Short-term Effects of Diverse Crops on Soil Condition

Research Results

2000 and 2001 cropping seasons

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Rationale

- Decreasing commodity prices have resulted in a shift in acreage from cereals to alternative crops in the Northern Great Plains.
- Understanding the effects of alternative crops on soil condition is essential to develop sustainable cropping systems.
- Crop effects on surface soil condition, in particular, are vitally important given the impact the soil surface has on erosion control, water infiltration, and nutrient conservation.

Objective and Hypothesis

- The objective of this study was to determine short-term effects of 10 crops on dynamic indicators of soil condition for a crop x crop-residue matrix experiment in the Northern Great Plains.
- Crops belonging to the same botanic family were hypothesized to affect soil condition more similarly than crops belonging to different botanic families.

Approach

- Soil samples were collected in April of 2000 and 2001 prior to planting spring wheat in plots where the same crop was planted the previous two years.
- Samples were collected from two depths, 0-7.5 and 7.5-30.0 cm.

Approach

- Samples were analyzed for physical, chemical, and biological properties considered to be sensitive to short-term changes in management.
- Results were analyzed with crops grouped within botanic families (grass, mustard, taproot, linum, legume) as well as individually.

Results

Summary

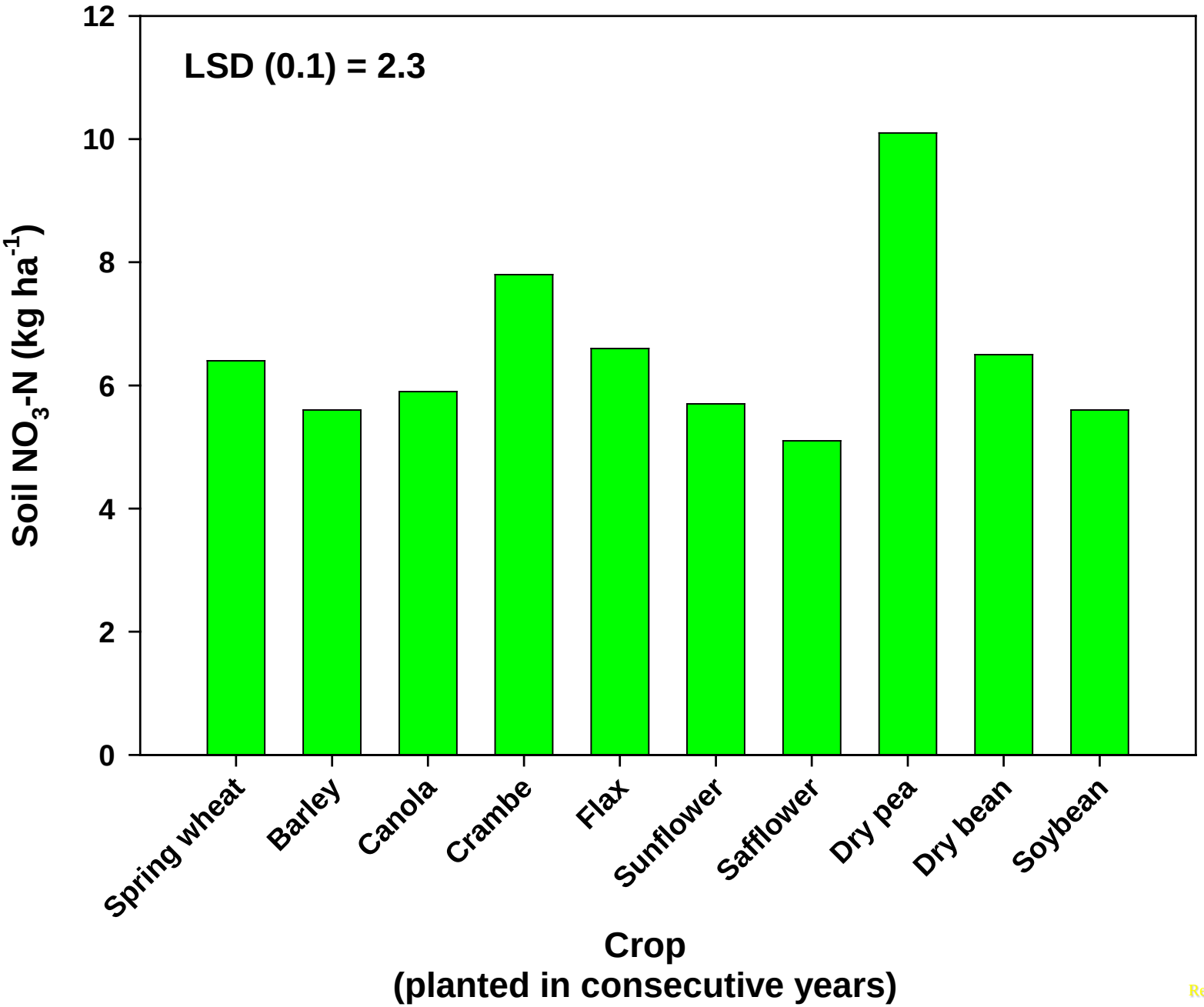
- Crop effects on soil were limited to the 0-7.5 cm depth.
- When crops were grouped by crop type, total glomalin was 23% greater in linum (flax) than legume (dry pea, dry bean, soybean). No other differences in soil properties were observed among crop types.
- Only soil nitrate, soil pH, microbial biomass, and glomalin were affected when crops were analyzed individually.

