Deliverable 2.3: Implementation and assessment of AWM strategies in conventional farming systems (version 1)

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Associated Work Package(s)

WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8
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Version History

Version number	Implemented by	Notes
1.0	AUA	With CICYTEX

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1. Introduction

1.1. Objective of the deliverable

The objectives of D2.3 (M18), D2.5 (M30) and D2.6 (M42) are to report on the implementation and assessments in conventional farming systems. These deliverables refer to Task 2.2 "*Implementation of AWM strategies under conventional farming systems*." and Task 2.3 "*Assessments of AWM strategies and design of the Best Practices for the transition to AWM in conventional farming systems*".

In particular, D2.3 will report what has been implemented during the first experimental year in the GOOD Living Labs (LLs).

The following Key Performance Indicators (KPIs) are covering both the conventional and the organic-mixed sites of the LLs.

***Table 1**: Expected results and target values in conventional and organic and mixed pilot sites*

Result	KPI – Target value
Design, assess and demonstrate combinations of AWM strategies in conventional, organic and mixed farming systems to enhance user acceptance	20 assessed cover crop species combined with 15 main crops & 48 assessed AWM solutions combined with cover crops (3 per LL)
	At least 14 assessed cover crops combined with inoculation (1 per LL) & at least 40 weed species identified using AI from the drone images
	32 Best combinations of AWM practices (2 per LL)
	15 Nº of crops that AWM solutions will be tested
	40 Nº of AWM strategies included in the repository

1.2. Connection with other Work Packages and Tasks

The results obtained from the implementation and assessments of cover crops (CC) and Agroecological Weed Management (AWM) practices will:

- Provide a list of Best Practices for AWM in conventional and organic & mixed farming systems (reference to D2.7/D3.7 by M46)
- Provide content for the implementation of the co-creation activities in the LLs (reference to WP1)
- Inform the relevant consortium experts and the LL managers about the best-performed CC to be inoculated in the second experimental year (reference to Task 4.1)
- Give feedback to the digital experts of the consortium about the performance of CC and the effectiveness of AWM practices to support the development of the AWM Toolbox (reference to Task 5.3)
- Be used to complement the socio-economic and environmental assessments, as well as support the formulation of policy recommendations (reference to WP6)
- Provide content for dissemination material (reference to WP7) and the writing of factsheets and practice abstracts

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2. GOOD Living Labs

GOOD has 16 LLs which are currently carrying our research in conventional farming systems. Those are listed in the following Table.

***Table 2**: Experimental sites of Organic and Mixed systems*

Annual crops			Permanent crops		
Crop	Country/Partner	LL code number	CROP	Country/Partner	LL code number
RYE/PEA	Latvia/LLKC	LV_rye-pea/11	**APPLE**	France/CTIFL	FR_apple/21
ONION	Netherlands/DELPHY	NL_onion/12	**OLIVES**	Portugal/ LSSV	PT_olives/22
SOYBEAN	Serbia/MRIZP	RS_soybean/13	**CITRUS**	Italy/AIAB	IT_citrus/23
MAIZE	Serbia/MRIZP	RS_maize/14	**GRAPES**	Italy/AIAB	IT_grapes/24
TRITICALE	Italy/CNR	IT_triticale/15	**GRAPES**	Greece/AUA	GR_grapes/25
WHEAT	Greece/AUA	GR_wheat/16	**OLIVES**	Cyprus/CUT	CY_olives/26
COWPEA	Portugal/LSSV	PT_cowpea/17	**CHERRY**	Spain/CICYTEX	ES_cherry/27
RICE	Spain/CICYTEX	ES_rice/18	**APPLE/GRAPES**	Spain/USC	ES_apple-grapes/28

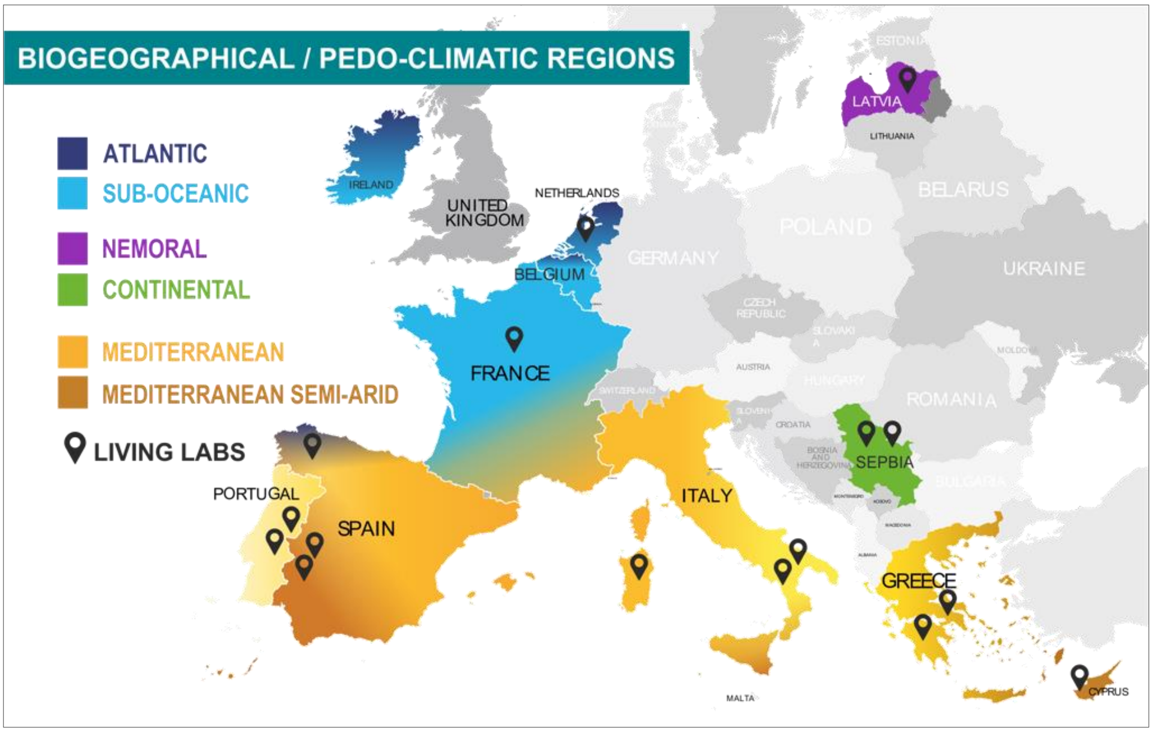

***Figure 1**: Geographical distribution of GOOD Living Labs (excluding the French in the organic and mixed systems). In accordance with the European Union's designation which is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ opinion on the Kosovo declaration of independence.*

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3. Results from the 1st experimental year in the conventional sites of the GOOD Living Labs

In the following Section, it is attempted to briefly report the main assessments from the experimental trials (cover crops and AWM) practices and provide some preliminary conclusions from the 1st experimental year in the GOOD LLs. Numerical values will be kept for further (statistical) analysis and will be used in future publications.

