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THEME

**Contribution to the study of fungal diseases of
tomatoes in the El Oued region**

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- + To our dear brothers and sisters, and to all our families*

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List of abbreviations

°C	Degré Celsius
cm	centimeter
CO₂	Carbon dioxide
Cu	Copper
DAP	Diammonium Phosphate
DAS	Directorate of Agricultural Services
EC	Electrical Conductivity
Fe	Iron
K	Potassium
Kg/ he	Kilogram per hectare
l/ he	liter per hectare
MARD	Ministry of Agriculture and Rural Development
Mg	Magnesium
mg/Kg	milligram per kilogram
mm	millimeter
Mn	Manganese
Mo	Molybdenum.
m/s	meter / second
N	nitrogen
NMO	National Meteorological Office
NPK	Nitrogen, Phosphorus, Potassium.
P	Phosphorus
Pr	Precipitation
qx	quintals
qx/hectare	quintals per hectare
S	Sulfur
Tm	Temperature
TSP	Triple Superphosphate
Zn	Zinc
%	Percent

Introduction

Introduction

Tomato (*Lycopersicon esculentum* Mill.) also called as “golden apple” belongs to nightshade family Solanaceae is the second extensively grown vegetable crop after potato due to its tangy fruit, taste and high nutritive value throughout the world (Saltueit, 2003). Tomato (*Solanum lycopersicum* L.) is one of the most important and widely grown vegetable crops. In comparison to other fruits and vegetables, tomatoes are relatively low in antioxidant content, but routine high-level consumption makes them a physiologically relevant source of antioxidants and other chemoprotective compounds (Boches et al., 2011).

During its vegetative cycle, this crop is continually threatened by various diseases that affect it both in terms of quantity and quality. Among the cryptogamic diseases of this crop, downy mildew, powdery mildew and gray rot (Blancard et al., 2009). This situation is aggravated by the fact that the greenhouse production system is characterized by microclimatic conditions (heat and high humidity) which favor the development of various diseases (Baptista et al. , 2012). In this regards, fungal plant pathogens can cause devastation in these crops under appropriate environmental conditions (El-Mohamedy et al., 2013). Some of the most important diseases in tomato caused by fungal pathogens are late blight, *Sclerotinia* rot, *Fusarium* wilt, *Fusarium* crown, and root rot. Late blight caused by the *Phytophthora infestans* is one of the most destructive diseases of tomato resulting in significant economic loss (20–70%) (Nowicki et al., 2013). *Sclerotinia* rot, caused by *Sclerotinia sclerotiorum*, is another one of the important diseases affecting the tomato crop productivity. Wilt, crown, and root rot diseases in tomato caused by *Fusarium* species have been most intensively studied (Laurence et al. 2014). *Fusarium* wilt is common vascular disease caused by *Fusarium oxysporum*, resulting in extensive (10–80%) yield loss in many tomato producing countries (Kesavan and Chaudhary, 1977). At present, such pathogens are causing extensive loss to this important vegetable crop in the field and under green house conditions, and remain major limiting factors for tomato production.

The study is an attempt to document the actual field diseases situation of tomatoes with the aim that results obtained can be depended on to develop appropriate control measures

This study is divided into two essential parts, the first part presents a bibliographical synthesis composed of two chapters, the first of which is devoted to

general information on tomato crop, the second chapter describes the main fungal diseases of tomatoes and their treatment.

The second part, experimental, divided into two chapters, the first chapter describes the material and methods used during the experimental work that it is a descriptive study based on a survey of farmers in the study communes which aims to inform us about the current state of tomato cultivation as well as the fungal diseases which affect it and pesticides used for to eliminate.

The second chapter presents all the obtained results and their discussion. And finally, we will end with a conclusion.

Bibliographic part

Chapter I

General information on growing tomatoes

CHAPTER I

General information on growing tomatoes

I.1. General Description

Tomato (*Solanum lycopersicum L.*) is an important vegetable crop. At present, about 160 million tonnes of fresh tomatoes are produced from 4.7 million ha (FAOSTAT, 2011). Tomatoes are native to South America, but were brought to Europe sometime in the 15th century, where they soon became popular and were exported around the world. For a long time tomatoes were known by the name *Lycopersicon esculentum*, but recent work has shown that they are part of the genus *Solanum* - as Linnaeus recognized when he first described the species. The tomato is consumed in diverse forms, including raw, as an ingredient in several dishes, sauces, salads, and drinks. While it is botanically a berry fruit, it is considered a vegetable for culinary purposes. The fruit is rich in lycopene, which has beneficial health effects. The plants typically grow to 1–3 meters in height and have a weak stem that often sprawls over the ground. It is a perennial in its native habitat, although often grown outdoors in temperate climates as an annual. Most cultivars produce red fruits, but a number of genotypes with yellow, orange, pink, purple, green, black, or white fruit are also available. Multi-colored and striped fruits are also quite striking. Tomatoes grown for canning and sauces are known as plum tomatoes, which typically have lower water content with elongated fruits (Singh et al., 2014)

I.2. Classification

I.2.1. Botanical classification

According to Munro and Small (1997) the tomato belongs to the following classification:

- Reign Plantae
- Under reign Tracheobionta
- Division Magnoliophyta
- Class Magnoliopsida
- Subclass Asteridae
- Order Solanales
- Family Solanaceae
- Genus Solanum or Lycopersicon
- Species Lycopersicon esculentum

I.2.2. Genetic classification

The cultivated tomato *Lycopersicon esculentum* is a diploid species with $2n = 24$ chromosomes, in which there are very many monogenic mutants, some of which are very important for selection. It is an autogamous plant but there can be a proportion of cross-fertilization by which the plant can behave as an allogamous plant (Gallais and Bannerot, 1992).

According to the method of fertilization, two types of tomato varieties are distinguished:

- ✚ **Fixed varieties:** They are characterized by homozygosity, i.e. they retain parental characteristics (Chaux and Fourry 1994).
- ✚ **Hybrid varieties:** They are characterized by a heterosis effect which allows an accumulation of favorable genes, disease resistance, better fruit set, particularly in unfavorable conditions (Chaux and Fourry, 1994)

I.3. Life cycle of a plant

In tomatoes, the duration of the complete vegetative cycle (from seed) varies according to: the varieties, time and growing conditions. It generally extends from 3.5 to 6 months, from sowing to the last harvest (Gallais and banneront, 1992). this species can be described by three main biological phases:

- _ **The vegetative phase** which corresponds to the exclusive phenological production of organic vegetative (leaves and stems) and it is between emergence and the appearance of the first inflorescence.
- _ **The reproductive phase** which corresponds to the period of production of flowers and fruits and which starts at flowering and ends at the end of cultivation.
- _ **The fruit maturation** phase which starts seven to ten days before the harvest of the first fruits and ends at harvest (Huat, 2008).

I.4. Morphological characteristics of tomato

I.4.1. Root system

The root of the taproot tomato grows to a depth of 50 cm or more. The root main produces a high density of lateral and adventitious roots. while the secondary roots perform their function more horizontally, in addition to providing anchorage and absorbing nutrients from water and soil (Shankara, 2005). tomato root is shown in figure 01.



Figure 01. Tomato roots (Anonym 01., 2023)

I.4.1.1. Stem

The stem (Figure 02) is angular in shape, thick between pubescent nodes (covered with hair), of herbaceous consistency at the start of growth, becoming lignified as it ages.

This monomodal growth at the beginning after 4 or 5 leaves becomes sympodial, that is to say that the axillary buds give rise to successive ramifications. On the other hand, the terminal buds produce flowers or abort. These branches from the axillary buds produce leaves at each node and end in an inflorescence (Chaux and Foury, 1994). The stem bears 2 types of hairs, simple or glandular. These latter containing an oil essential which gives the plant its characteristic odor (Kolev, 1976).



Figure 02. Tomato stem (Levisay, 2020)

I.4.1.2. Leaf

The leaves are composed of 5 to 7 main leaflets, 10 to 25 cm long and a number of small oval intercalary leaflets, slightly toothed on the edges, greyish on the underside. They are often folded in the shape of spoons or even with rolled edges above. These leaves are alternated on the stem (Figure 03) (Raemaekers, 2001).



Figure 03. Tomato leaves (Kimura and Sinha, 2008)

I.4.2. Reproductive system

I.4.2.1. Flower

Tomato flowers (Figure 04) had been reported to grow up to 2 cm in diameter. Flowers are borne in inflorescences of between four to twelve flowers. Its six petals are yellow and up to 1cm in length (Rice *et al.*, 1990). The flowers arise from the leaf axils, where the leaves join the stem. Each flower has both male and female reproductive organs. The male reproductive organ is the stamen, which consists of a filament and an anther containing pollen. The female reproductive organ is the pistil, which consists of the stigma, style, and ovary (Went, 1944). There are 6 stamens, the anthers are bright yellow in color and surround the style which has an elongated sterile end. The ovary is superior with 2 to 9 carpels. In general the plant is autogamous, but cross-fertilization can occur. Bees and bumblebees are the main pollinators (Shankara *et al.*, 2005).



Figure 04. Tomato flower (Oukala , 2014)

I.4.2.2. Fruit

Is a fleshy berry with an enlarged ovary and contains several chambers (locular fruits) which contain seeds (fertilized ovules) enveloped in a gelatinous placenta. The maturity of the fruit can continue even after picking, it is a c fruit. In general, the fruits are round and regular or ribbed (figure 05) (Naika et *al.*, 2005).



