Field lab: Flowering margins for diversity and abundance of pest natural enemies

Final report

[31/06/2023]

Author: D. J. Coston, M. Brearley & S. Ellis

1 Field lab aims

There were two main aims of this field lab:

- To assess the impact of flower margins on the level of entomological pest activity and natural enemy activity in cereal crops.
- To investigate whether the presence of a flower margin influences pest pressure and natural enemy activity into the field centre.

2 Background

Off-crop (i.e. non-cropped) habitat can be a valuable resource for natural enemy pest control. Research has suggested that the management of the non-cropped habitat can influence the level of ecosystem service provision in the form of natural pest control into the field and benefit natural pest control. It has also been suggested that the same factors can increase pest pressure and lead to an elevated pest problem. In recent years a lot of attention has been given to the introduction of wildflower margins and the benefit to insect pollinators, but less work has examined the relationship between pest and predator in the cropping area. See section 7 – 'Further reading' for more information.

This field lab was designed in collaboration with 7 farmers, AHDB and researchers to allow the landowner/farmer to perform the on-site sampling activities and send the catches to ADAS to identify the insects and spiders collected to species where possible. This data was then statistically analysed using ANOVA to compare the fields with and without a managed flower margin.

3 Methodology and data collection

To measure the impact of a flower margin on the adjacent crop two transects were set out parallel to each other, at least 50 metres apart, and extending from the field boundary into the crop centre. Along each transect at set distances into the field (with 5 sites sampling at 10, 25 and 50 metres and two also sampling at 75 and 100 metres), sampling locations were established (Figure 1). Each consisted of a pitfall trap and a sticky trap. At each farm two transects were set in a field with a flower margin (test field) and a field without a margin (control field). This allowed comparison between the two fields and assessment of how far into the crop any effect of the flower margin was observable.

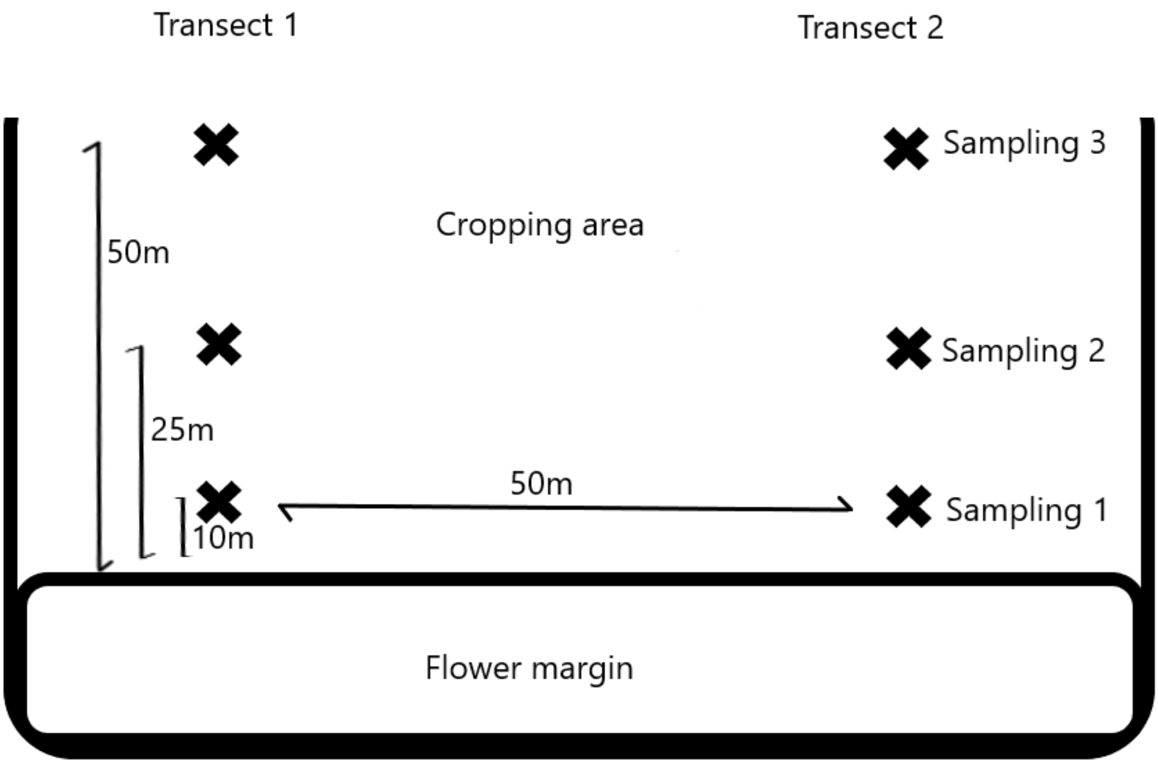

Figure 1. Layout of transects and sampling locations, showing their relation to each other and distances between locations. Each was set up by the host farmer.

A. Sticky trap

At each sampling location a sticky trap was set to record aphid and parasitoid abundance and activity. At each location one yellow sticky trap (10 X 25 cm) was set. This was attached to a cane with a twist tie for seven days at two distinct time periods (first in early May and the second in late June to early July).

Sticky traps were set vertically with the bottom edge at the height of the crop canopy. As the crop grew the traps were moved to ensure the bottom edge remained level with the top of the crop canopy. Upon collection, the sticky traps were sent to ADAS High Mowthorpe for identification of the insect catches. The number of aphids and parasitoids on each trap was counted. These were not identified to species as it is difficult to observe key diagnostic features on insects that are stuck to the trap surface.

B. Pitfall traps

At each sampling location, a pitfall trap was set out to assess spring/summer ground active natural enemies (ground beetles, rove beetles and spiders, Figure 2). These were set out at the same time as sticky traps and also left for seven days (first in early May and the second in mid-June to early July 2022). At the end of each sampling period the pitfall trap contents were emptied through a small sieve (Figure 3) and put in a zip lock bag for postage to ADAS High Mowthorpe. Where possible, the insects were identified to species level.

Each trap consisted of a plastic pot (~7cm aperture) buried in the ground, so the pot rim was flush with ground level. An inverted plant pot saucer supported with wire was positioned above the trap as a rain cover. This stopped the trap filling with water and rendering it ineffective. Each pitfall was ¼ to ⅓ filled with water, 1 Campden tablet (as a preservative) and a few drops of washing up liquid (to break the surface tension so that insects sunk and drowned).

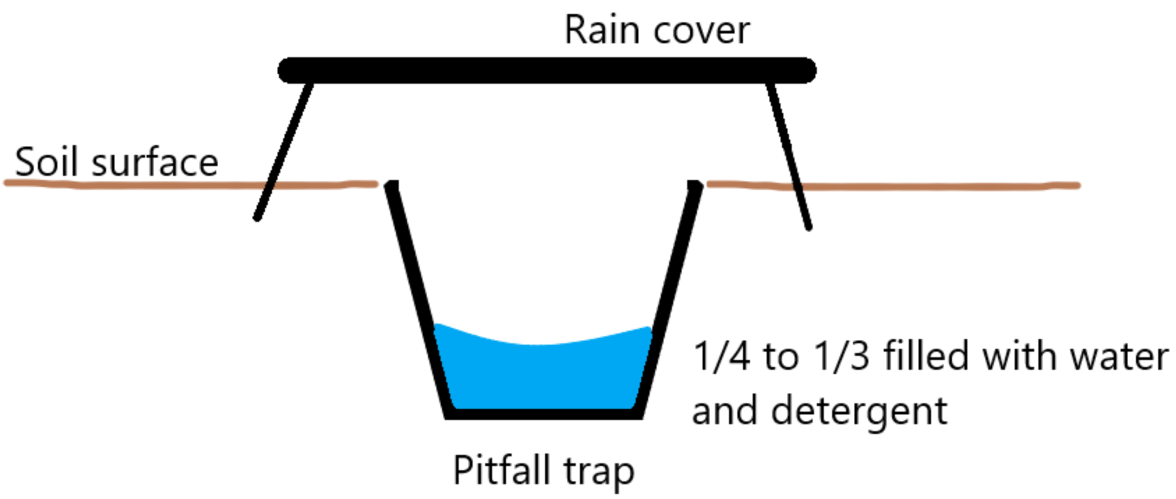

Figure 2. Pitfall trap set up. Showing trap edge flush with ground surface, rain cover plus supports and the water fill level.