3.1. Annual crops

LV_rye-pea/11

At the conventional site, the field trial was set up in a Randomized Complete Block Design (RCBD) with three replicates (blocks) according to the split-plot arrangement. Pea (cultivar '*Bruno*') was the main crop. Five weed management practices were assigned to the main plots which were the following: herbicide treatment at the recommended application rate, herbicide treatment at half of the recommended application rate, untreated control, one post-emergence harrowing pass and double (two post-emergence harrowing. Four cover crops were assigned to the subplots: control (without cover crop), CC1, a cover crop mixture of *Raphanus sativus* (field radish) + *Sinapis alba* (mustard) + *Avena sativa* (oats) (seeding rates were 9 + 9 + 110 kg ha^{-1}, respectively), CC2, a cover crop mixture of *Secale cereale* (rye) + *Raphanus sativus* (field radish) + *Phacelia* spp. (seeding rates were 50 + 2 + 1 kg ha^{-1}, respectively) and CC3 with the cover crop mixture *Secale cereale* (rye) + *Vicia sativa* + *Fagopyrum esculentum* (buckwheat) + *Phacelia* spp. (seeding rates were 30 + 5 + 5 + 3 kg ha^{-1}, respectively). This experimental arrangement resulted in a total of 60 experimental units (subplots).

The predominant weed species with a frequency of ≥ 56% at all 180 sampling points (three sampling points per plot), were the following: *Matricaria perforata* Mérat (scentless chamomile; botanical family Asteraceae), *Thlaspi arvense* L. (field pennycress; botanical family Brassicaceae), *Lamium purpureum* L. (red deadnettle; botanical family Lamiaceae), *Viola arvensis* Murray (European field pansy; botanical family Violaceae), *Capsella bursa-pastoris* (L.) Medik. (shepherd's purse; botanical family Brassicaceae) and *Stellaria media* (L.) Vill. (chickweed; botanical family Caryophyllaceae). The only species of the botanical family Poaceae that occurred in some plots was *Poa annua* L. (annual bluegrass).

Cover crop biomass production ranged between 74.3 g m^{-2} to 125.2 g m^{-2} with a maximum coverage percentage of 52%. Significant were the effects of the interaction of weed control and cover crop on important parameters as weed biomass and grain yield (P-Value ≤ 0.05). For example, the combination of herbicide application at the recommended rate with CC1, CC2 and CC3 reduced weed biomass by 71%, 77% and 80%, respectively, compared to the subplots where no weed management practice was applied and no cover crop was planted (untreated control). In terms of grain yield per unit area, the highest yielding interaction was harrowing (one pass) × CC3, which resulted in a production of 1.73 t grain ha^{-1}. In the main plots where the herbicide was applied at half the recommended application rate, the grain yield ranged from 1.34 t ha^{-1} (subplots without cover crop) to 1.48 t ha^{-1} (subplots with CC3). In addition, the combination of a harrow pass with CC3 resulted in a very high production of crop biomass (≥ 500 g m^{-2}).

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NL_onion/12

At the conventional site, the field experiment was set up in a Randomized Complete Block Design (RCBD) with four replicates (blocks) according to the split-plot arrangement. Onion was the main crop in the study. Four cover crops were assigned to the main plots: control (no cover crop), CC1, a Phacelia (*Phacelia tanacetifolia*. Benth.) cover crop (seeding rate 10 kg ha^{-1}), CC2, a grass (*Lolium* spp.) cover crop (seeding rate 20 kg ha^{-1}) and CC3, a yellow mustard (*Sinapis alba* L.) cover crop (seeding rate 20 kg ha^{-1}). Five weed management practices were assigned to the subplots: weedy (untreated control), herbicide treatment (chemical control), inter-row mechanical weed control + intra-row herbicide treatment, fully mechanical weed control (inter-row and intra-row) and site-specific precision agriculture (PA) herbicide treatment. This experimental design resulted in a total of 80 experimental units (subplots).

The predominant weed species in the experimental area were the following: *Matricaria* spp. (botanical family Asteraceae), *Lamium purpureum* L. (red dead-nettle; botanical family Lamiaceae), *Veronica agrestis* L. (green field-speedwell; botanical family Plantaginaceae), *Atriplex* spp. (botanical family Amaranthaceae) and *Senecio* spp. (botanical family Asteraceae). Cover crops suppressed the emergence and growth of weeds compared to the control without cover crops (P-Value ≤ 0.05). The weather in May and June 2024, the most important months for mechanical weed control, was characterized by frequent and heavy rainfall, which made it almost impossible to carry out mechanical weed control under optimal conditions. Therefore, mechanical weed control treatments were not as efficient as treatments with herbicides (P-Value ≤ 0.05).

The marketable bulb yield of onions has not yet been measured, as the harvested crop must be sufficiently dried before evaluation. Based on the initial assessments of crop biomass, it is expected that the effects of the interactions between cover crops and weed management treatments on marketable onion bulb yield will be statistically significant.

RS_soybean/13

On the conventional site, the field trial was set up in a Randomized Complete Block Design (RCBD) with three replicates (blocks) according to the split-plot arrangement. Soybean (cultivar '*Lela*') was the main crop studied. The cover crops planted in the fall on the main plots were: rye (seeding rate 90 kg ha^{-1}), vetch (seeding rate 120 kg ha^{-1}) and oats (seeding rate 120 kg ha^{-1}). An untreated control (plots without cover crop) was also included. After cover crop termination with a plant cutter in early April, five weed management practices were assigned to the subplots: untreated control, herbicide treatment at the recommended application rate, herbicide treatment at half the recommended application rate, bioherbicide application (pelargonic acid before emergence of the main crop) and mechanical weed control (inter-row cultivation). The herbicide was not applied by drone due to unfavorable climatic conditions at the time when the treatment should have been carried out. As a result, 60 experimental units (subplots) were formed.

In the cover crop evaluation, rye and oats had a higher biomass (about 30–50%) than vetch at the beginning of the season, and the differences were even more pronounced before the termination of the cover crop in the second evaluation, where the biomass of rye and oats was about 200 g m^{-2}, while vetch produced only 20 g m^{-2}. According to the LL managers, no weeds were present in any of the cover crops, which is probably due to the extensive crop rotation

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used in the previous growing seasons on the wider experimental area. Only a few weeds were detected in the plots without cover crops, i.e. mainly *Chenopodium album* L. (common lambsquarters; botanical family Amaranthaceae), which occasionally appeared in small patches.

