**- one important aspect that is not discussed at all and possibly overlooked in the resorption of nutrient along wood maturation / heartwood formation.**
**The authors explain that wood growth was assessed from girth increment (L163-165) and allometric equations (L249-256) and that the nutrient flux associated was computed by multiplying wood growth with tissue nutrient contents determined previously (Calvaruso et al. 2017 ; in the latter paper, no details are given regarding which wood depth was considered for determining tree nutrient contents).**
**Hence the current manuscript overlooks the fact that nutrient content decreases along the radial profile (see e.g. Penninckx et al. 2001), a pattern which probably relates to nutrient remobilization during wood ageing, even in Beech. This point, and the fact that the authors do not consider the wood remoblization flux, need clarification and clear argumentation.**

We agree that nutrient concentrations in woody tissues can vary along the radial profile due to nutrient remobilization. However, the nutrient concentrations from Calvaruso et al. (2017) were measured from wood samples accounting for the entire radial profile of stems and branches. Nutrient concentrations therefore represent average concentrations integrating the different wood ages and radial positions. Consequently, these values already incorporate the effects of nutrient redistribution associated with wood maturation and were not based on newly formed sapwood tissues.

In the present study, our objective was to estimate the net annual nutrient immobilization associated with wood biomass production rather than to quantify internal nutrient translocation processes within woody tissues. We have clarified this point in the Methods section to avoid any ambiguity : «*Stem and branches were considered as the aboveground perennial compartment, hereafter referred to as 'Wood'. Each year, biomass of stem wood, stem bark and branches in three diameter classes (<4, 4-7 and >7cm) was estimated for each tree using allometric equations based on measured DBH (Calvaruso et al., 2017). The total wood biomass was calculated by summing the biomass of these compartments. Annual wood production for each tree was then calculated as the difference in total wood biomass between two consecutive years. Wood production of each replicate (t.ha-1.yr-1) was calculated by summing the production of all trees and dividing it by the replicate area (2,500 m²), before conversion to a per-hectare basis.*

*Nutrient immobilization was estimated assuming constant nutrient concentrations throughout the study period, using compartment-specific concentrations measured in 2009 by Calvaruso et al. (2017). Briefly, stem wood, stem bark and branches from the three diameter classes were sampled from nine trees in each plot. Concentrations of K, Mg, N, P and S were determined for each compartment and*

*plot. Stem wood and branches samples included the entire woody tissue profile; therefore, the resulting nutrient concentrations represented average values across all radial positions. Annual nutrient immobilization in each compartment (kg.h-1.yr-1) was calculated by multiplying annual biomass production by the corresponding nutrient concentration. Finally, total annual nutrient immobilization in wood was obtained by summing the values for all compartments.*»

**- another point is related to the computation of NCB (i.e. the "nutrient content of aboveground biomass"). It's unclear to me and to my opinion misleading that NCB (nutrient amount required for biomass production) includes the resorption flux. I do agree this includes the canopy exchanges when positive (because this flux is lost by the aerial organs but has been part of them). In fact what would need to be measured is canopy green leaves content. Since the authors do not have this, they use a surrogate (= litterfall + resorption flux, which is about equal to green leaf content).... this is not easy to understand and must be clearly justified.**

We thank the reviewer for this comment, which highlights the need to clarify the calculation method of NCB. When we stated that nutrient stocks in green aboveground compartments could not be directly measured, we referred specifically to reproductive organs and other green tissues (e.g., green fruits and flowers), for which nutrient concentrations were available only after senescence through litterfall collections. In contrast, nutrient concentrations in leaves were measured both in their green and senesced form.

To estimate the nutrient content of annual aboveground biomass production (NCB), we reconstructed the nutrient pools of wood (=nutrient immobilization) and of green tissues (leaves, reproductive organs, and other tissues) from the measured nutrient fluxes.

