Field lab: Buckwheat for couch control

Final report

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1 Field lab aims

The aim of this field lab was to investigate the potential for buckwheat to reduce couch grass infestations in horticultural rotations. Through a series of on farm trials the group set out to answer the following questions:

- Can buckwheat be built into rotations to reduce the couch grass burden on farms?
- What are the costs and benefits of using buckwheat (as a potential crop or green manure) in the rotation?
- Can we compare it with other means of control (e.g. fallowing)?

Figure 1: Discussing trial set up at the first field lab group meeting

2 Background

Couch grass or twitch (*Elymus repens*) is a common perennial weed. It is found in most soil types and rapidly spreads by underground rhizomes. New shoots, produced from the rhizome tips in spring and autumn, quickly produce tufts of leaves and more rhizomes. This makes it difficult to control once established especially in organic systems. Traditional control methods in organic arable and vegetable systems include repeated cultivations, harrowing and raking to bring rhizomes to the surface where they are then killed by desiccation, as well as ploughing to bury foliage and rhizomes. Whilst with the right timing and weather conditions these methods can be effective, they can also be damaging to the soil structure.

Buckwheat (*Fagopyrum tataricum*) is a fast-growing annual green manure or cover crop, useful for suppressing weeds. It is frost sensitive so best suited for late spring/ summer sowing, sown in August and September buckwheat can flower within weeks of sowing offering food sources for pollinators. It is good at scavenging for phosphate in the soil, breaking it down and then making it available to subsequent crops after incorporation. There is also some evidence of allelopathic effects of buckwheat may also act as additional weed control.

This field lab group was set up in 2017 based on anecdotal evidence from one of the host farms indicating that when used as a cover crop the inclusion of buckwheat in a rotation might be able to control couch grass. Couch grass is well established in some areas of the rotation at this farm and can have significant negative effects on vegetable crop yields. Their current method of control is to use a bastard or half fallow, however this method has had varying levels of success, needs dry weather conditions to be effective and causes damage to soil structure.

The field lab group was formed with the support of Cotswold Seeds and the Organic Growers Alliance. Cotswold Seeds provided support in the form of free buckwheat seeds for all the trial hosts throughout the duration of the trial.

3 Methodology and data collection

Initially four organic vegetable growers with farms in Southern England signed up to be part of the trials and met in early 2017 to discuss the aims of the trial, how to set them up and trial monitoring plans. Trials were then set up and monitoring carried out over a three growing seasons between 2017 and 2019, two farms participated over the whole period, with two dropping out after 2017 and one more joining in 2018, bringing the total to five growers actively involved in the field lab over the duration.

Participating growers carried out a baseline sampling at the start of each year to determine the levels of couch grass infestation prior to any treatments being applied. They then grew a buckwheat crop, either on its own or as part of a mixture, with a control of their normal farm practice, in most cases a summer bastard fallow. When sown on its own buckwheat was sown at the rate recommended by Cotswold Seeds of 70kg/ha. Rates in mixtures varied. Photographs were taken throughout each growing season were used to monitor the treatments. Key dates and observations such as soil conditions and seed rates were recorded. Couch grass levels were then assessed again at the end of each trial. In 2019 and 2020 worm counts were also carried out to establish differences in soil health between the treatments.

Baseline and end of trial assessments

The methodology for baseline and end of trial assessments was the same; the assessments were carried out at the same time of year and at the same point in the rotation at the beginning and at the end of each year of the trial. Trial hosts aimed to carry out assessments in early spring after initial ground preparation but prior to spring crop establishment, but due to other commitments at this busy time of year the assessments were sometimes pushed later in the season.

