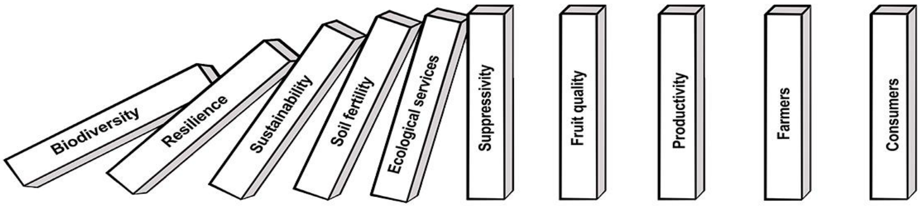
CORE organic

DOMINO



NEWSLETTER

Nº 1 December 2018

Release

This is the first issue of the DOMINO project newsletter. We want with this biannual publication inform all interested parties about the development of the project and its achievements and results.

In this issue, we provide a brief overview of the project and some basic information about its concept. We imagine the newsletter as an active tool for disseminating information, but also hosting ideas useful to further develop the project activities. For this reason, we will welcome any kind of contribution by the readers.

We take the opportunity to wish you all a Merry Christmas and a "fruitful" New Year!

The DOMINO consortium

DOMINO: introducing the idea of changing the monoculture paradigm in organic fruit production

Davide Neri and Eligio Malusá

Crop protection and management, including fertilization and weed control, requires high inputs in intensive organic fruit orchards, thus leading to increasing costs and undesired ecological impacts. The fulfilment of the crops' nutrient demand while maintaining at the same time the soil biological fertility and ecosystem services is a difficult task. Currently available organic fertilizers can still induce possible nutrient imbalances and have low nutrient efficiency. This is particularly true for fruit crops, where the need of nutrients, particularly of nitrogen, in early season is high and not paralleled by organic matter mineralization and availability. On the other hand, to reduce inputs might threaten crop production and quality. At the same time, there is the need to maintain soil fertility with an ever-decreasing availability fertilizers.

Plant protection in organic farming is also a practice that finds increasing challenges from "new" pests and diseases, frequently increasing their impact due to climate change or trade globalization. This situation requires new approaches, which should include physical barriers or a better management of the microbial community, both in the soil or in the plant. To achieve this, it is necessary to better understand how we can intervene to manage the natural biodiversity as well as to introduce new practices and concepts, which are finding their root in modifying the paradigm of specialised monoculture.

Such issues are tackled by the project "DOMINO", which aims at improving the long-term sustainability and the ecological foot print of intensive organic fruit orchards. The approach is based on an integrated strategy that includes:

a) introducing a second cash crop as living mulch in the row; these dynamic "living mulches" (consisting of plants with phytosanitary characteristics or productive

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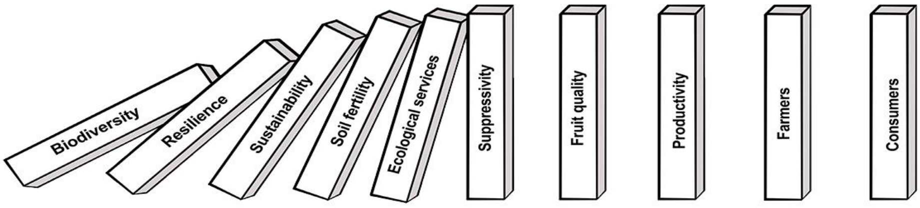


NEWSLETTER

Nº 2 June 2019

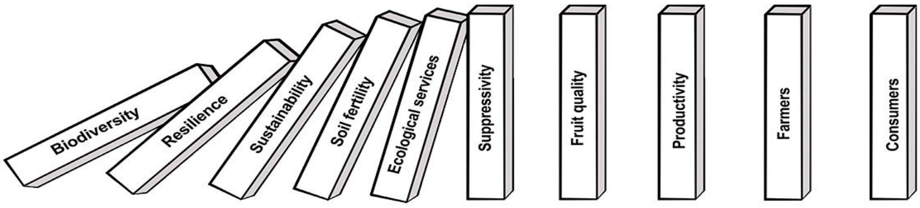
Release

It is already one year that the DOMINO project is running and we start to obtain some interesting data from the trials performed by the different partners which are confirming the concept at the base of the project: the introduction of a "vertical" production system, with the exploitation of different layers of the orchard, above and below ground, as a method to increase the agroecosystem resilience with a "domino" effect on biodiversity, fruit quality and overall sustainability of the cropping systems.

The article of Thomas Holtz and Markus Kelderer from the Experimental Station in Laimburg included in this issue is indeed presenting some outcomes from the trials with locally produced new organic fertilizers in comparison with those generally present on the market.

However, the project has been active in this first part of the growing season in setting several trials also with farmers dedicated to the innovative management of the row and of the inter-row. The proposed approach has met a high interest from the farmers, which have also underlined, during various meetings and events organized by the partners, the willingness to collaborate with the project. A detailed information about these meetings can be found on the project website, but we believe worthy to mention here those we consider the most important for the dissemination of the project concept and innovations:

- The presentation at the annual organic fruit growing conference ("Bio-Obstbautagung") organized by the partner FiBL in Lindau (CH), which was devoted to the organic fruit production of the future, underlining the need of a sustainable orchard management.



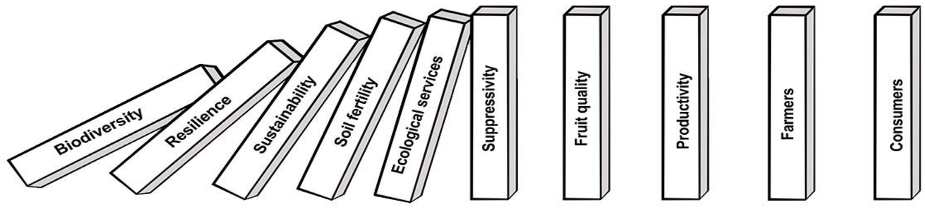
- The seminar at the International Agricultural Exhibition AGRA, the largest agricultural fair of Bulgaria, held in Plovdiv. It allowed to discuss environmental as well as political aspects of organic production in the country and the possibilities deriving from the innovations proposed by DOMINO.

- The workshop with the members of the Polish Association of Organic Fruit Growers in Biała Rawska (P), organized to define the method for the assessment and valorisation of the ecosystem services provided by the innovations proposed by the project.
- The workshop at the Competence Centre for Fruit Growing Bavendorf (D) organized with the Organic Fruit Growing Association (Fördergemeinschaft Ökologischer Obstbau) to present the first results of the trial using alternative fertilisers.
- The workshop organized at the University Alma Mater Studiorum of Bologna (IT) on strategies for sustainable organic orchard management, where the latest result on anti-hail net use and on live mulches application were presented along with the experience of a farmer involved in DOMINO's experimental activity.

- The presentation in the framework of the workshop "Cropping for the future: networking for crop rotation and crop diversification" organized by the Agricultural European Innovation Partnership (EIP-AGRI) in Almere (NL), to illustrate the activities and solutions of DOMINO as an example of the different approaches demonstrated throughout the EU tackling the issues of crop diversification and biodiversity improvement.

We take the occasion to wish all the readers a fruitful summer season.

Eligio Malusá and Małgorzata Tartanus



Nitrogen rich biomasses used as fertilizers. Laboratory and open field trials at Laimburg Research Center