- **For leaves**, this reconstruction relies on a mass balance approach: nutrients initially contained in green leaves before senescence are partitioned among (i) foliar resorption, (ii) litterfall, and (iii) canopy leaching. Consequently, foliar resorption is not an additional nutrient flux artificially added to the calculation, but represents the fraction of the initial green leaf nutrient pool that is retranslocated within the tree before leaf abscission.
- **For reproductive organs and other tissues**, we assumed that the nutrient content in their green form is fully accounted for by the combination of nutrient fluxes measured through canopy leaching and senesced biomass.

Therefore, NCB corresponds to the sum of nutrients contained in annual wood production and in the initial green aboveground tissues, the latter being reconstructed from the measured fluxes of

litterfall, canopy leaching, and foliar resorption. We have revised Section 2.4.7 to make this calculation and its definition clearer : « *The NCB was defined as the total amount of a nutrient (kg.ha-1) contained in the aboveground biomass produced during one year. Accordingly, it included nutrient contents in the different tree compartments (Eq.11.a): immobilization in Wood (Woodi), green leaves (Leafg), green Fruits (Fruitg) and other annual parts (buds scales, flowers ; Otherg). For some nutrients it also included foliar absorption (when canopy exchange < 0, mainly for N), and foliar accretion (when tree exchange < 0). Because nutrient stocks in the green compartments Fruitg and Otherg cannot be measured directly (i.e., only their senesced forms were sampled), NCB was quantified using Eq. (11.b) by summing the nutrient contents in Woodi, in litterfall (sum of senesced parts returning to the forest floor), in Foliar resorption (when tree exchange > 0) and in canopy leaching (when canopy exchange > 0):*

$$NCB = 〚Wood〛\_i + 〚Leaf〛\_g + 〚Fruit〛\_g + 〚Other〛\_g + Accretion + Absorption \quad (11.a)$$

$$= 〚Wood〛\_i + Litterfall + Resorption + Leaching \quad (11.b)$$

*This calculation assumed that the nutrient content of the green organs Leafg, Fruitg and Otherg was fully accounted for by the combination of nutrient fluxes measured via their senesced forms and canopy leaching.*»

**The overall production levels reported e.g. in Figure 2 are high to very high for temperate forests, but still plausible.**

Indeed, as mentionned a the end of 2.1. section, the productivity of the Montiers site corresponds to *« the highest beech yield classes in north-eastern France (Seynave et al., 2008)* »

**One central result is that during MY no trade-off is observed between fruit and wood production, even in the less fertile plot, which is different from what had been reported mostly in synthesis studies (Lebourgeois et al. 2018, Hacket-Pain et al. 2017) as ackwnowledged by the authors. What would be interesting here is to compare the nutritional and water status of trees at Montiers and on the sites considered in these studies, in order to evaluate whether this different behaviour is related to overall "better" nutritional and water status of Montiers plots.**

We agree that this type of comparison could provide valuable insights into the mechanisms underlying the absence of a growth–reproduction trade-off observed in our study. However, such a comparison is unfortunately beyond the scope of the present work. The synthesis studies cited (e.g., Lebourgeois et al., 2018; Hacket-Pain et al., 2017) compile results from numerous sites spanning a wide range of environmental conditions, but do not provide individual site-level information on tree

nutritional or water status that would allow a comparison with our study site. Moreover, because our work is based on a single, intensively monitored forest site, any comparison with aggregated results from these syntheses would remain speculative. We therefore preferred to restrict our interpretation to the mechanisms supported by our own dataset. However, we slightly modified the last sentence of the conclusion to highlight the need of multi-site studies to answer this question : «*To identify potential nutrient trade-off thresholds that may explain the regulatory effects of MY in some forest stands, future research should further investigate, at a multi-site scale, the NCB of N, K, P and Mg, together with the quantification of available nutrient resources (Rt + Rs) and water availability.*»

**Detailed responses to specific comments:**

**L43: Biological nitrogen fixation also contributes to N inputs. Please mention here.**

Thank you for pointing out this omission. We have included it in the revised manuscript : *« Finally, nutrient inputs to forest ecosystems can also occur through mineral weathering, atmospheric deposition or biological fixation (for N).»*

**Figure 1: nice plot. "Mineral weathering" does not apply to N, mention this in the figure caption. "Biological nitrogen fixation" applies to N, mention this also in the figure caption.**

We have revised both Figure 1 and its caption according to the reviewer suggestion.

