2021 Cover crop trials

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This report summarises the findings from 4 trials conducted in 2021. Cover crops were established in early autumn 2020 followed by vining peas in 2021.

Trials

Table 1. Site details.

Site	Soil type	Established	Foot rot pressure
Molescroft	Stony loam	Late May	Low
Vicarage	Heavy loam with variable sub-soil	Early April	Very high
Long Sutton	Silt	Early March	Medium
Eastfield	Sandy clay loam	Mid April	Very low

Cover crops were established in large replicated (3) strips in late summer/early autumn 2020. A sampling point was established in each half of the strips totalling 6 sampling points per treatment. Cover crops were destroyed in winter and drilled with vining peas in the following spring.

Table 2. Treatment allocations.

Site	Treatments	Varieties (Oat kg : addition kg)
Molescroft	Oat + phacelia, Oat + vetch	Black Oat = Pratex
Vicarage	Oat + phacelia, Oat + mustard	Phacelia = Angelia (4:1)
Long Sutton	Oat + phacelia, Oat + vetch	Vetch = Latigo (2.3:1)
Eastfield	Oat + phacelia, Oat + vetch, Oat + mustard	Mustard = Terrafit (2.3:1)

Cover crop establishment was variable. Cover crops were drilled on the 21st August, 6th September, 12th September and w/c 14th September at Long Sutton, Eastfield, Vicarage and Molescroft, respectively. The biomass and ground cover of the cover crops strongly reflected drilling date with the later drilled cover crops accumulating low biomass only. Overall, cover crop establishment was poor primarily due to poor preceding harvest weather which delayed cover crop drilling.

Assessments

Soil samples were taken prior to cover crop establishment and prior to vining pea establishment. Overall soil content of macronutrients was measured as well as foot rot pressure (Colony numbers per 10 mg soil for *Fusarium solani* and *Didymella pinodella*, infection score on pea seedlings (0 = no infection, 5 = seedling dead) for *Aphanomyces euteiches*. The relative changes in these criteria over winter were calculated also.

Soil moisture meters were deployed in triplicate at three sites in selected treatments to observe the effect of cover cropping on soil moisture through-out the growing season.

Foot rot in the crop was assessed at the onset of flowering. 25 plants per sampling point (150 per treatment) were assessed on a 0-5 scale reflecting the severity of foot rot infection with 0 = no foot rot present and 5 = dead roots.

Yield was recorded at each site. 6 m^2 plots were taken from each sampling point and threshed using a static viner.

Figure 1. Molescroft November 2020, low biomass and modest ground cover.

Figure 2. Vicarage November 2020, low biomass and modest ground cover, lots of volunteers.

Figure 3. Long Sutton October 2020, reasonable cover crop biomass but low ground cover. Significant weed chit in disturbed areas.

Figure 4. Eastfield November 2020, moderate biomass and good ground cover.

Results

Generally, there were no effects of cover cropping on soil macronutrient availability. However, at one site it appeared that cover cropping affected both soil organic matter and soil pH. At Eastfield, a slightly higher quantity of soil organic matter was recorded in the control areas prior to vining pea emergence compared to cover cropped areas although the control had the lowest organic matter content prior to cover crop planting. Also, the control areas showed the greatest lowering in pH between summer 2020 to spring 2021.

Table 3. Mean soil macronutrient availabilities prior to cover crop establishment.

		P	K	Mg	Ca	OM %	pH
Molescroft	Control	27.0	180.5	34.4	4673	5.24	8.05
	Oat + Phacelia	24.1	192.5	34.3	4802	5.11	8.07
	Oat + Vetch	30.4	194.1	32.4	4631	5.18	8.11
Vicarage	Control	4.2	110.4	485.5	4666	7.75	7.28
	Oat + Phacelia	3.6	116.9	635.9	4216	8.12	7.16
	Oat + Mustard	3.4	119.3	652.3	4558	8.34	7.41
Long Sutton	Control	19.4	192.7	135.2	2043	2.91	7.99
	Oat + Phacelia	15.9	181.0	106.1	2158	2.45	8.02
	Oat + Vetch	17.5	191.8	117.4	2115	2.64	8.02
Eastfield	Control	23.1	168.2	65.8	1790	2.99	6.58
	Oat + Phacelia	23.5	160.9	68.5	1657	3.20	6.37
	Oat + Vetch	24.7	159.6	66.7	1377	3.43	6.11
	Oat + Mustard	25.3	151.1	64.9	1451	3.22	6.22

Table 4. Mean soil macronutrient availabilities prior to vining pea emergence.

