- *Manual* -

SUSTAINABLE URBAN GARDEN MANAGEMENT

HORTIS

Lifelong Learning Programme

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This project has been funded with support from the European Commission.
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Publication realised within the European project
Hortis – Horticulture in towns for inclusion and socialisation
(n. 526476-LLP-1-2012-1-IT-GRUNDTVIG-GMP)
www.hortis-europe.net

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Urban gardening activities can encourage lifelong learning among adults by fostering the acquisition of key competences that are fundamental for each individual in a knowledge-based society.

The following educational materials were designed within the context of the European project Hortis – Horticulture in towns for inclusion and socialization (526476-LLP-1-2012-1-IT-GRUNDTVIG-GMP), bringing together the urban gardening experiences from the partner cities, namely Bologna (Italy), Berlin (Germany), Budapest (Hungary) and Cartagena (Spain).

Each partner contributed with its own knowledge on a specific topic in form of an e-book, which successively evolved through an empirical approach of knowledge transfer and participatory review, toward a common and transversal vision of urban agriculture.

The outcome of this participatory process are five knowledgeable e-books covering different topics such as Sustainable Community Gardening in Cities (e-book 1), Sustainable Urban Garden Management (e-book 2), Urban Garden Cultivation Systems (e-book 3), Simplified Soilless Systems for Urban Vegetable Production (e-book 4) and Zero km Agriculture: An urban consumer's manual (e-book 5).

We hope these material will bring a new dimension to your work and inspire you in turning your life and city greener.

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1. FOREWORDS

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In recent times, urban horticulture gained the attention of an increasing number of people interested to find a direct connection with nature and to rediscover the pleasure of taking care of a garden (Fig. 1). However, it should be kept in mind that horticulture (and urban horticulture too) has a potentially high environmental impact related to the considerable amount of inputs needed to support the production. For this reason, it is important to adopt practices that reduce the environmental risk and to use the natural resources in a sustainable way. In the vegetable garden management, care must be taken for soil fertility preservation, rational water management, crop protection from atmospheric agents and pests, in order to reduce the use of chemical products and to create a natural agro-ecosystem in equilibrium with the human being and the surrounding environment, both in rural and urban areas. Moreover, the rational use of technical means (chemical fertilizers, pesticides, etc.) and of the available natural resources, together with the reduction of wastes, may allow to decrease costs, to preserve farmers health and to produce healthy and tasty vegetables. The present manual aims to provide an easy reference tool that can be used by urban gardeners in their activity of the city green preservation. Even though it can be considered as a complete farming activity, the urban garden management requires some care and special considerations related to the peculiarities of the context in which it is practiced. For what concerns the agronomic management of the vegetable garden, it is important to carefully consider the environment in which the production process takes place, which is characterized by climatic, edaphic and biological factors that influence in different ways the cultivation requirements and that should satisfy the crop needs. If this does not occur, the plant undergoes a stress which reduces its produc-

tivity as compared with the maximum potential achievable.
A good practice could be the preliminary analysis of soil characteristics in terms of fertility and aptitude for cultivation of certain plant species as well as the presence of any pollutant. Moreover, to ensure the homogeneity and the structural harmony of the cultivated area, it is necessary to consider the vegetative habitus of the cultivated species. For instance, there should always be an equilibrium between fruit trees and ornamental plants, vegetables, aromatic and medicinal plants, that should also take into consideration the expected production and consumption needs of the urban farmer. Orientation and spacing in the vegetable garden need to be designed in a way that gives adequate natural lighting and ventilation. This can help to improve photosynthetic efficiency and consequently a better sanitary control of crops. To limit the garden area hedges can be used, but it is also common to find fences made from recycled materials such as bed frames, drying racks, doors, bricks covered with plastic and more rarely wooden materials, thus giving an uneven appearance to the entire area. Fences, if well designed, can play instead a productive (e.g. wood, small fruits and flowers), ecological (e.g. wind protection and shelter for animals), defensive (e.g. soil erosion, property and crop protection), sanitary (e.g. barrier to buffer noise or to reduce pollution) and aesthetic role. Extremely important aspects of both urban and peri-urban gardens are the good management of water and the recovery and disposal of solid and liquid wastes (including pruning). Consistently, it may be recommended to have a composting structure to collect crop residues derived from leaves, herbaceous residues and pruning, that after crushing and maceration will also be useful for fertilization.

Figure 1. An urban garden.

2. SOIL PREPARATION AND CULTIVATION METHODS

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2.1 / SOIL PREPARATION

Ideal conditions for plant growth can be obtained when the soil layers stratification is similar to the one found in natural soils. Under these conditions, the organic matter is conserved on the soil surface and its decomposition gives nutrition to the plants.
It is a good practice to overturn the soil only when it is strictly necessary (e.g. to bury the manure or to break up the lawn) and to limit the preparation depth to a small layer (max 20-30 cm). In general, it is advised to substitute soil digging with the use of a garden fork or other light tools which may provide several advantages:

- soil aeration;
- respect of natural layers;
- reduced labour (no need of overturning of soil);
- higher breaking up;
- lower compaction;
- lower risk of erosion (for sloped lands).

When soil digging cannot be avoided, it is important to operate only when crops are not present in the field and the soil is neither too wet or too dry (tools can be inserted easily in the soil and the soil do not stick to them).
After the main preparation, a hoe is used to break the clods and later a rake is passed taking care not to break up too much the soil aggregates and at the same maintain its structure.
Too frequent soil preparation interventions and the use of machines can cause the formation of a hard soil layer that turns out to be difficult to penetrate by the vegetable roots.

2.2 / SOWING AND TRANSPLANTING

Vegetables can be either directly sown in the field or, better, in a seedbed and successively transplanted (Fig. 2). The use of the seedbed presents several advantages:

- easier weed control
- lower pests damages
- shorter crop cycles (important when cultivation plots are small).

However, since the transplant is a stressful procedure for the plantlet, crops with short cycle and high planting density are better directly sown in the plots.

At the time of sowing the distance between plants should be determined depending on the size that the adult plant will reach (Table 1) and on the tools used for weed control and soil management. By adding some additional centimetres in width, crop management will be faster and more accurate.

/ TABLE 1. DISTANCE (in cm) FOR CULTIVATION OF SELECTED VEGETABLE CROPS.

CROPS	DISTANCE BETWEEN PLANTS	DISTANCE BETWEEN ROWS
ARUGULA	10	10
BASIL, BEETROOT	30	30
BEAN AND GREEN BEAN (WITH SUPPORT)	80	8
BEAN AND GREEN BEAN (WITHOUT SUPPORT)	40	5
CARROT	30	7
CAULIFLOWER, CABBAGE, BROCCOLI	60	40
CELERY	60	25
CHARD	30	4
CRESS	10	10
CUCUMBER	100	60
EGGPLANT	80	50
FAVA BEAN	50	20
FENNEL	40	30
GARLIC	30	10

CROPS	DISTANCE BETWEEN PLANTS	DISTANCE BETWEEN ROWS
LEEK	60	10
LETTUCE	10	2
MELON	150	50
ONION	30	10
PARSLEY	10	continuous
PEA	40	4
PEPPER	80	50
POTATO	60	30
PRICKLY LETTUCE AND ENDIVE	30	25
PUMPKIN	100	200
RADICCHIO AND CHICORY	30	30
SAVOY CABBAGE	70	50
SPINACH	30	4
RADISH	30	4
TOMATO	80	40
TURNIP	30	20
ZUCCHINI	100	80

Seed sowing

The seeds are arranged regularly on the bottom of a groove, which has been previously dug with a hoe following a straight line drawn with the aid of a tense string. For smaller seeds, instead of using the hoe, the groove can be made using an iron or wooden pole with a diameter of 2-3 cm. A more homogeneous sowing is possible by mixing seeds with fine sand or coffee powder (100 g for 1 g of seeds). A sowing calendar for selected vegetable crops is hereby provided (Table 2A, B, C, D).

/ TABLE 2A. SOWING TIME OF SELECTED CROPS IN BERLIN (in winter sowing in seedbeds).

CROPS	EARLY SEASON		LATE SEASON	
	start date	end date	start date	end date
ARUGULA *	10 Feb	20 Nov		
ARTICHOKE	1 Feb	31 May		
BASIL *	1 Feb	30 Jun		
BEAN	1 Apr	30 Sept		
BROCCOLI	1 Apr	31 Oct		
BRUSSELS SPR.	1 Apr	30 Jun		
CABBAGE	1 Jun	10 Nov		
CARROT	20 Mar	15 Oct	Oct	May
CAULIFLOWER	15 Jul	15 Dec		
CELERY	10 Jan	31 Jul		
CHARD *	1 Sept	15 Mar		
CHICORY	15 Jun	10 Oct		
CUCUMBER	1 May	15 Sept		
EGGPLANT	1 Feb	30 Apr		
FAVA BEAN	1 May	31 Aug	1 Oct	31 Dec
FENNEL	1 Jun	30 Apr		
LEEK	1 Jan	31 May		
LETTUCE	1 July	1 Sept	1 Oct	15 May
MELON	1 Feb	30 Apr		
ONION	-	-	1 Sept	31 June
PARSLEY	1 Mar	30 Jul	10 Aug	10 Nov
PEA	1 Jul	30 Oct	-	-
PEPPER	1 Feb	30 Apr		
PUMPKIN	1 May	10 Oct		
RADISH	10 Feb	10 Nov		
SAVOY CABBAGE	1 May	20 Sept		
SPINACH*	1 Mar	30 Jun	1 Sept	15 Jun
WATERMELON	1 Feb	30 Mar		
TOMATO	10 May	15 Oct		
TURNIP	1 Feb	31 May	1 Aug	30 Sept
ZUCCHINI	1 Feb	20 May		

/ TABLE 2B. SOWING TIME OF SELECTED CROPS IN BOLOGNA (in winter sowing in seedbeds).