**L54: I suggest replacing "exchanges and relationships" by "fluxes", if the authors agree.**

We agree with this suggestion as it is more concise and it preserves the meaning.

**L58-59: replace "individuals of the same species and the same stand" by "individuals of the same population".**

Rather than replacing *"individuals of the same species and the same stand"* with *"individuals of the same population"*, we revised the sentence to avoid specifying a particular spatial scale, as masting synchrony may occur from the stand to the regional scale : « *Mast events are the synchronized production of fruits and seeds among individuals of the same species at the stand level and even across broader spatial scales (Lebourgeois et al., 2018).*»

**L90: "Considering literature" is vague. Detail how the reference to literature led you to these specific hypotheses.**

As this sentence is part of the hypothesis section and the synthesis of the previous studies is already done in the previous paragraphs, we have replaced it with a more specific but concise formulation referring to the increased reproductive investment reported during mast years : « *Based on previously reported increases in reproductive investment during mast events, we expected total aboveground biomass production and NCB to increase during MY compared with NMY.*»

**L155: sampling leaves for nurtient content "in August" is imprecise, and possibly misleading. Which date exactly were condisered: the beginning of the month? the end of the month?. August is also relatively late to get fully mature leaves. Resorption has probably already started in August (e.g. Montpied et al. 2009), and this may particularly be the case in dry years.**

We agree that the wording "in August" was too imprecise. Leaf sampling was consistently performed in mid-August each year. This period was selected to ensure that leaves were fully expanded and physiologically mature, and it is consistent with the sampling period commonly used in foliar nutrition studies and monitoring networks for European beech and other temperate deciduous tree species (Borys et al., 2024; Jonard et al., 2009; Nussbaumer et al., 2021). We have clarified this point in the revised manuscript (section 2.2.2.) : « *Green leaves were sampled annually in mid-August by rifle shooting from five beech trees per plot.* »

**L164: was circumference measurement done at invariant position on the stem. State it.**

A permanent mark was established at 1.30 m on every tree to ensure consistent positioning of the measuring tape over the years. We have clarified this point in the revised manuscript (section 2.2.3.) : « *Measurements were performed every November at the end of the growing season, from 2011 to 2023, using a measuring tape and by two independent operators. A permanent mark at 1.30 m on each stem ensured consistent positioning of the measuring tape from year to year.*»

**L191: "in March of subsequent year": so there was absolutely no sapling between march and august ? (some, even if little material fall in between for sure).**

Indeed, litter was also collected in May (see section 2.2.2. : «*Six litter traps (0.34m² each) on each replicate were used to collect litterfall in March, May, August and five times from October to December each year.* ») , but fruit fall is negligible at this time of the year, as fruits have not yet developed. The purpose of this sentence was to clarify that litter collected during the March sampling originated from the previous growing season and were therefore assigned to the previous year's production. This point is particularly important during mast years, when delayed fruit fall can

represent a non-negligible fraction of the annual fruit production. We have revised the text to make this clearer and avoid any ambiguity (section 2.4.2.) : « *Annual biomass and nutrient fluxes (kg.ha-1.yr-1) were calculated as the sum of periodic fluxes from May to December of a given year, plus the fluxes measured in March of the following year which were assumed to correspond to delayed litterfall.* »

**Equation 2: isn't dry deposition (DD) a part of bulk deposition (BD)? Please clarify.**

Both terms refer to atmospheric deposition of dissolved elements (<0.45 µm), but they represent different components in our study. BD corresponds to the above-canopy deposition collected in solution using the flux tower collectors, whereas DD represents the atmospheric deposition intercepted by the canopy and was estimated using the canopy budget model described in Eq. 3 and Eq. 4. Therefore, in our approach, DD is not included in BD.