Figure 05. Tomato fruits (Oukala , 2014)

I.4.2.3. Seed

According to Chaux and Foury (1994), each fruit contains a large number of seeds which varies from 80 to 500 seeds per fruit. They are covered with a mucilage which presents at maturity a curved albumen and embryo, with epigeal germination. The seed is small (250 to 350 seeds per gram) and hairy (figure 06). After the cotyledonary stage, the plant produces 7 to 14 compound leaves before flowering (Dore and Varoqaux, 2006).

The cycle from seed to seed, is variable according to the varieties and the growing conditions, it is on average 3.5 to 4 months (7 to 8 weeks from seed to flower and 7 to 9 weeks from flower to fruit). Their color, greenish at first, usually turns red when ripe, but there are white, yellow, pink, orange and bicolor ones (Gallais and Bannerot, 1992).



Figure 06. Tomato seeds (Kimura and Sinha, 2008)

I.5. Culture requirements of tomatoes

I.5.1. Soil requirements

I.5.1.1. Soil

Tomato produces good yield in a fertile and well-drained soil rich in organic matter, particularly in sandy loam and clay loam soils with a pH value of 5.5-8.0.

During the wet season, choose a slightly elevated area with good drainage to avoid water logging. For dry season planting, make a catchment canal to drain excess water after irrigation (Cubero *et al.*, 2017).

I.5.1.2. pH

The tomato is moderately tolerant of a wide range of pH values (acidity level), but grows best in soils where the pH value varies between 5.5 and 6.8 and where the supply stimulates good growth (Shankara, 2005)

I.5.1.3. Salinity

The tomato tolerates an electrical conductivity (EC) of the order of 3 to 4.5 mmhos/cm. The impact of salinity is more serious on the yield following the reduction in the size of the fruit. Soil salinity must be maintained between 1 and 2 mmhos/cm at 25°C depending on the crop stage and the season (Ammari, 2012).

I.5.2. Climatic requirements

I.5.2.1. Temperature

Tomato is adapted to a wide range of climatic conditions. However, it requires a relatively cool and dry climate. The optimum temperature requirement of tomato ranges from 21o C -24o C. This vegetable is usually planted from September to January in hilly areas and from November to February in lowland areas. Grow off-season tomato from May to September to attain higher profit(Cubero *et al.*, 2017).

I.5.2.2. Light

According to Chaux and Foury (1994), tomatoes like very sunny situations, but they do not have very marked photoperiod requirements. The light intervenes on the growth and fruiting of tomato by its duration, intensity and quality. 1200 hours of sunshine are necessary during the 6 months of vegetation, 14 hours of light per day is necessary for good fruit set

I.5.2.3. Hygrometry

The tomato is very sensitive to hygrometry, it seems that a relatively ambient hygrometry of 60% to 65% is the best, the humidity of the air plays an important role in fertilization (Munro and Small, 1997). If the humidity is too high, the pollen is hardly released. Furthermore, the development of cryptogamic diseases is linked to high humidity accompanied by heat (Laumonier, 1979).

I.5.3. Nutritional Requirements

I.5.3.1. Water requirement

The tomato is very water demanding especially during flowering and finally during fruit development. Stress caused by water deficiency causes buds and flowers to drop and fruit to crack. On the other hand, when the showers are very intense and the humidity is very high, the growth of molds and the rotting of the fruits will be more important (Naika et al., 2005).

I.5.3.2. Nutrient requirement

Tomato requires nutrients such as nitrogen (N), phosphorus (P), potassium (K) and magnesium (Mg). For nitrogen, the main consumption period is during the active phase of growth and flowering (Naika et al., 2005). The nitrogen is an essential component of many compounds, including proteins, amino acids, and enzymes responsible for biochemical changes in tomato growth. While some nutrients, such as N, P, K, Ca, Mg, and S (also called macronutrients), are needed in large amounts for optimum production because the concentration of these nutrients are higher than other nutrients in tomato, others, such as B, Fe, Mn, Cu, Zn, and Mo (also called micronutrients), are needed in small amounts. Because soil can not supply adequate amounts of N, P, and K for optimum growth and production of tomato, these nutrients are added as amendments in the form of manures and fertilizers to the soil (Sainju et al., 2003)

I.6. Cultivation system of tomato

The tomato is cultivated according to two systems, namely fresh cultivation, generally carried out under shelter and harvested manually, and industrial cultivation, carried out in open fields and mechanically harvested (Chaux and Foury, 1994).

I.6.1. Protected culture

Protected cultivation involves the use of plant cover materials during all or part of the cultivation and, possibly, the use of artificial heat. Crops under flat tarpaulins, under small tunnels, in large tunnels, in twin tunnels or in multi-vault shelters with plastic cover as well as in greenhouses, constitute all of the protected crops (Polese, 2007).

I.6.2. Cultivation in open fields

In this method of cultivation, the tomato plants are either staked or supported on wire netting or grown flat without any support, the tomatoes produced by this latter method are generally intended for industrial processing (Gravel, 2007).

I.7. Tomato and its nutritional value

Tomato is consumed in diverse ways, including raw, as an ingredient in many dishes, sauces, salads, and drinks. Tomato is a good source of energy. Besides, carbohydrates, fats, proteins, vitamins, trace elements like magnesium, potassium, phosphorus, etc, and other constituents like water and lycopene are also present (Table 1). Tomato varieties are available with double the normal vitamin C (Double rich), 40 times normal vitamin A, high level of anthocyanin (resulting in blue tomatoes), and two to four times the normal amount of lycopene (numerous available cultivars with the high crimson gene) (USDA, 2009). The red pigment contained in tomatoes is called lycopene. This compound appears to act as a natural antioxidant that neutralizes free radicals that can damage cells in the body. Lycopene has also been shown to improve the skin's ability to protect against harmful UV rays. The lycopene from tomatoes has no effect on the risk of developing diabetes, but may help relieve the oxidative stress of people who already have diabetes (Valero *et al.*, 2011).

Table 01. Nutritional contents of Tomato (red tomatoes, raw)

Contents	Per 100 g of <i>Lycopersicon esculenta</i>
Energy	74KJ(18KCal)
Carbohydrates	3.9g
Sugar	2.6g
Dietary fiber	1.2g
Fats	0.2g
Proteins	0.9g
Vitamins	
Vitamin A equivalent	5% (42µg)
Beta carotene	4% (449 µg)
Lutein zeaxanthin	123 µg
Thiamine(B1)	3% (0.037mg)
Niacin(B3)	4% (0.594mg)
Vitamin B6	6% (0.08mg)
Vitamin C	17% (14mg)
Vitamin E	4% (0.54mg)
Vitamin K	8% (7.9 µg)
Trace metals	
Magnesium	3% (11mg)
Manganese	4% (0.114mg)
Phosphorus	3% (24mg)
Potassium	5% (237mg)
Other constituents	
Water	94.5 g
Lycopene	2573mg

Source: USDA Nutrient Database, 2009

I.8.Fruit quality

Greenhouse growers try to produce quality fruits, with high nutritional value and rich in bioactive molecules. Good management of humidity, temperature, luminosity and CO₂ concentration of the ambient air can improve the quality of the production (Dannehl *et al.*, 2014).

According to Bénard, 2009, The taste quality of fruits can be broken down into three parts: texture, flavor and aromas. The texture is mainly characterized by the firmness of the fruit. The aroma of the fruit is defined by the concentration of volatile aromatic compounds, knowing that more than 400 compounds have been identified in tomatoes, and finally the flavor is relative to the sugar and acid content.

I.9.Importance of tomato in Global Agriculture.

Tomato plays major role in human nutrition as a vegetable, it constitute an important component in human diet, especially in developing countries (Stevens, 1974). It is the second most consumed vegetable in the world behind potato. Tomatoes are eaten fresh in salads or processed and can be stewed, fried, baked and used to produce soup, or used as juice. In addition to this versatility, tomatoes are also an important source of vitamins and minerals. They are an excellent source of phosphorus, iron and vitamin A, B and C. They also contain small amounts of the B complex vitamins; thiamin, niacin and riboflavin (Naika et al., 2005).

I.10. Economic importance of the tomato

I.10.1. In the world

The tomato is the most consumed vegetable in the world after the potato, particularly by the Mediterranean people. Its annual world production is estimated at more than 100 million tonnes, 30 million of which are intended for processing (Lenne and Branthome, 2006). The tomato occupies a very important place in world agriculture. It is grown in almost every country in the world; its production is distributed in all climatic zones, including in relatively cold regions thanks to the development of crops under cover, China is in first position with a production of 52.86 million tons, followed by the United States for 14.20 million tons, and in third place comes India with 11.97 million tons produced in 2017 (Badaoui, 2018).

I.10.2. In Algeria

The national production of fresh tomatoes amounted to 13.72 million quintals (qx) during the 2017 campaign. The yield was 428 qx/hectare for the open-field tomato, and 1,225 qx/hectare for the greenhouse tomato. The largest wilayas producing fresh tomatoes are Biskra with a production of 2.33 million qx, Mostaganem with a production of 1.33 million qx, Tipaza with 1.04 million qx and Ain Defla with 728,250 qx(MARD, 2017).