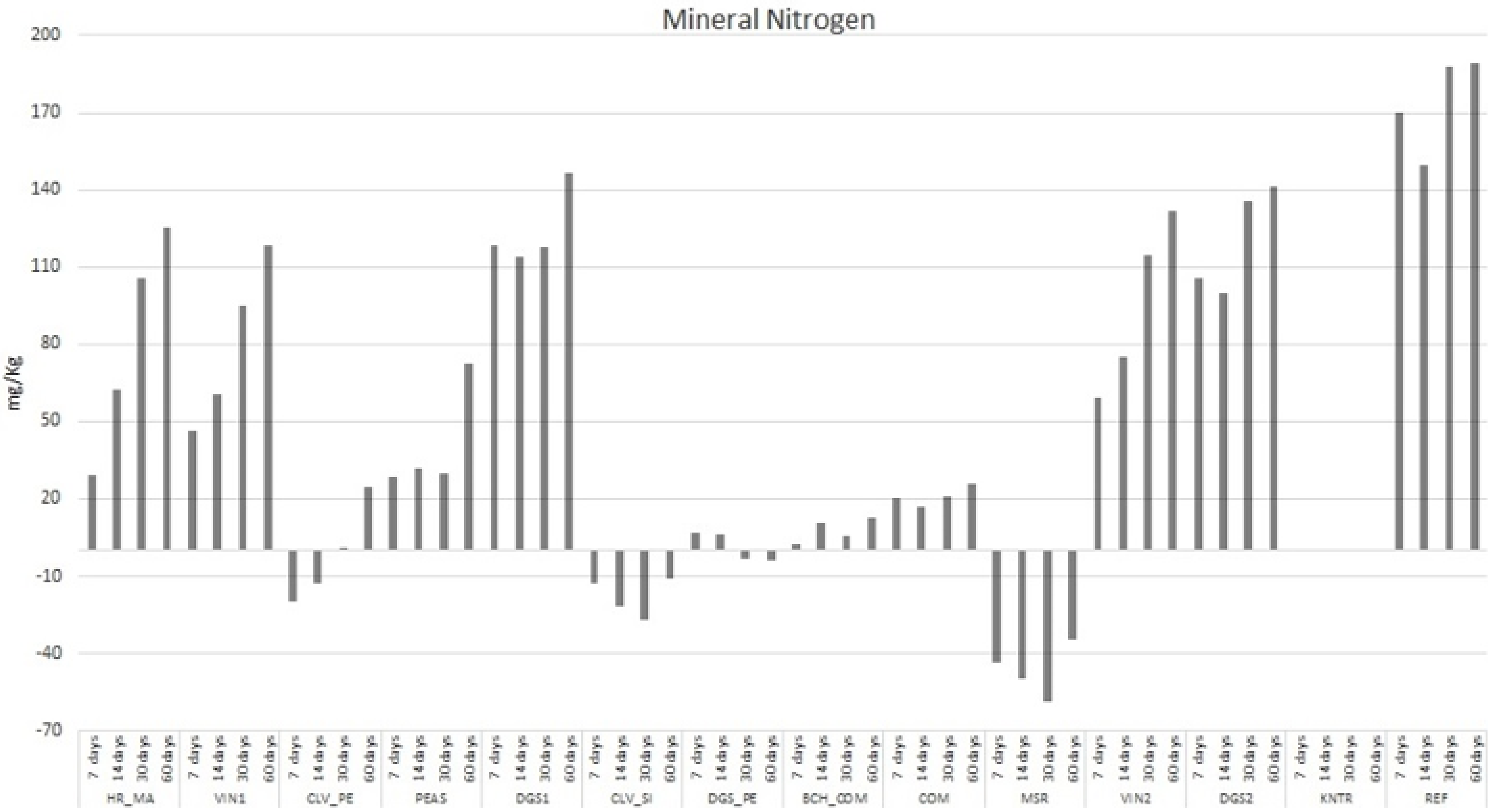
Thomas Holtz, Markus Kelderer

thomas.holtz@laimburg.it

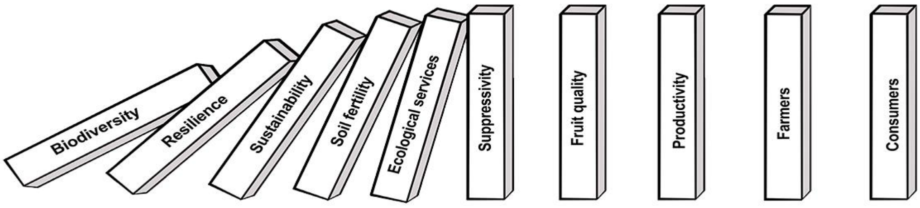
Nitrogen rich biomasses derived from industrial plants, organic waste plant-treatments and biogas production are becoming always more interesting for the organic agriculture. The ground idea is to exploit the organic nitrogen trapped into the biomass to cover the nitrogen demand of orchards and vineyards. Furthermore, as the nature of the products is organic, they can supply other nutrients like potassium, phosphorus, magnesium, calcium and increase the organic carbon pool of the ground. Starting from this concept, twelve organic substances (Tab. 1) were tested as nitrogen fertilizers. To understand if these products can be used in agriculture, bacteria and heavy metals content were examined, and laboratory trials to understand
how much and how fast these substances are releasing mineral nitrogen into the soil were performed. Every sample was mixed with 250g of soil and incubated for two months in aerobic condition. The mineral nitrogen was periodically extracted and quantified, while at the beginning and at the end of the experiment a complete soil characterization was effectuated.

Nr.	Row material	ID code	N content (%)
1	Bone and horn meal	HR_MA	14.09
2	Sillage	VIN1	4.28
3	Clover pellets	CLV_PE	3.62
4	Dried peas	PEAS	3.88
5	Digestate	DGS1	0.62
6	Clover silage	CLV_SI	1.70
7	Biodigestate pellets	DGS_PE	1.82
8	Biochar + compost	BCH_COM	1.04
9	Compost	COM	1.16
10	Mushrooms substrate	MSR	0.74
11	Sillage Inhort	VIN2	3.35
12	Digestate Inhort	DGS2	0.53
13	Control	KNTR	0.00
14	Reference - Ammonium sulfate	REF	21.18

Tab. 1 List of the 12 substances plus one control (nr. 13) and one chemical reference (nr. 14) incubated in controlled conditions. All the substances are reported with the relative nitrogen content.



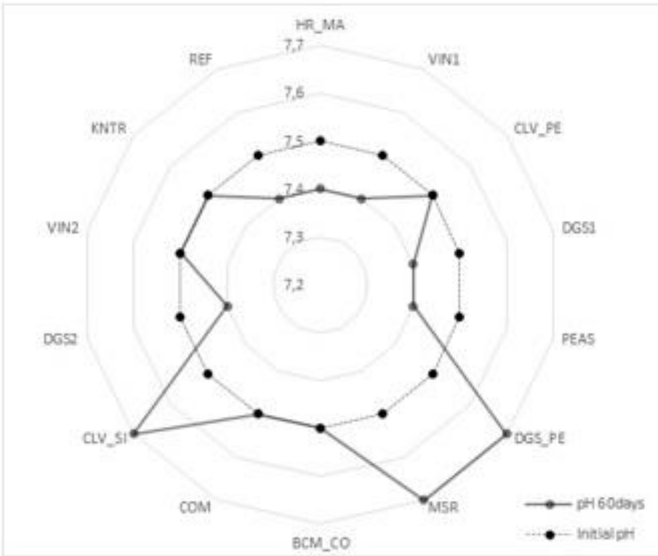
Graph 1. Mineral nitrogen extractions performed after 7, 14, 30 and 60 days of laboratory incubation. The mean values obtained from the control pots were subtracted from all the other samples.



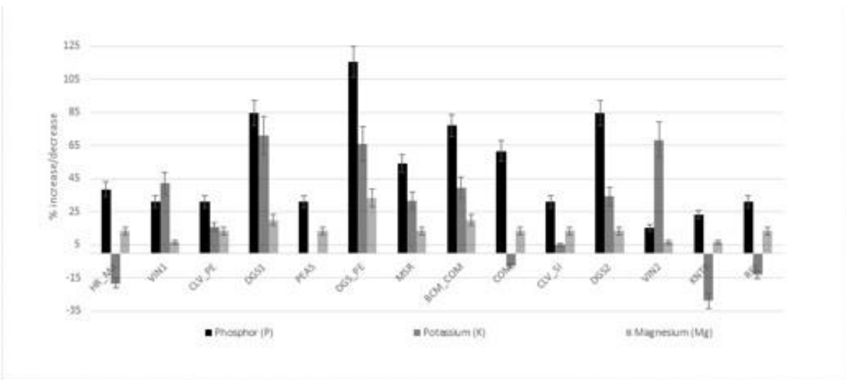
Graph 1 clearly shows how digestates (DGS1, DGS2) are the fastest nitrogen releaser, and how they are releasing the larger quantity of mineral nitrogen.

The two stillages (VIN1 and VIN2) are working well too, but both required more time than the digestates to reach high mineralization levels. From the solid products horn manure (HR_MA) is fast mineralized and bring constantly "new" mineral nitrogen to the soil, acting as slow releaser nitrogen fertilizer. Unfortunately, not all the tested products worked as expected. Using clover pellets (CLV_PE), during the first month, the mineral nitrogen was immobilized and only after 30 days it becomes available, but it stayed always low (<30 mg/Kg). Digestate pellets (DIG_PE) showed minimal influence on the soil mineral nitrogen, that remains extremely stable and close to the control value. For what concern clover silage (CLV_SI) and mushrooms substrate (MSR) the results are extremely negative, as in all the four extractions performed the values were lower than in the control pots. Finally, the compost (COM) brings slowly and only low quantity of mineral nitrogen, that was even lower when compost and biochar (BCH_COM) where mixed together (8:1 v/v).

To better understand what happened to the soil after the two months of incubation the main soil parameters were measured. As shown in graph 2, a few substances (CLV_SI, DIG_PE and MSR) are slightly basifying the soil, while others (DGS1, DGS2, PEAS, VIN1, HR_MA) are acidifying it, but the values remain quite close to the initial one (pH 7.5 ± 0.2). The Humus content increased in all the trials, while it remains quite constant (+5%) in the control. As expected, also the organic carbon pool increased, as all the tested substances contain mainly organic matter. For what concern macro-elements (graph 3), phosphor and magnesium increased in all the trials, particularly with the application of digestate pellets



Graph 2. Soil pH measured after 60 days of incubation.



Graph 3. Percentage of increase/decrease of soil macro-nutrients measured after 60 days of incubation.

(DIG_PE), the two bio-digestates (DGS1, DGS2) and the two composts (COM, BCH_COM). Only potassium, within horn manure (HR_MA), compost (COM) and control (KNTR) pot-trials decreased to lower values if compared to the potassium level at the beginning of the experiment.

From the laboratory incubations performed in 2018, six of the previous substances (Table 2) were selected for the second step, the open-field trial. Except for horn manure, already well known as nitrogen fertilizer, all the other substances did not show a proper mineral nitrogen supply to the soil, thus they are not interesting as nitrogen fertilizer. The goal of the open field trials of 2019 is to verify if the substances posed in open field conditions mineralize as well as in the laboratory incubation, where soil and air temperature and moisture were constant. In the field trials each pot was fertilized with 8g N and for the two digestates, the silages and the clover pellets, the pot fertilization was split in three biweekly distribution, to avoid possible root damages due to the nitrogen excess. The first distribution was performed three weeks after a one-year knip Gala Schniga Schnico Red / M9 was planted. A single application was performed only in the case of the dried peas, and after two weeks the germinated seeds were cut and incorporated to the soil. To understand how much organic nitrogen mineralize, five extractions will be performed II, IV, VIII, XII and XVI weeks after the second fertilizer application (see Table 3). The trial will last two years and as in the previous experiment, the soil will be fully characterized before and after the end of the experiment.