In the main crop, the most abundant annual weeds in the untreated plots were: *C. album* (botanical family Amaranthaceae), *Abutilon theophrasti* Medic. (velvetleaf; botanical family Malvaceae), *Amaranthus hybridus* L. (smooth pigweed; botanical family Amaranthaceae), *Amaranthus retroflexus* L. (redroot pigweed; botanical family Amaranthaceae), *Chenopodium hybridum* L. (mapleleaf goosefoot; botanical family Amaranthaceae), *Datura stramonium* L. (jimsonweed; botanical family Solanaceae), and *Solanum nigrum* L. (black nightshade; botanical family Solanaceae). The following perennial weeds, which belong to the botanical family Poaceae, were also present in many plots of the soybean trial field: *Sorghum halepense* (L.) Pers. (johnsongrass; botanical family Poaceae), *Cynodon dactylon* (L.) Pers. (bermudagrass; botanical family Poaceae), *Cirsium arvense* (L.) Scop. (Canada thistle; botanical family Poaceae) and *Convolvulus arvensis* L. (field bindweed; botanical family Convolvulaceae).

Either the full or half of the recommended amount showed excellent efficacy in weed control (90–95%), especially in combination with cover crops. Regardless of the cover crops, there was a significant yield loss in the plots where the bioherbicide was applied, except in the untreated control plots. Since pelargonic acid had to be applied before the main crop emerged and the conditions for emergence were unfavorable, very few weeds emerged when the bioherbicide was applied. In addition, the grain yield was strongly affected by the meteorological conditions (no precipitation in July and August) and was close to 1 t ha^{-1} in all experimental units.

RS_maize/14

On the conventional trial site, the field trial was set up in a Randomized Complete Block Design (RCBD) with three replicates (blocks) according to the split-plot arrangement. Maize (hybrid '*ZP 388*') was the main crop studied. The cover crops planted in the fall on the main plots of the experimental field were: rye (seeding rate 90 kg ha^{-1}), vetch (seeding rate 120 kg ha^{-1}) and oats (seeding rate 120 kg ha^{-1}). An untreated control (plots without cover crop) was also included. After cover crop termination with a plant cutter in early April, five weed management practices were assigned to the subplots: untreated control, herbicide treatment at the recommended application rate, herbicide treatment at half the recommended application rate, bioherbicide application (pelargonic acid before emergence of the main crop) and mechanical weed control (inter-row cultivation). The herbicide was not applied by drone due to unfavorable climatic conditions at the time when the treatment should have been carried out. As a result, 60 experimental units (subplots) were formed.

Regarding the measurements during the active growth phase of the cover crop, vetch produced 37% and 46% less biomass than rye and oats respectively at the beginning of the season, while oats had 14% more biomass than rye. However, at the last measurement before termination, rye and vetch had only produced 167.6 g m^{-2} and 163.8 g m^{-2} respectively, while oats exceeded 250 g biomass m^{-2}. As a continuous crop rotation with herbicides had been applied on this plot in the previous year, the weed infestation was not serious with only a few individuals of *Chenopodium album* L. (common lambsquarters; botanical family Amaranthaceae) in the plots where no cover crop had been planted.

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In the maize field, the most abundant annual weeds in the untreated plots were: *C. album* (botanical family Amaranthaceae), *Abutilon theophrasti* Medic. (velvetleaf; botanical family Malvaceae), *Amaranthus hybridus* L. (smooth pigweed; botanical family Amaranthaceae), *Amaranthus retroflexus* L. (redroot pigweed; botanical family Amaranthaceae), *Chenopodium hybridum* L. (mapleleaf goosefoot; botanical family Amaranthaceae), *Datura stramonium* L. (jimsonweed; botanical family Solanaceae) and *Solanum nigrum* L. (black nightshade; botanical family Solanaceae). The following perennial weeds, which belong to the botanical family Poaceae, were also present in many plots of the maize trial field: *Sorghum halepense* (L.) Pers. (johnsongrass; botanical family Poaceae), *Cynodon dactylon* (L.) Pers. (bermudagrass; botanical family Poaceae), *Cirsium arvense* (L.) Scop. (Canada thistle; botanical family Poaceae) and *Convolvulus arvensis* L. (field bindweed; botanical family Convolvulaceae).

Good results in weed control were achieved with the following treatments: herbicide application at the full application rate, at half the full application rate and mechanical weed control. Grain yields were very low ($\leq$ 1 t ha^{-1}) on untreated control plots and on plots treated with pelargonic acid. Even on the subplots where the most effective treatments were applied, the grain yield only reached 3–4 t ha^{-1} due to the difficult meteorological conditions (no rainfall events and drought) that prevailed in the experimental area. Overall, maize cultivation according to agroecological principles has provided some promising results that need to be further confirmed in the next growing seasons.

IT_triticale/15

On the conventional trial site, the trial was set up in a Randomized Complete Block Design (RCBD) with eight weed management treatments repeated three times. Triticale was the crop studied. The treatment list included: Medicago truncatula Gaertn. cover crop, *Trifolium brachycalycinum* (Katzn. & Morley) Katzn. cover crop, *M. truncatula* + *T. brachycalycinum* cover crop mixture, untreated control, chemical reference (herbicide application), mechanical weed control, cultural weed control and digital weed control. The cover crops were sown together with the main crop and covered the areas between the rows. The seeding rate was 10 kg seed ha^{-1} for *M. truncatula* and 15 kg seed ha^{-1} for *T. brachycalycinum*.

Weed diversity parameters such as weed density, weed biomass, the number of botanical weed families present and the number of weed species present were not affected by the treatments (P-Value $\geq$ 0.05). Indeed, the experimental field was heavily infested by the weed monoculture *Oxalis pes-caprae* L. (Bermuda buttercup; botanical family Oxalidaceae) and weed species from the botanical family Asteraceae; *O. pes-caprae* and Asteraceae weeds were present in almost all plots of the experimental field, while no other botanical weed families were observed ($\geq$ 95% frequency). The most common weed species of the botanical family Asteraceae was *Carthamus lanatus* L. (woolly distaff thistle).

It was notable that weed control was not affected by the treatment factor. In particular, O. pes-caprae infestation was heavy in all 24 experimental units. The density of this weed species varied between 563.6 plants m^{-2} and 632.9 plants m^{-2}, while its biomass was 1,565.8–1,825.2 g m^{-2} (P-Value $\geq$ 0.05).

The treatments affected the triticale grain at statistically significant point (P-Value $\leq$ 0.05). Compared to untreated plots, triticale grain yield increased by 20% in plots of *M. truncatula* +

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T. brachycalycinum cover crop mixture. The monoculture of *M. truncatula* also resulted in a high grain yield (4,344.1 kg ha^{-1}) and did not differ from the mixture of *M. truncatula* + *T. brachycalycinum* (4,420.6 kg ha^{-1}). Cultural weed control and mechanical weed control did not have a positive effect on grain yield compared to the cover crop treatments (grain production of 1,511.1 kg ha^{-1} and 2,497.2 kg ha^{-1} respectively). The higher yield cannot be attributed to the stronger suppression of weeds in the plots with *M. truncatula* + *T. brachycalycinum* cover crop mixture. Rather, the explanation for the positive effects of the cover crops on grain yield is that the cover crops were legumes capable of fixing atmospheric nitrogen and supplying it to the main crop during the grain filling growth stage.