CROPS	EARLY SEASON		LATE SEASON	
	start date	end date	start date	end date
ARUGULA *	10 Feb	20 Nov		
ARTICHOKE	1 Feb	31 May		
BASIL *	1 Feb	30 Jun		
BEAN	1 Apr	30 Sep		
BROCCOLI	1 Apr	31 Oct		
BRUSSELS SPR.	1 Apr	30 Jun		
CABBAGE	1 May	10 Oct		
CARROT	1 Feb	30 Jun	1 Aug	30 Sept
CAULIFLOWER	1 Mar	30 Sept		
CELERY	10 Jan	31 Jul		
CHARD *	1 Mar	15 May		
CHICORY	1 Feb	30 Sept		
CUCUMBER	1 Feb	30 Apr		
EGGPLANT	1 Feb	30 Apr		
FAVA BEAN	1 Jan	31 Mar	1 Oct	31 Dec
FENNEL	1 Jun	30 Apr		
LEEK	1 Jan	31 May		
LETTUCE	1 Jan	31 May	1 Aug	30 Oct
MELON	1 Feb	30 Apr		
ONION	1 Jan	31 Aug	1 Dec	31 Dec
PARSLEY	1 Feb	30 Jun	10 Aug	10 Nov
PEA	1 Jan	20 May	1 Oct	31 Dec
PEPPER	1 Feb	30 Apr		
PUMPKIN	1 Feb	10 May		
RADISH	10 Feb	10 Nov		
SAVOY CABBAGE	1 May	20 Sept		
SPINACH*	1 Feb	30 Jun	1 Aug	30 Nov
WATERMELON	1 Feb	30 Mar		
TOMATO	20 Jan	30 Apr		
TURNIP	1 Feb	31 May	1 Aug	30 Sept
ZUCCHINI	1 Feb	20 May		

/ TABLE 2C. SOWING TIME OF SELECTED CROPS IN BUDAPEST (in winter sowing in seedbeds).

CROPS	EARLY SEASON		LATE SEASON	
	start date	end date	start date	end date
ARUGULA *	31 Mar	1 May		
ARTICHOKE	1 Apr	30 Apr		
BASIL *	1 Apr	30 Jun		
BEAN	20 Apr	20 May	30 Jun	31 July
BROCCOLI	15 Mar	1 Aprl		
BRUSSELS SPR.	31 Mar	31 May		
CABBAGE	15 Mar	30 Apr		
CARROT	1 Mar	30 Apr	15 Jun	15 July
CAULIFLOWER	1 Mar	1 Apr	15 May	30 Jun
CELERY	1 Mar	30 Apr		
CHARD *	1 Apr	30 Apr		
CHICORY	15 Mar	30 Apr	1 July	31 Aug
CUCUMBER	15 Apr	15 May	15 July	15 July
EGGPLANT	15 Mar	30 Apr		
FAVA BEAN	1 Apr	30 Apr		
FENNEL	15 Apr	1 May		
LEEK	1 Mar	31 Mar		
LETTUCE	1 Mar	15 Apr	30 Jun	31 Aug
MELON	15 Apr	15 May		
ONION	1 Mar	31 Mar		
PARSLEY	15 Feb	31 Mar	10 Jun	10 July
PEA	15 Feb	20 Apr		
PEPPER	15 Apr	15 May		
PUMPKIN	1 Apr	10 May		
RADISH	10 Mar	10 Apr	1 Aug	20 Sept
SAVOY CABBAGE	1 Mar	10 Apr		
SPINACH*	1 Mar	30 Apr	31 July	31 Aug
WATERMELON	20 Apr	20 May		
TOMATO	1 Aprl	5 May		
TURNIP	1 Mar	30 Apr	1 Aug	30 Sept
ZUCCHINI	20 Apr	31 May		

/ TABLE 2D. SOWING TIME OF SELECTED CROPS IN CARTAGENA (in winter sowing in seedbeds).

CROPS	EARLY SEASON		LATE SEASON	
	start date	end date	start date	end date
ARUGULA *	1 Jan	30 Apr		
ARTICHOKE	1 Jan	30 Jun		
BASIL *	1 Mar	31 Oct		
BEAN	1 Mar	30 Sep		
BROCCOLI	1 Jan	31 Mar		
BRUSSELS SPR.	1 Mar	30 Jun		
CABBAGE	1 Jan	31 Mar		
CARROT	1 Jan	31 July	1 Aug	30 Sept
CAULIFLOWER	1 Jan	31 Mar		
CELERY	1 Jan	31 July		
CHARD *	1 Mar	31 Oct		
CHICORY	1 Jan	31 Mar		
CUCUMBER	1 Jan	30 Jun		
EGGPLANT	1 Feb	30 Jun		
FAVA BEAN	1 Jan	31 Mar	1 Oct	31 Dec
FENNEL	1 Jan	30 Apr		
LEEK	1 Jan	31 July		
LETTUCE	1 Jan	31 Apr	1 Aug	30 Oct
MELON	1 Jan	31 May		
ONION	1 Jan	31 July	1 Dec	31 Dec
PARSLEY	1 Jan	30 Jun	10 Aug	10 Nov
PEA	1 Jan	30 Jun	1 Oct	31 Dec
PEPPER	1 Feb	30 Jun		
PUMPKIN	1 Feb	31 May		
RADISH	1 Jan	30 Jun		
SAVOY CABBAGE	1 Jan	31 Mar		
SPINACH*	1 Jan	30 Apr	1 Aug	30 Nov
WATERMELON	1 Jan	31 May		
TOMATO	1 Feb	30 Jun		
TURNIP	1 Jan	31 May	1 Aug	30 Sept
ZUCCHINI	1 Jan	20 May		

Seedbeds

The seedbed (Fig. 2) is composed of a frame made of wood or iron closed on the top with a glass or plastic plate, or even with a transparent polyethylene sheet. It needs to be positioned exposed to the south and in the hottest days it is should be kept open in the morning. The seedbed can be filled with a soil made of river sand (1/3), compost (1/3) and soil from the garden (1/3). Alternatively, also yogurt jars and plastic bottles drilled at the bottom can be used by filling them with soil. When using the box-seedbed seedlings will be transplanted with the "bare-root", while when using the jars the seedlings will be transplanted with the whole soil cube containing the roots. In both cases the soil should be kept moist by watering frequently at low doses.

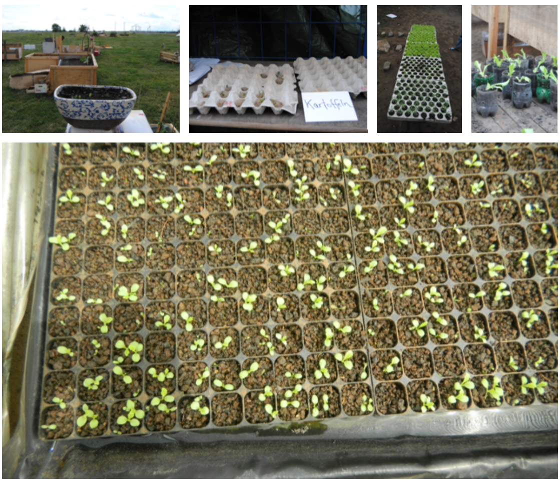


Figure 2. Seedbeds.

After sowing

To facilitate germination it is important to water regularly in order to maintain a stable soil moisture. When plants have reached 3-5 cm in height, thinning should be performed to select the best seedlings and give them an appropriate living space. To operate thinning, it is better to have a moist but not too wet soil. To avoid seedlings damages, it is a good practice to remove them with one hand while the other hand will keep pressure on the soil around the plants that will remain in the field. If the seedlings that are being removed are in good condition, they can be transplanted.

Transplanting

Seedlings are ready for transplant when they have around 4-5 leaves. It is better to avoid the transplant of stunted, weak, or even too developed seedlings. In the case of seedlings in jar, it is a good practice to put them in the field few days before transplant to make gradual the transition from the protected environment to the open air. Another expedient is to prepare the holes or grooves before transplanting to reduce the direct exposure of roots to the sun. It is also important to irrigate the seedlings on the day before transplanting to avoid damages when removing from the seedbed. The preparation of grooves and holes is carried out with a hoe that can possibly drill also the plastic mulching. It is important that the groove respects the development of roots and aerial part of the plant and that the collar (transition zone between root system and aerial part of the plant) is slightly higher, so that after soil adaptation it will be positioned at ground level as occurs in nature.

For “bare-root” seedlings:

- the seedling must be positioned lower than the soil level;
- roots should be covered with soil;
- the collar should be positioned so that it is higher than the soil level;
- the soil should be pressed firmly in order to give stability and to

make the roots stick to the ground.

The transplant should be preferably carried out in the evening or when the sky is cloudy. After transplanting, it is necessary to water the plants to reach an uniform soil moisture paying attention to avoid compaction. Transplanting times in central Europe are summarized in Table 3A, B, C, D.

/ TABLE 3A. TRANSPLANTING TIMES IN BERLIN (Germany).

MONTH	JANUARY			FEBRUARY			MARCH			APRIL			MAY		
DECADE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
ARTICHOKE															
BASIL													■	■	■
BROCCOLI													■	■	■
BRUSS. SPR.															■
CABBAGE												■	■	■	■
CAULIFLOWER															
CELERY													■	■	■
CHICORY															
CUCUMBER										■	■	■	■	■	■
EGGPLANT										■	■	■	■	■	■
GARLIC															
LEEK												■	■	■	■
LETTUCE								■	■	■	■	■	■	■	■
MELON										■	■	■	■	■	■
ONION				■	■	■	■	■	■						
PEPPER										■	■	■	■	■	■
PUMPKIN										■	■	■	■	■	■
SAVOY												■	■	■	■
STRAWBERRY	■	■	■	■	■	■									
WATERMELON											■	■	■	■	
TOMATO										■	■	■	■	■	■
ZUCCHINI										■	■	■	■	■	■


JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3

/ TABLE 3B. TRANSPLANTING TIMES IN BOLOGNA (Italy).

