

# EUROPEAN INNOVATION PARTNERSHIP PROJECT: Maximising Organic Production Systems (MOPS)

## OBJECTIVES

Part of the MOPS project involves a 3-year trial of winter and summer green manure crops under Irish conditions. The trial will be carried out over three seasons on the same farm in Co. Wexford, to determine the robustness of any effects.

Each of the green manure trials consists of three green manure mixes and an unsown control, in which the natural weed population is incorporated. The mixes used in the summer and winter green manures and the experimental design were described in the Winter 2018 issue of "Organic Matters".



## SUMMARY (JUNE-NOVEMBER 2018)

Delays in starting the project meant that both the summer and winter green manures were sown later than usual in 2018. In the summer green manure:

- Biomass:  
buckwheat/phacelia>rye/phacelia>clover/ryegrass>control
- Annual weed control:  
buckwheat/phacelia>rye/phacelia>clover/ryegrass>control
- Beneficial insects:  
clover/ryegrass>rye/phacelia>control>buckwheat/phacelia
- Soil bacterial diversity:  
clover/ryegrass>rye/phacelia>control>buckwheat/phacelia

## RESULTS (DECEMBER 2018-MAY 2019)

### SUMMER GREEN MANURE TRIAL

**Soil nutrient analysis:** Nutrient analysis was carried out on the plots representing the four different green manure treatments, including the non-planted controls, two weeks after incorporation of the green manure but before planting of the cash crops. Compared to the analysis of soil samples taken from the trial site before the green manures were sown ("Previous analysis"), all green manures (including the non-planted control, where weeds were allowed to grow) exhibited higher soil nutrient concentrations than in the pre-planting soil, with the exception of potassium which decreased in all the test plots (Table 1), particularly the control plots.

Because potassium is not incorporated into organic matter and is highly soluble, a possible cause of the decrease in concentration could have been the irrigation carried out during the dry conditions of summer 2018.



Table 1. Effect of green manure incorporation on soil nutrient analysis

Nutrient	Previous analysis	Control	Buckwheat/ phacelia	Rye/ phacelia	Clover/ ryegrass
Total nitrogen (ppm)	2314	2980	3016	2694	2894
Phosphorus (ppm)	600	719	709	947	841
Potassium (ppm)	4000	2830	3206	3766	3242
Calcium (ppm)	1024	1628	2201	2338	1957
Magnesium (ppm)	1350	1995	1898	2053	2020
Water (%)	-	18.1	18.0	17.1	18.2

The general trend was that, as predicted, the control plots exhibited among the lowest nutrient levels, although with respect to both nitrogen and magnesium there was no marked difference between any of the treatment plots.

The most successful of the green manures was the rye/phacelia green manure which exhibited the highest concentrations of phosphorus, potassium, calcium and magnesium, due presumably to the very long root system of rye which could harvest nutrients from deep in the soil profile; this green manure also exhibited the lowest total nitrogen (Table 1).

Unexpectedly, the N-fixing clover/ryegrass green manure did not show any increased soil N, the P-scavenging buckwheat did not accumulate more phosphorus and the high biomass of the buckwheat/phacelia green manure did not increase the soil % water content, which would be expected from the effect of organic matter on water-holding capacity.

The delayed start meant that the green manures grew for only two months which could have resulted in the limited performances of the clover/ryegrass and buckwheat/phacelia green manures in increasing soil N and P, respectively.

**Weed management:** After incorporation of each of the three summer green manures and transplantation of the onion or cabbage cash crops in October 2018, weed cover was determined on 27 February 2019. Annual weed cover was significantly lower in each of the green manure plots than in the control plots (Table 2), with the buckwheat/phacelia green manure being the most effective, reducing the annual weed density by almost 40% compared with the control. When the dock population (*Rumex spp*) was assessed, it was observed that both the buckwheat/phacelia and the rye/phacelia green manures resulted in significant decreases in the dock population compared with the control plots (Table 2).

**Table 2. Effect of incorporated summer green manures on weed cover**

	Clover/ryegrass	Rye/phacelia	Buckwheat/phacelia	Control
Total weed cover (% area)	30 b	34 b	27 b	46 a
Number of dock plants per plot	16 a	3 b	8 b	17 a

Any two samples within a row with a common letter were not significantly different

Possible explanations for this weed control include competition for light (and other resources) during the green manure phase, where the tall plants of the buckwheat/phacelia green manure reduced the number of annual weeds which flowered, reducing the soil seed bank (Winter 2018 "Organic Matters"), and allelopathic effects (particularly pre-emergence effects on weed seed germination) of decomposing green manure, an effect where rye is known to be particularly effective. The summer green manure plots were mechanically weeded on 27/02, and then hand-weeded on 20/03

**Cash crop survival and development:** The onion and cabbage plants were transplanted into the green manure plots as described in Interim Report 1. Some pigeon damage occurred on the cabbage plants, which were netted in November 2018. No herbivory damage was observed on the onion plants, although some wind damage was observed. No significant difference in cash crop plant survival between the different green manure plots was detected in either the onion or cabbage plots.