		P	K	Mg	Ca	OM %	pH
Molescroft	Control	28.8	163.7	31.8	5072	4.97	8.02
	Oat + Phacelia	23.0	152.6	30.5	5139	5.26	8.02
	Oat + Vetch	27.8	167.3	30.2	5102	5.21	8.08
	F statistic	1.46	0.75	0.22	0.07	0.42	0.36
	p-value	0.26	0.49	0.80	0.93	0.67	0.71
Vicarage	Control	6.5	121.1	599.5	4934	8.18	7.12
	Oat + Phacelia	5.3	101.7	613.1	4680	8.22	7.04
	Oat + Mustard	5.4	102.0	671.9	5096	8.10	7.38
	F statistic	1.13	1.92	0.78	0.51	0.01	0.35
	p-value	0.35	0.18	0.48	0.61	0.99	0.71
Long Sutton	Control	21.0	190.6	139.0	2524	2.64	7.79
	Oat + Phacelia	18.1	195.0	117.4	2884	2.60	7.85
	Oat + Vetch	18.5	182.0	122.0	2663	2.45	7.83
	F statistic	1.36	0.44	0.50	1.80	0.84	0.48
	p-value	0.29	0.65	0.62	0.2	0.45	0.63
Eastfield	Control	27.1	189.2	79.7	1820	3.70_{a}	5.95
	Oat + Phacelia	23.0	174.5	83.2	1935	3.59_{ab}	6.24
	Oat + Vetch	25.3	177.0	79.0	1697	3.36_{ab}	5.94
	Oat + Mustard	24.7	162.5	72.7	1536	3.16_{b}	5.88
	F statistic	0.91	0.73	1.18	1.20	3.40	0.64
	p-value	0.46	0.55	0.34	0.33	0.04	0.60

Table 5. Mean % change in macronutrient availability between cover crop drilling and vining pea drilling.

		P	K	Mg	Ca	OM %	pH
Molescroft	Control	6.3	-8.1	-7.6	8.7	-3.6	-0.3
	Oat + Phacelia	-4.0	-19.6	-11.5	7.1	3.6	-0.6
	Oat + Vetch	-8.3	-13.4	-6.9	10.5	0.7	-0.4
	F statistic	1.61	1.75	0.38	0.26	0.51	0.05
	p-value	0.23	0.21	0.69	0.77	0.61	0.95
Vicarage	Control	57.7	13.3	37.9	5.6	6.1	-2.3
	Oat + Phacelia	52.2	-12.8	-2.9	11.6	0.2	-1.8
	Oat + Mustard	60.9	-14.3	3.9	11.1	-2.2	-0.3
	F statistic	0.05	2.85	2.28	0.92	0.94	1.16
	p-value	0.95	0.09	0.14	0.42	0.41	0.34
Long Sutton	Control	7.9	-1.1	0.9	24.5	-7.2	-2.5
	Oat + Phacelia	14.2	8.5	12.8	33.7	6.9	-2.1
	Oat + Vetch	7.2	-4.5	7.0	25.6	-4.9	-2.4
	F statistic	0.33	1.64	0.41	0.60	1.09	0.09
	p-value	0.72	0.23	0.67	0.56	0.36	0.91
Eastfield	Control	21.8	13.3	24.4	1.1	24.4_{a}	-9.7_{a}
	Oat + Phacelia	-0.6	8.9	22.7	21.0	13.3_{ab}	-1.6_{b}
	Oat + Vetch	3.9	10.9	18.4	23.4	-1.7_{b}	-2.7_{ab}
	Oat + Mustard	-2.4	7.6	12.4	6.5	-1.3_{b}	-5.4_{ab}
	F statistic	1.78	0.11	0.62	3.17	4.25	3.97
	p-value	0.18	0.96	0.61	0.05	0.02	0.02

Pre-existing foot rot pathogen levels were low at Molescroft and Eastfield, with negligible risk at Eastfield. A modest risk of *Fusarium* was recorded at Long Sutton prior to cover crop establishment. At Vicarage, a very high risk of *Aphanomyces* was recorded prior to vining pea establishment. There was no meaningful or statistically significant treatment effect on pathogen abundance at any site.

Table 6. Mean foot rot pathogen abundance/score prior to cover crop establishment.

