

# The Nutrient Contribution of Pulse Crops to Next Year's Crop



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# Why Important?

- Want to maintain soil fertility as efficiently, effectively as possible.
- Fertilizer is \$\$ input.
- All aspects: product price and production, input costs, risks need to be considered in crop rotation planning.
- **Pulse Crops:** Pea, Lentil, Chickpea are an **important** part of the picture!



# Outline

1. Pulse Crops and Their Contribution to Nitrogen (N) Fertility
2. Effects of Pulses on Phosphorus (P) Availability

# Pulse Crops and Their Contribution to Soil Nitrogen Fertility:

IT ALL STARTS HERE!



**Nodules** that form on legume roots containing superior strains of N fixing bacteria **fix N** for **legume crop** and contribute to N nutrition of following crop

# How Much Nitrogen is Derived From the Air and Converted Into Plant N By a Pulse Crop?

- Variable: Different ways to measure give different numbers

**BUT A SIGNIFICANT CONTRIBUTION!**

***~ 70% to 80% of N in Pulse comes from atmosphere via biological fixation in nodule***

## Amount of N fixed

lbs N / acre

<b>Alfalfa</b>	<b>100 - 250</b>
<b>Pea</b>	<b>50 - 200</b>
<b>Lentil</b>	<b>30 - 150</b>
<b>Chickpea</b>	<b>20 - 120</b>
<b>Dry Bean</b>	<b>5 - 70</b>

- Significant \$ Value
- Actual amount depends on inoculation/nodulation, environmental conditions, soil available N and other nutrients like P.

# What is Nitrogen Contribution of the Pulse to a Following Crop?

- Significant, but not typically huge if the seed is harvested and removed.



**Seed contains about 70% of N in a mature pulse crop. When harvested, not a lot left behind.**

## **Example:**

100 lbs fixed N/acre in 35 bu/ac pea crop:

Pea harvest takes 70 lbs fixed N/acre off field,  
leaving only about 30 lbs fixed N/acre behind.

**Benefit:** The total amount of N in seed harvested (soil + fixation) just about equal to amount of N fixed from atmosphere.

