Cover crops

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Factsheet about integrated weed management

Introduction

Cover crops can be used to diversify a cropping system, one of the pillars for a successful integrated weed management strategy¹¹. Cover crops are defined as all subsidiary crops that are grown in between main crops to cover the soil that otherwise would have been bare or covered with spontaneous vegetation. They may naturally die off, or can be deliberately killed before planting or sowing the following main crop. Inclusion of a cover crop between two cash crops can benefit weed management.

For more practical information about cover crops you can read the Best4Soil factsheet 'Green manures & cover crops: practical information' and for their (dis) advantages the Best4Soil factsheet 'Green manures & cover crops: advantages & disadvantages at <u>www.</u> <u>best4soil.eu</u>.

Applicability

The choice of cover crops is large and they can be grown either in a monoculture or a mixture. Cover crops can be sown in any cropping system and region, also in notillage systems. However, which species and management regime are most appropriate is location-specific. It depends on the soil type, climate and weather conditions, the aim for growing a cover crop, and pests like nematodes that are expected or present in the field.

Cover crops can benefit weed management by suppressing weed growth, weed seed production and shedding but this needs to be balanced with the opportunity for depleting seedbanks using a stale seedbed. Local conditions will determine the choice between these weed management practices. In regions with high precipitation levels around sowing time, stale seedbeds may not be feasible while the use of cover crops with



allelopathic potential may be a useful addition to other weed control measures.

- The critical issues in successfully implementing cover crops are related to the difficulty in killing the vegetation in temperate regions, especially if one of the overall aims is to reduce the use of herbicides. The main challenges are the selection of cover crop or living mulch species and varieties that can be successfully killed before planting or sowing of the following crop, either mechanically, through natural senescence or frost.
- The termination of cover crops and living mulches can be done by incorporation into the soil before sowing or planting of the following crop, or the vegetation can be killed and left on the soil surface as a dead mulch, depending on the tillage system. When a dead mulch provides a dense soil cover, it can have a significant weed suppressive effect in the following crop².

Furthermore, the success of a cover crop or cover crop mixture depends on the conditions and how the species and management are adjusted to local conditions. Points to consider are:

- Cover crops can be a host for different nematodes, fungi, insects and other plagues. Consider the host plant status of the cover crops you intend to grow. You can check their status in the *Best4Soil database*.
- Some cover crops are resistant against certain pests or are able to kill pests (e.g. *Tagetes patula* against the nematode *Pratylenchus penetrans*).
- The appropriate way of killing and incorporation of the cover crop needs adjustment to the cover crop species, soil type, weather conditions and subsequent crops.
- It is important to use good quality certified seeds to avoid contamination with weed seeds and to promote a good establishment, especially under harsh conditions.

504. https://doi.org/10.3390/agronomy9090504.

¹ Riemens, M., Sønderskov, M., Moonen, A., Storkey, J. and Kudsk, P., 2022. An Integrated Weed Management, framework: A pan-European perspective. European Journal of Agronomy, 133, p.126443.

² Abou Chehade, L., Antichi, D., Martelloni, L., Frasconi, C., Sbrana, M., Mazzoncini, M., Peruzzi, A., 2019. Evaluation of the agronomic performance of organic processing tomato as affected by different cover crop residues management. Agronomy





• If cover crops have a weak establishment or slow soil cover, weeds can establish instead.

Efficacy

Cover crops are generally sown to provide ecosystem services such as improved soil fertility, suppression of soil-borne diseases and pests, reduced erosion, leaching and run-off, and improved soil structure, depending on the characteristics of the selected species.

By increasing the diversity of the cropping system (types, sequence, arrangement of crops) a broader ecological niche for weeds can be achieved. By broadening the ecological niche for weeds, a more diverse weed community helps to avoid excessive reproduction of the same weed species or groups of weed species in the cropping system. Such a more functionally diverse weed community is expected to have a reduced competitive ability in any one crop³¹. With cover crops, the cropping system can be diversified in time.



of subsidiary crop between harvest and planting of commercial crops. Several months may separate two cash crops and the uncovered soil in this period is favourable to weed growth and dissemination. The use of cover crops can improve weed control in this time and provide significative substantial benefits at crop rotation level.