Crop biomass and final straw yield did not show similar trends and differences between treatments. In terms of some significant differences between treatments, straw yield was up to 21% lower in the herbicide-treated plots than in the cover crop plots and 13% lower than in the untreated control plots. It is possible that the herbicide application injured the triticale plants to some extent and suppressed their biomass production.

GR_wheat/16

On the conventional site, durum wheat (cultivar 'Maesta') was investigated as the main crop in a field trial conducted in a Randomized Complete Block Design (RCBD) with three replicates (blocks) according to the split-plot design. Four cover crops were studied as main plots: untreated control, *Trifolium alexandrinum*, *Lolium perenne* and the mixture of the two species (*T. alexandrinum* + *L. perenne*). Five weed management practices were studied as subplots: untreated control, herbicide application at the recommended rate, herbicide application at a reduced rate, mechanical weed control and false seedbed. A total of 60 experimental units (subplots) were created based on the experimental design. Cover crops were sown in the fall (seed rate 30 kg ha^{-1}). Durum wheat was sown after mechanical termination of the cover crops and incorporation of their residues into the soil.

The mixture of the two cover crops (*T. alexandrinum* + *L. perenne*) produced a significantly greater amount of biomass compared to the monocultures of *L. perenne* and *T. alexandrinum* (P-Value $\leq$ 0.001). Before cover crop termination, weed biomass was 62%, 76% and 85% lower in the *T. alexandrinum* + *L. perenne* mixture plots compared to *L. perenne*, *T. alexandrinum* and the non-cover crop control plots, respectively (P-Value $\leq$ 0.001).

In the main durum wheat crop, the most common weed species in the experimental area were *Avena sterilis* L. (sterile wild oat; botanical family Poaceae) with an occurrence at 221 of 240 sampling points (92% frequency), *Sinapis arvensis* L. (wild mustard; botanical family Brassicaceae) with an occurrence at 199 of 240 sampling points (83% frequency), *Veronica hederifolia* L. (ivy-leaved speedwell; botanical family Plantaginaceae) with an occurrence at 168 of 240 sampling points (70% frequency) and *Gallium aparine* L. (cleavers; botanical family Rubiaceae) with an occurrence at 87 of 240 sampling points (36% frequency). Weed diversity was affected both by main plot and subplot factors and their interactions (P-Value $\leq$ 0.001). In particular, the number of botanical weed families and the number of weed species present were lower in the interaction subplots ($\leq$ 4): *T. alexandrinum* + *L. perenne* × false seedbed, *T. alexandrinum* + *L. perenne* × herbicide application at either the recommended or reduced rate. In addition, the effect of the interaction between the two factors on weed biomass (P-Value $\leq$ 0.001) and durum wheat grain yield (P-Value $\leq$ 0.05) was significant. The combination of *T. alexandrinum* + *L. perenne* mixture together with the herbicide application at the recommended

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rate reduced weed biomass (3.2 g m^{-2}) by 99% compared to the interaction *T. alexandrinum* × untreated control (343.1 g m^{-2}). In addition, the combinations *T. alexandrinum* + *L. perenne* × herbicide application at a reduced rate (5.7 g m^{-2}) and *T. alexandrinum* + *L. perenne* × false seedbed (11.6 g m^{-2}) reduced weed biomass by more than 95% compared to the combination *T. alexandrinum* × untreated control. The combination of *T. alexandrinum* + *L. perenne* × herbicide application at the recommended rate increased grain yield (4,258.0 kg ha^{-1}) by 65% compared to the combination of *L. perenne* × untreated control (1,489.7 kg ha^{-1}). The yield performance of *T. alexandrinum* + *L. perenne* × herbicide application at reduced rates was also quite satisfactory (3,915.2 kg ha^{-1}).

PT_cowpea/17

On the conventional trial site of cowpea, the field trial was set up in four replicates (blocks) according to the split-plot arrangement. The cover crops were sown between the rows of a conventional intensive olive grove, after the mowing of the trial plots with a chain-mower to remove early germinated winter weeds. Cowpea was the main crop studied in spring-summer 2024, sown as a companion crop of olives. Cover crops were sown in December 2023 after a delay caused by heavy rainfall in November which made the access to the field by tractors difficult. Three cover crop options were introduced: rye (*Secale cereale* L.) , a three-species mixture of oat (*Avena sativa* L.), lupin (*Lupinus* spp.), and turnip (*Brassica rapa* subsp. *rapa*), and a six-species mixture of oat, rye, lupin, turnip, mustard (*Sinapis alba* L.), and flax (*Linum usitatissimum* L.). The seeding rate for rye as single cc was 100 kg seed ha^{-1}. The seeding rates in the three-species mixture were 60 kg seed ha^{-1} for oat, 30 kg seed ha^{-1} for lupine and 3 kg seed ha^{-1} for turnip. In the six-species mixture, the seeding rates were the same for oat, lupine and turnip, and 40 kg seed ha^{-1} for rye, 6 kg seed ha^{-1} for flax, and 3 kg seed ha^{-1} for mustard. One block wasn't sown with cover crops and left untreated until the weed management practices were applied in the next spring. The cover crops were terminated at the end of May 2024.

Five weed management practices were studied as subplots: untreated control, mowing with a chain mower, mowing with a manual disc cutter simulating the roller-crimper, half-rate herbicide, full-rate herbicide. The olive trees were in raised beds at a 4-meter distance between rows. In total, 60 subplots were set up, each 4x20 m and the total area was approximately 4800 m^2. The seeding rate of cowpea was 100 kg/ha and the crop was sown in mid-June. The distance between rows was 17 cm. The raised beds and concave nature of the terrain led to irregular sowing depths, affecting crop establishment. There was no fertilization or irrigation in the cover crops and the cowpea. The rows of olive trees between the blocks were irrigated with drip irrigation. The overall outcomes were affected by the delayed cover crop establishment and inadequate crop maturity at termination, necessitating an early sowing in the second experimental year. The cowpea trial encountered additional complications due to compacted soil and irregular sowing depths, resulting in uneven crop establishment. Limited irrigation also impacted growth, and while some cowpea plants survived, sporadic growth was observed in areas benefiting from water exposure. Among the tested practices, the roller-crimper method showed the best weed suppression results (P-Value ≤ 0.01). Based on these issues, future trials for cowpea conventional decided to be conducted at a new location closer to the research facility to facilitate improved monitoring and minimize third-party machinery dependencies.

In the evaluations of the cover crops in winter, the most dominant weeds were *Papaver rhoeas* L. (common poppy, botanical weed family Papaveraceae), *Sonchus oleraceus* L. (thistle; botanical family Asteraceae), *Lolium rigidum* Gaud. (rigid ryegrass, botanical family Poaceae),

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and *Fumaria officinalis* L. (common fumitory, botanical family Papaveraceae). The weed suppression was higher (or conversely, the higher coverage by cover crops) was observed in the plots of the six-species mixture (P Value ≤ 0.05) where the cc ground coverage was in some plots higher than 60%. In the main cowpea crop, the most common weed species in the experimental area were *Conyza canadensis* L. (horseweed, botanical family Asteraceae), *Cynodon dactylon* L. Pers. (bermudagrass, botanical family Poaceae), *Chenopodium album* L. (common lambsquarters; botanical family Amaranthaceae), and *Convolvulus arvensis* L. (field bindweed, botanic family Convolvulaceae). The weed diversity parameters (density, biomass, coverage) were affected by the treatments (P-Value ≤ 0.05). The number of botanical weed families and the number of weed species present were lower in the treatments of reduced herbicide rate and mowing but the density of the present weed species was significantly higher than mulching.