I.10.3. In Oued Souf

According to statistics from the DAS of Oued Souf, it can be seen that tomato cultivation occupies a very important place in market gardening production in terms of area and therefore production The area cultivated with tomatoes is estimated at 3130 hectare, with a production

exceeding 2163100 qx. The following table shows the evolution of tomato crop yields in Oued Souf between 2011 and 2019.

Table 02. Evolution of tomato crop yields in Oued Souf between 2011 and 2019 (DAS of El-Oued, 2020)

Year	Yields Qx/h
2011	121,933
2012	186,127
2013	543,000
2014	611,000
2015	1 023,000
2016	1 785,000
2017	611,000
2018	1 023,000
2019	1000,000

Chapter II

Fungal diseases of tomato

CHAPTER II

Fungal diseases of tomato

II.1. Early blight

II.1.1. Definition and etiology

Early blight is a common leaf-spotting fungal disease of tomato. It is also known as *Alternaria* leaf spot or target spot. Early blight, caused by the fungus *Alternaria solani* (figure 07)(Baysal-Gurel et al., 2009). The early blight fungus can come from many sources. It can be in the soil, or on purchased seeds or seedlings, and it can overwinter in the diseased debris of tomato plants and it can persist in the soil or debris for at least 1 year (Kouyoumjian, 2007).

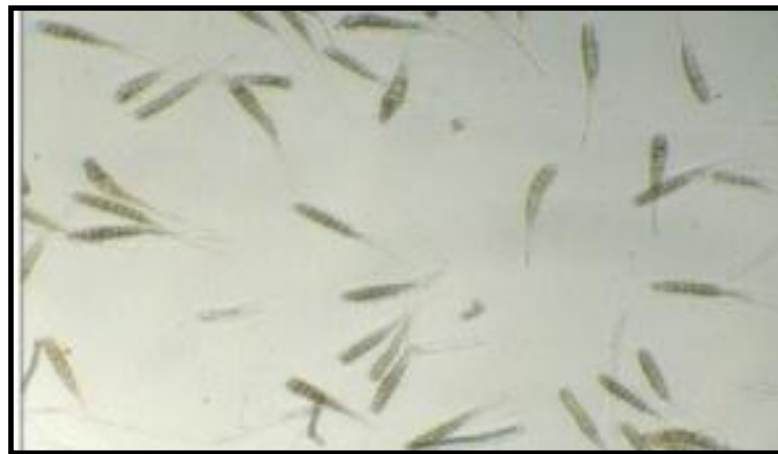


Figure 07. *Alternaria solani* under optical microscope (Chaerani et al., 2017)

II.1.2. Favorable conditions

Initial infections via spores often develop during periods of mild, rainy weather, conditions which favor further spore production. The optimum temperature range for infection is 28° to 30°C (82° to 86°F). However, even with less favorable conditions, lesions may be visible about 7 days after infection. Spores are mainly disseminated short distances by wind and rain splash; however, human contact and equipment can also aid in pathogen spread (Fealko and Pfeufer, 2020)

II.1.3. Symptoms

Premature loss of lower leaves is the most obvious symptom of the disease (Tsrer, 2007).on seedling leaves, although uncommon, begin as small, dark, slightly sunken spots that enlarge and may exceed 1/2 inch. The circular or elliptical spots have a target-like appearance due to alternating light and dark brown concentric rings (Figure 08). Early in disease development, spots may be difficult to distinguish from bacterial spot, but as the season progresses, rings become more apparent within early blight

lesions(Fealko and Pfeufer, 2020). Concentric rings are usually seen within the enlarged spots. Similar spots may occur on stems (Figure 08) and if the plant is in the seedling stage, the spot will girdle the stem, often killing the plant. the fungus attacks the fruits from the stem burrowing extensive lesions with concentric rings and black mold (Kumar et al., 2018). As a secondary effect of this disease, healthy fruit can be damaged by sunscald when plants are defoliated (Fealko and Pfeufer, 2020).



Figure 08. Symptoms of Early blight on infected tomato leaf, stem and fruits (Pandey et al., 2021)

II.1.4. Control

Control of early blight is best achieved by using several techniques together. Cultural controls will allow the fungicide to do a better job as cultural controls reduce the amount of initial inoculum (spores).

- ✚ A good method of control is to carry out long crop rotations lasting three to four years, to transplant seedlings healthy, to minimize injuries and to maintain the plant vigor.
- ✚ When irrigation is required, watering in morning allows the leaves to dry before a new dew period in the evening (Richard and Boivin ,1994).
- ✚ Destroy volunteer tomato and potato plants in and around the field.
- ✚ Adjacent fields planted to potatoes or tomatoes the previous season should have been plowed down immediately after harvest.
- ✚ Maintain host vigor via adequate fertilization. Less vigorous plants are more susceptible to early blight than vigorous plants.
- ✚ Begin a fungicide spray program at first sign of disease or before, based on your experience in your particular area(Kucharek, 2000).

II.1.5. Chemical control

Foliar fungicides applied to appropriate time reduce the losses caused by *alternaria*. Fungicides are commonly used to control leaf scorch and consist of protective products such as mancozeb (Dithane) and chlorothalonil (Bravo), maneb, iprodione, difenoconazole, cymoxanil + famoxadone, thiophanate-methyl (Bartlett et al., 2002; Blancard et al., 2012). During cultivation, the plants must be treated as soon as the first symptoms appear. detected as quickly as possible. Applications must be renewed after heavy rains and irrigation, as these favor the spread of the disease (Blancard et al., 2012).

II.2. Septoria Leaf Spot (*Septoria lycopersici*)

II.2.1. Definition and etiology

The most common foliar disease in tomatoes is the Septoria leaf spot, that may also attack stems, but not fruit. This disease is caused by the fungus *Septoria lycopersici* (figure 09)(Khaire et al., 2021). This fungus can attack tomatoes at any stage of development (Douglas,2023).

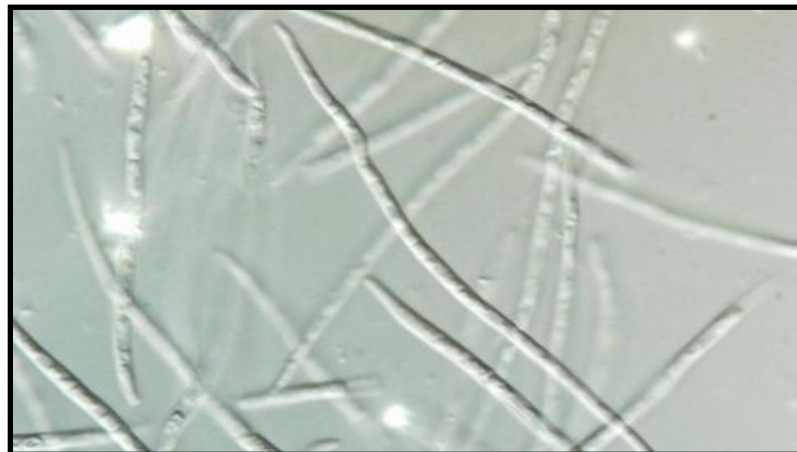


Figure 09. *Septoria lycopersici* under optical microscope (Watt, 2018)

II.2.2. Favorable conditions

The disease is favored by warm temperatures 20-25°C and high relative humidity or the extended periods of leaf wetness caused by overhead irrigation, rain or heavy dews. Most infection probably arises from infested plant debris remaining in the soil from a previous tomato crop (Hansen, 2000). Most infection early in the season probably arises from infested plant debris remaining in the soil from a previous tomato crop (Khaire et al., 2021).

II.2.3. Symptoms

The disease first appears on the lower leaves after the plant has set fruit. Leaf spots begin as yellow areas that later become circular with gray centers and dark borders (Figure 5). Spots may reach 1/8 inch in diameter and be surrounded by a yellow halo. Tiny black specks may develop in the center of these spots (Hansen, 2000). The lesions gradually develop grayish white centers with dark edges. The light-colored centers of these spots are the most distinctive symptom of Septoria leaf spot (figure 10). When conditions are favorable, fungal fruiting bodies appear as tiny black specks in the centers of the spots (Zitter,2018).These are fruiting structures that release spores. Severely infected leaves fall off. Defoliation progresses from the base of the plant upwards, and it can be severe after periods of prolonged warm and wet weather. Loss of foliage may cause fruits to become sun scalded. The Septoria defoliation resembles early blight disease. However, the larger dark leaf spots with concentric rings of early blight are clearly different from smaller Septoria leaf spots (Kumar et al., 2018).



Figure 10. Symptoms of Septoria leaf spot on infected tomato leaf (Wyenandt and Nitzsche,2020)

II.2.4. Control

Deeply bury crop debris soon after harvest to reduce pathogen overwintering and survival. Promote rapid leaf drying by avoiding dense plantings, staking plants, and orientating rows parallel to the prevailing wind direction. Avoid overhead irrigation if possible, and time irrigations to end before dusk and avoid prolonged periods of leaf wetness. Reduce the contact between foliage and soil. Do not work in tomato fields when foliage is wet to reduce plant-to-plant spread of the fungus(Khaire et al., 2021).

