Rotational benefits following different field pea cultivars

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Key findings

- Canola growth and grain yield was better following PBA Percy, than after PBA Hayman or Kaspa.
- Pea shoots contained 23, 17 and 13 kg fixed N/t DM, for PBA Percy, Kaspa and PBA Hayman, respectively.
- PBA Percy produced less dry matter, but increased available soil N and used less water.
- Pea roots and nodules of PBA Hayman were estimated to have contributed 37 kg/ha to the available soil N pool of 107 kg/ha (0-60 cm soil depth) in the 6 month period following peas.

Why do the trial?

Field pea cultivars vary in their N_2-fixation. On average, fixed N in the above ground herbage (shoots) has been found to range from 78 kg/ha for Kaspa to 95 kg/ha for PBA Percy at maximum dry matter production (mid pod fill). This trial sought to improve our understanding of below ground nitrogen contributions in the year following peas and to what extent different pea cultivars affect the performance of the following crop (canola).

How was it done?

The trial was conducted over two years, where pea cultivars were grown in year 1 and the plots over sown with canola in year 2.

Year 1 (2014)

Plot size	1.4 m x 12 m	**Fertiliser**	80 kg/ha MAP (10:22) + 2% Zinc
Seeding date	28th May 2014		

The trial was arranged in split-plot design with three replications (Figure. 1). Main plot treatments were fallow or sown to one of the field pea cultivars; PBA Percy (hereafter Percy), Kaspa or PBA Hayman (hereafter Hayman) to achieve a seedling density of 50 plants/m^2. Peas were grown to maximum dry matter production (mid pod fill), then cut at ground level. Sub-plots comprised retention or removal of the above-ground material including all shoots and pods (hereafter referred to as shoots). Retained shoots (mimicking an unincorporated green manure) were pegged down on the surface of plots until April 2015.

Bay	Row	Cultivar	Treatment
1	1	Kaspa	Shoots Removed
	2	Kaspa	Shoots Retained
	3	Percy	Shoots Removed
	4	Percy	Shoots Retained
	5	Fallow	n/a
	6	Fallow	n/a
	7	Hayman	Shoots Removed
(a)	8	Hayman	Shoots Retained

Figure 1. (a) Schematic of the trial design for replicate 1 and (b) an example of plots following retention (left) or removal (right) of the pea shoots at maximum dry matter.

The fallow treatment was included to provide an estimate of background N mineralisation at the site.

- Shoot material was removed so that changes in available soil N in addition to those in the fallow treatment could be attributed to the roots and nodules remaining in the soil.
- Where shoots were retained on the plots we would expect mineralisation from both the roots and shoots to contribute to increased soil N levels.

Available soil N was measured in all treatments at depths 0-10 cm, 11-30 cm and 31-60 cm on 1st May and again for the Fallow and Hayman treatments on 28th November. Ten plant shoots were sampled from each plot at mid pod fill (27th Aug. for Percy, 14th Oct. for Kaspa and 28th Oct. for Hayman) and combined with earlier pea density measurements to estimate shoot dry matter (DM). Shoots were also used to determine N concentration (%N), proportion of N derived from fixation and total N_2 fixed.

Year 2 (2015)

Available soil N and soil moisture content was measured in all treatments at depths 0-10 cm, 11-30 cm and 31-60 cm on 16th April 2015.

Pea shoot residues that remained on 'retained' sub-plots were removed in April to avoid any confounding effects to the subsequent canola crop (e.g. pests and disease, sowing issues). The amount of dry matter, N concentration (%N) and total N content of the removed residues was determined. The trial was sown with 44Y89 canola on 15th May, with no addition of N fertiliser (only 100 kg/ha triple super phosphate at seeding). Growth of the canola crop was monitored through the season. Ten plants were removed from each plot near maximum dry matter production (13th August) and combined with earlier density measurements to estimate shoot dry matter (DM). Shoots were also used to determine % N and total N content. Plots were machine harvested on 16th November and seed yield determined.

Results and discussion

Year 1.