MONTH	JANUARY			FEBRUARY			MARCH			APRIL			MAY		
DECADE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
ARTICHOKE															
BASIL													■	■	■
BROCCOLI													■	■	■
BRUSS. SPR.															■
CABBAGE												■	■	■	■
CAULIFLOWER															
CELERY													■	■	■
CHICORY															
CUCUMBER										■	■	■	■	■	■
EGGPLANT										■	■	■	■	■	■
GARLIC															
LEEK												■	■	■	■
LETTUCE								■	■	■	■	■	■	■	■
MELON										■	■	■	■	■	■
ONION				■	■	■	■	■	■						
PEPPER										■	■	■	■	■	■
PUMPKIN										■	■	■	■	■	■
SAVOY												■	■	■	■
STRAWBERRY	■	■	■	■	■	■									
WATERMELON											■	■	■	■	
TOMATO										■	■	■	■	■	■
ZUCCHINI										■	■	■	■	■	■


JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3

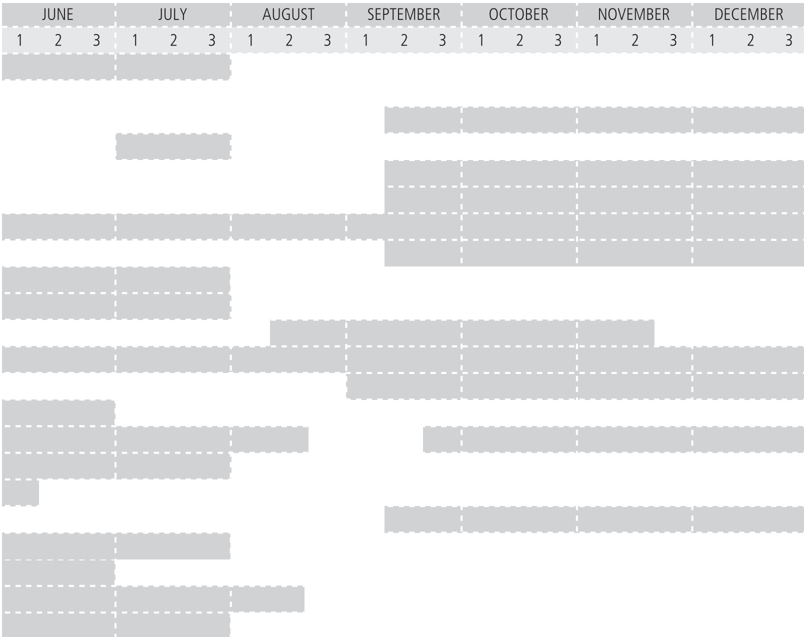
/ TABLE 3C. TRANSPLANTING TIMES IN BUDAPEST (Hungary).

MONTH	JANUARY			FEBRUARY			MARCH			APRIL			MAY		
DECADE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
ARTICHOKE													■	■	■
BASIL													■	■	■
BROCCOLI										■	■	■	■	■	■
BRUSS. SPR.										■	■	■	■	■	■
CABBAGE										■	■	■	■	■	■
CAULIFLOWER										■	■	■	■	■	■
CELERY													■	■	■
CHICORY										■	■	■	■	■	■
CUCUMBER													■	■	■
EGGPLANT														■	■
GARLIC							■	■	■	■	■	■			
LEEK										■	■	■			
LETTUCE							■	■	■	■	■	■			
MELON													■	■	■
ONION							■	■	■						
PEPPER													■	■	■
PUMPKIN											■	■	■	■	■
SAVOY							■	■	■	■	■	■	■	■	■
STRAWBERRY							■	■	■	■					
WATERMELON													■	■	■
TOMATO											■	■	■	■	■
ZUCCHINI													■	■	■


JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3

/ TABLE 3D. TRANSPLANTING TIMES IN CARTAGENA (Spain).

MONTH	JANUARY			FEBRUARY			MARCH			APRIL			MAY		
DECADE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
ARTICHOKE															
BASIL															
BROCCOLI	■	■	■	■	■	■	■	■	■						
BRUSS. SPR.															
CABBAGE	■	■	■	■	■	■	■	■	■						
CAULIFLOWER	■	■	■	■	■	■	■	■	■						
CELERY							■	■	■	■	■	■	■	■	■
CHICORY	■	■	■	■	■	■	■	■	■						
CUCUMBER							■	■	■	■	■	■	■	■	■
EGGPLANT							■	■	■	■	■	■	■	■	■
GARLIC															
LEEK	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
LETTUCE	■	■	■	■	■	■	■	■	■	■	■	■			
MELON										■	■	■	■	■	■
ONION	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PEPPER							■	■	■	■	■	■	■	■	■
PUMPKIN										■	■	■	■	■	■
SAVOY	■	■	■	■	■	■	■	■	■						
STRAWBERRY	■	■	■	■	■	■	■	■	■						
WATERMELON										■	■	■	■	■	■
TOMATO							■	■	■	■	■	■	■	■	■
ZUCCHINI				■	■	■	■	■	■	■	■	■	■	■	■


JUNE
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2.3 / WEED CONTROL

Weeds can be considered as a resource because they host beneficial insects, protect crops from thermal shock and reduce the leaching of nutrients. Nevertheless, weed control is very important in the early stages of growth of the seedlings because they may compete with crops for the access to light, water and nutrients.

Manual control

For vegetables that germinate slowly like carrots, it is advisable to sow "row-indicator" plants (e.g. radish), that have fast germination and help recognizing the row and be able to efficiently control weeds. In the early years of cultivation the presence of weeds may be more conspicuous, so a good practice could be the "fake sowing". This technique consists in preparing the soil, watering it, waiting for the weeds to grow, prepare the soil again and finally sowing the crop. Usually for weed control is enough to use a hoe. During spring, the manual weed removal also affects soil fertility since it accelerates the mineralization of organic matter. As previously mentioned, all these practices are facilitated when the distance between plants and rows are organised based on the tools available.

Mulching

Mulching consists in covering the soil between crops with materials that prevent the growth of weeds. These materials can be organic waste, plastic films or inert sheets. The advantages of this technique, in addition to the control of weeds, are numerous:

- retain moisture;
- heat the soil (possible advance of harvest);
- limit the temperature range;
- maintain the soil structure;
- avoid leaching of nutrients;

- improve the quality (the product is clean);
- generate organic matter (when organic mulching is used);
- reduce the damage caused by pests;
- increase the irradiation (the reflective film can anticipate harvest).

Organic mulching

It is usually carried out using straw. Alternatively, it is possible to use walnut or chestnut leaves, since they are rich in tannins, although being light they are easily removed by the wind. Other possibilities are rice husk, sawmill waste, manure, pruning residues or residues from lawn mowing. Care should be given not to use fresh mowing lawn or residues since they can cause mould development. The layer of mulching material must be of 2-10 cm in order to prevent the passage of light. Periodically, the cover should be renovated because part of it is degraded by atmospheric agents and soil microorganisms. When using dry plant material (like straw), it is important to supply an higher amount of nitrogen by fertilization, or mix the straw with compost.

Mulching with inorganic materials

Black waterproof plastic films are widely used for mulching. When an irrigation system is used, it is necessary to place the hose before covering the soil with the waterproof sheet. Another possibility is to use transpiring plastic films equipped with micro-holes. To settle the plastic film mulching, the film is fixed by placing 10 cm of soil along its edge or using fixing nails. The plastic mulches are placed in the field before transplant. To transplant it is necessary to make a round or cross cut, or to use predrilled sheets. Harvest can be performed without removing the film and the following crop can be transplanted in other positions with no need of additional soil preparation. This technique of consecutive planting on the same plastic film allows the usage of mulching for an additional crop cycle. A valid alternative to

the plastic film is represented by the biodegradable film made of corn starch. At the end of the crop cycle this film is milled into the soil and degraded by soil microorganisms. Another possibility is represented by nonwoven fabric sheets, which are permeable to water and air, and particularly suited for multiannual crops such as strawberry. However, they can be degraded by light and therefore they need to be covered with gravel or bark. Finally, paper films can be used. They have a good resistance and they reduce the risk of leaf burn compared to the black film that in summer can reach temperatures of 70 °C.
In general, mulching presents also some disadvantages that should be considered:
• difficult distribution of fertilizers;
• increase of underground pest attacks;
• risk of leaf burns when using black film;
• mulching, even if done with black materials, may not be sufficient to resolve the problem of weeds.
Soil solarization
It is a practice that allows the recovery of the soil for what concerns weeds and pathogens control. It is carried out by covering the soil with a transparent film in summer time. By using the energy from the solar radiation, in the first 20 cm of soil the temperature reaches 30-35 °C. Keeping these conditions for 1-2 months, the germinated seeds are killed while nematodes and fungal spores are damaged. The intervention should be carried out every 2 years.

2.4 / CROP ROTATION AND INTERCROPPING

The accumulation of crop residues in the soil and the presence of specific parasites can be avoided adopting rotation and intercropping. To rotate crops means not to put on the same area of land crops belonging to the same family (see Table 4 for specifics) for at least three years (or, when cultivating two different crops in the same year, at least for 4 crop cycles). For example, a succession of onions (autumn) and zucchini (spring-summer) in the first year and pea (autumn) and tomatoes (spring-summer) in the second year, allows to cultivate again onion (or leek or garlic) in the following year. Similarly, intercropping (Table 5) can improve growth conditions of individual crops by exploiting characteristics and functions of other crops. For example, you can intercrop carrot with leek or onion, which have a repellent capacity against insects, or corn with bean, in a way that the former provides support, and the latter is capable of fixing nitrogen.

/ TABLE 4. MOST COMMON VEGETABLES DIVIDED ACCORDING TO THEIR FAMILY.

FAMILIES OF THE MAIN VEGETABLES	
ASTERACEAE	endive, prickly lettuce, lettuce, radicchio, chicory, artichoke
BRASSICACEAE	cauliflower, broccoli, cabbage, savoy cabbage, Brussels sprouts, turnip, radish, arugula, Chinese cabbage
LAMIACEAE	basil, lemon balm, mint, oregano, marjoram, rosemary, sage, savory, thyme
FABACEAE	bean, green bean, pea, fava bean, chickpea
LILIACEAE	garlic, onion, leek, asparagus, shallot, chives, and also flowers like lily, tulip, lily of the valley, hyacinth
APIACEAE	carrot, fennel, parsley, celery, cumin, dill
ROSACEAE	strawberry, rose
SOLANACEAE	eggplant, pepper, tomato, potato
CHENOPODIACEAE	beetroot, chard, spinach, quinoa
VALERIANACEAE	valerian

/ TABLE 5. RECOMMENDED (+) AND NOT RECOMMENDED (-) INTERCROPPING COMBINATIONS

	GARLIC	CARROT	CABBAGE	CUCUMBER	ONION	FRENCH BEAN	BEAN	FENNEL	STRAWBERRY	LETTUCE	EGGPLANT	POTATO	BELL PEPPER	PEA	TOMATO	LEEK	PARSLEY	TURNIP	RADISH	SAGE	CELERY	SPINACH	ZUCCHINI
CARROT	+																						
CABBAGE	-	+																					
CUCUMBER	+		+																				
ONION		+	-	+																			
FRENCH BEAN	-																						
BEAN		+		+	-																		
FENNEL				+		-	-																
STRAWBERRY																							
LETTUCE		+	+	+	+		+	+															
EGGPLANT					+					+													
POTATO			-																				
BELL PEPPER					+					+	-												
PEA		+	+	+				+		+													
TOMATO	+		+	-				-		+	-		-	-									
LEEK	-	+	+	+	-		-	+		+	+		+	-	+								
PARSLEY										-				-		+							
TURNIP	+		+	+			+			+	+		+										
RADISH		-	+	-			+			+	-		-	+	+	+							
SAGE																							
CELERY	+	-	+	+	+		+			-		-		+	+	+		+					
SPINACH		+	+				+							+	+	+			+		+		
ZUCCHINI		+			+		+				+		+										