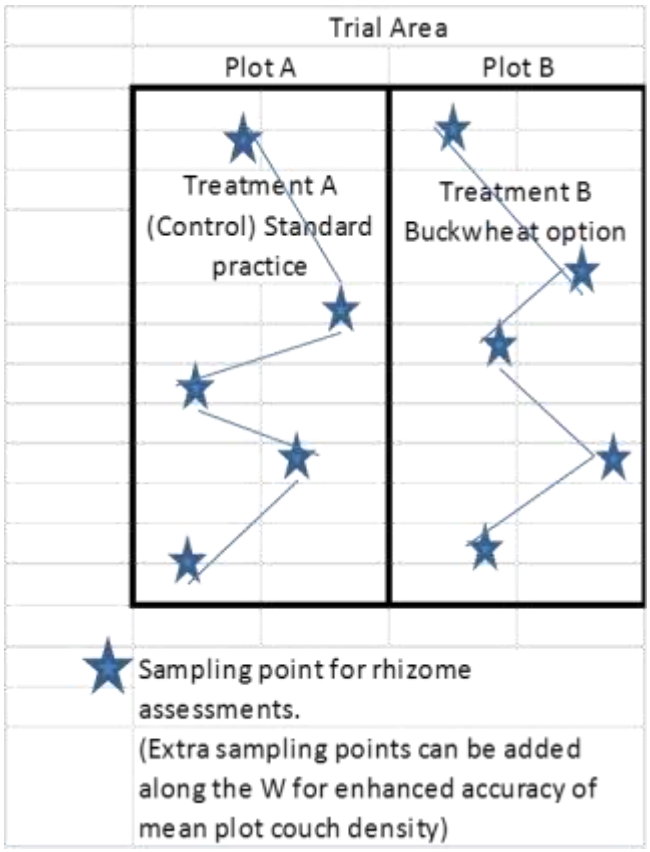

Figure 2: Example of rhizome sampling points in the couch control trials

Assessments involved digging a series of five holes randomly situated in a zigzag pattern across each treatment area (figure 2) with a 2-5 m buffer around the edge of each plot. Each hole was approximately a spades width and depth (c.20 cm by 20 cm by 20 cm deep). All soil was removed from each hole and sorted through for couch grass rhizomes, rhizomes from each subsample were then bagged and the fresh weight was recorded. Average rhizome density (grams per cubic metre) per treatment could then be calculated.

In addition to the rhizome sampling a visual assessment of couch grass infestation across each treatment plot was carried out and ranked on a scale of 0 (no couch) to 10 (wall to wall couch).

Monitoring and observations

Photos of the treatments including cover crop establishment and termination were taken throughout the trials to help evaluate the treatments. In 2019 the ground cover smartphone app Canopeo (figure 3) was also trialled at one of the farms to record couch emergence on the newly prepared field. Photos were taken with a mobile phone at 10 points across each trial plot and the percentage cover of vegetation calculated using Canopeo.

Figure 3: Canopeo app for recording ground cover

Observations were recorded from all trials included the seed drilling date and rates used, soil conditions around drilling/establishment and any other notes such as the occurrence of extreme weather conditions (e.g. frosts/dry spells/heavy rainfall) that may affect cover crop establishment.

Earthworm counts

In spring 2019, earthworm counts were carried out on the two participating trials and repeated on one farm in spring 2020. The methodology used was the same as for the rhizome sampling and was carried out at the end of the trial period using earthworm abundance as an indicator to assess any differences in soil health. Five holes were dug in each plot and all earthworms separated, counted and classified into adult or juvenile and where possible the earthworm ecotype was noted.

4 Results and discussions

The first year of the field lab (2017) was a proof of concept year. All four of the growers involved had different situations and space available for trials, different kit and rotations, so it was not possible to standardise everything across all farms. The challenging weather conditions and competing work pressures resulted in only two of the original farms continued with their participation in the trials in 2018. Results from the two participating farms in 2018 were significantly impacted by the prolonged drought and in 2019, the final year, both farms repeated the trials along with an additional farm that joined the group at the end of 2018.

Figure 4: The group examining the buckwheat trial block in flower at one of the participating farms

Individual site findings

Farm 1

2017 Trial: Three treatments were tested: (1) pure buckwheat stand (2) buckwheat with white clover/trefoil (3) bastard fallow control. Seed was hand broadcast at 70kg/ha. Germination/ establishment was poor and very little buckwheat emerged; it was therefore not possible to compare plots for efficacy of treatment due to lack of buckwheat.

2018 Trial: Ground preparation for the trial was seriously hampered by drought conditions. The trial was reduced to one area of 0.5ha. Buckwheat was sown as a monocrop on 0.25ha and an adjacent

control area of 0.25ha with a bastard fallow. The buckwheat seed was broadcast on the 15th August, rolled and irrigated with half an inch of water. A visual pre-trial couch assessment for both the control and treatment plots scored 8 out of 10. There was excellent germination and very speedy growth. The buckwheat was destroyed at 6 weeks with flail then incorporated with rotavator to 15cm depth and rolled.