Percy was the fastest maturing cultivar and produced 4.5 t DM/ha up until maximum dry matter (max DM) when the shoots were cut at ground level (Figure. 2). This compared to 5.2 t DM/ha for Kaspa and 6.5 t DM/ha for Hayman. The shoot N concentration at max DM was significantly higher for Percy (2.46%) than for the other cultivars (2.1% for Kapsa and 1.55% Hayman). Percy also fixed a higher percentage of N (93%) than Kaspa (80%) and Hayman (85%). This resulted in the shoots containing 23, 17 and 13 kg fixed N/t DM, for Percy, Kaspa and Hayman, respectively.

Overall, total N in the above ground DM was not significantly different between cultivars, averaging 107 kg/ha.

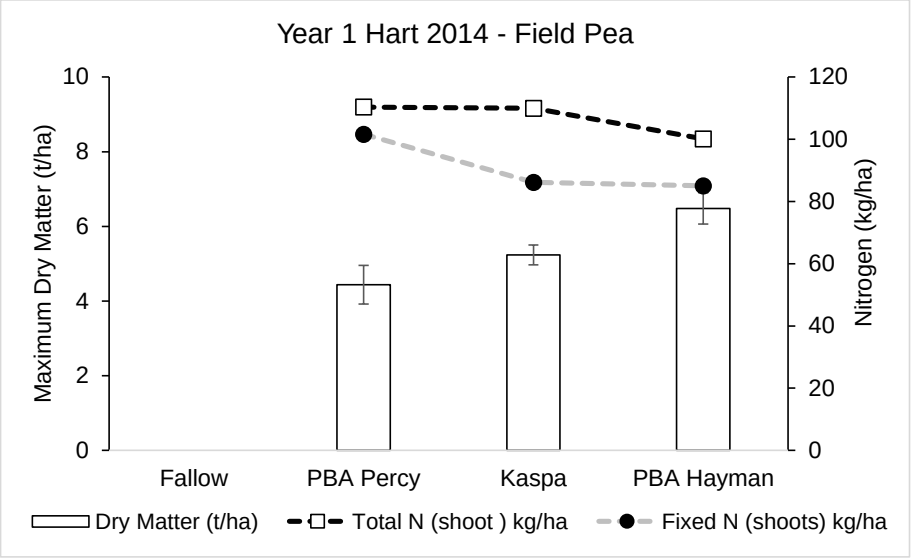

Figure 2. Above ground (shoots and pods) dry matter production, total N and total fixed N at mid pod fill of PBA Percy, Kaspa and PBA Hayman field pea grown at Hart in 2014.

Year 2.

Approximately half the pea residues in the retained treatments remained on the surface of sub-plots in April 2015. The amount of residue was similar for each of the cultivars and on average contained 53 kg N/ha (about half of what was produced in 2014).

Canola sown in the 2014 fallow treatment produced most DM, total crop N (shoots and pods) and seed yield (Figures. 3 & 4). There were significant differences following different pea cultivars. Canola after Percy produced more DM, total crop N and seed yield compared to the Kaspa and Hayman treatments. There were no significant differences between the DM removed and DM retained treatments.