3. WATER IN THE VEGETABLE GARDEN

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Water is the main element in plants, constituting 90-95% of a plant organism. Its function is related to the regulation of temperature (via the evapotranspiration), the transport of nutrients between the different plant organs and the physical support of the plant concurrent to the cell turgor. Taking into consideration the "plant/soil system", variations in the water balance resulting from outflows (water lost for transpiration from the leaves, evaporation from the soil, runoff and percolation) and inflows (rainfall and irrigation). When the incoming flows are lower than the outflows, plants can experience drought stress conditions, with initial symptoms of withering that, in extreme conditions, can lead to desiccation and death.
To better understand the garden irrigation requirement, in the following paragraphs the different elements of the water balance will be analysed:

Irrigation = *Evaporation* + *Transpiration* + *Percolation* + *Runoff* – *Rain*

3.1 / EVAPORATION

Evaporation is the process by which liquid water is converted into the gaseous phase (vapour) and removed from the evaporating surface (soil, rivers, lakes). It occurs in the presence of energy (solar radiation) and continues until the saturation of the atmospheric moisture. When the air is very humid, the evaporative process tends to stop.
The turnover of saturated air depends mainly on the wind speed. Furthermore, the evaporation rate is a function of soil moisture and

presence of vegetation. Therefore, the evaporation is higher in sunny, hot, dry and windy days, in wet areas covered with low vegetation. Moist soils allow a continuous evaporative stream towards the atmosphere. Few days after the rain (or the irrigation), the soil surface is dry and no longer allows the transfer of water to the atmosphere.

3.2 / TRANSPIRATION

Transpiration is the evaporation of liquid water contained in the plant tissues towards the atmosphere. Almost all the water absorbed by the plant (95-99%) is lost by transpiration, so only a small fraction remains within the plant. Transpiration is influenced by the same factors that determine the evaporation from the soil, but also by the plant water status and the capacity of the plant to hold water (e.g. plants living in arid environments have elaborated mechanisms to reduce water loss, for instance developing spike shaped leaves).

3.3 / RUNOFF AND PERCOLATION

Runoff is the surface flow of water on the soil and occurs when the amount of incoming water (rain, irrigation) exceeds the infiltration capacity of the soil. Similarly, percolation occurs when the soil is water-logged and it consists in losses towards the deeper soil layers, not reached by the roots of plants.
Tables 6 and 7 address the determination of water and irrigation requirements in urban gardens in the city of Bologna.

/ TABLE 6. WATER REQUIREMENTS OF A VEGETABLE GARDEN (LITRES PER SQUARE METER PER DAY, IN SELECTED EUROPEAN CITIES)

	MONTH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.
	CROP						
BERLIN	FRUITING VEGETABLES	-	0.3	0.6	3.0	2.0	-
	LEAFY VEGETABLES	0.6	1.3	2.4	5.0	3.2	0.6
	AVERAGE	0.3	0.8	1.5	4.0	2.6	0.3
BOLOGNA	FRUITING VEGETABLES	-	0.5	1.0	4.0	2.5	-
	LEAFY VEGETABLES	1.0	2.0	3.0	6.0	4.0	1.0
	AVERAGE	0.5	1.5	2.0	5.0	3.5	0.5
BUDAPEST	FRUITING VEGETABLES	-	0.3	0.8	3.4	2.0	-
	LEAFY VEGETABLES	0.8	1.5	2.4	5.0	3.6	0.6
	AVERAGE	0.4	0.9	1.6	4.2	2.8	0.3
CARTAGENA	FRUITING VEGETABLES	-	0.8	1.2	5.0	4.0	-
	LEAFY VEGETABLES	2.0	3.0	3.5	6.0	5.0	0.6
	AVERAGE	1	1.9	2.4	5.5	4.5	0.3

/ TABLE 7. WATER REQUIREMENTS OF A VEGETABLE GARDEN (LITRES PER SQUARE METER), BASED ON BOLOGNA CLIMATIC CONDITIONS.

	MONTH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.
BERLIN	RAINFALL (mm)	36	42	72	51	45	45
	RAINFALL (l/m² day)	1.2	1.4	2.4	1.6	1.5	1.5
	REQUIREMENT (l/m² day)	0.3	0.8	1.5	4.0	2.6	0.3
	IRRIGATION NEEDED	-	-	-	2.4	1.1	-
BOLOGNA	RAINFALL (mm)	67	65	52.6	42.8	57.9	61
	RAINFALL (l/m² day)	2.2	2.2	1.8	1.4	1.9	2.0
	REQUIREMENT (l/m² day)	0.5	1.5	2.0	5.0	3.5	0.5
	IRRIGATION NEEDED	-	0.7	0.2	3.6	1.6	-
BUDAPEST	RAINFALL (mm)	45.2	57.3	68.9	78	63.3	85
	RAINFALL (l/m² day)	1.5	1.8	2.3	2.5	2.0	2.8
	REQUIREMENT (l/m² day)	0.4	0.9	1.6	4.2	2.8	0.3
	IRRIGATION NEEDED	-	-	-	1.7	0.8	-
CARTAGENA	RAINFALL (mm)	23.9	30.6	4.3	1	4.6	35.1
	RAINFALL (l/m² day)	0.8	1.0	0.1	0.0	0.1	1.2
	REQUIREMENT (l/m² day)	1	1.9	2.35	5.5	4.5	0.3
	IRRIGATION NEEDED	0.2	0.9	2.2	5.5	4.4	-

3.4 / RAINFALL

Rainfall is a positive element of the soil water balance since it represents (particularly in the northern regions of Italy) an important source of water for crops. The previous tables show that the average irrigation requirement of a vegetable garden should be about 1 liter per square meter per day, giving a total amount of about 180 liters per square meter per season. In practice, in the gardens of Bologna, consumption is about 600 liters per square meter per season (3.2 liters per day), equivalent to 320% of the theoretical requirement.

Where does the excess water supply goes?

Into the soil:

• if the soil surface is wet … evaporation continues and the water reservoir is consumed;

• the exceeding water flushes out the nutrients present in the soil (depleting it) and brings them down to the belowground water table (polluting it);

• a waterlogged soil is a favourable environment for pathogen attack, mainly of root rot;

• a waterlogged soil is poor in oxygen and limits plant development;

• a soil rich in water favours the development of all plants, including undesired weeds.

To the plant:

• a plant that receives the right amount of water gives a better and more nutritious product;

• an excessive water amount on the leaves can promote the development of pathogens, such as downy mildew;

• plants that receive a lot of water have consequently smaller roots, which can reach a lower amount of nutrients in the soil;

• when the product is a root (e.g. carrots), it is important to make it developing well and therefore it is much better to provide a smaller amount of water.

3.5 / GOOD PRACTICES FOR IRRIGATION

When?

Irrigation is performed in the morning or in the evening, in order to avoid the hottest periods of the day (central hours). Morning watering during winter reduces the risk of frosts, while evening irrigations during summer allow plants to cool down for the night.
In all cases, it is important to minimize the temperature shocks for the plant, therein cold water should be used at night, whereas warm water should be applied in the morning. The type of soil should be considered, too. In sandy soils frequent and small irrigations should be applied, while in clay soils it is possible to make major and less frequent watering. It is also important to learn to observe the plant.
A dehydrated plant during the hottest hours of the day is not necessarily "thirsty".
Under these conditions, leaf transpiration is more intense than the capacity of the roots to absorb water. Yet in the evening and then during the night, the plant will recover turgor. Vice versa, if the dehydration symptoms appear in the morning the plant should be immediately watered. It is finally essential to learn to wait: under normal conditions, a garden with plants that have strong and well-developed roots should be irrigated only once every 5-7 days. A good rule for understanding when it is necessary to irrigate is to look at the soil and see when the first two centimetres above the surface are completely dry.

Where?

Once the water reaches the soil, it starts to penetrate towards the deeper layers. The direction that the water follows inside the soil is generally vertical, with minimum horizontal movement. This means that to increase the efficiency of irrigation the water should be provided (with a watering can or with drippers) nearby plant roots.

How?

There are many different irrigation methods. When using a watering can, the water should be directed to the roots of the plant, avoiding to wet the leaves and to use the rose. When using an irrigation system, it is preferred to choose drip irrigation methods instead of sprinkler and overhead irrigation, in order to keep leaves dry. An interesting alternative is given by sub-irrigation, which consists in burying the irrigation pipes so that they release the water (drop by drop) directly at the level of the plant roots without wetting the soil surface. In this way evaporation from the soil is avoided and moisture in the subsoil is maintained. The irrigation pipes should not allow the entry of the roots that might otherwise clog them.

How much?

With a drip irrigation system, the flow rate is determined by the water pressure and by the drippers flow rate (e.g. 2 litres per hour). Based on the number of drippers per square meter and on the watering time it is possible to regulate the amount of water distributed, always bearing in mind the previous considerations concerning overall garden water requirements.

4. PLANT NUTRITION

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4.1 / SOIL FERTILIZATION

Soil fertilization is the set of practices that allow to preserve the soil ability to support crops without affecting its productivity. Therefore the practices of soil fertility include the administration of nutrients (plant nutrition) and the addition of amendments and conditioners which influence the physical characteristics and the biochemical reactions in the soil. The "fertilization season" usually starts in spring, continues throughout the whole growth cycle and ends in September-October, when instead a organic basal application or a slow-release mineral fertilization should be performed.

