Guideline of

Cucumber

Cultivation in Syria

Syrian
Academic expertise

LDO Local Development Organization
منظمة التنمية المحلية

Preface

Since ancient times, the impact of agriculture has been profound on humanity, most clearly through an organic relationship that is deemed as a link between agriculture and human being. That relationship has contributed to the development of agricultural methods as an urgent need to achieve food security for society and to keep pace with continuous scientific progress. Also, agricultural methods have evolved and the use of machinery and technology has increased in all agricultural operations such as production and cultivation of seeds, fertilization, irrigation, control, marketing, storage, and food processing technology. The transition to contemporary forms of agriculture, including protected agriculture in tunnels and greenhouses or glasshouses in addition to agriculture without soil (hydroponic) has become a vital necessity; to increase production per unit area, to rationalize water use and to preserve natural resources.

"The Agricultural Guidelines Project for the Most Important Agricultural Crops in Syria" aims to raise awareness of community members about the importance of growing vegetables in every home, where the home farm is considered an important source for the family to meet some of the needs through sustainable development of society and its material, financial and social support.

This guide also contributes to enabling farmers, technicians, and agricultural engineers to raise their capabilities to make optimal use of the requirements of agricultural production, which may lead to abundant production in terms of quantity and quality without causing any imbalance in the natural and nutritional balance of health. This is done by devoting a culture of food security and achieving a surplus in production that contributes to the process of social development and national economic growth. When preparing this guide, we envisioned that the scientific method should be used in a simplified and useful way; giving vocabulary and presenting information therein as a guide for all workers in the agricultural sector in Syria, which is described as the Cradle of Human Civilizations and their food basket throughout the ages.

This guide is ample for fixing basic ideas of agriculture methods and for making concepts intelligible; and also, it includes numerous chapters such as the morphology of the crop, environmental requirements, nutritional and health values, agricultural service operations, methods of cultivation, plant diseases, methods of prevention and control, harvest, food processing, the economics of the crop and challenges facing farmers. So, we had to submit technical recommendations that

reflect the findings of researchers at all disciplines related to this crop. It relies on clear meanings, expressive images, easy-to-understand tables, and agricultural calendar so that it may contribute to persuading farmers to apply modern patterns in agriculture; to accomplish abundant production per unit area within the framework of agricultural intensification and rationalization of waste in water, soil, fertilizers, and pesticides. Furthermore, it proposes appropriate solutions to problems that may lead to a decline in production and an achievement of economic losses.

In other respects, the work team has established a distinct methodology in preparing this guide to produce accurate information relating to all of its contents, instructions, and recommendations for agricultural engineers and farmers; in other meanings, scientific and applied content has been taken into consideration. Moreover, the guide also simulates the current reality of agriculture through communication with Syrian farmers and gathering of information that may pertain to all technical and marketing problems facing them and thus directing them to benefit from progress in the field of agriculture; to improve their living standards. It may contribute to the creation of a rural social renaissance by utilizing all available natural resources, raising awareness of farmers, developing capabilities, and upgrading skills. Besides, there is an absolute necessity to replace some wrong agricultural methods, and therefore we are allowed to work with a distinct methodology that affects the reality of our local agriculture, hoping that this work would be part of our commitment to serving the community.

Contents

Chapter 1:

Morphological Description and Nutritional Value

Introduction:

Cucumber is cultivated and consumed abundantly in many countries of the world, but it is more commonly used in Levant and Turkey to prepare countless types of fresh salads. There are two main varieties of cucumber—slicing or pickling—within which several cultivars have been created. Cucumbers grown to eat fresh are called slicing cucumbers, and those cucumbers intended for pickling, called picklers, and pickling with brine, sugar, vinegar, and spices creates various flavored products and sandwiches. In general, the cucumber is not cooked (with a few exceptions), and its juice may be drunk while trying to lose weight. Occasionally the taste of cucumber is aqueous, cold, and as light as watermelon, and sometimes it has an aromatic smell and delicious sweet taste.

Arabic Name: Khiar, Khiar Alma'a, Alqathad

English Name: Cucumber

Scientific Name: Cucumis Sativus

First: Origin

The cucumber is originated in India, spread to China, Iran, Turkey, Russia, and then arrived in North America in the mid-1700s. It is currently cultivated in temperate regions worldwide such as the Mediterranean Basin, Southern Europe, North Africa, South Asia, and Southeast Asia.

Second: Botanical Description

Cucumber (Cucumis Sativus) is a widely-cultivated creeping vine plant in the Cucurbitaceae gourd family that bears cucumiform fruits, which are used as vegetables. Cucumber is dicotyledonous and grown as an annual, which means that the plant does not regenerate after the growing season. Also, the Cucurbitaceae gourd family is one of the most important species in the Cucurbitales that include cucumber, pumpkin, Armenian cucumber /Yard-long cucumber / Snake cucumber, squash, cantaloupe, marrow, etc.

Third: Morphology

» Root System:

Cucumber vines put down a single tap root that grows at a depth of (50- 25 cm), but the main bulk of the roots extends out 60 cm in diameter right below the soil surface. The lateral-growing surface roots form a dense mat at a depth of 20 cm and spread laterally to a distance of (45 -60 cm).

» Stem:

The stem varies in shape but is generally a curved cylinder rounded with a length ranging from (120-250 cm), and it has a short fluff with thick hair.

» Leaves:

The leaves are semi-triangular, medium to large, fluffy, and are arranged alternately on the vines, dividing into 3–7 pointed lobes. The superior lobe is pointed and has an obtuse angle with the two lateral lobes.

» Flowers:

The cucumbers are considered unisexual and monoecious (some varieties of flowers are perfect/ hermaphrodite

or staminate/male), and produce separate staminate (male) and pistillate (female) flowers on the same plant which vary (according to the varieties and the prevailing conditions of weather and soil). The increase in the number of male flowers is attributed to the increase in carbohydrates rather than nitrogen.

Several male flowers are arranged in groups; each group consists of 2- 3 flowers; they are borne on short petioles that emerge from the axils of leaves and then distributed along with the plant. Also, the male

flowers are about four times the female flowers.

The staminate (male) flower has a gamopetalous calyx and a yellow corolla, composed of 5 joined hairy sepals, 5 connate petals, and 5 stamens.

On the other hand, the pistillate (female) flower has a gamopetalous calyx, a yellow corolla, an ovary that consists of three fused carpels, and a stigma that is divided into three style branches. The male and female blooms do not appear at the same time because the male flowers

begin forming before the female flowers form. Cucumber plant pollination by hand is desirable and necessary in some situations; however, it can be done by natural pollinators (insects).

In other meanings, in botanical terms, these plants are said to be monoecious. On monoecious plants, the male flowers contain stamens that produce pollen, while female flowers have pistils that contain the ovule.

» Fruits:

Fruits have a cylindrical, curved in shape, rounded on both ends, they can reach a length of 60 cm and a diameter of 10 cm and have a smooth texture, while varieties of pickling have small warts.

» Seeds:

The seed is a small, pointed, and often white.

Fourth: Suitable Environmental Conditions

Table No. (11-) Suitable environmental requirements for the cucumber crop

	Climate	Soil	Temperature	Moisture	Light
Environmental Requirements	Humid tropical climates	All types of fertile, ventilated, and well-drained soils	Appropriate (15-30 ° C)	70-80 %	short-day plant (10-12 hours)

Climate:

Cucumbers need hot, humid weather conditions and grow at lower temperatures than other types of cucurbits. The flowers grow after a short period of planting (about 60 days); however, in the summer the period ranges between (30- 35 days).

Soil:

Cucumbers can be cultivated in all types of soils provided that they are loose, fertile, ventilated, well-drained and free from harmful salts and nematodes; preferably cultivated in light yellow soils because of their positive effect on early yielding of the crop, as it is cultivated in light clay soils to obtain a bumper crop. Moreover, the pH of the soil should range between (5.5- 6.7), and the degree of salinity should be less than 2.5 dS/m.

Temperature:

Cucumber is deemed a thermophilic crop, so the optimum temperature of seed germination is 15–16°C, and the optimum temperature of cucumber growth is 25–30°C. If the temperature falls below that, the fruit growth becomes slow. Otherwise, if the temperature rises during the fruit harvest season, yellow spots may appear on those fruits, which can reduce their marketing value. Delayed planting is recommended because low temperature prevents the germination of seeds, as it can accelerate the emergence of female flowers, and increase their number by exposing dry seeds to a temperature of (50- 60 ° C) for a maximum period of 3 hours, by increasing the temperature gradually.

Moisture:

Cucumber is one of the crops most in need of moisture, due to the large size of the root system, its spread in the surface layer, and its weak absorption capacity as well. In different stages of growth, the appropriate

soil moisture ranges between 70- 80% of field capacity in cloudy weather, and between 85- 90 % in sunny weather. The cucumber growth also requires relatively high humidity ranging between 70- 80 %, as low humidity and irregular irrigation may lead to poor vegetative growth in addition to delayed flowering and fertilization.

Light:

As cucumber is a short-day plant, it can lead to faster flowering, female flower formation, and early production. While the increase in the optical period and temperature may cause the formation of male flowers due to the high proportion of carbohydrates formed.

Water:

Cucumber is a water-loving plant. A fully grown plant needs a large amount of water estimated at 2- 3 liters of water per day. At the same time, the lack of water can impede the growth and give the plant a bitter taste.

Fifth: Nutritional and Health Value:

» Nutritional Value:

Cucumbers are good sources of phytonutrients. Peel and seeds are the most nutrient-dense pieces in cucumbers since they contain fibers and beta-carotene. The following table shows the nutritional value of 100 g /cucumber.

Table No. (2- 1) Nutritional value of cucumbers

Nutrient Element	Calories	Water	Protein	Fat	Carbohy-drates	fibers	Sugars
Nutritional value	16 Calories	99.04 g	0.68 g	0.11 g	3.78 g	0.5 g	1.74 g
Nutrient Element	Phosphorus	Calcium	Sodium	Vitamin K	Vitamin A	Vitamin C	Potassium
Nutritional value	25 mg	17 mg	2 mg	17.1	109 Interna-tional units	2.9 mg	153 mg

» Health Value:

- Cucumbers are high in antioxidants; they are molecules that block oxidation, a chemical reaction that forms highly reactive atoms with unpaired electrons known as free radicals. The accumulation of these harmful free radicals can lead to several types of autoimmune disease and chronic illnesses such as cancer, heart, and lung.
- Cucumbers promote Hydration. Water is crucial to the body›s function, playing numerous important roles. It is involved in processes like temperature regulation and the transportation of waste products and nutrients. Proper hydration can affect everything from physical performance to metabolism. Fruits and vegetables, in particular, can be a good source of water such as cucumber that is composed of about 96 % water.
- Cucumbers may aid in weight loss. Cucumbers could potentially help lose weight in a few different ways. First of all, they are low in calories. This means that eating plenty of cucumbers without packing on the extra calories that lead to weight gain. They may also be used as a replacement for higher-calorie alternatives. Furthermore, the high water content of cucumbers could aid in weight loss as well.
- Cucumbers could promote regularity. Eating cucumbers may help support regular bowel movements. Dehydration is a major risk factor for constipation, as it can alter your water balance. Cucumbers are high in water, promote hydration, prevent constipation, and help maintain regularity.
- Eating a variety of fruits and vegetables of all kinds is associated with a reduced risk for many health conditions, such as heart disease, diabetes, stroke, and obesity. So, cucumber consumption may lead to reducing hypertension, and lower blood pressure because it promotes vasodilation (widening of the blood vessels). In other meanings, they may protect the body against blood clots that block blood vessels or buildup of cholesterol, fibrin, or other material. Cucumbers are good sources of the potassium and magnesium elements necessary to maintain blood pressure within its normal levels.
- Cucumbers may lower blood sugar. They may help reduce blood sugar levels, prevent some complications of diabetes, stimulate insulin secretion/ release, and regulate the metabolism of blood sugar.

- Cucumbers have a cooling and soothing effect that may decrease swelling, irritation, puffiness, and inflammation when used topically or may alleviate and treat sunburn when placed on the affected areas.

<table>
<tr><th colspan="4">Crop Identification</th></tr>
<tr><td>Scientific Name</td><td>Cucumis Sativus</td><td rowspan="2">Cultivation</td><td rowspan="2">By seeds or seedlings
Open cultivation: has four cultivation periods (spring, Spring-summer, summer, and autumn).
Protected cultivation: either planting in tunnels (an early spring period) or planting in greenhouses (early spring period, autumn, and winter).</td></tr>
<tr><td rowspan="2">Environmental Requirements</td><td rowspan="2">pH: (5.5- 6.7)
Temperature: (15- 30 ° C)
Moisture: 70- 80%
Climate: is humid and tropical
Soil: All types of fertile, ventilated, and well-drained soils</td></tr>
<tr><td>Harvest</td><td>Fruits are picked up at the stage of growth or maturity</td></tr>
<tr><td rowspan="2">Most Common Diseases</td><td rowspan="2">Damping Off, Fusarium Wilt, Verticillium Wilt., White Mold, Gray Mold, Powdery Mildew, Downy Mildew, Blights, Scab, White Fly, Thrips, Aphids, Cucumber Beetles, Cucumber Mosaic Virus, Angular Leaf Spot
Spider and Root-Knot Nematode</td><td>Productivity</td><td>Depends on variety and cultivation method:
Open fields: 9.5 dunums / tons
Tunnels: 11 tons / dunums
Protected (greenhouses): 15 tons / dunums</td></tr>
<tr><td>Consumption</td><td>Fresh or Processed</td></tr>
</table>

Chapter 2:

Field operations (Cultivation and Service)

First: Varieties:

Although there are hundreds of species and varieties of cucumbers, they are divided into the following main groups:

» Slicing or Fresh Salad (Fresh Consumption) Cucumber:

Beit Alpha Type:

They are thought to have excellent taste and low bitterness. As they are adapted for trellising under protected cultivation. This group includes most types of regular cucumbers grown in the Middle East. They can be grown in open fields or protected fields (greenhouses) and the fruits are short at a length of 12- 20 cm. The varieties of cucumbers, that are prevalent in the region are generally Parthenocarpic varieties, where all flowers on plants are largely or wholly female, and so do not need cross-pollination.

Dutch Type:

The European cucumber is called (Dutch, hothouse, greenhouse, hydroponic). It is cultivated in greenhouses, spread to most European countries, and characterized by its long fruits, which range when picking between 25- 50 cm.

» Pickling Cucumber

«Pickling» refers to cucumbers that are primarily used for processing and pickling. They are characterized by their short fruits and spines on the fruit surface, which are of the species that spread in the American market.

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Local varieties of cucumbers are more adaptive to environmental conditions and resistant to diseases and insects, but one of the advantages is their low productivity and quality. As for hybrids' varieties grown in Syria, most of which are of American or Dutch origin, they are packed in envelopes; each one contains 2,200-2600 seeds; their price ranges between $ 27-32. They are often called different local commercial names; the hybrids traded on the market until April 2020: Oro, Alexander, Rania, Majdal, Tala, Massa, Adana, Bablyon, Alsae'en, Akkad, Joud , Hima, Concord, and Local Cucumber.

Second: Cultivation Practices and Seedling Production:

» Methods and Dates of Planting

In the field, when using seeds for planting, per dunum needs 100- 110 grams of seeds, but when transplanting the seeds decreases to about 60- 70 g; where the plant density in open cultivation reaches approximately 3000 seedlings/ dunum. While, in the cultivation, in plastic tunnels, they reach approximately 1500 seedlings/dunum and in greenhouses about 2500 seedlings/dunum (Gruda et al., 2017). In Syria, the cultivation of cucumber crops is distributed over almost all the year; depending on the region, production system, date of cultivation, and cultivated variety.

Table No. (2- 1) Production systems, planting periods, planting dates, and planting methods (seeds or seedlings).

Production Systems	Planting Periods/Grown Seasons	Planting Dates	Planting Method
Spring	15 March - 15April	seeds or seedlings	Open cultivation
Spring-Summer	15 May	seeds or seedlings	
Summer	15 June	seeds	
Autumn	August - September	seeds or seedlings	
Early Spring (winter)	February - March	seedlings	Cultivation in plastic tunnels
Early Spring	December - February	seedlings	Cultivation in greenhouses
Autumn	August - September	seeds or seedlings	
Winter	October - November		

» Seedling Production

Seedlings are produced by planting seeds in a special building known as the nursery. After seedlings grow to the appropriate size, they are transferred to the field. Transplanting has two methods:

First Method: Seedling Trays

In a suitable planting environment, trays are filled, and seeds are grown; until they become ready to be transported to the field. Also, the environment of seedlings consists of peat moss or agricultural soils.

Second Method: Plastic Bags

Seeds are sown in nylon plastic bags (10- 12 cm) in suitable environments (dust, sand, fermented local fertilizer), and placed in plastic tunnels to produce early seedlings.

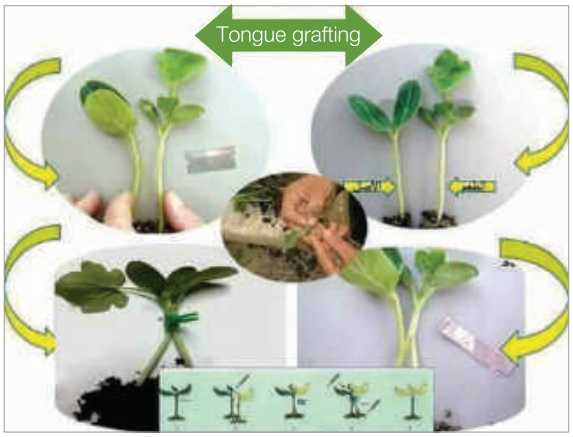
» Nursery Service Operations:

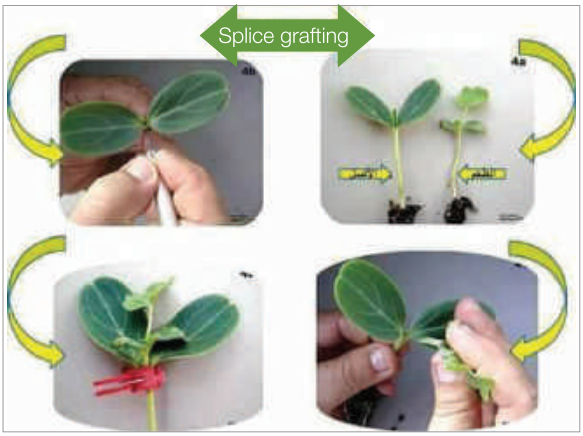
Nurseries need much care to obtain seedlings with strong growth and free of diseases, and the following measures should be taken:

1. Controlling diseases, insects, and weeds from the beginning of germination.
2. Avoid trying to push plants to abnormally rapid growth by prolific fertilization or by raising the temperature.
3. Provide appropriate temperature and adequate ventilation for the growth of seedlings (Hasan, 2015).