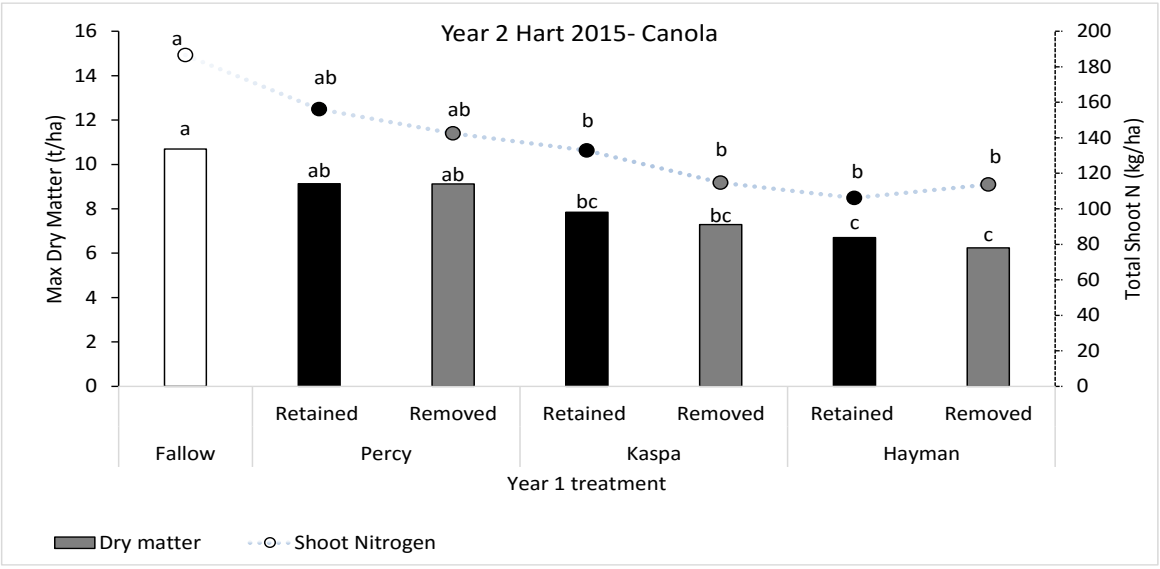

Figure 3. Max dry matter and total N (shoots and pods) of canola in 2015 following treatments from 2014 pea trial (fallow or retained vs removed dry matter of PBA Percy, Kaspa, PBA Hayman). Different letters between treatments (for each parameter) indicate mean values are significantly different (P<0.05).

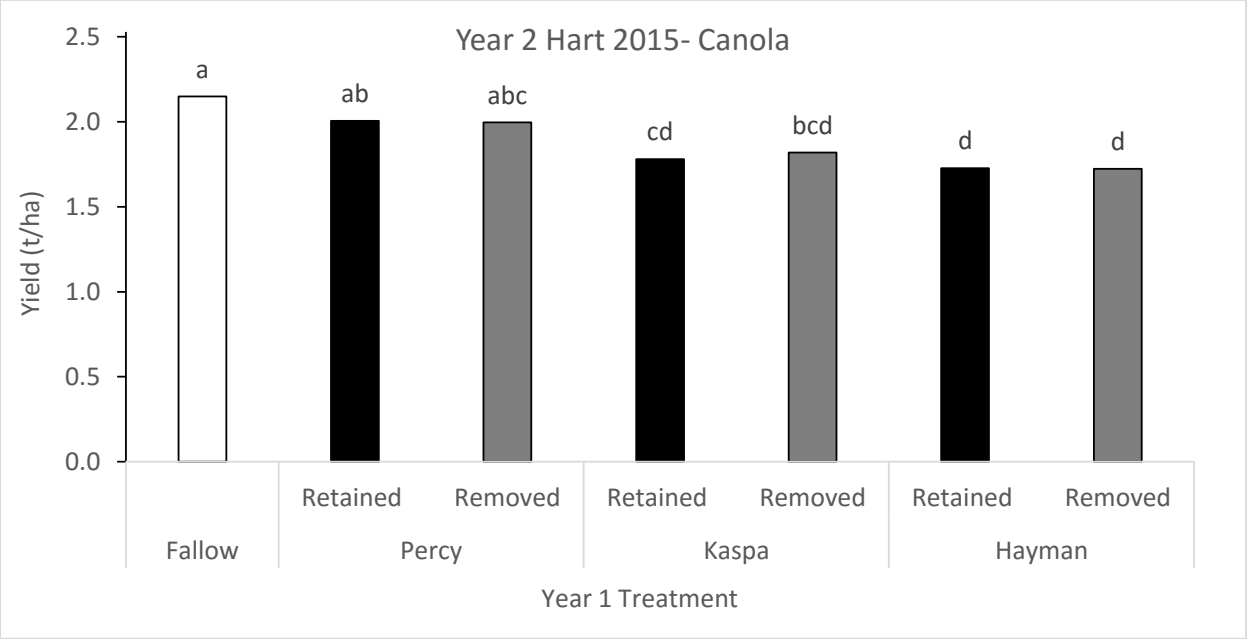

Figure 4. Seed yield of canola in 2015 following treatments from 2014 pea trial (fallow or retained vs removed dry matter of PBA Percy, Kaspa, PBA Hayman). Different letters between treatments (for each parameter) indicate mean values are significantly different (P<0.05).

Soil N and Water Budget

All trial plots had similar levels of available soil N before sowing peas, approximately 20 kg/ha in the 0-10 cm soil zone, 49 kg/ha (11-30 cm) and 62 kg/ha (31-60 cm), a total of 131 kg/ha (0-60 cm).

