ARE CURRENT RECOMMENDATIONS TOO HIGH? EXAMINING THE NITROGEN FERTILIZER NEEDS OF DRY FIELD PEAS IN THE WILLAMETTE VALLEY

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Introduction

Field crop producers in the Willamette Valley are always on the lookout for alternative crops to add to their grass seed systems and are particularly interested in broadleaf crops. Dry field peas grown for seed (either for the sprouting or cover crop market) are a rotational crop that has expanded noticeably in Willamette Valley acreage over the past several years. While field peas were grown extensively in the region decades ago, it is a new crop for many growers, and optimal management practices are still emerging. For example, nitrogen (N) fertilizer rate recommendations can vary from 20 to 100 lb N/acre.

The only fertilizer guide (Gardner et al., 2000) for field peas grown in western Oregon, which was revised in 1983, does not recommend any N inputs for a properly inoculated legume crop in western Oregon. Similarly, studies from the Canadian prairies and North Dakota have shown that properly inoculated field peas can meet all of their N requirements through N_2 fixation, and no starter N is needed (Gan et al., 2004). Research from North Dakota has shown that 60–80% of the N found in a field pea is derived from N_2 fixation, with the remainder being derived from soil N sources (Franzen, 1998). Furthermore, it has been shown that high levels of available soil N (more than 50 lb/acre) reduce nodulation because the legume crop preferentially uses soil N, and the grower then misses out on using "free N" from fixation.

Nearly all of the research conducted on dry field peas has been done in climates that are very different from western Oregon, such as semiarid environments where soils carry over N from the previous crop. In western Oregon, it is assumed that most NO_3-N present in the fall is leached and lost over the winter.

Research suggests that in very N-limited fields (less than 20 lb NO_3-N/acre), a small amount of top-dressed N (about 20 lb N/acre) is recommended to initiate root nodulation and symbiotic N_2 fixation (Miller et al., 2005). Fields in western Oregon may fall into this category, in which case a small addition of N would make sense. However, the average N rate used in the southern Willamette Valley is approximately 50 lb N/acre.

It would benefit growers to both observe and measure field pea performance at different N rates to learn whether they could cut down on input costs by maximizing the N_2-fixing abilities of field peas. This research project aimed to measure field pea performance at different N rates to determine whether fertilizer N rates could be reduced. With an average price of $0.30/lb for field peas, any input cost savings would be beneficial to growers.

Objectives:

- To demonstrate the effect of zero N on field pea growth and yield
- To measure the effect of N rate on root nodulation, seed yield, and seed yield components
- To develop recommendations for N use in field pea production based on research results and to disseminate this information to growers.

Materials and Methods

Three trials were established on growers' fields in the spring of 2016: one trial each in Polk, Linn, and Benton counties. Sprouting peas (variety 'W-II') were inoculated and planted with grower equipment on April 6 (Polk), April 7 (Linn), and April 9 (Benton). The Polk field was drilled into perennial ryegrass stubble, the Linn field was drilled into wheat stubble, and the Benton field was planted into worked ground that had previously been in annual ryegrass grown for seed. The experiment was set up as a randomized complete block design with three replicates. The plots measured 25 feet x 300 feet. Preplant soil samples (0–6 inches, 6–12 inches, 12–24 inches) were taken at each study site. See Table 1 for field activity dates.

Table 1. Trial activities and dates completed at three field pea trial sites, 2016.

Activity	Polk	Linn	Benton
Preplant soil sample	Apr. 1	Mar. 30	Apr. 4
Field planting	Apr. 6	Apr. 7	Apr. 9
Plots fertilized	Apr. 29	May 2	Apr. 29
Plots swathed	Aug. 1	Jul. 27	Jul. 26
Plots combined	Aug. 4	Aug. 11	Aug. 13
Postharvest soil sample	Aug. 18	Aug.17	Aug. 18

At the four-leaf stage of the peas, four fertilizer treatments were applied with an Orbit Air Spreader to achieve a comparison of 0, 40, 80, and 120 lb N/acre using urea fertilizer (46-0-0). Roots from each plot were sampled approximately 6 weeks after planting, and root nodulation was assessed visually according to the Nodulation and Nitrogen Fixation Field Assessment Guide published by the Saskatchewan Ministry of Agriculture (Risula, 2016). In this protocol, nodulation and N fixation potential of a legume plant are scored based on: (1) plant growth and vigor, (2) nodule color and abundance, and (3) nodule position. Plants are awarded higher scores for greener and more vigorous plants, greater numbers of nodules having pink pigments, and nodules positioned both near the crown and laterally. Scores from each category were summed to give a total score for each plant, with the total score corresponding to one of three categories: (1) effective nodulation, (2) less effective nodulation, or (3) poor nodulation.