» Seedling Grafting:

The grafting process can be performed during the seedling phase and before the emergence of the first true leaf of the two cotyledons, where several methods of grafting (tongue, cleft, and splice) are used. One of the most commonly used methods is tongue/whip graft (Lee and Oda, 2010). Moreover, the spinal cucumber shows good compatibility with the cucumber in fighting root-knot nematodes and stimulates the early growth of grafts, as the popular C.ficifolia and cucumber resist both Fusarium Wilt and Phomopsis sclerotioides.





» Seedling Sterilization

To obtain healthy seedlings free from infection with any fungal diseases, it is recommended to abundantly spray (spraying should be repeated every ten days) nurseries with one of the appropriate fungicides such as previcure, bavistin, topsin, and consent. Otherwise, the roots of the seedlings are immersed with the same solution.

» Seedling Acclimation or Hardening

Acclimation or hardening process is carried out 35- days before transplanting the seedlings (depending on how long the plants remain at the nursery); by reducing irrigation and nitrogen fertilization, exposing plants to open field conditions (gradually reduce heating or shading) and exposing the shaded plants to direct sunlight (raising the shading nets).

» Specifications of Good Seedlings

A fringe of well-branched roots will do far more for the developing plant/seedling. Also, for obtaining best seedlings, the length of vegetative growth should be between 1015- cm, the stem of the seedling should not be succulent /Vine/herbs or woody/Liana/shrubs, but rather in the middle, and the leaves should be well-planted and have a dark green color as well as pest-free seedlings.

Third: Planting Methods:

» 1. Open cultivation

1.1. Soil preparation

The land is prepared two or three weeks before the start of planting, and if the soil is sterilized by solar radiation, two months will be added to the previous period; this is done through the following agricultural operations:

2.1. Tilling and Levelling

Before preparing the land for planting, the remnants of the previous crop and the harmful weeds should be removed from the ground and completely cleaned from residues. Then, soil tilling/ plowing is carried out with a depth of 30- 40 cm, followed by conducting two perpendicular tillage operations at a depth of 20- 25 cm to break up the soil clods. After that, the fermented organic fertilizers are added with basic mineral fertilizers, followed by surface tillage to mix the fertilizers with the soil; and then level it. Also, the planting beds are prepared, and the depth of plowing must be changed every year to prevent the formation of a hardpan “A hardened

impervious layer, typically of clay, occurring in or below the soil and impairing drainage and plant growth beneath the soil surface".

3.1. Soil Analysis (Procedures & Precautionary Checks)

Before conducting the agricultural operations and creating the fertilization plan, it is recommended to conduct a preliminary analysis of the soil to recognize the texture of the soil, its type, its level of salinity, its content of the main nutrients, and its elements. It is also advised to conduct a complete analysis of irrigation water to recognize its nutrient content, to develop a fertilization plan for the crop of cucumber (Vandre, 2013).

4.1. Soil Sterilization

The sterilization process seeks to eliminate many lesions present in the soil by using thermal sterilization, chemical sterilization, biological control (Bio-Arc + Bioside), or biological control with solar sterilization.

Thermal Sterilization:

Soil sterilization by heating (steam) or solar radiation can then be an effective way of eliminating or controlling lesions populations. Also, it is considered less expensive than chemical sterilization, does not cause damage to most beneficial organisms present in the soil, and can be done from June to August.

Soil steam sterilization (soil steaming) is a farming technique that sterilizes soil with steam in open fields or greenhouses. Pests of plant cultures such as weeds, bacteria, fungi, and viruses are killed through induced hot steam which causes vital cellular proteins to unfold. While, the method of solar radiation is summarized by

removing plant waste/residue of the previous crop, conducting deep tillage of the soil, adding fermented organic fertilizers at a rate of 35- tons per acre to the soil, and then plowing/tilling of the ground at a depth of 20- 25 cm to mix the organic fertilizer. Furthermore, the field is submerged with water and then the soil is left to dry, usually about two weeks, depending on the type of soil. Then, the soil is tilled and smoothed, the drip irrigation network is established, the soil is covered with transparent nylon (Plastic Mulches), and the water is added every five days for 45 days to 50 days; where it is preferable to irrigate the soil with drip irrigation network for short periods ranging between 10 and 15 minutes every 3 to 4 days. After the sterilization period, the transparent nylon (Plastic Mulches) is carefully and cautiously removed to avoid contamination of the sterilized soil with the non-sterilized soil.

Chemical Sterilization:

Chemicals such as Agrocelhone NE, Tri-Form 30, Basamid 96%, Loser 98%, Pladin 94.8%, or any of the alternatives to methyl bromide that was banned in the year of 2014 CE due to its serious impact on health and environment. (Gullino et al., 2003)

5.1. Adding Fertilizers Before Planting

Cucumber is a fast-growing crop and responds well to fertilization. When preparing the soil for cultivation, organic fertilizers are added during tillage, to improve the nature and fertility of the soil. Also, basic mineral fertilizers are added before the last tillage, and they are mixed with the soil.

Fertilizer quantities added to open cultivation before planting

3- 5 tons/dunum fermented local fertilizer (livestock waste) or 1- 2 tons/dunum fermented local fertilizer (chicken manure), (15- 25) kg/dunum urea (46%), (25- 14) kg/dunum Triple Superphosphate fertilizer (46%); taking into account the increase of potassium proportion in sandy lands and increasing of phosphorous proportion in heavy lands and newly reclaimed lands in addition to decreasing the proportion of nitrogen in organic lands.

6.1. Seedlings planting

Cultivation in the Field:

In general, Cucumbers are planted through sowing seeds. However, in the early Autumn period (in a

cold climate) cucumbers are planted through seedlings; where they are transplanted to the field after about three weeks. There are 3 different irrigation methods to irrigate the cucumber crop: by drip (dribble) irrigation, by surface (flooding) irrigation, or by sprinkler (mist) irrigation. Drip irrigation lines will be at a distance of (120 -150) cm from each other, and burr holes will be at a distance of 35- 40 cm from each other in the line that was previously covered with black mulch.

When using the flood irrigation method, planting will be on a furrow on both sides of the furrow with a width of (120- 150) cm, burr holes will be at a distance of 3540- cm, and the soil will be irrigated one or two days before planting according to the type of soil; as the number of plants reaches approximately 1.9- 2.5 plants / m2. (Hassan, 2015)

Seeding/ Transplanting:

Procedures must be observed when transplanting:

- Plants should always be transplanted (planted) in the permanent ground on the same day as they are transported by trays from the nursery.
- The ground should be well prepared, moisturizing the place of planting.
- Good seedlings are 15 cm long, 3 to 5 weeks old, and most importantly, they are free of diseases.

7.1. Patching and Replanting

The planted seedlings must be monitored regularly for 3- 7 days after planting to ensure that the remaining seedlings are healthy and naturally grow. The patching process of the dead or weak seedlings is conducted to draw attention and ensure the efficient use of emitters (irrigation water), especially for dry or unhealthy seedlings.

8.1. Irrigation

Cucumber is a water-loving plant and should not be thirsty during the growth stages; however, its thirst during the formation of fruits will cause bitterness and slow growth. Cucumber plant needs permanent moisture during the growing season, especially during flowering, setting, and

fruit growth (critical irrigation period) (Gruda et al., 2017). When the growth is complete, the plant will need about 2 -3 liters of water per day, and the cucumber will consume 1559.4 m3 / hectare during the season depending on the type of soil. Noting that it is preferable to irrigate plants in the morning or evening while avoiding irrigation in the afternoon.

Cucumber Irrigation Methods in Open Cultivation

1.8.1. Surface (Flooding) Irrigation:

Surface irrigation is often referred to as flood irrigation; where water is applied and distributed over the soil surface by channels or waterbeds to irrigate the land. Cucumber crop is irrigated every 6- 8 days, but it is not recommended to use this method of irrigation for several disadvantages:

- » It requires well-trained workers to carry out the irrigation process.
- » Salts appear on the soil surface in saline soils/areas.
- » It leads to the loss of much irrigation water in light porous soils.
- » The water distribution is not equal in the field.
- » Surface irrigation cannot be performed in uneven lands.
- » It leads to water scarcity.

2.8.1. Sprinkler (Mist) Irrigation:

Spray irrigation is a modern and commonly-used system of irrigating, but it also requires machinery. The water is delivered to the field through sprinklers, and the cucumber crop is irrigated every 4- 5 days. But this method has some disadvantages:

- » The sprinklers have high costs.
- » It helps in spreading many pathogens.

» It cannot be performed during wind blowing, especially during flowering, setting, and fruit growth.

Therefore, it is not recommended to use this type of irrigation to grow the cucumber crop; however, when using this, fungal diseases should be controlled by spraying fungicides every 15 days.

3.8.1. Trickle or Drip (Dribble) Irrigation:

Drip irrigation is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface.

This method mainly depends on the delivery of ground moisture to the field capacity in a limited area (root zone) to save irrigation water, reduce water loss during infiltration/transpiration, and minimize evaporation. Cucumber is irrigated every day or every two days (every 48 hours), under the prevailing temperature.

9.1 Fertilization

To maximize production without adding further fertilizers which lead to high production costs, environmental pollution, and soil salinity, a fertilization plan shall be designed after the soil analysis.

In open agriculture, it is recommended to add high phosphorous fertilizer (18: 46: 0) (5- 10 kg/ dunum) in three batches during the germination (three days after transplanting) and a week after the first batch and the third batch (during the setting stage). Urea fertilizer (46%) (10- 20 kg/ dunum) is added in two batches; the first one during germination (three days after transplanting) and the second one a week after the first batch. A balanced fertilizer (15:15:15) (10 -15 kg/dunum) or (20:20:20) (6- 10 kg/dunum) is added in two batches, the first one during the setting and the second one in conjunction with 1the first batch. Microelements such as «humic, Biostimulants (1.5- 2 l / dunum) and calcium (1- 2) l / dunum" are added at the beginning of the setting.

1.9.1. Fertigation of cucumbers according to the irrigation system

Fertigation is the type of fertilization in which fertilizers are applied through an irrigation system

directly to the plant roots. This is the most advanced and efficient fertilization practice.

2.9.1. Fertigation may be practiced under any irrigation system:

- Fertigation by flood irrigation: Fertilizers are mixed and added directly at a distance of about 7 cm around the base of plants, and the dose is done every two weeks with irrigation.
- Fertigation by sprinkler irrigation: This type is conducted through a fertilizer spreader/manure distributor.
- Fertigation by drip irrigation: It is one of the simplest and most successful methods of fertigation as the amount of water is relatively small; and also, fertilizer can be dissolved in all the amount of water used for irrigation. Fertilizer is added around the roots of plants, and it is not lost by infiltration.

» 2. Protected cultivation:

The greenhouse is a structure with walls and roof made chiefly of transparent material; used in planting plants to protect them against inappropriate environmental conditions, and so that the roof is high enough to allow movement. It has a width of 8 meters and a length of 35 meters.

a) Types of greenhouses:

1. Glass Greenhouses

   The glasshouse is a structure with a glass cover; as types of transparent glass (6 -8 mm thick) or fiberglass are used in covering these houses.

2. Greenhouse (plastic sheets)

   It is one of the most prevalent types that is characterized by a lightweight, cheap price, low construction costs, and ease of dismantling, installation, and transportation. Plastic greenhouses are covered with a transparent plastic cover, and they may be air-conditioned or not.

3. Plastic Tunnels

   Hoops for a small plastic tunnel can be made from sturdy wire or plastic tubing. The

arched hoops can be secured to a foundation or wooden raised bed frame with brackets. Also, the sheeting around the bottom edges and closed ends of the tunnel can be held in place with soil. Moreover, the tunnels promote early growth by warming the air surrounding the plants, using heat from the sun; and also, they protect plants from frost that can destroy or damage them. Greater overall crop yields are obtained when the plants come into earlier production and continue to bear throughout the season.

b) Preparing the soil for planting in greenhouses

Preparing the land: Before preparing the land for planting, the remnants of the agricultural waste and the harmful weeds should be removed from the ground and completely cleaned from residues. Then, soil tilling/plowing is carried out with a depth of 30- 40 cm, followed by conducting two perpendicular tillage operations at a depth of 20- 25 cm to break up the soil clods. After that, the fermented organic fertilizers are added with basic mineral fertilizers, followed by surface tillage to mix the fertilizers with the soil; and then level it. After that, the soil is smoothed, the planting beds are prepared, the irrigation networks are established, and then the soil is sterilized; using solar radiation sterilization. After removing the sterilization nylon and soil ventilation for 7- 10 days, the black mulch is used to control the weeds and to improve the efficiency of using water while reducing evaporation.

» 3. Seedlings planting

1.3. Planting distances in plastic tunnels

Cucumbers are planted in plastic tunnels on lines/rows after being covered with black mulch, the distance between the lines is (150 cm) and between seedlings is (35 -40 cm). Besides, the number of seedlings reaches approximately (1.5- 1.7) seedlings / m2 Vandre, 2013; Gruda et al., 2017)).

2.3. Planting distances in greenhouses

Cucumbers are planted in greenhouses on beds, after being covered with black mulch; where

the planting is either on single lines (the distance between irrigation lines is (80 -100 cm), and the distance between seedlings is 40 cm), or on double lines, each one is about (60 cm) apart, and the distance between the seedlings is 40 cm on one line. Furthermore, (90 -120 cm) are left on both sides of the greenhouse as a path, and thus each house contains (5- 4) beds; the number of seedlings reaches approximately (2.2- 2.5) seedlings / m2.

» 4. Irrigation

Irrigation is the critical determining factor for both production and quality of production, as daily water consumption depends on climatic conditions, plant density, and growth stages. In protected cultivation of cucumber crops, the need for water decreases due to low evaporation, and cucumber plants are irrigated every 2- 3 days using emitters; with a regular quantity of 4 liters per hour. It is preferable to irrigate every day in small quantities equal to the total water which is consumed every 2 to 3 days. In saline soils, irrigation in excess quantities should be acceptable to allow the infiltration of salts.

Table No. (2- 2) Irrigation times and methods of adding fertilizers to cucumber crop, according to the cultivation systems.

Irrigation Methods	Irrigation Dates		
	Open Agriculture	Plastic Tunnels	Greenhouses
Flood Irrigation	Every 6-8 days	------	------
Sprinkler Irrigation	Every 4-5 days	------	------
Drip Irrigation	Every 1-2 days	Every 1-2 days	Every 1-2 days

» 5. Fertilization

Cucumbers are deemed as sensitive-crops to the lack of nutrients necessary for plant growth in the soil, so to reach the highest productivity of cucumber plants, a fertilization plan must be developed based on the results of soil analysis before planting. Similarly, to clarify the fertilizer quantities added to the cucumber crop according to cultivation systems, the following table has been prepared:

Table No. (2- 3) Fertilizer quantities added to the cucumber crop according to cultivation systems.

Used Fertilizers	Quantities of Chemical Fertilizer per Acre		
	Open Agriculture	Plastic Tunnels	Plastic Houses
Before Planting			
Urea (46%)	15-25 kg	20-25 kg	20-29 kg
Triple superphosphate (46%)	14-25 kg	15-25 kg	20-28 kg
After Planting			
High-phosphorus fertilizer (18: 46: 0)	5- 10 kg	5-10 kg	8-12 kg
Urea fertilizer (46%)	10- 20 kg	10-20 kg	25-30 kg
Balanced fertilizer (20:20:20)	6- 10 kg	6-10 kg	12-15 kg
Balanced fertilizer (15:15:15)	10- 15 kg	10-15 kg	20-25 kg
Calcium	1- 2 liters	1-2 liters	2-3 liters
Microelements and foliar fertilizers	1.5- 2 liters	1.5-2 liters	2-2.5 liters

» 6. Service Operations in Greenhouses

1.6. Trellising

The cucumber is vertically trellised on stakes or supports of 2 m in length; where the first step begins after planting (or after finishing the patching) directly through strings attached from the top

of the trellising wire (located at the house). Besides, it is trellised at the required height; leaving good spare distances in the string for trellising purposes. Moreover, it is recommended to avoid tying the string to the seedling directly from the bottom, but it should be tied to a plastic thread to be placed under the black mulch while preparing alongside the sowing lines.

The trellising process begins after ensuring the vegetative growth of the crop, forming new leaves and buds, growing new root hairs, and holding the plant firmly in the ground.

In this process, the plant is carefully twisted around the string in a clockwise direction; taking into account not to damage the plant, stem, and growing bud. This process is usually done at a rate of twice a week, often, and should not be delayed to avoid breaking the plants (Vandre, 2013).

2.6 Pruning

Cucumber vines generate from a single stem and produce multiple shoots. Pruning is a necessary process for maintaining a balance between vegetative growth and fruiting growth to obtain ample production; pruning must be done in a suitable manner that ensures a balance between vegetative growth and productivity (Gruda et al., 2017).

In other meanings, pruning is the process of removing laterally growing shoots from the main vine of the cucumber. It can keep plants healthy and looking good, and it can help avoid overgrowth as well as facilitate vertical growth. It is important to avoid bending vines too much or tightening the vines to avoid breaking or crushing blossoms which may make the vines wilt and eventually die.