II.2.5. Chemical control

Fungicides are very effective for control of Septoria leaf spot and applications are often necessary to supplement the control strategies previously outlined. The fungicides chlorothalonil and mancozeb are labeled for homeowner use. Since these are protectant materials, they should be applied as soon as symptoms are observed and repeated as necessary when conditions are favorable for disease development and spread (Douglas,2023).

II.3. Powdery mildew

II. 3.1. Definition and etiology

Powdery mildew diseases affect cultivated tomato (Palti,1988) *Leveillula taurica* and *Oidium neoglycopersici* (figure 11). are some of the agents responsible for the infection (Babadoost, 2014). The maladies of the letters, like the oidium, are often difficult to prevent the treatment of the epidemiologist so that the caractère explodes. It is necessary to protect the culture, as different conditions are favorable for development (Anonym 02., 2023).

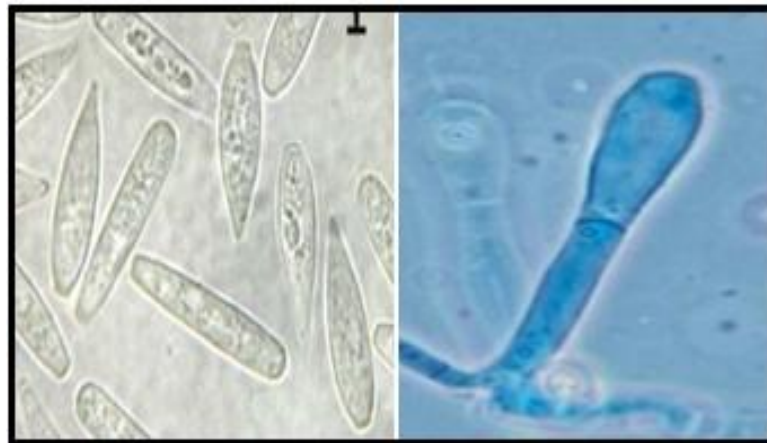


Figure 11. a) *Leveillula taurica* under optical microscope (Hoseinkhaniha et al., 2012)b) *Oidium neoglycopersici* under optical microscope (Lebeda et al., 2015).

II.3.2. Favorable conditions

Both powdery mildew agents proliferate strongly under optimal climatic conditions for tomato growth (Babadoost, 2014). *Leveillula taurica* is a so-called "internal" fungus, it penetrates inside the limbus via the cuticle or by the stomata, develops between the cells, then after around twenty days, conidiophores emerge on the underside releasing responsible conidia of the spread of the disease via the air (draft in shelters). The fungus develops at temperatures around 25°C and humidity of 70-80%. The presence of liquid water would seem to limit its development (Anonym 02., 2023).

Oidium neolycopersici is a so-called “external” or “superficial” pathogen. Primary contamination occurs via spores which germinate directly on contact with the leaves. The fungus continues its development at the level of the epidermal cells of the blade. The powdery spots sporulate abundantly and are spread by air and splashes. Its development is optimal at warm temperatures and humidity less than or equal to 80%, beyond that, its growth slows down (Anonym 02., 2023).

II.3.3. Symptoms

The most common initial symptom of powdery mildew caused by *L. taurica* is the development of small (less than 1 cm) irregularly shaped, light green to bright-yellow lesions on upper leaf surfaces (Figure 12). Lesions appear first on older leaves. Under warm conditions, the lesions may expand and become necrotic, often coalescing; entire leaflets may die. Severely affected leaves remain attached to the stem. Sporulation is typically observed on lesions on the undersides of leaves. Under conditions of high humidity, a powdery sporulation may be observed on both upper and lower leaf surfaces. (Babadoost, 2014). Symptoms of the disease caused by the ectoparasite *O. neolycopersici* include powdery white lesions on leaf blades (Figure 12) and, in severe epidemics, similar lesions may also be observed on other organs, i.e., petioles, stems, and sepals, but not on fruit. This is in contrast to *L. taurica*, a hemiendophytic powdery mildew pathogen that causes symptoms only on leaves (Jones, 2001).



Figure 12. a) Yellow leaf spot of powdery mildew on tomato leaves caused by *Leveillula taurica* b) Conidiofore and conidia of *Oidium neoglycopersici* on tomato leaves (Babadoost, 2014)

II.3.4. Control

The best method of control is prevention.

- ✚ Plant healthy clean transplants.
- ✚ Reduce fungal inoculum by destroying crop debris between production cycles.
- ✚ Avoid high density stands, and promote air circulation through the canopy.
- ✚ Avoid high nitrogen rates. Scout regularly.
- ✚ Eliminate infected plants particularly in greenhouse production.
- ✚ Apply protective fungicides (organic/inorganic) particularly when transplants originated in areas where the pathogen is present year round.
- ✚ Spray fungicides at the appearance of first symptoms, rotating compounds to prevent the development of fungicide resistance. Thorough coverage is critical for effective control(Schultz and French, 2011).

II.3.5. Chemical control

In order to protect the plants as early as possible, it is necessary to carry out regular monitoring of the plots and follow the evolution of the disease. Carrying out preventive treatments in the nursery and during cultivation during periods of risk remains the most effective means of control.

Chemical control must be launched as early as possible, before the first characteristic spots appear, using systemic or penetrating anti-powdery products (the parasite being endophytic). Care must also be taken to alternate the modes of action of fungicides to prevent the risk of resistance. Furthermore, because this fungus sporulates on the underside of the leaves, treatments must be carried out with a sprayer powerful enough for the products to reach this location(Anonym 03., 2017).

II.4. Tomato wilt

II.4.1. Definition and etiology

Tomato wilt is one of the chief diseases of tomato it can affect very young plants as well as adult plants (Blancard, 2013) caused by *Fusarium oxysporum* f. sp. *lycopersici* (figure 13)(Borisade et al., 2017). The *Fusarium oxysporum* f. sp. *lycopersici* enters the epidermis of root, later spreads through the vascular tissue and inhabits the plant xylem vessels, resulting in vessel clogging, and severe water stress as a result wilt like symptoms appear (Singh et al., 2017).

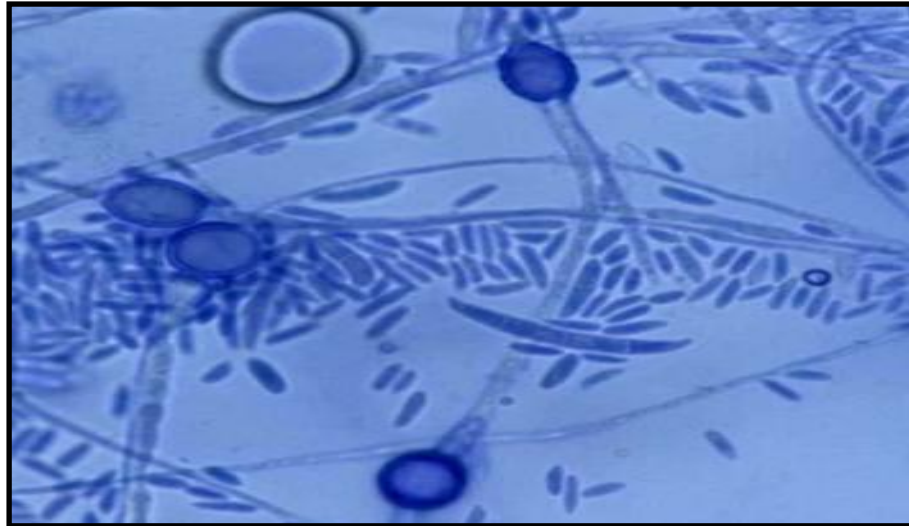


Figure 13. *Fusarium oxysporum* f. sp. *lycopersici* under optical microscope (Blancard, 2013)

II.4.2. Favorable conditions

F. oxysporum f. sp. *lycopersici* preferring rather high temperatures, it thrives during the hot periods of the year, its thermal optimum is around 28°C. It particularly likes sandy and acidic soils. The disease is favored by low soil humidity, short days, low light intensities, plant tissues deficient in nitrogen, phosphorus and calcium. Excessive nitrogen fertilizers, especially based on ammonia, would have the same effects (Blancard, 2013).

II.4.3. Symptoms

Fusarium wilt of tomato is a systemic vascular disease. The pathogen enters tomato plants through roots and colonizes the plant's vascular tissues, which clogs the xylem and causes drooping of leaves (Li, 2021), it can be confused with other wilts, but here are some symptoms to help you identify it in tomatoes:

Wilting-The plants will literally wilt. Often it starts with a single leaf or shoot, near the top of the plant. It will recover at night when temperatures are cooler, but as it progresses, the entire plant will wilt and not recover. Watering does not make a difference.

- ✚ Yellowing- Lower leaves will turn yellow (figure 14), often starting on only one side. As with the wilting, the yellowing will gradually move up the plant.
- ✚ Dry Leaves-The wilted leaves will dry out and fall off.

- ✚ Discolored Stem-If you cut open the stem length-wise you will see dark brown streaks (figure 14) (Iannotti, 2021).

Note that *F. oxysporum* f. sp. *lycopersici* would also be responsible for fruit rot (Blancard, 2013).



Figure 14. Symptoms of Fusarium Wilt on Tomatoes a) Yellowing b)Discolored Stem (Blancard, 2013)

II.4.4. Control

During cultivation

No control method or product can effectively control this disease during cultivation. it will be appropriate to use quality seeds, free from contamination (Blancard, 2015).