		Fusarium	*Didymella*	*Aphanomyces*
Molescroft	Control	9.00	0.00	0.08
	Oat + Phacelia	13.17	0.00	0.19
	Oat + Vetch	7.67	0.00	0.07
Vicarage	Control	7.33	0.67	1.37
	Oat + Phacelia	7.00	0.67	0.71
	Oat + Mustard	5.00	1.67	2.23
Long Sutton	Control	22.00	0.83	0.26
	Oat + Phacelia	24.33	1.50	0.08
	Oat + Vetch	19.00	0.33	0.12
Eastfield	Control	1.83	0.00	0.59
	Oat + Phacelia	0.67	0.00	0.17
	Oat + Vetch	0.50	0.00	0.34
	Oat + Mustard	0.83	0.00	0.48

Table 7. Mean foot rot pathogen abundance/score prior to vining pea establishment.

		Fusarium	*Didymella*	*Aphanomyces*
Molescroft	Control	2.00_{ab}	0.33	0.00
	Oat + Phacelia	3.17_{a}	1.67	0.00
	Oat + Vetch	0.33_{b}	0.50	0.04
	F statistic	5.67	0.98	2.5
	p-value	0.01	0.40	0.15
Vicarage	Control	1.00	2.83	2.48
	Oat + Phacelia	0.67	1.33	2.72
	Oat + Mustard	1.17	1.83	3.39
	F statistic	0.09	0.20	0.24
	p-value	0.91	0.82	0.79
Long Sutton	Control	16.83	1.17	0.00
	Oat + Phacelia	17.17	1.67	0.00
	Oat + Vetch	20.17	2.17	0.00
	F statistic	0.14	0.17	n/a
	p-value	0.87	0.85	n/a
Eastfield	Control	0.50	1.67	0.89
	Oat + Phacelia	0.00	1.83	0.00
	Oat + Vetch	0.17	0.00	0.21
	Oat + Mustard	0.33	1.50	0.00
	F statistic	0.98	1.26	1.30
	p-value	0.42	0.31	0.30

Due to extreme variability in the changes of pathogen abundance data is not presented here. Analysis was performed. There were no significant treatment effects.

There was no significant treatment effect on foot rot severity that developed in crop. Very low levels of foot rot were recorded at Eastfield, thus the data is not presented here.

Table 8. Analysis of treatment significance for foot rot severity.

	Molescroft	Vicarage	Long Sutton
Kruskal-Wallis χ^2	3.82	0.34	2.56
p-value	0.15	0.84	0.28

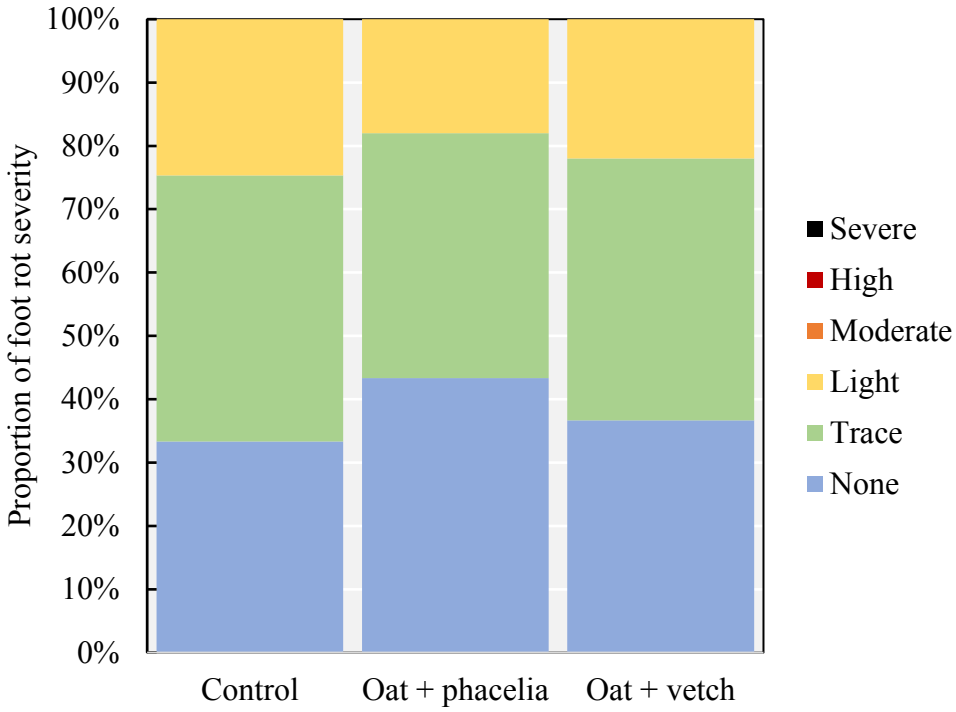

Figure 5. Proportion of foot rot severities in crop, Molescroft.