Furthermore, cucumbers grow from a leader stem. This is the lifeline of the plant and won't regrow if cut. So, it should only prune the shoots coming from that main leader stem. Usually, it is recommended to stick to pruning the base of the plant. This keeps it to one leader vine but allows the top to fill out its trellis. Where the leaf joins the stem, the cucumber will start another stem. Left alone, this stem will form more stems and those in turn yet more stems.

Pinching (a form of pruning) means removing new shoots on the main stalk or side branches. Its goal is either to prevent the development of a new shoot, usually done by pinching of lateral shoots, or slowing down the vertical growth of plants and boosting the development of lower shoots which can be done by pinching the main terminal or the tops of side branches.

In respect of that, cucumbers are divided into two types according to the method of growth.

The first type lies on the main branch (short season); as all the buds, branches and leaves are gradually removed up to 50 cm and the plant is left on the main stem and all branches are removed until they reach the end of the upper wire; when the plant reaches there, it is pinched to give two or three branches. The lateral branches are also removed, the fruits are picked from the two main branches, and after the nodes appear, the leaves are removed gradually to increase ventilation and reduce moisture; to avoid fungal diseases and pests. After picking each node, the leaves underneath are removed until the seedlings of the cucumber reach above the end of the upper wire, so the two branches are moved downward, especially for the long season.

As for the type that lies on the lateral branches (a long season), the buds, branches, and leaves are gradually removed up to 50 cm, then the lateral branches are left and pinched to 3- 4 nodes to obtain early production, provided that the vegetative growth should not be crowded so the plant is susceptible to diseases and then all the lateral branches and leaves are gradually removed. After obtaining the fruits up to 50 cm, the plant is left to lie on the branches, which are pinched to 3- 4 nodes, and after picking all the nodes on the branch; the entire branch is removed. After harvesting all the nodes, the leaves underneath are removed to increase ventilation and reduce moisture; to avoid fungal diseases and pests. Then, all branches are removed until they reach the end of the upper wire, then the plant is pinched and left to give two branches, but the lateral branches are still pinched to 3- 4 nodes. After that, they are removed and the fruits are picked from the lateral branch on the two main branches. 2019).

» 7. Agricultural Rotation

The agricultural rotation should not be less than three years, during which the cultivation of cucurbits and aubergines is prohibited because they have joint pests with cucumbers. So, they should be replaced with the cultivation of leafy/foliar and leguminous vegetables in protected agriculture in addition to the cultivation of legumes and gramgramineae; gramineae in open cultivation; where the cultivation of cucumbers is done after legumes (beans, peas, broad bean), potatoes, onions, cabbage, or one of the vegetables of the nightshade family, as well as after legumes such as alfalfa and gramgramineae; gramineae such as wheat and barley. Nevertheless, if it is proven that there are soil diseases such as Fusarium and Verticillium, the cultivation of cucumber (after Cucurbit vegetables) is only allowed after 4- 5 years for the short agricultural cycle, and 7- 8 years for the long agricultural cycle.

Fourth: Modern Technologies in Protected cultivation

» 1. Hydroponic Cultivation (Soilless)

Soilless cultivation means planting plants in agricultural environments where the soil is not one of their components, and they are fed using special nutrient solutions that contain the nutrients necessary for plant growth. It is an advanced method of cultivation that helps get rid of problems related to the lack of soil fertility, non-arable soil, the harsh climatic conditions, the lack of water resources, and other problems facing traditional agriculture.

Types of Hydroponics

There are two main types of hydroponic systems – closed hydroponic systems and open hydroponic systems. Hydroponic systems that do not involve growing media are usually closed systems, while hydroponic systems that involve growing media (container plants), may be closed or open systems.

Open System: defined as growing plants in agricultural media (without soil), using mineral nutrient solutions that are not reused. In other words, a fresh nutrient solution is introduced for each irrigation cycle. Types of media that can be used: (sand, gravel, Vermiculite, Perlite, and Rock wool).

Closed System: defined as growing plants in agricultural media (without soil), using mineral nutrient solutions; the same nutrient solution is recirculated to irrigate the plants in a closed-loop. Types of media that can be used: NFT (Nutrient Film Technique) hydroponic systems, closed systems with the use of agricultural media, vertical farming, aeroponic farming (Savvas et al., 2013).

Hydroponics has the following advantages:

1. The possibility of agricultural production in non-arable areas, especially soils affected by salinity.
2. Contribute to solving the problem concerning the lack of nutrients in the soil by providing all the elements needed for plant growth, reducing fungal diseases, and soil salinity.
3. No need for preparation of the ground and removing weeds.
4. Rationalization of water and fertilizer consumption.
5. Early maturity and increased productivity per unit area, especially in vertical farming systems.

Hydroponics has the following disadvantages:

1. High initial construction costs.
2. Changing the pH of the nutrient solution.
3. Dysfunction in the nutrient solution system leads to plant degradation.
4. The need for skilled workers and continuous monitoring of production processes.
5. The possibility of transmitting fungal diseases through the irrigation tank, especially in the closed system.

» 2. Organic Agriculture

Organic agriculture is a production system that sustains the health of soils and ecosystems. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects.

It can be also defined as a system for planting plants without the need for agricultural fertilizers and chemical pesticides. Instead, biological fertilizers are used, which can be obtained from

animal and plant waste residues to produce a clean, healthy, and safe product free of pesticide residues or fertilizer residues and heavy elements. Besides, there are numerous great advantages of organic farming to the environment and its components.

Advantages of Organic Farming:

1. Preserving biological diversity due to the non-use of inorganic fertilizers and chemical pesticides that contaminate the soil and water.
2. Reducing environmental pollution due to the use of compost that can be created at the planting location to increase soil fertility.
3. Healthy, non-GMO products which increase the demand for their purchase by consumers.
4. Maintaining sustainability as it does not depend on specific sources to do but depends only on nature.
5. farmers can increase their profit margin.
6. It needs less agricultural inputs than other cultivations.
7. Increase soil fertility, and protect it from long-term degradation.

Fifth: Safely Handling of Pesticides:

Some recommendations that must be adhered to avoid pesticide poisoning:

1. Pest control with pesticides can be made only as a last resort to combat pests and diseases.
2. The use of pesticides is somewhat related to the economic limit of damage caused by the pests to the cucumber.
3. Determine the lesion and adhere to the correct amount of the appropriate pesticide applied to the cucumber.
4. Use environmentally friendly pesticides; with short safety periods, and systemic pesticides if possible.

5. While preparing spray solutions and when applying pesticides, it must wear protective spray suit/apron such as body covering, goggles, face shield, head, and neck coverings, gloves, apron, boots, and air-purifying respirators.

6. Use the appropriate sprayer and ensure its safety, provided that the control of pests should be in the early morning or evening hours.

7. Stop spraying pesticides in the event of any malfunction in the machine used, and open the sprayers (nozzles) using a thin wire, not the mouth.

8. Avoid spraying during winds blowing, high temperatures, or heavy precipitation.

9. Never smoke, drink, or eat while mixing or applying pesticides. Besides, evacuating residents, animals, and bees from the area.

10. Commitment to the safety period, which means the period from the time of spraying until the consumption of the crop.

11. The fields sprayed with pesticides should not be visited until at least 24 hours after the spraying time.

12. close the containers tightly after using the product as well as keep children, foods (grains), pets (including birds and fish), and toys (including pet toys) away from areas while mixing and applying pesticides.

13. Correctly, dispose of empty pesticide containers in designated places for hazardous waste; where the container should be washed with water at least three times, and then destroyed so that it is not reused.

Table No. (4- 2) Agricultural operations of the cucumber crop in open agriculture

Month	Planting Periods/Growing Seasons	Agricultural Operations
January	Spring	• Conducting the last tillage operation in the second half of this month, adding basic fertilizers and mixing them with the soil to a depth of 20-25 cm, levelling and preparing the land for planting.
	Spring-Summer	• Conducting a tillage operation and getting rid of the remains of the previous crop to reduce the spread of diseases.
February	Spring	• Complete the preparation of the land for cultivation if there is a delay due to climate conditions. • Start planting seeds in the nursery to obtain seedlings for transplanting them to the permanent land. • Conducting a hardening process for seedlings and planting them at the beginning of March.
	Spring-Summer	• Performing two deep tillage operations as well as adding fermented organic fertilizers and mixing them with the soil.
March	Spring	• Start planting the spring season by transplanting the seedlings from the nursery to the field in mid-March. • Applying one irrigation dose after planting and then irrigating every 2-3 days. • The first addition of fertilizers (high-phosphorus+ urea) is applied three days after transplanting. • The second addition of fertilizers (high-phosphorus+ urea) is applied a week after the first addition.
	Spring-Summer	• Conducting the last tillage operation in the second half of this month, adding basic fertilizers and mixing them with the soil to a depth of 20-25 cm, levelling and preparing the land for planting.
	Summer	• Conducting a tillage operation and getting rid of the remains of the previous crop to reduce the spread of diseases.
April	Spring	• The first addition (balanced fertilizer + high phosphorus fertilizer + fertilizers + amino, organic acids + calcium) is applied when fruit setting. • Applying the irrigation system every 2 days in addition to control and prevention procedures. • The harvesting process begins at the end of April or the beginning of May.
	Spring-Summer	• Start planting seeds in the nursery to obtain seedlings for transplanting them to the permanent land. • Conducting a hardening process for seedlings and planting them at the beginning of mid-April.
	Summer	• Performing two deep tillage operations as well as adding fermented organic fertilizers and mixing them with the soil.

Month	Planting Periods/Growing Seasons	Agricultural Operations
May	Spring	• Applying the second addition of balanced fertilizer with the first harvesting. • Applying the harvesting, control, and irrigation processes every 2 days.
	Spring-Summer	• Start planting the Spring-Summer season by transplanting the seedlings from the nursery to the field in mid-May. • Applying one irrigation dose after planting and then irrigating every 2-3 days. • The first addition of fertilizers (high-phosphorus+ urea) is applied three days after transplanting. • The second addition of fertilizers (high-phosphorus+ urea) is applied a week after the first addition.
	Summer	• Conducting the last tillage operation in the second half of this month, adding basic fertilizers and mixing them with the soil to a depth of 20-25 cm, levelling and preparing the land for planting.
	Autumn	• Conducting a tillage operation and getting rid of the remains of the previous crop to reduce the spread of diseases.
June	Spring-Summer	• The first addition (balanced fertilizer + high phosphorus fertilizer + fertilizers + amino, organic acids + calcium) is applied when fruit setting. • Applying irrigation system every 2 days in addition to control and prevention procedures. • The harvesting process begins at the end of April or the beginning of May.
	Summer	• Start planting seeds directly in the permanent land.
	Autumn	• Performing two deep tillage operations as well as adding fermented organic fertilizers and mixing them with the soil.
July	Spring-Summer	• Applying the second addition of balanced fertilizer with the first harvesting. • Applying irrigation system every 2 days in addition to control and prevention procedures.
	Summer	• Applying one irrigation dose after planting and then irrigating every 2-3 days. • The first addition of fertilizers (high-phosphorus+ urea) is applied after planting. • The second addition of fertilizers (high-phosphorus+ urea) is applied a week after the first addition.
	Autumn	• Conducting the last tillage operation in the second half of this month, adding basic fertilizers and mixing them with the soil to a depth of 20-25 cm, levelling and preparing the land for planting.

Month	Planting Periods/Growing Seasons	Agricultural Operations
August	Summer	• The first addition (balanced fertilizer + high phosphorus fertilizer + fertilizers + amino, organic acids + calcium) is applied when fruit setting. • Applying the irrigation system every 2 days in addition to control and prevention procedures. • The harvesting process begins at the end of April or the beginning of May.
	Spring-Summer	• Start planting seeds in the field. • Applying one irrigation dose after planting and then irrigating every 2-3 days.
September	Summer	• Applying the second addition of balanced fertilizer with the first harvesting. • Applying the irrigation system every 2 days in addition to control and prevention procedures.
November	Spring	• Conducting a tillage operation and getting rid of the remains of the previous crop to reduce the spread of diseases.
December	Spring	• Performing two deep tillage operations as well as adding fermented organic fertilizers and mixing them with the soil.

Table No. (5- 2) Agricultural operations of the cucumber crop in the protected agriculture

Month	Planting Periods/Growing Seasons	Agricultural Operations
January	Early spring (tunnels)	• Conducting the last tillage operation in the second half of this month, adding basic fertilizers and mixing them with the soil to a depth of 20-25 cm, levelling and preparing the land for planting.
	Early spring (greenhouse)	• At the beginning of the month, the seedlings are transplanted to the greenhouse (December – February), or the seeds can be used for cultivation in the greenhouse directly. • The first addition of fertilizers (high-phosphorus+ urea) is applied three days after transplanting. • The second addition of fertilizers (high-phosphorus+ urea) is applied a week after the first addition. • The first addition (balanced fertilizer + high phosphorus fertilizer + fertilizers + amino, organic acids + calcium) is applied when fruit setting.
	Winter (greenhouse)	• Continuing the harvesting process. • Continuing the control process and the irrigation system.

Month	Planting Periods/Growing Seasons	Agricultural Operations
February	Early spring (tunnels)	• Complete the preparation of the land for cultivation if there is a delay due to climate conditions. • Start planting seeds in the nursery to obtain seedlings for transplanting them to the permanent land.
	Spring (greenhouse)	• Start the process of harvesting. • Applying the second addition of balanced fertilizer with the first harvesting. • Conducting the irrigation process per day or every two days in small quantities. • Conducting a preventive control.
March	Early spring (tunnels)	• At the beginning of March, the seedlings are transplanted to the permanent land (the end of February, the beginning of March). • The first addition of fertilizers (high-phosphorous + urea) is applied three days after seedling. • The second addition of fertilizers (high-phosphorus+ urea) is applied a week after the first addition. • The first addition (balanced fertilizer + high phosphorus fertilizer + fertilizers + amino, organic acids + calcium) is applied when fruit setting.
	Early spring (greenhouse)	• Continuing the harvesting, control, and irrigation processes.
April	Early spring (tunnels)	• Start the process of harvesting. • Applying the second addition of balanced fertilizer with the first harvesting. • Applying the irrigation system every 2 days in addition to control and prevention procedures.
May	Early spring (tunnels)	• Continuing the harvesting, control, and irrigation processes.
June	Autumn (greenhouse)	• Clean the land by removing previous agricultural residues and weeds, and burning them. • Tilling the soil at a depth of 30-40 cm. • Performing two deep tillage operations perpendicularly at a depth of 20-25 cm to break up the soil clods. • Adding basic fertilization (organic and mineral), and conducting surface tillage for mixing compost with soil. • Smoothing the soil and preparing the beds. • Establishing irrigation networks. • Soil sterilization, it is recommended to use solar radiation sterilization.
July	Autumn (greenhouse)	• Planting seeds in the nursery to obtain seedlings for transplanting them to the greenhouse.

Month	Planting Periods/Growing Seasons	Agricultural Operations
August	Autumn (greenhouse)	• Remove sterilization nylon and ventilate the soil for 7-10 days. • Using the black mulch, which helps in fighting weeds.
	Winter (greenhouse)	• Clean the land by removing previous agricultural residues and weeds, and burning them. • Tilling the soil at a depth of 30-40 cm. • Performing two deep tillage operations perpendicularly at a depth of 20-25 cm to break up the soil clods. • Adding basic fertilization (organic and mineral) According to the specified amount, and conducting surface tillage for mixing compost with soil. • Smoothing the soil and preparing the beds. • Establishing irrigation networks. • Soil sterilization, it is recommended to use solar radiation sterilization.
September	Autumn (greenhouse)	• At the beginning of the month, the seedlings are transplanted to the greenhouse (the end of August, the beginning of September), or the seeds may be used for cultivation in the greenhouse directly. • The first addition of fertilizers (high-phosphorous + urea) is applied three days after seedling. • The second addition of fertilizers (high-phosphorus+ urea) is applied a week after the first addition. • The first addition (balanced fertilizer + high phosphorus fertilizer + fertilizers + amino, organic acids + calcium) is applied when fruit setting.
	Winter (greenhouse)	• Planting seeds in the nursery to obtain seedlings for transplanting them to the greenhouse.
October	Autumn (greenhouse)	• Start the process of harvesting. • Applying the second addition of balanced fertilizer with the first harvesting. • Applying the irrigation process per day or every two days in small quantities, and conducting preventive control.
	Winter (greenhouse)	• Remove sterilization nylon and ventilate the soil for 7-10 days. • Using the black mulch, which helps in fighting weeds.
November	Early spring (tunnels)	• Conducting a tillage operation and getting rid of the remains of the previous crop to reduce the spread of diseases.

Month	Planting Periods/Growing Seasons	Agricultural Operations
November	Early spring (greenhouse)	• Clean the land by removing previous agricultural residues and weeds, and burning them. • Tilling the soil at a depth of 30-40 cm. • Performing two deep tillage operations perpendicularly at a depth of 20-25 cm to break up the soil clods. • Adding basic fertilization (organic and mineral) According to the specified amount, and conducting surface tillage for mixing compost with soil. • Smoothing the soil and preparing the beds. • Establishing irrigation networks. • Soil sterilization, it is recommended to use solar radiation sterilization.
	Autumn (greenhouse)	• Continuing the harvesting process. • Continuing the control process and the irrigation system.
	Winter (greenhouse)	• At the beginning of the month, the seedlings are transplanted to the greenhouse (the end of October, the beginning of November), or the seeds may be used for cultivation in the greenhouse directly. • The first addition of fertilizers (high-phosphorous + urea) is applied three days after seedling. • The second addition of fertilizers (high-phosphorus+ urea) is applied a week after the first addition. • The first addition (balanced fertilizer + high phosphorus fertilizer + fertilizers + amino, organic acids + calcium) is applied when fruit setting.
December	Early spring (tunnels)	• Performing two deep tillage operations as well as adding fermented organic fertilizers and mixing them with the soil.
	Early spring (greenhouse)	• Remove sterilization nylon and ventilate the soil for 7-10 days. • Using the black mulch, which helps in fighting weeds.
	Winter (greenhouse)	• Start the process of harvesting. • Applying the second addition of balanced fertilizer with the first harvesting. • Applying the irrigation process per day or every two days in small quantities, and conducting preventive control.