4.2 / INORGANIC FERTILIZATION

All inorganic fertilizers contain the so-called macro-elements, that is those elements that are absorbed in a greater quantity by plants and that are essential for growth and for an adequate execution of all vital functions. Macro-elements are: nitrogen (N), in nitric, ammoniacal or urea form; phosphorus (P), in the form of phosphorus pentoxide; potassium (K), in the form of potassium oxide; calcium (Ca); magnesium (Mg); and sulfur (S). Always more frequently, however, in commercial fertilizers are also present important micro-elements such as iron (Fe), manganese (Mn), boron (B), zinc (Zn), copper (Cu), which contribute to the proper operation of the basic plant metabolism. Fertilizers with high nitrogen content are recommended for green plants, trees (including fruit trees) and growing shrubs, leafy vegetables and stem vegetables.
This is because nitrogen stimulates the growth processes and there-

fore the development of vegetative organs (leaves and sprouts) and of the root system. Phosphorus promotes resistance to diseases and adverse weather conditions, therefore it is recommended to use it in case of particularly rainy seasons. Finally, potassium is essential for the production of flowers and fruits, of which it influences the colour and flavour: a high potassium content is necessary for all flower and fruit plants during their development.
Calcium (Ca) is essential for plant nutrition in general and has a positive effect on soil structure: it improves it, increasing the permeability and porosity. Magnesium (Mg) is the central atom of the chemical structure of chlorophyll, which is essential for photosynthesis; it is also responsible for the formation of sugars, proteins, fats and vitamins. Sulphur (S) participates in the formation of many compounds, such as enzymes, proteins and vitamins; improves the physical-chemical soil characteristics, lowers the pH and promotes the absorption of nutrients from the root system. Commercially, a large selection of mineral fertilizers is available, including the so-called "universal fertilizers", cost-effective products that save time (one product for all plants), but rarely offer satisfactory results. When available, it is better to choose specific products for each crop category (green plants, flowers, acidophilic plants, strawberries, vegetables, fruit trees, etc..).
Finally, ash can be used in the garden adding it to the soil before preparation and sowing, or directly in the grooves, as once farmers used to do before the sowing of potato or carrot; it can also be spread at the base of trees. The ash is rich in potassium, phosphorus and calcium, but not in nitrogen, therefore it can be a good product to use but it does not have the characteristics of a complete fertilizer.

4.3 / ORGANIC FERTILIZATION

Organic fertilizers, compared to the inorganic ones, have the advantage of operating at the soil level (improving its physical-chemical characteristics) as well as at the plant level. Commonly in horticulture it is unlikely to deal with the so-called "loam-soil" that is perfectly balanced and does not require adjustments. In general, the soil needs at least to be improved with the addition of organic matter. Unless the organic matter cannot completely change the soil type, it contributes to create a soil that is as close as possible to the ideal soil for the cultivation of vegetables. The organic matter in fact lightens and aerates the soil, increases the ability to retain water and feeds all microorganisms that improve fertility. The most useful supply is done in October-November when, after a season of intense production, it is necessary to replenish the depleted reserves. Therefore, once the soil has been prepared, a 2 to 5 cm layer of organic matter is distributed on the whole soil surface. It is important to abound with the amount of organic matter if you are dealing with a new plot or if the soil is too sandy or clayey; conversely the amount should be decreased if the soil is cultivated for long time. Once the entire area has been covered, the organic matter must be mixed to the soil by a 15 cm depth tillage with a spade or a hoe. There are numerous types of organic fertilizer that can be used in gardening. A description of the most widely used and easily available follows.

Cattle manure

The cattle manure is the most common and readily available organic fertilizer. It is possible to find it in bags of pellets (large particles that facilitate a smooth and homogeneous distribution). It is an excellent fertilizer for the soil: in addition to the release of nutrients, it improves the texture and helps to limit the compaction of clay soils. When fresh, it is needed to leave it on the soil for at least a year before planting.

Horse manure

It is traditionally considered the best. If fresh, it requires at least a couple of months of rest. It can also be added to the developing compost, to make it more nutritious and to accelerate its maturation. Com-

pared with cattle manure, is richer in phosphorus and potassium.
Poultry droppings
Poultry droppings typically contains a large amount of nitrogen, so it is not advisable to use it in the pure form. It is better to use it in the pellet form, since in this case it undergoes a slow process of maturation and a gradual drying process to preserve the valuable bacterial flora. It is used especially for high nitrogen demanding plants.

Guano

It is a natural fertilizer formed by the decomposition of the remains, eggs and droppings of seabirds, which have been accumulating for millennia along the arid coasts of Peru and Chile. Packs for hobby use are easily available and recommended especially for vegetables, fruits and acidophilic plants. It has a high nitrogen content.

Earthworm humus

One of the best soil fertilization for garden plants and vegetables comes from the biological cycle of earthworms. The earthworms humus contains a high percentage of organic matter, trace elements, enzymes, minerals, an optimum proportion of NPK and microorganisms. It can also be used for mulching or mixed with the soil before planting.

Compost

Compost is the ideal fertilizer for vegetables, fruit trees and aromatic plants. Clean and easy to use, it can be bought in bags but it can also be self-produced by recycling plant residues from the garden (dried flowers, grass, leaves, straw, etc..) and the organic waste from the kitchen (peels and vegetable scraps, coffee and tea powder after use, egg shells, stale bread cut in small pieces, etc.). To make compost is necessary to bear in mind that each ingredient is important but any excess is negative, therefore the quantities of the various components should always be kept in balance. Moreover, it should be reminded that the transformation happens thanks to the activity of small organisms (bacteria, fungi, insects) present in the soil and in the same residues, and that these organisms need oxygen, moisture and heat to survive. In fact, in summer and autumn decomposition is faster because temperature is higher. To promote aeration is necessary to occasionally turn upside down the compost. For what concerns moisture, a too dry mass can be wet with a watering can and a too moist one can be implemented with dry straw or ash.

Rules for a good compost:

- *shred the materials, especially the hard and woody ones;*
- *mix well different materials (wet and dry, major and small, fresh and matured, kitchen waste, garden waste) trying to balance the final composition;*
- *from time to time add a small amount of soil, crop residuals and ash;*
- *always keep the pile covered for instance with a thick layer of grass mowing or straw;*
- *prevent the material to dry completely (in dry periods remember to water);*
- *if the compost has a bad smell is usually because it is too wet and the decomposition process is not proceeding properly; in this case, add dry material and a bit of ash or clay flour to bind the smells and the excess water;*
- *if you have large amounts of a same material (leaves, grass), compost them separately, after the addition of substances that equilibrate the composition.*

Green manure

The green manure is an agronomic practice widely used in organic farming and it is well suited even for small gardens. It consists in cultivating specific plants that are then cut and buried at the time of their maximum development.
The green manure is carried out in order to enrich the soil in organic matter, increase the water reserves of dry soils, improve the physical structure of the soil, protect the surface layers from leaching and erosion and - when made with leguminous plants - provide a good amount of nitrogen.
The green manure practice can be carried out in the garden after harvest of a main crop in order to restore soil fertility or before sowing in order to enrich the soil. It can be performed only once a year as green manure in a garden, or also to revitalize a wild plot that is supposed to be converted into a vegetable garden to improve fertility of the whole soil.
Once the plant (or the intercropping) chosen for the green manure has been sowed, it is advised to proceed with occasional watering, if necessary. At the beginning of bloom, when the plant is at his maximum consistency, mowing is performed.
For leguminous plants it is better to do the mowing a few days before bloom, to prevent that a part of the nitrogen contained in the roots is used to mature seeds.
The burial of the green manure must be made at least one month before the sowing of the horticultural crop.
The cut plants should partially dry before being buried but not completely exsiccate; therefore, it is advisable to proceed with the burying almost immediately after the mowing to avoid too long air exposure times.
The burial depth should not exceed 10-15 cm, especially in clay soils, to not inhibit decomposition processes which require atmospheric oxygen.

Plants to be used for green manure.

• Fabaceae (or Leguminosae) enrich the soil with nitrogen and adapt to any climate and soil type. The most important Leguminosae for green manure include field bean, crimson clover, vetch (which survive at -12°C), forage pea ,common sainfoin, lupin, soybean, common melilot, and some vegetables like lentil, pea, bean and fava bean.

• Brassicaceae (or Cruciferae) grow very fast and allow to obtain a great green mass in short time. The most used are rapeseed (resistant to cold), Brassica rapa Campestris and mustard (which has a short cycle but do not like low temperatures).

• Poaceae (or Gramineae) usually associated with Leguminosae being the combination beneficial for both: the former protect the latter from the cold and the latter better stand drought. Oat and forage pea or oat and vetch are among most frequent combinations.

• Other plants used, although not belonging to the three families mentioned, are: buckwheat, which grows quickly (almost a meter in 40 days), produces a lot of vegetation and its leaves prevents weeds from growing; the Lacy phacelia, which has a short crop cycle (7-9 weeks) and blue-violet flowers that work as a powerful signal for bees and other pollinators.

Macerated stinging nettle (fertilizer)

Fertilizer and pesticide at the same time, the macerated stinging nettles is a blessing in the care of the garden. Preparation: 1 kg of leaves per 10 liters of water - cut into pieces and soak in cold water the aerial part of the plant. If you want to use dried leaves the amount should be 200g per 10 litres of water. The macerated is ready when the liquid has became very dark and has stopped to make foam. Usually seven days are enough, but the decomposition process is accelerated if the temperature is high or if the container is exposed to the sun. To facilitate oxygenation is advisable to mix the macerate at least once a day. Once ready, the liquid needs to be diluted in the ratio of 1:20 (1 litre of macerate / 20 litres of water). To fight aphids, mites (spider mites) and insects like moths and cherry fruit flies it can be filtered and sprayed on the plants for two/three consecutive days, with two weeks interval. It can also be used as fertilizer to irrigate the plant base (better in the cooler hours of the day) or to wet plant roots before planting them.

5. BIOLOGICAL PEST CONTROL IN THE VEGETABLE GARDEN

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A vegetable garden is a small ecological system. Rational management of this system is based on knowledge of all the organisms that populate the garden and the network of interactions that develops among them.
Only secondarily, the adoption of the various methods that technology has made available shall be considered.
The irrational use of insecticides, particularly those with broad-spectrum, may result in greater problems than those that are intended to be solved; both for the consequences for the human and ecosystem health, and for the well-being of the cultivated plants.

5.1 / INSECTS IN THE GARDEN

Not all insects that populate or "visit" the garden are pests. Most of them are harmless or even beneficial. It is an important thing to keep in mind, that also in the fight against insect pests, panic may be our first enemy.
Furthermore, some insects, such as the pollinators, are actually essential for the life of the garden and in order to get good productive results.
A good gardener is someone that is able to observe: only careful observation and time can lead to the ability to recognize the "garden inhabitants" and their interactions with the plants grown.

In the following pages, most common insects that can be found in the garden are listed and briefly described.