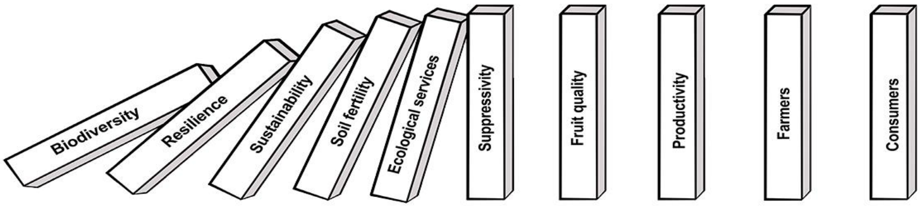
Nr.	Row material	ID code	N content (%)
1	Control	KNRT	0
2	Sillage	VIN1	4.22
3	Sillage Inhort	VIN2	2.96
4	Digestate	DGS1	0.52
5	Digestate Inhort	DGS2	0.50
6	Clover pellets	CLV_PE	3.60
7	Dried peas	PEAS	3.48

Tab. 2 List of the 6 substances plus control (nr. 7) posed in open field conditions. All with the relative nitrogen content.

	May					June				July					August/September		
Weeks	0	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	...	XVII	XXI
Tree transplanting	■																
Fertilizer applications				■		■		■									
N-min analyses								■		■				■		■	■

Tab. 3 Time table of the fertilizer applications and mineral nitrogen analysis planned from week 0, when the apple trees were transplanted in pots.

Laimburg, 25.05.2019



Read more at the CORE Organic website: *http://www.coreorganic.org/*
find publications from the project at: *http://www.domino-coreorganic.eu/*

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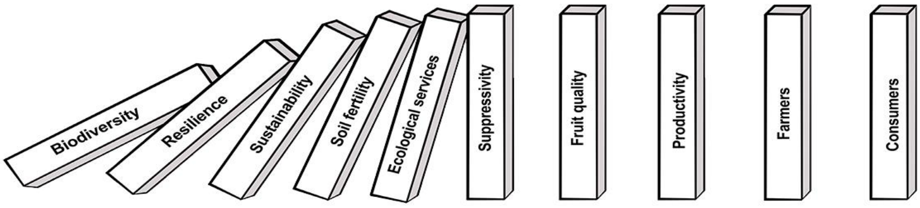


capacities or multifunctional features) will be grown in the row also to help weeds control and/or in the inter-row (leguminous plants or other floral species) to increase soil fertility, N availability or biodiversity.

b) introducing new fertilizers (locally available recycled organic materials, e.g., composted waste and biogas digestates) and legume mulches in the row to increase resource use efficiency and improve ecosystem services.

c) using transitory overhead net systems to support non chemical pests and diseases control.

In addition, the strategy includes the introduction of microbial-based products and the overall adaptation of orchard management to promote ecosystem services.

This innovative management is expected to maintain and enhance soil fertility, enhance inputs efficiency, improve plant nutrition and health, also by increasing the orchard biodiversity. We expect that the increase of overall biodiversity will make these intensive cropping systems more resilient to climate changes, reducing the dependency on external inputs and will improve the orchard carbon balance (i.e. the organic matter budget).

The overall hypotheses, which are the fundament of the project, are:

1) The management of herbs containing essential oils and commercial phytochemicals as living mulches in the tree rows will increase the biodiversity of secondary species and improve the control of weeds and rodents, representing meanwhile a second cash crop.

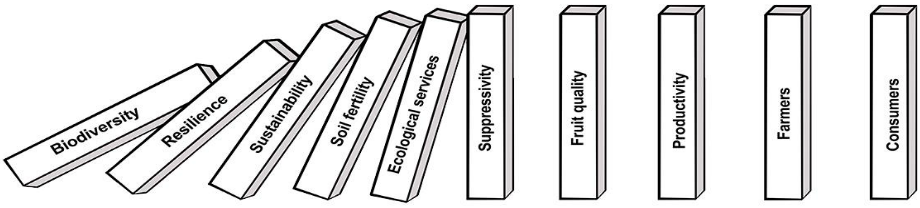
2) The use of leguminous species as living mulch, and applying fertilization using microorganisms' inocula and local recycled materials (e.g., food wastes, biogas-digestates) will provide a more balanced nutrient management and better fruit tree root growth because of improved soil fertility.

3) The use of the proposed fertilization and living mulching strategies will increase the nutrient use efficiency and will have a beneficial impact on fruit and soil quality, improving the current fertilization practices.

4) The use of semi-closed cover systems as physical barriers will reduce the need of external inputs for plant protection leading to a limited impact on biodiversity while ensuring better plant health and higher fruit quality.

5) The more efficient plant protection strategy will reduce the use of copper and sulphur, which affects the soil chemical characteristics and overall fertility.

The proposed practices should thus introduce the concept of vertical production, with the exploitation of different layers of the orchard, above and below ground, reducing the potential long-term impact of intensive organic orchards and increasing the agroecosystem resilience with a "domino" effect on biodiversity, fruit quality and overall sustainability of the cropping systems.



Agro-ecological engineering for a sustainable intensification

Serena Polverigiani

It is nowadays widespread the approach that aims to increase the sustainability of agricultural practices by promoting the biodiversity of the ecosystems. However, the further challenge consists in moving from a **greater biodiversity** (Fig.1) to a **targeted** management of **diversity** within the ecological communities. The difference is substantial and is based on the achievement of precise objectives.

A quarter of the soils in our planet are at great risk of degradation, and there are evidences that organic farming cannot unequivocally fight similar dynamics; it can do so at the cost of a less efficient land use. Organic farming is also particularly exposed to the risk of leaching and eutrophication and the achievement of greater precision in nutritional management can be considered as a primary objective for the sector. The idea is that the promotion of biodiversity focused on specific changes in the composition of the weed communities could allow a greater sustainability, but also an increased stability of the ecosystems.

Figure 1. A general increase of biodiversity in the agro-ecosystem s not always compatible with intensive systems.

The goal is not to replace intensive with extensive systems, evidently not sustainable from an economic point of view, but to model biological diversity so that agro-ecological services could compensate, at least in part, the needs for an increasing intensification.

The growing world population requires increasing resources and it is clear that the road to reducing the intensity of land use is hardly viable in a large scale. What we should aim for is, instead, a “different” intensification: a process of intensification still based on the protection of biodiversity, which, however, will include a further analysis of the **composition of the plant communities**, rather than simple diversity.

Figure 2. Tap root weeds are not compatible with an increase in land-use efficiency.

A generic increase in diversity above, as well as below ground, based on the random inclusion of many species can lead to competitions and

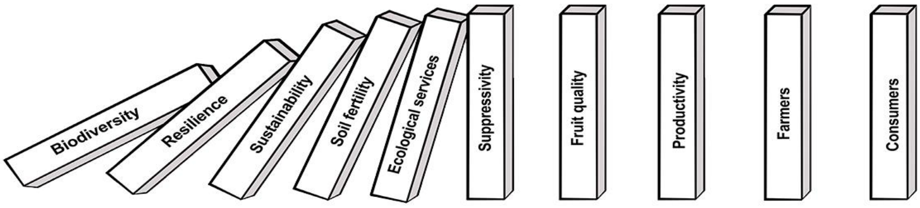


Figure 3. Selected ecological communities reduce competition and increase ecological services. Here stoloniferous species, with fibrous roots, increase soil holding capacity without a detrimental competition.

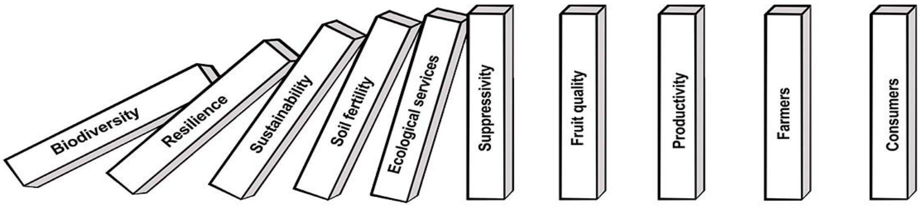
imbalances hardly manageable in a productive context. The DOMINO's innovative proposal consists of a targeted programmatic approach to improve services and functions within the agro-ecosystem.

The challenges are thus related towards the identification of combinations of plant species able to offer services to the system and, at the same time, characterized by precise traits that limit their competitiveness with respect to the main crop.

The selective weeding

In Mediterranean climate, the Università Politecnica delle Marche, tested the opportunity to manually select the weed community in the row of an orchard of young apricots grafted on Mirabolano.
Weed selection was performed in May by manually removing all creepers, tall and tap root species, considered as highly competitive with the main crop *(Fig.4).*

Figure 4. Examples of species selectively removed.



After 4 months the average canopy eight of the population was a 22% lower than in the control, not weeded treatment. The manual selection of the weeds induced a significant advantage to the main crop, being the apricot trunk development, 20% greater in the selectively weeded parcel (Fig.5).

