Characteristics of Defense Chemicals of Mountain Alder Seedlings Raised under Elevated CO_2 and Nitrogen Supply

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Mountain Alder (*Alnus hirsuta*)

- 典型的な遷移初期種
- 窒素を葉に多く含む(根粒形成菌である*Frankia* sp.と共生)
  →虫にとってよりいい餌となる

- Common early successional tree species
- High leaf nitrogen content
  (symbiosis with the actinomycete *Frankia* sp.)
  →high food quality of leaves

Atmospheric environments

- 二酸化炭素濃度の上昇
- 窒素沈着量の増加　→　土壌環境の変化

- Atmospheric CO_2 is increasing
- Greater atmospheric nitrogen deposition
  → soil fertility also changes

- 本実験では、二酸化炭素と土壌の肥沃度の組み合わせを変えて実験を行い、それらがケヤマハンノキの実生の防御能にどう影響するのかについて調べる。
- 防御能力の評価の指標として、エリサンの生存日数を用いた生物検定を行う。

- In this study , we ask what would be the effect on defense capacity of alder seedlings from different combinations of CO_2 enrichment and soil fertility.
- Carry out bioassay with Erisan in order to evaluate the degree of defense in alder leaves

Materials

- 二年生のケヤマハンノキ
- 5Lのポットに鹿沼土と粘土質土を体積比２：１で混合
- 高CO2と大気CO2、富栄養土壌と貧栄養土壌

- Individual two-year-old seedlings of mountain alder
- 5 liter pots filed with Kanuma pumices soil and clay soil (2:1 in volume)
- High CO2 (72Pa) and Atmospheric CO2 (36Pa)
- Fertile (fertilize at once a week) and Infertile(once a month)

Results＆Discussion

- エリサン全個体がサナギになる前に死亡

(ケヤマハンノキは他の樹木より葉に含まれる縮合タンニン量が少ない)

- All individuals(Erisan) were dead before they reached the pupa

(alder leaves have less condensed tannin than other tree species)

- サナギになるために必要な要素がケヤマハンノキ葉内に不足
- ケヤマハンノキ葉内に含まれる物質がエリサン幼虫の成長阻害。
- Some essential elements in alder leaves to develop into pupa were insufficient.
- Harmful chemicals in alder interfered with larvae development