**N in harvested pulse seed obtained for “free” from fixation**



*In non-legume, this N has to come from soil and fertilizer*



But what about next year's crop?  
*Where does the **N benefit** come from?*

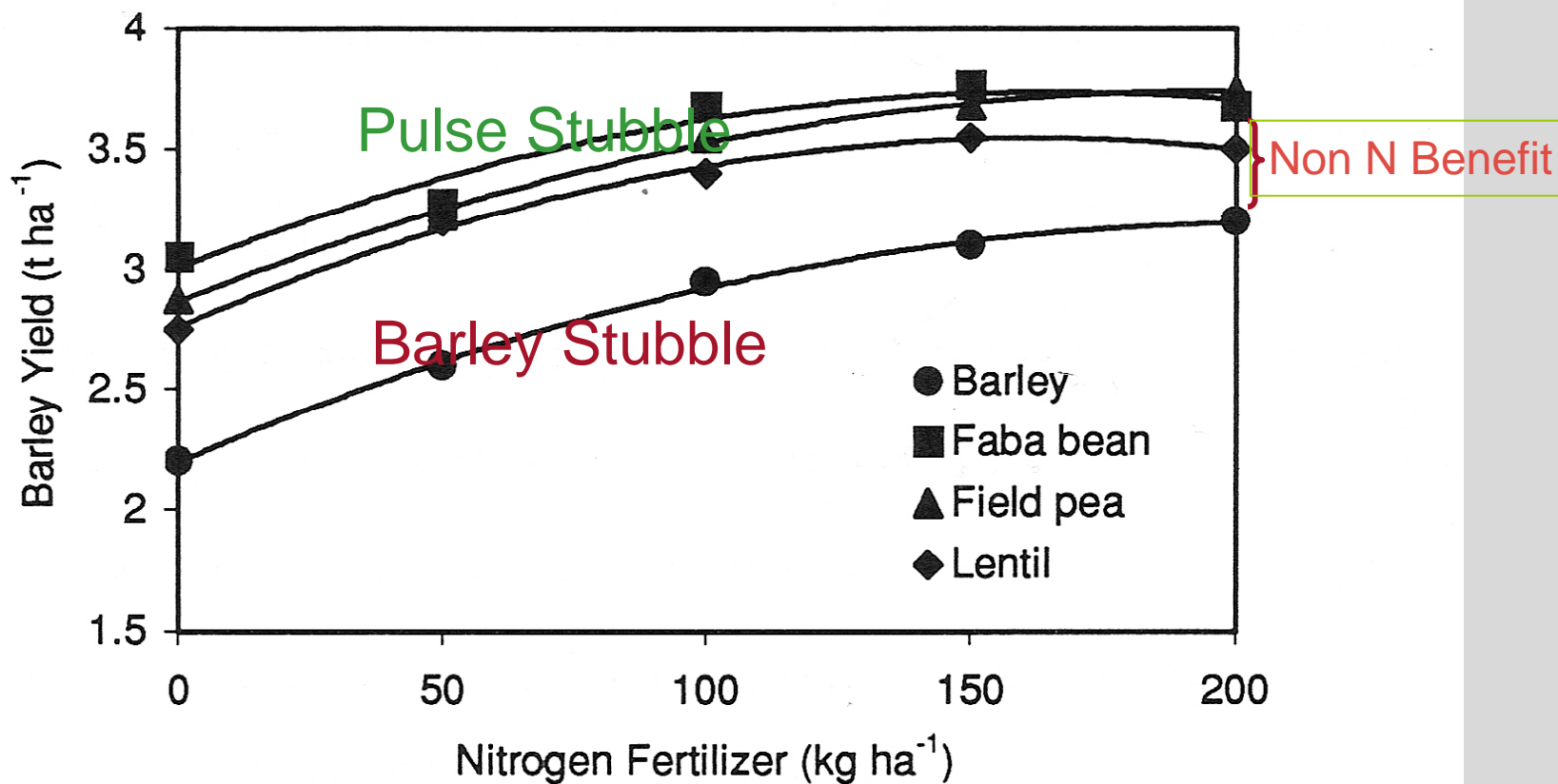
## **BENEFITS FROM PULSES IN ROTATION**

### 1. NON-N Benefit

- break pest cycles
- improve soil tilth
- soil moisture utilization
- promote beneficial soil biological activity : AM fungi, PGPR
- promote uptake of other nutrients



## Barley Yield Response to Added N Fertilizer



From Wright 1990 at Melfort SK

# **Nitrogen Benefits to Following Crop**

## **N Fertilizer Replacement Value (Total N Benefit)**

*How much extra fertilizer N needs to be added to bring yield of non legume crop on its own or some other non legume stubble to same yield as crop grown on pulse stubble.*

***What you are saving by growing a pulse the year before versus some other non-legume.***

# N fertilizer replacement value

- Variable estimates!

Depends on what you are comparing to.

***For wheat***

**20                      to                      100 lbs N / acre**

pea vs. canola stubble

pea vs. wheat stubble

# Direct N Benefit

- Nitrogen derived specifically from the pulse crop is made available to a following crop by microbial decomposition of surface residues, roots, old nodules.
- May already be happening after harvest and in early spring, shows up in soil test.

Soil conditions following different crops  
over five years at Scott, SK (Brandt, 1996)

<b>Previous Crop</b>	<b>Spring Soil Moisture</b> <i>mm</i>	<b>Spring Available N</b> <i>kg/ha</i>
Fallow	110	72
Field Pea	87	42
Lentil	86	45
Wheat	77	34

- **Release of available N also takes place during the growing season:** affected by many factors, difficult to predict.

*Example: N credit of 20 lbs N/acre for every 40 bu/ac of pea yield (Beckie et al. 1997)*

