









Summary of biological control of crop pests through the manipulation of the farm ecological infrastructure and modification of the tillage regime








The management implications for the main pests are listed below. Please be aware that some pests are not restricted to one crop, management strategies may transfer. Some conflicting management was identified whilst compiling this report and is highlighted accordingly. This summary is intended to give a broad overview of a range of cultural control methods. The full report is available by clicking on the link to the right.

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Cereals (3179 thousand ha) or (3362 thousand ha including maize)

Key Pests	Management implications
<p>Aphids</p>  <p>e.g. Rose-grain aphid <i>Metopolophium dirhodum</i></p>	<ol style="list-style-type: none"> Insecticide cannot prevent BYDV transmission, but may decelerate the spread. Use resistant cultivars (e.g. 'Rapier') to lessen chemical inputs. Provide flowering borders (e.g. <i>Phacelia</i> spp.) and increase non-crop structural complexity for natural enemies (e.g. parasitoid wasps). Encourage springtails (as alternative food source) [conflicts with OSR point: 25], and hoverflies, lacewings, ladybirds, spiders, carabids, and parasitoid wasps as natural enemies. Reduce spring cereal cropping after mild winters or within landscapes dominated by grassland to reduce BYDV transmission. Use artificial flowers in margins to encourage predatory hoverfly larvae early in the season.
<p>Frit fly</p>  <p><i>Oscinella frit</i></p>	<ol style="list-style-type: none"> Use wild grass margins (e.g. with red fescue) to promote parasitoid wasps. Encourage spiders, carabids, rove beetles, and predatory flies. Avoid cereals immediately following grass leys. If unavoidable, plough grass [conflicts with cereal point: 12] and leave for 4+ weeks before sowing. Sow rye 2 weeks <i>late</i> and spring oats 2 weeks <i>early</i>. Rolling will help crop establishment. Avoid cereals in dense grassland areas, and avoid cultivating grassland [conflicts with cereal points: 9, 17] which destroys parasitoid populations.
<p>Gout fly</p>  <p><i>Chlorops pumilionis</i></p>	<ol style="list-style-type: none"> Encourage parasitoid wasps. Sow winter wheat and barley after late-Sep when sheltered or near woods. Spring cereals should be sown as early as possible in high risk areas.
<p>Leatherjackets</p>  <p>e.g. <i>Tipula</i> sp. larva</p>	<ol style="list-style-type: none"> Encourage parasitoid wasps, carabids, and farmland birds. Following grass, plough [conflicts with cereal points: 12] from Jul to early-Aug and bury herbage. In spring cereals, apply 2+ seedbed preparations following grass, aiming for consolidation and a good tilth. Monitor 'trapped' adults under OSR canopy, and avoid following with winter cereals if numbers are high in OSR. Producing a soil cap by rolling may reduce pest emergence and egg laying in Aug-Sep.
<p>Orange wheat blossom midge</p>  <p><i>Sitodiplosis mosellana</i></p>	<ol style="list-style-type: none"> If chemical treatment is required, apply early to protect parasitoids. Intersperse resistant wheat with 5% susceptible wheat for natural enemies. Cultivate soil [conflicts with cereal points: 12, 31] in dry conditions if pest was a problem in the previous season.
<p>Slugs</p>  <p>e.g. Grey field slug <i>Deroceras reticulatum</i></p>	<ol style="list-style-type: none"> Promote grassy margins <i>with</i> hedges to increase carabids, and reduce slug incidence. Multiple cultivations [conflicts with cereal points: 12, 31] in dry conditions will reduce slug survival, particularly if a fine, firm seedbed is produced. Use a narrower drill coulters to hinder slug movement. Under lower tillage regimes, remove debris and stubble (slug habitat). Wheat can be drilled deeper in cloddy soils. If the previous approaches fail, apply metaldehyde only in Sep, and consider iron (ferric) phosphate as an alternative, although the latter is deleterious to earthworms.
<p>Wheat bulb fly</p>  <p><i>Delia coarctata</i></p>	<ol style="list-style-type: none"> Encourage fungal parasites, predatory flies, carabids, and rove beetles. Avoid soil cultivation from late-Jul and early-Aug [conflicts with cereal points: 23, 25] to stop egg laying. Sow early and at a greater seed rate to compensate for damage.
<p>Wireworms</p>  <p>e.g. <i>Agriotes lineatus</i> larva</p>	<ol style="list-style-type: none"> Neonicotinoids are ineffective, but biocidal compounds and plant meals may produce better control. Encourage parasitoid wasps, predatory flies, and farmland birds. Only use non-sensitive crops (e.g. brassicas) in infested/high risk fields.