Results & Discussion

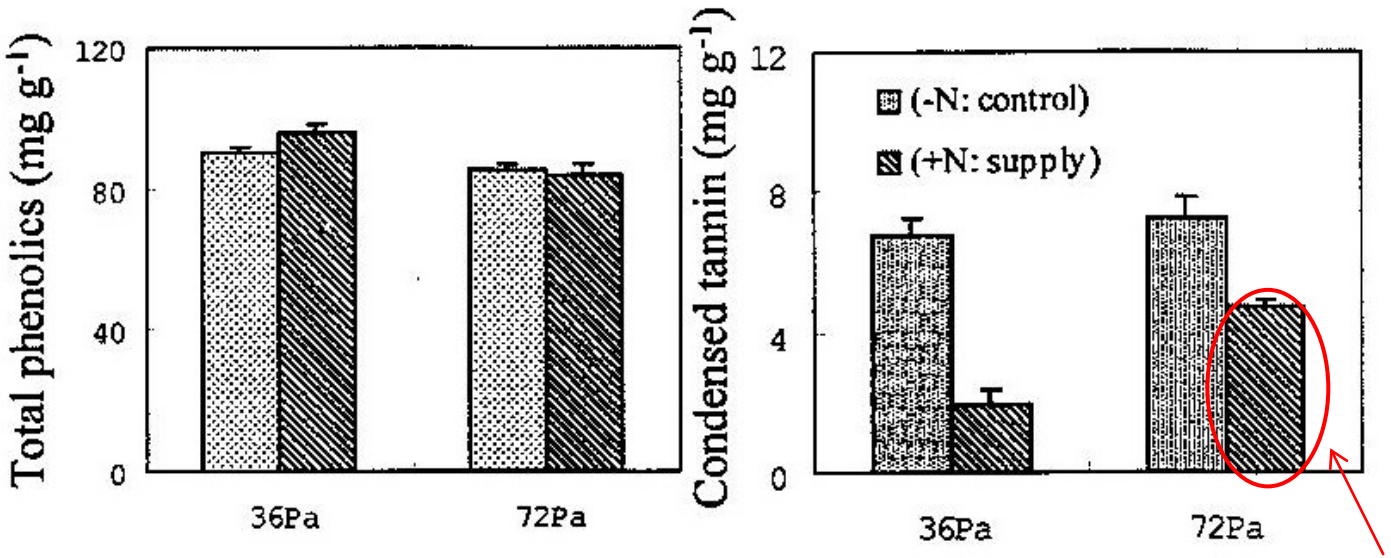

Fig. 2. Concentration of defense chemicals (total phenolics and condensed tannin) of alder leaves raised under two levels of CO_2 and nutrient. Statistical test of the treatment effects of total phenolics is: CO_2^{***}, N-Supply***, CO_2 x N-Supply***; that for condensed tannin is: CO_2^{***}, N-Supply ns, CO_2 x N-Supply*, where *** is $p<0.001$, * is $p<0.05$ and ns is not significant.

Results＆Discussion

- Longevity of Erisan

Opposite to CNB hypothesis

long

short

Atmospheric CO2 + infertile soil(大気CO2＋貧栄養)

Atmospheric CO2 + fertile soil(大気CO2＋富栄養)

High CO2 + infertile soil(高CO2＋貧栄養)

High CO2 + fertile soil(高CO2＋富栄養)

- 葉のLMAはどの区も同等の値になった。

  →化学的防御が物理的防御に比べ大きく作用した。

- LMA showed a similar value of 3.5mg/cm2

  →chemical defense is more important than physical defense

Results＆Discussion

- 共生菌が高CO2環境において、貧栄養条件で活発になる。
- 貧栄養、富栄養どちらも葉の含有窒素濃度は大差がなかった。

高CO2環境において、共生菌による働きが窒素分の不足を補う形で作用する。

- Activities of the symbiotic *Frankia* sp. is accelerated by infertile soil in high CO2.
- No difference in leaf nitrogen concentration between fertile soil and infertile soil.

In carbon-rich environment , the enhanced activity of *Frankia* sp. compensate for the deficiency in nitrogen.

Results & Discussion

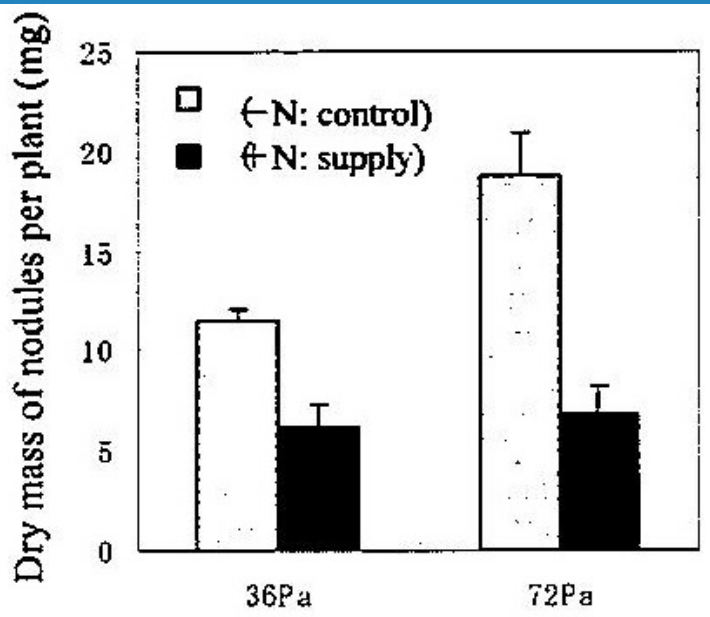

Fig. 3. Nodule formation of alder seedlings grown under the two levels of CO_2 and nutrient. Statistical test of the treatment effects of dry mass of nodules per plant is: CO_2***, N-Supply***, CO_2 x N-Supply*, where * is $p<0.05$ and *** is $p<0.001$.

Results＆Discussion

- 純光合成速度が高CO2 環境で比較したとき、貧栄養の方が富栄養よりわずかに遅くなった。

- The net photosynthetic rate was slightly lower in high CO2 and infertile soil than in high CO2 and fertile soil.

Conclusion

- 共生菌の働きによって貧栄養土壌においても不足分窒素が補充されるが、光合成産物を共生菌に与える分、炭素由来の防御物質を生成しにくいため、富栄養の方が高い防御能を獲得した。
- Although an accelerated activity of *Frankia* sp. in alder can mitigate a lack of plant nitrogen in high CO2 and infertile soil environment , the cost in photosynthates to *Frankia* probably reduced the alder's carbon-based defense capacity.