Next crop

- ✚ We will avoid producing tomato plants in an already affected plot. Sufficiently long crop rotations, of at least 3 to 4 years, will help prevent the appearance of this disease.
- ✚ Soil disinfection with steam or a fumigant
- ✚ Above ground, it will be necessary to disinfect all the equipment used to carry out the cultivation, the nutrient solution tanks (which must be covered) and the nutrient solution supply circuit (Blancard, 2015).
- ✚ Resistant cultivars are the most effective measure of controlling Fusarium wilt (Amini 2009).

II.4.5. Chemical control

Fungicides including benomyl, captafol, imazalil, thiram, and prochloraz Mn, provided inconsistent control of *Fusarium* crown and root rot on tomatoes, leaving problematic residues in fruit tissues (Jarvis, 1992; Hartman and Fletcher 1991). Mandal and Sinha (1992) found out that such compounds as copper chloride, ferric chloride, manganese sulfate, controlled *Fusarium oxysporum* f. sp. *lycopersici* by inducing resistance in susceptible tomato plants. The effect of mixture of metamidoxime and copper oxychloride on *F. oxysporum* f. sp. *lycopersici* was tested in vitro, and the results showed that these fungicides had a strong synergistic effect and could be used as a basis for a new product to control tomato diseases (Nedelcu and Alexandri 1995). In addition, it was demonstrated that Prochloraz and bromuconazole were the most effective fungicides against the pathogen both in vitro and in vivo, followed by benomyl and carbendazim (Jahanshir and Fevz, 2010).

II.5. Late blight (Downy mildew)

II.5.1. Definition and etiology

Late blight is a potentially destructive disease of tomatoes (and potatoes) caused by the fungal-like organism, *Phytophthora infestans*, (figure 15). This pathogen is referred to as a 'water mold' since it thrives under wet conditions (Gevens et al., 2010)



Figure 15. *Phytophthora infestans*, under optical microscope (Nelson, 2008)

II.5.2. Favorable conditions

The fungus is a wet weather disease favored by cool nights and warm days. Temperatures above 30°C are considered unfavorable for late blight development. The fungus survives mainly in potato seed tubers and in infected tomato transplants. Some survival may also occur in dead potato and tomato vines (Dixon, 1981).

II.5.3. Symptoms

All parts of the plant are affected and fruit decay can be severe. Late blight may infect either young (upper) or old (lower) leaves. It first appears as pale green water-soaked spots starting at leaf tips that enlarge rapidly, forming irregular, greenish black blotches (Figure 16) that expand rapidly when leaves are wet or humidity is high (Dixon,1981).White mold usually develops at the margins of affected areas giving the plant a frost-damaged appearance. Entire plants may be rapidly defoliated when conditions favor the disease. If stems and petioles are infected, brown streaks along the stems will be presented and the areas above these infections wilt and die (Figure 16) (Dixon,1981).Dark, olivaceous greasy spots develop on green fruit; a thin layer of white mycelium may be present during wet weather (Figure 16).

The late blight symptoms are distinct from and should not be confused with symptoms of powdery mildew disease, the spores of which appear usually on the upper leaf surface of tomato(Kumar et al., 2018)..



Figure 16. Symptoms of late blight of tomato on leaves, stem and fruits (Nelson, 2008)

II.5.4. Control

Management of late blight requires aggressive measures that include combined use of cultural, scouting, sanitation, and most importantly the combination of host plant resistance with application of fungicides (Getachew, 2017).

- ✚ Implement all measures to avoid excess humidity (ventilate shelters as much as possible, use the drip watering system, schedule appropriate sprinkler watering, etc.).
- ✚ Reason fertilization (avoid excesses, favor organic manure).
- ✚ Promote good ventilation of the vegetation (reduced planting density, good orientation of the mounds).
- ✚ Mulching would help reduce the risk of mildew.

- ✚ Eliminate weeds susceptible to the disease as well as as much plant debris as possible at the end of cultivation (Anonym 04., 2023)..
- ✚ Every effort should be made to avoid introducing late blight into the production field. This includes purchasing only healthy-appearing tomato transplants (or raising your own transplants from seed). There are tomato varieties with varying levels of resistance to late blight. Once late blight has been identified in a region, it is critical that tomato plants be protected prior to first infection(Gevens et al., 2010).

II.5.5. Chemical control

Monitor the progression of the disease and carry out regular monitoring of the plots.

Protect the plants as early as possible to prevent downy mildew from taking hold. Preventive treatments are essential in nurseries and during cultivation during periods of risk and remain the most effective means of control (Anonym 04., 2023). therefore, the treatment programs will be defined according to the local context in order to best adapt the positioning of fungicides. Depending on the stage(s) of development of downy mildew on the plot, it will be appropriate to choose the fungicide(s) presenting the appropriate modes of action and modes of penetration into the plant also taking into account their versatility to fight against alternaria. During periods of risk, the time between two treatments should not exceed 7 to 12 days depending on the products used. Be sure to alternate the modes of action of fungicides to prevent the risk of resistance (Anonym 04., 2023).different fungicides like Mancozeb, Agrolaxyl, Metalaxy, copper, phosphorus acid and Ridomil for the control of late blight of tomato are used by growers (Randriantsalama et al., 2014; Njoroge et al., 2019).

II.6. Gray rot

II.6.1. Definition and etiology

Gray is rot considered among the most dangerous diseases in greenhouse cultivation, in Algeria, gray mold is considered as one of the main tomato diseases (Aissat et al. 2008). it is caused by *Botrytis cinerea*(figure 17), this fungus can attack all parts of the plant, mainly the leaves, stem and fruit.It is caused by the fungus *Botrytis cinerea* (El akel et al., 2001). *Botrytis cinerea* is a worldwide distributed and well-described pathogen. *B. cinerea* belongs to the phylum Ascomycota, family Sclerotiniaceae (Williamson et al., 2007). This pathogen has a necrotrophic lifestyle (Williamson et al., 2007). *B. cinerea* causes grey mould on 589 species of plants (Elad et al., 2016),

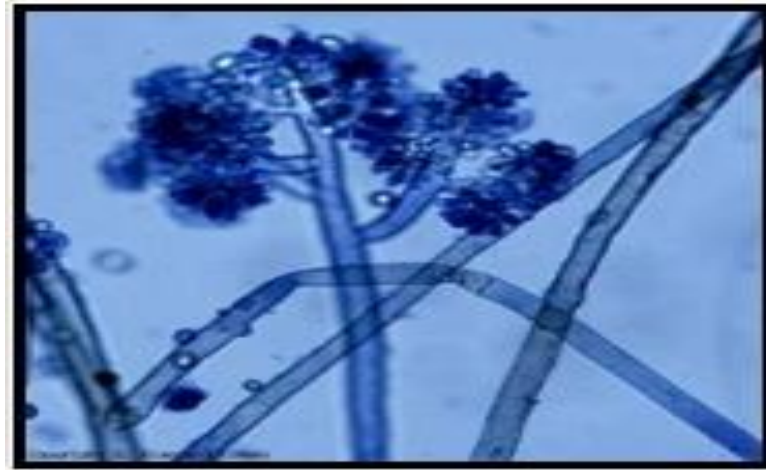


Figure 17. *Botrytis cinerea*, under optical microscope (Blancard, 2009)

II.6.2. Favorable conditions

Infection is favoured by cool temperatures and moisture. Spore germination occurs over a wide range of temperatures from 0 to 25°C, with 10 - 20°C being optimum. Spore germination requires free water on a plant surface, or very high humidity, above 90% RH. At 15°C and 98% RH, a high proportion of spores may germinate within 24 hours. Ghost spotting only develops on fruit that have been wet. On stems however, the occurrence of condensation moisture is not essential for infection(O'Neill, 2012).

II.5.3. Symptoms

All aerial organs of the tomato can be affected, at any time of its development, but the main symptoms appear mainly during fruit set and on the stems (Jones et al., 2014).

The disease manifests itself in the form of spots beige in centric rings sometimes in the shape of a flame in addition to cankers of beige-gray colors slightly depressed with a grayish down made up of the conidial fructifications of the fungus. Stem rot (figure 18) is the most damaging form of the disease, especially when symptoms develop early (Figure 5) (O'Neill, 2012). On fruit, we observe a soft rot (figure 18) with weakening of the tissues which generally begins at the level of the dried sepals or petals. We can also observe whitish rings called ghost spots (El akel et al., 2001).



Figure18. Symptoms of gray rot of tomato on stem and fruits (O'Neill, 2012)

II.6.4. Control

Reduce sources of infection, destruction of plant debris, choice of resistant varieties, avoid excess water, avoid excess nitrogen, adequate ventilation of greenhouses, chemical treatment, preventative (try to alternate products from the benzimidazole family and dicarboximides) (Blancard .,2009)

II.6.5. Chemical control

Traditionally, chemical control is the method most used against *Botrytis* spp. It is based on the use of fungicides either by spraying over the entire crop, or by localized application in the form of a concentrated paste at the level of infected wounds (Elad et *al.*, 1995)., although the strains *botrytis* tend to become resistant to the chemicals usually used. Spraying the foliage is the most reliable method of control; the choice of chemicals and interventions must be carefully managed to avoid the development of resistance. It is recommended to choose products with anti-*botrytis* preventive action. Multi-site fungicides (chlorothalonil, dichlofluanid, thiram) are available, but their application is recognized as less effective than that of specific fungicides (Elad et *al.*, 1995). the application of a commercial product containing iprodione (dicarboximide) and thiabendazole (benzimidazole family) against *B. cinerea* proved to be more effective than the application of each of the products separately on celery crops (Barkai- Golan et *al.*, 1993). However, alternating active ingredients belonging to different fungicide groups is difficult. A limited number of approved products are available in all countries

PRACTICAL PART

Objective of the study

Objective and Methodology

Tomato is susceptible to many diseases which contribute to high losses in yields. Given the scarcity of documentation devoted to phytopathology in the region, we are interested in this work in the inventory of the main fungal diseases affecting tomato crops.