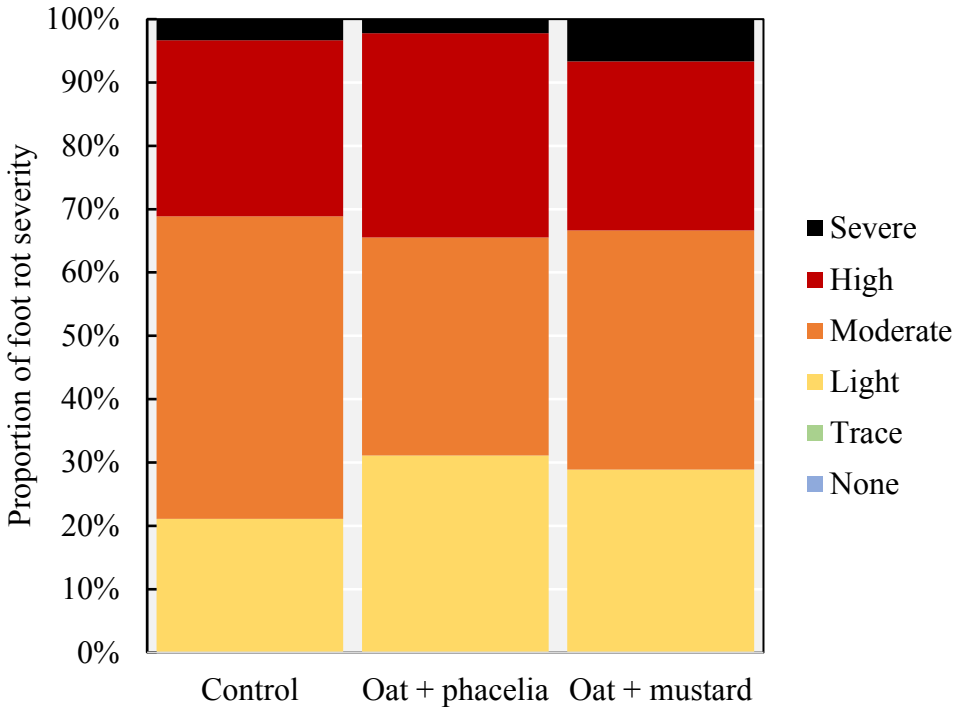

Figure 6. Proportion of foot rot severities in crop, Vicarage.

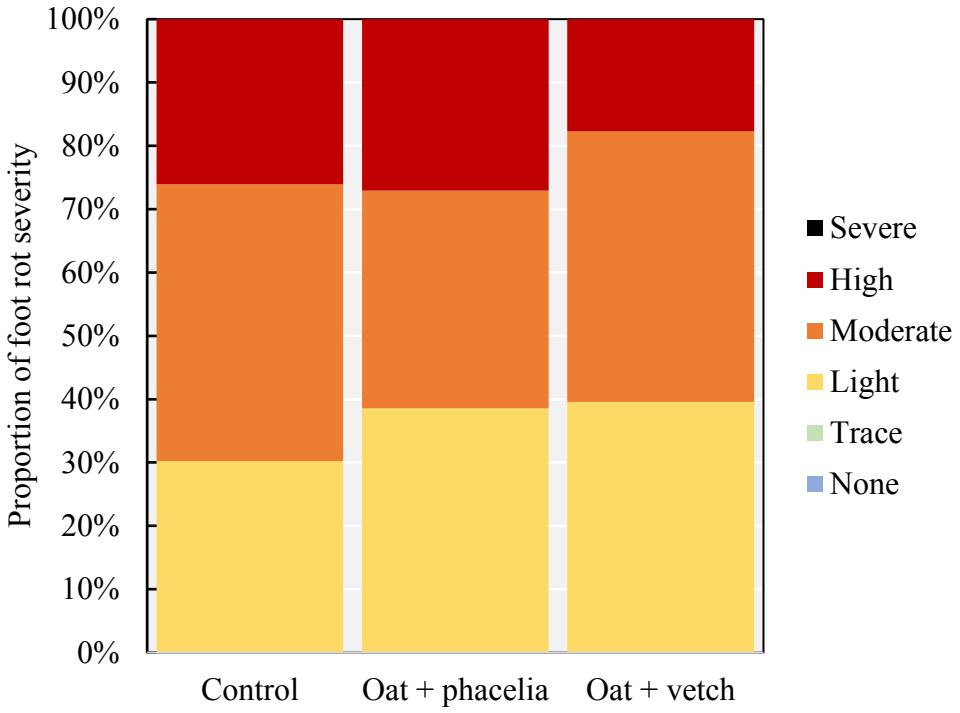

Figure 7. Proportion of foot rot severities in crop, Long Sutton.