Figure 3. Equipment used for setting pitfall traps and collecting the sample.

Figure 4. Pitfall trap and sticky trap in situ.

4 Results and discussion

Sticky Traps – analysis of all seven sites combined

Sticky traps caught a total of 710 aphids and 934 parasitoid wasps over all farms and both assessment rounds.

At the first round of assessments (early May 2022) there was no statistically significant difference in aphid numbers between fields with or without a flower margin ($F=0.19_{1,92}$ $P=0.660$, Figure 5). There was a statistically significant difference observed at the second assessment timing (late June to early July), with most aphids found on sticky traps in fields without a flower margin ($F= 10.25_{1,81}$ $P=0.002$, Figure 5).

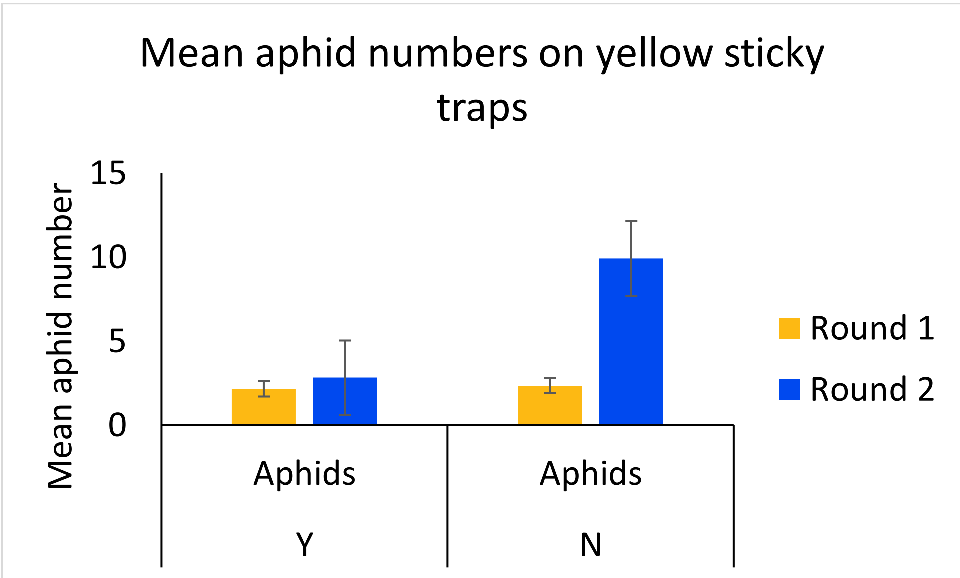

Figure 5. Mean aphid caught on yellow sticky traps for both first round (yellow) and second round (blue) of trapping. On the X-axis Y denotes the presence of a flower margin and N the absence of flower margin. Data presented here includes all farms and all distances from the margin. Y denotes the presence of a flower margin and N denotes no margin present. bars represent the SED.

The same pattern was observed for parasitoids wasps with no difference in numbers between fields at the first assessment ($F=2.27_{1,92}$ $P=0.135$, Figure 6) but significantly more in fields without a flower margin than with ($F=5.75_{1,81}$ $P=0.019$, Figure 6). The analysis performed here includes all sites and all sampling locations. Therefore, caution should be taken when interpreting the results.

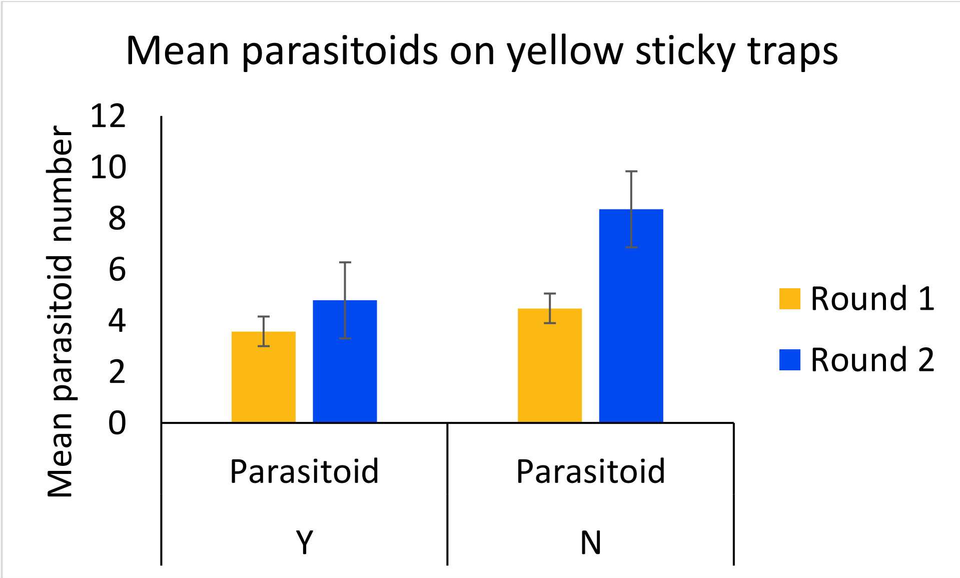

Figure 6. Mean parasitoid caught on yellow sticky traps for both first round (yellow) and second round (blue). On the X-axis Y denotes the presence of a flower margin and N the absence of flower margin. Data presented here includes all farms and all distances from the margin. Y denotes the presence of a flower margin and N denotes no margin present. bars represent the SED.

Sticky trap observations at set distances into the crop

There was no significant difference in aphid or parasitoid catches between trap locations at the various distances into the crop at the first round of assessments (aphids $F=1.85_{4,95}$ $P=0.126$, parasitoid wasps $F=0.77_{4,95}$ $P=0.548$, Figure 7). Nor was there any statistical difference in the second assessment (flower margin aphids $F=0.87_{4,48}$ $P=0.487$,parasitoid wasps $F=1.87_{4,48}$ $P=0.131$, no margin aphids $F=0.66_{4,30}$ $P=0.624$, parasitoid wasps $F=0.89_{4,30}$ $P=0.483$, see Figure 8 and Figure *9*). There was however, a trend for higher numbers closer to the field boundary and with greater replication a pattern may become apparent. As this data set is relatively small, caution should be taken when interpreting the results.