The study is an attempt to document the actual field diseases situation of tomatoes with the aim that results obtained can be depended on to develop appropriate control measures. The objectives of the study were to determine the major fungal diseases of tomatoes and document farmers' knowledge of these diseases and their control measures in six municipalities: El Oued, Guemar, Trifaoui, Hassani Abdelkerim, Magrane, Debila, of El Oued region.

The survey was carried out during the period from July to August 2023.

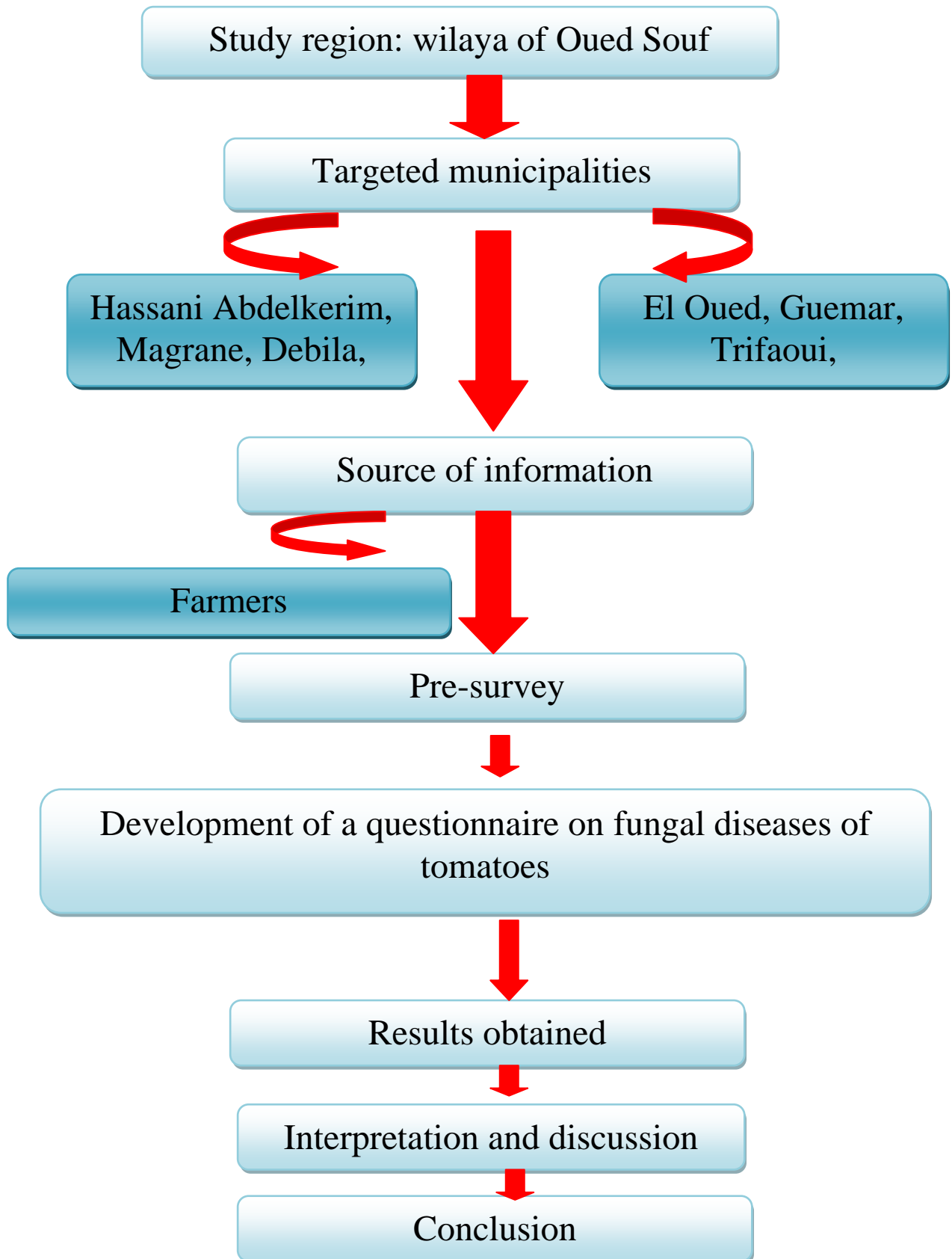


Figure 19. Work methodology

Chapter I

Material and Methods

Chapter I : Materiel and Methods

I.1. Geographical location of the study region

The wilaya of El Oued (figure 20) is located in the southeast of Algeria, at a distance of 650 km from the capital, northeast of the northern Sahara and 350 km west of Gabes (Tunisia). It occupies an area of 44,586 km², representing 1.87% of the national territory (ANDI, 2014).

The Souf region is part of the wilaya of El Oued attached to the northern Sahara and characterized by fairly specific ecological factors, between 33°19' to 33°61'N 6° 80' to 7° 10' E (Nadjah, 1971) this region is at an average altitude of 80 m, thus showing a notable decrease from south to north to be 25 m below sea level in the chott Melghir which occupies the bottom of the immense Basin of the Lower Sahara. It has dunes that sometimes exceed 100 m in height (NAHR, 2009).

It is limited by:

The chotts area (Melghir and Merouane) to the north

The Tunisian border area with the Chott El-Djérid in the East

The wilaya of Ouargla and the Oued-Righ valley to the West

The extension of the Erg Oriental to the south (Voisin, 2004).

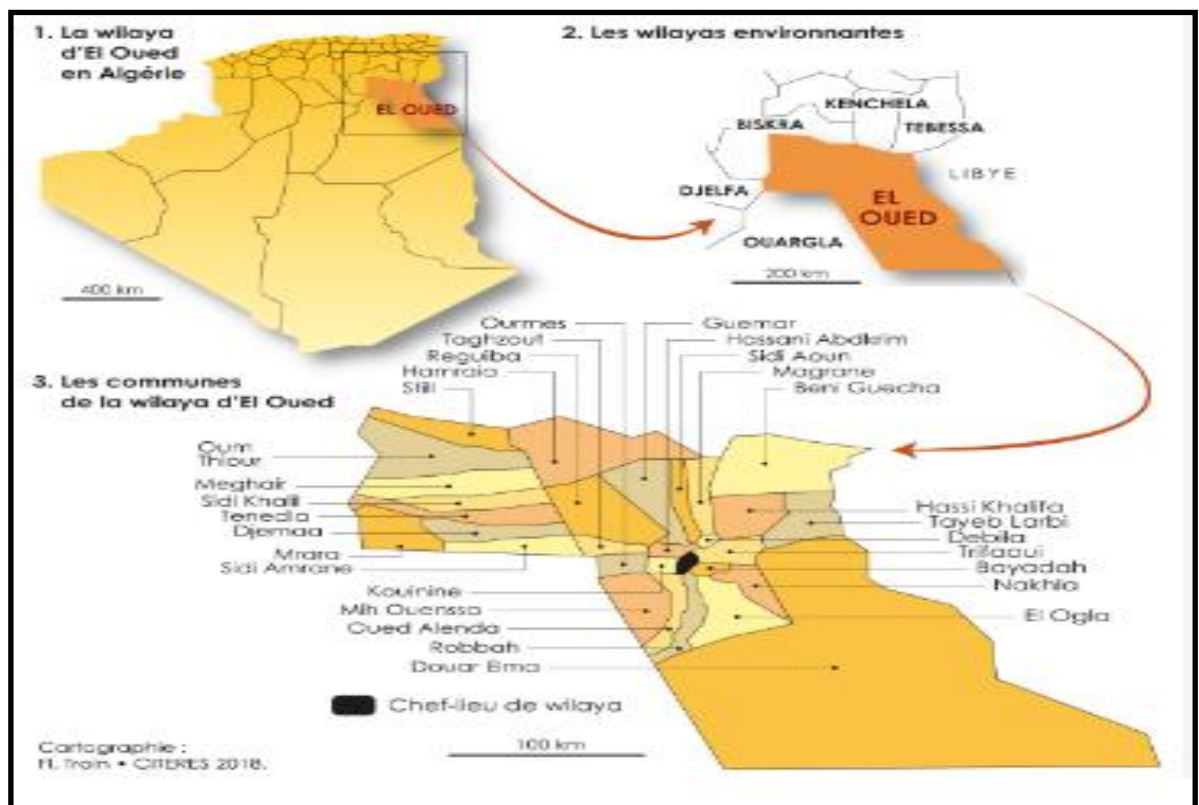


Figure 20. Geographical location of the study region (Kadri and Chaouche., 2018).