Chapter 3:

Agricultural Pests and Diseases

Cucurbits and cucumber crops, in particular, suffer from economically damaging insect pests and insect-transmitted virus pathogens. This matter has a bad influence on the root system or shoot system, affects the productivity of the crop, and usually causes a large loss. Therefore, it is necessary to intervene to deal with these diseases; where it has been concentrated on applying the approach of Integrated Pest Management (IPM) programs which entail an interdisciplinary combination of chemical and biological measures to manage pest damage as well as mentioning the agricultural methods (in greenhouses and open fields), the mechanical control and the biological control.

As for agricultural methods of control: it means creating environmental conditions that are not suitable for the pest, either by making a disruption in its reproductive capacity, getting rid of its alternate hosts, creating appropriate conditions for its natural enemies to kill it, or creating conditions unfavorable for disease development. These are the methods that should be used:

- Tilling, exposing the land to the sunlight before planting, and getting rid of surrounding weeds (inside and outside greenhouses).
- Ensure that the seeds are free of all pathogens and that the seeds are treated with one of the recommended fungal disinfectants before planting.
- Cultivation of resistant varieties.
- Using well-fermented organic fertilizers.
- No planting should be done in lands infested with the spores of the pathogen, and no planting of a new crop alongside another infected one.
- Getting rid of any plant that shows symptoms of infection, especially in the case of viral and bacterial diseases.
- Using nets (with vents less than 0.35 mm in greenhouses) that effectively block the invasion of aphids, and reduce the incidence of viruses.
- Collect and burn plant residues.
- Sterilization of tools used in the field to avoid transmission of the disease infection.
- Using yellow sticky traps to reduce the number of harmful insects.
- Follow an appropriate agricultural cycle with no frequent cultivation of cucumbers in the same land.

- Avoid planting in waterlogged land, moderate in irrigation, and improve drainage to create conditions that help discourage pathogens and reduce diseases.
- Open greenhouses window for lateral ventilation.
- Moderation in nitrogen fertilization, and increase in phosphate and potassium fertilization.
- Not to damage the roots during hoeing and agricultural service operations.
- When resorting to chemical control, the following measures must be observed:
  - » Read the label thoroughly.
  - » Be familiar with all precautions.
  - » Be familiar with First Aid information.
  - » When using any pesticide, it is necessary to follow the instructions written on the containers by the competent engineer to determine the method of using, the appropriate amount of pesticide, and the safety period because it varies from company to company.
  - » The random use of pesticides kills many natural enemies, thus increasing the number of harmful insects and the spread of the infection.
  - » It is recommended to use preventive, curative, and systemic fungicides.
  - » It is recommended not to spray one pesticide more than twice in succession to avoid creating the resistance phenomenon in pathogens towards the pesticide.

1) Fungal Diseases

» Fungal diseases that affect the root system.

a. Damping Off:

It is a horticultural disease or condition, caused by several different pathogens that kill or weaken seeds or seedlings before or after they germinate, such as *Pythium* spp., *Rhizoctonia* spp.,

.Figures No. (3-1) Symptoms of Seedlings Wilt

Phytophthora spp. and *Fusarium* spp. It is considered a soil-borne fungal disease that affects seeds and new seedlings. Symptoms: Fungi may attack the roots of old plants; causing mold of their roots and leading to stunting and wilting of plants. Seeds may rot before germinating or seedlings may die before emergence, resulting in gaps and uneven stands. Young seedlings may develop rot at the crown; later, the tissue becomes soft and constricted and the plants wilt and fall over. This area turns a light yellow-brown color. Within two to three days a dry red-brown rot develops, which may lead to seedling death. Lesions begin as grey to reddish areas that almost immediately turn coal black. Moreover, the number of plants may decrease per unit area, and the yield may decline.

Protection and control methods:

1. Biological control: *Trichoderma* fungi can be used at 150 g / dunum.
2. Chemical control: One of the following fungicides can be used: Tolclofos-Methyl % 50 Wp (Wettable powder), Carbendazim, Hymexazol 360g / l, Thiram + Carboxy, Thiophanate Methyl % 70 Wp.

b. Fusarium Wilt:

The pathogen that causes Fusarium wilt is *Fusarium oxysporum f.sp. cucumerineum.*

Symptoms: The fungus can attack a susceptible plant at any stage of growth. Infection of young plants can result in pre- or post-emergence damping-off; However, infection of older plants is most common. Initially one or more runners wilt and later the entire plant wilts. In advanced stages, the roots begin to decompose, and the infection of older plants can cause yellowing (starting in the older leaves), stunting, or wilting, and once wilting occurs, which may lead to plant death. Then, white mycelial growth may be visible on the stem at the base of infected plants, especially in humid weather, it may extend to the branches and petioles of leaves. Also, other symptoms are reddish-brown discoloration of the xylem vessels which can be seen by longitudinal and cross-sections of the stem. Browning of the vascular system is usually evident in the lower stem, crown, or taproot.

Figures No. (3-2) Symptoms of Fusarium Wilt.

Protection and control methods:

Chemical control: One of the following fungicides can be used for either watering or spraying: Tolclofos-Methyl % 50 Wp (Wettable powder), Carbendazim, Hymexazol 360g / l, Thiram + Carboxy, Thiophanate Methyl % 70 Wp.

c. Verticillium Wilt:

It is caused by *Verticillium* ssp. (*verticillium dahlia*), and it is a fungal disease that lives in the soil. It invades susceptible plants through their roots and spreads through the plant's vascular system.

Symptoms: They may appear after or before the fruit set when the temperature rises, and they are manifested as the leaves wilt, curl, and become yellow A-shaped spots on margins. Then, the vascular tissues (xylem) of the stem show a brown discoloration which may sometimes be seen in a cross-section of the stem.

Figure (3-3) symptoms of verteslium wilt

Protection and control methods:

Chemical control: Control here is considered useless because this pathogen is somehow difficult to control, but it is advisable to apply the following pesticides: Carbendazim or Hymexazol, either for watering or spraying.

d. Gray Mold:

It is a fungal disease caused by *Botrytis cinereal.*

Symptoms: They appear as yellow-colored soft, sticky, mushy spots on leaves; spots may become covered with a coating of gray fungus spores. While, on the stalks, plant branches become infected as a result of the accumulation

Figure (3-4) Symptoms of Gray Mold

of water droplets that help the growth of gray fungi and then move to the stem. Thus, the plants begin to curl and wilt in the affected areas. As for the fruits, they are considered more susceptible to infection with this pathogen, as light gray mold appears on the crown of the fruit and extends towards its base until the whole fruit become infected with a prolific gray, fuzzy fungal growth.

Protection and control methods:

Chemical control: One of the following pesticides can be used: Cyprodinil% 50 Wg, or Cyprodinil% 37.5 + Fludioxanil% 25 Wg.

d. White Mold:

It is caused by *Sclerotinia sclerotiorum,* a fungus. It is caused by Sclerotinia sclerotiorum, a fungus. **Symptoms:** They occur primarily as a stem blight or fruit rot. Older vines are affected most often. After a white cottony mold develops, the stem dries and withers and small, black sclerotia appear in rotting tissues.

Figure (3-5) Symptoms of White Mold

Prevention and control methods:

Chemical control: One of the following pesticides can be used: Thiophanate Methyl % 70 WP (Wettable granules) or Carbendazim.

Table No. (3- 1) Chemical control of fungal diseases affecting the root system of cucumber crops

#		Name of the Disease	Name of the Pesticide	Method and Dosage of Use	Prohibition Period/Day
Root system diseases	1	Damping- Off	Tolclofos–Methyl 50% WP (wettable powder)	100-200 ml / 100 liters of water, watering after transplanting, or 3-5 g / 1 kg seeds, mixing before planting	7 days
			Thiophanate Methyl % 70 Wp	500-700 g / h, watering	1 day
			Hymexazol 30% SL	100-200 ml / 100 l, watering after transplanting	20 days
			Carboxin 375 g/ kg + Thiram 375 g/ kg	1-2 g / kg seeds, mixing before planting	/

#		Name of the Disease	Name of the Pesticide	Method and Dosage of Use	Prohibition Period/Day
	2	Fusarium Wilt	The same treatment and previous pesticides	=	=
	3	Verticillium Wilt	Thiophanate Methyl % 70 Wg	500-700 g / h, watering	1 day
	4	Gray Mold	Fenhexamid 500 g / l	100 ml / 100 liters of water, spraying	7 days
			Thiophanate Methyl % 70 Wg	50-100 g / l, spraying during the season	7 days
			Fludioxonil 37.5%	60 g / 100 liters of water, spraying	7 days
	5	White Mold	Thiophanate Methyl % 70 Wg	500-700 g / h, watering	1 day

» Fungal diseases that affect the shoot system.

a. Downy Mildew:

It is a fungal disease caused by *Pseudoperonospora cubensis* pathogen.

Symptoms: are shown in Table No. 2, 3.

Prottection and control methods:

It is preferable to collect the affected leaves before spraying one of the following pesticides: Mancozeb %80 wettable powder, (Metalaxyl+ Mancozeb 72%), (Famoxadone 22% + Simoxanil 30%), and Fosetyl-Aluminium 80%, (Azoxystrobin 25%).

Figure (3-6) symptoms of Downy Mildew

b. Powdery Mildew:

Powdery mildew disease is caused by the fungus *Erysiphe Cichoracearum.*

Symptoms: are shown in Table No. 3- 2.

Protection and control methods:

Using one of the following pesticides: Trifloxystrobin 50%, Triadimenol 250 g / l, Macron Sulfur 80%, and Azoxystrobin 25%.

Figure (3-7) Symptoms of Powdery Mildew

Comparison between Downy Mildew and Powdery Mildew.

Table No. (3- 2) A comparison between downy mildew and powdery mildew

	Downy Mildew	Powdery Mildew
Spores of Fungi	Spores of Fungi only appear on the underside of the leafs.	It appears on the upper and lower surface of the leafs.
Description	Yellow spots are between the veins of the leaf on the upper surface. In the lower surface, there are Hyphae of fungi (Hypha means the thread-like filaments formed by a germinating spore), and they do not grow on the veins at all.	It does not have a specific shape, and it affects the veins and the stem as well as it looks as if they have been dusted with flour.
Shape of Spores	Stalks are short, such as a tree whose leaves are fallen, they insert into the leaf by stomata, and have no absorbents.	It looks like tubes penetrate the plant epidermal cells.
Temperature	Low temperature	Moderate temperatures and above

c. Gummy Stem Blight:

Gummy stem blight is a common disease found worldwide in greenhouse cucumber. It is caused by the fungus *Didymella bryoniae*. Symptoms: Leaf symptoms are usually visible at the tips as pale yellow or brown dead tissue, often with a yellow halo, extending backward in a V-shape. Sometimes the entire margin is affected, creating a brown edge and downward cupping of the leaf. Lesions may also consist of circular spots on the leaves. The spots may also crack and exude a gummy amber-colored sap. Such lesions often occur at the base of the main stem, and if girdling by the lesions is complete, wilting and plant death. Also, fruits can be affected internally and externally. Internal fruit rot is not externally visible and is characterized by a tapering of the

blossom end and discolored centrally located tissues. The brownish-black internal discoloration often extends along the length of the fruit. External fruit lesions appear as irregular circular spots that are initially yellow, then grey to brown. These lesions are soft, wet, sunken, and often contain spots of gummy exudate on the stem. Eventually, it is noted that there are green sticky water spots on the fruits that may expand, and then the black spores appear.

Figure (3-8) Symptoms of gummy stem blight

Protection and Control Methods:

One of the following pesticides can be used: Chlorothalonil 50% Suspension Concentrate (SC), Copper chloride oxide, Copper Hydroxide, and Copper Sulfate.

d. Alternaria Leaf Blight:

Figure (3-9) Symptoms of Alternaria Leaf Blight

It is caused by the fungus *Alternaria cucumerina*. Symptoms: They first appear on the upper leaf surface as small, circular, tan spots with white centers. These spots enlarge, turn light brown, and form a slight depression. Small leaf veins within the spots darken, resulting in a netted appearance. Then, concentric rings develop that are visible only on the upper leaf surface, giving the spot a target-like appearance. These circular spots can eventually affect the entire leaf. Drying may occur, resulting in defoliation of leaves. Severely affected plants also are more susceptible to heat and wind damage. The small infected fruit develops circular, brown sunken lesions.

Protection and control methods:

One of the following pesticides can be used: Chlorothalonil, Copper Oxy-Chloride Compounds (85%), Famoxadone (22%) + Simoxanil (30%), and Pyraclostrobin + Metiram (60%).

e. Scab:

It is caused by the fungus *Cladosporium cucumerinum.*

Symptoms: Pale green, water-soaked areas on cucumber leaves are the first symptom of this fungal disease. At advanced stages, infected leaf areas often have an angular shape; they gradually turn from pale green to brown then to white. As the infection ages, the center of the leaf spot falls out, and leaves look ragged.

The disease also manifests as small, circular spots on the skin of fruits. These spots often lead to rot as the areas become infected with secondary diseases such as bacterial blight. Out of these areas, a viscous liquid is produced by the progression of the infection on the fruits. So, the affected areas turn black and have dark green spores that can be seen easily.

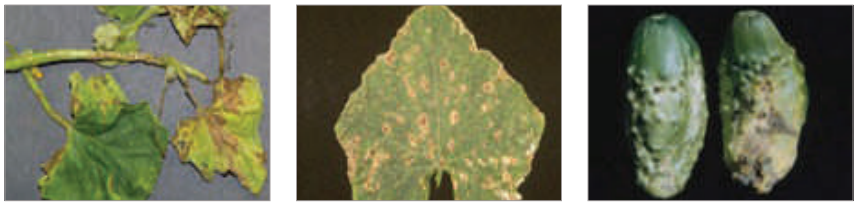


Figure (3-10) Symptoms of Scab

Protection and control methods:

One of the following pesticides can be used: Benomyl, Difenoconazole 250 g / l, and Tebuconazole.

f. Anthracnose:

It is caused by the fungus *Colletotrichum orbiculare*, is a destructive disease of cucurbits. Significant damage can occur to cucumber.

Symptoms: They begin to appear about a month after planting; where all aboveground plant parts can be infected. On mature leaves, small pale yellow, water-soaked areas emerge near veins and enlarge rapidly, turning tan to dark brown. The spots may coalesce, resulting in blighting, distortion, and death of entire leaves. The dry, dead centers of old lesions often crack and tear, giving a ragged appearance to the foliage. Young fruit may turn black and die if their pedicels are infected, while older fruit develops circular, noticeably sunken, dark-green to black lesions.

Figure (3-10) Symptoms of Anthracnose

Protection and Control Methods:

One of the following pesticides can be used: Copper Oxychloride 85% (equivalent to 500 g / kg metallic copper), or Copper Hydroxide 77%.

Table No. (3- 3) Chemical control of fungal diseases affecting the shoot system of cucumber crops

Name of the Disease		Name of the Pesticide	Method and Dosage of Use	Prohibition Period/Day
Shoot system diseases	Downy Mildew	Mancozeb 80% Wp (Wettable Powder)	2 kg / h, spraying over the shoot system	3 days
		Metalaxyl + Mancozeb 72%	100-150 g / 100 liters of water	20 day
		Famoxadone 22% + Cymoxanil 30.0 %	100-150 g / 100 l	15 days
		Fosetyl-Aluminium 80%	100-150 g / 100 liters of water	15 days
		Azoxystrobin 25%	100-150 ml / 100 liters of water	
	Powdery Mildew	Trifloxystrobin 50%	140-250 g / h	3 days
		Triadimenol 250 g / l	40-50 ml / 100 liters of water, spraying	28 days
		Macron Sulfur 80%	200-400 g / 100 liters of water, spraying	5 days
		Azoxystrobin 25%	70-80 ml / 100 liters of water	7 days
	Alternaria Leaf Blight	Copper Oxychloride 85% (Equivalent To 500 G / kg Metallic Copper)	3.5-5 kg / h, spraying	3 days
		Metiram 55% + Pyraclostrobin 5%	1.5 - 2 kg / h, spraying	7 days
		Keralaxil 40 G / kg + Mancozeb 650 g / kg	2.5 kg / h, spraying on leaves	14 days
		Fenamidone 75 g / l + Propamocarb Hydrochloride 375 g / l	2 liters / h, spraying	7 days
		Copper Hydroxide 77%	2-3 kg / h, spraying	3 days
		Copper Trio-Sulfate 345 g / liter	5 liters / h, spraying	3 days
	Gummy Stem Blight	The same previous treatments mentioned in Alternaria Blight		
	Scab	Benomyl 50 %	1.7 kg / h, spraying	7 – 10 يوم
		Chlorothalonil	2 g / l, spraying	10 يوم
	Anthracnose	Copper Oxychloride 85%	3.5-5 kg / h, spraying	3

2) Viral Diseases

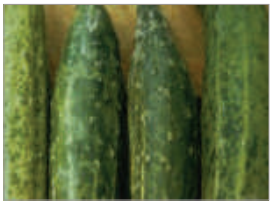
There is no cure for viral diseases and when they are spread in the field, the entire crop must be removed; however, there are preventive measures to avoid this disease. So that, the pathogens and vectors are controlled by using appropriate pesticides to combat the insects of aphids and whitefly and spraying the plants with horticultural oil (summer oil) that reduces the rate of infection.

a. Cucumber Mosaic Virus:

Cucumber mosaic virus (CMV) is a plant pathogenic virus in the family Bromoviridae.

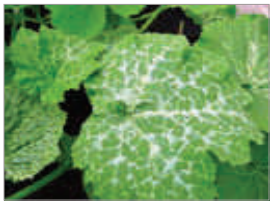
Symptoms: yellowish patches or green and yellow mottling appear on leaves. Plants are stunted due to a shortening of the internodes (lengths of stem between leaves). Infected leaves curl downwards and are distorted and reduced in size. Furthermore, spots of dead leaf tissue may become apparent on fruits. Cankers appear on the stems of plants, leaves, and fruits. In flowers, white streaks known as 'breaks' appear, in addition to a significant decrease in flowering and fruiting; where the fruits have a bitter taste.