The garden diary

In a vegetable garden, events regularly occur over the years. Keeping in a small pocketbook (or other more technological means) annotation of the period when certain insects (pests or beneficials) appear, or the flowering period of a plant, may turn out to be extremely useful.

5.2 / INSECT PESTS

Phytophagous insects (those that feed on plants) below certain densities (the so called "damage threshold") do not represent a threat to crops. In the present chapter, those insects that in European urban gardens may turn out to exceed the damage threshold are summarized.

Aphids. *Small insects (Fig. 3), 1-3 mm, generally living in large colonies. Aphids feed through a stinging and sucking mouthpart (rostrum) constituted by stylets enclosed in a sheath, which perforate the surface of leaves and buds, to suck the sap of plants. These insects emit a sugary liquid, called honeydew, which becomes a breeding ground for numerous kinds of fungi (sooty mold), which limit plant photosynthesis. In addition to these damages often aphids are vectors of viruses and pathogenic bacteria for plants. Their main natural enemies are: ladybirds (Adalia bipunctata, Coccinella septempunctata), Chrysoperla carnea and some parasitoids (such as Lysiphlebus testaceipes).*

Figure 3. Aphids.

Leafminer flies. *Small Diptera Agromizidae (Fig. 4, 1-3 mm in length). Females oviposition is done in the thickness of the leaves (mesophyll) through a sting called ovipositor. Larvae create serpentine mines inside the leaves, causing serious damages to the plants. Through the ovipositor, females may also perforate plant tissue in order to obtain cellular fluids (feeding punctures). The most common leafminer is Liriomyza trifolii an important pest of potato, beans, cucurbits, and many other crops. A widely adopted natural enemy is the parasitoid Diglyphus isaea.*

Figure 4. Agromyzidae.

Thrips. *Microscopic insects (Fig. 5), highly mobile, with mouthparts equipped with a thin stylet used to penetrate the cell wall of tissues. Generally difficult to detect both as a consequence of their small size and the habit of hiding in tiny cracks and between shoots. Rather easier, instead, to identify the damage, similar to that of the red spider mite. They can transmit viral or bacterial diseases of plants. The adults of thrips are attracted by the blue color. Although natural enemies of thrips are not commercially available, they widely exist in nature.*

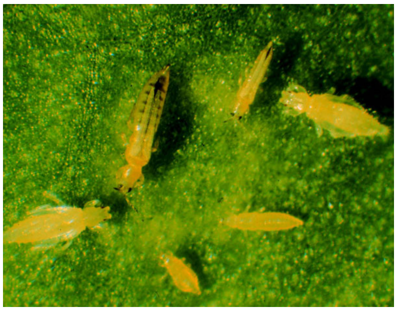

Figure 5. Thrips.

Colorado Potato Beetle (Leptinotarsa decemlineata). *Adults (10-12 mm long, Fig. 6) have ten characteristics black lines on the yellow-orange elytra, while larvae are orange-red. Both stages attack the green parts of plants (mainly Solanaceae, as potato and eggplant), resulting in complete plant defoliation. The Colorado beetle overwinter, as adult, in the soil where potatoes were previously grown. Consistently, crop rotation may turn out of great relevance in reducing damages associated to the Colorado Beetle.*

Figure 6. Colorado Beetle.

Red spider mite (Tetranychus urticae). *A species of plant-feeding spider mite (not insect, with 8 legs, Fig. 7) very small in size and yellowish with two brown spots.*
The red spider mite is widespread over most of ornamental plants and horticultural crops. The attacked plants show necrotic spots that, when in large quantities, may cause foliar desiccation. Small but dense webs may also be observed.
The main natural enemy is another small spider mite (Phytoseiulus persimilis, Fig. 7) easily recognizable by its prey because of its color, which is actually bright red, bigger in size (visible to the naked eyes), very mobile and fast.

Figure 7. Red spider mite (yellow/black) and P. Persimilis (orange/red).

Caterpillars. *Many larvae of Lepidoptera (Fig. 8) (Noctuidae, Geometridae, Pieridae, Lymantria, etc.) have chewing mouthparts with which cause great damages to the leaves of many leafy vegetables grown in the garden. Although they primarily operate during night, their size and the characteristic leaf damage (leaves are "eaten" from the margin) make them easy to detect and remove manually. The most common method of control uses the Bacillus thuringiensis preparations. Wild natural enemies may also operate effective control.*

Figure 8. Larvae of Lepidoptera.

5.3 / BENEFICIAL INSECTS

Pollinators: *this category includes those insects that visiting flowers (they feed the nectar contained in them) carry pollen from one plant to another and, in so doing, allow plants to develop the fruits (Fig. 9). For most fruiting vegetables the "visit" of pollinators is essential. The main pollinators of the gardens are honeybees, bumblebees, Osmia spp. and other solitary bees, hoverflies (Diptera that mimic bees or wasps, and characterized by typical flying "habits" that recalls an helicopter) and a myriad of small Hymenoptera (small wasps or bees).*

Figure 9. Pollinator.

If you see flowers, do not spray!
Remember that spraying with pesticides (also organic or natural ones) on plants during their flowering period, other than being forbidden by the law, may result in killing those beneficial insects that enable the garden to produce fruits!

Natural enemies of insect pests: *enthomophagous insects (they predate other insects) are natural enemies that help us in the fight against pests. Two types of insects fall into this category: - predators, such as ladybirds predators of aphids (e.g. A. bipunctata (Fig. 10), which as adults, and often also at the larval stage, actively feed on insect pests, and – parasitoids (Fig. 11), that insert their eggs in the body of the phytofagous insect, causing later its death by the activity of their larvae, so they prey on it from the inside. Encouraging the presence of these insects or their active introduction (beneficial insects are marketed) constitutes probably the most effective action of biological pest control.*

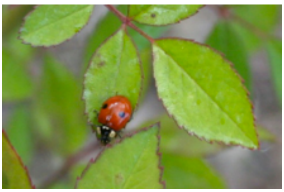

Figure 10. Ladybird A. bipunctata.

Figure 11. Parasitoid.

Good or bad?
Understanding whether we have found an useful predator or parasitoid rather than an harmful pest is not very difficult. The secret is, once again, observation. Even if we do not get to see when one insect prey another one, predators and parasitoids are generally characterized by extremely rapid movements and changes of direction, due to the fact that they are actively looking for preys. On the other hand, phytophagous insects are generally intent on feeding on the plant and do not move around.

5.4 / PREVENTION

The conventional strategies of pest control, and mainly those based on the use of synthetic insecticides, do not make distinctions between dangerous, harmless and beneficial insects.
Beyond environmental considerations and of human health care, one wonders whether there may not be "smartest" methods to ensure the health of our plants.
Proper garden management is in itself a method for preventing the attack of insect pests.
Stress due to shortage or, more often, to excess water supply and/or fertilizer (excessive amounts of nitrogen, for example, greatly favor the proliferation of the aphids), constitute disequilibrium situations that favor the presence of insect pests.
Furthermore, proper crop rotation and effective intercropping, may result in greater ecological balance of the vegetable garden ecosystem.

5.5 / PHYSICAL METHODS

It is commonly accepted that "chemistry" is the only or best ally to get rid of the pests. However, in small plots as kitchen gardens, for example, the chromotropic traps (small panels of colored plastic sprinkled with a tenacious glue and hung just above the level of the vegetation), mainly used in agriculture to monitor the presence and density of insect pests, can be an effective aid in the actual pest control. This is particularly true if the plot is not too close to other vegetation, since otherwise traps could actually attract further insects. Yellow traps attract a wide range of insects (also pollinators, unfortunately) and they should be used sparingly. Blue traps, on the other hand, attract few types of insects, and particularly thrips. The use of these traps does not have significant side effects and can be a good way to control these insects. A density of at least one trap per square meter of garden is recommended. A good way to control slugs and many crawling insects such as beetles that are found in the soil are the pitfall traps (Fig. 12). These are simple plastic containers (one glass of beer or a half-liter cup of yogurt) buried up to the ground level and filled with an inch of beer. The fermentation will attract slugs and beetles that, once fell down in the trap, will not be able to get out of it. The beer should be replaced once a week and whenever it rains (otherwise the trap should be repaired, as shown in the figure). Place the pitfall traps around the perimeter of the garden and in its wettest parts.

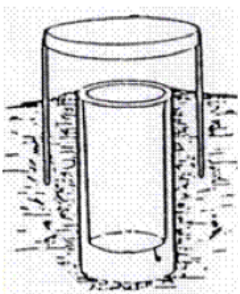

Figure 12. Pollinator.

5.6 / NATURAL INSECTICIDES

Among natural insecticides, the Neem oil occupies a prominent place. It is an extract of a tropical plant (Azadirachta indica, also referred to as the "Village Pharmacy"!), which may be used both on the soil, being absorbed by the plant roots, or directly sprayed on the leaves. Neem oil is completely harmless to humans and mammals.

Both commercial products or the pure neem oil may be generally found in garden shops or even in supermarkets. Recently, neem pellets and the "neem cake" have been marketed, with the main advantage of being usable as a preventive measure, distributed into the soil. In any case it is necessary to be very careful not to exceed the recommended dose because it may have phytotoxic effects (damaging plant tissues). The distribution at the root zone level should be preferred since the related benefits will last longer and damages to beneficial insects will be avoided. Another substance used in organic farming is the natural Pyrethrum (not to be confused with Pyrethroids which are molecules similar to pyrethrum but synthetically produced).

The pyrethrum, which actually exist in different formulations, has a very powerful "knock-down" effect on the pest population density, and is also active on flying insects (unlike the neem), but on the other hand requires several application, since the active ingredient degrades very rapidly. It should be used to obtain an immediate, but not durable, effect. Spray it in the evening after the sunset.

5.7 / MICROBIOLOGICAL PREPARATIONS

Control pests with their diseases. This is the basic concept of a series of very interesting products that rely on entomopathogenic fungi or bacteria (completely harmless for humans), whose application is, in fact, similar to any other synthetic insecticide. The most widely used is Bacillus thuringiensis (BT), a very common bacterium that produces toxins that result to be lethal to some insects. The advantage of the preparations of BT is that they are very specific. Depending on the strain used, it may only attack mosquito larvae (israeliensis strain: BTI), or caterpillars (kurstaki strain: BTK) or beetles (tenebrionis: BTT). Extensive is also the use of a fungus pathogenic to insects, called Beauveria bassiana. Products based on this fungus are very effective and absolutely harmless to humans and the environment. In this case, however, the fungus similarly attack most of the insects, therein resulting in mortality also of beneficial insects. This eventuality shall be kept in mind in all cases where products, including organic ones, are not highly specific against pest insects: in order to prevent harmful effects on beneficial ones, they should be used with special care and never while plants are in the flowering period.