The suppressive effect of cover crops on weeds is characterised by competition for light, water, space and nutrients. Cover crops cover the soil and can prevent weed seedlings from germinating and establishing, compete with weeds and reduce their growth, and some cover crops can be mowed which kills or prevents weeds from shedding seeds⁴¹. In addition, their allelopathic effect can significantly contribute to the overall competition⁵¹, although in practice it is still difficult to make targeted use of this. Allelopathy involves excretion of toxics by the one plant that can limit the germination of seeds and growth of seedlings.

Especially cover crops from the family of brassicas and Italian ryegrass have a strong weed suppressing ability thanks to a fast cover of the soil. The efficacy also depends on the characteristics of the cover crop in relation to the characteristics of the local weed species. For example, cover crops with a fast initial growth and much leaf surface are preferred for locations where high weed species dominate. Besides the adjustment to local conditions, the management (e.g. sowing density, fertilisation, timing etc.) largely determines the success of a cover crop. Grass cover crops in general suppress weeds better than broad leaved cover crop species. A high cover crop biomass increases the weed suppressive ability of a cover crop. Timely sowing and an increased seeding rate can aid a large cover crop biomass.

Costs

Costs for cover crops are relatively low. For sowing, killing and incorporation of the cover crop into the soil the same equipment can be used as used on most farms for main crops and soil management. Cover crops are normally not sprayed and fertilized throughout the season, only for establishment and depending on the cover crop species and aim, a (limited) nitrogen fertilisation is applied. Some cover crops (e.g. clover or nitrogen fixing species) do not require nitrogen fertilisation at all.

Main costs are those of seeds, one nitrogen fertilization and for killing and/or incorporating the cover crop at the end of the growing season. If the appropriate sowing machine is not available costs increase to involve a contractor. Some cover crop species require a sowing time that is not combinable with the season of a cash crop, then a cropping season and its profit are lost. However, higher yields in the subsequent cash crops thanks to the effects of a cover crop can (partly) compensate for this loss.

^{3|} Adeux G, Munier-Jolain N, Meunier D et al (2019). Diversified grain-based cropping systems provide long-term weed control while limiting herbicide use and yield losses. Agronomy for Sustainable Development 39. https://doi.org/10.1007/s13593-019-0587-x

⁴⁾ Osipitan OA, Dille JA, Assefa Y, Radicetti E, Ayeni A & Knezevic SZ (2019). Impact of cover crop 1024 management on level of weed suppression: A meta-analysis. Crop Science 59 (3): 833-842. 1025 https://acsess.onlinelibrary.wiley.com/doi/pdf/10.2135/ cropsci2018.09.0589

^{5|} Jabran K, Mahajan G, Sardana V & Chauhan BS (2015) Allelopathy for weed control in agricultural systems. Crop Protection 72, 57–65.





Equipment

Depending on the cover crop and local conditions, the management includes the following practices:

- Seedbed preparation.
- Sowing (preferably directly after preparation to prevent moisture evaporation).
- Nitrogen fertilisation (or none).
- Prevent seed development in the cover crop by mowing or shredding high.
- Killing and spreading by: mowing, shredding, rolling or (figure 2) with a herbicide.
- Incorporation into the soil by: disc harrowing (figure 2), using a cultivator, ploughing, non-inversed tillage.
- or leaving it as mulch.



Figure 1 | Rolling the cover crop in order to kill and spread it well.

Figure 2 | With a disc harrow the cover crop is made smaller and superficially incorporated before ploughing.

Cover crops can be killed with a non-selective herbicide such as glyphosate. However, this strategy is under political and societal pressure because of its negative impact on the environment. The properly mechanical management of a cover crop is necessary for exclusion of a herbicide. Mechanical interventions using machines such as roller crimpers, sometimes in combination with flaming, may help to kill the vegetation without the use of broad spectrum herbicides such as glyphosate⁵.