Yield results were mixed and there were no meaningful treatment effects on yield. The trial at Vicarage was not taken to yield as it was destroyed by foot rot and burdened by patchy thistle pressure.

Table 9. Mean yield in comparison to control.

	Molescroft	Long Sutton	Eastfield
Control	100	100	100
Oat + phacelia	95.2	103.2	98.8
Oat + vetch	91.0	110.9	102.9
Oat + mustard	-	-	111.3
F statistic	1.12	1.63	0.22
p-value	0.36	0.23	0.88

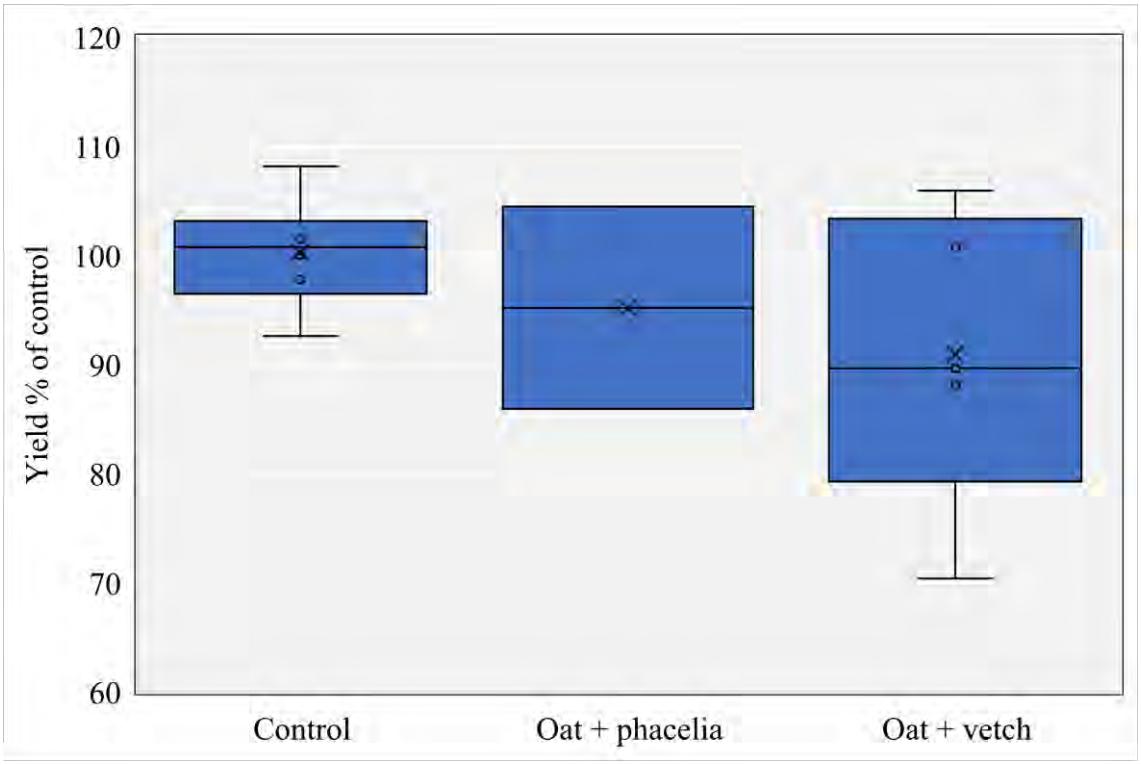

Figure 8. Mean vining pea yield, Molescroft.