3 weeks after sowing

Destroyed at 6 wks with flail

Incorporated with rotavator

6 wks no couch/cover crop

Spring '19 couch growth

Spring '19 couch rhizome

Figure 5: Trial photos from 2018 at farm 1 showing buckwheat establishment, destruction and post-trial couch grass growth.

Six weeks after incorporation there was no couch growth in the buckwheat plot, but no germination of the cover crop either. Sixteen weeks after incorporation there was still no couch growth and very little cover crop. The ground was prepared for the following onion crop in March 2019 and lots of healthy couch rhizomes were still observed in both the treated plots and control.

Although both plots started with the same visual score for couch cover, end of trial couch assessments carried out in April 2019 showed a higher mean weight of couch rhizomes in the buckwheat plot than in the control (figure 6). This maybe be a result of the dry summer weather in 2018 giving excellent conditions for killing couch grass by cultivations.

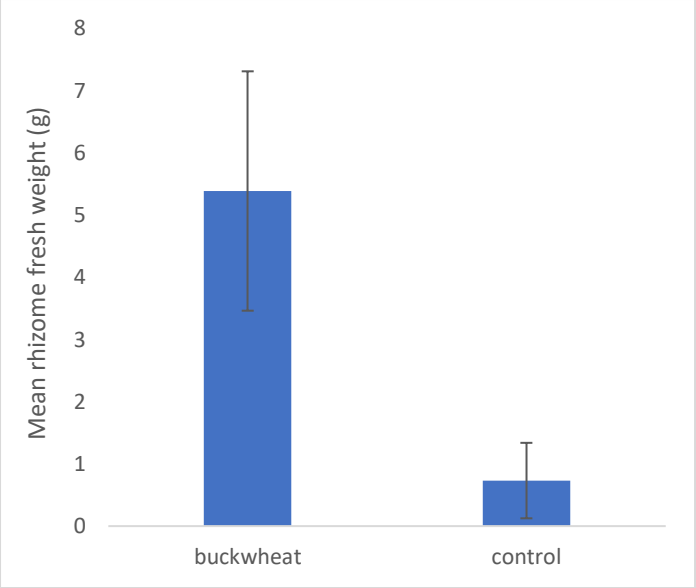

Figure 6: Mean fresh weight of couch rhizomes in April 2019 at the end of the 2018 trial at farm 1 (+/- standard error)

2019 Trial: Two trials were established in 2019, both compared buckwheat as a monoculture against a bastard fallow. Trial one was at the same point in the rotation as the 2018 trial (after brassicas but before onions) but in a different area of the field. Trial 2 was established in the summer before sowing a mixture for a longer-term fertility building ley. Baseline assessments were carried out on both trials in April 2019. Rhizome weights were recorded from trial 1 (figure 7), the amount of couch in each treatment was not significantly different.

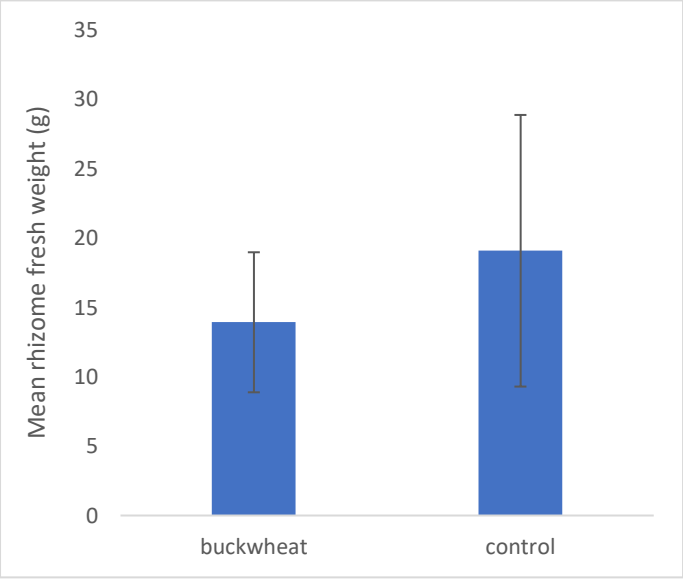

Figure 7: Mean fresh weight of couch rhizomes in April 2019 at the start of the 2019 trial 1 at farm 1 (+/- standard error)

The Canopeo app was successfully used to assess percentage cover of couch in trial 2 (figure 8) as this plot had been cultivated several times and this was the main weed present. Couch cover was slightly higher in the control plot but was generally low (<1%) in both treatments (figure 8).