Figure (3-11) Symptoms of mosaic virus



Symptoms of Mosaic Virus on Cucumbers

A light green mottling on leaves



Deformation of leaves

b. Cucumber Vein Yellowing Virus:

Cucumber vein yellowing virus (Ipomovirus) (CVYV) causes severe damages in cucumbers and other cucurbits. Symptoms: There will be a yellowing of the leaf veins, followed by a yellowing of the entire plant, stunting of the plant, and a

Figure (3-12) Symptoms of vein yellowing virus

decline in production. As the infection progresses, the plant will become dry, and then die. Moreover, light or dark green mottling will appear on fruits; thus, they may lose the marketing value.

3) Bacterial Diseases

a. Angular Leaf Spot

It is a bacterial disease, caused by *Pseudomonas syringae pv. Lachrymans.*

Symptoms: They appear on the shoot root; as small, angular, irregular round water-soaked spots appear on leaf tissue and expand until they are confined by veins, giving them the characteristic angular look. Under moist conditions, a milky white exudate containing bacterial cells may ooze out of the lesion on the lower leaf surface. These wet-looking spots will dry out and turn yellow-brown or the dead tissue may fall out leaving a "shot-hole" appearance. On the affected fruits, circular water spots appear, and bacterial secretions emerge from these spots. As a result, the internal parts of the fruit rot, and the infection of the young fruits may lead to deformation when ripening.

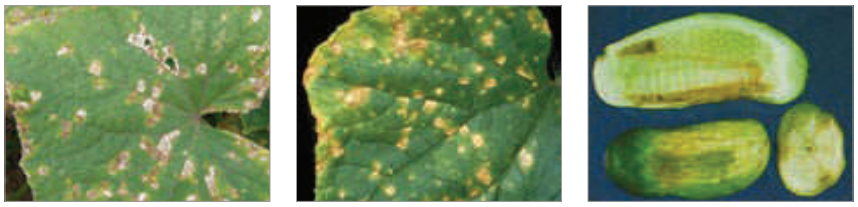


Figure (3-12) Symptoms of vein yellowing virus

Protection and control methods:

To reduce infection, one of the following pesticides can be used: Copper Hydroxide, Fosetyl-Al % 80 Wp; in addition to the control of insects that transmit infection and increase the spread of the disease by using appropriate insecticides.

b. Bacterial Wilt:

Cucumber bacterial wilt is caused by the bacterium, *Erwinia tracheiphila.*

Symptoms: One sign of bacterial wilt is the plants wilting even when they've been well watered. As the leaves wilt and shrivel, stems may dry out suddenly. Later, wilting spreads to entire branches and vines. Eventually, however, the entire vine will wither, collapse, and die. In partially

resistant plants, symptoms appear as dwarfing, excessive blooms, and branching. A good diagnostic test for this wilt is to cut a badly wilted stem just above soil level and squeezing it. If a sticky, oozy substance comes out, it's bacterial wilt. This slimy substance clogs the plant's circulatory system, so it can't take in the water it needs.

Figure (3-14) Symptoms of Bacterial Wilt

Leaf Wil

A sticky substance / cross section at the stem

The bacteria overwinter in the gut of striped and spotted cucumber beetles. Not all beetles carry the bacteria. Beetles that feed on infected plants pick up the bacteria. They then move to new plants, creating wounds through feeding. The bacteria are on the mouthparts or in the fecal matter of the beetle and enter the plant through the feeding wounds. The bacteria multiply rapidly within the plant and plug the vascular tissue, resulting in wilting of the vines.

Protection and control methods:

Chemical treatments are useless and ineffective in the event of an infection. However, the disease can be combated by controlling vectors of this disease, such as insects that transmit the disease; the most important of which are beetle cucumbers. As well, while the controlling process, sterilization of the tools used in agriculture is a very essential matter.

4) Insect Pest:

a. Whitefly:

The Whitefly is called *Bemisia tabaci* (Homoptera: Aleyrodidae). It (Trialeurodes vaporariorum) is a sap-sucking insect that is often found in thick crowds on the undersides of leaves.

Life Cycle:

In the adult stage, the adult insects overwinter under plant residues or tree bark

Harmful Stage: Nymph and Adult

Symptoms: Whiteflies suck plant sap and, in turn, produce a sticky substance known as

Figure (3-15) White Fly Insect

Laying eggs directly on the undersides of plant leaves

Adult Insect

honeydew. The secretion of this honeydew left on its own can cause fungal diseases to form on leaves such as black fungus of the genus "Aspergillus", which causes Sooty Mould.

Due to whitefly feeding, plants will quickly become extremely weak and may be unable to carry out photosynthesis. Leaves will wilt, turn pale or yellow, and growth will be stunted.

Then the leaves of the plant are covered with soil, which leads to the weakening of the plant due to the failure of the leaves to perform photosynthesis. Nevertheless, indirect damage is the transmission of viral diseases, such as the Cucumber Vein Yellowing Virus.

Figure (3-16) Symptoms of White Fly

Whitefly

Black fungus (Sooty (Mould

Protection and control methods:

1. Biological control: It is used by some parasitic enemies such as the parasitic insect: Eretmocerus mundus and Encarsia formosa. Many fungi parasitize whitefly Nymphs (Verticillium lecanii, Paecilomyces farinosus, P. fomosoroseus). (CABI 2017)

Figure No. (3-17) Biological Control of the White Fly

Eretmocerus mundus

Encarsia formosa

2. Chemical control: one of the following pesticides can be used: Acetamide 20%, Malathion 650 g / l Emulsion Concentrate (EC), imidacloprid 350 g / l, Deltamethrin 2.5%.

a. Thrips:

The Thrips is called *Thrips tabaci.*

Life Cycle:

In the adult stage, the adult insects overwinter under plant residues in soil.

Harmful Stage: Nymph and Adult

Symptoms: Thrips insect appears on the lower leaves, flowers, and young succulent fruits. Thrips damage includes streaks, silvery speckling, and

Figure (3-18) Thrips Insect

Nymph

Adult Insect

small white patches. This happens because the thrips suck plant cells from fruits.

As the infection progresses, the leaves turn white and dry and the seedlings die, forcing the farmer to patch up and this means delaying the planting date. Also, this causes distorted parts of the plant or black specks, which are the feces from the thrips.

Leaves and fruits of the cucumber become infected with thrips insect and cause many spots that become brown and then dry, which leads to deformation of fruits and lowering their marketing value.

Figure (3-19) Symptoms of Thrips

Symptoms of infection on the upper leaves

Symptoms of infection on the lower leaves

Fruit Infection

Protection and control methods:

1. Biological control: by raising and using several predators such as Orius spp, Amblyseius cucumeris, and Surphus corollei.
2. Chemical control: one of the following pesticides can be used: Acetamide 20%, Malathion 650 g / l Emulsion Concentrate (EC), imidacloprid 350 g / l, Deltamethrin 2.5%.

Figure No. (3-20) Biological Control of Thrips

Orius spp

Surphus

b. Aphids:

They are called *Aphis gossypii* and Myzus persicae, they are tiny insects with long, slender mouthparts used to pierce stems and leaves of plants to suck out the plant's fluids. They often appear on the undersides of leaves and rarely on the upper-sides.

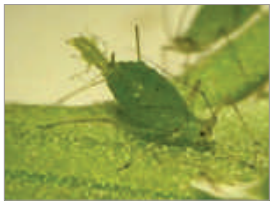


Figure No. (3-21) Aphids

Life Cycle:

The insects overwinter as eggs in the pupal stage.

Harmful Stage: Nymph and Adult


Figure No. (3-22) Symptoms of Aphids

Symptoms: Aphids can form colonies where they feed on the underside of leaves and young seedlings; thus, they absorb fluids from tissues. As the leaves become yellow, they dry and shrivel, and eventually may drop out. Aphids suck plant sap and, in turn, produce a sticky substance known as honeydew. The secretion of this honeydew left on its own.

can cause fungal diseases to form on leaves such as black fungus of the genus “Aspergillus”, which causes Sooty Mould. Moreover, they produce saliva that is toxic to the plant. This toxic saliva causes chlorophyll to be destroyed. The indirect harm is the transmission of serious viral diseases such as the Cucumber Mosaic Virus.

Protection and control methods:

1. Biological control: There are many natural enemies of aphids (predators: Coccinella septempunctata, Chrysopidae, some types of wasps, and parasitic insects such as: (Aphidius Coleman, Powell and Pell 2017), and there are many entomopathogenic fungi such as (Beauveria bassiana *Lecanicillium* spp.).

Figure No. (3-23) Biological Control of Aphids


Feeds on Aphids


The Seven-Spot Ladybird


Aphidius Colemani


Aphids Lion

2. Biological insecticides: Plant extracts can be used such as garlic (*Allium sativa* L.), neem (*Azadirachta indica* A. Juss.), red chili (*Capsicum annum L.*), pyrethrum flowers (*Chrysanthemum sp.*), either singly or in mixtures provide some aphid control, especially at an early stage of infestation.
3. Chemical control: It is not preferable to spray the field as a whole. One of the following pesticides can be used: Acetamide 20%, Malathion 650 g / l Emulsion Concentrate (EC), imidacloprid 350 g / l, Deltamethrin 2.5%.

c. Leaf Miner:

The leaf miners are called *Liriomyza bryoniae* and *L. Trifolii* (Diptera).

Life Cycle:

The insects overwinter as pupae in the soil at a depth of (3 - 6) cm.

Harmful Stage: Larvae

Figure No. (3-24) Symptoms of Aphids

Adult Insect

Larvae

Symptoms

Symptoms: The females cause damage to the leaves of the plants while laying their eggs under the upper skin of the leaf, as other holes in the leaves occur by the egg-laying machine for feeding by absorbing the contents of the mesophyll. While the males do not cause any damage, and the larvae make yellow squiggly lines and create winding tunnels between the two skin of the leaf. The tunnel gradually widens as the larva grows.

Protection and control methods:

1. Biological control: There are several parasites, including Dacnusa sibirica and Diglyphus isaea. These parasites may help in controlling during the infection with this pest.

Figure No. (3-25) Biological Control of Leaf Miner

Dacnusa sibirica

Diglyphus isaea

2. Chemical control: It should not use an excess of pesticides in order not to eliminate these beneficial insects and disturb the vital balance.

   Furthermore, systemic insecticides and non-abrasive pesticides are used: Cyromazine 75% (Wettable powder), Abamectin (Emulsion), Carbosulfan (Emulsion).

d. Cut worm

It is called *Agrotis* ipsilon. They are the larvae (in caterpillar form) of night-flying moths.

Life Cycle:

Harmful Stage: Larvae

Symptoms: The insect infects cucumbers in all growing season; cutworms chew through plant stems at the base. They primarily feed on roots and foliage

Figure No. (3-26) Cut worm

Larvae

caterpillar

of young plants, and will even cut off the plant from underneath the soil. In most cases, entire plants will be destroyed; they do a lot of damage in no time at all. Even if only the bottom of the plant is destroyed, the top will often shrivel and die. Besides, a single larva can chew more than one plant, and more larvae can be seen under the plant.

Newly hatched larvae feed on leaves, while older larvae lose the ability to climb the plant so they only appear near or on the surface of the soil. So that the older larvae chew the stems of young succulent plants at the surface of the soil, which leads to the fall of plants as a result of chewing. As well, the larva can cut down several plants at a single night, and the infection appears in the form of holes suddenly, noting that there will be black caterpillars twisting around themselves; where the parts of the mouth touching the end of the abdomen.

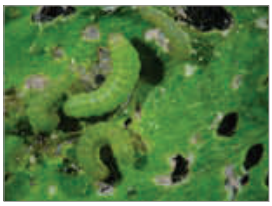


Figure No. (3-27) Symptoms of Cut worm

Protection and control methods:

Toxic baits are prepared as a mix of bran, molasses, water, and insecticide should be applied at the base of plants at dusk (CIP 1996; Larrain et al. 2003). One of the following insecticides may also be used: Deltamethrin 2.5%, Thiamethoxam 25%, and Indoxacarb 15%.

e. Cucumber Beetles

The scientific name of the insect: there are three types of beetles; Western striped cucumber beetle; scientific name: *Acalymma vittata*

Spotted cucumber beetle; scientific name: *Diabrotica undecimpunctata*

Red pumpkin beetle; scientific name: *Foveicollis LucasRhaphidopalpaa*

Life Cycle:

In the adult stage, adults overwinter in protected locations.

Harmful Stage: Larva and Adult

Symptoms: Most parts of the plant can be affected, including girdled stems and munched leaves. However, the worst damage is not from the insects themselves because the most serious damage comes from bacterial wilt. The bacteria are secreted in the beetle›s stomach and are spread to the plant by the beetle chewing on it, and then they spread to the plant›s vascular system and cause the leaves to wilt.

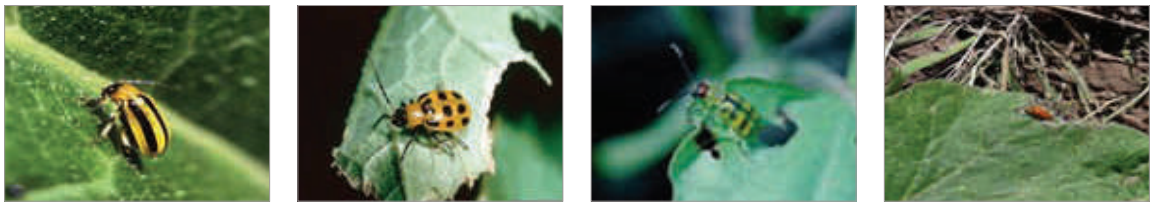


Figure No. (3-28) Symptoms of Cucumber Beetles

Protection and control methods:

One of the following insecticides can be used: Carbaryl, Chlorpefos, and Deltamethrin.

Table No. (3- 4) Chemical Control of Cucumber Crop Insects

	Name of the Pathogen	Name of the Pesticide	Method and Dosage of Use	Prohibition Period
1	Whitefly	Acetamiprid 20% SP	25 g / 100 liters of water, spraying on the shoot system	7 days
		Thiamethoxam 25% WG	30 g / 100 liters of water, spraying on the shoot system	6 days
		Imidacloprid 70% WG	30 g / 100 liters of water, spraying on the shoot system	8 days
		Deltamethrin 2.5% Emulsion Concentrate	75-125 ml / 100 liters of water, spraying	3 days
2	Thrips	Thiamethoxam 15%	100-125 ml / 100 liters of water, spraying	6 days
		Thiocyclam 50%	50-100 g / 100 liters of water	6 days

	Name of the Patho-gen	Name of the Pesticide	Method and Dosage of Use	Prohibition Period
3	Aphids	The same plan for controlling the whitefly insect		
4	Leaf Miner	Abamctin (Emulsion)	50 - 100 ml / 100 liters of water, spraying	7 days
		Cyromizine 75% WP	15 g / 100 liters of water, spraying on the shoot system	3 days
		Imidacloprid 20 %	350-500 g / 100 liters of water	8 days
5	Cutworm	Deltamethrin 2.5% Emulsion Con-centrate	75-125 ml / 100 liters of water, spraying	3 days
		Chlorpyrifos 48%	Poisonous bait or 2 liters / h, watering	15 days
		Emamectin benzoate 5.7 %	50 - 100 g / 100 liters of water	7 days
		Lambda – Cyhalothrin 25%	Poisonous bait or 2 liters / h, watering	15 days
		Diazinon 60%	Poisonous bait or 2 liters / h, watering	15 days
6	Cucumber Beetles	Deltamethrin 2.5% (Emulsion Concentrate)	75-125 ml / 100 liters of water, spraying	3 days
		Chlorpyrifos 48%	2 liters / h, watering or spraying	15 days

5) Non-insect animal pests:

Among these pests are mites, spiders, nematodes, snails, rodents, and birds, as these pests infect all parts of the plant, including some pests that feed on fruits, the matter which reduces the final yield of farms. Here, the most important of these pests, which are spiders, mites, and nematodes.

a. Spiders (Red Mite):

The pathogen is *Terranychus cinnabarinus.*

Description and families: All arthropods possess an exoskeleton, bi-lateral symmetry, jointed appendages, segmented bodies, and specialized appendages. The major arthropod classes can

be separated by comparing their number of body regions, legs, and antennae. Spiders are small animals (0.4- 0.45) mm for nymphs, which have three pairs of legs. Adult animals have four pairs of legs, and they have no antennae; however, the body is not divided into a head, thorax, and abdomen. The red spider feeds on a large number of trees, crops, and vegetables.

Figure No. (3-29) Symptoms of Red Spider


Bronze Color


Spider Webs


Red spider shape

Life Cycle:

The female spiders overwinter under the tree bark or between the leaves in the soil.

Symptoms: Leaves and fruits are brick-red to yellow, the infection can be noted by the presence of silk webs/ threads on the lower surface of the leaves with dust; Where the red spider appear to feed on leaves by absorbing the plant sap. So that, the affected leaves may have collapsed, pale patches; and then, with the progress of the infection, the spots/patches increase and turn into light brown until the whole leaf becomes dry.

Silk threads produced by the spider appear on the underside of the leaf, where the dust and the residue of the spider then cause a dirty leaf. Moreover, the red spider makes threads to move from one leaf to another.

Protection and control methods:

1. Biological control: it addresses this pest with a predatory mite of the genus *Phytoseiulus macropilis* which is a small microscopic animal and characterized by the presence of two brown spots on the dorsal surface.
2. Chemical control: Although spiders can withstand some pesticides and form an immunity by the repeated use of pesticides, there are many special pesticides applied for spiders, the most important are: Spiromesifen 240 G / L Sc (Bizantion), Etoxazole 110 G / L Sc, and Avermectin.


Phytoseiulus macropilis
Figure No. (3-30) Biological Control of the Red Spider

b. Root-Knot Nematode: The pathogen is *Meloidogyne* spp.