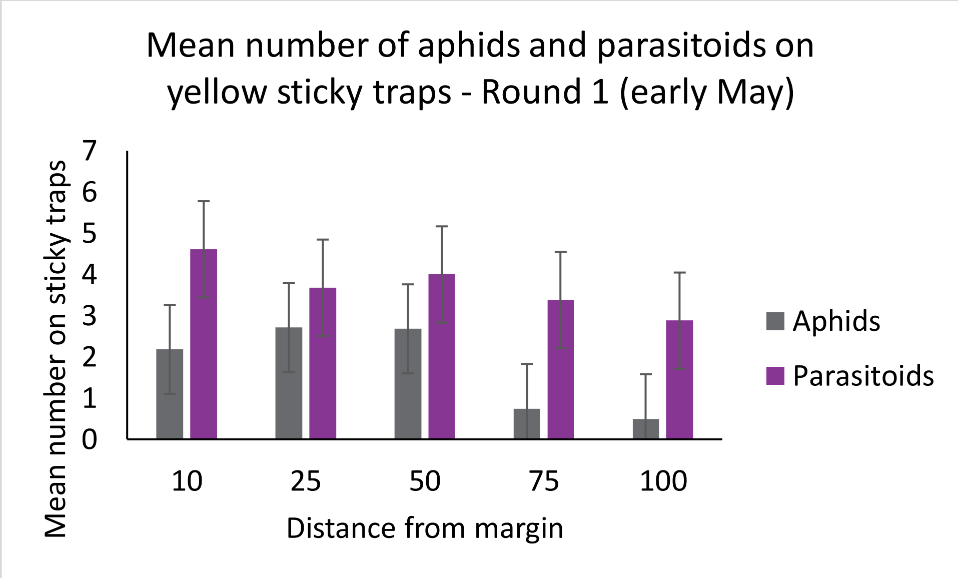

Figure 7. Mean number of aphids (grey) and parasitoids (purple) found on yellow sticky traps during first round of assessments at five distances from field margin. Data includes all sites and both sites with and without a flower margin. bars represent the SED.

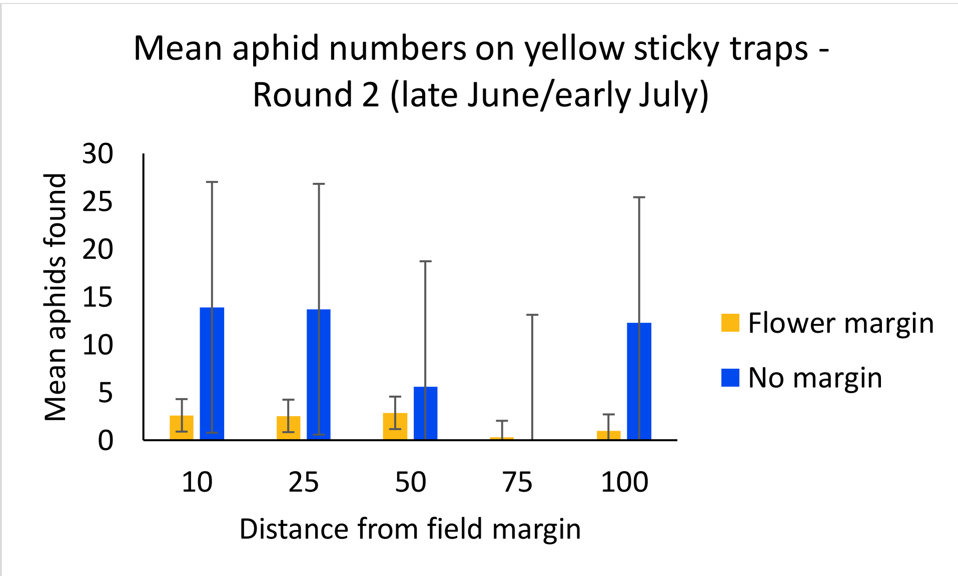

Figure 8. Mean number of aphids found at the second round at five distances from field margin. Showing where a flower margin was present (yellow) and where there was no margin (blue). Data includes all sites. Bars represent the SED.

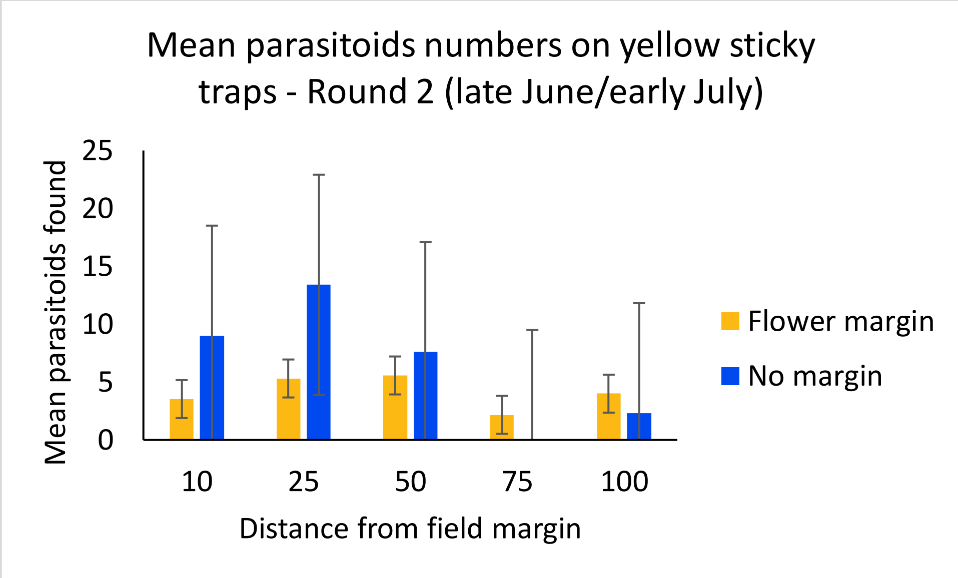

Figure 9. Mean number of parasitoids found at the second round at five distances from field margin. Showing where a flower margin was present (yellow) and where there was no margin (blue). Data includes all sites. Bars represent the SED.

Pitfall Traps – analysis of all seven sites combined

A total of 38,632 specimens were captured over the duration of this field lab and identified at ADAS High Mowthorpe. Statistical analyses were done on three groups: ground beetles (*Carabidae*), rove beetles (*Staphylinidae*) and spiders (*Arachnids*).

At the first round of trapping, a statistically significant difference in numbers was observed for *Carabidae* between fields with and without a flower margin. More *Carabidae* beetles were caught in fields without than with a flower margin ($F=1.06_{1,92}$ $P<0.001$, Figure 10). There was no variation for *Staphylinidae* beetles ($F=0.15_{1,92}$ $P=0.689$) or spiders ($F=1.15_{1,92}$ $P=0.287$) at the first round of trapping. At the second round of trapping, no statistically significant differences in numbers were observed for *Carabidae* ($F=1.96_{1,92}$ $P=0.164$), *Staphylinidae* ($F=0.21_{1,92}$ $P=0.651$) or spiders ($F=2.14_{1,92}$ $P=0.147$) for fields with and without flower margins.

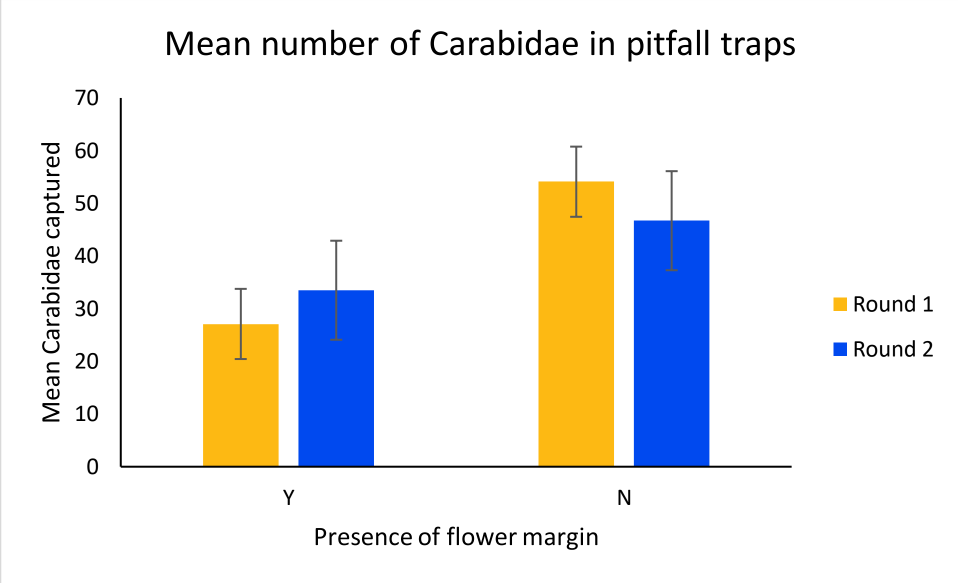

Figure 10. Mean number of *Carabidae*/ground beetles caught in pitfall traps at round 1 (yellow) and round 2 (blue). On the X-axis Y denotes the presence of a flower margin and N the absence of flower margin. Bars represent the SED.