ES_rice/18

On the conventional site, the field trial was set up in a Randomized Complete Block Design (RCBD) with four replicates (blocks) according to the split-plot arrangement. Rice (cultivar 'Thaiperla') was the main crop investigated. The cover crops planted in the fall on the main plots were: *Avena sativa* (seeding rate 173 kg ha^{-1}), *Medicago scutelatta* (seeding rate 30 kg ha^{-1}) and *Hordeum vulgare* (seeding rate 106 kg ha^{-1}). An untreated control, i.e. plots with spontaneous weed flora and without any cover crop, was also included. After termination of the cover crops by mowing at the end of April, the residues of the cover crop were incorporated into the soil. Four weed management practices were assigned to the subplots: weedy check (untreated control), herbicide treatment with the recommended application rate, herbicide treatment with reduced application rate and mechanical weed control. In this way, 64 experimental units (subplots) were formed.

In the first evaluation of the cover crops in late winter, *M. scutelatta* produced 59% and 63% less biomass than *A. sativa* and *H. vulgare*, respectively. In the second assessment before termination, *A. sativa* and *H. vulgare* produced significantly higher amounts of biomass (7,000–7,500 kg ha^{-1}) than the corresponding amounts of the legume cover crop *M. scutelatta* (6,586.9 kg ha^{-1}). The total biomass of winter weeds amounted to 7,501.2 kg ha^{-1} in the main plots without cover crop. Lower values were found for the cover crops *A. sativa* (38%), *M. scutelatta* (55%) and *H. vulgare* (66%). It is noteworthy that although *M. scutelatta* produced less biomass than *A. sativa*, the legume cover crop achieved a significantly higher ground cover (P-Value $\leq$ 0.01) and thus weed suppression (27%). This can be attributed to the fact that annual medics (*Medicago* spp.) have great potential as weed-smothering cover crops because of their prostrate growth habit, short life span and good germination, which leads to rapid ground cover.

In the rice field, the weed flora consisted mainly of noxious weed species that typically infest paddy fields and belong to two botanical families, Poaceae and Cyperaceae, which were present in all experimental units (frequency 100%). The predominant weeds of the botanical family Poaceae were *Echinochloa crus-galli* (L.) P.Beauv. (barnyardgrass) and species of the genus *Leptochloa* spp. (spangletops). The predominant weeds from the botanical family Cyperaceae were the perennial sedges *Cyperus rotundus* L. (purple nutsedge) and *Cyperus esculentus* L. (yellow nutsedge) and the annual sedge *Cyperus difformis* L. (smallflower umbrella-sedge).

Crop biomass and weed density were significantly influenced by the interaction between cover crops and weed management factors (P-Value ≤ 0.001). Crop biomass was highest in the *H. vulgare* × herbicide application plots with the reduced field rate (11,160.0 kg ha^{-1}). The lowest

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values corresponded to the *M. scutelatta* × mechanical weed control subplots (1,631.2 kg ha^{-1}). The interaction *H. vulgare* × herbicide application with the reduced application rate resulted in a 78% lower density of Cyperaceae weeds compared to no cover crop × untreated control (23 weeds m^{-2}). Application of *H. vulgare* × herbicide at the recommended application rate also reduced the density of Poaceae weeds (especially *Echinochloa* spp.) by 77% compared to *M. scutelatta* × untreated control (14 weeds m^{-2}). Similar trends were observed when measuring weed biomass (P-Value ≤ 0.001). Grain yield data is not yet available as grain moisture (21%) is unacceptable at this stage of the growing season. Yield data will be available in November 2024 and will be interpreted in relation to crop growth and weed parameters.

3.2.Perennial crops

FR_apple/21

Agroecological weed management was studied in two separate field experiments in orchards in the LL established in France. The first experiment, hereafter referred to as Trial 1, was conducted in a young orchard. The first experiment, hereafter referred to as Trial 2, was carried out in a newly established orchard.

In Trial 1, a Randomized Complete Block Design (RCBD) with four replicates (blocks) was created according to the split-plot arrangement. In 2021, three types of soil preparation were carried out before the trees were planted and were assigned to the main plots. The three soil preparation practices were: false seedbed, solarization and standard tillage. Standard soil preparation refers to the maintenance of a grass cover crop (*Lolium perenne* + *Lolium arundinaceum*) with mowing along the tree rows throughout the growing season. Eight weed control strategies have been tested on these three main plots since the trees were planted: herbicide application, herbicide application + hoeing, herbicide application + mowing, hoeing, mowing, mowing + hoeing in spring, mowing + hoeing in summer, and mowing + hoeing in fall. A total of 96 experimental units (subplots) were formed on the basis of the experimental design.

The results showed that the dominant species were: *Plantago lanceolata* L. (ribwort plantain; botanical family Plantaginaceae) with 27% of the total weed cover, species from the botanical family Poaceae (18%), *Rumex obtusifolius* L. (bitter dock; botanical family Polygonaceae) with 14% of the total weed cover, *Trifolium repens* L. (white clover; botanical family Fabaceae) with 10% of the total weed cover and *Stellaria media* (L.) Vill. (chickweed; botanical family Caryophyllaceae) with 10% of the total weed cover. The standard practice i.e. the grass cover crop introduced on the rows in fall 2022, reached an average coverage of 69% at the end of 2023 and also showed a strong correlation with *R. obtusifolius* (P-Value ≤ 0.001; $R^2 \geq 65\%$), which was one of the most aggressive weed species in the young orchard.

However, total weed coverage was not affected by the factor of soil preparation (P-Value ≥ 0.05). In contrast, weed management and its interaction with weed management had a significant effect on weed coverage (P-Value ≤ 0.01). In most false seedbed main plots, total weed coverage was low especially when combined with herbicide application (38%) and herbicide application + hoeing (42%). Solarization × hoeing, solarization × mowing + hoeing in spring, solarization × mowing + hoeing in summer, solarization × mowing + hoeing in fall led to a significantly higher weed infestation (60–70%). Weed coverage was 50–60% in subplots: standard soil preparation × herbicide application, standard soil preparation × herbicide

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application + hoeing, standard soil preparation × mowing + hoeing in spring, standard soil preparation × mowing + hoeing in summer and standard soil preparation × mowing + hoeing in summer.