I.2.Climatic factors

The region's climate is Saharan, characterized by a hot and dry summer where the temperature can reach 35°C and a mild winter. The main climatic constraints remain the regular frequency of winds and their violence known as Sirocco as well as sandstorms during spring (Arami, 2008).

I I.2.1.Temperature

The table below shows the monthly average temperatures of the El-Oued region during the period (2012-2022)

Table 03. Average temperatures in the El-Oued region during the period (2012-2022) (NMO of El Oued, 2023)

Mois	Jan	Feb	Mar	Apr	Mai	Jui	Jul	Aug	Sep	Oct	Nov	Dec
Tm(°C)	18,00	19,90	23,70	28,70	33,76	39,22	41,74	40,85	36,66	30,63	23,21	18,73

The Souf region is characterized by an average annual temperature which oscillates between 18.00 - 41.74°C. The coldest months are January and December with 18.00 and 18.73°C respectively. The hottest months are July and August with averages varying between 41.74 and 40.85°C respectively.

I.2.2.Precipitation

The monthly distribution of average rainfall during the period (2012-2022) is shown in table 04.

Table 04. Average precipitation in the El-Oued region during during the period (2012-2022)(NMO of El Oued, 2021)

Mois	Jan	Feb	Mar	Apr	Mai	Jui	Jul	Aug	Sep	Oct	Nov	Dec
P(mm)	1.24	6.02	5.47	8.91	1.41	0.16	0.06	0.67	8.49	1.50	7.82	1.66

Precipitation is low, between 0.06 and 8.91 mm. April is the rainiest month with an average of 8.91 mm. While the driest month is July with an average value of 0.06 mm.

I.2.3.Humidity

Table 05 shows the average humidity levels in the Souf region during the period (2012-2022) is shown in table 04.

Table 05. Average relative humidity in the El-Oued region during the period (2012-2022) (NMO of El Oued, 2023)

Mois	Jan	Feb	Mar	Apr	Mai	Jui	Jul	Aug	Sep	Oct	Nov	Dec
HR(%)	55.18	46.80	43.42	38.06	32.29	29.18	26.65	30.33	39.78	4.13	53.46	61.30

The values reported in the table above indicate that the month of December is the wettest with a percentage of 61.30%. However the lowest humidity rate is noted during the month of July with 26.65%.

I.2.4.Wind

The average wind speeds during the period (2012-2022) are recorded in table 06

Table 06. Average wind speed in the El-Oued region during the period (2012-2022) (NMO of El Oued, 2023)

Mois	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
V(m/s)	7.39	8.51	9.84	11.60	10.90	10.51	9.42	9.20	8.80	6.46	7.06	6.74

Table 06 shows that winds are frequent throughout the year. The highest speeds are recorded during the month of April with an average of 11.60 m/s.

I.3.Water Resources

Despite the absence of surface resources, the Souf region has a very significant water reserve, present in the form of three underground aquifers: the Albien aquifer (or Continental Interlayer CI), the Terminal Complex aquifer (TC) and the water table, table 02 summarizes the aquifer systems in the El-Oued region (Khechana, 2007).

I.4.Materiel

The information was collected through a questionnaire

I.5.Method

I.5.1. Study period

This survey was carried out during the period from July to august 2023 covering the following municipalities: Trifaoui, Hassani Abdelkerim, Magrane, Debila, El Oued, Gemar .

I.5.2. Type of study

This is a descriptive, cross-sectional study.

I.5.3. Study population

The study population is made up of tomato farmers from the municipalities concerned by this study.

I.5.4. Data collection methods

The survey was carried out through direct meetings with farmers. We fill out the questionnaire ourselves.

I.5.5. Organization of the questionnaire

The questionnaires are prepared in an easy way in order to collect as much information as possible on fungal diseases that affect tomato cultivation in our region; The questionnaire included several questions divided into 5 sections:

- ✚ Have information on the study population.
- ✚ Identify the characteristics of culture of tomato.
- ✚ Determine technical field works
- ✚ Identifying tomato fungal diseases, their symptoms and treatment
- ✚ Evaluate farmer knowledge of the risks associated with use of pesticides

I.6. Statistical analyzes

All data collected was entered into a Microsoft Excel file. Data processing was restricted to descriptive statistical analysis.

Chapter II

Results and Discussion

Chapitre II : Reults and discussion

II.1. Results

Our survey, carried out in a way to cover a few subdivisions, allowed us to have a lot of information on fungal diseases in farms in the wilaya of Oued Souf and the use of fongicides. We were able to recover 36 copies from the farmers, or 100%. The responses obtained for each of the targeted parameters are reported and/or presented in the form of graphs or tables.

II.1.1. Population characteristics

II.1.1.1. Gender

Figure 21 represents the distribution of the study population according to sex.

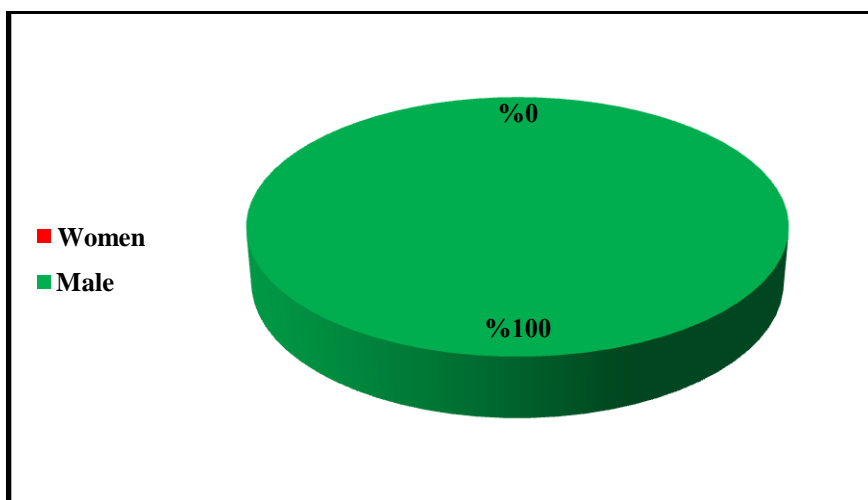


Figure 21. Distribution of the study population by gender

The results show that the farmers surveyed are 100% men.

II.1.1.2. Age

The distribution of participating individuals in this study according to their age is illustrated in Figure 22.

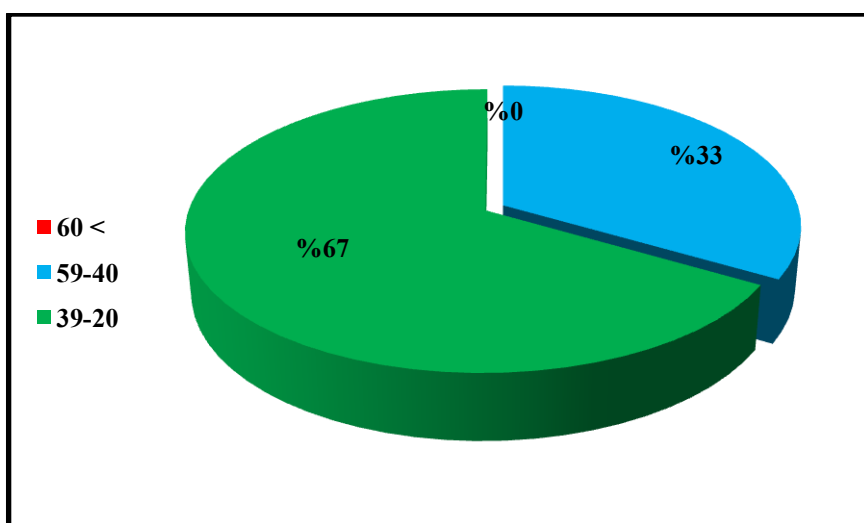


Figure 22. Distribution of farmers according to their age

The most of farmers are aged between 20-39 years while 33% of them are aged between 40-59 years.

II.1.1.3. Educational level

The educational level of farmers is illustrated in Figure 23.

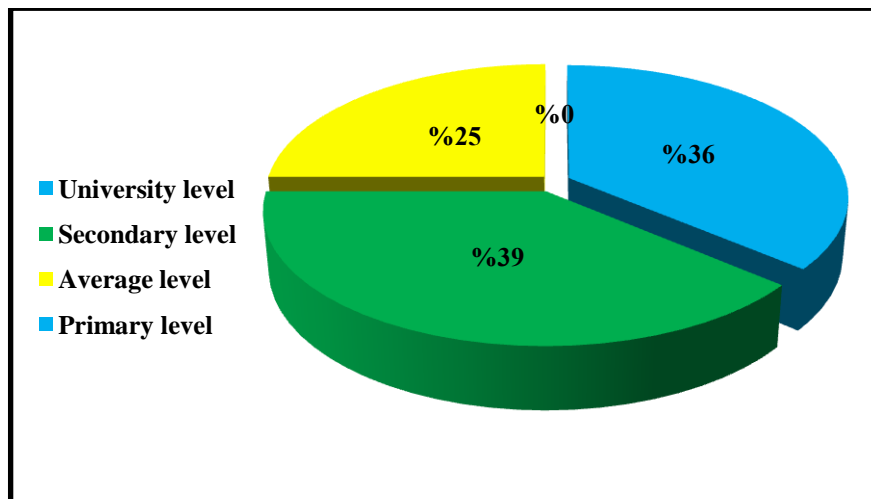


Figure 23. Distribution of farmers according to their educational level

39% of the farmers surveyed had a secondary level followed by people with a university level and a average level with respective rates of 36 % and 25%.