*1 lb N /ac for every bu/ac of pea yield (McKenzie, 2008)*

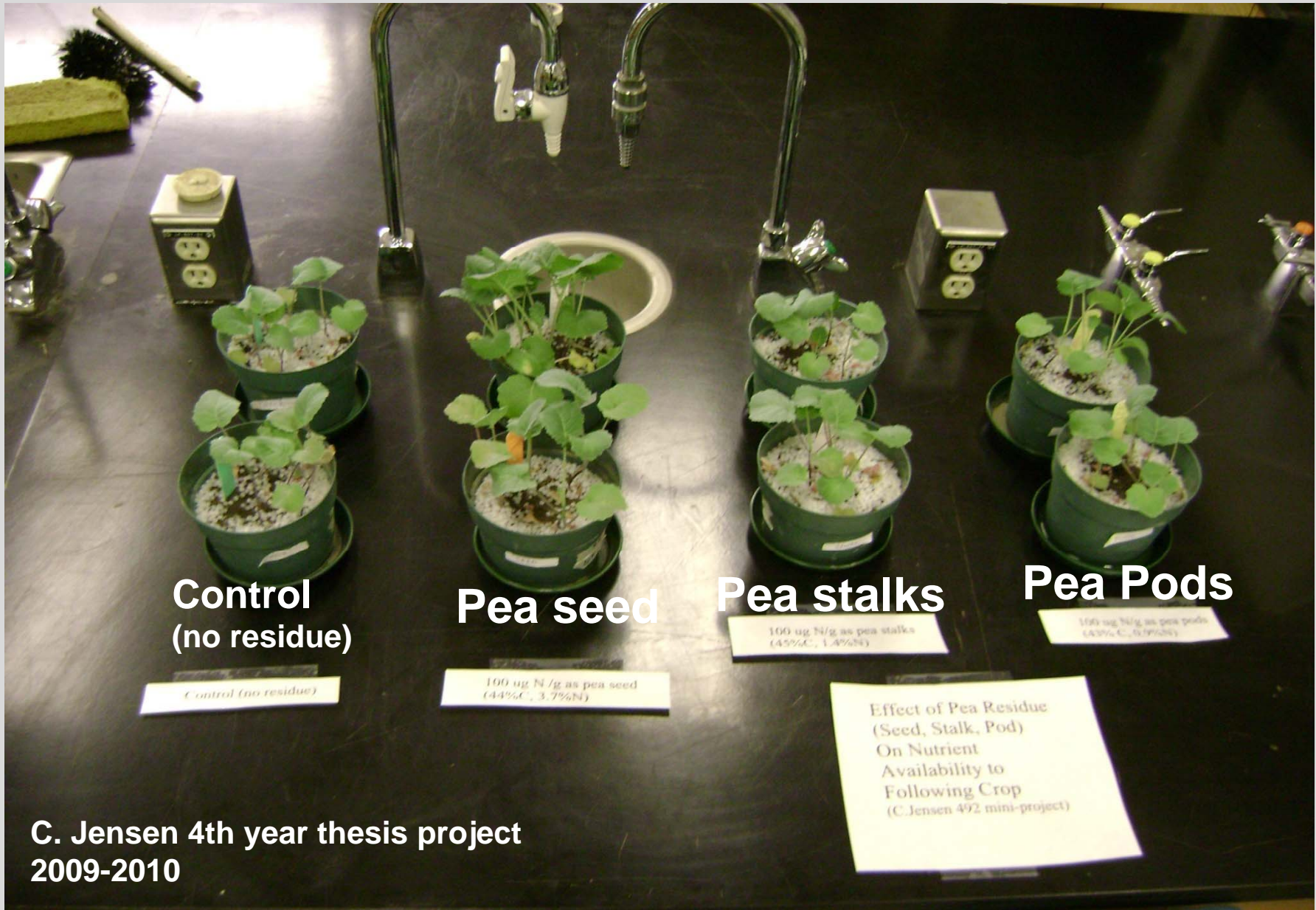
*Pea credit greater than lentil credit (Adderley et al. 2005)*

- Some fertilizer recommendation systems provide a credit based on yield of last year's crop: higher yield = higher credit.
- Others account for release potential in measurement ex: PRS probe

Note: Nitrogen in above ground after harvest pulse residue makes little contribution to N supply to following crop.



< 10% of N in pulse residue is made available to crop in following year.



**Control  
(no residue)**

*Control (no residue)*

**Pea seed**

*100 ug N/g as pea seed  
(44%C, 3.7%N)*

**Pea stalks**

*100 ug N/g as pea stalks  
(45%C, 1.4%N)*

**Pea Pods**

*100 ug N/g as pea pods  
(43%C, 0.9%N)*

**Effect of Pea Residue  
(Seed, Stalk, Pod)  
On Nutrient  
Availability to  
Following Crop  
(C. Jensen 492 mini-project)**

**C. Jensen 4th year thesis project  
2009-2010**

Crop nitrogen uptake on pulse stubble is typically enhanced by a greater amount than what can be contributed by the pulse residue itself.