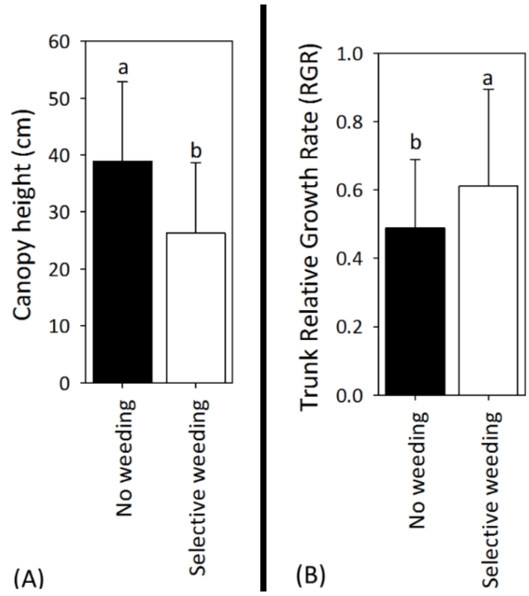
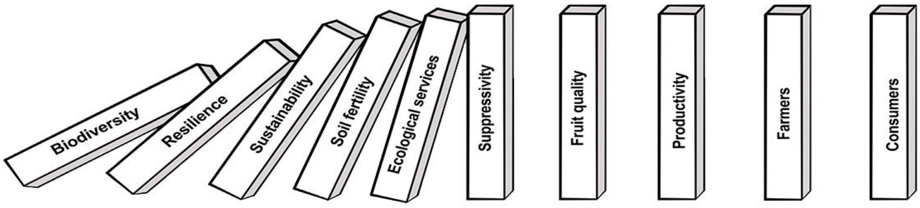


Figure 5. Effect of selective weeding on weed community canopy height (A) and apricot trunk growth (B)



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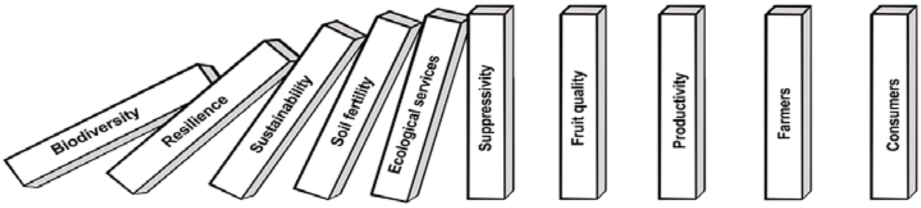


NEWSLETTER

Nº 3 January 2020

Release

Arrived at midway of the project implementation period, we are starting to gather interesting results from the trials established in the six partner countries and also from the evaluation of the status quo of the methods utilized for organic production of fruits. Therefore, we would like to share some of these results, particularly related to the effect of different fertilizers on the biodiversity of soil nematodes community, the practical experience of a farmer implementing the living mulching technique in his vineyards and the analysis of the answers from about 200 farmers and advisors about the technical and research needs for organic fruit producers. The three articles are underlining how biodiversity is affected by the agricultural practices and how innovative strategies of soil management can bear substantial positive effects on the farm income. We wish you an inspiring reading.

The DOMINO consortium

Relationships between soil fertilization practices and nematodes communities in organic apple orchard

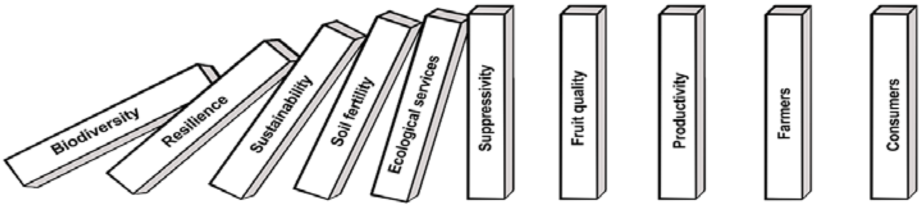
Dawid Kozacki, Grażyna Soika, Małgorzata Tartanus and Eligio Malusa

Developing optimal fertilization methods that match plant nutrient requirements while maintaining soil biodiversity is a challenge for organic fruit production. Properly developed methods should increase nutrient efficiency and improve nutrition and health of cultivated plants and soil.

The assessment of the impact of different organic fertilizers on soil nematode communities in an organic apple orchard was carried out in a trial where five types of organic fertilizers were used: dry manure, dried clover pellet, keratin-based fertilizer, biodigestate (by-product of fermentation of grain and vegetables wastes) and a stillage from yeast production (Vinassa).

Photo. 1. Oostenbrink elutriator.

The effect of the fertilizers on the nematode communities was assessed by analysing the structure of trophic groups and estimating the plant parasite index – PPI, which is a separate ecological measure proposed for nematodes feeding on higher plants. As soil nematodes are represented in many levels of a food web, the various species, genera and families have specific significance within a particular level.



Therefore, the trophic structure of nematode communities, and occasionally single trophic groups, can provide an indication of various ecosystem disturbance. Photos 2-5 are showing some specimens of nematodes belonging to the different trophic groups. The major difference is in the feeding apparatus.

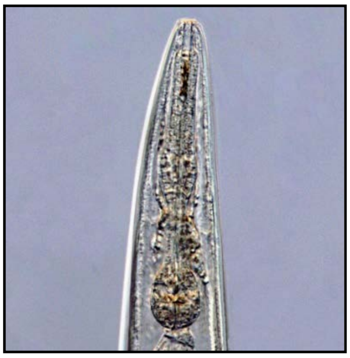


Photo. 2. Bacterial feeding nematode


Photo. 3. Fungal feeding nematode

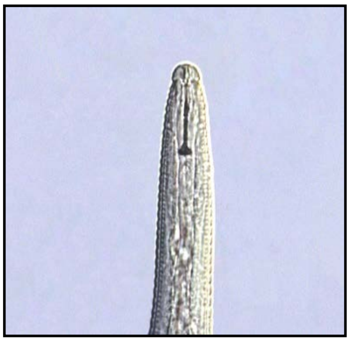


Photo. 4. Plant feeding nematode

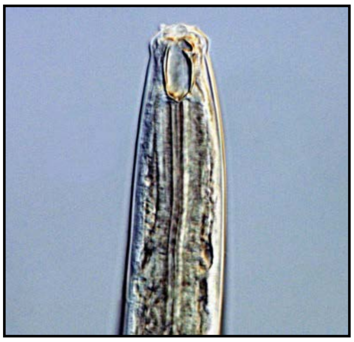


Photo. 5. Predator nematode.

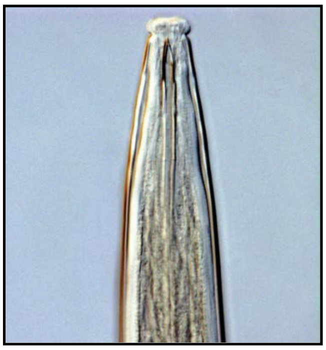


Photo. 6. Omnivore nematode.

To extract the nematodes from the soil, an Oostenbrink elutriator was used (Photo 1). This is an efficient and easy to standardize method that allows to separate the nematodes from heavier soil particles by their specific gravity in a water current. Nematodes are then collected on a set of sieves and further cleaned by passing on mesh dishes.

The effect of the application of the different fertilizers on the trophic groups of soil nematodes is clearly shown on Figure 1.

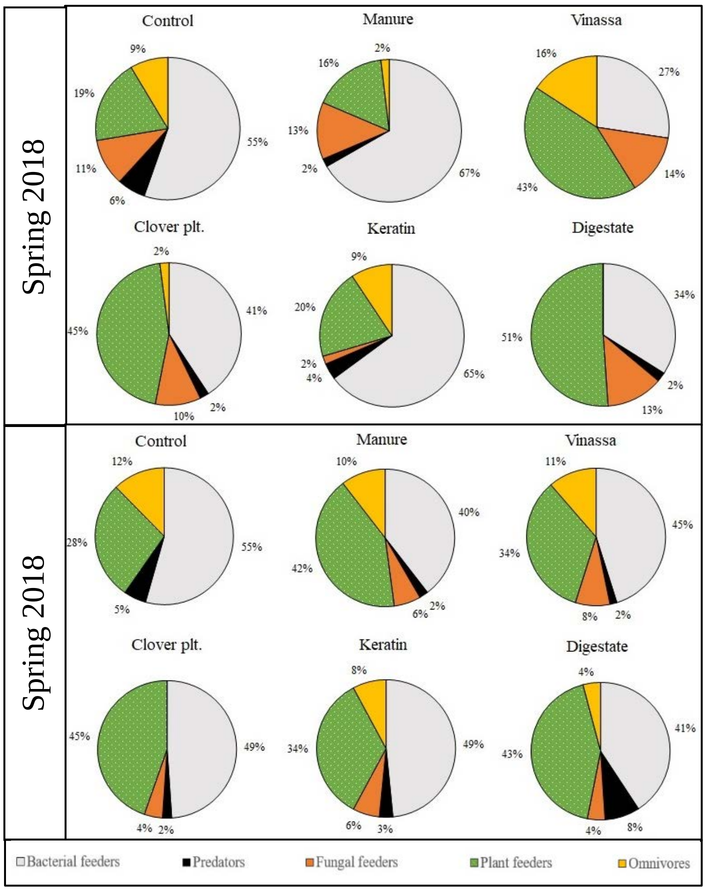
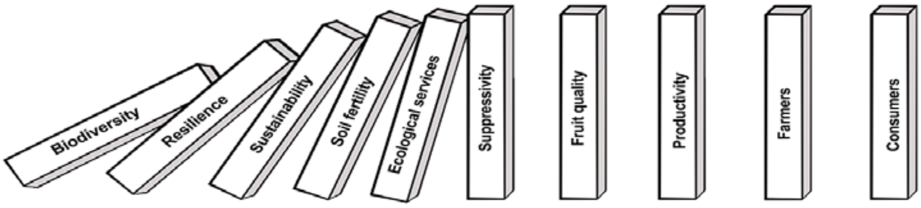


Figure 1. Effect of different fertilizers on the composition of trophic groups of nematodes in an organic apple orchard

The thropic structure of the nematode communities at spring time represents the situation before the application of the fertilizers. Bacterial feeding nematodes (Photo 2) are generally reacting very rapidly to environmental changes, especially to introduction of nitrogen compounds, as is the case with organic fertilizers. The enrichment stimulates bacteria and fungi activity and subsequently can promote nematodes development. Comparing with the unfertilized soil, the bacterial feeders were increased particularly after the application of manure (67% of the total community); fungal feeders (Photo 3) were promoted by Vinassa (14%), while the biodigestate induced an increase (51%) particularly of plant feeders (Photo 4). Predators (Photo 5) and omnivores (Photo 6) represent the highest trophic level amongst soil microfauna and their presence is thus underlining the complexity of the nematodes community in the soil. They are highly dependent on soil properties and very sensitive to pollutants. The highest share of omnivores was observed in soil fertilized with Vinassa (16%), while predators were highly present after application of the biodigestate (8%).