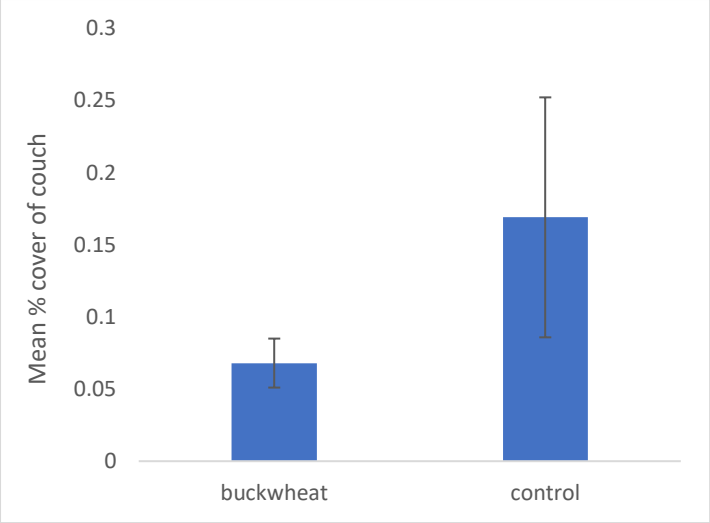

Figure 8: Mean percentage cover of couch in April 2019 at the start of the 2019 trial 2 at farm 1 (+/- standard error)

In 2019 after the buckwheat and bastard fallow treatments, both areas were cultivated and sown with a follow-on crop of phacelia for an over winter green manure to protect the soil before a crop of onions the following season. After sowing the phacelia extreme wet weather set in for the whole of the winter, this had serious effect on crop of phacelia however distinct differences were immediately apparent in different trial areas (figure 9).

Figure 9: The 2019/20 over-winter green manure crop of phacelia sown after the different trial treatments in trial 1, bastard fallow area (top photos) and buckwheat area (bottom photos)

Water infiltration was noticeably different in the two areas, it was far better in the buckwheat area where soil structure was much better due to increased organic matter.

Figure 10: 2019 trial 1 in spring 2020 following ploughing, showing the different response of the soil between couch control treatments.

When the trial area was ploughed in spring 2020, after one of the wettest UK winters on record, there were noticeable differences observed between the different treatments (figure 10). The area where the buckwheat had been the previous year ploughed beautifully and crumbled off the plough despite heavy winter, whereas the area which had been bastard fallowed was heavy and compact to plough resulting in smearing and slow drying.

Observations on the follow-on crop of onions again growing in extreme weather conditions, this time drought, showed that the different couch control techniques showed different end results. In the buckwheat area there was no couch seen at all in the onion crop and the soil structure was good resulting in increased moisture retention and far superior crop growth. In contrast the area which used a bastard fallow to control the couch whist also having no visible couch in the onion crop, had very poor soil structure leading to a poor tilth and therefore slow establishment of crop, poor moisture retention during drought conditions and poorer crop growth.

Farm 1: Observation and conclusions

- When successfully established, the buckwheat formed a dense cover crop fairly quickly which slowed the spread of couch but did not kill it.
- Destruction of the buckwheat was easy with flail and incorporation with rotavator was very good with the majority of green crop buried. However, there was still quite a lot of healthy looking couch rhizome visible at incorporation stage.
- Germination of the following cover crop was poor.
- Couch growth slowed following incorporation of buckwheat, possibly due to an allelopathic effect of the buckwheat caused at incorporation. The couch in the buckwheat trial plot did no growing at all right the way through a very mild winter, where couch on other areas of the farm that had had similar cultivation timings grew well during the mild winter.
- Both buckwheat and a bastard fallow appear to be effective ways of controlling couch grass. However, the impact of the different control methods on the soil structure meant that buckwheat had a significant beneficial effect on the subsequent green manure and onion crop, whereas bastard fallow had a negative effect on both these crops.

Farm 2

2017 Trial: Two treatments were tested with two replicates of each: (1) pure buckwheat stand; (2) bastard fallow. Both trial areas had a high initial couch infestation (figure 9).

A hot and dry early spring in 2017 gave good conditions for stale seed bed and two cultivations prior to sowing. Buckwheat was sown mid-May just before rain forecast, germination and growth was good and opportunities to cultivate were also good with two cultivations achieved in the control bastard fallow treatments.