No statistical difference in beetle and spider numbers in pitfall traps at various distances into the field was seen at either trapping round 1 or 2. F test results and probability values for each invertebrate group are as follows: *Carabidae* (Round 1 no margin $F=0.73_{4,35}$ $P=0.577$, round 1 margin $F=1.71_{4,55}$ $P=0.161$, round 2 no margin $F=0.29_{4,32}$ $P=0.883$, round 2 margin $F=0.69_{4,58}$ $P=0.602$), *Staphylinidae* (Round 1 no margin $F=0.52_{4,35}$ $P=0.719$, round 1 margin $F=0.90_{4,55}$ $P=0.469$, round 2 no margin $F=0.29_{4,32}$ $P=0.884$, round 2 margin $F=1.73_{4,58}$ $P=0.155$) or Spiders (Round 1 no margin $F=0.31_{4,35}$ $P=0.868$, round 1 margin $F=2.24_{4,55}$ $P=0.076$, round 2 no margin $F=2.25_{4,32}$ $P=0.086$, round 2 margin $F=0.62_{4,58}$ $P=0.649$).

These results should be interpreted with caution as there was a lower sample size for the 75- and 100-metre traps than for those at shorter distances into the crop. There is insufficient resource in this project to examine fully this data set. Also, the statistical analysis does not take into account the withinfield agronomy. Further examination that incorporates both the local habitat and on farm agronomy differences between insect and spider numbers may become apparent.

Pitfall trap species composition

The highest level of diversity was observed in the C*arabidae* (ground beetles) with a total of 16 species identified (Figure 11, Figure 12, Figure 13 and Figure 14). *Staphylinidae* (rove beetles) were identified as either *Tachyporus spp*, *Philonthus spp* or *Staphylinidae* (Figure 15, Figure 16, Figure 17 and Figure 18). Spiders were recorded to family level as *Linyphiidae* (money spiders), *Lycosidae* (wolf spiders) or other (Figure 19, Figure 20, Figure 21 and Figure 22).

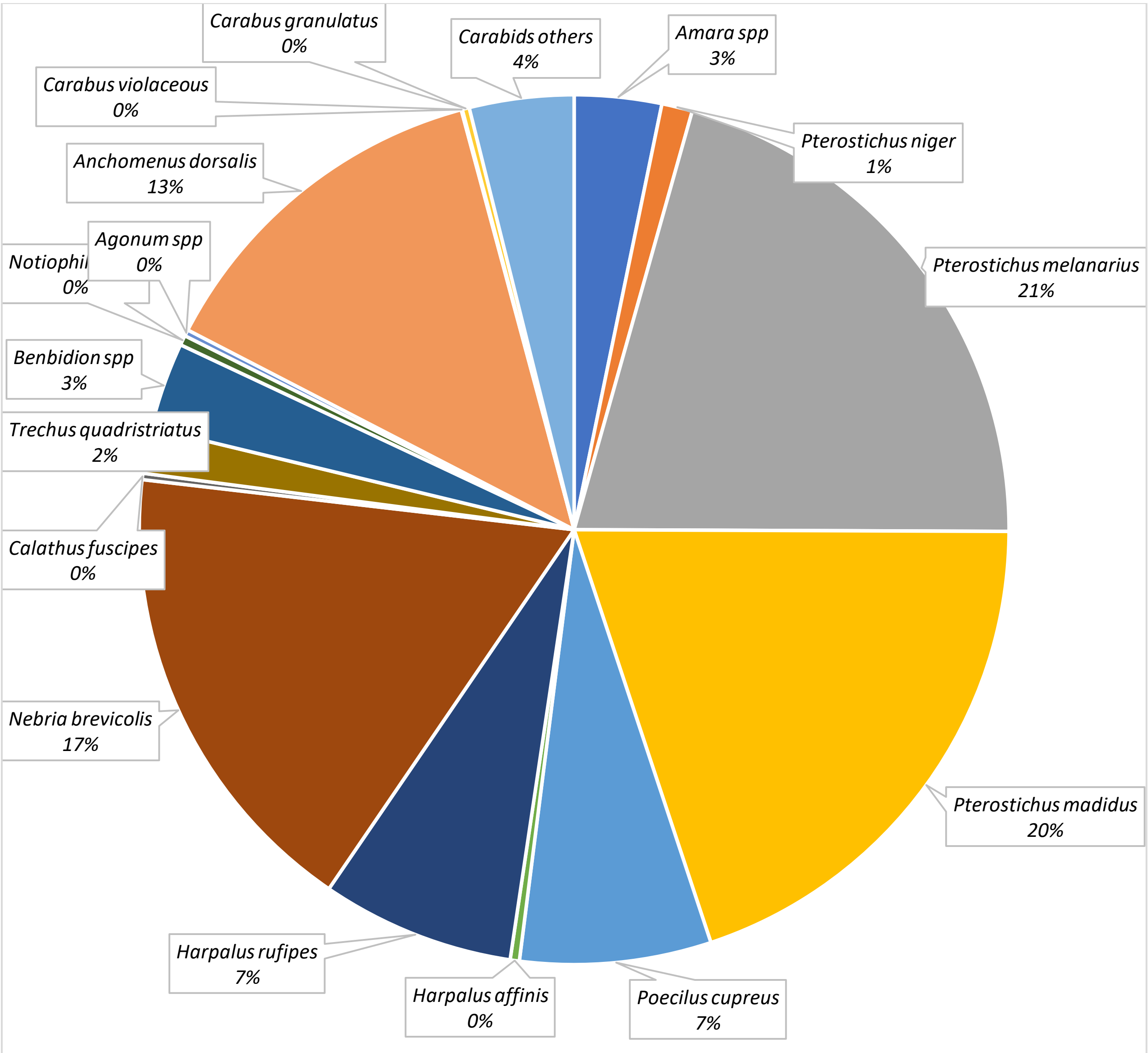

Figure 11. *Carabidae* species recorded at the first round of assessments in fields with a flower margin.