- Better conditions for root growth
- Stimulated biological activity

**The Magic of Pulses!**

Also long-term benefits of pulse in rotation:  
*build soil organic N reserve and available N supply power*



# Effects of Pulse Crops on Phosphorus Fertility

In contrast to N, legume crops do not bring in P from an external source.

However, they can often mobilize and access P already present in the soil better than many other crops can.

Pulse roots can acidify root zone and solubilize calcium phosphates common in prairie soils.

Explains why pulses are sometimes not highly responsive to P fertilization.

# What are effects of pulses on P nutrition of following crops?

- P uptake by non-legume generally increased following legume versus non-legume.

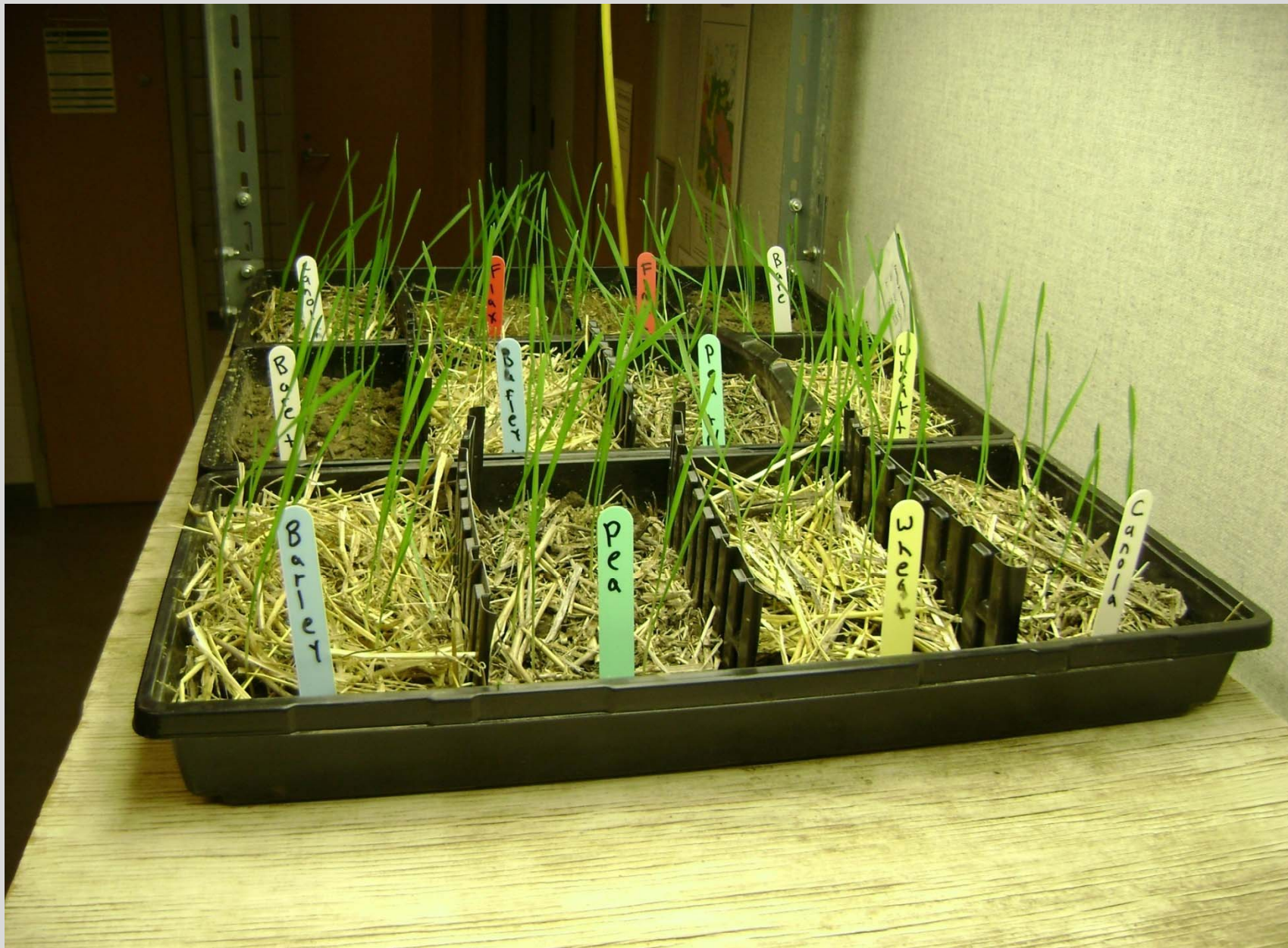
## **Possible Reasons**

- Increased soil P availability
- **Increased colonization of roots by beneficial AM fungi**
- **Improved root growth and crop demand**

- No unique external addition of P from pulses compared to other crops.