OSR (675 thousand ha)

Key pests	Management implications
<p>Aphids</p>  <p>By Ptaszek Gilles San Martin (CC-BY-SA-3.0) e.g. Cabbage aphids <i>Brevicoryne brassicae</i></p>	<ol style="list-style-type: none"> 1. Encourage parasitoids, carabids, spiders, ladybirds, lacewings, and predatory flies. 2. Increasing the area of semi-natural habitat, particularly flowering margins, will increase hoverfly populations. 3. Avoid spring and winter rape crops in close proximity to hinder cabbage aphid colonization [conflicts with OSR point: 25]. 4. Use artificial flowers in margins to encourage predatory hoverfly larvae early in the season.
<p>Brassica pod midge</p>  <p>By Gilles San Martin (CC-BY-SA-3.0) <i>Dasineura brassicae</i> larva</p>	<ol style="list-style-type: none"> 5. Biostimulant application (e.g. nitrophenolate) may improve yield against pest, and is not considered toxic to other flora and fauna. 6. Encourage parasitoid wasps and carabids. 7. Avoid spring and winter rape crops in close proximity to hinder pest colonization [conflicts with OSR point: 25]. 8. Pod midge damage requires weevil boring, so control of weevils are most important (see below).
<p>Cabbage root fly</p>  <p>By James Graham (CC-BY-2.0) <i>Delia radicum</i></p>	<ol style="list-style-type: none"> 9. Encourage parasitoid wasps, carabids, rove beetles, and predatory flies. 10. In previously infested areas, use OSR in fields surrounded by hedges and woods, and avoid OSR crops in fields surrounded by field banks. 11. Avoid spring brassicas close to fields that were previously damaged by root fly. 12. Consider a finger weeder-type action [conflicts with OSR point: 15] to reduce pest emergence, and to allow access for parasitoids to pest hosts.
<p>Flea beetles</p>  <p>By Udo Schmidt (CC-BY-SA-2.0) e.g. Cabbage stem flea beetle <i>Psylliodes chrysocephala</i></p>	<ol style="list-style-type: none"> 13. Resistance to pyrethroids is confirmed for the UK. 14. Encourage parasitoid wasps, wolf spiders, and carabids. 15. Zero/reduced-tillage systems [conflicts with OSR points: 12, 31] reduce pest incidence, while shallow tillage allows for some natural enemy survival. 16. Sowing early and higher plant densities (increase seeding rates and wider row spacing) will reduce pest incidence. 17. Consider using turnip rape as a bordering trap crop around OSR.
<p>Leatherjackets</p>  <p>By Ptaszek Gilles San Martin (CC-BY-SA-3.0) <i>Tipula sp. larva</i></p>	<ol style="list-style-type: none"> 18. Encourage parasitoid wasps, carabids, and farmland birds. 19. Following grass, plough [conflicts with OSR point: 15, 25] from Jul to early-Aug and bury herbage. 20. Thorough seedbed consolidation and a good tilth should be aimed for. 21. Monitor 'trapped' pest under OSR canopy, and avoid following with winter cereals if numbers are high in OSR. 22. Producing a soil cap by rolling may reduce pest emergence and egg laying in Aug-Sep.
<p>Pollen beetle</p>  <p>By gloomie (Raspiglanstafer) (CC-BY-SA-2.0) <i>Meligethes aeneus</i></p>	<ol style="list-style-type: none"> 23. Resistance to pyrethroids is confirmed for the UK. 24. Spray in early bud stage to protect parasitoids, if spraying is necessary. 25. Intensively flowering field margins, increased brassica diversity in landscapes, and reduced ploughing following OSR [conflicts with OSR point: 30] will enhance parasitoids. 26. Spring and winter rape crops in close proximity will favour parasitoid migration upon emergence [conflicts with OSR points: 3, 7]. 27. Enhance carabids, tangle-web spiders, and wolf spiders, though control by the latter may be reduced by a greater variety of alternative prey [conflicts with cereal point: 4]. 28. Increased soil-N and plant density will increase plant vigour and prevent damage. 29. Consider selecting varieties which emit more parasitoid-attracting herbivore-induce plant volatiles (HIPVs).
<p>Slugs</p>  <p>By AfroBrazilian (CC-BY-SA-3.0) e.g. Grey field slug <i>Deroceras reticulatum</i></p>	<ol style="list-style-type: none"> 30. Promote grassy margins <i>with</i> hedges to increase carabids, and reduce slug incidence. 31. Multiple cultivations [conflicts with OSR point: 15, 25] in dry conditions will reduce slug survival, particularly if a fine, firm seedbed is produced. 32. Use a narrower drill coulter to hinder slug movement. 33. Under lower tillage regimes, remove debris and stubble (slug habitat). 34. If the previous approaches fail, apply metaldehyde only in Sep, and consider iron (ferric) phosphate as an alternative, although the latter is deleterious to earthworms.
<p>Weevils</p>  <p>By Ptaszek Gilles San Martin (CC-BY-SA-3.0) e.g. Cabbage seed weevil <i>Ceutorhynchus assimilis</i></p>	<ol style="list-style-type: none"> 35. Cabbage seed weevil resistance to neonicotinoids partly confirmed in Poland. 36. Insecticide application of winter OSR causes high mortality of parasitoids which can achieve 50 % of pest parasitism. 37. Diversifying the landscape with brassicas will help enhance natural enemies. 38. Encourage carabids. 39. Early drilling of winter OSR can reduce risk of attack. 40. Trap cropping with turnip rape followed by a sustainable insecticide application (only in the trap crop) may reduce weevil infestation in the maincrop OSR.