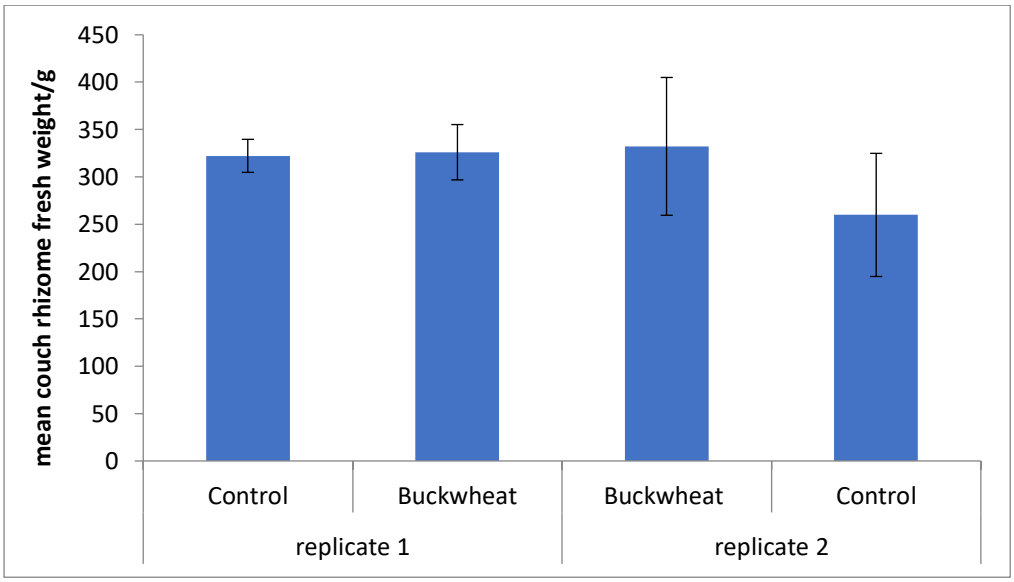

Figure 9: 2017 baseline couch assessment at farm 2, mean rhizome fresh weight per sample (+/- standard error)

Following incorporation both areas were sown with a rye/vetch over-winter mix. Assessments the following spring showed very low levels of couch survival for either block using either treatment (figure 10). Rhizome weight was much lower in this assessment than the baseline and percentage couch control was nearly 100% for all four areas with no significant difference between treatments.

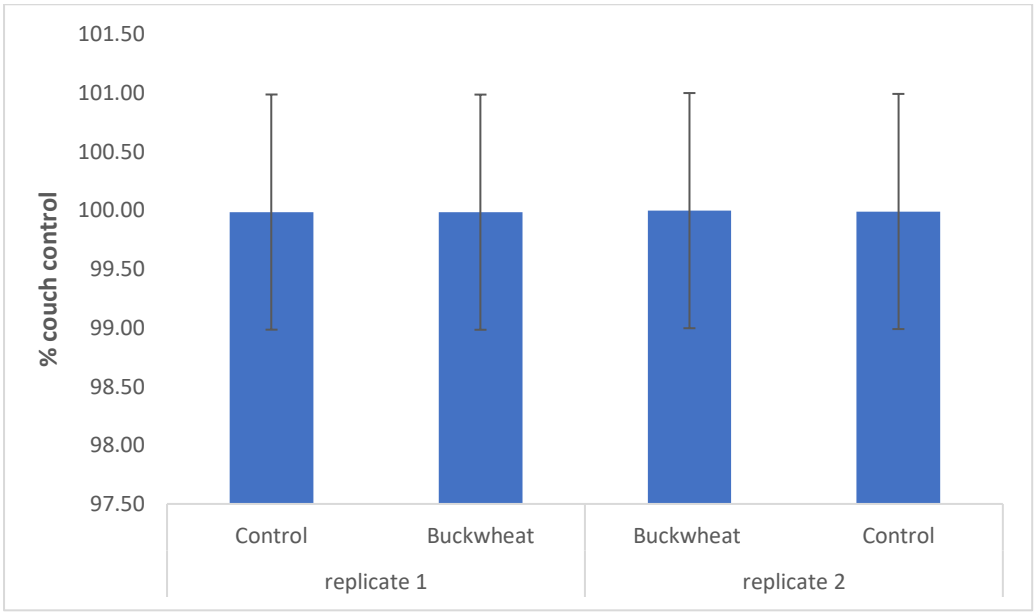

Figure 10: Percentage couch control achieved in treatment and control plots in the 2017 trial measured in spring 2018 (+/- standard error)

The dry weather in 2017 favoured a bastard fallow and farm 2 decided that a more useful comparison for the effectiveness of buckwheat would be to compare it against another green manure crop.