Results

Soil Nitrate

- Nitrogen is a key element in plant growth.
- Soil nitrate is an anion (NO_3^-). In this form, it is most readily taken up by plants, but also easily lost by leaching.
- Maintaining an adequate supply of nitrogen for plant needs while minimizing environmental risk requires knowledge of plant nitrogen uptake patterns.

CROP EFFECT ON SOIL NITRATE



Results Soil Nitrate Graph

Results

Soil Nitrate

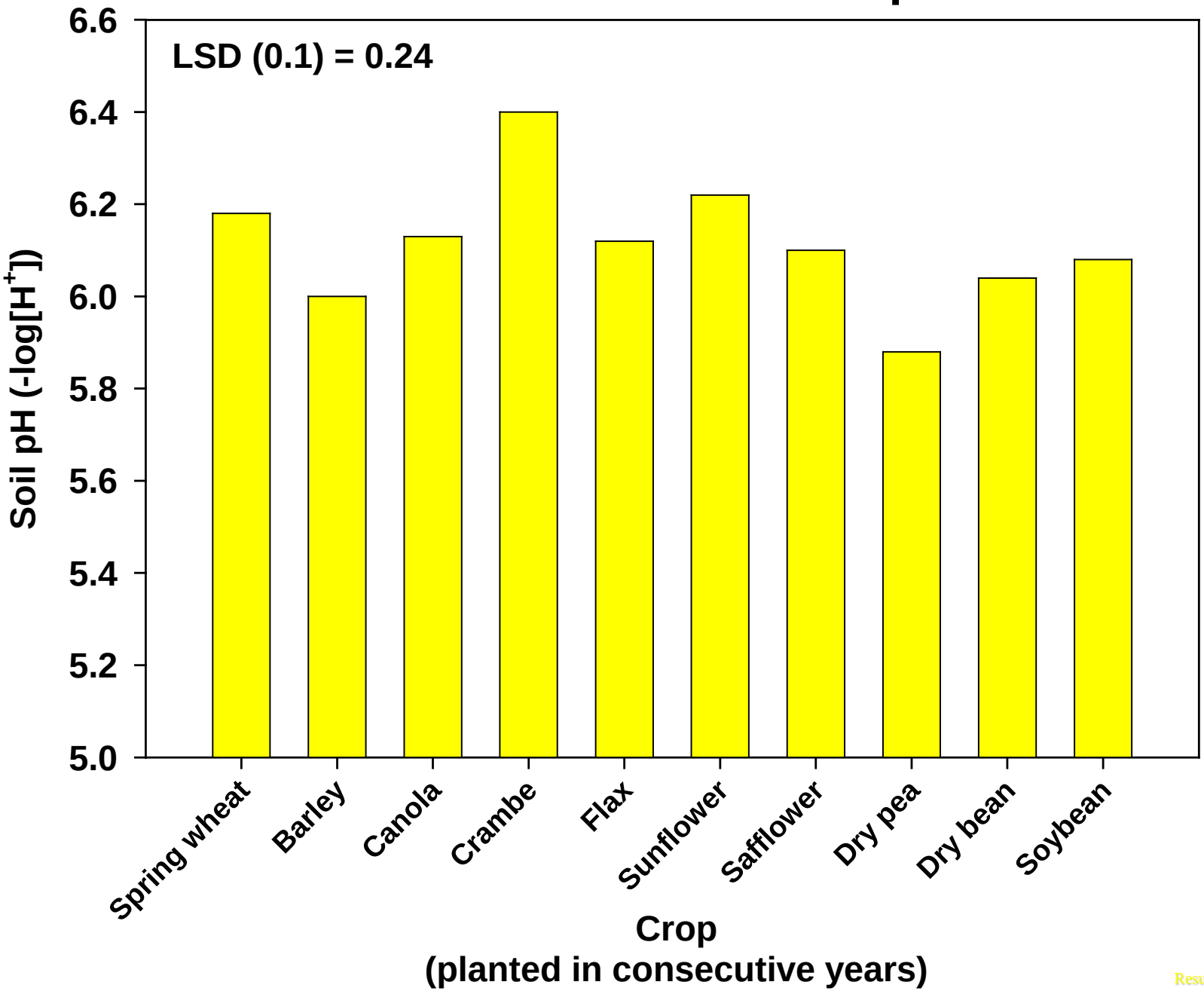
- Dry pea tended to enhance soil nitrate levels in comparison to other crops.
- Nitrogen rotation benefits from dry pea are well documented.
- In the crop by crop-residue matrix experiment, spring wheat yield was 10% greater in plots following dry pea than in plots following wheat.

