

EUROPEAN INNOVATION PARTNERSHIP PROJECT:
MAXIMISING ORGANIC PRODUCTION SYSTEMS (MOPS)

GREEN MANURES: INTERIM REPORT 5 (NOVEMBER 2020)



Maximizing Organic Production Systems (MOPS) is a European Innovation Partnership (EIP) project that is co-funded by the Department of Agriculture, Food and the Marine and the European Commission.

Objectives

Part of the MOPS project involves a 3-year trial of short-term winter and summer green manure crops under Irish conditions. The same trial will be carried out over three seasons on different sites on the same field on the same farm in Old Ross, Co. Wexford, to determine the robustness of any green manure effects. Each of the two green manure trials (summer and winter) consists of three green manure mixes and an unsown control, in which the natural weed population is allowed to establish and be incorporated. The mixes used in the summer and winter green manures and the experimental design were described in Interim Report 1 (see Organic Matters, Winter 2018).

Summary (June 2018 – November 2019)

In the summer green manure:

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



Cabbage cash crop (spring 2020) after incorporation of summer green manure (summer 2019)

- Soil organic carbon:
buckwheat/phacelia>rye/phacelia>clover/ryegrass~control
- Cash crop development:
buckwheat/phacelia>rye/phacelia~clover/ryegrass>control
- Onion yield:
clover/ryegrass>rye/phacelia>buckwheat/phacelia>control

In the winter green manure:

- Biomass: Wild Atlantic mix*>rye/vetch>Landsberger**>control
- Perennial weed control:
rye/vetch> Wild Atlantic>Landsberger>control
- Beneficial insects: Landsberger>Wild Atlantic~control>rye/vetch
- Soil nutrient levels:
Landsberger~Wild Atlantic~rye/vetch>control
- Soil organic carbon:
Wild Atlantic> rye/vetch>Landsberger>control
- Broccoli yield: Wild Atlantic>rye/vetch>Landsberger>control
- Lettuce yield: Wild Atlantic>Landsberger>control>rye/vetch

*Wild Atlantic mix = oats/rye/vetch/clovers

** Landsberger = ryegrass/clovers

>= significantly greater; ~ = not significantly different

Cash crop yield returns in two years of green manure trials

Overall, these short-term green manures (two months for summer green manure, six months for winter green manure) have achieved consistent beneficial effects over the first two years of the study, associated with better weed control, more beneficial insects, more and greater functional diversity of soil bacteria, greater soil organic matter content and earlier-developing cash crops than in the control. The short green manure growing season may explain the inability to detect increased soil N in the legume-based summer or winter green manures.

Of the nine, green manure cash-crop combinations evaluated in 2019, eight produced significantly higher yields than in the control and higher cost-benefit analysis (after subtraction of additional costs) than the control, with extra profits in the range of €38-106 per 50 m² (onion), €16-53 (lettuce) and €28-46 (broccoli). The only exception was for the lettuce-rye/vetch winter green manure combination, where the yield was 23% lower and returns were €86 per 50 m² lower than in the control.

Yield returns in Year 2 (2019 – 2020) of green manure trials

The “gold standard” for research studies on aspects of field crop agronomy is the use of multi-annual field trials, i.e. repeating the same field trials in the same site over at least two years, ideally over at least two different sites (i.e. multi-site trials).

The MOPS green manure trials are being run on one field (at different sites) in Co. Wexford over three years, with some additional field experiments being carried out over the same period at different locations around the country, for added robustness.



Harvested red oakleaf lettuce

The reasoning behind the use of multi-annual trials is that, to be of value to growers, the effects being studied (eg. the effect of incorporation of summer or winter green manures on cash crop yield in the MOPS trials) need to be robust enough to be expressed despite changes in growing conditions, as would naturally arise from year to year.

Summer green manure: yield of cabbage

In Years 1 (2018–2019) and 2 (2019–2020), the pointed cabbage (cv. Duncan F1) was planted after summer green manure incorporation. The yields were similar between the two years (Table 1), with the yield of the control plots (no green manures sown) being the lowest in both years, but with different green manures giving the highest cabbage yields: buckwheat/phacelia gave the highest cabbage yield in 2019, compared with clover/ryegrass which gave the highest yield in 2020 (Table 1).