Symptoms: Symptoms of nematode infestation of roots generally involve canker, root rot, and excessive branching. Also, they involve the emergence of abnormal swelling; called a gall or knot in the places of nematode feeding (root-knot), as well as stunting, premature wilting, and leaf chlorosis (yellowing) especially in the middle of the day. The symptoms of infection also appear on the upper parts of the plant such as stunting. One of the most important of these fungi (Verticillium, Phytophthora, Pythium, and Fusarium).

Figure No. (3 -31) Symptoms of Root-Knot Nematode

Protection and control methods:

1. Chemical control: One of the following pesticides can be applied, taking into account the PH of each pesticide: Oxamil. SCA 24%, or Fenamiphos.

Table No. (3- 5) Chemical Control of Spiders and Nematodes - Cucumber Crop

Name of the Pathogen	Name of the Pesticide	Method and Dosage of Use	Prohibition Period
Spiders (Red Mite)	Abamctin 1.8%	50 - 100 ml / 100 liters of water, spraying	7 days
	Hexythiazox 10% (EC)	50 ml / 100 liters of water, spraying	7 days
	Propargite 57%+ cypermethrin 13%	75- 125 ml / 100 l water	7 days
	Microbial Sulfur	250 g / 100 liters of water, spraying	3 days
	Spraying by mineral oils	1 liter / 100 liters of water	=
Root-Knot Nematode	Oxamyl 24%	250 ml / 100 liters of water, spraying or 1 liter/dunum, watering with irrigation water	14 days
	Imecafus 30% (SL)	1 liter/dunum, watering with irrigation water	10 days
	Fenamephos 40%	1 liter/dunum, watering with irrigation water	10 days

6) Physiological Diseases:

a. Fruit Set Failure Phenomenon

It is known as the low percentage of the fruiting set in cucumbers and occurs in greenhouses and open fields. It is divided into:

Figure No. (3-32) Fruit Set Failure Phenomenon

- Natural Fruit Set Failure: It occurs in January and February; where this type of failure/drop appears after the plant has spent a period of active growth, and after that as a result of lower temperatures and slow growth, there will be no sufficient vegetative growth to supply the plant with its needs, which results in fruit drop/fruit failure.
- Non-natural Fruit Set Failure:

1. Failure may occur as a result of pathological injuries to the fruits or molds of the fruits, such as Rhizoctonia and Botrytis.
2. Lack of proper ventilation of the greenhouse.
3. Lack of balance between vegetative growth and fruiting growth because of the deficiency in pruning, which leads to incomplete growth of fruit and formation of seedless fruits (lack of early fruit setting).
4. Increased nitrogen fertilization or increased irrigation leads to increased vegetative growth and less oxygenation, which is responsible for the fruit set.
5. Lack of lighting also leads to a higher level of fruit failure (lack of early fruit setting) due to lack of oxygenation.
6. The high temperature during the day leads to a rapid vegetative growth; where the stem becomes thin and thus the failure and drop of the fruits formed on the vegetative system will increase.
7. Relative humidity, especially in April and May; where the humidity increases more than 78%. That is because the high relative humidity makes the leaf stomata closed, and this can lead to a decrease in water transpiration. Consequently, the stream of water transported to the elements decreases, so as a result of that, any nutritious substance cannot reach to the fruits.

8. Nematode infection and zinc deficiency can also lead to this phenomenon.

Treatment is done as follows:

- » Harvest infected fruits and dispose of them by burning.
- » Moderation in nitrogen fertilization or not adding nitrates excessively.
- » Early harvesting of the crop in order not to delay the formation of the new fruits.
- » Spraying with one of the following pesticides provided that spraying should be repeated after 7- 10 days: Topsin 1 per thousand Yubarin at 2.5 per thousand.
- » Choose varieties that have an early fruit setting in the greenhouse.
- » Increasing potassium fertilization.
- » Moderation in irrigation.
- » Eliminate weeds.
- » Achieve proper ventilation in greenhouses.

b. Deformation of Fruits:

Crooked fruits:

This may happen because of the thirsty plants: the lack of irrigation leads to the crooked, small-sized fruits. Furthermore, the low night temperature leads to a decrease in the speed of fruit growth; and thus, the fruit becomes shorter and the color of the fruit becomes darker. Besides, some of the sucking insects, such as thrips, that feed on one small side of the fruit may cause pale fruits or crooked fruit.

Figure No. (3-33) Deformation of Fruits

Comma shaped fruit:

This may be due to a lack of nitrogen or a lack of lighting, as a lack of nitrogen leads to poor quality of the fruits. Symptoms of nitrogen deficiency appear on the cucumber fruit as the color of the fruit becomes pale, the size of the fruit decreases, and the length of the fruit becomes shorter.

Figure No. (3-34) Crooked fruits and Comma shaped fruits

In respect of this, a severe deficiency of nitrogen can lead to:

some non-thorny bumps appear on the fruits, the fruits are distorted, the cucumber fruit has a narrow, tapered blossom end, the color of the fruit turns pale yellow near the apical end, and the fruits may be crooked or comma shaped, which is called Comma shaped fruit.

Symptoms: The rate of growth is slow in addition to the poor growth or stunting of plants and the small size of young leaves. Also, the flowers appear to be larger, the lower leaves pallor is discolored in pale green or yellowish color, and the growth of the branches may become limited as the stems grow thin and solid.

Club Shape:

Fruits are club shaped due to a lack of potassium:

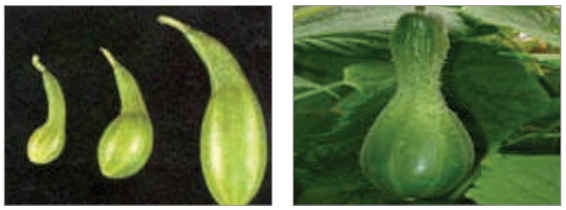


Figure No. (3-35) Club Shape

Symptoms: The plants grow stunted and the internodes become short, the leaves become wilted due to a lack of potassium that leads to non-swelling of cells. Also, there is yellowing on the lower (older) leaves' edges; the leaves first turn yellow at the tip and then the entire leaf eventually turning yellow (newly emerged leaves are a normal green). Fruits are club shaped, where the fruit is tapered at the stalk and is swollen at the base. Also, the fruits are not crooked, due to the lack of potassium.

7) Mineral Nutrition Stress

A deficiency of mineral elements will be addressed in this research.

» 1.7. Deficiency of Mineral Elements:

First: Deficiency of Plant Macronutrients:

Macronutrients; nutrients that plants require in larger amounts. About half of the essential elements are considered macronutrients: carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. As the plant gets carbon and oxygen from the air and hydrogen from the water while the soil supplies the plant with other elements.

1. Nitrogen:

A Nitrogen deficiency can be recognized by yellow leaves. This is because chlorophyll disappears from the leaves. This happens in the older leaves at the bottom of the plant. This happens because plants transport the available nitrogen to their young leaves and growing points. Eventually, the growth of plants will stop as a result, and leaves will fall off. Leaves become straight and hardened; as well, have short petioles and visible veins. They have a pale green color at the early stages, and yellow or even red colors may appear as the growth stages progress. The low percentage of plants flowering: the insufficiency of nitrogen leads to the stunting of the plant, and ultimately death. Treatment of nitrogen deficiency: it is carried out with nitrogen fertilization (Urea 46%, Ammonium nitrate 33.5% - Ammonium nitrate 30%).

2. Potassium:

Symptoms of Potassium deficiency include brown scorching and curling of leaf tips as well as chlorosis (yellowing) between leaf veins. Purple spots may also appear on the leaf undersides. Plant growth, root development, and seed and fruit development are usually reduced in potassium-deficient plants. In the severe deficiency, the leaves die, especially in the middle of the branches. Potassium deficiency is treated with the available fertilizers in the form of potassium sulfate.

3. Magnesium:

Symptoms of Magnesium deficiency begin to appear on the lower old leaves in the form of yellowing or redness. Also, there will be mixed areas of pale or dark green colors, the Chlorophyll breakdown, and the disappearance of green color between the veins. These symptoms appear in acidic and sandy soils and treated with adding fertilizers: Dolomite, Lime, Magnesium Sulfate, and Magnesium Nitrate.

4. Phosphorus:

A Phosphorus deficiency can be seen in the older leaves at the bottom of the plant; where

the leaves are small, narrow, and elongated and turn bluish-green or cochineal. Leaves remain small, but new leaves appear in a purple or red color due to the accumulation of anthocyanin; besides, the veins of the lower leaves and the leaf stalk petioles show a purple color. In the severe deficiency, the formation of fruiting buds decreases, and the older leaves are mottled with light yellow and dark green colors; these leaves fall off quickly.

Treatment of phosphorous deficiency: It can be treated with available phosphate fertilizers in the form of superphosphate 46%.

5. Calcium:

Symptoms of Calcium deficiency include drying of the growing tips of the branches and roots, emerging of dead spots on the leaves, and drying of the newly developed leaves. On the fruits, dead spots appear, and «Bitter Bit» forms. roots are short and twisted and most of the roots die from the top.

Treatment of calcium deficiency is carried out by adding calcium carbonate, as it is done indirectly when using superphosphate.

6. Sulfur:

Symptoms of Sulfur deficiency: leaves retain pale yellow color, branches become dry in the fruit trees, stalks are to be shorter in severe deficiency, and redness appears on the lower leaves and the veins. Sulfur deficiency can be treated with the addition of ammonium sulfate or calcium sulfate. It is also done indirectly using superphosphate or potash sulfate.

Second: Deficiency of Plant Micronutrient:

Micronutrients are just as important as macronutrients, but the amount required is very small. The elements are Boron, Iron, Copper, Zinc, Manganese, Molybdenum, Chlorine, Nickel, and Cobalt. The symptoms of deficiency of the main elements will be addressed:

1. Iron:

Symptoms of Iron deficiency: The primary symptom of iron deficiency is interveinal chlorosis, the development of a yellow leaf with a network of dark green or red veins. Also, symptoms appear in calcareous soils or alkaline soils. In severe cases, the entire leaf turns yellow or white and the outer edges may scorch and turn brown as the plant cells die; which leads to poor or no production. Deficiency is treated by adding iron chelators to the soil that are sold under different brand names.

2. Boron:

Symptoms of Boron deficiency: Meristematic tissues exhibit a stunted appearance in the growing tips of the branches, the lateral branches appear as a rosette, the thickness of the young leaves is increased, and there is a speed in breaking the leaves as well as fewer nodes.

Deficiency is treated using fertilizers of micronutrients, of which boron is an element.

3. Zinc:

Symptoms of Zinc deficiency: On new leaves, a yellowing appears between the veins and turn pale green and white. Also, the new leaves are short, small, and elongated, and the intervals (internodes) on the stem between the nodes are short.

Deficiency is treated with a spraying of zinc sulfate in the event of a slight injury. In cases of severe infection, zinc chelators are used.

4. Copper:

Symptoms of Copper deficiency: include falling of leaves, shortened internodes, white spots on the fruits, and delayed growth. Deficiency is treated with spraying copper sulfate or any of the copper compounds.

5. Manganese:

Symptoms of Manganese deficiency, which often look like those of iron deficiency, appear as interveinal chlorosis (yellow leaves with green veins) on the young leaves, and sometimes tan, sunken spots that appear in the chlorotic areas between the veins. Plant growth may also be reduced and stunted. In cases of severe deficiency, the flowers and leaves may fall. Deficiency is treated with spraying manganese sulfate.

8) Weed Control

Narrow-leaved Weeds: Seraria Spp, Sorghum halepens, Cyperus Spp, and Cynodon dactylen.

Broad-leaved Weeds: Amaranthus Spp, Portulaca oleracea, Cenvolvulus althaeaides, solanium nigrum, Datura stramonium, and Xanthium strumarium.

Parasitic weeds: Orobanche ramos and Cuscuta.

Figure No. (3-36) of some broad-leaved summer weeds

Datura stramonium

Amaranthus Spp

Xanthium strumarium

Figure No. (3-37) of some narrow-leaved summer weeds

Cyperus Spp

Sorghum halepensa

Cynodon dactylen

Protection and control methods:

At the beginning of the chapter, the aforementioned agricultural methods must be followed to avoid the spread of these weeds. As for chemical control, narrow-leaved weeds can be controlled

by using several pesticides that we will mention in a special table. Nevertheless, it is difficult to control broad-leaved weeds because the cucumber crop is broad-leaved, but we can carry out pre-cultivation control using Trifluralin substance. Concerning fighting parasitic weeds, they cannot be chemically controlled, but we must focus on agricultural methods to prevent their spread, and if they spread, they must be dealt with by hoeing and manual collection.

Table No. (3 -6) Chemical Control of Weeds

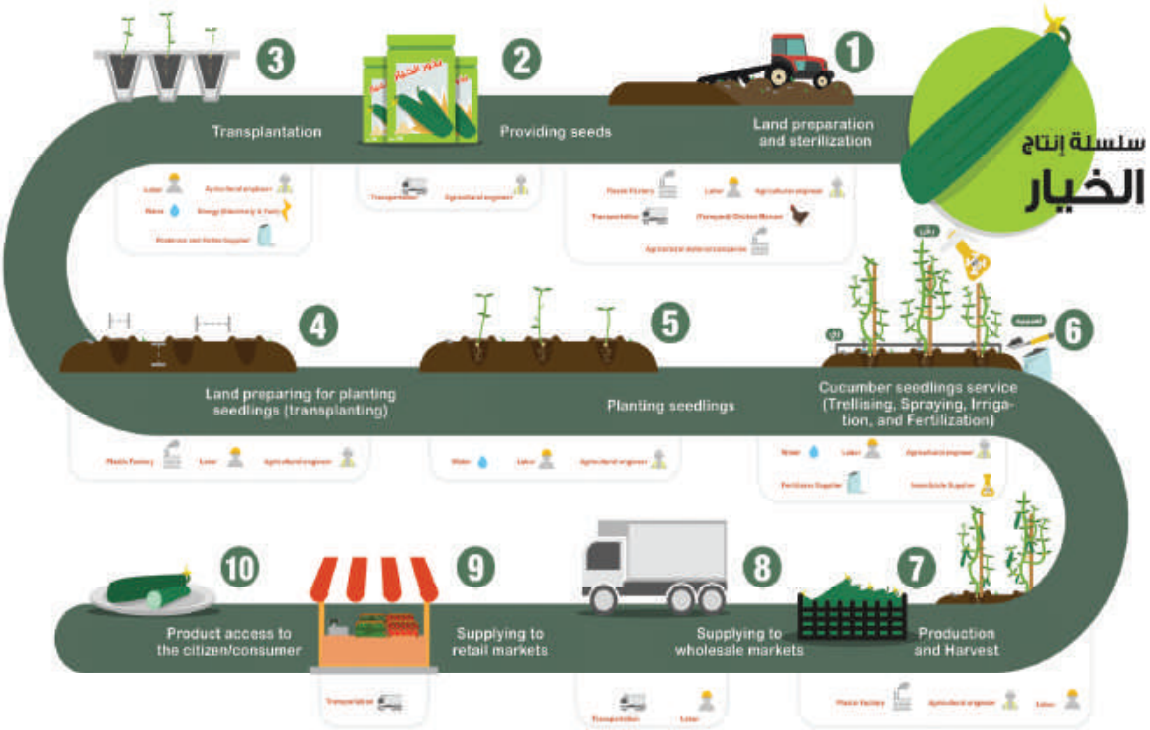
Name of the Pesticide	Type of the Weed	Use Stage	Dosage
Quizalofop-P-Methyl 5%	Narrow-leaved, annual	At the stage of 3 true leaves	0.5-1 l / h
	Narrow-leaved, perennial	At the stage of 3-4 true leaves	2 l / h
Haloxyfop-R-methyl 108 g/l	Narrow-leaved, annual	At the stage of 3 true leaves	1 l / h
	Narrow-leaved, perennial	The weed is 15-20 cm long	2.5 liters / h
Trifluralin 480 g/l	To eliminate broad-leaved weeds and narrow-leaved weeds seeds in the soil before planting	Before planting, mix the pesticide with the soil while preparing the ground for planting	2 l / h / 1000 liters of water

Chapter 4:

Value Chain

Value Chain:

The food supply chain is a complex network based on analyzing the definition and characteristics of the agricultural supply chain. It includes producers, consumers, agricultural input merchants, processing, storage, transportation, and marketing, etc. while the term “value chain” in this guide, we mean a complete set of goods, and services necessary to transport the agricultural product from the farm to the final client or the consumer. The following figure shows the cucumber crop supply chain.



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Harvest:

Cucumber is one of the plants that grow very quickly, so the process of harvesting should be conducted per day, and it is advised to check the plant after the emergence of the fruits; if the farmer notices any yellowing at the end of the cucumber, this will be as an indicator that the cucumber is overripe, and thus it requires immediate harvest. Because the harvest is daily, it must also stop the chemical control before the harvest, taking into account the safety period for the used pesticides.

The most important signs of maturity/ripening and reaching the crop to the harvest stage:

- The right size of the fruit; where the harvest process depends on the demands of the consumer, some prefer smaller fruits, while others prefer larger fruits.
- The age of the fruit; where the cucumber fruits are deemed to be completed according to the purpose of harvesting. If the product will be used in manufacturing (pickling) treatments, the period is determined between 4 -5 days; however, if it will be used for fresh consumption, it is 15- 18 days.

The size and color of the fruit are affected by the variety and the prevailing temperature, that is, when the size of the fruits reaches the maximum limit (8- 15 cm), and the internal seeds grow in the fruits, they become either hard or surrounded by a gelatinous substance. As for the effect of temperature, the yield of cucumbers is characterized by its intolerance to hypothermia for a long time. If the temperature drops below 11 °C, this leads to delayed germination of seeds and mostly stops their growth.

- The color of the fruit; The fruit has a glossy outer shell and dark green color.
- The hardness of the fruit; The fruits become soft when they get older, and the viability of the fruits for harvesting can be determined by their degree of softness.

Harvest date:

The harvesting of cucumbers begins 45-60 days after the date of planting the seeds, and the harvesting time depends on the variety and the prevailing temperatures during the growing season. Moreover, the date of harvest is determined based on the size of the fruits, and the marketing purpose of the crop. The harvest is usually done every two or three days at the beginning of the season; then it becomes daily. The period of harvest lasts 5- 7 days in cold weather as well as the harvest may last for one and a half to two and a half months depending on the variety and prevailing weather conditions.