2018 Trial: Only one block was used this year, the cover crop phacelia was chosen as comparison treatment as it has similar qualities to buckwheat and was a better comparison than a bastard fallow which is clearly effective given good conditions but is worse for the soil. Half the block was sown to buckwheat, half sown to phacelia. Initial visual assessments showed a very high couch burden with fat hen as secondary weed in both trial areas. A hot dry early/ mid spring delayed sowing. The ground was prepared by ploughing, rotovating and then one pass with a spring tine cultivator. In May 2018 seed was broadcast at 70kg/ha and irrigated before and after sowing.

2 wks after sowing

7 wks after sowing

mowing at 9 weeks

Rotovation after incorporation

2nd rotovation 2 weeks later

Weed germination Mar 2019

Figure 11: Pictures show plot with buckwheat treatment on left and phacelia on right.

There was good germination on both plots and excellent, rapid growth. Very little evidence of couch in either plot was observed the following year (figure 11). There was a higher cover of weeds observed in the phacelia treatment and it was obvious during growth phase that buckwheat grew taller and did a better job of out competing the weeds. In September 2018 both plots were mown and then incorporated using a rotovator, the plots were rotovated again 2 weeks later and sown with a rye vetch mixture, which failed to establish.

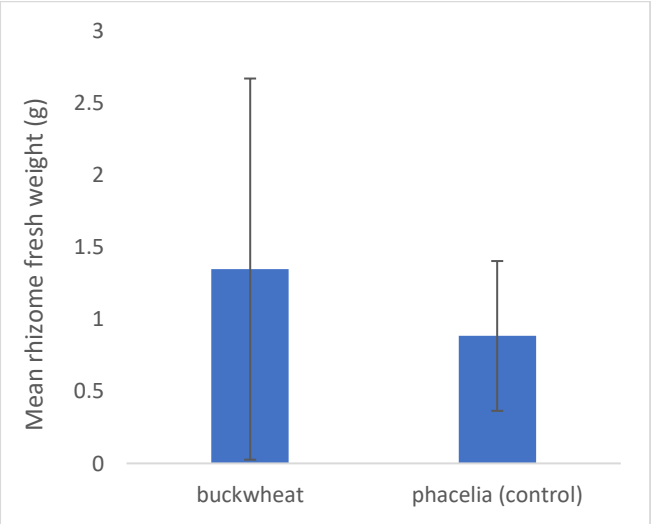

Figure 12: Mean fresh weight of couch rhizomes in April 2019 at the end of the 2018 trial at farm 2 (+/- standard error)

End of trial couch assessments were carried out in April 2019 and showed a large variation between samples but very low amounts of couch in both the buckwheat and phacelia plots and no significant difference between treatments (figure 12) suggesting effective control of the couch by both treatments.

Table 1: Worm counts at the end of the 2018 trial in the buckwheat and no buckwheat plots – taken in spring 2019 and repeated in spring 2020

		2019 worm counts			2020 worm counts		
		adult	juveniles	total	adult	juveniles	total
Buckwheat	**1**	0	3	3	1	9	10
	2	2	8	10	5	9	14
	3	1	7	8	1	10	11
	4	-	-	-	3	7	10
	5	-	-	-	2	8	10
Phacelia (no buckwheat control)	**1**	1	8	9	3	9	12
	2	3	8	11	4	14	18
	3	1	4	5	5	3	8
	4	-	-	-	1	6	7
	5	-	-	-	1	1	2

The differences in the number of worms observed between plots with and without buckwheat in either 2019 or 2020 were minimal (table 1). More juveniles than adults were present both years in both treatments and in 2020 the variability between the samples was higher in the block which had the phacelia sown in 2018. By 2020 the worm populations are likely to be responding to a range of other environmental variables in addition to any effect of the 2018 treatments, so it is not possible to draw any conclusions from this data. Repeat couch grass assessments were also carried out on

the 2018 trial in spring 2020 again with a large amount of variability seen and no clear trends. However later in the year the farmer found that the phacelia area had too much couch in to grow a good crop and this area has being put to a bastard fallow to reduce the couch and will be sown with buckwheat later in the summer 2020. In contrast the buckwheat area is relatively free of couch and has been planted with courgettes.