Plant biomass samples (1 ft^2) taken at harvest were separated into stems and pods to be analyzed separately. The stems were analyzed for total biomass, %N and %C. Pods were processed to measure the number of pods/stem, pods/ft^2, peas/pod, and peas/ft^2. A 15-foot swath was taken down the center of each plot with grower equipment, and each plot was combined separately to calculate yields using a weigh wagon. Postharvest soil samples (0–6 inches) were taken from each plot to determine residual soil N.

Results and Discussion

The preplant soil samples revealed sufficient starter N (at the 0- to 12-inch depth) at all sites and high levels at some sites: 79 lb NO_3-N/acre at Polk, 38 lb NO_3-N/acre at Linn, and 65 lb NO_3-N/acre at Benton. All sites had sufficient soil P and K levels and suitable soil pH for field pea production. Averaged across all sites, root nodulation appeared to be more effective at the 0 and 40 lb N/acre rates and less effective at the higher rates (Table 2). None of the assessed plants had "poor nodulation," even though N fixation is generally considered to be depressed when soil N is more than 50 lb N/acre.

There were no significant differences or trends in the plant samples taken at harvest, including N uptake, C:N ratio, biomass, or seed yield components (Table 2). There were no significant differences found in pea seed yield between the fertilizer treatments at any site (Table 2). High yields were maintained with zero fertilizer N applied, and trial yields were comparable to grower field average yields (Table 3). Residual soil N did tend to be higher at the 80 and 120 lb N rates (Table 2).

The first-year results suggest that the fertilizer N rate did not impact yield (Table 3) or seed yield components, but higher N rates resulted in higher soil residual N levels at the end of the growing season (Table 2). It is likely the preplant soil N level was sufficient to supply the pea crop and that fertilizer N was not needed. The 2016 results indicate that a successful pea crop can be grown with zero N fertilizer without impacting overall seed yield or seed yield components.

Table 2. Harvest stem and pod characteristics, nodule ratings, yield, and postharvest soil sample results averaged across three field pea trials in the Willamette Valley grown under different fertilizer N treatments, 2016.

Tmt	Harvest plant sample[1] (stems only)									
N rate	N uptake	C:N ratio	Biomass	Nodule rating	Yield	Pods/ft^2	Pods/stem	Peas/pod	Peas/ft^2	Postharvest soil N[2]
(lb/a)	(lb/a)		(lb/a)		(lb/a)	(no.)	(no.)	(no.)	(no.)	(lb/a)
0	88	37	6,242	Effective	3,439	65	6.4	5.0	313	11 b
40	87	31	5,791	Effective	3,302	53	6.1	5.2	281	16 ab
80	74	34	5,876	Less effective	3,439	59	5.7	5.3	312	25 a
120	70	41	6,172	Less effective	3,492	66	6.3	4.7	311	26 a

[1] Plant samples were collected on July 22, 2016.
[2]Results followed by a different letter are significantly different at LSD ($P = 0.05$).

The average N application rate of growers in this study was 55 lb N/acre. A zero N application rate would result in $32.50/acre savings (N at $0.65/lb). In additional to saving money, lower fertilizer rates would reduce the environmental risk of residual N in the fall. The trial will be repeated in 2019.

Table 3. Yield results of three field pea trials in Polk, Linn, and Benton counties under different N rates as compared to the grower's field average in 2016. Grower fertilizer rate included.

	Yield		
Treatment	Polk	Linn	Benton
(lb N/a)	(lb/a)		
0	2,714	3,817	3,787
40	2,613	3,585	3,707
80	2,738	3,704	3,876
120	2,783	3,823	3,869
Trial average	2,712	3,732	3,809
Grower field average	2,800	3,500	3,430
Grower fertilizer rate	60 lb N/a	65 lb N/a	40 lb N/a

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