By the end of the 2014 growing season (November) available soil N (to 60 cm depth) had increased in the fallow treatments to 144 kg/ha, but decreased under Hayman to 61 kg/ha. Compared to N levels at the start of the season, this was an increase of 28 kg under fallow and a decrease of 68 kg/ha under Hayman. The peas had used some available soil N for growth.

At the start of the 2015 season (April) available N (to 60 cm depth) had increased marginally under fallow treatments (from 144 to 152 kg/ha) and to a greater extent (from 61 to 110 kg/ha) under the pea treatments. Where shoots had been retained on the plots there was 117 kg available N, compared to 104 where shoots were removed, but the mean values were not significantly different. Therefore, the average of the retained and removed treatments is presented from here on.

A more detailed examination of the plant available soil N (April 2015) with soil depth is shown in Figure 5. All pea treatments had a similar total available N in the top 0-10cm (30 kg N/ha), but less than the fallow, which had 49 kg/ha. Available N increased at 11-30 cm depth under all pea treatments, the greatest being under Percy (46 kg/ha) and least under Hayman (34 kg/ha). Fallow treatments again had the highest available N (56 kg/ha) at this depth. Fallow and Hayman had similar available N at the 31-60 cm depth (45 kg/ha), with slightly lower amounts under Percy and Kaspa (40 and 37 kg/ha respectively).

Over-summer mineralisation of the pea roots and nodules from PBA Hayman is estimated to have contributed 37 kg/ha to the available soil N pool (106 kg/ha, 0-60 cm) measured in April 2015.

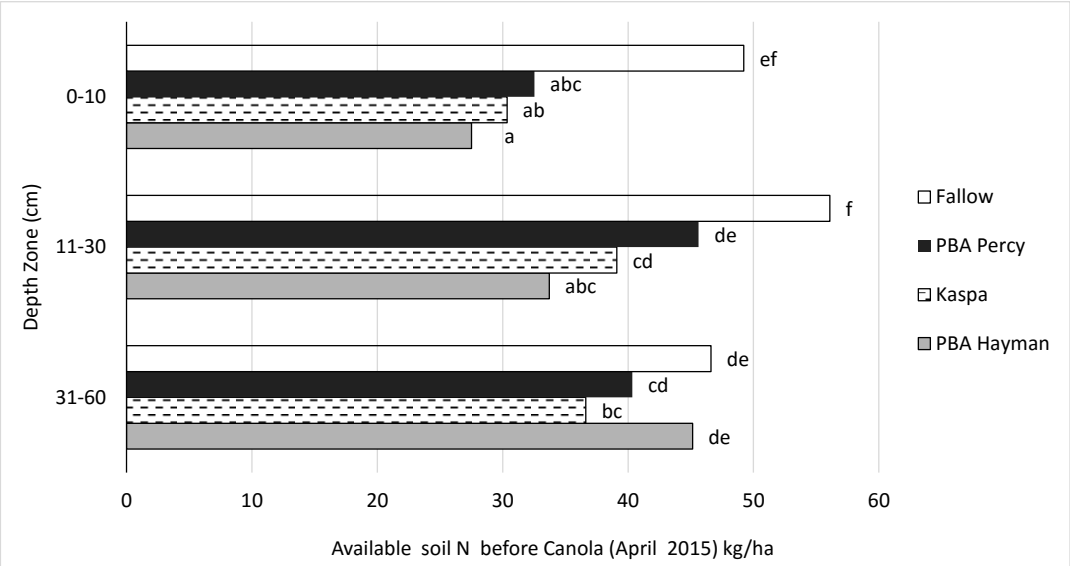

Figure 5. Available soil N before canola (April 2015) at three soil depths (0-10cm, 11-30 cm, 31-60cm) under treatments from 2014 pea trial (fallow, PBA Percy, Kaspa, PBA Hayman). Different letters between treatments (for each parameter) indicate mean values are significantly different (P<0.05).

Retaining or removing the pea shoots did not significantly affect plant available water (PAW) within the 0-60 cm soil zone, when estimated in April 2015 from gravimetric water content measurements (data not shown). However, there were significant effects of pea cultivar and fallow (Figure 6). Fallow treatments had more PAW in the 11-30 cm zone. Similarly, the deficit in PAW was lowest under fallow in the 31-60 cm zone. In this zone, the PAW deficit was also less under Percy than Hayman, probably because the Hayman grew for longer and extracted more water at depth.