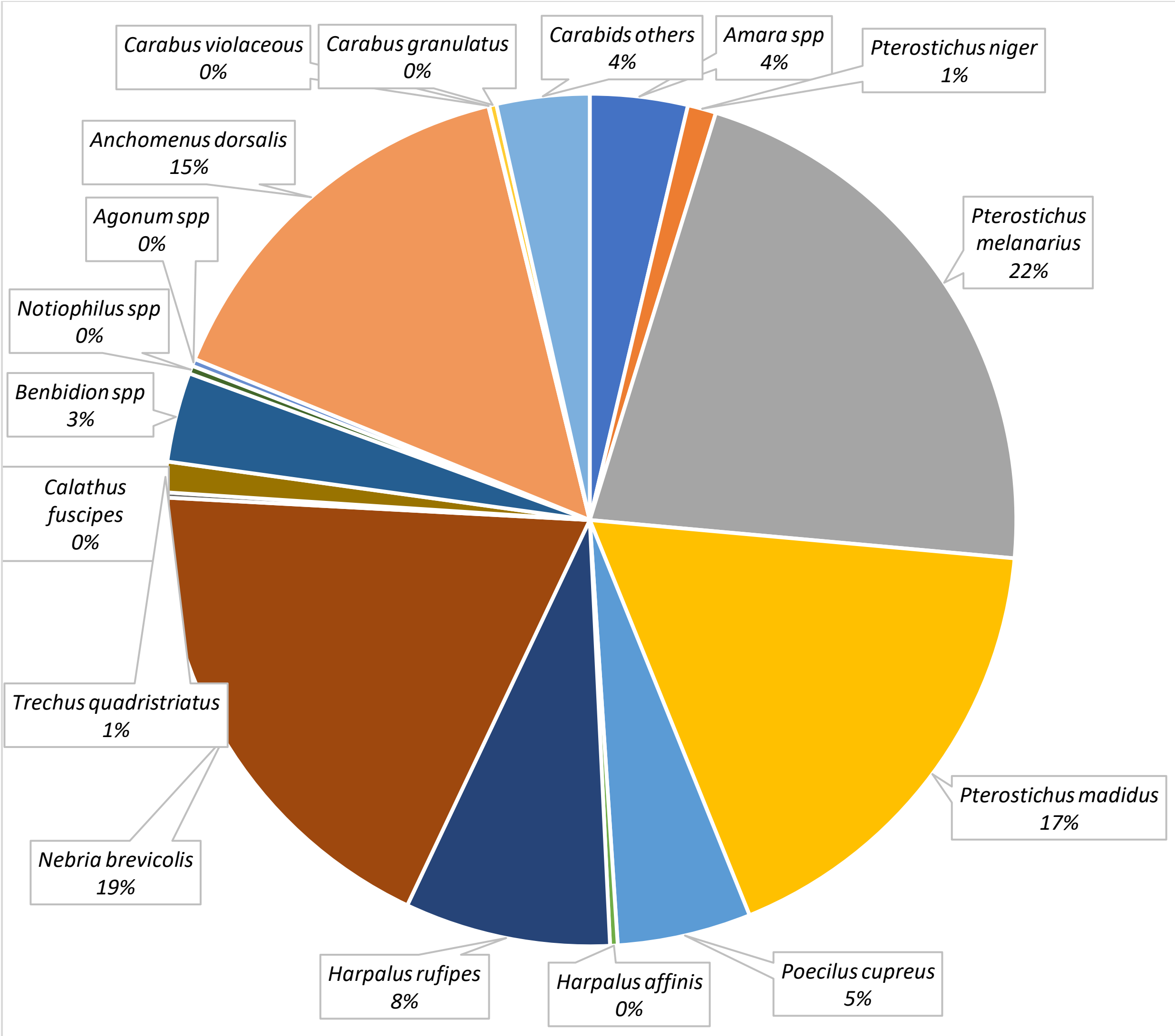

Figure 12. *Carabidae* species recorded at the first round of assessments in fields without a flower margin.

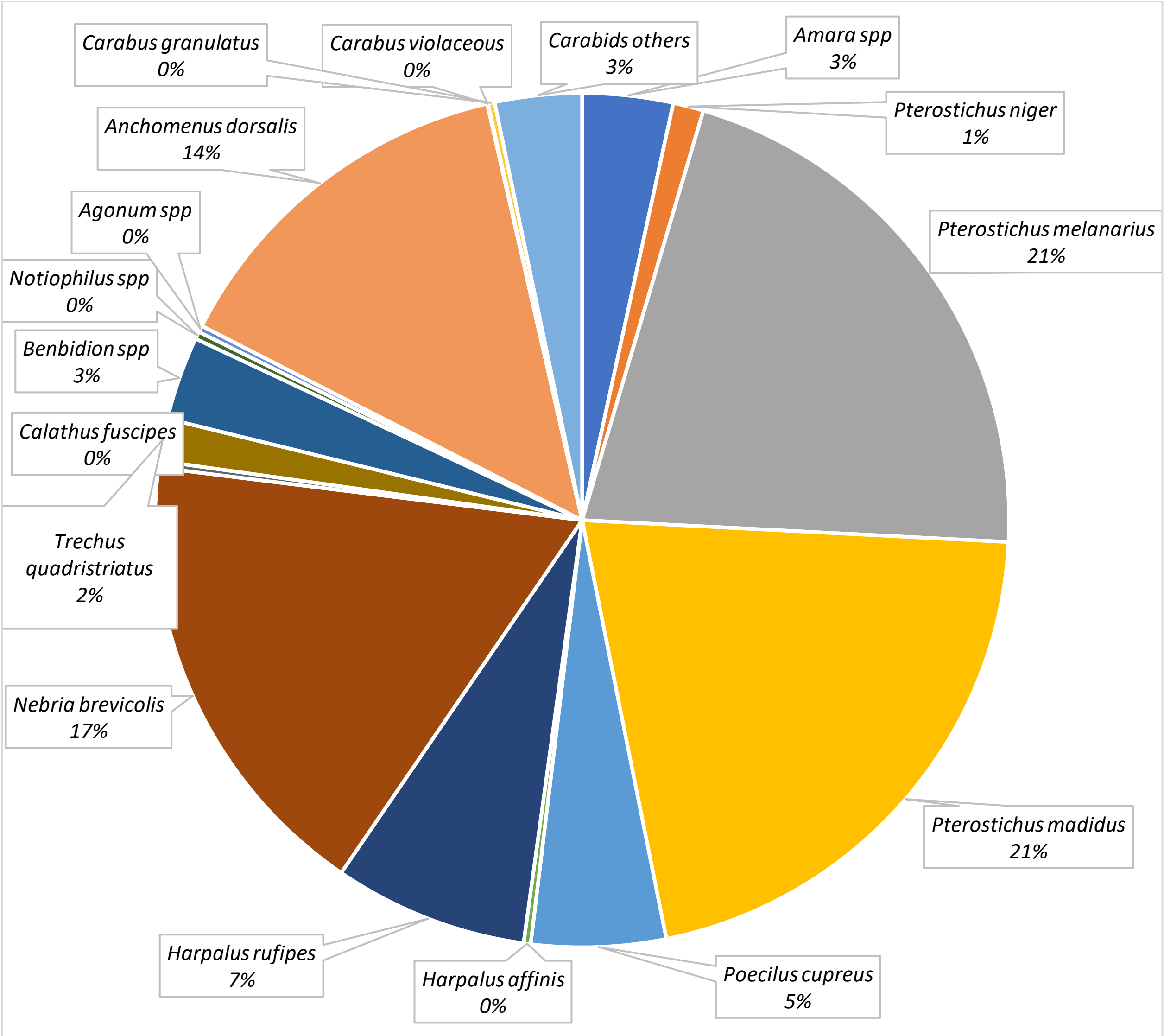

Figure 13. *Carabidae* species recorded at the second assessment in fields with a flower margin.

