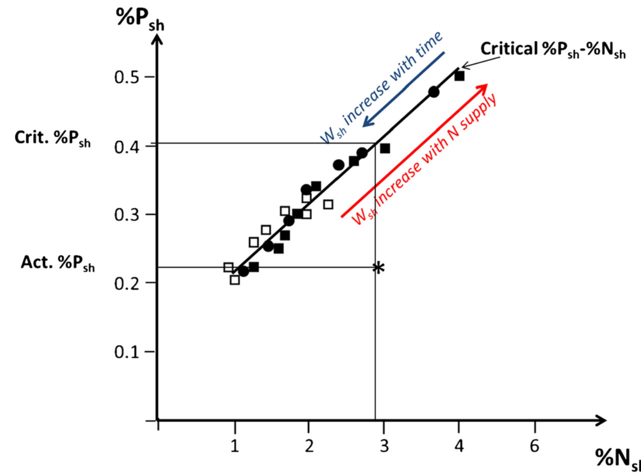

Fig. 6 Relationship between P and N concentrations in shoots (%Psh and %Nsh expressed in per cent of dry matter) for different natural grasslands in spring under non-limiting P supply conditions and having received different levels of N supply at the end of winter: white square no N application; black square100 kgN ha^{-1}; black circle 150 kgN ha^{-1}. The regression line [%Psh = (0.091 × %Nsh) + 0.133; $R^2 = 0.97$] represents the "critical %Psh." Variations in %Nsh are due to either (i) variation in shoot mass (Wsh) due to different N supplies and (ii) a N dilution effect associated to biomass accumulation with time. A P nutrition index (PNI) can then be calculated as PNI = (Act.%Psh)/(Crit.%Psh) for estimating the P nutrition level of a given crop. Adapted from Salette and Huché (1991)

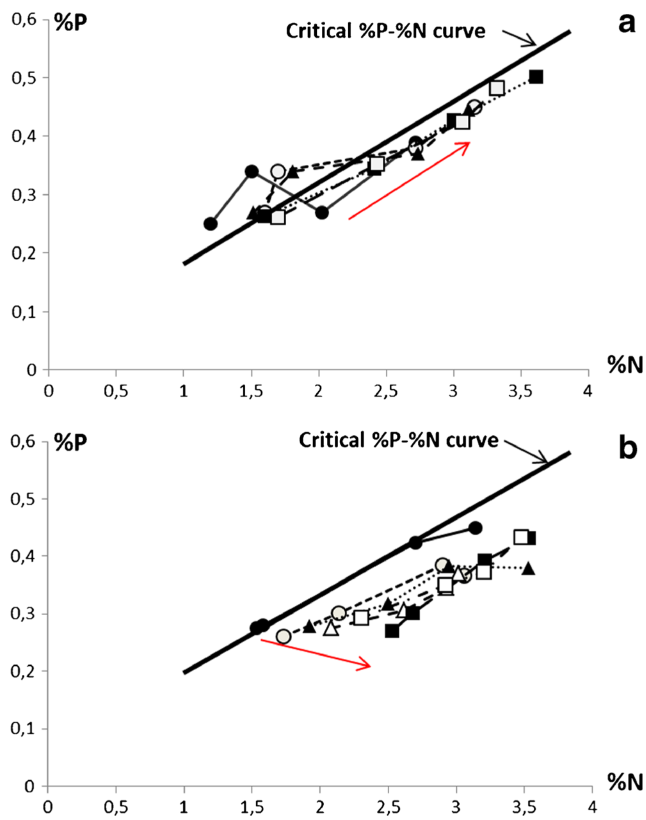

Fig. 7 Shift in the %P-%N relationship according to the N supply of a maize crop in conditions of high (a) or low (b) soil P availability in eastern Canada. The red arrow in a indicates the positive shift in both %P and %N as N supply increases, while the arrow in b indicates a negative shift in %P associated with a positive shift in %N. The N supply treatments were 0 (dark circles), 40 (open circles), 80 (dark triangles), 120 (open triangles), 160 (dark squares), and 200 kgN/ha (open squares). The critical %P-%N curve is $\%P = 0.107\%N + 0.094$ as determined by Ziadi et al. (2008a, b, c). Redrawn from Ziadi et al. (2008a, b, c)

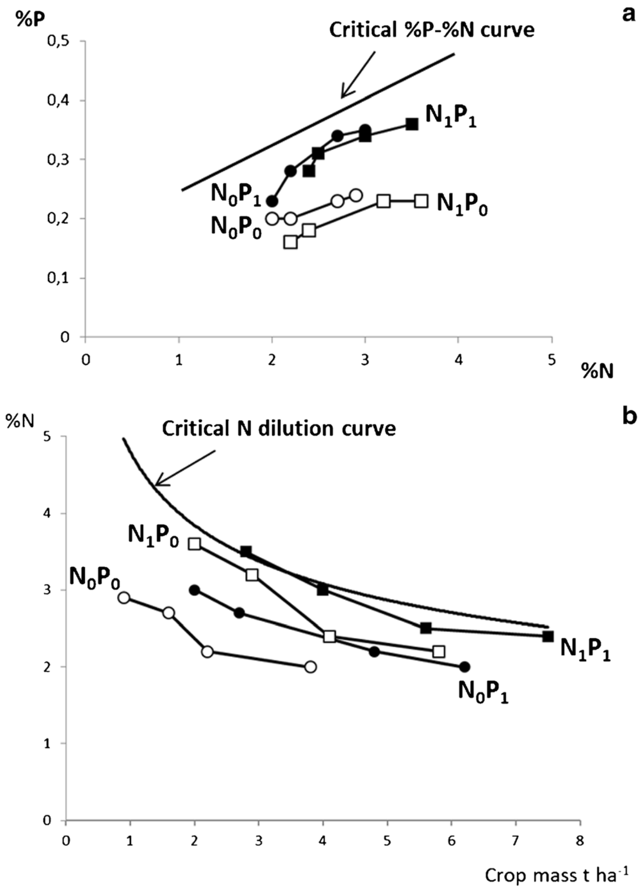

Fig. 8 Nitrogen–phosphorus interactions in natural grasslands receiving a factorial combination of high applications of N (squares) and P (dark symbols) and no application of N (circles) and P (open symbols). A Effects of the N and P supplies on shoot P and N concentration (P%, %N); the line represents the critical P concentration: %Pc = 0.065%Nc + 0.15 as determined by Duru and Thellier (1997). b Effects on the N and P supplies on shoot N concentration (N%); the line represents the critical N dilution curves for C3 grasses species (Lemaire and Gastal 1997). Adapted from Duru and Ducrocq (1997)