**Is there more coming from the residue?**

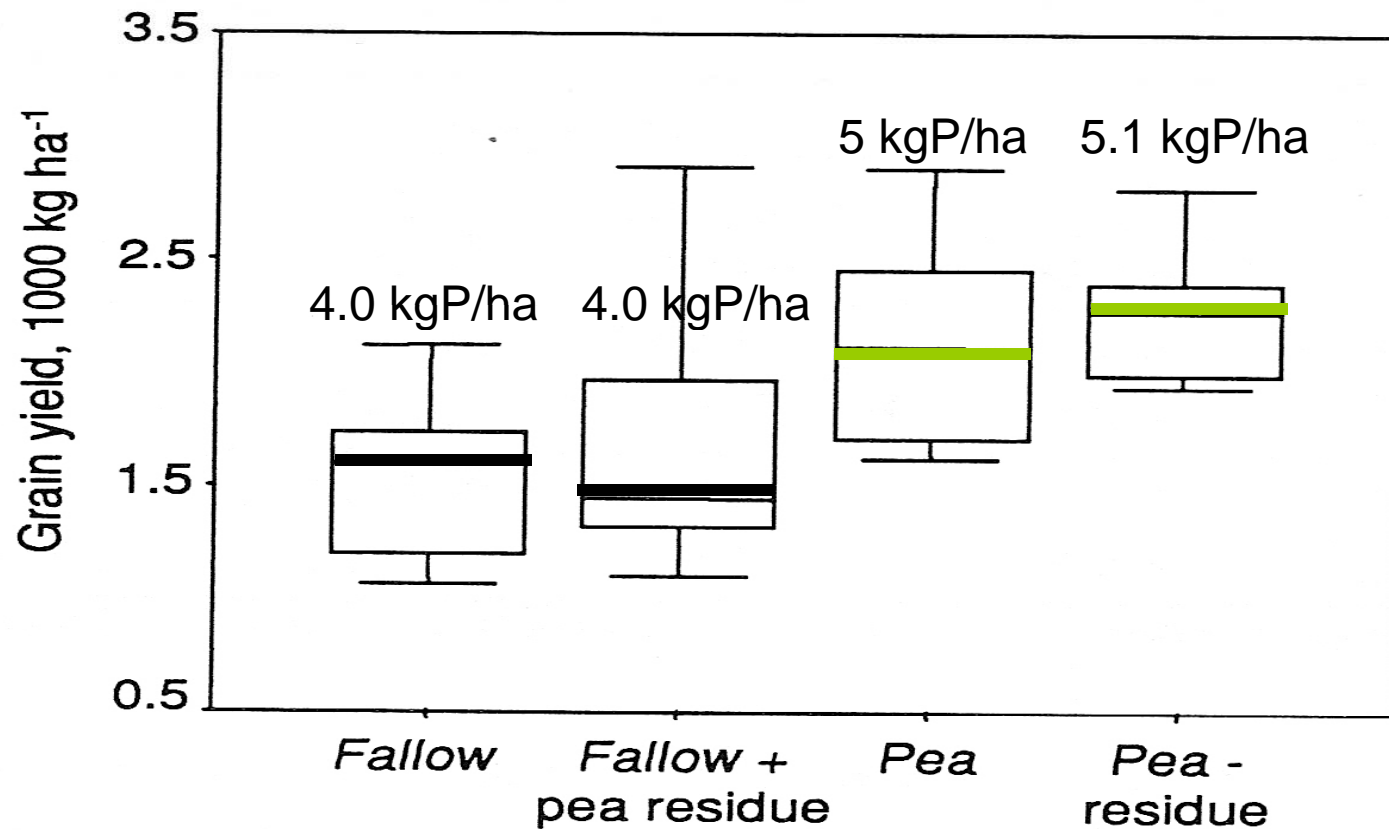




- **All above-ground crop residues reduced P and N availability** initially due to microbial tie-up (immobilization) during residue decomposition.
- **Pulse residue resulted in less P and N tie-up** than cereal residue.
- Amounts of P released from above ground residues calculated to be only **0.9, 1.2 and 1.0 kg P/ha** from chickpea, pea and wheat residue respectively (C. Sulewski, 1999).