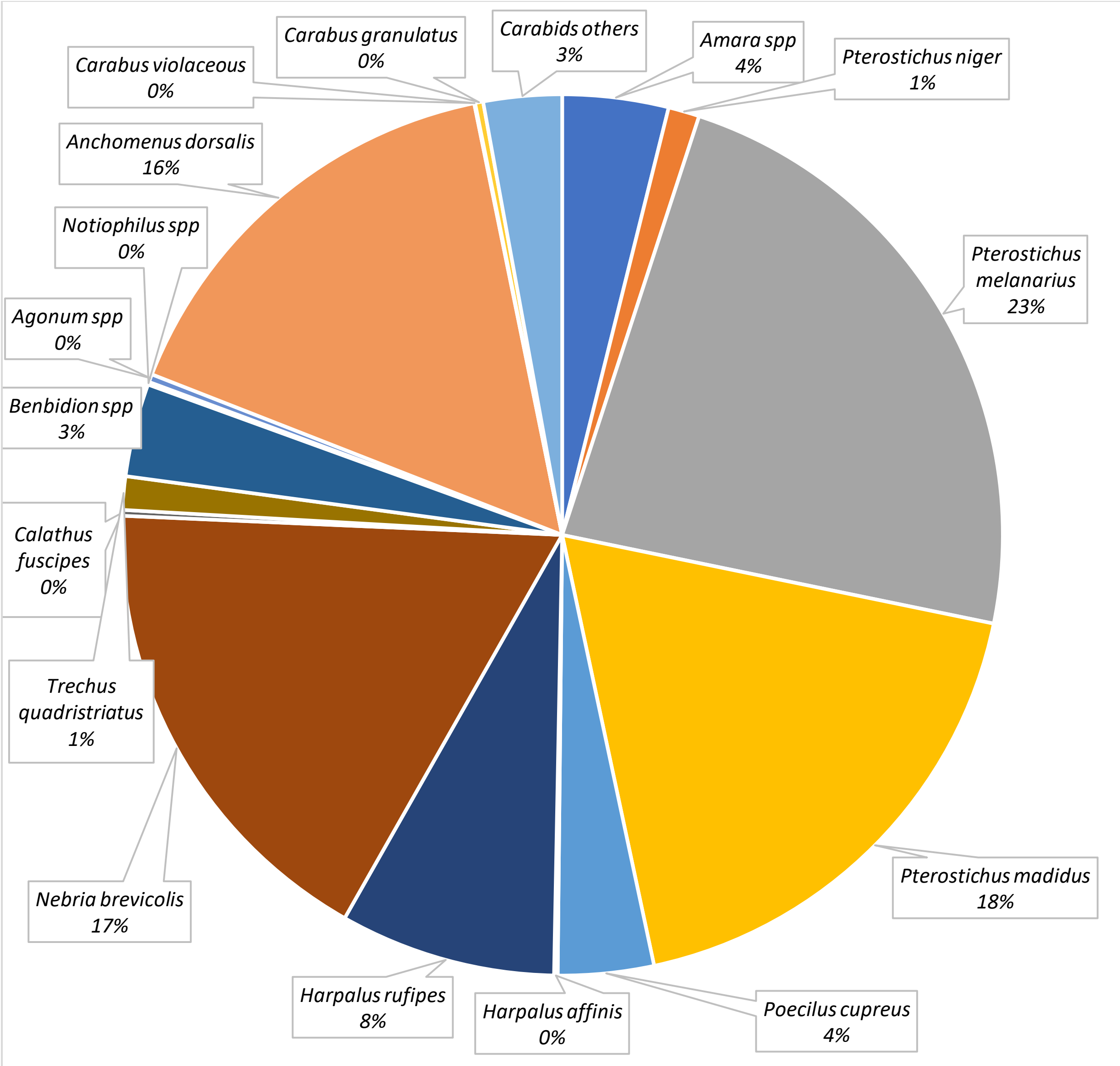

Figure 14. *Carabidae* species recorded at the second assessment in fields without a flower margin.

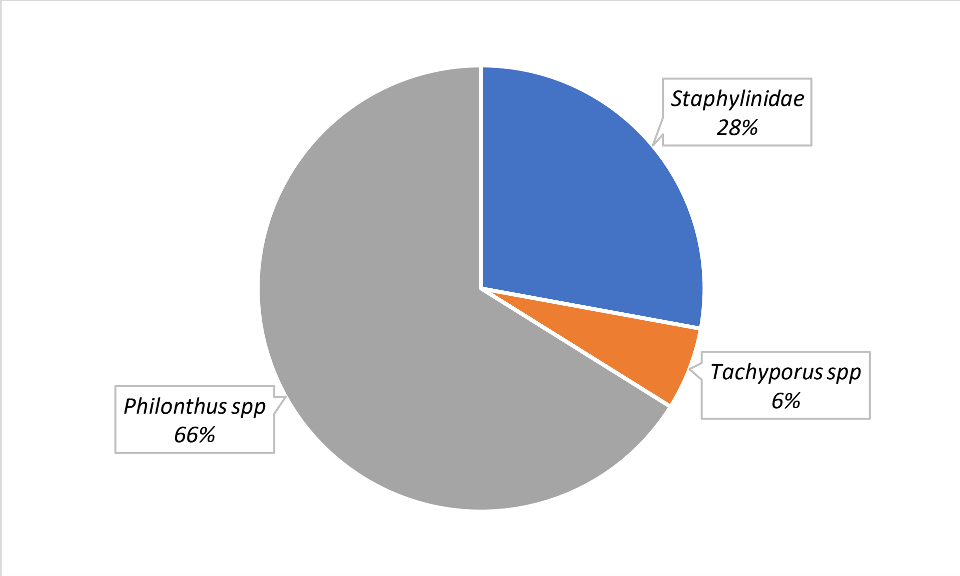

Figure 15. *Staphylinidae* species recorded at the first assessment in fields with a flower margin.

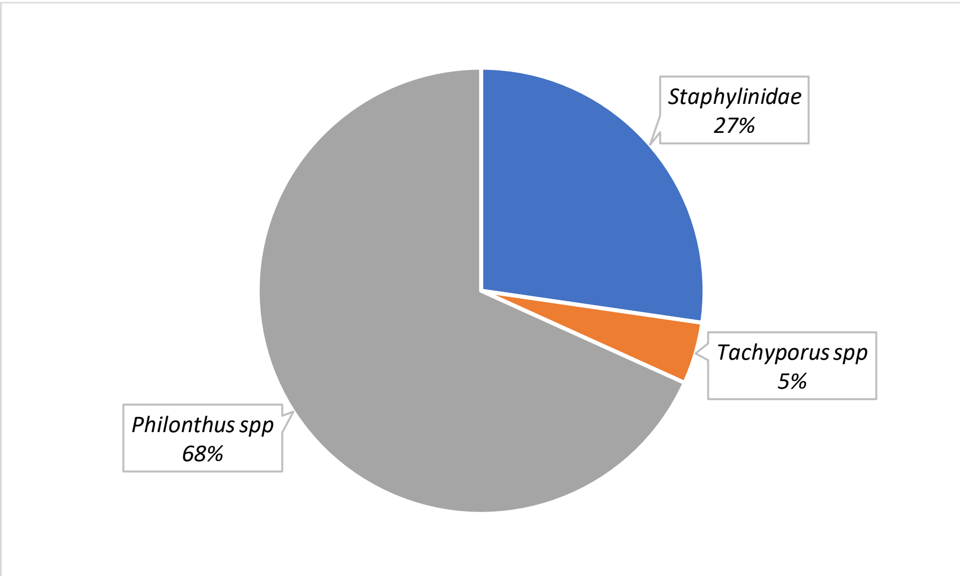

Figure 16. *Staphylinidae* species recorded at the first assessment in fields without a flower margin.