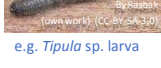




Potatoes (141 thousand ha)

Key pests	Management implications
<p>Aphids</p>  <p><small>By Scott Bauer</small> e.g. Peach-potato aphid <i>Myzus persicae</i></p>	<ol style="list-style-type: none"> 1. Insecticide cannot prevent PVY transmission, but may decelerate the spread. 2. Use maize, lucerne, or wheat as trap crops to reduce PVY-virus transmission. 3. Encourage hoverflies lacewings, ladybirds, spiders, carabids, parasitoid wasps and springtails. 4. Increasing the area of semi-natural habitat, particularly flowering margins, will increase hoverfly populations. 5. Use seed potato varieties that resist aphids, and verified by Seed Potato Classification Scheme. 6. Use artificial flowers in margins to encourage predatory hoverfly larvae early in the season. 7. Protect potatoes from PVY transmitted by probing bird cherry-oat aphids, use maize (preferred), lucerne, or wheat as a non-virus host trap crop.
<p>Slugs</p>  <p><small>By AfroBrazilian (CC-BY-SA-3.0)</small> e.g. Grey field slug <i>Deroceras reticulatum</i></p>	<ol style="list-style-type: none"> 8. Promote grassy margins <i>with</i> hedges to increase carabids, and reduce slug incidence. 9. Multiple cultivations <small>[conflicts with OSR point: 25]</small> in dry conditions will reduce slug survival, particularly if a fine, firm seedbed is produced. 10. Use a narrower drill coulter to hinder slug movement. 11. Under lower tillage regimes, remove debris and stubble (slug habitat). 12. If the previous approaches fail, apply metaldehyde only in Sep, and consider iron (ferric) phosphate as an alternative, although the latter is deleterious to earthworms.
<p>Wireworms</p>  <p><small>By Danny Stepien (CC-BY-SA-3.0)</small> e.g. <i>Agiotes lineatus</i> larva</p>	<ol style="list-style-type: none"> 13. Neonicotinoids are ineffective, but biocidal compounds and plant meals may produce better control. 14. Encourage parasitoid wasps, predatory flies, and farmland birds. 15. Avoid potatoes if pest risk is high, and lift early if damage is suspected. 16. Use pea trap crops or mixed trap crops (e.g. buckwheat, wheat, beans).

