Title: Elevated CO_2 Accelerates Depletion of Phosphorus by Common Bean (*Phaseolus vulgaris*) in association with Altered Leaf Biochemical Properties

Author: Zhong MA, Jennifer FLYNN, Grant LIBRA, Zechuan SHI

PII: S1002-0160(17)60420-X
DOI: S1002-0160(17)60420-X
Reference: NA

To appear in:

Received date: NA
Revised date: NA
Accepted date: NA

Please cite this article as: Zhong MA, Jennifer FLYNN, Grant LIBRA, Zechuan SHI, Elevated CO_2 Accelerates Depletion of Phosphorus by Common Bean (*Phaseolus vulgaris*) in association with Altered Leaf Biochemical Properties, *Pedosphere* (2017), S1002-0160(17)60420-X.

PEDOSPHERE

Pedosphere ISSN 1002-0160/CN 32-1315/P doi:10.1016/S1002-0160(17)60420-X

Elevated CO_2 Accelerates Depletion of Phosphorus by Common Bean (*Phaseolus vulgaris*) in association with Altered Leaf Biochemical Properties

Zhong MA, Jennifer FLYNN, Grant LIBRA, Zechuan SHI

Department of Biology, Truman State University, Kirksville, MO 63501, USA

ABSTRACT

Phosphorus (P) is a major limiting factor for plant productivity in many ecosystems and agriculture. The projected increase in atmospheric CO_2 is likely to result in changes in plant mineral consumption and growth. We studied phosphorus depletion by common bean plants cultured hydroponically under ambient (377 ± 77 μmol mol^{-1}) or elevated (650 ± 32 μmol mol^{-1}) CO_2, in media of low or high phosphorus. Compared to ambient CO_2 environment, under elevated CO_2: 1) maximum phosphorus depletion rate increased by 98% at low phosphorus and 250% at high phosphorus, and phosphorus was depleted about 2 to 5 weeks sooner; 2) leaf acid phosphatase (APase) activity and leaf chlorophyll content both increased significantly; 3) root-to-shoot ratio increased significantly at high phosphorus, although it was unaffected at low phosphorus; 4) lateral root respiration rate had no change, suggesting that CO_2 did not affect phosphorus depletion via metabolic changes to the roots; 5) total biomass at final harvest was significantly higher at both low- and high- phosphorus. Our data show that the increased rate and amount of phosphorus depletion during growth under elevated CO_2 occurred in association with alteration in leaf biochemical properties, i.e., enhanced activities of leaf APase and increased leaf chlorophyll content.

*Key words***:** phosphorus depletion, elevated CO_2, dry matter accumulation, biomass partitioning.

INTRODUCTION

Plant growth is dependent on below- and above-ground resources including water, mineral nutrients, light, and CO_2. The concentration of CO_2 in the Earth's atmosphere was below 300 μg g^{-1} prior to the Industrial Revolution of the late 18th to 19th centuries. Since then, increased use of fossil fuels has led to the present level of CO_2 close to 400 μg g^{-1}, and it is predicted to reach about 1000 μg g^{-1} by the end of this century and nearly 2000 μg g^{-1} by the end of the next century (Change, 2013). The projected rise in atmospheric CO_2 could result in higher rate of photosynthesis and increased plant productivity. In a CO_2 enriched environment with adequate water, nutrients, and a lack of pests or disease, both C3 and C4 plants have been found to respond positively (De Souza *et al.*, 2008; Clark *et al.*, 2010). Such responses include faster development, greater biomass, and higher yield due to increased photosynthesis and