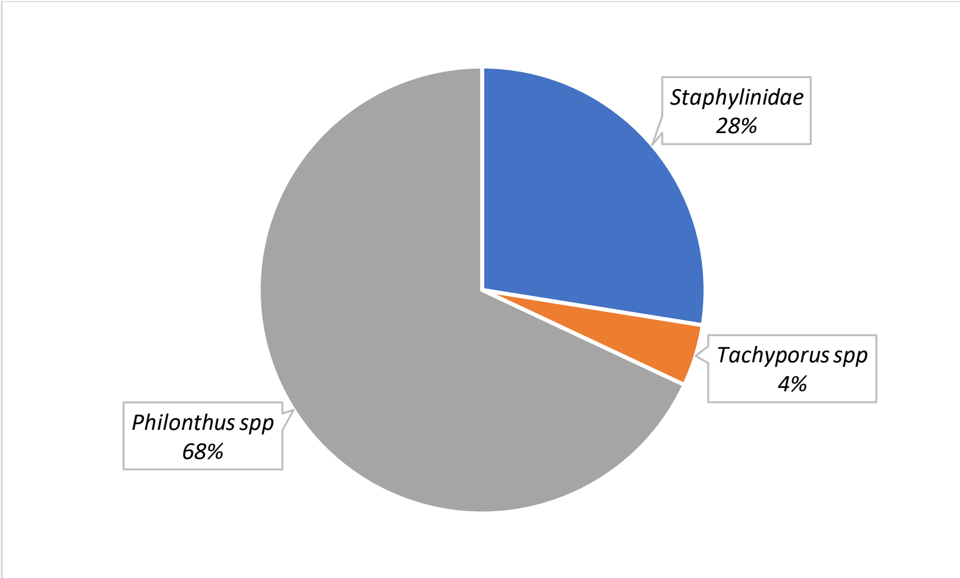

Figure 17. *Staphylinidae* species recorded at the second assessment in fields with a flower margin.

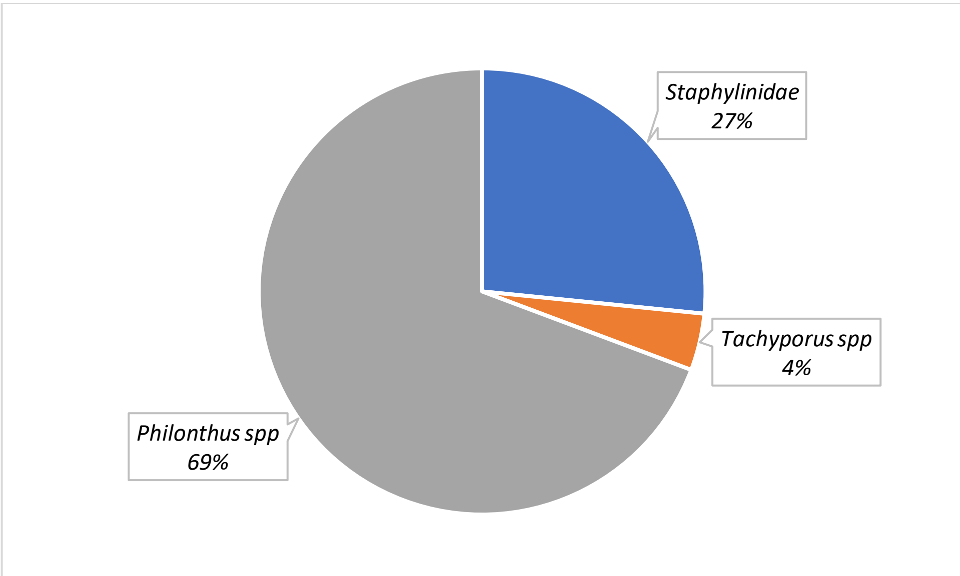

Figure 18. *Staphylinidae* species recorded at the second assessment in fields without a flower margin.

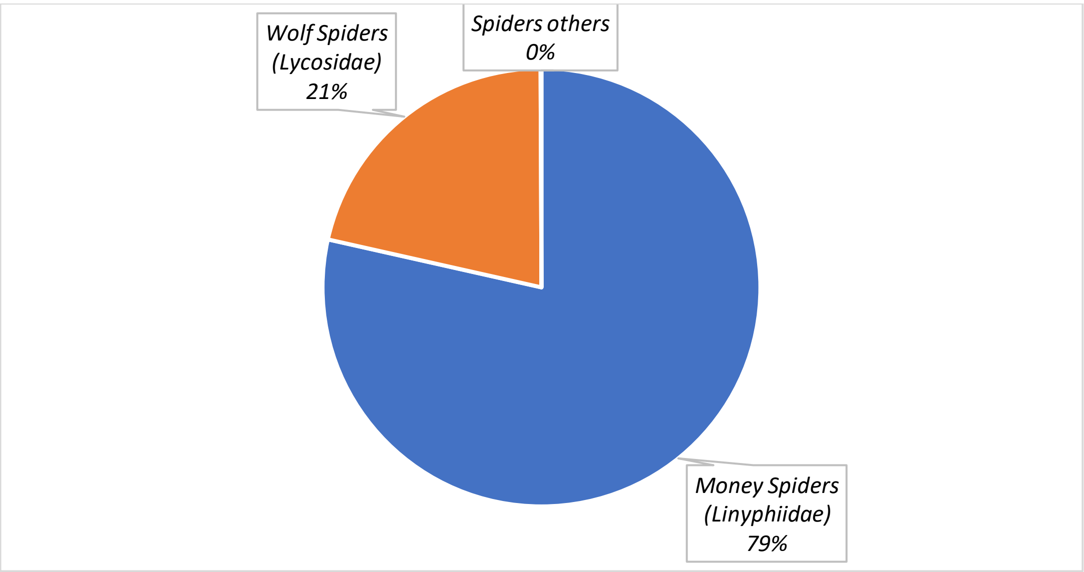

Figure 19. Spiders recorded at the first assessment in fields with a flower margin.

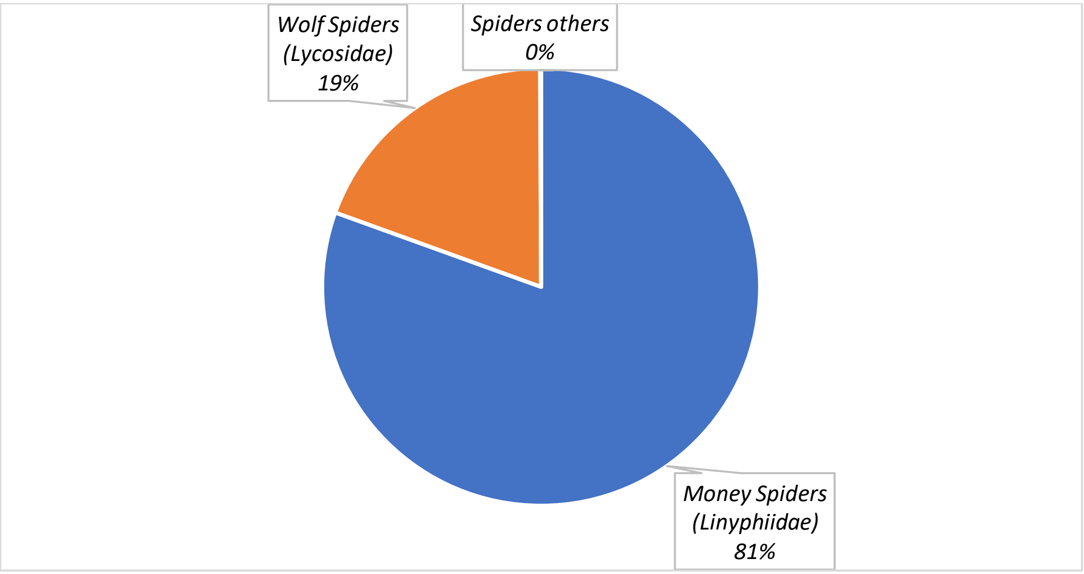

Figure 20. Spiders recorded at the first assessment in fields without a flower margin.