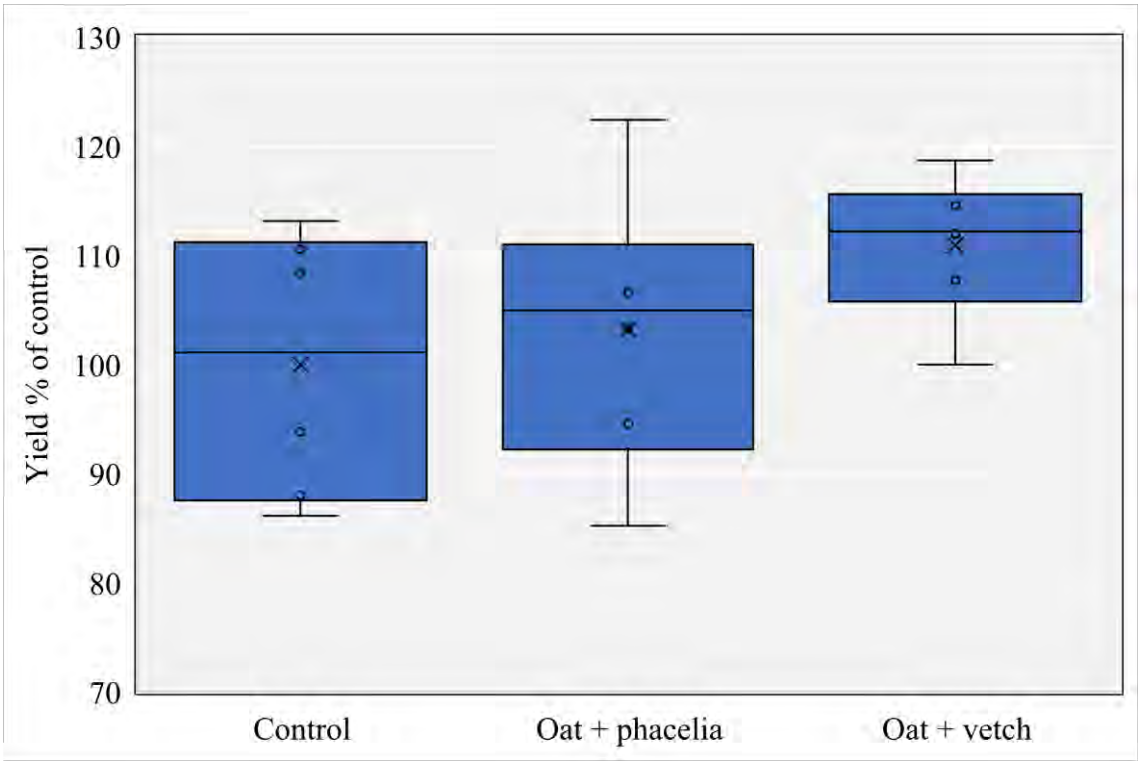

Figure 9. Mean vining pea yield, Long Sutton.

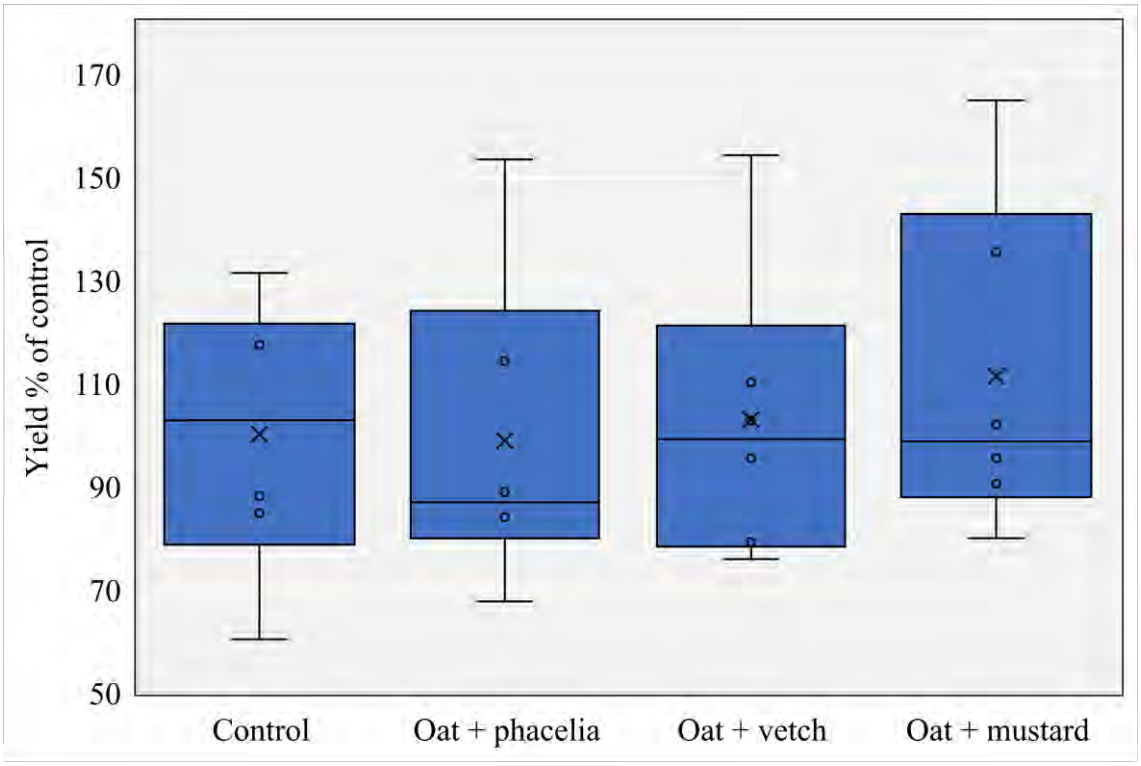

Figure 10. Mean vining pea yield, Eastfield.