**Equation 3: how were SD_na and BD_na measured? (as well as SD and BD for the other nutrients)**

Na concentrations (SD_na and BD_na) were measured by ICP-OES analyses. Thank you for pointing out this omission. This information was added in the corrected manuscript (section2.3.) : « *Water samples were analysed for K, P, Mg, S and Na concentrations using inductively coupled plasma-atomic optical emission spectrometry (700 Series ICP-OES, Agilent Technologies). N concentration was quantified using a TOC analyser (TOC-L, Shimadzu). Na concentration was measured to allow the estimation of atmospheric deposition intercepted by the canopy using to a canopy budget model described in the following section 2.4. »* The Na ion is used as a tracer to determined the DD of the other nutrients, K and Mg (Eq.4). The DD is in fact an essential information for accurately calculate the canopy exchange (CE, Eq.5) of these elements.

In addition, BD and SD for each nutrient are calculated by multiplying measured concentrations with corresponding water volume (SD is the sum of throughfall and stemflow fluxes as mentionnend in (Eq.2). This explication was not clearly stated in 2.4.1 section, thus we clarified it in the corrected manuscript : « *The K, Mg, N, P, S and Na fluxes (kg.ha-1.period-1) in bulk deposition, throughfall and stemflow were obtained by multiplying the measured concentrations by the corresponding water fluxes (mm.period-1), followed by conversion to a per-hectare basis. Annual water and nutrient fluxes (mm.yr-1 and kg.ha-1.yr-1) were obtained by summing the periodic fluxes within the same calendar year.*»

**Equation 7: what do CE_SV1 (or CE_SV2) mean?**

CE_sv1 and CE_sv2 are two models used to estimate the correcting factor $f_{CE}$ (Eq.9) to accurately calculate the resorption flux $R_S$ (Eq.10) of each nutrient during the mast years. This correction is necessary to exclud the part of the canopy leaching related to fruits in the leaf resorption calculation.

**Table 2: what does "ecosystem" refer to here?**

The terme « ecosystem » was replaced by « plot » in the corrected manuscript.

**L290-291: Where do we see this (which figure)? Need to display the actual time series (e.g. as a suppl mat)!**

The definition of mast years were moved to the method section where it is more appropriate, see the end of section 2.1. : *«Over the 2012–2023 study period, four mast years (MY) occurred simultaneously across the three plots: 2014, 2016, 2020, and 2023. On the S1 and S2 plots, these MY could be further classified into two categories: (i) three full mast years (2016, 2020, and 2023), characterized by high fruit production, and (ii) one half-mast year (2014), characterized by substantially lower fruit production than the full mast years.»*

In addition, the year 2014 is systematically visually distinguished in the figures presented in the result section. For example, in the Figure 2.e. we can see the lower fruit production in 2014 (crossed circles) compared to the other full MY.

**Figure 6: replace the qualitative "sampling period" by a quantitative time indicator, in order to place the value in the season.**

We modified the Figure 6 and its caption by adding colored bars as visual indicators of the different season to make the message clearer.

**L381: "0< foliar leaching ; 0> foliar absorption" --> this is the opposite, right?**

Thank for pointing out this error, modifications were done in the corrected manuscript.

**L440: replace "thereby explaining" by "probably causing"**

We consider that the observed patterns, which are higher leaching during flowering period and senescence during MY and for several element systematically, provide sufficient evidence to discuss the mast event as an explanation rather than only as a possible hypothesis.