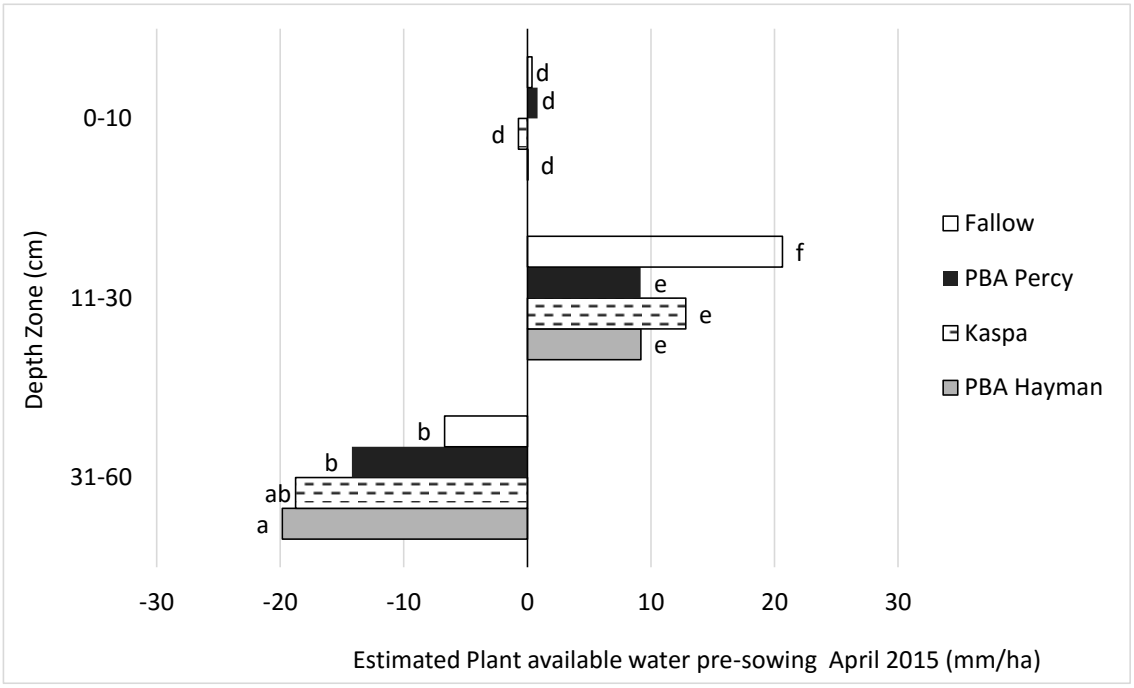

Figure 6. Estimated plant available water before sowing (April 2015) at three soil depths (0-10cm, 11-30 cm, 31-60cm) under treatments from 2014 pea trial (fallow, PBA Percy, Kaspa, PBA Hayman). Different letters between treatments (for each parameter) indicate mean values are significantly different (P<0.05).

Summary & implications

- Pea cultivars differed in their dry matter production, with Hayman greater than Kaspa which in turn was greater than Percy, at mid pod fill. However, because the cultivars with higher DM had lower shoot N concentrations, their overall accumulation of shoot N was similar.
- Cultivar had a small effect on the total amount of available soil N for the subsequent canola crop. Pea cultivar also had a significant effect on the distribution of N in the profile, with significantly more N available in the 11-30 cm zone following Percy (46 kg/ha) compared to Hayman (34 kg/ha).
- Over-summer mineralisation of the pea roots and nodules from Hayman is estimated to have contributed 37 kg/ha to the available soil N pool (107 kg/ha, 0-60cm) measured in April 2015.
- Where shoots had been retained on the plots, there was 117 kg/ha available soil N, compared to 104 where shoots were removed. Since about half the retained residues did not break down over summer, the full potential contribution from shoots was not realised. At least 53 kg of shoot N was not returned to the soil.
- Canola had the highest dry matter, above ground N and seed yield following the fallow treatment from year 1. This is almost certainly the result of the increased PAW and available soil N following the fallow.
- Canola dry matter and yield after pea was highest after Percy which used the least water and left the most available soil N.
- Additional N benefits from the peas are expected to accrue for at least another year, as N continues to be mineralised from pea residues remaining in the soil.

Acknowledgements

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