5.8 / CONSERVATIVE BIOLOGICAL CONTROL: THE GARDEN OF BENEFICIAL INSECTS

Some flowering plants attract beneficial insects (both pollinators and natural enemies of pests). If a small area of the garden is dedicated to these plants, possibly with prolonged flowering time in most months of the year, the function of reducing pest incidence may be coupled with aesthetic improvement of the garden. However, if a biological pest control is pursued, synthetic large-spectrum pesticides shall be completely avoided.

Colors in the garden

A practical but effective way to choose plants based on the preferences of the insects relies in the color of the flower: Hymenoptera (e.g. bees and bumblebees, but also parasitoids wasps) are generally blind to red and prefer blue flowers or the white/yellow flower heads of the Compositae (or Asteraceae, e.g. aster, daisy and sunflower); the different shades of red, purple and yellow are particularly appreciated by butterflies.

Among plants attracting beneficial insects reference can be made to, for instance: thymus, different types of mint, fennel (Foeniculum vulgare), catnip (Nepeta cataria), yarrow, the beautiful cinquefoil, wild parsley (Petroselinum crispum), the magnificent Coreopsis tinctoria, marigold , dandelion, veronica, artemisia (Anthemis tinctoria), echinacea (Echinacea purpurea), the small common daisy (Bellis perennis) rich in pollen, Anethum graveolens, lemon balm, many Solidago, the vetch (Vicia sativa), alfalfa, lupine and most wild legumes (rich in nectar and protein) and ornamentals, such as sweet pea (Lathyrus odoratus). Furthermore, in order to attract parasitoids and hoverflies: alder, phacelia, coriander, shy buckwheat (Fagopyrum esculentum) and the spectacular mustard (Sinapis arvensis). Finally, it is very important to plant perennials (the artichoke for example) and shrubs or aromatic plants (lavender, rosemary) that serve as winter refuge for beneficial insects.

6. DISEASE MANAGEMENT IN THE VEGETABLE GARDEN

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6.1 / THE URBAN GARDEN ECOSYSTEM

In the small green corner of an urban vegetable garden we can recreate, in a simplified way, all the elements of natural ecosystems. This limited area is a portion of biosphere formed by abiotic components - soil and climate - and biotic components - cultivated plants and all other living organisms interacting with them.

The diverse components of an ecosystem establish complex trophic interactions that allow grouping the different biotic elements in primary producers (plants and all autotrophic organisms) and consumers - decomposers (all heterotrophic organisms, animals, insects, fungi and most part of bacteria).

As primary producers, grown vegetable species are in the middle of interactions between the elements of the "urban garden" ecosystem and represent the focus of the grower expectations. The interactions that consumers and decomposers established with the primary producers can be recognized as forms of parasitism, commensalism, neutralism and symbiosis.

These interactions may be considered either positive when they improve the condition of cropped plants or negative if they restrict in any way their development, growth or simply their aspect. Increasing the complexity of these relations within the simplified system of an urban vegetable garden let achieve better production results in qualitative and quantitative terms.

In general, there are several organisms that live or can live causing damage to the cultivated plants. Nevertheless to trigger a pathogenic mechanism that leads to a disease status, some conditions must occur (Fig. 13): the presence of a susceptible host, a virulent pathogen and favorable weather conditions extended over a sufficiently long period of time (a); the absence and/or the intensity of one of these factors determines the absence and/or severity of a disease (b, c). This condition can be represented by a geometric figure defined as "the disease triangle".

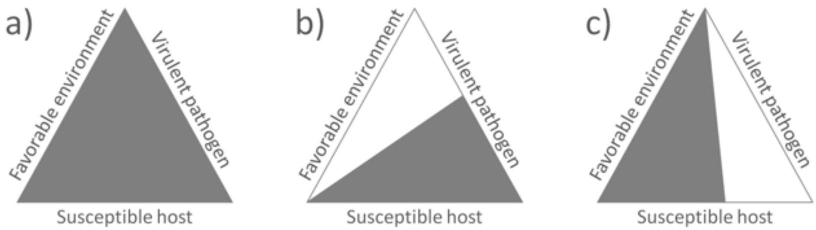

Figure 13. The disease triangle.

6.2 / DISEASE CONTROL IN THE VEGETABLE GARDEN

Disease control can be performed only considering the above parameters and thus changing, with different approaches, either host susceptibility or environment conductivity or, although this may result to be more difficult, through a targeted struggle against the pathogen. Organic control of pests and diseases takes into account primarily the crop vocation to different environments. Then it uses natural products, such as cupper, sulfur, potassium bicarbonate, etc., and some microorganism that have a direct effect to the pathogen or a direct or indirect effect to the host.
Antagonist microorganisms can be divided in:
1) Bio-phytochemicals, preparations of micro-organisms that play a direct action against the pathogen mainly through mechanisms of parasitism or antibiosis or through a competition for exploitation of ecological niches;
2) Bio-soil amendments that do not perform a direct action on the pathogen, but improve the nutritional and physical properties of soil, acting

directly on the environment and indirectly on the plant health status. A consistent side effect of both Bio-phytochemicals and Bio-soil amendments, is to induce through a fine molecular interaction between plant and microorganism, a series of changes in the host plant that lead to an increased tolerance to biotic stress and thus to a greater disease resistance.
This phenomenon is indicated with the acronym SAR (Systemic Acquired Resistance) or ISR (Induced Systemic Resistance) and can be considered as the effect of an immune response of higher plants. Some bacterial microorganisms also are generally referred to as PGPR (Plant Growth Promoting Rhizobacteria) and generally result in a better plant development. Since this manual do not have the aim of going into details of all diseases that may appear in a urban orchard, we have tried to separate them according to approaches in the organic control. In fact common traits may be found, in relation to the different ecological aspects of the pathogen that influence the processes of pathogenesis and that are reflected on the organ affected: leaves, roots, or fruits. Substances and products allowed in organic farming Regulation [Regulation (EC) No . 889/2008 (Annex II)], have been thereafter reported in a table (Table 8), divided according to the different observable symptoms, and including some useful advices on their use.

6.3 / FOLIAR DISEASES

The foliar diseases can be caused by various fungal or bacterial microorganism.
The symptom appears on the leaves in a more or less spread way. These microorganisms infect the tissues generally as a result of prolonged periods of dampness or wetting, which allow the early stages of the infectious process (adhesion, penetration) (Fig. 14).

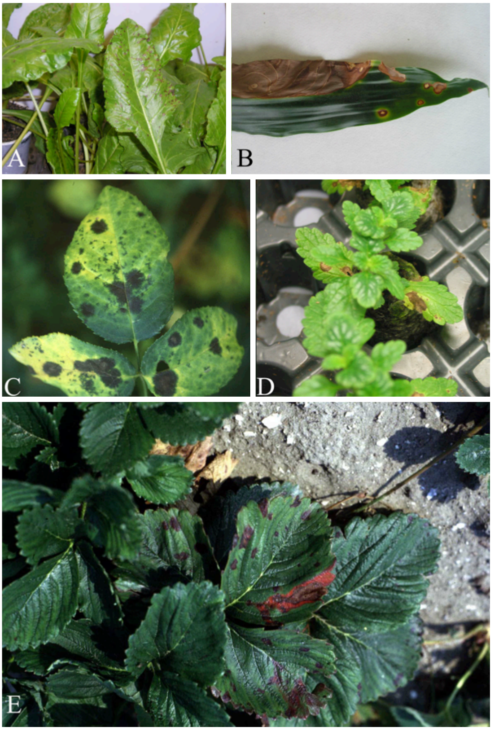

Figure 14. Foliar diseases. Photos by Phytopathology Lab, DIPSA, University of Bologna.

Once penetrated, the pathogen develops within the leaf lamina in the intercellular spaces giving rise, as the infectious grows, to roundish (in the case of Fungi Ascomycetes) or polygonal (downy mildews and bacteria) stains with different aspect, shape, extension and color (sometimes characteristic for each disease). In this phase, the pathogen is more resistant to preparations and products which do not have a systemic cytotropic or translaminar activity (none of preparations permitted in organic farming), therein the control can only be preventive.

Figure 15. Mildew symptoms. Photos by Phytopathology Lab, DIPSA, University of Bologna.

A particular type of foliar pathogens are the mildew (Fig. 15). This type of fungi is characterized by a form of obligate parasitism. Symptoms include white spots isolated at first that coalesce then to cover the whole organ with a whitish powdery efflorescence, formed by the reproductive elements of fungus. Unlike other agents of foliar diseases, the infective process of the mildwes is favored by hot and dry weather conditions, very frequent in the urban environment and in our terraces.

6.4 / ROOT DISEASES

The root pathologies often occur with non-specific symptoms of generalized leaf chlorosis and wilting (Fig. 16). The non-specificity and the relative severity of the symptom is due to the partial or total impairment of the root system and/or the collar which are damaged by the active growth of the pathogen within the vessels and ground tissues of the host. The localization of the pathogen in the tissues allows to distinguish between Tracheomycosis (when the pathogen is located in the vascular tissues of the host) and rot and cancers (when the lytic activity of the pathogen is expressed in parenchyma tissue of the host). Also in this case the control is based on a preventive approach, which includes the adoption of resistant or tolerant cultivars, grafting on tolerant rootstocks or by using preparation enabling to improve resistance to the pathogen.

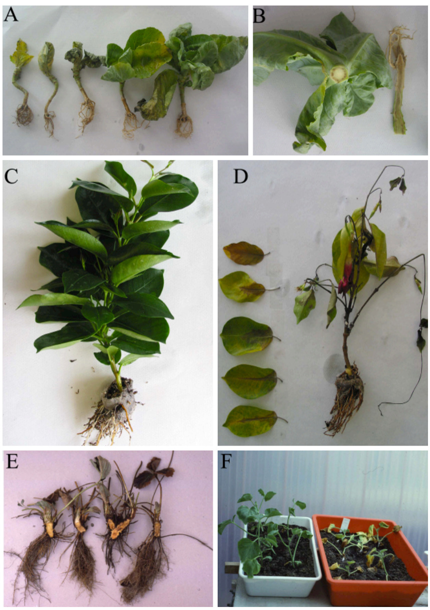

Figure 16. Root diseases, different symptoms. Photos by Phytopathology Lab, DIPSA, University of Bologna.