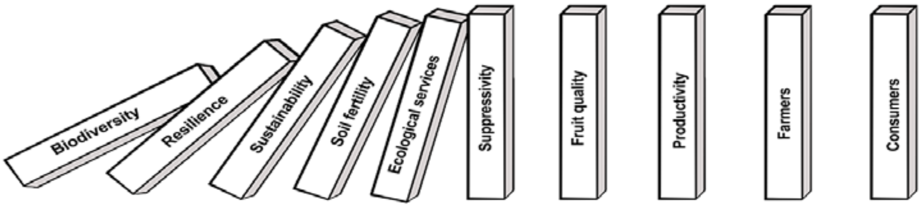


Interesting from the point of view of the farmers, is the evaluation of the Plant Parasite Index (PPI), i.e. the share of plant parasite nematodes within the whole nematodes community. A significant increase of PPI was induced by manure and keratin (Table 1), while other fertilizers (e.g. the clover plt or the Vinassa) provoked a reduction of the index value in comparsion to the untreated control. It is known that PPI increases with increased levels of primary production, including root growth, and soil physical properties. However, the feeding of these nematodes can have a negative impact on plant health.

Table. 1. PPI – Plant Parasite Index in soils with different fertilizers

Row material	Spring 2018	Autumn 2018
Control	2.91	2.88
Manure	2.44	2.70
Vinassa	2.91	2.76
Clover plt	2.73	2.52
Keratin	2.45	2.64
Digestate	2.63	2.67

We are continuing the analyses to have a full evaluation of the impact of the fertilizers on the soil biodiversity also considering the availability of nutrients and the behaviour of the populations of other soil microorganisms (bacteria and fungi), trying to link this to the plant growth and yield.



To valorise the biodiversity: an experience with living mulches.

Matteo Zucchini and Davide Neri (Polytechnic University of Marche, Italy)

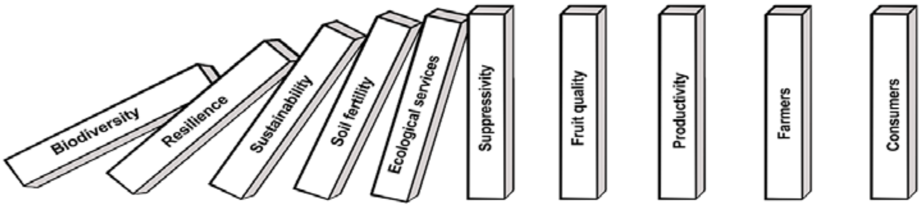
What does it mean to produce organic wine? For some producer this may simply mean to replace chemical inputs with products allowed by strict regulations. But, at Colle Stefano, to produce organic it means something more. It means focusing on the endogenous resources of a rich and complex agro-ecosystem, it means betting on biodiversity as a source of resilience. That is how, at Colle Stefano, weed management in the line turned from a problem into a resource: when, just for fun, the first wild strawberries have been introduced as live mulching in 2007. The innovative power of this idea was, perhaps, not entirely clear at that time. But after a few years, the collaboration with the Faculty of Agriculture of the Polytechnic University of Marche and the inclusion of the company in the international research project DOMINO http://www.domino-coreorganic.eu/ , the Colle Stefano intuition is, today, a case study to be taken as a model.

The wild strawberries, chosen among native ecotypes, are now planted in all new vineyards of the company: one plant at each side of the trunk, during autumn of the first year. Three hectares have been already renewed by such technique. Within the first growing season, thanks to the abundant rain, the fresh soil and an appropriate management, the strawberries produce a large set of runners and succeed in covering the soil and reduce weed development up to over 50%. A full weed suppression can be achieved starting from the second year, in the area surrounding the trunk. There, any other manual weeding would no longer be necessary.

Beside the contribution to weed management under the line, living mulches provide ecological advantages and increases the multi-functionality of the vineyard. A permanent soil cover strongly reduces the risk of erosion and leaking, dramatic in the hilly region where the company is located. Furthermore, mulches produce a large amount of organic matter that enriches the soil, thus increasing its chemical, but also, physical and biological fertility.

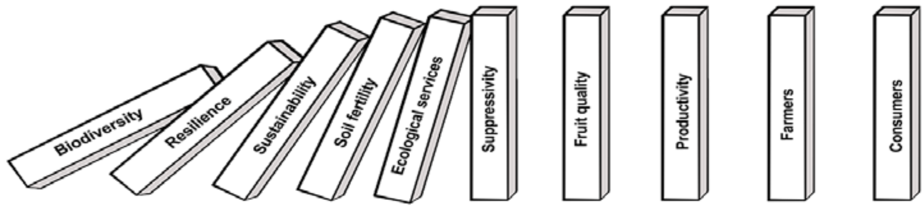
In a virtuous loop, a permanent cover of the floor increases the resilience by limiting thermic excesses and improves water management and the overall sustainability of the cultural system, thus reducing the need for external inputs. Mulching species (not just strawberries, but potentially, also many other stoloniferous) must be selected among local ecotypes and to be scarcely competitive: of short size and whit a moderate summer growth. In such integrated system, plant protection is achieved by valorising endogenous resources, with a drastic reduction of anthropic intervention toward an increasing ecologic (ecosystemic services), economic (secondary income and input reduction) and social (better use of labour with more diversified activities) sustainability.

Strawberries, ripening in May, also have an interesting aesthetic impact. The company cares a direct relationship with costumers and offers to visitors a rich sensorial experience. To visit Colle Stefano vineyard it means to experience how anthropic activity can melt with the



landscape improving it further, it means to meet a successful experience of multifunctionality and to take home an example of organic production on its most authentic mission: to promote soil fertility and agroecosystem biodiversity.

Check for more at https://www.youtube.com/watch?v=SiIKRZ2lIA4



What is the status quo for organic fruit producing farms in Europe and in which areas is research needed?

Friedli Michael and Boutry Clémence (FIBL)

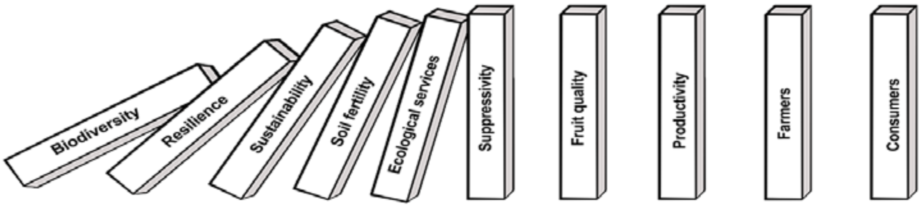
Within the CORE Organic project DOMINO, a questionnaire-based survey was conducted to evaluate the status quo in organic farming including the structure of the farm, biodiversity, fertilization, and areas with need for research. The results are used to draw conclusions for the development of the project.

The aim of the project DOMINO is to demonstrate that innovative orchard management can enhance soil fertility, biodiversity and economic sustainability of intensive organic fruit orchards. However, to evaluate the current status of organic fruit (particularly apple) farms, a survey was conducted in Italy, Bulgaria, Poland and Switzerland, involving a total of 140 participants (farmers and agricultural advisors). The questionnaire aimed at collecting data about the farm structure, the major practices utilized and the needs for technical support. We are presenting here the most interesting results.

Considering the period of time the farmers are producing organically, Swiss farmers are those practicing it for the longest time (around 25 years on average), followed by Italy (around 15 years on average), while organic farming is quite new in Poland and Bulgaria (3 years on average).

The size and type of orchards differed quite widely from country to country. In Italy, the farm size is rather small, with an average size of around 6 ha. Apple production represents about three quarters of the fruit producing area, and an average yield of 50 t/ha is attained (planting distance 3.0 x 0.9 m). Poland and Switzerland have a quite similar average farm size, but different production structures: around 20 ha in Poland, used almost exclusively for fruit production, around 30 ha in Switzerland, with only about half of it used for fruit production (about ¾ dedicated to apple as in Italy) and the remaining used as grassland or for production of fodder or arable crops. In Bulgaria, the farm size is very heterogeneous and ranging from 0.4 to 100 ha with a great share of walnut producers.

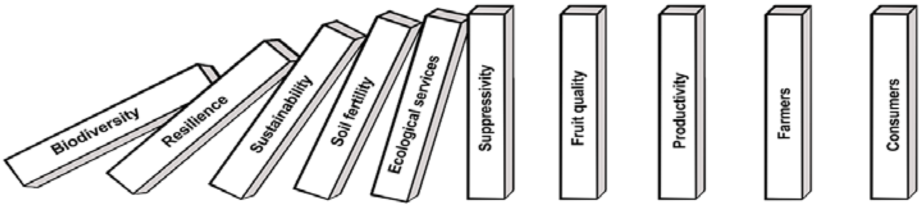
Hedges and flower strips are two important biodiversity elements in the orchard as they offer food and habitat for beneficial insects or animals. However, hedges were more often present in the orchard compared to flower strips, but farms having hedges often have flower strips as well. Farms in Italy, Poland, and Switzerland have hedges in 76%, 54% and 26% of the cases, respectively. Any Bulgarian farm resulted to have hedges. These are most of the time located outside the orchard as opposed to inside the orchard, and include a wide array of species: bushy types (bladder-senna, boxwood, elderberry, forsythia hop-hornbeam, ligustro, lilac, rosehip, sea buckthorn, shark roses) and tree types (acacia, ash, black alder, chestnut, dogwood, downy oaks, hazel, quaking aspen, white horn, wild cherry, wild figs, and willow). Flower strips are very



common in Italy (71% of the farms), in Switzerland only one in five farmers is implementing this practice, and none or almost none are using it in Poland and in Bulgaria. Other biodiversity elements implemented in Italian and Swiss farms are nesting boxes, cairns and insect hotels. On the other hand, the concept of biodiversity is rather new in Bulgaria and Poland, and farmers in these countries are just starting to add biodiversity elements to their orchards.