In Trial 2, an RCBD was established with 12 treatments that were replicated four times. The cover crop treatments included in particular the use of cover crops established on the tree rows. The cover crops were grown in different ways to facilitate their establishment. The cover crop treatments were in detail: hand-planted wild thyme (density 6 plants m^{-2}) + sown dwarf alfalfa (seeding rate 20 kg ha^{-1}) supported by selective herbicide use in the first two or three years (treatment CTIFL-B-1), hand-planted thyme (density 6 plants m^{-2}) + sown dwarf alfalfa (seeding rate 20 kg ha^{-1}) supported by frequent mowing and selective herbicide use in the first two or three years (treatment CTIFL-B-2), thyme sown (seeding rate 9 kg ha^{-1}) supported by selective herbicide use in the first two or three years (treatment CTIFL-B-3), thyme sown (seeding rate 9 kg ha^{-1}) supported by frequent mowing and selective herbicide application in the first two or three years (treatment CTIFL-B-4), hand-planted green mint (density 6 plants m^{-2}) supported by frequent mowing and selective herbicide application in the first two or three years (treatment CTIFL-B-5), hand-planted green mint (density 6 plants m^{-2}) supported by frequent mowing (treatment CTIFL-B-6), orchard grass mixture with a seeding rate of 80 kg ha^{-1} (20% *L. perenne* + 80% *Festuca rubra*) with regular mowing (treatment CTIFL-B-7) and another grass mixture with a seeding rate of 250 kg ha^{-1} (10% *L. perenne* + 20% *Festuca rubra* + 30% *Festuca ovina* + 40% *Koeleria macrantha*) with regular mowing (treatment CTIFL-B-8). In addition to the eight cover crop treatments mentioned above, four other weed control treatments tested: herbicide application (chemical control; treatment CTIFL-B-9), herbicide application followed by hoeing in the first year and mowing from the second year (treatment CTIFL-B-10), hoeing only (treatment CTIFL-B-11) and an untreated control (treatment CTIFL-B-12).

According to LL managers, it is still far too early to assess the ability of these slow-growing cover crops to suppress weeds. At this stage, the outcome of the main trial is that they have established successfully and, contrary to initial expectations, the sown thyme has so far performed well despite the summer drought. Two months after planting or sowing, green mint achieved the best growth (50% cover), followed by the thyme with a significantly lower growth; there was no statistical difference between the planted thyme (16%) and the sown thyme (11%). Grass cover crops achieved an even lower cover of 2–6%.

PT_olives/22

On the conventional trial site of olives in Portugal, the field trial was set up in four replicates (blocks) according to the split-plot arrangement, on the same field where cowpea (PT_17) was sown. The cover crops were sown between the tree rows in a conventional intensive olive grove, after the mowing of the trial plots with a chain-mower to remove early germinated winter weeds. Cover crops were sown in December 2023 after a delay caused by heavy rainfall in November which made the access to the field by tractors difficult. Three cover crop options were introduced: rye (*Secale cereale* L.) , a three-species mixture of oat (*Avena sativa* L.), lupin (*Lupinus* spp.), and turnip (*Brassica rapa* subsp. *rapa*), and a six-species mixture of oat, rye, lupin, turnip, mustard (*Sinapis alba* L.), and flax (*Linum usitatissimum* L.). The seeding rate for rye as single cc was 100 kg seed ha^{-1}. The seeding rates in the three-species mixture were 60 kg seed ha^{-1} for oat, 30 kg seed ha^{-1} for lupine and 3 kg seed ha^{-1} for turnip. In the six-species mixture, the seeding rates were the same for oat, lupine and turnip, and 40 kg seed ha^{-1} for rye,

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6 kg seed ha^{-1} for flax, and 3 kg seed ha^{-1} for mustard. One block wasn't sown with cover crops and left untreated. The sowing was conducted with an APV Direct Seeder, which spread the seeds at a controlled rate. However, without irrigation or fertilizer, the late establishment hindered crop development, and weed suppression remained suboptimal. There was no fertilization or irrigation in the cover crops. The cover crops were terminated at the end of May 2024.

Five weed management practices were studied as subplots: untreated control, mowing with a chain mower, mulching, half-rate herbicide, full-rate herbicide. The olive trees were in raised beds at a 4-meter distance between rows. The rows of olive trees between the blocks were irrigated with drip irrigation. Among the tested practices, the herbicide at full-rate led to the highest weed suppression (>90%), followed by mulching (>70%).

In the evaluations of the cover crops in winter (similar to PT_17), the most dominant weeds were *Papaver rhoeas* L. (common poppy, botanical weed family Papaveraceae), *Sonchus oleraceus* L. (thistle; botanical family Asteraceae), *Lolium rigidum* Gaud. (rigid ryegrass, botanical family Poaceae), and *Fumaria officinalis* L. (common fumitory, botanical family Papaveraceae). The weed suppression was higher (or conversely, the higher coverage by cover crops) was observed in the plots of the six-species mixture (P Value ≤ 0.05) where the cc ground coverage was in some plots higher than 60%. In autumn 2024 (before the initiation of the second experimental year), measurements were taken on the diversity of the weed flora (species, families, frequencies). The results revealed that the six-species mixture of cover crops led to statistically higher number of weed species and botanical families than the treatments of mowing and herbicide, either at full or half rate. Notably, the plots which were treated with herbicides were dominated by 3 species, present in high densities (common poppy, thistle, and rigid ryegrass). The weed diversity parameters (density, biomass, coverage) were also affected by the treatments (P-Value ≤ 0.05).

IT_citrus/23

At the conventional site, a field trial was conducted in a citrus orchard using the Randomized Complete Block Design (RCBD) with seven treatments and three replicates (blocks). Three cover crops were established between the tree rows: *Vicia faba* (seeding rate 358 kg ha^{-1}), *Trifolium alexandrinum* (seeding rate 50 kg ha^{-1}) and the mixture *Vicia villosa* + *Avena sativa* (seeding rate 50 + 60 kg ha^{-1}). After cover crop termination, in new plots, three additional weed control methods were evaluated: application of herbicide at the recommended rate, application of herbicide at a reduced rate and mechanical weed control through soil tillage with a spader. An untreated control was also included in the treatment list (no cover crop and no weed control). All treatments relate to weed suppression in the inter-rows of the citrus orchard.

During the active growth phase of the cover crops, the dominant winter weeds in the experimental area were species of the genus *Sonchus* spp. (thistles; botanical family Asteraceae), *Gallium aparine* L. (cleavers; botanical family Rubiaceae), *Stellaria media* (L.) Vill. (chickweed; botanical family Caryophyllaceae), *Avena sterilis* L. (sterile wild oat; botanical family Poaceae) and *Oxalis pes-caprae* L. (Bermuda buttercup; botanical family Oxalidaceae). The cover crop mixture *V. villosa* + *A. sativa* produced a high amount of biomass (607.3 g m^{-2}) which was 76% and 78% compared to *T. alexandrinum* and *V. faba*, respectively. *V. villosa* + *A. sativa* reduced total weed biomass by 89%, 94% and 97% compared to *T. alexandrinum*, *V. faba* and the untreated control, respectively.

