Response to referee #1

Below are the comments of the referee #1 in black and our responses in blue font and changes to manuscript *italicized and gray*.

Soil nutrients and stoichiometry is an important topic in forest ecosystems. The manuscript studied the relationships between understory vegetation species abundance in a boreal forest and soil /leaf nutrients. However, there are several major concerns about the statistical methods, the data presented in the figures and tables and shortage of basic information regarding the study site. Additionally, there are also grammatical issues and inappropriate descriptions of the results. The discussion cannot fully support their hypotheses and results.

Response: We thank anonymous referee #1 for the time they have spent revising our manuscript. We found the comments very helpful and sincerely appreciate all the detailed and concrete suggestions on how to proceed with the manuscript. As both referees brought up points about the role of tree species in soil nutrient content, we have added analyses and discussion about this topic in our manuscript.

Statistical analysis:
One-way ANOVA were chosen in the manuscript, it implies that the plot was the only factor. However, tree species plays an important role in soil nutrients as well, thus tree species should be considered as a confounding factor. Due to high spatial heterogeneity in soil samples, when you determine the difference in different plots, the block effects also should be considered in the statistical analysis.
Considering the relationships between species composition and soil nutrients, besides the species, the authors also should treat age classes as the second factor. For the same reason, soil layer also should be considered in the analysis.

Response: We agree with these comments. Unfortunately, we do not have exact knowledge of the age of the trees at each plot, as we did not core the trees. We know the approximate age of trees at plot A6 and have used this as help, when we now estimated the tree ages based on their dbh and put the trees in three different classes (young trees 1-9.9 cm, mid-aged 10-14.9 cm and old > 15 cm).We added information about the tree age classification to materials and methods. We tested the effect of dominant tree species, tree age, soil parent material/bedrock type, and soil horizon on soil P, N and C:N with linear mixed-effect models and have added the following description to section 2.4:

"*We tested the effects of environmental variables on soil P, N and C:N with linear mixed-effect models. We used dominant tree species, estimated tree age, rock parent material and soil horizon as fixed effects and plot as random effect. Soil P needed to be log-transformed while for N and C:N the visual inspection of residual plots did not reveal obvious deviations from homoscedasticity or normality. We obtained p-values for the fixed effects by likelihood ratio tests, where the full model with all the fixed effects was tested against model where each fixed effect was removed in turn. We used package lme 4 (Bates et al. 2015) in R programme 3.4.3 (R Development Core Team, 2017) for building the models. Pseudo R2-value for the models were calculated by using package r2glmm (Jaeger 2017)The models took the form:*

$$SC_{P,N,CN} = B_0 + B_{dt} + B_{ta} + B_g + B_h + \in, \quad (1)$$

where $SC_{P,N,CN}$ is the soil nutrient content (P, N or C:N ratio), B_0 denotes a fixed intercept parameter, B_{dt} denotes the fixed unknown parameters associated with the dominant tree species, B_{ta} denotes the fixed unknown parameters associated with the age of the dominant tree species, B_g denotes the fixed unknown parameters associated with the rock parent material, B_h denotes the fixed unknown parameters associated with soil horizon. The random effect $\in$ is assumed to take the form:

$$\in = \propto_p + u\,, \qquad (2)$$

where $\propto_p$ denotes the random parameters related with the research plot and u is an unobservable error term. Random-effect parameters and random-error term are assumed to follow normal distributions $\propto_p \sim N(0, \sigma_p^2)$ and $u \sim N(0, \sigma_u^2)$."

We made a new subsection for the results of mixed effect models under section 3 and added a table, which includes the fixed effects and their Chisq values, p-values and pseudoR2 values. To the appendices we added figures of the fitted vs. residuals, q-q plots and histograms of the residuals and removed the unnecessary tables of the previous one-way ANOVAs.

While we agree that the within-plot variation of soil element content is important, it could not be added to this same model, as the other factors were on the plot scale. We made box plots about the within plot variation of soil total P, N and C:N ratio.

In order to more precisely study the relationship of tree species and understory vegetation, we added the volume of birch per plot to the ordination and to Fig. 7d. We also added the cover (% of surface area) of species in the same species groups to the ordination and Fig. 7d.

Shortage of basic information: the authors provided the basic tree and other species composition in the Table 3. The tree age and biomass also affects the soil nutrients. The author should provide the mean basal area, leaf area index and mean DBH. These basic information would be useful to estimate the effects of tree species on the under-story species composition and on soil nutrients.

Response: Yes, we agree. We redid Table 3 so that it includes the following information in their own columns: plot, trees/ha, basal area, total volume of trees, volume of pine, volume of spruce, volume of birch, mean dbh of pine, mean dbh of spruce and mean dbh of birch. Unfortunately, we have no information of LAI.

As to the weather information, the min and max temperature should also be provided in Table 1.

Response: Agreed, we added the min and max temperature to Table 1.

Authors should add a new table/Figure to show the mean soil nutrients in the birch, scots pine and spruce plots in each layer and make stat analysis.

Response: We agree. We made such a table and did the statistical analysis related to that. We marked the stat. differences between tree species to the table. We added the following piece of text to section 2.4:

"*We grouped the plots based on their dominant tree species and calculated the means of soil nutrients and ratios in each soil horizon in pine, birch and spruce plots. We then compared the nutrient contents in each soil horizon with one-way ANOVA.*"

We also added explanation of the results of the ANOVA to section 3.1.

In Fig 5, there were no adj-R2 value to show which factor possessed the most weight. At the same time, these correlations could be better presented in Table not in fig.

Response: We corrected the unclear figure caption in Fig 5 to include the following information:

"In the figure positive correlations are displayed in blue and negative correlations in red color. Color intensity and the size of the circle are proportional to the correlation coefficients."

The confusing plot numbers in table A2/A3 /A4 and Table B2. In the Table A, the plot number was in alphabetical order while the Arabic number was adopted in table B2.

Response: We corrected the confusing and incorrect plot numbering in B2 to match the numbering in table A2/A3 /A4 and Table B2.

We cannot find the stats evidence support the data. For example: "Foliar N:P ratio did not show any differences in either species between plots.. . .. . .green leaves
compared to other species." (3.2)

Response: We changed this sentence to:

"We could not find statistical evidence for the between plot variation of foliar N:P ratio in either species."

In the results section, the first sentence in each sub section provides meaningless information for the data and these sentences can be deleted. For example: " The average contents. . .. . .. In fig 4" (3.1 soil element contents). The same was also found in each paragraph.

Response: Agreed, we deleted the sentences including meaningless information.

There were some grammatical issues in each paragraph. There was no deep discussion to support the hypotheses and results.

Response: We thank the referee for pointing out these issues. A native English speaker checks our revised manuscript before re-submission.
We have revised the discussion section based on the comments from both referees. We synthesized and shortened the part of text where we compare our total nutrient contents to previous studies as well as reorganized the sections so that the main results become clear in the first paragraph of the discussion section. We wrote more about the role of tree species in soil P content and highlight how and why our results are important and relate with the previous findings.