Regarding soil fertilization, around half of the farmers in Italy, Poland, and Switzerland are using a decision support system, with soil analyses being the main tool mentioned by farmers. Overall, only a limited number of fertilizers is used. In Bulgaria, Poland, and Switzerland farmers use mainly farmyard manure (dung, compost) as fertilizer, while in Italy commercial fertilizers are widely applied (Fig. 1). In case of the farmyard manure, most common are cattle dung (compost) in Italy, chicken dung in Poland and green compost in Switzerland (Fig. 2). Fertilizers are mostly applied in spring and/or fall, and usually only into the tree row. Another method to provide nutrients is through the use of legumes (e.g. clover, faba beans, peas, vetch) as intercrops in the orchard. However, only around 20% of farmers in Italy and Switzerland are using legumes as intercrop, and none in Poland and Bulgaria.

When asked about the needs for research activities in order to further develop organic orchards, the majority of participant farmers expressed a need for research activities related to plant health. A high number of respondents considered useful to search for methods to control the main diseases (e.g. apple scab, sooty blotch) and pests (e.g. codling moth, aphids, and invasive species such as stink bugs or *Pseudococcus comstocki*). Related to this was the request for new resistant varieties suited for organic farming as well as about knowledge on the “ecologization” of the orchard, for biological control of pests with beneficial insects, birds and animals. Always related to plant health, another area for research seen as important was the relationship between soil health and diseases. Finally, farmers asked for alternatives to the widely used copper and lime sulphur, and for new plant protection products including biological control products, or for an extension of the list of plant protection products allowed for organic farming. Interestingly, considering the variety palette, an early apple variety with good storability was also among the priorities. New solutions for the tree strip management and weed control, citing either with undergrowth grazing or new machines for mechanical weed control as possible solutions, were also suggested to be addressed. However, the emphasis from several respondents was to not forget the economic viability of any new proposed technical solution.



The outcome of the survey was confirming that the practices addressed by DOMINO are matching several requested areas for new research, particularly the new management strategies for the tree strip, the improvement of the nutrient balance with new regional available fertilizers or legume intercropping, the reduction of diseases and pests incidence by weather protection systems, all performing an economic evaluation of the proposed strategies.

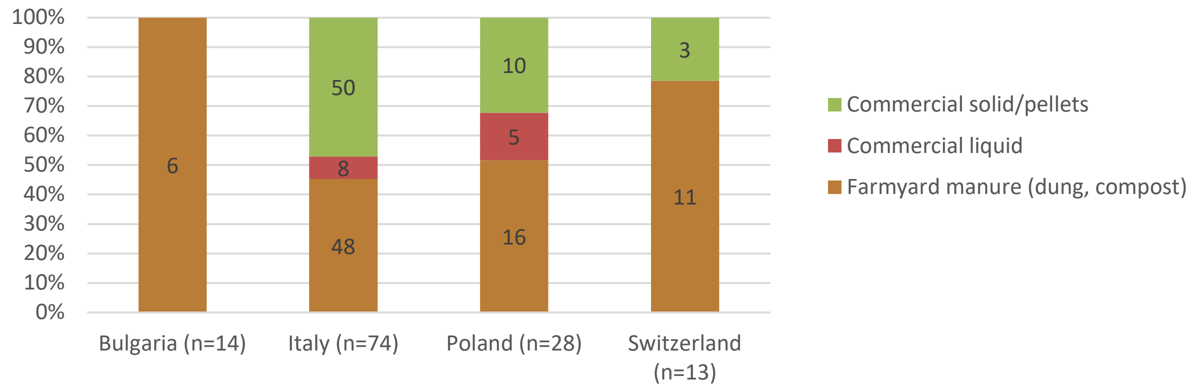


Figure 1: Type of fertilizer used by farmers per country. Values in brackets indicate the number of answers; values within the column indicate the number of mentions per category (multiple mentions possible).

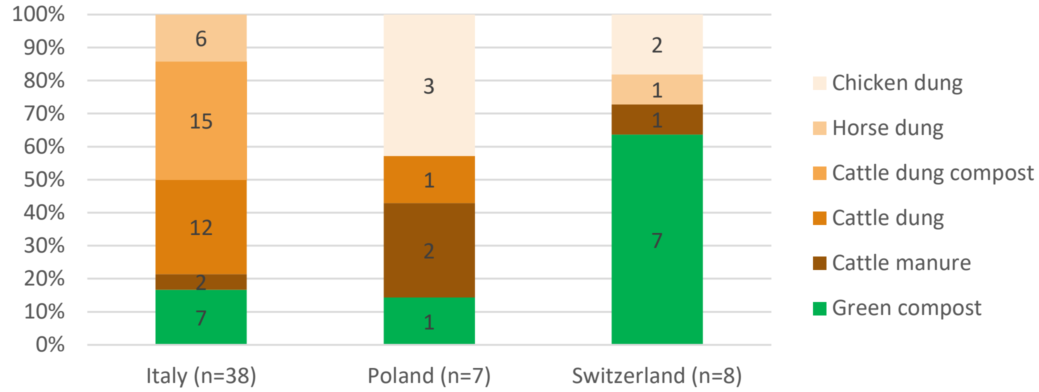
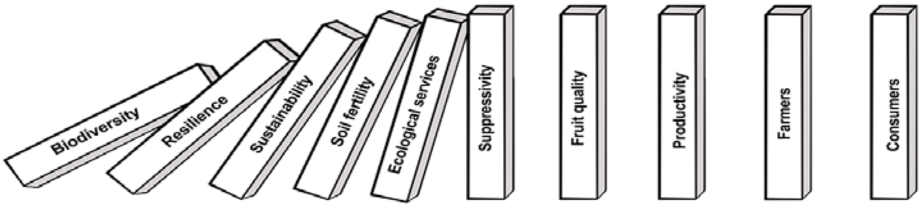


Figure 2: Type of farmyard manure used by farmers per country. Values in brackets indicate the number of answers; values within the column indicate the number of mentions per category (multiple mentions possible).



Read more at the CORE Organic website: *http://www.coreorganic.org/*
find publications from the project at: *http://www.domino-coreorganic.eu/*

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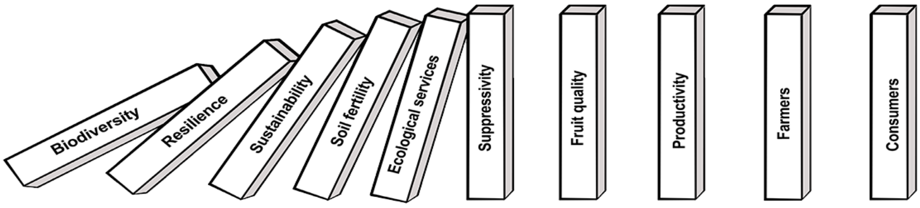


NEWSLETTER

Nº 5 December2020

Release

Dear Readers,

Plant species are associated with many beneficial insect species (e.g., pollinator) or species having a detrimental effect (e.g. pests). The insect-plant interactions and the mechanisms by which insects choose their host plants can help understanding the association patterns observed in nature, which could be "exploited" by organic farming methods. Sometime, the compounds produced by plants, that at a first look do not seem to be useful for the plant, play instead a central role in the insect-plant interactions or can interfere with the interactions of other plants. This is the subject of the research that has been carried out in DOMINO when assessing the effect of the different living mulch species on both beneficial insects and pests. Indeed, it is important to verify whether these plants do not negatively impact on parasitoids or predators.
The current issue of the newsletter is thus presenting some results about the effect of the living mulches on the composition and size of the populations of predatory mites commonly present in Polish apple orchards.

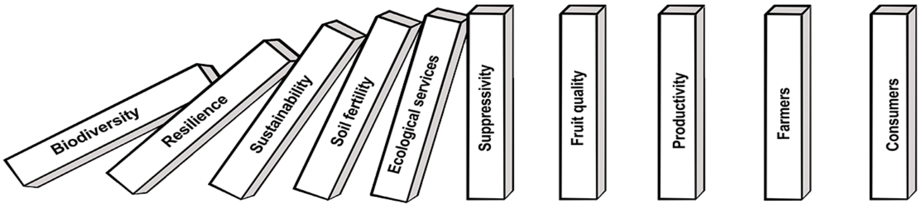
We wish you an interesting reading.

Eligio Malusá and Davide Neri

Living mulching species as a possible factor affecting the occurrence of predatory mites on organic apple orchards

Małgorzata Sekrecka, Eligio Malusa
Research Institute of Horticulture - National Research Institute, Poland

Spider mites and eriophyid mites are among the major pests in apple orchards. Feeding of these pests cause chlorosis of leaves, reduction in photosynthesis, abnormal tree growth and defoliation, thus resulting in decreased yield.
Predatory mites of the family Phytoseiidae (Photo 1) are the most common predators of phytophagous mites. Besides them, predators mites from the family Stigmaeidae (Photo 2) are also present in Polish apple orchards.
Living mulches, i.e. the cultivation of plants on the tree row, can be selected to provide several eco-services, including a support to orchard protection. We have tested within



DOMINO several species that could provide additional income to the farmer (e.g. wild strawberry), that have bioremediation activity (e.g. pumpkin against organic soil pollutants), that can have phytosanitary effect (e.g. marigold against soil pests) or that increase the orchard biodiversity (e.g. mint or Alchemilla toward pollinators). However, we have also evaluated the effect of these species on the abundance of predatory mites from both mentioned families on the leaves of organic apple trees.

The effect of the living mulch was visible for both 2019 and 2020, even though, overall, the number of beneficial mites was higher in the first season than in the second. However, the results were not always consistent. Indeed, mint resulted among the species that favored the presence of predatory mites in 2019, but in the following season this was no more observed. On the other hand, wild strawberry and Pulmonaria resulted to support the presence of the beneficial mites in both seasons.