2019 Trial: The 2019 trial was set up in a different new part of the field, the same approach was used as in 2018 but with earlier sowing to enable better establishment of follow-on green manure. Both treatment plots again had a very high initial couch burden and high volumes of couch were recorded in the baseline assessment in both treatments (figure 13).

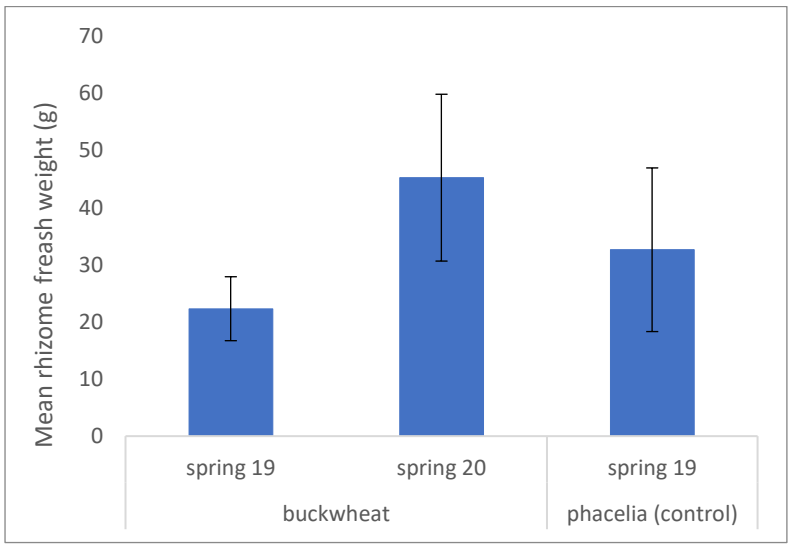

Figure 13: Mean fresh weight of couch rhizomes in April 2019 at the start of the 2019 trial at farm 2 (+/- standard error), repeated for buckwheat in March 2020

The conditions were excellent for early cultivation and sowing and germination and growth of the buckwheat was good. However, phacelia did not germinate well at all and couch was taking over in that plot. Rather than risk further infestation, the farmer decided to revert to bastard fallow on this section.

In spring 2020 end of trial couch grass assessments were carried out but only in the buckwheat plot (figure 13), where the mean couch grass rhizome weights were over twice those at the start of the trial. The large increase in couch is counter to what was found in earlier years and may have been due to the wet autumn weather in 2019 which meant that the buckwheat was not incorporated and the planned winter cover crop not sown.

Farm 2: Observation and conclusions

- The overall conclusion was that with the right management and successful establishment buckwheat had a clear impact on couch.
- Results and observations from 2018 suggest that the phacelia may also have a significant effect on couch growth
- Based on observations the time/ cost of buckwheat vs bastard fallow are likely to be similar. If this is the case then with the right conditions, the benefits for biodiversity and soil health of having a living ground cover rather than bare soil make buckwheat a better option than repeated cultivations.

- The soil type on this farm (relatively heavy clay) mean that the use of buckwheat will be more reliable as there will almost always be a suitable window to get it in, whereas bastard fallow might not always be possible.
- The farm sowed c. 3ha of pure buckwheat elsewhere on the farm in 2019 where couch is an issue as they are so convinced it is effective. It would be useful to include information on these sowings as an addendum to this report in due course.

Farm 3: The trial area was ploughed and buckwheat sown by broadcasting in mid May 2017 with a seed rate of 70kg/ha. Germination was patchy and a heavy weed pressure meant that establishment and growth was also poor (figure 14).

The whole area was mown and re-sown with a cover crop of Westerwolds rye, a fast growing annual high yielding variety of ryegrass, at the end of September and the trial was discontinued. The trial host did observe that when the plot was prepared the following spring there was very little couch, which may have been due to an allelopathic effect of the buckwheat, the regular cultivations, competition from the dense stand of rye or a combination of all three.

Figure 14: Trial plot at farm 3 showing the three-way battle between couch grass, redshank and buckwheat.

Farm 4: The trial plot (12m by 25m) was divided in two and baseline couch assessments carried out in June 2017. Plot A (control) showed 7.7% coverage and Plot B (buckwheat mix) 12.8%. The plots were then spring tine harrowed and sown a week later on 26th June with:

- Plot A with Cotswold Seeds standard Summer Quick Fix (SQF)
- Plot B with SQF but with the mustard replaced by buckwheat.