**Contribution of above-ground pulse residue to P nutrition of following crop is rather small.**

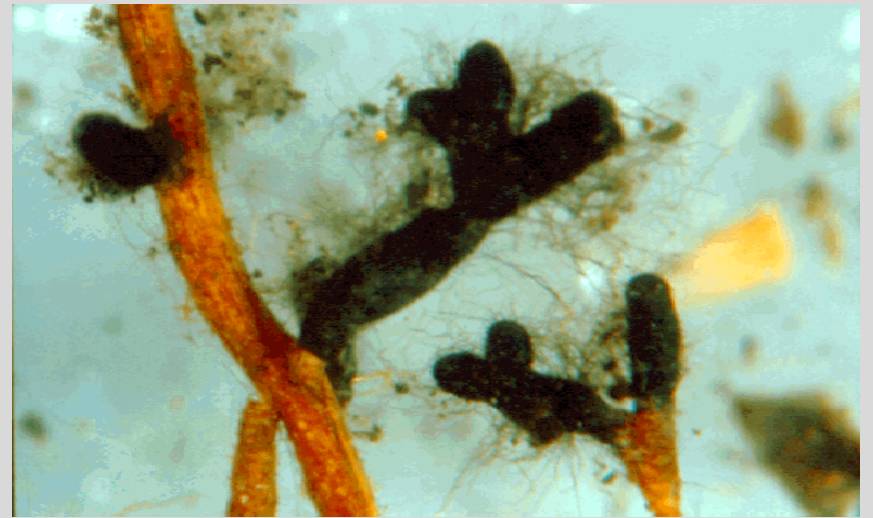
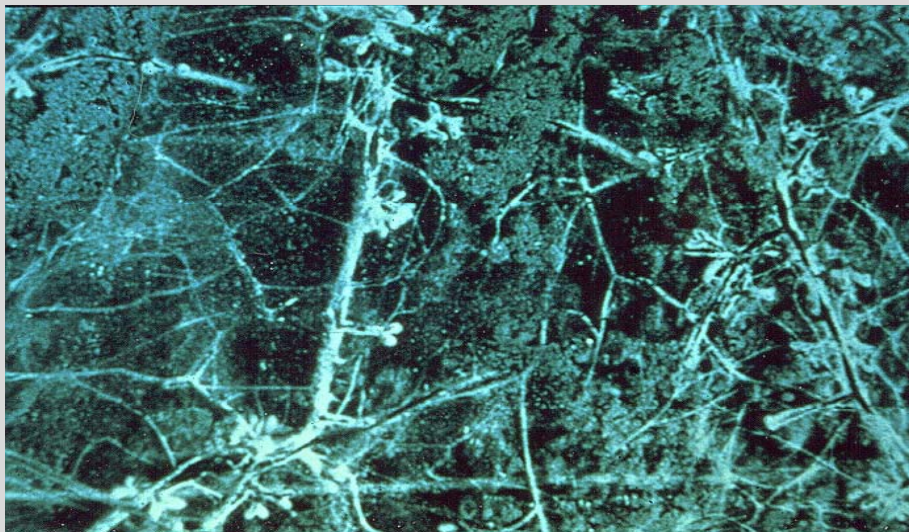
However, greater grain yield and P uptake observed on pea stubble versus wheat stubble or fallow



***Pulse crops do not appear to greatly increase the content of available P in the soil***

But they can promote greater access to soil P and other nutrients by the following crops:

*Better rooting environment, root health, beneficial biological associations (AM fungi).*



A benefit that is rather difficult to directly measure!

# Conclusion



- **N fertility benefit** from pulse in rotation is **significant**, both to the pulse and following crop, and should be considered.
- **P fertility** benefits arise from ability of pulses to access soil P, and **improve access conditions** for following crops.
- Maintenance of fertility in rotations containing pulses is important for a profitable production system down the road.