Plant development of both onion and cabbage was measured as leaf number. For both crops, the number of leaves in the buckwheat/phacelia plots was significantly greater than that in the control plants (Table 3).

The stage of development was largely reflected in the mean cabbage head fresh weight harvested on 21/05/2019, although only the yield of cabbage planted after buckwheat/phacelia green manure was significantly greater (by 13.6%) than that of the control (Table 4). The yield of the onion cash crop will be determined in June 2019.

**Table 3. Effect of incorporated summer green manures on crop plant development**

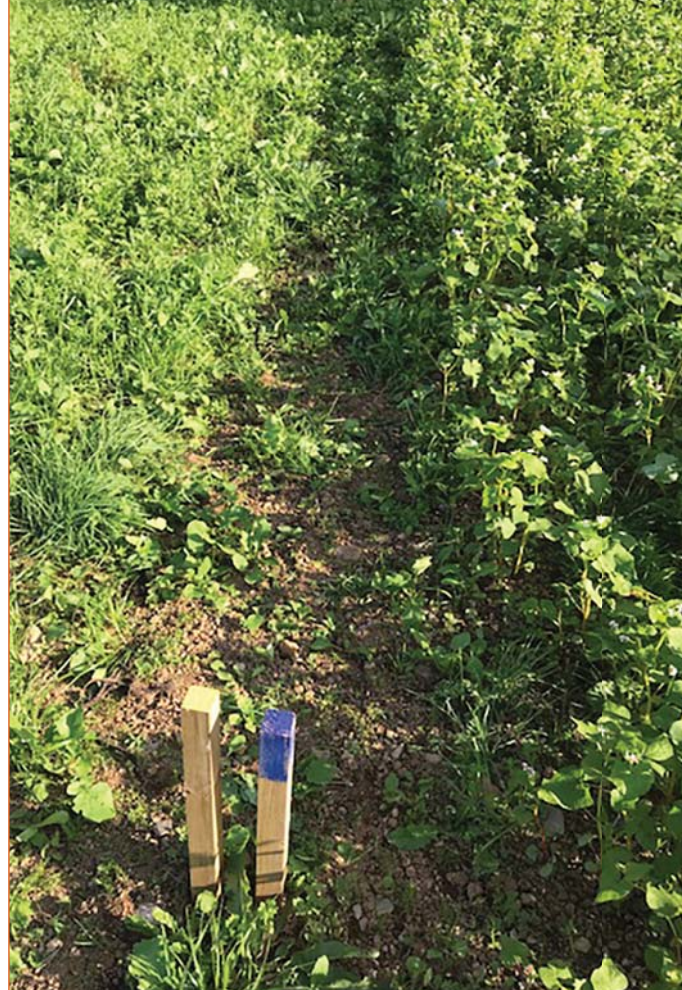
Leaf number per plant	Clover/ryegrass	Buckwheat/phacelia	Rye/phacelia	Control
Cabbage	6.61c	7.93 a	7.20 b	7.02 bc
Onion	2.89 ab	3.05 a	2.73 b	2.58 b

Any two samples within a row with a common letter were not significantly different.

**Table 4. Effect of incorporated summer green manures on mean cabbage head fresh weight (g)**

Clover/ryegrass	Buckwheat/phacelia	Rye/phacelia	Control
59.6 ab	64.1 a	60.9 ab	56.4 b

Any two samples within a row with a common letter were not significantly different.



**Stakes indicating different green manures**

## WINTER GREEN MANURE TRIAL

**Green manure establishment:** On 06/02, there was a significant difference in soil area covered by the three green manures, with the Wild Atlantic mix having a significantly higher coverage than rye/vetch (due largely to the oats component of the former mix), which in turn was significantly higher than that of the Landsberger mix. By the second assessment on 27/02, the differences had decreased, due to rapid growth of the Landsberger mix, the % cover of which was no longer significantly different from that of rye/vetch (Table 5), and the same trend, of rapidly increasing cover by the Landsberger green manure, was apparent at 20/03/2019, an observation supported by the percentage establishment values on 21/05, where no significant difference in establishment between the three winter green manures was determined (Table 5). These results suggest that Landsberger mix requires an earlier autumn sowing date, whereas the Wild Atlantic mix is suitable for later-than-usual sowing of a winter green manure.