**L446-447: But do we see this anywhere ? No. Illustrate or mention as an hypothesis.**

The statement refers to seasonal patterns that were observed when analysing periodic fluxes, whereas the results presented in the manuscript focus on annual fluxes. We consider that presenting the seasonal dynamics of the "others" compartment (mainly composed of male flowers and bud scales) would substantially increase the complexity of the manuscript while providing limited additional information, as the spring production of these tissues is well established. Instead, to avoid any ambiguity, we clarified this point in the Results section as follows: : «*This compartment, mainly composed of male flowers and bud scales produced during spring* ***(periodical data not shown)****, showed a significant difference between MY and NMY, with an average production of 0.7±0.2 t·ha$^{-1}$·yr$^{-1}$ during MY which was 67% higher than during NMY (0.4±0.1 t·ha$^{-1}$·yr$^{-1}$).*»

We also clarified this seasonal pattern in the Discussion: «*Moreover, similarly to canopy leaching, litterfall nutrient fluxes during NMY occurred mainly during senescence, whereas during MY, substantial nutrient fluxes also occurred in spring through the "others" compartment, which was largely composed of male flowers (data not shown).*»

**L455: "a process that may be negatively affected by the fruit biomass during MY". Interesting but unclear, clarify.**

Clarification was done in the corrected manuscript : « *In addition, nutrient inputs via litterfall benefit trees only after the decomposition and mineralization of organic matter. However, during MY, the higher contribution of reproductive tissues to litterfall may modify decomposition dynamics (Brumme et al., 2021; Michaud et al., 2024).*»

**L485: probably because resorption fluxes are little affected and the fruit litter decomposes fast so that the nutrients are recycled rapidly and available as soon as the year after msting? Have you specifically looked at years after masting ? This would be interesting.**

Thank you for this interesting suggestion. During the data analysis phase, we specifically examined whether delayed effects could be detected in the year following mast events. However, no consistent pattern emerged from our dataset. In addition, our results do not support a direct effect of masting on foliar nutrient resorption, which remained largely unchanged between mast and non-mast years (Fig. 8). Regarding the hypothesis that rapid decomposition of fruit litter could enhance nutrient availability in the year following masting, this would involve belowground mineralization processes, which were not investigated in the present study and therefore remain beyond the scope of this work.

**Figure 9: about the figure design: I would put leaf_resorption and leaf_s close together because they are part of what would be the "green leaf content" that we would like to have.**

We agree that placing Leaf Resorption next to $Leaf_S$ would better reflect that both compartments contribute to the initial nutrient content of green leaves. However, we intentionally grouped Leaf Resorption, Canopy Leaching, and $Fruit_S$ at the top of the stacked bars to emphasize the importance of these three nutrient compartments in the quantification of NCB. We therefore chose to retain the original figure layout, as we believe it better highlights the main message of the figure.

**Minor comments (strictly copy editing):**

*L13: replace "an" by "a"*

*L106: there is an extra space in the web address*

*L150-151: precise "microbial processing of the organic matter"*

*L161: replace "before the grounding process" by "before being grinded"?*

*L219: "obtained"*

*L228: replace "modelize" by "model" or "simulate"*

*L262: "is quantified"*

*Table 2: "1|replicate": indicate this for each line of the table. Confuse*

*L286: replace "applied" by "mentioned"*

*L334: "Mellert"*

*L388: repetition of "during MY"*

*L455: why is "in the soil" crossed?*

*L506-507: "significant differences among ecosystems": is it in terms of wood production or fruit production?*

*Table 3: what do numbers between brackets represent?*

*L521: "reduced"*

*L550: what does "available" mean: is it "available to plants"? Precise it.*

*L553: parentheses missing: "(soil reserve + resorption)"*

*L563: rephrase to "Given that many worldwide forest ecosystems experience low P or K availability"*

*L574 "This pattern can be attributed to Montiers": rephrase to: "this pattern may be particular to our study site, where..."*

*L575: remove "C" --> "allocation" instead of "C allocation"*

*L578: "which increased by 46% (+9 kg.ha-1.yr-1) in MY" (add "in MY").*

*L585: rephrase to "In MY, a substantial..."*

The corrections and precisions were done according to all the comments above, to improve readability of the manuscript.