Cucumbers are grown in greenhouses in three planting periods due to the appropriate temperature provided, as greenhouses produce cucumbers from September to May. while in the open fields, the crop is available during the summer period from March to September because it is cultivated during four periods in open fields and tunnels. Thus, the crop of cucumbers will be available throughout the year.

Harvest Methods:

Cucumbers must be harvested in the evening so that the wounds can heal and have less disease and pests, but in the case of growing cucumbers in greenhouses, they are less exposed to diseases at the time of harvest. Also, in the summer period, the harvesting process is done with hand per day (in the protected agriculture) (Muhammad Al-Tamazini, 2008). They are harvested by pulling or twisting the fruit pedicel; and then, they are wrapped in plastic baskets and transferred to the place of sorting, grading, and packing. During the harvesting process, the following rules must be observed:

- Raise awareness of workers on personal hygiene such as hand washing, fingernails clipping, and no eating and or smoking during working.

- Despite environmental campaigns against plastic field boxes (usually made of polyethylene boxes), and the demand to use wooden pallet bins; manufactured plastic crates are still used due to the current circumstances of the high prices of wooden boxes, the lack of manufactured factories, the difficulty of the transportation process during the use, and the moisture provided by plastic boxes for fruits.
- The fruits should be carefully picked or harvested; without being pressed.
- Pickers must wear soft cotton gloves to avoid injuring the fruit surface during harvest.
- Not to throw the fruits vigorously while removing the infected ones, and getting rid of them.

Sorting (packaging):

The fruits are sorted, and all ones affected by diseases, insects, malformed, broken, or injured are excluded. At that point, the packing process is conducted in the field or in the packing centers.

Fifth: Sorting (packaging)

The fruits are sorted, and all ones affected by diseases, insects, malformed, broken, or injured are excluded. At that point, the packing process is conducted in the field or in the packing centers.

1. Field packaging: The fruits are classified or sorted according to size, maturity, and defects. After that, they are packed according to weight or amount in field packing containers or boxes; and then, they are collected and transported to the market.
2. Packaging Centers: After the manual harvesting, the fruit boxes are moved to the packing centers where they are emptied, sorted, and then processed with wax or vegetable oil. Furthermore, the fruits are wrapped in a thin plastic film, transported and distributed to the markets and merchants.

Packing

The fruits are preferably packed in wooden crates of 30 - 40 kg, or cardboard boxes, but it is common for the farmer to use plastic crates or polyethylene boxes of 7- 10 kg. The fruits are packed in two containers for consumers with a capacity of 1 to 2 kg, either in cork boards wrapped in cellophane bags or mesh bags.

Types of packages: Four types are classified, according to the purpose of their use (Ahmed Hassan, 1998):

- Collection containers: It is a container, where the crop is collected and farmers may use packages such as baskets, picking buckets, or field boxes suitable for harvesting.
- Field containers: It is a container, where the crop is emptied to be transported to the commercial packing houses or markets, and nylon bags with a capacity of 20- 30 kg are used for this.
- Shipping or transportation containers: It is a container, where the fruits are shipped to consumption areas, and they often use cork boxes or plastic bags.
- Consumer containers: It is a container, where commodities are sold to the consumer directly so they are packed either in nylon bags (with a capacity of one kilogram or more according to the consumer's request), in paper bags, small crates, or cork dishes covered with transparent plastic.

Storage

The optimal conditions for storing the cucumber fruit are the temperature between (10- 12 ° C) and relative humidity 95% for 7- 14 days. After this period, the quality of the fruits deteriorates quickly, and fruits are exposed to wither and yellowing, which causes damage to the crop.

The most important challenges and difficulties facing the farmers

01 The challenges faced during cucumber cultivation

1. The instability of the economic situation has led to continuous fluctuations in prices, high prices of fuels, and an increase in the cost of all agricultural operations.
2. The scarcity of agricultural inputs, such as seeds, fertilizers, and pesticides, which has led to an increase in their prices and a lack of quality and effectiveness.
3. The lack of water sources and high costs of irrigation networks
4. Many agricultural lands are considered out of service due to the absence of their owners.

02 In the absence of agricultural extenstion

1. Most farmers are conservative and follow traditional methods of growing and maintaining crops. Consequently, many farmers do not follow guidance instructions except in necessary

2. The lack of access to market information for productive farmers has led to great losses of product. Thereafter, the average percentage loss has reached 35% because agricultural products are perishable

3. The farmer must possess practical experience in addition to scientific experience through the implementation of guidance courses. However, the migration and the lack of technical competencies has led to the difficulty in disseminating

03 In the absence of agricultural guidance

4. The presence of some agricultural pharmacies belonging to the possession of people who do not have agricultural scientific expertise and are not qualified. Therefore, they sell pesticides and fertilizers randomly, which leads to a lack of the farmer's confidence

Chapter 5:

Food Processing

Food processing; in particular, plays a pivotal and fundamental role in agricultural production and food security by achieving the maximum possible benefit from surplus agricultural production. That is done by preparing, preserving, and delivering the product to the consumer at different times, which enhances the continuity and accessibility of food security and community peace. There is a well-known proverb that says “Someone who does not have his food, does not have his freedom.”

Moreover, food is exposed to spoilage and corruption within a short period after harvest. Some types of spoilage are accompanied by the production of toxic substances, while others are exposed to a loss in the nutritional value. So, we see that we need most to know how to preserve food and convert the crop from fresh fruit to another new product that is more suitable and more capable of storage, transport, and trading.

Types of processed products for cucumber crops

» First: Pickling

Pickling is the process of preserving or extending the shelf life of food by either anaerobic fermentation in brine or immersion in vinegar. Pickles in a vinegar-based brine (acetic acid) is one type of traditional pickling. Vinegar pickling (or quick pickling) is a simple process. Water, salt, and vinegar (and sometimes sugar) are combined and heated and then fruit or vegetables are immersed in that liquid. However, there is a lot of variation within those ingredients that need to be taken into account to turn food into so-called pickled. Nevertheless, vegetables can also be macerated in a brine solution for pickling, which preserves the product for a long period. Vegetables can also be preserved by a fermentation process. During fermentation of raw vegetables, lactic acid bacteria develop, transforming the natural sugars present and the added sugar into acid. In general, a low salt concentration is used to prevent the growth of spoilage bacteria, while lactic acid bacteria under development.

Pickling is considered one of the ways of preserving foodstuffs (especially for some types of vegetables) by storing them with brine and inducing some chemical changes to produce lactic acid that performs the preservative.

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Pickling is done by submerging the vegetables in diluted or concentrated solutions for a while until chemical changes occur, and vegetables absorb a quantity of salt. In this process, the characteristic flavor, color, and texture of fermented vegetables are produced by the action of lactic acid bacteria. The duration of pickling varies from several days to several years. If the salt concentration in the solution is less than 10%, the preservation period does not exceed a few days, and if it reaches 16% it may reach several years.

How to make homemade pickles?

To make pickled cucumbers at home, the following steps must be followed:

1. Start with the jars:

   Clean them with warm water and soap. Then, sterilize them.

2. Choose the appropriate varieties of healthy cucumbers with no defects or spots:

   The fruits are sorted and graded according to size so that they are cohesive, thick peel, regular in shape and small in size, and there are now cultivars/varieties specially grown for pickling.

3. Wash the vegetable and carefully remove the petal from the cucumber:

   The petal is removed because it causes the freshness and wear of the pickles during storage; then small cracks are created in each of them or they are cut to allow pickling solution to penetrate and facilitate the release of the sap from inside the cucumbers.

4. Prepare a brine:

   Bring brine to immerse the cucumbers, so that the pickling solution/liquid becomes sterile and its temperature is approximately 20 ° C.

   Ingredients; to make a simple brine for any homemade pickle:

   The brine generally consists of water, salt, and sugar; where 1 tablespoon of kosher salt and 1 teaspoon of sugar are placed per 1 liter of water as a fixed base in the pickling. The sugar is added to activate the bacteria producing lactic acid, and the saline solution/brine is according to the following concentrations: salt about 6- 8% (i.e. a cup of salt and 12- 13 cup of water each), sugar about 1% (i.e. equals to a teaspoon of sugar per liter of water), and a little natural vinegar can be added in addition to flavors such as spices, garlic, bay leaf, or any other flavor.

5. Pour the brine over chosen vegetables, packed neatly into the jars:

   The pickles are packed in clean, sterilized plastic or glass jars; then, pour the brine over the vegetables, filling each jar to within 12/ inch of the top.

6. Remove air bubbles, pour the brine:

   Gently tap the jars against the counter a few times to remove all the air bubbles. Top off with more brine if necessary; then add a layer of oil or grape leaves to prevent the fruits from rising to the top and injuring the fruits with mold.

7. Seal the jars:

   Place the lids on the jars and screw on the rings until tight.

8. Keep the jars:

   Let the jars cool to room temperature. They should be stored above the ground, and kept in a dark room for a period ranging from two to three weeks. The pickles will improve with flavor as they age — try to wait at least 10 days before cracking them open.

Pickling Defects:

Pickles are exposed to several types of spoilage and can be summarized as follows:

- **Shriveled or soft pickle:** It occurs due to the enzymatic activity of pectinases, it is treated with 0.5% calcium chloride.
- **Mycoderma growth:** Scum, wild yeasts, molds, and bacteria may appear on brine surfaces, thus reducing the concentration if allowed to accumulate. The growth of this scum can be prevented by completely covering and preventing a vacuum between the surface of the brine and the lid; or by placing a layer of oil on the surface.
- **Gaz-pocket/ blister:** It occurs due to the low acidity.
- **Hollow pickle:** It is due to the faulty growth of cucumber or the formation of gases by yeasts and bacteria.
- **Slippery pickle:** It is due to the exposure to air and the activity of some bacteria on pectin that predominates in the outer layers.

- **Dark or discolored pickle:** It is due to the formation of hydrogen sulfide gas and its interaction with iron (Ground spices used, Brass, iron, copper, or zinc utensils used), causing blackening of the pickles.
- **Shrunken pickle:** It is due to the use of high concentrations of salt, sugar, or vinegar.

Basics of food processing for cucumber crop (devices and equipment for processing):

Table No. (5- 1) The most important equipment needed for food processing transactions for cucumber crops:

	Food Processing Transactions		
	Pickling	Drying	Cold Storage
Required Equipment	• Tables for processing vegetables. • Cucumber washing basins. • Glass or plastic containers of different sizes for pickling. • Packing boxes. • Simple tools like knives and others.	• Drying trays (solar drying). • Mesh cover to protect the fruits from insects. • Drying ovens (industrial drying).	• Refrigerators for preserving Fruits. • Some bags needed for cooling.

Operational processing requirements for pickling the cucumber:

- **Pickling barrels:**

  It is preferable to use vessels that are not exposed to rust or corrosion so that they do not interact with brine or acidic solutions formed during the fermentation processes. One of the most used utensils in pickling processes is the wooden vessels “barrels”. they must be cleaned before use in addition to removing any odors; where they should be washed with a caustic soda of 0.5%, then with soap and water before use. When pickling small amounts of vegetables, it is preferable to use containers made of plastic or glass.

- **The lactic acid bacteria (a group of Gram-positive bacteria):**

  Two types of bacteria contribute to the completion of lactic fermentation shown in the table.

Table No. (5- 2) Types and functions of lactic fermentation bacteria

Bacteria Function	Bacteria Type	
	Homofermentative Lactic acid	Heterofermentative Lactic acid
	The homofermentative LAB converts carbohydrates .to lactic acid as the only or major end-product	The heterofermentative produces lactic acid and additional products such as ethanol, acetic acid, .carbon dioxide, and glycerin

Conditions to be observed during the processing of pickles:

- The salt used in production must be pure, free from impurities, reliable and conform to the established standards.
- All other production inputs such as spices, seasonings, and vinegar must be suitable for human use or consumption.
- Fruits should be fresh and free from signs of damage, spoilage, and retain all their natural properties. Also, they must be in the appropriate degree of ripeness and free from any fungal or insect infestations.
- The cleaning process should be done by soaking the vegetables in water and then washing them thoroughly to get rid of impurities, dust, and suspended materials.
- The water used for washing vegetables and preparing the brine should be clean and free of pathogens.
- All tools and equipment used must be made of harmless materials and do not react with acids or any foodstuff.
- The containers are stored appropriately, bearing in mind that the storage temperature is no more than 25 ° C; with proper ventilation and general hygiene available.
- The food label card must be placed on all packages, regardless of size, weight or shape, with the date of manufacture and the shelf life.

Recommended consumption periods for pickle packaging:

Food processing products for the crop of cucumber are consumed almost throughout the year, and there are specific periods for the viability of pickles according to the type of packaging, according to what was mentioned in the Syrian Official Gazette (Part One) No. 42 of 1997 and it is summarized in the following table:

Table No. (5- 3): Shelf Life for Pickles

Canned Pickles	
Packaging Type	Shelf Life
Acid-Resistant, coated, metal containers	months 24
Glass, paper, or wooden containers	months 18
Aluminum foil containers	months 12
Plastic containers	months 6

» Second: Drying cucumbers

Food drying “dehydrating” is one of the oldest methods of preserving food for later use that is simple, safe, and easy to learn. It removes enough moisture from the food so bacteria, yeast, and molds cannot grow. Drying also slows down the action of enzymes because it removes moisture, the food shrinks, and it becomes light in weight. Besides, the percentage of moisture in fresh cucumbers ranges from 9095%-, and for safe drying the water content should be reduced to 10%.

Steps for drying cucumbers:

The process of drying cucumbers is done to preserve the product through stages:

- Choosing the appropriate varieties for the drying process.
- Washing the cucumber and cleaning it with solutions appropriate and water.
- Sorting, grading, and slicing the cucumbers.

- Conducting the appropriate preliminary procedures (immersion in brine for 25- minutes), and then the cucumbers will be prepared for drying.

Methods of drying cucumbers:

1. Industrial dryer: This method gives the best quality of dried cucumber
2. Solar dryers: They are devices that use solar energy to dry substances, especially food. There are two general types of solar dryers: Direct and indirect.
   - Direct solar dryer: It is one of the oldest methods depending on solar energy, and the natural movement of air to get rid of a large part of the moisture in cucumbers. In other meanings, the direct solar drying exposes the substance to be dehydrated to direct sunlight, and it is assisted by the movement of the air (wind) that removes the more saturated air away from the items being dried. Also, it is characterized by its low cost as it needs only to get drying trays and a mesh cover to protect from insects.
   - Indirect solar dryer: In this method, the black surface heats incoming air rather than directly heating the substance to be dried. This heated air is then passed over the substance to be dried and exits upwards often through a chimney, taking moisture released from the substance with it.

» Third: Storing cucumbers in the domestic refrigeration

Fresh cucumbers can be stored for up to three or five days, and it is important not to wash the fruit so as not to damage the natural protective peel that protects from early rot, and not to keep the cucumbers in a plastic bag so that the fruits do not suffocate in the process of moisture evaporation. Cucumbers are difficult to store. Cold temperatures below 10 ° C cause chilling injury, especially if they were kept under these conditions for a period longer than 13- days, depending on the temperature and variety. Symptoms include the development of sunken pits and lesions which may or may not have a water-soaked appearance, detachment of the skin from the underlying flesh, internal flesh breakdown, and increased rot development. Cucumbers can be refrigerated for up to ten days by wrapping the unwashed fruits with a damp cloth and do not allow them to dry. The storage of fresh cucumbers in domestic refrigeration can be extended to two weeks.

Safe handling of processed products (transportation and its specifications):

During transportation, it is necessary to take appropriate actions to maintain food safety, i.e. ensuring food health, safety, and suitability for human consumption. Therefore, it is essential to protect food from potential sources of contamination or any damage that may make it unfit for consumption and to provide an environment that helps to effectively combat the growth of pathogens or damage caused by microorganisms in addition to the release of toxic substances in food.

Transport specifications:

Food should be adequately protected during the transportation process. The type of transportation, and the containers needed, depend on the nature of the food and the conditions for transport. The transportation means, and the containers in which the food is transported, should be designed to ensure that there are no causes that lead to contamination of food or packaging, with the possibility of cleaning them effectively as well as disinfection when necessary. food items and non-food items must not be transported at the same containers that should provide effective protection from contamination, including contamination with dust or fumes, and taking into account the possibility of maintaining temperature and humidity. Other actions may be taken to protect food from the growth of harmful, unwanted microbes and damage which can lead to unfit products for consumption.

Chapter 6: Economics of Cucumber Crop (Costs & Revenues)

First: Type of Costs

To understand the economics of the crop, we must distinguish between two types of costs in the agricultural project, namely fixed costs and operating costs.

Fixed Costs:

They are called capital costs representing investment costs, and they are the farm's assets that are sufficiently utilized for more than a year or a production cycle. These costs do not vary with the scale of production or agricultural activity over the short term; they are represented in the purchase of assets that the agricultural project needs such as lands, buildings, and tools (pumps, fertilizers, agricultural equipment), irrigation network, greenhouse, transportation and tractor, and other farm assets.

Operational Costs:

They are called variable costs that are used to cover agricultural production expenditures for the production cycle, and are linked to the seasonal agricultural production processes. They represent expenses that the project needs from the beginning of the operation phase and ensure business continuity. Moreover, variable costs fluctuate as the level of production output changes, contrary to a fixed cost. They are represented in the following costs: salaries and wages, rental expenses, and prices of production inputs such as fertilizers, seeds, pesticides, water and electricity, consumables, and other materials that are purchased, and consumed during production processes.

Economics of Cucumber Cultivation:

In this chapter, it has been identified what are the basic and technical operational costs' items for producing the cucumber crop, as well as the expected returns, as the costs and returns of planting cucumbers are considered in three production methods: The first method is open agriculture with drip irrigation, the second method is agriculture with tunnels and drip irrigation, and the third method is protected agriculture in greenhouses. The following table shows a summary of the rates of costs and revenue of crop cultivation in the three methods mentioned above.