Table 1. Effects of summer green manures on yield of pointed cabbage in 2019 and 2020.

Treatment	Green manure	Yield/plant (2019) (%)*	Yield/plant (2020) (%)*
A	Rye/phacelia	108 ab	104 ab
B	Buckwheat/phacelia	114 b	110 b
C	Clover/ryegrass	106 ab	126 c
D	Control	100 a	100 a

*Yield expressed as % of control

Any two treatments within a year with a common letter are not significantly different

Winter green manure: yield of cash crops

The yields of the broccoli and red oakleaf lettuce cash crops were broadly similar in 2020 to those in 2019, although the effects in 2019 were more extreme than those in 2020 (Tables 2 and 3). The broccoli yields after each green manure incorporation in 2019 were at least 30% higher than the control, whereas, in 2020, the highest broccoli yield increase was 28% (Table 2).

In both years, the green manure which resulted in the highest increase in broccoli was the clover/oats/rye green manure. In 2019, the second-highest increase in broccoli yield was achieved from the rye/vetch green manure, but in 2020, this green manure did not result in a significant increase in broccoli yield (Table 2).



Fig. 1. View of summer green manure site, 11/09/2018, facing N.
The tall flowering blocks are the buckwheat/phacelia green manure (>30 cm) immediately before incorporation.

Table 2. Effects of winter green manures on yield of broccoli in 2019 and 2020.

Treatment	Green manure	Yield/plant (2019) (%)*	Yield/plant (2020) (%)*
A	Vetch/clover/ryegrass	133 b	116 bc
B	Clover/oats/rye	154 c	128 c
C	Rye/vetch	148 bc	105 ab
D	Control	100 a	100 a

*Yield expressed as % of control

Any two treatments within a year with a common letter are not significantly different

In 2019, the clover/oats/rye and vetch/clover/ryegrass green manures caused a significant increase in lettuce yield (though lower increases than in broccoli yield), whereas the rye/vetch green manure caused a significant decrease in lettuce yield. Subsequent studies showed that the inhibitory effect was caused by an inhibitory (“allelopathic”) effect of the 60% composition of the rye/vetch green manure on the lettuce, though not by the 30% rye composition in the clover/oats/rye green manure.

In 2018-2019 a period of fourteen days was allowed between green manure incorporation and transplanting of the cash crops; because this short period could have exacerbated the allelopathic effect of the rye/vetch green manure on the lettuce yield, the period was extended to 23 days in 2019-2020.

In 2020, instead of a 20% inhibition of lettuce yield, the rye/vetch green manure resulted in the highest promotion of lettuce yield (Table 3). There was clear evidence of green manure-specific effects on cash crop yield in 2020, with rye/vetch green manure causing the least yield-stimulation of broccoli but the greatest stimulation of lettuce yield, after extending the period between green manure incorporation and cash crop transplantation.

Table 3. Effects of winter green manures on yield of red oakleaf lettuce in 2019 and 2020.

Treatment	Green manure	Yield/plant (2019) (%)*	Yield/plant (2020) (%)*
A	Vetch/clover/ryegrass	107 c	109 b
B	Clover/oats/rye	118 d	104 a
C	Rye/vetch	80 a	122 c
D	Control	100 b	100 a

*Yield expressed as % of control

Any two treatments within a year with a common letter are not significantly different

Although green manures caused marked increases in yields of most of the green manure/cash crop combinations in both years, showing that the effects of green manures were robust, the effects in 2019 were larger than in 2020. Part of this difference could have been due to differences in the characteristics of the growing seasons in 2018–2019 and 2019–2020, with, for example, summer 2018 being hotter and drier than 2019.

Interestingly, establishment of the summer and winter green manures in 2018–2019 (larger effects on cash crops) was greater than in 2019–2020. For example, the buckwheat plants in the buckwheat/phacelia summer green manures at incorporation time were approximately twice the height in 2018–2019 (32–37 cm) (Fig. 1) than in 2019-2020 (15–19 cm).