Core results

- Osipitan OA et al. (2019)⁶ describe the impact of cover crop management on the level of weed suppression in a meta-analysis.
- Sturm et al. (2018)^{7|} assume that "the degree of cover crops allelopathic effects on weeds is species-specific, both on the side of cover crops and on the weed side. The cover crops *Raphanus sativus*, *Fagopyrum esculentum* and *Avena strigosa* showed the highest allelopathic weed suppression with up to

28%. Additionally, *Stellaria media* turned out to be the most sensitive weed against allelopathic effects induced by all cover crops, except for *Linum usitatissimum* and *Guizotia abyssinica.*"

- Sturm et al. (2018)⁹ describe the contribution of allelopathic effects to the overall weed suppression by different cover crops.
- Schappert et al. (2019)¹⁰ tested the weed suppression ability of single cover crop species and mixtures in a field trial during two years. The mixtures reached a generally lower soil cover, aboveground dry matter and weed control efficacy but species combinations increased resilience against adverse weather conditions.
- Büchi et al. (2020)¹¹¹ support that cover crops prior to maize can efficiently control weeds, some cover crops improved maize yield compared to the control, and cover crops efficiently reduce weed control intensity.

Extra information

See <u>https://iwmpraise.eu/publications/</u> for all crop diversification strategies and their definitions, and for more information on integrated weed management and the following factsheets about cover crops:

- A botanical overview of the most common spontaneous grass cover crop species in olive orchards.
- Crop diversification through use of intercrops and subsidiary cash crop.
- Combining roller crimpers and flaming for the termination of cover crops.
- Cover crops in olive field trials of southern and northern Spain.

Figure 3| gives an overview of the potential benefits and the related cautions when applying cover crops.

⁶⁾ Frasconi, C., Martelloni, L., Antichi, D., Raffaelli, M., Fontanelli, M., Peruzzi, A., Benincasa, P., Tpsti, G., 2019. Combining roller crimpers and flaming for the termination of cover crops in herbicide-free no-till cropping systems. PLoS One 14 (2), e0211573. https://doi.org/10.1371/ journal.pone.0211573.

⁷⁾ Osipitan OA, Dille JA, Assefa Y, Radicetti E, Ayeni A & Knezevic SZ (2019). Impact of cover crop 1024 management on level of weed suppression: A meta-analysis. Crop Science 59 (3): 833-842. 1025 https://acsess.onlinelibrary.wiley.com/doi/pdf/10.2135/ cropsci2018.09.0589

^{8]} Sturm, DJ, Peteinatos, G & Gerhards, R. (2018). Contribution of allelopathic effects to the overall weed suppression by different cover crops. Weed Research 58, 331-337.





Benefit	Point of attention
Fertilizing	
Prevent leaching of nitrogen	
Nitrogen fixation	
Savings on nitrogen fertilisation	Unwanted subsequent nitrogen delivery
Organic matter supply	
Better mineral balance	
Soil structure	
Better soil structure	Ensiling effect
Prevent erosion	Dehydration
Soil permeability	
Moisture evaporation / retention	
Prevent soil compaction	
Diseases and pests	
Resilience of the soil	
Activation of soil life	Increasing pests and diseases
Nematode control	
Weeds	
Weed suppression	Weed development (from contaminated seeds or if establishment is weak)
	Cover crops groundkeepers in subsequent crop
	Control of potato plants (groundkeepers)
Biodiversity	
Attract beneficial insects and birds	Attract unbeneficial insects
Financial profit	
Higher yield	Cropping costs
Greening subsidies	

Figure 3 | Benefits and points of attention regarding cover crops

(adjusted from Handboek Groenbemesters, Wageningen Research, 2019).

Contact| Timo Sprangers M| *timo.sprangers@wur.nl* T| (+31)320 29 12 37

Contact| Saskia Houben M| **saskia.houben@wur.nl** T| (+31)320 29 12 09



8| Sturm, DJ, Peteinatos, G & Gerhards, R. (2018). Contribution of allelopathic effects to the overall weed suppression by different cover crops. Weed Research 58, 331–337.

9| Schappert A, Schumacher M, Gerhards R. Weed Control Ability of Single Sown Cover Crops Compared to Species Mixtures. Agronomy. 2019; 9(6):294. https://doi.org/10.3390/agronomy9060294.

10| Büchi L, Wendling M, Amossé C, Jeangros B, Charles R. (2020) Cover crops to secure weed control strategies in a maize crop with reduced tillage, Field Crops Research, Volume 247, 107583, 155N 0378-4290, https://doi.org/10.1016/j.fcr.2019.107583.