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Table No. (6 -1) Comparing the costs and revenues of growing cucumber according to the cultivation method

Cultivation method	Average total operational costs	Average productivity (tons)	Average price per ton	Average total revenue	Expected profit
Open	600	9.5	100 $	955 $	290 $
Tunnels	975	11	200 $	2200 $	1225 $
Greenhouses	1350	15	200 $	3000 $	1650 $

Source: Preparation of the work team based on information collected from farmers.

Information on the previous table indicates that the production of cucumber crop is considered the most profitable cultivation and that the more modern agricultural techniques are used, the greater profits and the lower risks are achieved. This result is not considered an economic feasibility study for the cultivation and production of cucumber crop; nevertheless, it is only an attempt to determine the operational costs of this crop as well as the returns in addition to determine the accounting profit.

Data on the costs and returns of the cucumber crop have been collected from several farmers, and several regions in Syria, meaning that the numbers mentioned in these tables are realistic, practical, and updated, but they will differ from one region to another, and from one variety to another, as well as will vary according to seasons, price fluctuations and the extent of the farmer's good agricultural practices. The work team has priced the requirements for inputs (in dollars) due to fluctuating exchange rates during this period. The farmer is advised to add the domestic work wage allowance within the operational costs under the wages item, even if it is not received, but to determine more accurately the costs and then profitability. Also, if you are a tenant of the land, it is preferable to add the land wage allowance as part of the operational costs, but if you are the owner of the land, it is recommended to adding an "example wage allowance" to the operational costs to reach a more accurate cost value for the crop production, and thus define the profitability criterion more accurately.

In the feasibility studies of agricultural projects, it is calculated the depreciation premium or amortization quota for equipment and devices according to the productive life of the asset. Likewise, the interest premium in case the farmer obtains loans, the inserting of scrap value into

the revenue account and the addition of replacement's and maintenance's costs in calculating fixed costs; actually, this is what has been neglected in this study to simplify the matter on the individual farmer.

The following tables show the most important items of costs and revenues that have been approved to demonstrate the economics of cucumber crops.

Table No. (6- 2) Costs of cultivation and production of cucumbers using open agriculture

Type of activity	Cucumber Crop			
Cultivation Method		Open field (dunum of land)		
Irrigation Method		Drip		
Cost Items	Unit	Quantity	Unit Price (US)	Value
Seeds	Seed	2500 every 2 seeds are sown in a hole/ bag The average acre is 1,250 seedlings	30$ (envelope contains 2500 seeds)	30 $
Organic Fertilizers				
Farmyard, Chicken Manure	M3	1 m3	12 $	12 $
Mineral Fertilizers and Trace Elements				
Phosphor	Kg	10 Kg	20 $ per bag (10) kg	20 $
Balanced (NPK)	Kg	20 Kg	20 $ per bag (10) kg	20 $
Liquid Calcium	Liter	2 Liter	20 $	20 $
Microelements	Liter	2 Liter	20 $	20 $
Pesticides and Treatments				
Insecticides	Liter	1 liter / 7 sprinkles per season	10 $	10 $
Insecticides	Liter	21/ liter (five batches)	20 $	20 $
Black Mulch	Kg	15 Kg	2 $	30 $
Synthetic Fibers	ROll	2 ROll	2.5 $	5 $

Type of activity	Cucumber Crop			
Irrigation				
Irrigation Costs	M3	20 amounts of irrigation water (two hours + 8 liters of diesel) per amount of irrigation water	10 $	200 $
Drip network (dunum)			60 $	60 $
Rented Equipment				
Land preparation for planting	dunum	Two farmers	4 $	8 $
Manual Labor				
Permanent	Worker	It is always advisable to estimate the fee or allowance for the owner	The stakeholder	0 $
Temporary	Worker	400	0.17	70 $
A worker to combat pesticides	Worker	12 sprinkles	0.9 $	18 $
Containers	Container	700	0.17 $	119 $
Total costs				662 $

Source: Preparation of the work team based on information collected from farmers.

As for protected agriculture and tunnel farming, the following table has been prepared based on information collected from Syrian farmers in more than one region.

Table No. (6- 3) - Costs of cultivation and production of cucumbers using protected agriculture

Type of activity			Cucumber				
Cultivation Method			Protected “Tunnels” (acres of land)			Protected “Greenhouses” (acres of land)	
Irrigation Method			Drip			Drip	
Cost Items	Unit	Quantity	Unit Price (US)	Value	Quantity	Unit Price (US)	Value
The seedlings	seedling	1200	0.1 $	120 $	2400	0.1 $	240 $

Organic Fertilizers							
Chicken Manure	m3	1 m3	8 $	8 $	2 m3	15 $	30 $
Cow Compost	m3	1 m3	5 $	5 $	-	-	-
Compound Mineral Fertilizers and Microelements							
Liquid Calcium	Liter	2 liters	13$	26$	2 liters	13$	26$
Balanced (NPK)	Kg	35 kg	2$	70 $	35 kg	2$	70$
Microelements	Liter	2 liters	13$	26$	2 liters	13$	26$
Phosphor	Kg	20	2$	40	20 kg (Two batches)	22 $ per bag (50) kg	10$
Urea	Kg	45 kg (Three batches)	17$ per bag (50) kg	16$	25 kg (Five batches)	17 $ per bag (50) kg	9
Pesticides and Treatments							
Fungicides	Liter	12/ liter (4 batches)	20$	10$	2 liters (5 sprinkles)	20$	20$
Black mulch	Kg	15 kg	2 $	30 $	30	2 $	60 $
					Annual maintenance of the greenhouse		
Synthetic Fibers					2 Roll	2.5 $	25 $
Irrigation and Drip Network							
Irrigation costs	m3	25 amounts of irrigation water (two hours + 7 liters of diesel) per amount of irrigation water	250 $	250 $	25 amounts of irrigation water (two hours + 7 liters of diesel) per amount of irrigation water	250 $	250 $

Rented Equipment							
Land preparation for planting	Dunum/ house	A railway worker	Agricultural worker 3	10 $	3 tillage	5 $	15 $
Manual Labor							
Permanent	worker	It is advised to offer a salary or equivalent to the landowner even if he will not receive		The landowner	Worker	The landowner	-
Temporary	Hour	500	0.17 $	85 $	1000	0.17 $	170 $
A worker to combat pesticides	Worker	20 sprinkles	0.9 $	36 $	30 sprinkles	0.9 $	54 $
Nylon (Plastic Mulches)	Kg	100 kg	1.2 $	120 $	Maintenance of covers		50 $
Containers	Container	1000	0.17 $	170 $	1200	0.17 $	204 $
Petty Cash and Miscellaneous items				8			30
Total costs				975$	Total costs		1350 $

Source: Preparation of the work team based on field information

Table (6- 4) Returns of cucumber crop production, by protected agriculture method

Activity Type	Productivity rate	Average selling price (US/ ton)	Rate of return (US)
Open Agriculture (dunum)	9.5 (tons)	100 $	950 $
Cultivation of open tunnels (dunum)	11 tons	200 $	2200 $
Protected Agriculture (dunum)	15 tons	200 $	3000 $

Source: Preparation of the work team based on field information

General Recommendations

Dear farmers;

1. To obtain abundant, ample, and high-quality production, we kindly consider the following:
2. Not to allow the fruits to grow more because this can prevent the growth of new fruits, and does not help to increase crop productivity. So, the harvest process should be done regularly.
3. The greatest attention must be drawn to the temperature, irrigation, and soil preparation, to obtain high productivity and quality.
4. Control the temperature of irrigation water to avoid the shock caused by cold water at the beginning of cultivation, and the water must be kept for a period in a small tank to reach the ambient temperature in the protected agriculture.
5. Avoid using saltwater and increasing fertilization, and it is advised to irrigate frequently at short intervals and in small amounts.
6. The use of black mulch on the cultivation lines to eliminate weeds, increase soil temperature, reduce water consumption by reducing evaporation, and increase productivity.
7. Before planting, analyze the soil and irrigation water to determine its nutrient content to add the required fertilizers in appropriate amounts.
8. Your crop is your source of income, so please follow up and take care of it, and follow the recommended instructions for the pest control.
9. The random use of pesticides may kill the biological/natural enemies of many harmful insects, which increases their damage and spread.
10. If you have to use chemical control, please adhere to the recommended concentrations on the label sticker to recognize the method and dosage of use as well as the prohibition period because it varies from company to company.
11. There must be a way to deal with excess production through processing, storage, or refrigeration.

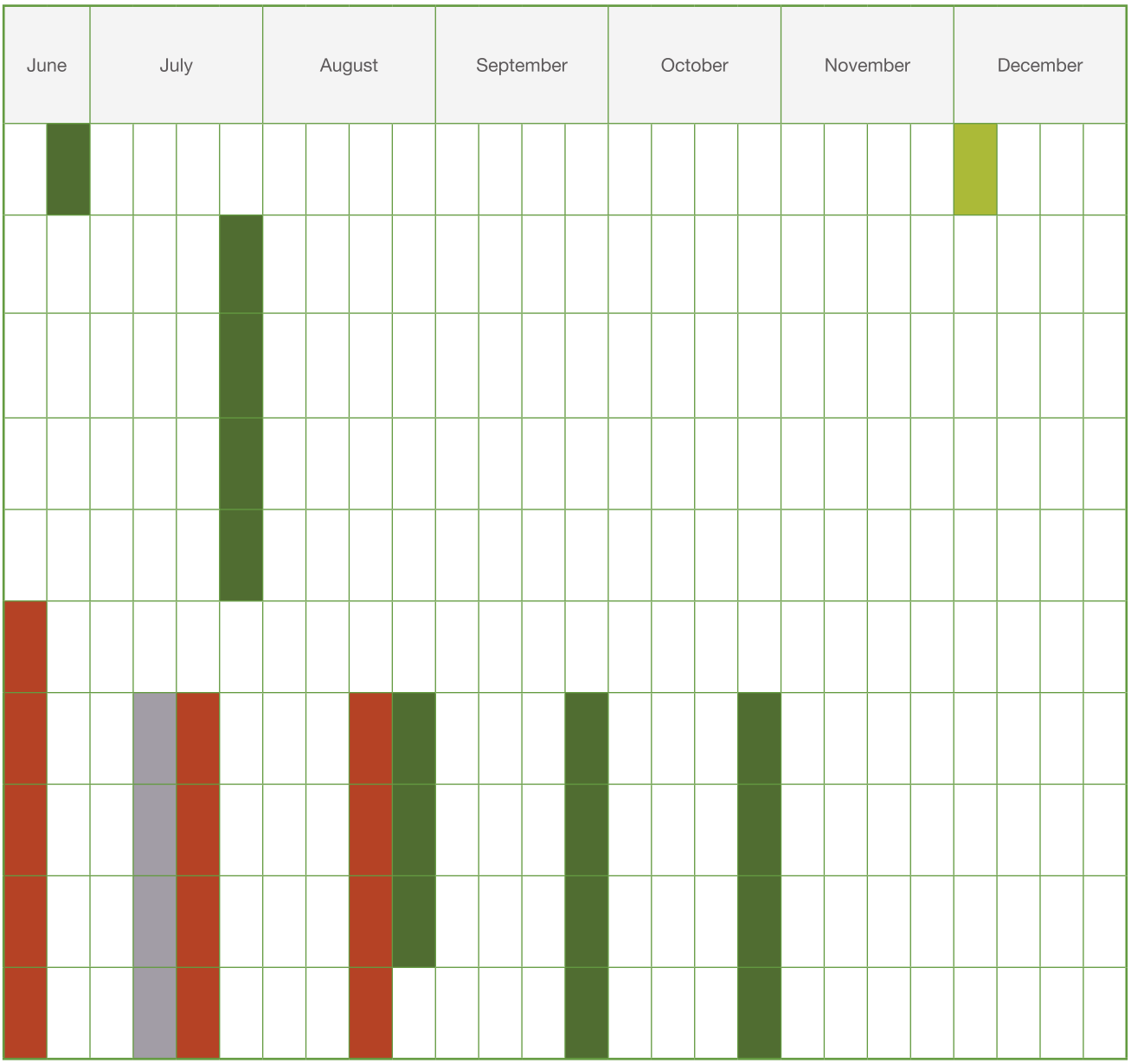
    - Dear farmer, to avoid the effect of high temperature on your crop, you have to:
    - Not to add urea because it leads to weak leaves that cannot withstand high temperatures.

- Add phosphorous or balanced fertilizer to the plant.
- Spray magnesium, boron, and micronutrients.
- Spray amino acids (folic) and algae freely to increase chlorophyll storage within the leaves, which can reduce high temperatures.
- Spray calcium because it helps to harden the plant's cell wall; and in this way, the plant cannot sleep.
- It is advised to irrigate (by drip) in the evening and avoid irrigation during the day to avoid plant stress.

Schedule of agricultural operations of the cucumber crop for open agriculture

Growing Seasons/Planting Periods — Autumn | Summer | Spring-Summer | Spring

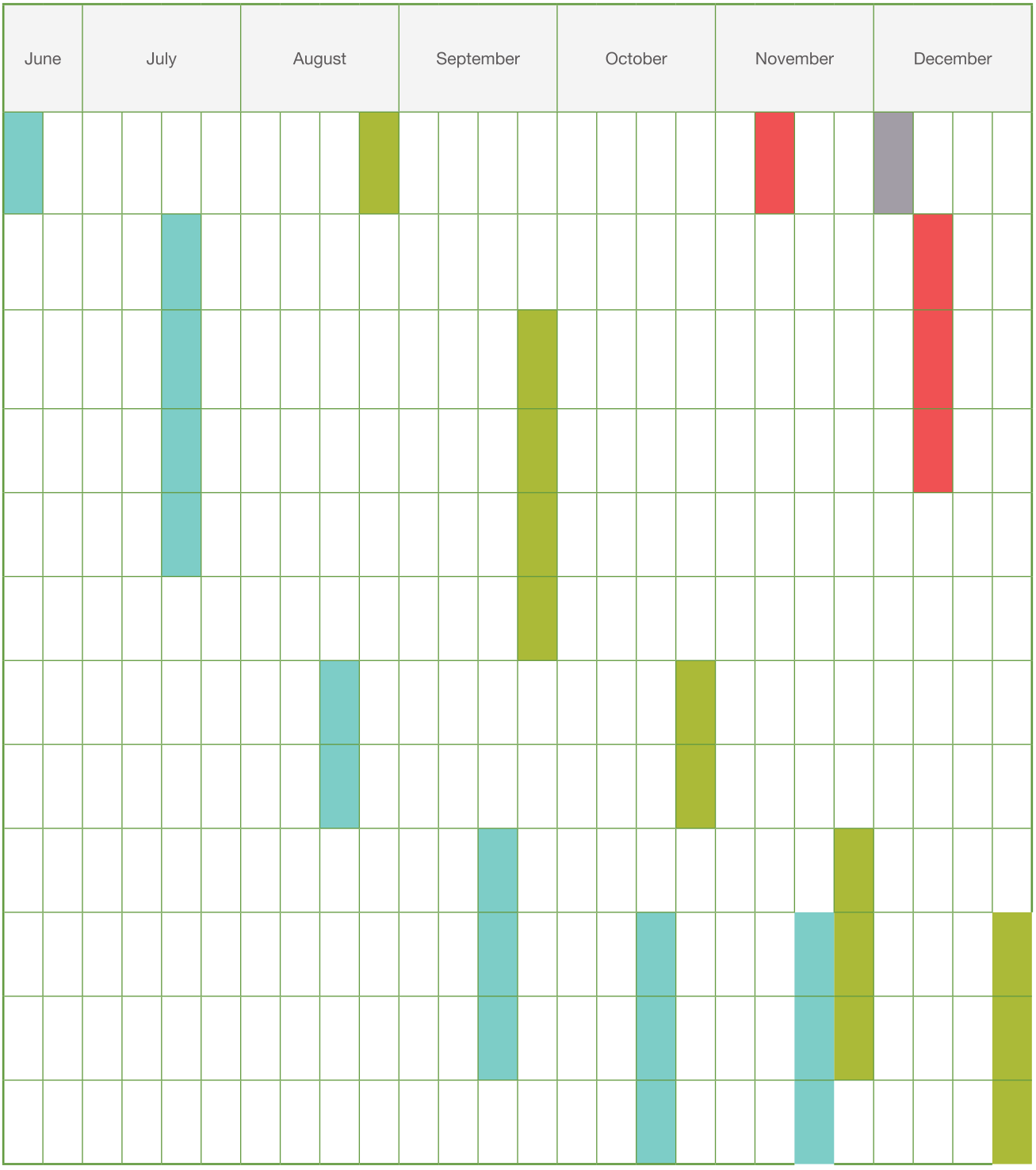
The agricultural operation	January	February	March	April	May	June
Preparing the land						
Basic organic and chemical fertilization						
Smoothing the soil and preparing the beds						
Transplanting						
Hardening off						
Cultivation						
Irrigation						
Fertilization						
Prevention and control						
Ripeness and harvest						


June
July
August
September
October
November
December

Schedule of agricultural operations of the cucumber crop for protected agriculture

Greenhouses Winter Autumn Early Spring Tunnels Early Spring

The agricultural operation	January				February				March				April				May				June	
Preparing the land or the greenhouse																						
Basic organic and chemical fertil-ization																						
Smoothing the soil and preparing the beds																						
Transplanting																						
Hardening off																						
Cultivation																						
Tying																						
Trellising and Pruning																						
Irrigation																						
Fertilization																						
Prevention and control																						
Ripeness and harvest																						


June
July
August
September
October
November
December

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The Guide of Cucumber Cultivation in Syria

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This guide aims to provide scientifically and applied recommendations for growing cucumber crops according to using advanced methods.

It also includes a detailed explanation of the agricultural, marketing, and manufacturing processes in proportion to the agriculture conditions in Syria, in order to become an integrated guide to which the engineers and farmers return, especially in absence of the active role of agricultural extension. In addition, this guide was prepared according to a scientific methodology and presented its contents in a clear and simplified manner.