Soil moisture was recorded at three sites. At Vicarage, cover cropped areas had greater soil moisture for the entire growing period. However, it emerged that the soil moisture was significantly affected by underlying sub-soil conditions which were extremely variable, thus the data probably do not reflect any treatment effect.

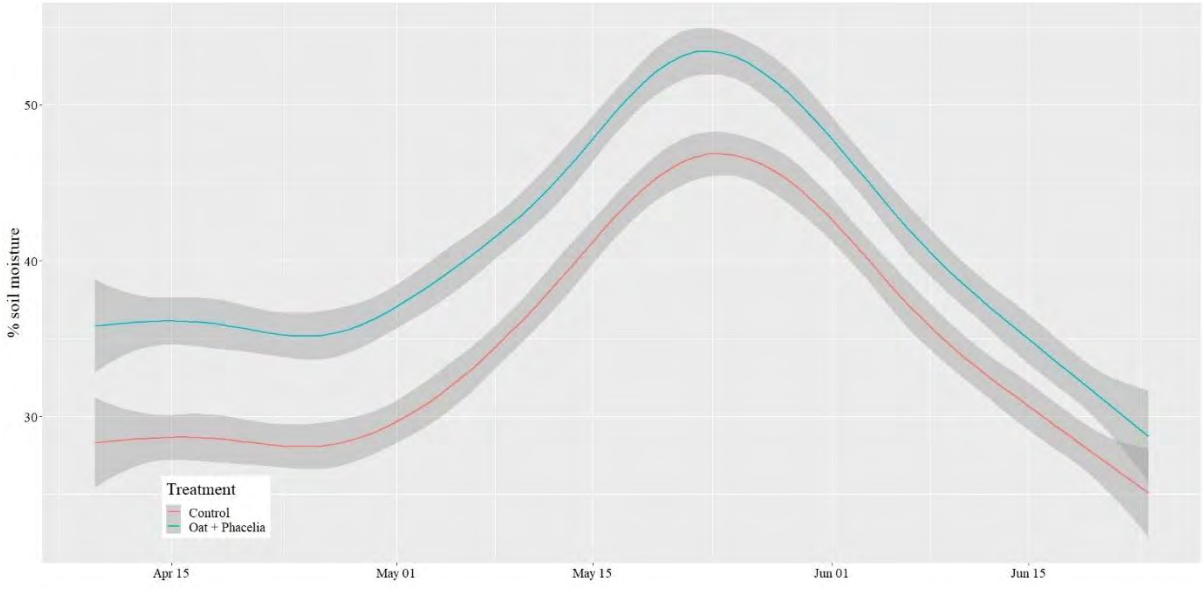

Figure 11. Soil moisture, Vicarage.

At Long Sutton there appeared to be marginally lower soil moisture where cover crops were used, but only during the earlier part of the growing season. After that, there was no difference in soil moisture between treatments.