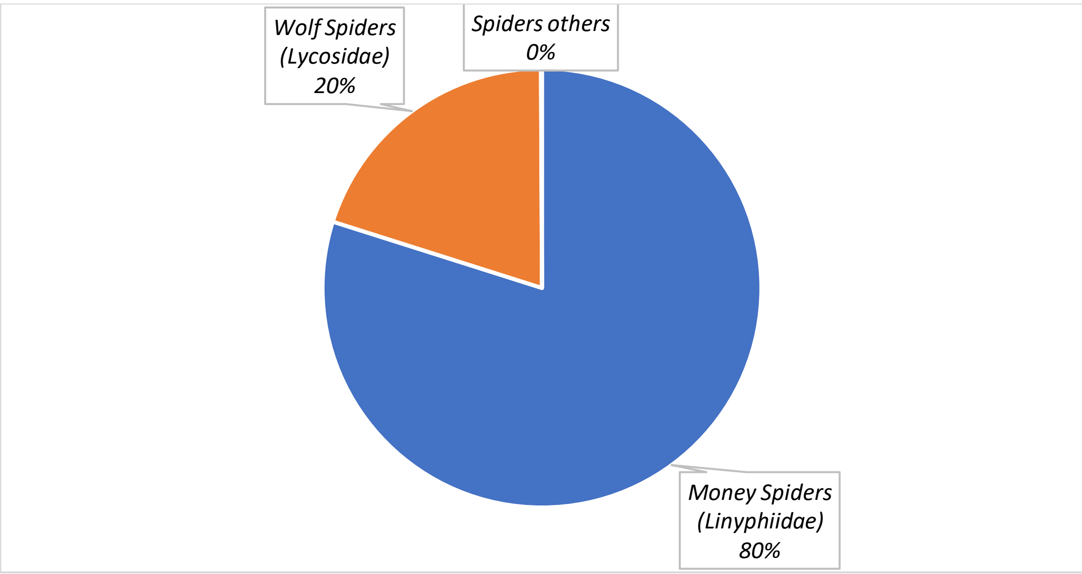

Figure 21. Spiders recorded at the second assessment in fields with a flower margin.

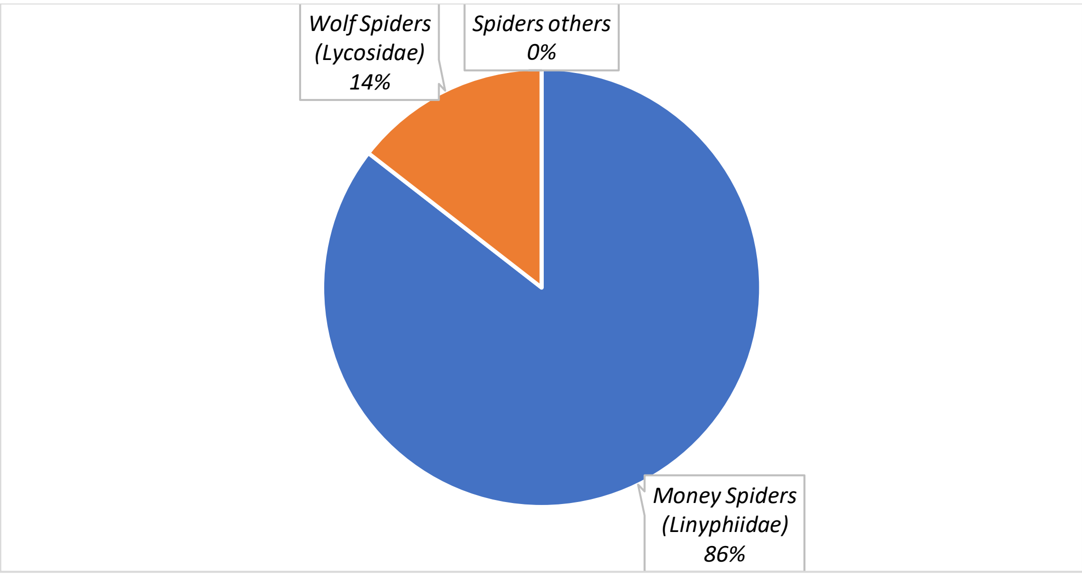

Figure 22. Spiders recorded at the second assessment in fields with no flower margin.

5 Conclusions

The data presented in this report show some evidence that the presence of a flower margin may result in lower grass specialist pest species in the adjacent crop and does not necessarily result in an increase in pest pressure in the adjacent cereal crop, as has been reported in previous literature In fact, the opposite was shown across the whole study with aphids at greater abundance in the fields associated with a non-flower rich margin. Further data would be required to confirm the hypothesis suggested from this field lab that flower margins can potentially reduce pest presence.

The difference observed in this field lab may be because the species of aphids caught on sticky traps were specialist colonisers of grasses and were therefore attracted to the non-flower margin borders which contained more grass than the flower margin borders. Where a flower margin is present, the plant community is dominated by broadleaf flowering plants which do not provide as much refuge habitat for grass specialist aphids. Further research would be required to confirm this.

Like aphids, parasitoid wasps were also most numerous in fields without a flower margin. This is probably because the highly mobile parasitoids were attracted to the higher aphid numbers in these fields.

Carabid beetles were caught more in the fields with a flower margin than without a flower margin during the second round of assessments. There are a wide range of factors which may be influencing this variation in carabid community, which is difficult to extrapolate from the presented data set. Furthermore, detailed examination of the specific species observed may allow a greater understanding of the variations in carabid numbers seen in this field lab.

The main conclusions from this field lab would be that flower margins do not increase the pest pressure in the adjacent cereal crop and may in fact be leading to a reduction in aphid pressure in the crop, but it is difficult to confirm this with the data collected here. Further research would be interesting to examine the interactions with the on field agronomy and margin management along with data on the floral community present in the margins.

7 Further reading

Brittain, C., Benke, S., Pecze, R., Potts, S. G., Peris-Felipo, F. J. and Vasileiadis, V. P. (2022) 'Flower Margins: Attractiveness over Time for Different Pollinator Groups', *Land*, 11(11). DOI: 10.3390/land11111933.

Garratt, M. P. D., Coston, D. J., Truslove, C. L., Lappage, M. G., Polce, C., Dean, R., Biesmeijer, J. C. and Potts, S. G. (2014) 'The identity of crop pollinators helps target conservation for improved ecosystem services', *Biological Conservation,* 169, pp. 128-135.

Garratt, M. P. D., Senapathi, D., Coston, D. J., Mortimer, S. R. and Potts, S. G. (2017) 'The benefits of hedgerows for pollinators and natural enemies depends on hedge quality and landscape context', *Agriculture Ecosystems & Environment,* 247, pp. 363-370.

Jowett, K., Milne, A. E., Garrett, D., Potts, S. G., Senapathi, D. and Storkey, J. (2021) 'Above- and below-ground assessment of carabid community responses to crop type and tillage', *Agricultural and Forest Entomology,* 23(1), pp. 1-12.

Jowett, K., Milne, A. E., Metcalfe, H., Hassall, K. L., Potts, S. G., Senapathi, D. and Storkey, J. (2019) 'Species matter when considering landscape effects on carabid distributions', *Agriculture, Ecosystems & Environment,* 285, pp. 106631.

Jowett, K., Milne, A. E., Potts, S. G., Senapathi, D. and Storkey, J. (2022) 'Communicating carabids: Engaging farmers to encourage uptake of integrated pest management', *Pest Management Science,* 78(6), pp. 2477-2491.

Marshall, E. J. P. and Moonen, A. C. (2002) 'Field margins in northern Europe: their functions and interactions with agriculture', *Agriculture, Ecosystems & Environment,* 89(1), pp. 5-21.

Farmland carabid identification guide by Dr Kelly Jowett (Kelly.jowett@rothamsted.ac.uk): https://repository.rothamsted.ac.uk/item/98999/farmland-carabids-identification-guide