Results

Soil pH

- Soil pH is a measure of the acidity or alkalinity of the soil solution.
- Because pH is a logarithmic function, a pH of 5.0 is 10 times more acid than a pH of 6.0, and 100 times more acid than a pH of 7.0.
- In general, pH values between 6.0 and 7.5 are optimal for crop growth.

CROP EFFECT ON SOIL pH



Results Soil pH Graph

Results

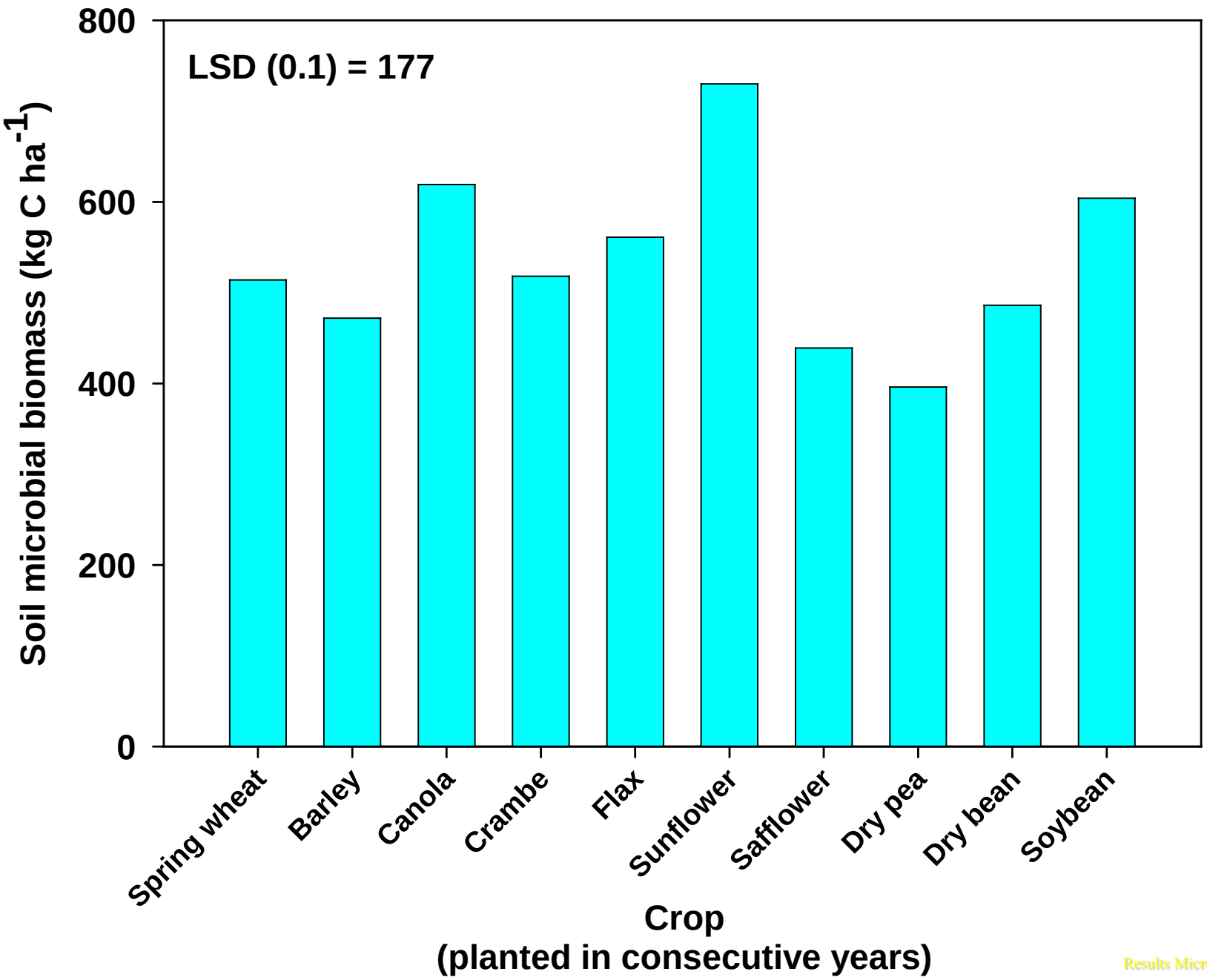
Soil pH

- Soil pH varied little among crops, ranging from 5.9 to 6.4.
- Soil pH was greatest in crambe, and lowest in dry pea.
- The relatively low soil pH in dry pea may have been caused by greater nitrogen mineralization and subsequent nitrate loss from the surface depth.

Results

Microbial Biomass

- Microbial biomass is the living component of soil organic matter (e.g., bacteria, actinomycetes, fungi, etc.).
- Microbial biomass is involved in nutrient transformations and storage.
- In agricultural systems that rely on internal sources of nutrients, microbial biomass supplies nutrients to plants.


CROP EFFECT ON MICROBIAL BIOMASS
LSD (0.1) = 177
Soil microbial biomass (kg C ha-1)
800
600
400
200
0
Spring wheat
Barley
Canola
Crambe
Flax
Sunflower
Safflower
Dry pea
Dry bean
Soybean
Crop
(planted in consecutive years)