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During the summer growing season, when all seven treatments were completed, the predominant weeds in the citrus orchard were species of the genera *Bidens* spp. (botanical family Asteraceae), *Conyza* spp. (fleabanes; botanical family Asteraceae), and the noxious rhizomatous perennial summer grass *Cynodon dactylon* (L.) Pers. (Bermudagrass; botanical family Poaceae). *V. villosa* + *A. sativa* reduced total weed density by 40%, 65% and 85% compared to *V. faba*, *T. alexandrinum* and the untreated control, respectively. It was remarkable that the mixture of *V. villosa* + *A. sativa* suppressed weed density by at least 80% or more compared to herbicide treatments at the recommended, half the recommended application rate and mechanical weed control. In fact, all cover crops showed higher efficacy than herbicide and mechanical treatments.

There are possible explanations for the lack of herbicide efficacy and the poor performance of mechanical weeding. One possible reason could be the presence of herbicide-resistant *Conyza* spp. in the orchard. But even if there is no resistance, *Bidens* spp. and *Conyza* spp. are difficult to control if the herbicide is not applied at certain optimal growth stages of these weeds. On the other hand, while mechanical weed control has brought these weed classes under control, it may have increased infestations of *C. dactylon* by cutting rhizomes that germinated later in the season, leading to a proliferation of the weed in the field.

IT_grapes/24

At the conventional site, a field trial was conducted in a vineyard using the Randomized Complete Block Design (RCBD) with seven treatments repeated in three replicates (blocks). Three cover crops were established between the vine rows: *Vicia faba* (seeding rate 358 kg ha^{-1}), *Trifolium alexandrinum* (seeding rate 50 kg ha^{-1}) and the two-species mixture *Vicia villosa* + *Avena sativa* (seeding rate 50 + 60 kg ha^{-1}). After cover crop termination, in new plots, three weed management practices were assessed: application of herbicide at the recommended rate, application of herbicide at a reduced rate and mechanical weed control through soil tillage with a spader. An untreated control was also included in the treatment list. All treatments aimed to suppress weeds in the inter-rows of the vineyard.

During the active cover crop growth, the predominant winter weeds in the experimental area were species of the *Sonchus* spp. (thistles; botanical family Asteraceae), *Gallium aparine* L. (cleavers; botanical family Rubiaceae), *Stellaria media* (L.) Vill. (chickweed; botanical family Caryophyllaceae), *Avena sterilis* L. (sterile wild oat; botanical family Poaceae) and *Oxalis pes-caprae* L. (Bermuda buttercup; botanical family Oxalidaceae). *V. villosa* + *A. sativa* was the most effective cover crop in terms of biomass production (373.2 g m^{-2}). *V. faba* produced 16% less biomass than the mixture while *T. alexandrinum* was the least effective cover crop in terms of biomass production (160.5 g m^{-2}). *V. villosa* + *A. sativa* reduced total weed density by 50%, 82% and 91% compared to *T. alexandrinum*, *V. faba* and the untreated control, respectively.

During the summer growing season, when all seven treatments were completed, the predominant weeds in the citrus orchard were species of the genera *Bidens* spp. (botanical family Asteraceae), *Conyza* spp. (fleabanes; botanical family Asteraceae), and the noxious rhizomatous perennial summer grass *Cynodon dactylon* (L.) Pers. (Bermudagrass; botanical family Poaceae). *V. villosa* + *A. sativa* reduced the total biomass of weeds by 58% and 85% compared to herbicide application (at the recommended rate) and mechanical weeding, respectively. There are possible reasons for the superiority of the cover crop mixture over herbicide application and mechanical weeding. One possible explanation for the low

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effectiveness of herbicide treatment could be the presence of herbicide-resistant *Conyza* spp. However, even if there were no herbicide-resistant weeds in the vineyard, *Bidens* spp. and *Conyza* spp. are difficult to control if the herbicide is not applied at certain critical growth stages of the weeds. Another reason for the low effectiveness of mechanical weed control is the presence of *C. dactylon* in the vineyard. Mechanical weed control did control *Bidens* spp. and *Conyza* spp. but may have increased the infestation of *C. dactylon* by cutting rhizomes that germinated later in the season, leading to the spread of this particular noxious perennial grass weed species in the field.

GR_grapes/25

At the conventional site, a field trial was conducted in a vineyard using the Randomized Complete Block Design (RCBD) with seven treatments and three replicates (blocks). In particular, three cover crops were established between the vine rows in late fall: *Vicia sativa* (vetch), *Avena sativa* (oats) and their mixture *V. sativa* + *A. sativa*. All cover crops were sown at a rate of 30 kg ha^{-1}. After termination of the cover crops by mowing in late spring, three additional weed control measures were carried out in early summer: application of herbicide at the recommended rate, application of herbicide at a reduced rate and mowing. An untreated control was also included in the treatment list (no cover crop and no weed control). All treatments relate to weed suppression in the inter-rows of the vineyard.

During the active growth phase of the cover crops, the dominant winter weeds on the experimental area were *Calendula arvensis* (Vaill.) L. (field marigold; botanical family Asteraceae) with an occurrence at 45 out of 48 sampling points (94% frequency), *Euphorbia peplus* L. (petty spurge; botanical family Euphorbiaceae) with an occurrence at 23 out of 48 sampling points (48% frequency), *Avena sterilis* L. (sterile wild oat; botanical family Poaceae) with an occurrence at 17 out of 48 sampling points (35% frequency) and *Fumaria officinalis* L. (common fumitory; botanical family Papaveraceae) with an occurrence at 10 out of 48 sampling points (21% frequency). The cover crop mixture *V. sativa* + *A. sativa* had the highest biomass production (≥ 5,000 kg ha^{-1}), while *V. sativa* was the least productive cover crop and *A. sativa* had intermediate biomass values. In addition, the cover crop mixture *V. sativa* + *A. sativa* reduced weed biomass by 61%, 78% and 84% compared to *A. sativa*, *V. sativa* and the untreated control, respectively.

After cover crop termination, the dominant summer weeds on the experimental area were *Convolvulus arvensis* L. (field bindweed; botanical family Convolvulaceae) with an occurrence at 49 out of 84 sampling points (58% frequency) and *Cynanchum acutum* L. (swallow-wort; botanical family Apocynaceae) with an occurrence at 33 out of 84 sampling points (39% frequency). Due to the limited rainfall and the long drought in the Nemea region, the weed density was indeed low compared to previous years. The two species that dominated the field were not affected by the climatic conditions, as both are perennial weed species that typically emerge in the summer months of the growing season after rhizome sprouting in the wider area. In any case, herbicide application, especially at the recommended field rate, reduced the density of *C. arvensis and C. acutum* by more than 95% compared to the untreated control. The suppression of *C. arvensis* and *C. acutum* density was about 50–60% in *A. sativa* and *A. sativa* + *V. sativa* cover crop plots. In contrast, mowing and *V. sativa* cover crop had no significant effect on the density of these noxious broadleaf vine-climbing perennial weed species.