The reasons for this result could be several. Surely, climatic conditions can affect the impact of the living mulches on the mites, but also the growth pattern of these plants could be another reason. For example, mint was growing more in 2020 than in 2019, so producing also a higher amount of essential oil (which release in air was felt in the orchard!). It is known that essential oils can have some effects on pests, but it is also possible that they could interfere with the beneficial fauna. On the other hand, it is worthy to note that wild strawberry, which was also successful in reducing the growth of weeds, was positively affecting the beneficial mites population.

The seasonal differences involved also the species present in the beneficial mites populations: four species were identified in 2019; (*Typhlodromus pyri*, *Amblyseius (Amblyseius) andersoni*, *Euseius finlandicus* and *Phytoseius echinus*), while only two species were observed in 2020: *Typhlodromus pyri* and *Amblyseius (Amblyseius) andersoni*.

It should also be mentioned that in both seasons, the number of phytophagous mites was very low, which could possible be derived from the activity of the predatory species as well as by a direct effect of the living mulches

The results point to a possible unexpected eco-service for some of the plants used in the trial useful to protect the apple trees from high infestation of parasitic mites. They need to be further verified considering also other agronomical aspects, but open a new opportunity for the exploitation of the agro-ecological approach in the management of organic apple orchards.

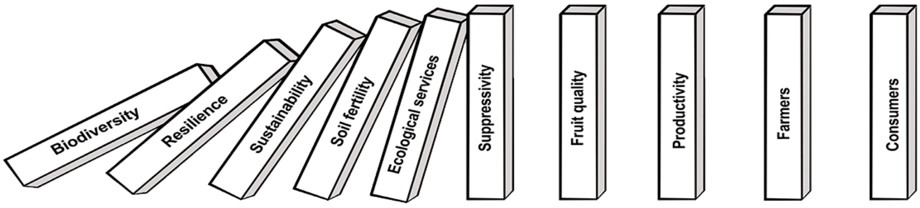


Photo 1. *Typhlodormus pyri* (Phytoseiidae), a species of beneficial mites commonly present in apple orchards

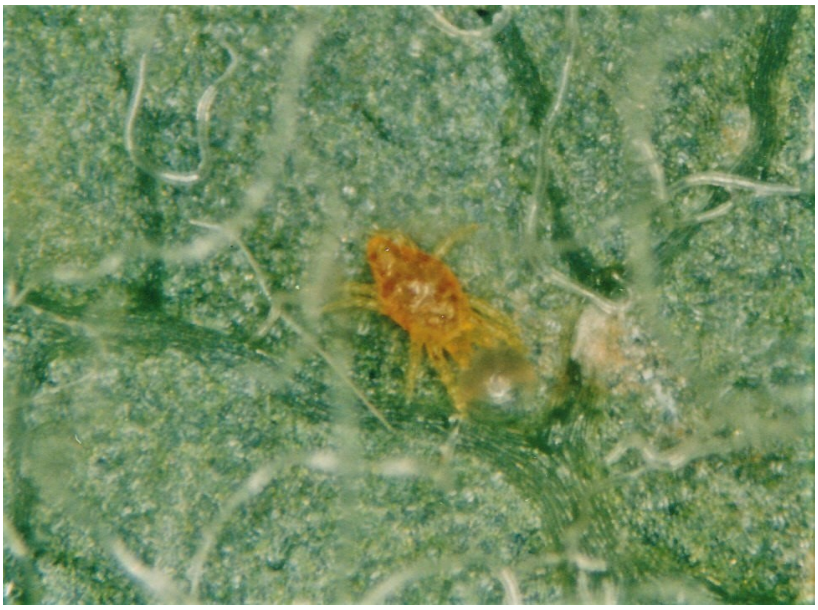


Photo 2. Species of the Stigmaeidae family of beneficial mites are less common, but were found in the trial.

Read more at the CORE Organic website: *http://www.coreorganic.org/*
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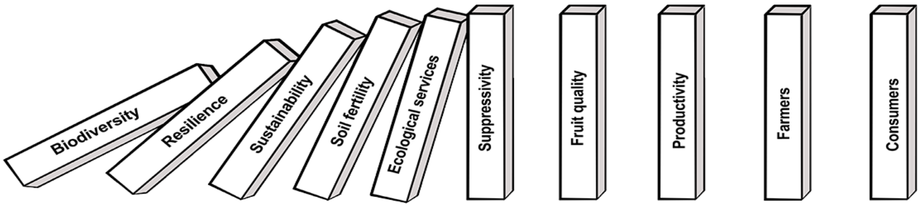

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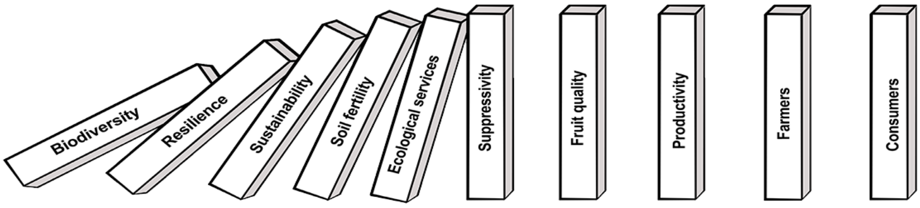


NEWSLETTER

Nº 4 June 2020

Release

Dear Readers,

Unexpectedly, as for other colleagues, projects, and any activity in the world, we have been hit by the Covid19 pandemic and the lockdown it has brought to all the countries involved in DOMINO. It has disrupted the plan of activities, particularly those requiring laboratory work. However, since the season has arrived and plants in the field have continued to grow, uptake nutrients, developed leaves, flowers and fruits, as under normal times, we also had to continue our field works. Somehow, these field activities have helped each of us keeping the contact with a "normal" reality.

The current issue of the newsletter is thus presenting some results about the possibility of controlling weeds developing on the row of the apple orchard by exploiting living mulches that could have different functions.

Thank you for following our website and wishing you a safe return to the living routines.

Eligio Malusá and Davide Neri

Can the use of living mulches reduce weeds infestation in organic orchards?

Joanna Kwiatkowska, Joanna Golian

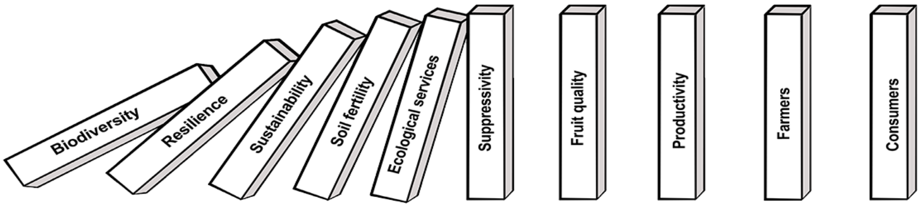
Weeds are an essential element of biodiversity, a component of the landscape and an important link in the animal food chain. However, in agricultural and horticultural crops they are undesirable plants that must be controlled. In orchards, the effect of excessive weeds infestation is a competition with trees for water and nutrients, as well as attractiveness for pollinating insects and the risk of inducing an excessive development of pests and fungal diseases. Moreover, soil overgrown with weeds absorbs less solar energy, which increases the risk of frost. The critical period during which fruit trees are particularly exposed to competition from weeds is from April to August. In organic orchards, where the use of herbicides is not allowed, there is an increasing interest about how to regulate weeds infestation, i.e. keeping them at a relatively low level, tolerated by trees. Therefore, research is constantly being carried out to develop new solutions to reduce weed infestation in orchards where fruits free from residues of plant protection products are produced, maintaining at the same time the profitability for the fruit grower.

In the years 2019-2020, at the Weed Science Laboratory of The National Institute of Horticulture Research in Skierniewice, a research was carried out assessing the effect of several living mulches on weed infestation in tree rows of an organic apple orchard. The goal of growing living mulches on the tree row included the possibility to have a secondary source of income for the farmer, e.g. growing medicinal plants, or increasing ecological services (e.g. additional feed for pollinators, soil bioremediation from persistent organic pollutants – POPs, increase the control of soil-borne or air-borne pests and pathogens of the apple crop). Determining the suitability of the various species of living mulches planted in the tree row in covering the soil and reduce weed infestation was also an aspect interesting to evaluate. The study included 11 living mulch species, such as: lady's mantle (*Alchemilla vulgaris*), violet (*Viola odorata*), sweet woodruff (*Galium odoratum*) in association with common hedgenettle (*Stachys officinalis*), lungwort (*Pulmonaria officinalis*) in association with marigold (*Tagetes patula*), common gypsyweed (*Veronica officinalis*), wild strawberry (*Fragaria vesca*), mint (*Mentha x piperita*), nasturtium (*Tropaeolum* sp.) and the winter squash (*Cucurbita maxima*).

A total of 51 weed species were present in the apple orchard. Regardless of the living mulch plant used, the soil surface was mostly covered by two perennial weed species, horsetail (*Equisetum arvense)* and dandelion (*Taraxacum officinale*), and several annual species, particularly purple deadnettle (*Lamium purpureum*), chickweed (*Stellaria media*), quick weed (*Galinsoga parviflora*), shepherd's purse (Capsella bursa-pastoris) and annual meadow grass (*Poa annua*).

E. arvense is considered one of the particularly persistent and difficult to control weed species that appear in orchards. Both mechanical and manual attempts to eradicate this species usually do not bring results, because fragmentation of runners stimulates vegetative reproduction. Horsetail plants can outgrow ground cover plants and also break through organic mulch. However, some of the living mulches species were able to contain its development.

The lowest weed infestation was found with mint, Alchemilla, nasturtium and pumpkin, (approx. 20% for all species). On the other hand, Pulmonaria and Veronica allowed the weeds to cover more than 50% of the soil. The production of mint and Alchemilla biomass was also remarkable, being these plants assessed as potential secondary cash crops, amounting to approximately 500 g/m2 and 386 g/m2, respectively, for the Alchemilla and mint.