Results

Microbial Biomass

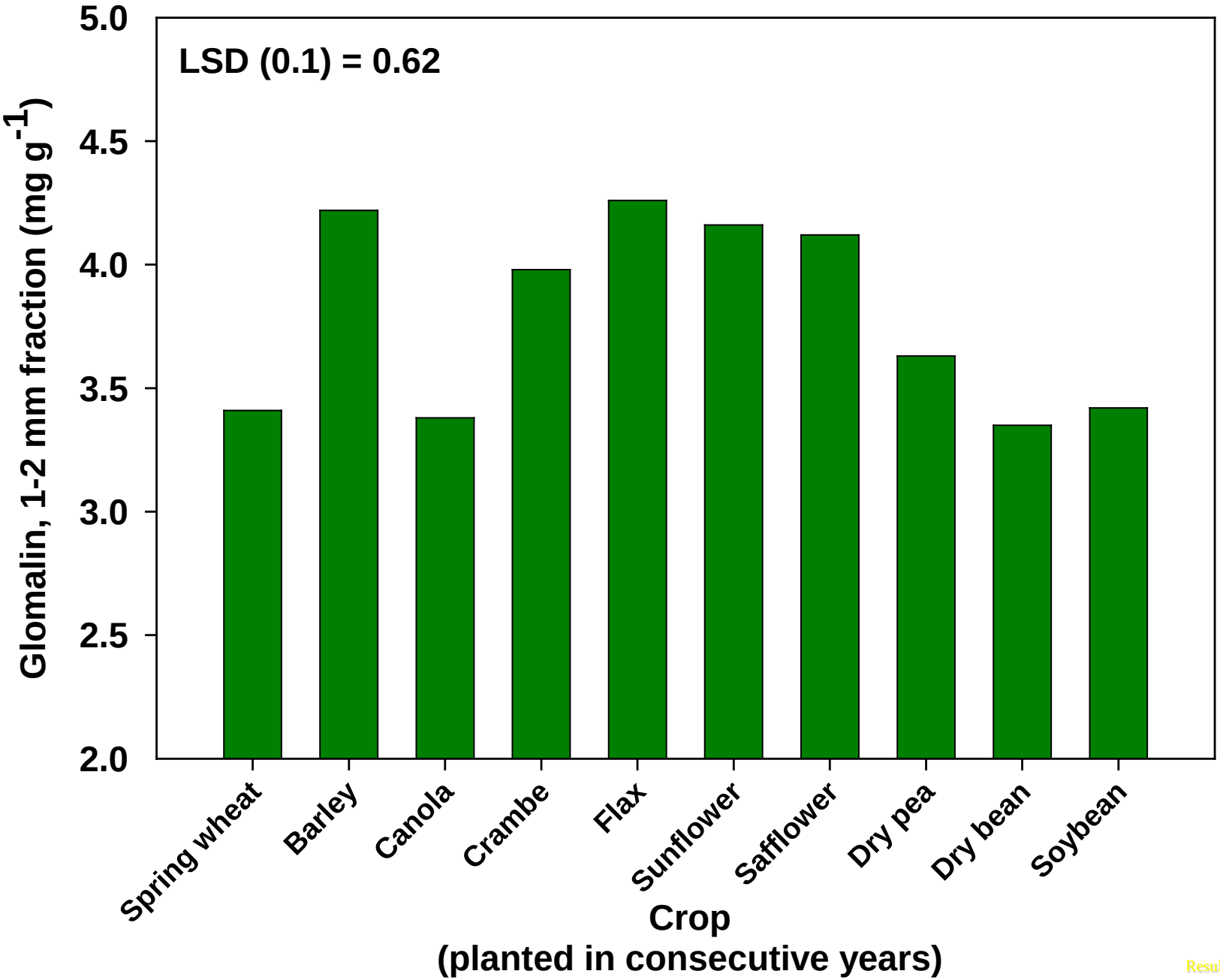
- Microbial biomass carbon varied greatly among crops, ranging from 396 to 730 kg ha^{-1} for the 0-7.5 cm depth.
- Microbial biomass carbon was greatest in sunflower and lowest in dry pea.
- Carbon contained in microbial biomass represents stored energy for biological activity.

Results

Glomalin

- Glomalin is a glycoprotein produced by arbuscular mycorrhizal fungi.
- Glomalin acts like a glue that holds soil particles together.
- One benefit of glomalin is increased aggregate stability, leading to better soil structure and improved air and water transfer through the soil.

CROP EFFECT ON GLOMALIN



Results Glomalin Graph

Results

Glomalin

- Barley and flax possessed higher levels of glomalin as compared to other crops across multiple aggregate-size fractions.
- Easily extractable glomalin, representative of recently deposited glomalin, was greatest in barley and lowest in spring wheat (data not shown).
- Glomalin was not correlated with aggregate stability.

Conclusions

- Given the short time-frame of the study, few of the measured soil properties were affected by crop.
- Assessment of crop effects on soil condition require additional time to ensure trends are constant and not ephemeral.