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CY_olives/26

In a field trial in an olive plantation in Cyprus, four cover crop treatments and six weed management practices were evaluated. The cover crops sown in winter were: *Vicia* spp. (seeding rate 24 kg ha^{-1}), *Pisum sativum* (seeding rate 22 kg ha^{-1}) and the triple species mixture of *Vicia* spp. + *P. sativum* + *Triticum durum* (seeding rate 8 + 8 + 4 kg ha^{-1}). An untreated control without cover crop was also included. In the plots with cover crops, the following six weed management practices were tested: untreated control, mechanical weed control by mowing, mulching, mechanical weed control by hoeing, herbicide application at the recommended rate and herbicide application at half the recommended rate.

The predominant weed families identified were Poaceae and Asteraceae. Weeds of the genera *Avena* spp. and *Lolium* spp. were the Poaceae species present at all 72 sampling points (100% frequency). *Conyza* spp. and *Sonchus* spp. were the most frequently encountered species of the Asteraceae, occurring at 62 of 72 sampling points (47% frequency). The third most common weed species was the invasive *Oxalis pes caprae* L. (Bermuda buttercup; botanical family Oxalidaceae) with an occurrence at 34 of 72 sampling points (47% frequency) and the fourth most common weed species was *Ecballium elaterium* A.Rich. (squirting cucumber; botanical family Cucurbitaceae) with an occurrence at only 5 of 72 sampling points (7% frequency).

The cover crop mixture *Vicia* spp. + *P. sativum* + *T. durum* and the cover crop *Vicia* spp. produced about three times as much biomass as P. sativum (P-Value ≤ 0.001). The combination of the cover crop mixture *Vicia* spp. + *P. sativum* + *T. durum* with mulching resulted in a very low weed biomass (28.8 g m^{-2}). The interaction *Vicia* spp. + *P. sativum* + *T. durum* × herbicide application at the recommended rate also resulted in a very low weed biomass value (28.8 g m^{-2}). In contrast, *P. sativum* × mowing and *P. sativum* × untreated control had weed biomass values of 111.2 g m^{-2} and 161.9 g m^{-2}, respectively. Herbicide application at half the recommended rate showed high weed biomass and thus low efficacy, regardless of cover crop factor. In addition, although Vicia spp. produced large amounts of biomass, it was less weed suppressive compared to the cover crop mixture *Vicia* spp. + *P. sativum* + *Triticum durum*. The reason for this could be the nitrogen supply to the weeds in the *Vicia* spp. plots, which stimulated the emergence of the weeds and favored their growth. On the other hand, the presence of cereal straw in the cover crop mixture suppressed the emergence of weeds, probably due to the release of allelochemicals and the longer time required for the straw to decompose compared to legume cover crops.

However, the cover crop *Vicia* spp. offers some advantages that should be taken into account when selecting it for the next trial year. In particular, the shorter growth height of *Vicia* spp. contributes to critical safety and environmental aspects: it reduces the risk of fire associated with the high temperatures in Cyprus and helps to mitigate the risk of snake establishment, improving both field safety and crop management efficiency.

ES_cherry/27

In a field trial conducted in a cherry orchard in Spain, four different types of cover crops were sown in late fall in the corridors between the rows of trees: *Ornithopus sativus*, *Trifolium subterraneum*, a biodiverse mixture of *O. sativus* + *T. subterraneum* + *Trifolium michelianum* + *Trifolium resupinatum* + *Trifolium vesiculosum* + *Trifolium incarnatum* + *Lolium multiflorum* and a grass mixture of *Festuca arudinacea* + *L. multiflorum* + *Lolium perenne* + *Dactylis*

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glomerata. In all plots, the sowing rate of the cover crops was 25 kg ha^{-1}. An untreated control with spontaneous vegetation was also maintained.

Rainfall was very abundant during the sowing period and soil preparation was carried out immediately before sowing. The abundant presence of the noxious perennial weed *Cynodon dactylon* (L.) Pers. (Bermudagrass; botanical family Poaceae) prior to the establishment of the trial caused a strong allelopathic effect on the germination of the cover crop seeds. This species was incorporated into the soil during tillage and there was no time to wash out the allelopathic substances as the cover crop was sown immediately afterwards to take advantage of the favorable weather conditions. The effects on seed emergence were not the same for all species (P-Value ≤ 0.05). The most severely affected cover crop was *T. subterraneum*. Due to the high rainfall in the previous season, the species used in the different covers also showed a high plasticity in their development cycles, resulting in excessively long growth stages, which in turn caused delays in the maintenance of the covers. The intensity of the fall rains prevented earlier seeding. The cover crops that produced sufficient biomass to have an impact on the surface of the inter-rows, although it should be noted that this biomass does not fully correspond to the proposed cover: Ornithopus sativus (6,483 kg ha^{-1}), biodiverse mixture (5,369 kg ha^{-1}) and grass mixture (5,569 kg ha^{-1}). The predominant winter weed species belonged to the *Lolium* spp. weeds (botanical family Poaceae).

Since the goal of cover crops is the ability to self-seed, it is necessary that they complete their cycle and allow their seeds to mature before they are mowed. However, cover crop growth was very slow, with a very long winter break, which delayed the late spring mowing. In addition, thanks to a very rainy year, biomass development was very high and dense, which could hinder the cherry harvest (which starts in mid-May). This was particularly observed in the biodiverse mixture and *O. sativus* plots. Prior control of *C. dactylon* is necessary to avoid allelopathic effects. It is interesting to look for short-cycle cover crops that can be incorporated before the cherry harvest. Although the biodiverse mixture and *O. sativus* have shown good results in terms of biomass and weed reduction on the plots where they have done well, a short-cycle *T. subterraneum* cover crop will be sown next year as it is smaller and the cover crop can be completed before the cherry harvest. Furthermore, the following weed management treatments are planned to be assessed on the tree lines during the second and third experimental years: Mechanical weed control by mowing, herbicide application at the recommended rate and herbicide application at half the recommended rate. An untreated control will also be included.

ES_apple-grapes/28

At the conventional site of this Living Lab, two field trials are set up in a Randomized Complete Block Design (RCBD) with six treatments and three replicates (blocks). The first experiment is conducted in an apple orchard and the second experiment in a vineyard. The treatment list is the same for both field experiments and includes the following six treatments: untreated control, mulching, mowing, cover-cropping in the inter-rows of the orchards/vineyards, herbicide application at the recommended rate and herbicide application at half the recommended rate. A mixture of subterranean clover + white clover + red clover + Italian ryegrass + English ryegrass was used as a cover crop (the sowing rate was 10 + 15 + 15 + 7.5 + 7.5 kg ha^{-1}). The measurements are not yet available, as the cover crops were planted in November 2024 and the herbicide treatments will be carried out in spring 2025. Mowing is always carried out when the vegetation reaches 25 cm and mulching is done by applying mulch before weeds germinate.

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