Peas & field beans (139 thousand ha)

Key pests	Management implications
<p>Aphids</p>  <p>By Whitney Crane/istock ©bigwood.org (CC-BY-3.0-US) e.g. Pea aphids <i>Acyrtosiphon pisum</i></p>	<ol style="list-style-type: none"> Insecticide cannot prevent PSbMV, PEMV, and BLRV, but may decelerate the spread. Encourage ladybirds, hoverflies, spiders, fungal pathogens, and parasitoid wasps. Use artificial flowers in margins to encourage predatory hoverfly larvae early in the season. Intercropping (e.g. using 'Dragonhead' of the mint family) in field beans reduces pest and enhances natural enemy populations. Consider using biofertilizers and intercropping to reduce pest incidence.
<p>Bean seed flies</p>  <p>©Farmhouse & Garden/istock ©bigwood.org e.g. <i>Delia platura</i> pupa</p>	<ol style="list-style-type: none"> Encourage spiders, rove beetles, pathogenic fungi, and parasitoid wasps. Burying organic matter from previous crop will reduce egg laying. Consider a finger weeder-type action <small>[conflicts with pea & bean point: 20]</small> to reduce pest emergence, and to allow access for parasitoids to pest hosts.
<p>Bruchid beetle</p>  <p>©Brent Scott/istock ©bigwood.org <i>Bruchus rufimanus</i></p>	<ol style="list-style-type: none"> Encourage parasitoid wasps and consider fungal pathogen treatment. Risk is greater when pest was present on previous crop, so consider altering rotation. Consider mustard and nigella oil vapours which act as strong repellent. Select resistant cultivars, delay sowing to reduce seed damage.
<p>Leatherjackets</p>  <p>e.g. <i>Tipula</i> sp. larva</p>	<ol style="list-style-type: none"> Encourage parasitoid wasps, carabids, and farmland birds. Following grass, plough <small>[conflicts with pea & bean point: 20]</small> from Jul to early-Aug and bury herbage. Thorough seedbed consolidation and a good tilth should be aimed for. Producing a soil cap by rolling may reduce pest emergence and egg laying in Aug-Sep.
<p>Pea and bean weevil</p>  <p>©entomart/istock ©bigwood.org <i>Sitona lineatus</i></p>	<ol style="list-style-type: none"> Increased soil-N will increase plant vigour and prevent damage. Encourage carabid and rove beetles, and consider the application of pathogenic nematodes. Avoid pea and bean cropping close to other legumes (esp. clover and lucerne), uncultivated grassland, and fields recently cropped with pea and bean. Zero-tilled <small>[conflicts with pea & bean points: 8, 14, 26]</small> pea fields will reduce pest incidence and damage. Select resistant cultivars, which will increase pest susceptibility to pathogenic nematodes.
<p>Pea moth</p>  <p>©James Lindsay/istock ©bigwood.org <i>Cydia nigricana</i></p>	<ol style="list-style-type: none"> Encourage parasitoid wasps. Plough in unharvested green peas before the larvae can leave the dry pods. Early maturing pea varieties, or later/early sown peas may miss the pest flight period and any damage.
<p>Slugs</p>  <p>By AfroBrazilian (CC-BY-SA-3.0) e.g. Grey field slug <i>Deroceras reticulatum</i></p>	<ol style="list-style-type: none"> Promote grassy margins <i>with</i> hedges to increase carabids, and reduce slug incidence. Multiple cultivations <small>[conflicts with pea & bean point: 20]</small> in dry conditions will reduce slug survival, particularly if a fine, firm seedbed is produced. Use a narrower drill coulter to hinder slug movement. Under lower tillage regimes, remove debris and stubble (slug habitat). If the previous approaches fail, apply metaldehyde only in Sep, and consider iron (ferric) phosphate as an alternative, although the latter is deleterious to earthworms.
<p>Thrips E.g. pea thrips <i>Kakothrips pisivorus</i></p>	<ol style="list-style-type: none"> Encourage spiders, ladybirds, predatory flies, and lacewings by diversifying landscape. Consider inoculating crops with fungal endophyte to increase plant resistance to pests. Sow late emerging crops to prevent pea and field thrips in high risk areas.
<p>Wireworms</p>  <p>By Danny Steaven/istock ©bigwood.org e.g. <i>Agriotes lineatus</i> larva</p>	<ol style="list-style-type: none"> Neonicotinoids are ineffective, but biocidal compounds and plant bio fumigant meals may produce better control. Spray/apply fungal spores when rain is not forecast for 2 days following. Encourage parasitoid wasps, predatory flies, and farmland birds.