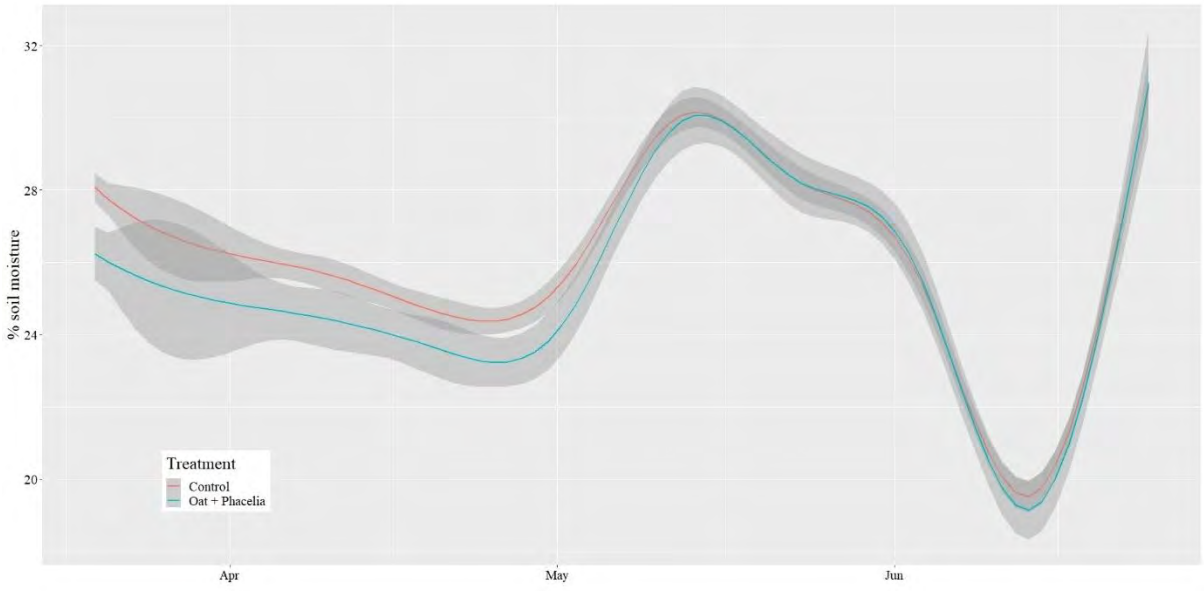

Figure 12. Soil moisture, Long Sutton.

At Eastfield, soil moisture was lower in cover cropped areas in the winter and early spring. From May onwards, soil moisture was highest in oat + phacelia treatments and lowest in oat + mustard.

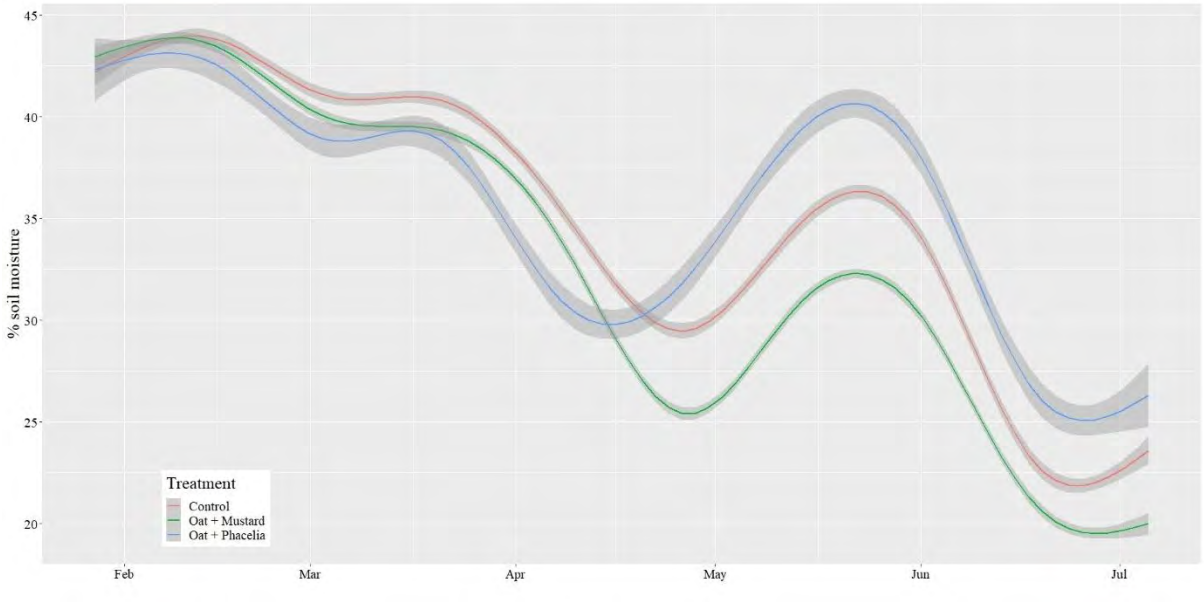

Figure 13. Soil moisture, Eastfield.

Conclusions

There were practically no effects of cover cropping on any measured soil or crop parameter. The effect of cover crops on soil organic matter and pH at one site were inconclusive. The lack of responses is likely due to two factors. First, none of the cover crops showed strong and vigorous establishment. In previous trials, it has been noted that the strongest responses follow big and well-established cover crops which was not achieved this year. Secondly, mild weather and ample rainfall in May and June will likely have protected against moisture stresses often seen at this time of year. Foot rot destroyed the crop at Vicarage. Eastfield and Molescroft had hardly any foot rot development. Under very low or very high foot rot pressures, it is much less likely to see an effect of cover crops on disease development. At Vicarage, foot rot risk was medium and disease moderately developed in the crop. Although not statistically significant, disease development was lowest after oat and vetch cover crops which aligned with highest yields after this treatment. Over the last seasons, positive effects of cover cropping were often seen in vining pea crops suffering from lack of soil moisture or high compaction. This year, environmental stresses on vining peas were lower and cover crop biomass low. Under these circumstances, cover crops did not present an advantage to vining pea cropping.

Acknowledgements

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