Plots were irrigated with about 12mm after sowing.

Observations were that buckwheat cover was inadequate allowing some weeds to get away (mainly Fat Hen and Annual Nettle). However, after the crop was terminated in September and the residue had died off much less couch was observed in plot B. There was no gap in the rotation for a summer green manure in 2018 and the trial was discontinued.

Farm 5: Buckwheat seed was sown by broadcasting then harrowing at the beginning of September 2019, a seed rate of 70kg/ha was used. The buckwheat was oversown with red clover/crimson clover for winter persistence and irrigated.

Figure 15: Buckwheat growing in the trail plot at farm 5

Germination and emergence was good (figure 15) but the couch also came through as quick. Initial observations on the trial indicated that the buckwheat appeared to be achieving some creeping thistle control compared to fallowed beds. The trial and observations were discontinued due to personal circumstances.

5 Overall Conclusions/Recommendations

Results from the trials indicate that combining approaches may be most effective in controlling buckwheat, with targeted cultivations in early spring before sowing the buckwheat. Late sowing of buckwheat allows more time for cultivation and could be the factor influencing the survival of couch (or not) in the subsequent crop. Results from one trial also indicate that other fast-growing green manures which quickly put on large amounts of biomass such as phacelia may also be effective in the control of couch grass. In the challenging weather conditions of 2019/2020, the advantage of buckwheat over bastard fallowing in protecting soil structure and improving soil organic matter became apparent and was evident in the quality of the subsequent crops.

One trial host felt that due to reduced labour requirement, reduced fuel consumption and increased soil benefit, the buckwheat method of couch control was preferable and more reliable than hoping for good summers and sufficient time for multiple cultivations.

Limitations of the trial methodology include the sample size used. The number of samples was chosen to be manageable by the trial hosts and large enough to be a representative sample of the plots but may not have been large enough. Couch grass mainly spreads via underground rhizomes and hence its distribution is often uneven, occurring in patches in some areas but not in at all in other areas. As a result, distribution may not have been accurately recorded. The walk over scoring system whilst more subjective may have given a more accurate picture. Increasing the sample size would reduce the margin of error in the trial results.

The size of seed is also an issue; most growers don't have arable drills and tend to broadcast green manures onto the surface of the soil, which can result in predation by birds and buckwheat not been able to get enough moisture from the soil. This may have been the cause of the low germination rates in some of the trials.

More research into the potential allelopathic effect of buckwheat post incorporation is needed. One trial host noted that when destroyed and incorporated, they believed that the buckwheat had a strong allelopathic effect on the couch grass. If so, this could be used to knock back couch to allow good establishment of following crop. This is not a magic bullet to get rid of couch, but rather a helpful tool alongside well timed cultivations, rotations and vigorous competitive crops.

A full cost comparison of the different methods trialled was not carried out, but results indicate that there is a similar impact of buckwheat on couch grass as a bastard fallow but less soil damage and less cultivations. Buckwheat seed can be costly especially if sown as a monocrop and this cost is not likely to be offset by the reduction in cultivations. However, the impact on the soil, especially over longer time periods, is likely to be significant with increased organic matter, ground cover preventing nutrient leaching and reductions in cultivations. More research is required to understand this and to get an idea of the economic implications.

Special thanks to Cotswold seeds for the provision of buckwheat seeds throughout the duration of the trial.

6 Further reading

- Quackgrass (*elytrigia repens*) control methods in organic agriculture: https://www1.maine.gov/dacf/php/gotpests/weeds/factsheets/Quackgrass-organic.pdf
- Can cover crops aid weed suppression in horticultural crops? ADAS publication: http://www.bcpc.org/wp-content/uploads/2016/11/Angela-Huckle-v2.pdf
- Tatnell, Lynn & Jones, K & Clarke, J. (2012). The suppression of common couch grass (*elytrigia repens*) by buckwheat: https://www.researchgate.net/publication/283086316
- Common Couch Management in Organic Systems: https://www.agricology.co.uk/sites/default/files/files/couch(1).pdf
- Allelopathy - a practical weed management tool? https://www.agricology.co.uk/sites/default/files/files/allelopathy(1).pdf
- Fallowing in Organic Systems - a last resort: https://www.agricology.co.uk/sites/default/files/files/fallowing.pdf