Vegetables grown outdoors (116 thousand ha)

Key pests	Management implications
<p>Aphids</p>  <p>e.g. Potato aphids <i>Macrosiphum euphorbiae</i></p>	<ol style="list-style-type: none"> 1. Encourage parasitoids, carabids, spiders, ladybirds, lacewings, and predatory flies. 2. Increasing the area of semi-natural habitat, particularly flowering margins, will increase hoverfly populations. 3. The use of straw mulch <small>[conflicts with veg points: 19]</small> reduces spider cannibalism for better aphid control. 4. Select brassica crops with high chlorophyll and water content will reduce aphid abundance. Selecting for thin leaves and low protein content can reduce honeydew damage. 5. Consider using a fine mesh netting over vegetable crops. 6. Use artificial flowers in margins to encourage predatory hoverfly larvae early in the season.
<p>Cabbage root fly and bean seed flies (BSF)</p>  <p>e.g. BSF pupa <i>Delia platura</i></p>	<ol style="list-style-type: none"> 7. Encourage parasitoid wasps, carabids, rove beetles, and predatory flies. 8. In previously infested areas, use OSR in fields surrounded by hedges and woods, and avoid OSR crops in fields surrounded by field banks. 9. A fine mesh netting on vegetables will reduce root fly infestations. 10. Use finger weeders to reduce pest emergence, and to allow access for parasitoids to pest hosts. 11. Avoid spring brassicas close to fields that were previously damaged by root fly.
<p>Cutworms</p>  <p>e.g. <i>Agrotis segetum</i></p>	<ol style="list-style-type: none"> 12. Consider bio-insecticides (e.g. Bt) or pathogenic nematode application. 13. Young larvae are susceptible to irrigation when feeding on foliage.
<p>Diamond-back moth</p>  <p><i>Plutella xylostella</i></p>	<ol style="list-style-type: none"> 14. Consider neem-based insecticide, which reduces pests and has little effect on ladybird predators. 15. Consider other bio-insecticides (e.g. Bt) which can cause complete mortality and encourage natural enemies. 16. Encourage spiders (particularly wolf spiders) for early season suppression and parasitoid wasps. 17. Intercropping vegetable brassicas with tomatoes may increase parasitoids <i>and</i> reduce pests.
<p>Leatherjackets</p>  <p>e.g. <i>Tipula sp. larva</i></p>	<ol style="list-style-type: none"> 18. Encourage parasitoid wasps, carabids, and farmland birds. 19. Following grass, plough from Jul to early-Aug and bury herbage <small>[conflicts with veg point: 3]</small>. 20. Thorough seedbed consolidation and a good tilth should be aimed for. 21. Establish vegetable brassicas after mid-June (after main pest feeding stops). 22. Producing a soil cap by rolling may reduce pest emergence and egg laying in Aug-Sep.
<p>Silver Y moth</p>  <p><i>Autographa gamma larva</i></p>	<ol style="list-style-type: none"> 23. Consider bio-insecticides (e.g. Bt). 24. Encourage parasitoid wasps, though this would not provide immediate control.
<p>Slugs</p>  <p>e.g. Grey field slug <i>Deroceras reticulatum</i></p>	<ol style="list-style-type: none"> 25. Promote grassy margins <i>with</i> hedges to increase carabids, and reduce slug incidence. 26. Multiple cultivations in dry conditions will reduce slug survival, particularly if a fine, firm seedbed is produced. 27. Use a narrower drill coulter to hinder slug movement. 28. Under lower tillage regimes, remove debris and stubble (slug habitat) <small>[conflicts with veg point: 3]</small>. 29. Cultural control is needed for vegetables sown when natural enemies are inactive and slugs are active (e.g. Brussels sprouts). 30. If the previous approaches fail, apply metaldehyde only in Sep, and consider iron (ferric) phosphate as an alternative, although the latter is deleterious to earthworms.
<p>Thrips</p>  <p>e.g. Onion thrip <i>Thrips tabaci</i></p>	<ol style="list-style-type: none"> 31. Onion thrip resistance to pyrethroids is confirmed for the UK. 32. Row application technique ensures a more even fungicide and insecticide application in leeks. 33. Encourage spiders, ladybirds, predatory flies, and lacewings by diversifying landscape. 34. Consider inoculating crops with fungal endophyte to increase plant resistance to pests. 35. Intercropping in onion crops can reduce infestations. 36. Consider irrigation to reduce pest incidence.
<p>Wireworms</p>  <p>e.g. <i>Agriotes lineatus larva</i></p>	<ol style="list-style-type: none"> 37. Neonicotinoids are ineffective, but biocidal compounds and plant meals may produce better control. 38. Spray apply fungal spores when rain is not forecast for 2 days following.