Nevertheless, among the studied living mulches species, the best effect was produced by mint. Indeed, since already in the second year after planting it limited weed infestation by 60-70 %, compared to the natural cover. Annual living mulches such as pumpkin and nasturtium also showed strong growth and good soil cover, competing well against weeds. The effects on reducing weed infestation by these species were, however, slightly smaller than that of mint, because of their annual growth behaviour, and by the time these plants grew properly some of the weeds had already germinated. The remaining species of cover plants showed a weaker effect on the reduction of weed infestation, and the weakest effect was observed in the rows of trees in which the cover plants were lungwort and forest speedwell.

All the collected data show that not all studied species are similarly useful in soil management of tree rows. While none of them adversely affected the nutritional status of the trees, some of them are of more interest in weed control and others, such as wild strawberries, require more attention in the first year after planting to allow them to develop and cover the soil. An effect that has not been assessed but is expected to be interesting for the overall management of the orchard has been observed for some species. For example, a long flowering period (e.g. for nasturtium) resulted in a greater attraction of pollinating and possibly other beneficial insects, which could also have an impact on the health of the tree. The fertilization needs and the water management of the orchard using this new row management method will be further assessed. Indeed, in the long run, their growth and biomass production may need to be maintained through proper fertilization and irrigation to avoid possible competition with tree species. The good biomass production of some live mulches also points to their use as an additional source of income, as their leaves and flowers are used commercially to make valuable medicinal products as well as for aesthetic purposes.

We thus believe that the answer to our initial question can be positive, but a careful consideration of the orchard conditions and soil fertility must be done when selecting the potential living mulch species. The different options and ecological services that the different species can provide are also opening new opportunities to exploit them for different purposes, including the improvement of the orchard biodiversity.

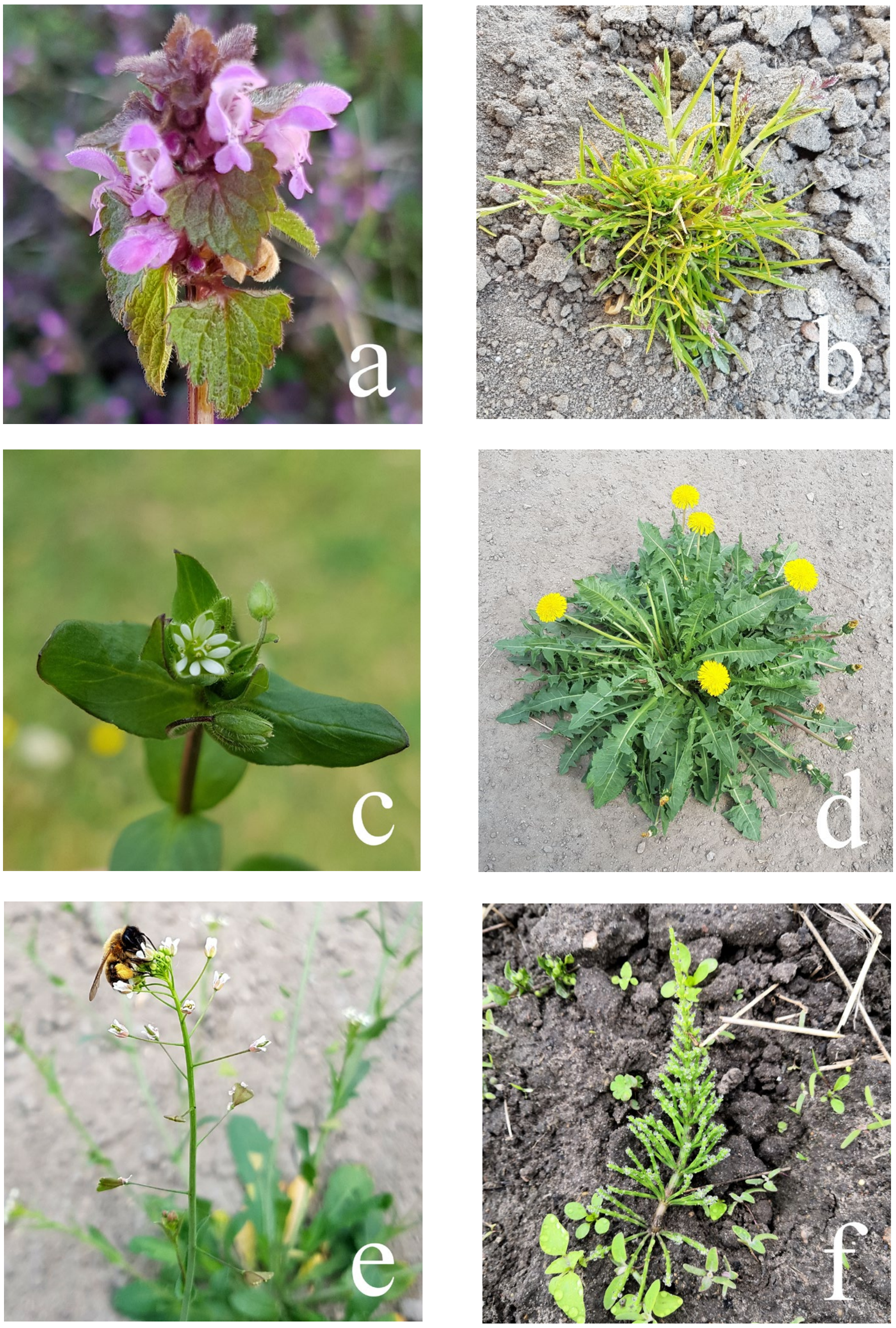
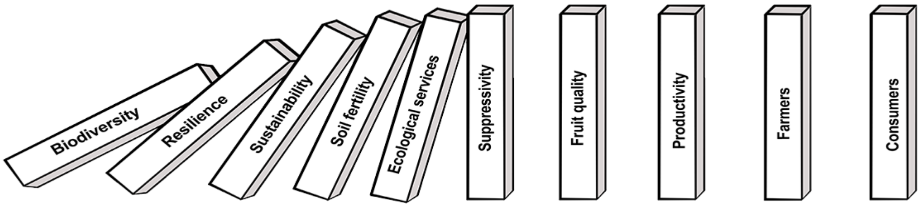


Fig. 1: Weed species common in apple orchards: a) purple deadnettle (*Lamium purpureum*); b) annual meadow grass (*Poa annua*); (c) chickweed (*Stellaria media*); d) dandelion (*Taraxacum officinale*); (e) shepherd's purse (*Capsella bursa-pastoris*); f) horsetail (*Equisetum arvense*).



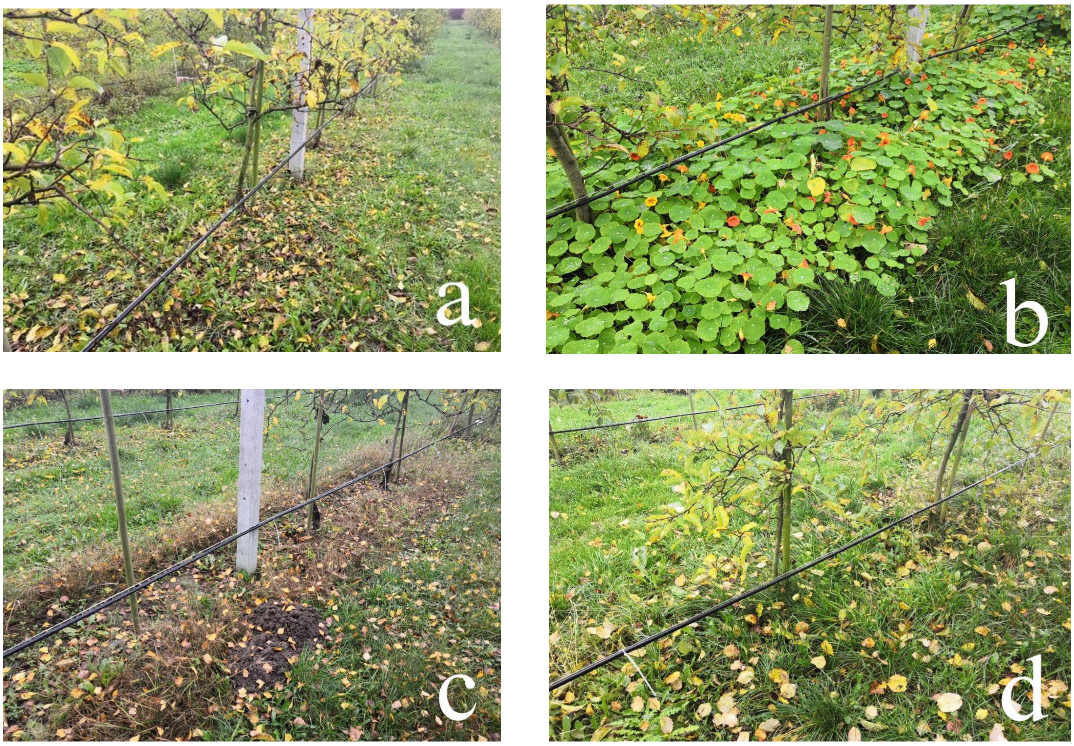
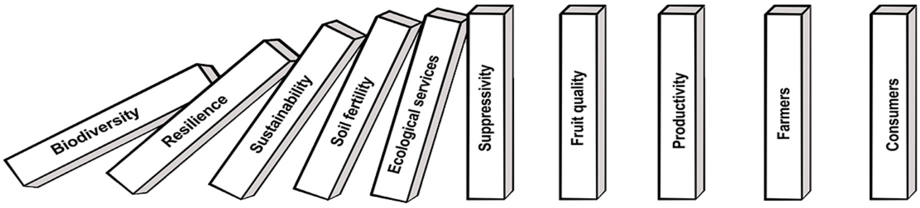


Fig. 2: The effect of the use of row living mulches on the orchard' weeds at the end of the growing season: a) lady's mantle (*Alchemilla vulgaris*); b) nasturtium; c) pumpkin; d) mint.



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