Effect of fertilisation with wood ash and nitrogen in a spruce stand on mineral soil

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INTRODUCTION

- The production of ash from wood has greatly increased the last years, because biofuels are increasingly being used for heating and energy production.
- The ash may either be viewed as a waste problem, or as a resource. Wood ash has a liming effect and contains essential nutrients (P, K, Ca, Mg) which can be exploited for soil fertilisation.
- Ash does not contain nitrogen, thus effects on tree growth on mineral soils after pure ash fertilisation are often small.
- However, studies have shown that on rich soils a positive growth effect may be found. Wood ash supplied together with nitrogen has also been shown to prolong the effect of nitrogen fertilisation.
- We studied the effect of fertilizing a Norway spruce (*Picea abies*) stand on relatively high site index in SE Norway with ash, nitrogen, or ash + nitrogen.

Fig. 1. The spruce stand in Hobøl, SE Norway, before fertilising.

MATERIALS AND METHODS

We set up a field trial[1] with spreading of wood ash and nitrogen fertiliser in a ca. 60 year old Norway spruce forest at Bærøe farm in Hobøl municipality, south-eastern Norway (latitude 59.56°N, longitude 10.95°E, altitude 200 m a.s.l.). The site index corresponded to a production capacity of 11 $m^3\ ha^{-1}\ year^{-1}$.

Treatment plot size was 25 m× 25 m, including a 5 m buffer zone. All sampling was carried out in the inner 15 m × 15 m area. Before treatment, all trees were measured and stem volume per treatment plot was calculated. On average, standing volume was 302 $m^3\ ha^{-1}$.

Spring 2013, four treatments were applied in three blocks:

- ASH: 3 t ha^{-1} ash
- N: 150 kg ha^{-1} ammonium nitrate fertiliser
- ASH+N: 3 t ha^{-1} ash + 150 kg ha^{-1} N
- CONTROL: unfertilised control

Fig. 2. Self-hardened wood ash used in the experiment.

After five growing seasons in autumn 2017, all trees were remeasured, and increment cores were taken.

The effect of fertilisation on current annual increment (CAI) and standing volume was tested with an analysis of variance. Standing volume in 2013 was used as a covariate.

The annual growth of the year rings was calibrated against the growth 5 years prior to 2013 to adjust for differences in growth before treatment.

Fig.3. Taking increment cores five years after fertilisation.

RESULTS

After five years, both current annual increment (CAI) and standing volume was best in the ASH + N treatment and least in the Control plots. The ASH+N treatment was significantly different from both the Control and the ASH treatment for annual increment (Fig. 4) as well as for the standing volume.

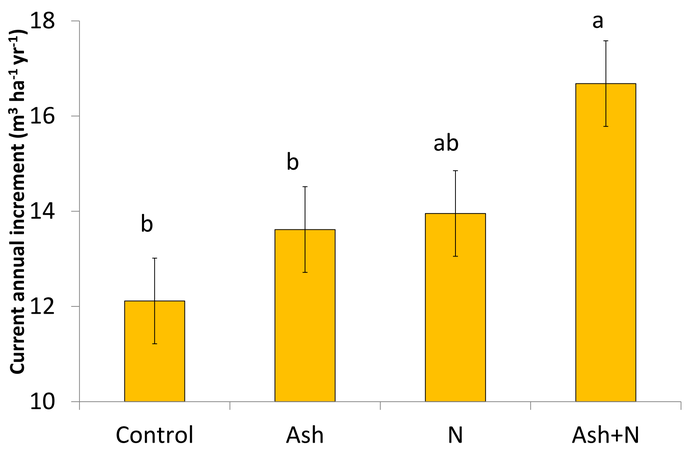

Fig. 4. Mean values for annual increment 2013-2017, adjusted for initial volumes before treatments in 2013. ± 1 std.error. Different letters indicate significant differences ($p<0.05$) between treatments.

The increment cores (Fig. 5) showed that N gave a small positive effect which seemed to be diminishing after only 4-5 years. The ASH + N treatment, on the other hand, showed an increasing growth trend throughout the period.

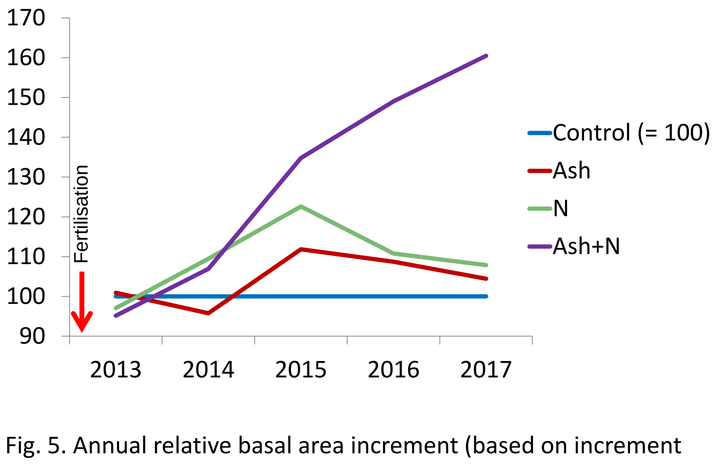

Fig. 5. Annual relative basal area increment (based on increment cores) for the different treatments in relation to Control plots.

DISCUSSION

- Our study showed that the application of wood ash together with nitrogen may have a positive effect on the growth of mature Norway spruce on high site indices.
- Addition of either N or wood ash alone rendered smaller, non-significant growth effects.
- The recirculation of wood ash may become increasingly important as a more intensive use of forest biomass (e.g. branches, tops, roots) for bioenergy will lead to increased export of nutrients from forest ecosystems.
- Several studies have shown increased microbial activity in the soil after application of wood ash, and there are indications of slight positive effects on net N mineralization in the organic layer in some coniferous stands[2].
- As long as N is the growth-limiting nutrient, addition of other nutrients will not increase growth. At poor sites, even negative effects of ash addition have been found. However, adding ash together with N could ensure that the nutrient balance is maintained.
- In Norway, spreading of ash in the forest is not allowed, because the relevant regulation does not define forest as one of the land use types that can be fertilised by ash[3]. This regulation is currently under revision.

CONCLUSION

- With enhanced knowledge about where and how wood ash addition may increase forest growth - without having negative effects on the environment - wood ash may go from being a waste problem to being a renewable nutrient source.
- Our study in a Norway spruce stand on relatively high site index shows highest growth increment of adding both wood ash and nitrogen.
- The field trial should be followed for a longer period of time, as the ASH + N treatment still shows an increasing growth trend after five years.

REFERENCES

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