**Weed management:** Low annual weed seed germination at assessment on 27/02/2019 meant that there were no significant differences in weed cover between the four green manure treatments. On the other hand, the number of dock plants per plot was significantly affected by the composition of the green manure treatment when scored on 21/05 (Table 6), with both the Wild Atlantic mix and the rye/vetch mix supporting significantly fewer dock plants than in the control plots. Rye, a component common to both of these green manures, is known to release allelopathic chemicals from its roots, which can interfere with the growth of neighbouring plants; decomposing rye plants are reported to be highly active allelopathically. Incorporation of the rye/phacelia summer green manure also resulted in a significant decrease in the numbers of dock plants (Table 2). The impact on dock plants and on the cash crops following incorporation of the winter green manures will be closely monitored over the next few months.



Examining soil profile on Green Manure Trial Site, September 2018

**Table 5. Winter green manure establishment (percentage soil cover)**

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Date	Landsberger mix	Rye/vetch	Wild Atlantic mix
06/02/2019	23 c	40 b	66 a
27/02/2019	40 b	52 b	71 a
21/05/2019	71 a	70 a	81 a

Any two samples within a row with a common letter are not significantly different.

**Table 6. Effect of winter green manure treatments on the frequency of dock (*Rumex spp.*) plants (mean number per plot) (21/05)**

Landsberger mix	Rye/vetch	Wild Atlantic mix	Control
16.0 ab	5.8 b	6.8 b	22.3 a

Any two samples within a row with a common letter are not significantly different.

**Beneficial insects:** The only species caught in the deadfall traps were the beneficial common ground beetles and two specimens of *Deroceras reticulatum* (grey field slug). The numbers of ground beetles collected per plot on 21/05 from the winter green manure plots were similar to the numbers collected from the summer green manure plot (see Winter 2018 "Organic Matters"), though the average weight of each beetle was only 21% that of the value from those in the summer green manure, indicating that these were juveniles. In both the summer and winter green manures, a 30-cm wide strip of the green manure crop was left unincorporated to provide a refuge for beneficial insects, from which they could colonise the cash crop; this strip around each plot formed a corridor ("beetle bank") for ground beetle migration from the adjoining headland into the trial plots.

The highest frequency of ground beetles was obtained from the Landsberger mix, which was significantly higher than the frequency in either the Wild Atlantic mix or the control, which, in turn, attracted significantly more ground beetles than did the rye/vetch green manure (Table 7). This finding mirrors that from the summer green manure, in that low-growing green manure plants supported a greater frequency of ground beetles than did tall green manure plants such as in the rye/vetch and Wild Atlantic mix winter green manures (Table 7) or the buckwheat/phacelia summer green manure (Winter 2018 "Organic Matters").

The low number of slugs in the pitfall traps, which are known to be effective at trapping slugs, is interesting. It is tempting to link the relative lack of slugs in the deadfall traps (two in the winter green

manure trials, zero in the summer green manure trials) with the relatively large populations of ground beetles, which are known to consume slugs. It is hoped to set up a sub-trial within the 2019 summer green manure trial to test the hypothesis that increased ground beetle populations in the green manure plots, including the controls, associated with the "beetle bank" strip left after incorporation of the green manures, can help to manage the slug population

**Table 7. Numbers of ground beetles in winter green manures**

Landsberger mix	Rye/vetch	Wild Atlantic mix	Control
125 a	70 c	92 b	95 b

Any two samples within a row with a common letter are not significantly different.

## MAIN FINDINGS (JUNE 2018-MAY 2019)

- The rye/phacelia summer green manure was the most effective at raising soil nutrient levels
- All three summer green manures reduced weed cover relative to the control, with buckwheat/phacelia and rye/phacelia being the most effective at generating biomass and decreasing the dock population in the cash crop. The rye/vetch and Wild Atlantic (rye/oat/vetch/clover) winter green manures reduced dock numbers in the green manure. Rye seems to be a common factor in the control of docks.
- Incorporation of the buckwheat/phacelia summer green manure accelerated the development of both onion and cabbage transplants, and resulted in heavier cabbage heads at harvest
- Of the winter green manures, the Wild Atlantic mix was most effective at generating biomass over the winter, while the Landsberger mix needed warmer conditions (either in autumn or spring) to establish well.
- The highest ground beetle populations were associated with low-growing green manures, such as clover/ryegrass (summer green manure) and Landsberger winter green manure (clover/ryegrass/vetch).