6.5 / DISEASES OF FRUITS AND TUBERS

Many of the pathogens that affect the above ground apparatus of plants can also give symptoms on fruits; microorganisms involved in root disease can, on the other hand, cause symptoms on the structures derived from them as bulbs, tubers and rhizomes (Fig. 17). Other microorganisms benefit, for their growth and development, from ripening fruits, causing more or less early rottenness, that lead to the disintegration of tissues, with the appearance of alterations of different types even after harvesting. Even in these cases the control provides a preventive approach against the primary infection.

Figure 17. Tubers and fruit diseases, different symptoms. Photos by Phytopathology Lab, DIPSA, University of Bologna.

/ TABLE 8. DISEASE CONTROL IN THE URBAN VEGETABLE GARDEN.

SYMPTOM	PATOGEN/PATOGENS	PRODUCT/MICROORGANISM	TYPE
LEAF DISEASES	MILDEW	AMPELOMYCES QUISQUALIS (FUNGUS SPORES AND MYCELIUM)	BIO-FUNGICIDE
		POTASSIUM BICARBONATE	FUNGICIDE
		SPRAYING SULFUR; WETTABLE SULPHUR	FUNGICIDE - ACARICIDE
	ALBUGO, ALTERNARIA (B1, D1), BREMIA, CERCOSPORA (A1), CYTOSPORA, COLLETOTRICHUM (E1),	BACILLUS SUBTILIS (SPORE).	BIO-FUNGICIDA

CONTROL MEASURE	TREATMENT	USE	RECOMMENDATIONS
PARASITISM	FOLIAR	PROTECTANT-CURATIVE	IT IS ADVISABLE TO CARRY OUT THE TREATMENT IN THE EARLY HOURS OF THE MORNING OR BETTER IN THE EVENING, MIXING WITH MINERAL OIL, PINOLENE OR WITH A SILICONE WETTING AGENT, TO ENSURE THE NECESSARY MOISTURE FOR GERMINATION OF THE SPORES
TOXICITY	FOLIAR	PROTECTANT-CURATIVE	YOU NEED A GOOD WETTING OF THE LEAF SURFACE. IT CAN BE PHYTOTOXIC AT CONCENTRATIONS GREATER THAN 0.5%. USE AT THE ONSET OF THE FIRST SYMPTOMS OF THE DISEASE
SO_4^{--} ANION TOXICITY	FOLIAR	PROTECTANT-CURATIVE	ACTIVE UP TO 40°C, IT REDUCES ITS ACTIVITY WITH INCREASING HUMIDITY. AVAILABLE BOTH LIQUID AND IN POWDER. HARDLY COMPATIBLE WITH OTHER PESTICIDES DUE TO ITS ALKALINITY. THE USE MUST BE ALTERNATED IN 15 DAYS OF TREATMENT WITH MINERAL OILS AND 20-25 DAYS BY TREATMENT WITH COPPER-BASED PRODUCTS. IT CAN BE PHYTOTOXIC ON CUCURBITS
COMPETITION	FOLIAR	PROTECTANT	REPEAT THE TREATMENT EVERY 10-15 DAYS. DOSE: 7.5 G / L USING WATER VOLUMES OF 100 ML/M^2

	CORYNEUM, CYCLOCONIUM, CYLINDROSPORIUM, DEUTEROPHOMA, DIPLOCARPON, BLACK MOULD, GIBBERELLA, GLOEOSPORIUM (D4), MARSSONINA, MONILIA, MYCOSPHAERELLA, NECTRIA, MILDEW, PENICILLIUM, PERONOSPORA, PHOMA, PHYLLOSTICTA, PHRAGMIDIUM, PHYTOPHTHORA, PHOMOPSIS, PLASMOPARA, PUCCINIA, SEPTORIA, SPHAEROPSIS, TAPHRINA, TILLETIA, UROMYCES, VENTURIA. THEY ALSO SHOW A BACTERICIDAL ACTION	TRICHODERMA HARZIANUM (CONIDIUM AND MYCELIUM) T-39 AND T-22	BIO-FUNGICIDE
		COPPER (COPPER HYDROXIDE, COPPER OXYCHLORIDE , COPPER SULPHATE, DICOPPER OXIDE, COPPER)	FUNGICIDE BACTERICIDE
ROOTS AND ROOT COLLARS DIESEASES	FUSARIUM SPP.(A3, B3, C3, D3, F3) PYTHIUM SPP., VERTICILLIUM DAHLIAE (E3), PYRENOCHETA LYCOPERSICI, PHYTOPHTORA CAPSICI	STREPTOMYCES GRISEOVIRIDIS (BACTERIAL CELLS)	BIO-FUNGICIDE
	RHIZOCTONIA SPP., SCLEROTINIA SPP., SCLEROTIUM ROLFSII, VERTICILLIUM SPP. (E3), THIELAVIOPSIS BASICOLA, PYTHIUM SPP., PHYTOPHTHORA CAPSICI	TRICHODERMA ASPERELLUM CEPPO ICC012 (CONIDI)	BIO-FUNGICIDE

COMPETITION ANTIBIOSIS PARASSITISM - ISR	IN SOIL - FOLIAR	PROTECTANT	IT MAY BE PHYTOTOXIC TO CROPS NOT LISTED ON THE LABEL. THE STRAIN T-22 IS SENSITIVE TO THE FUNGICIDES USED IN ORGANIC FARMING, UNLIKE THE STRAIN T-39. FOR THE STRAIN KRL-AG2 ANY LATENCY PERIOD IS RECOMMENDED
CU^{++} ION TOXICITY	FOLIAR	PROTECTANT	MAY CAUSE PHYTOTOXICITY PARTICULARLY AS IT IS USED DURING THE FLOWERING PERIOD, AS IT MAY DAMAGE THE POLLEN AND PRODUCE TOXIC EFFECTS ON THE FLOWERS. THE ACCUMULATION OF COPPER IN THE SOIL INTERFERES WITH THE ACTIVITY OF EARTHWORMS, OF MOST OF THE FUNGI AND BACTERIA DEGRADING ORGANIC MATTER AND NITROGEN FIXING. THE COPPER IS EASILY ABSORBED BY AQUATIC ORGANISMS, AGAINST WHICH HAS A HIGH TOXICITY
COMPETITION-ANTIBIOSIS - PGPR	IN SOIL	PROTECTANT	USED AS A TREATMENT FOR DRY SEEDS, OR USED IN AQUEOUS SUSPENSION TO THE SUBSTRATE CULTIVATION, SPRAYING. YOU MUST AVOID CONTACT WITH SKIN AND INHALATION BECAUSE THE PRODUCT MAY CAUSE IRRITATION. TOXICOLOGICAL CLASS: XN (HARMFUL)
COMPETITION-ANTIBIOSIS PARASSITISM	IN SOIL	PROTECTANT	THE TREATMENT TO CROPS IN CONTAINERS IS DONE BY UNIFORMLY MIXING THE PRODUCT TO THE SUBSTRATE OR BY SUSPENDING IN WATER AND WETTING THE SUBSTRATE SUFFICIENTLY SOON AFTER TRANSPLANTING. THE APPLICATION MUST BE MADE WHEN THE SOIL TEMPERATURE REACHES AT LEAST 10 °C

	PYTHIUM SPP., PHYTOPHTHORA CAPSICI, RHIZOCTONIA SOLANI AND VERTICILLUM SPP	TRICHODERMA ASPERELLUM CEPPO TV1 (CONIDI)	BIO-FUNGICIDE
	RHIZOCTONIA SPP., SCLEROTINIA, SCLEROTIUM ROLFSII, VERTICILLIUM SPP.(E3), THIELAVIOPSIS BASICOLA, PYTHIUM SPP, PHYTOPHTHORA CAPSICI	TRICHODERMA GAMSII CEPPO ICC080 (CONIDI E MICELIO) (EX T. VIRIDE)	BIO-FUNGICIDE
	PYTHIUM SPP., RHIZOCTONIA SPP., FUSARIUM SPP.,(A3, B3, C3, D3, F3) CYLINDROCLADIUM SPP., THIELAVIOPSIS SPP., MYROTHECIUM SPP. AND ARMILLARIA MELLEA	TRICHODERMA HARZIANUM (CONIDI E MICELIO) T-39 E T-22	BIO-FUNGICIDE
MALATTIE DEI FRUTTI	SLEROTINIA SP. (C4)	CONIOTHYRIUM MINITANS	BIO-FUNGICIDE
	BOTRYTIS (B4)	BACILLUS SUBTILIS (SPORES).	BIO-FUNGICIDE

COMPETITION-ANTIBIOSIS PARASSITISM - ISR	IN SOIL	PROTECTANT	THE PREPARATION (REGISTERED) IS MISCIBLE WITH ALL INSECTICIDES, FUNGICIDES AND FERTILIZERS FOR ORGANIC FARMING
COMPETITION-ANTIBIOSIS PARASSITISM - ISR	IN SOIL	PROTECTANT	IT IS SENSITIVE TO UV RADIATION AND THEREFORE EASILY DEGRADABLE. IN CERTAIN CONDITIONS IT IS ALSO AGENT OF WOOD ALTERATIONS. IT GROWS IN THE SURFACE LAYERS OF THE SOIL. APPLY OTHER AGROCHEMICALS AT A DISTANCE OF 10 DAYS FROM TREATMENT
COMPETITION-ANTIBIOSIS PARASSITISM - ISR	IN SOIL - FOLIAR	PROTECTANT	IT MAY BE PHYTOTOXIC TO CROPS NOT LISTED ON THE LABEL. THE STRAIN T-22 IS SENSITIVE TO THE FUNGICIDES USED IN ORGANIC FARMING, UNLIKE THE STRAIN T-39. FOR THE STRAIN KRL-AG2 ANY LATENCY PERIOD IS RECOMMENDED
PARASSITISM	IN SOIL	PROTECTANT	TO MAKE SURE THAT THE FUNGUS IS ACTIVE, THE TREATMENT SHOULD BE CARRIED OUT 2-3 MONTHS BEFORE THE ATTACK OF SCLEROTI-NIA, EMPLOYING 50-60 ML/M2 WATER. THE PRODUCT IS APPLIED WITH A TREATMENT TO THE SOIL OR RESIDUE FROM THE PREVIOUS CROP
COMPETTION	FOLIAR	PROTECTANT	7,5 G/L USING 100 ML/M^2 VOLUMES

HORTIS