II.1.1.4. Municipality

Figure 24 represents the distribution of questionnaires according to municipality.

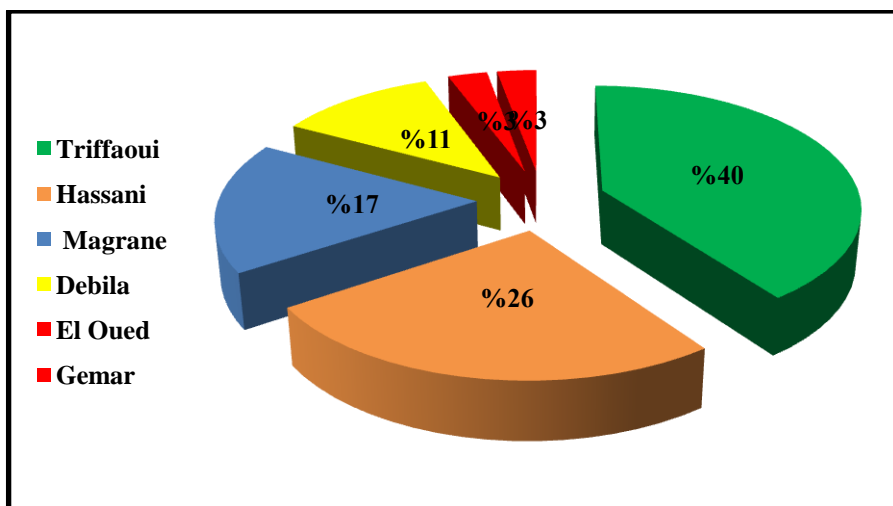


Figure 24. Distribution of questionnaires according to municipality

Out of a total of 36 questionnaires, we counted:

- 14 in the municipality of Trifaoui, or a percentage of 40%.
- 9 in the municipality of Hassani Abdelkerim, i.e. a rate of 26%.
- 6 in the municipality of Magrane, or a percentage of 11%.
- 4 in the municipality of Debila, or a percentage of 3%.

- 1 in the municipality of El Oued, or a rate of 3%.
- 1 in the municipality of Gemar, or a rate of 3%.

II.1.2.Characteristics of culture

II.1.2.1. Nature of ownership

Figure 25 represents the nature of land ownership of the farmers interviewed

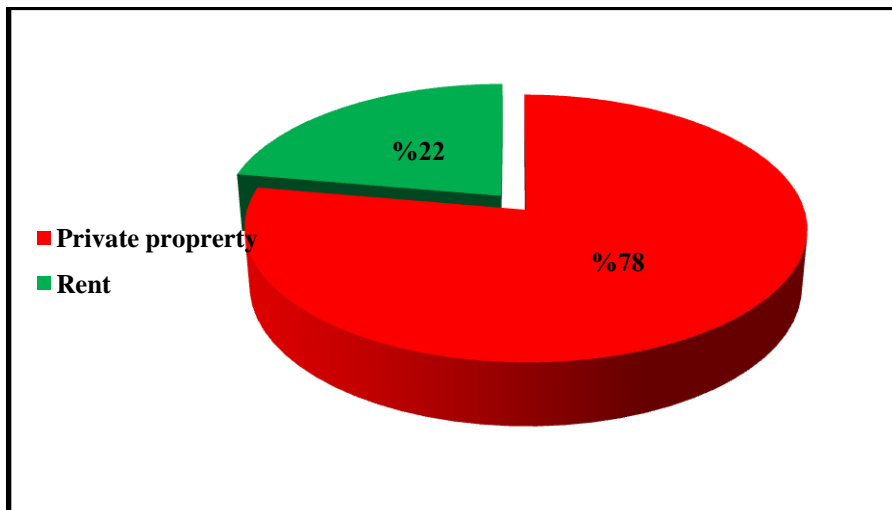


Figure 25. Nature of land ownership of the farmers

According to the results obtained, 78% of the farmers surveyed have own private lands. Whereas, 22% of them have rented land.

II.1.2.2. Total area

The total areas of the interviewed farmers are shown in Figure 26.

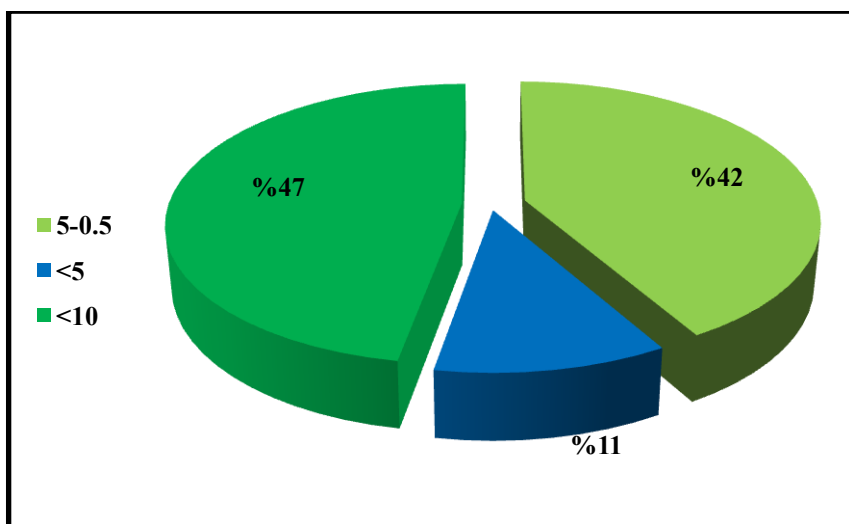


Figure 26. Total land surface of the farmers

The almost half (47%) of farmers surveyed have land surface more than 10He while 42% of them have less than 5He and 11% of farmers have land surface more than 5He.

II.1.2.3. Cultivated area

Figure 27 represents the cultivated area of the farmers interviewed

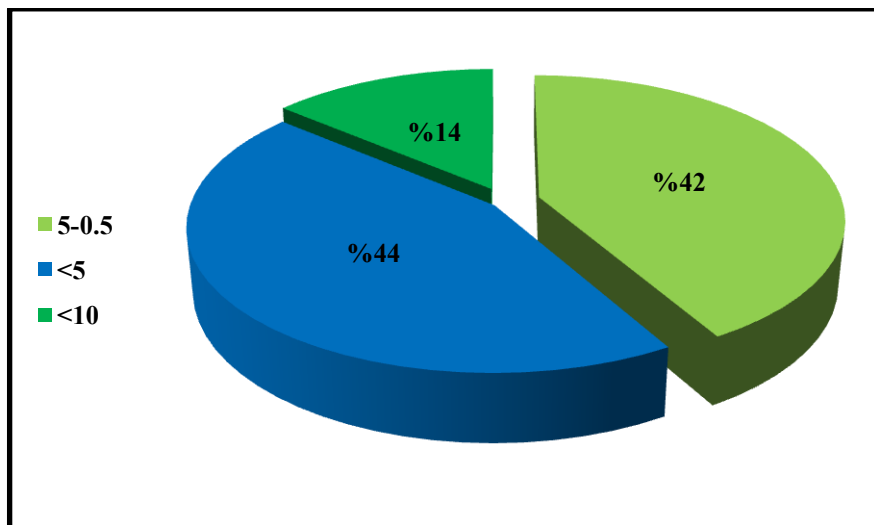


Figure 27. Cultivated Area surface of the farmers

44% of farmers surveyed have cultivated Area surface more than 5He while 42% of them have less than 5 He and 14% of farmers have land surface more than 10He.

II.1.2.4. Type of crops

Figure 24, represents the distribution of Type of crops among the interviewed farmers

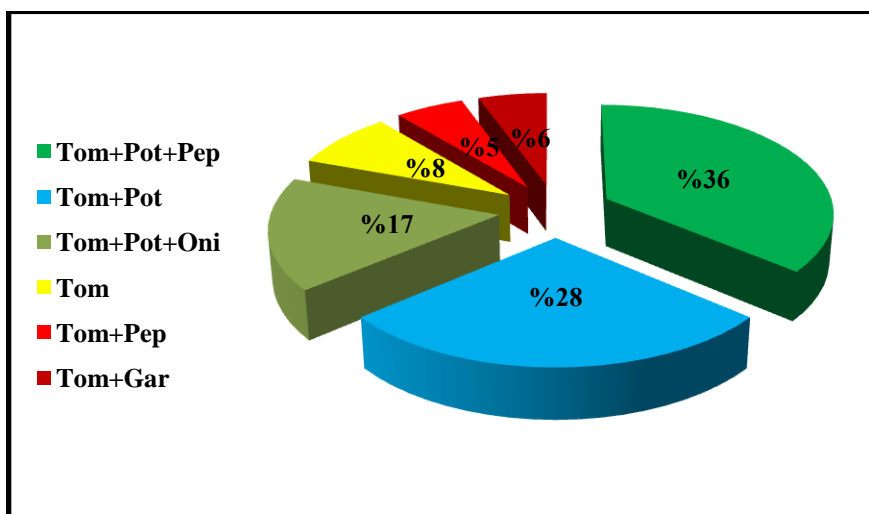


Figure 28. Distribution of type of crops

According to Figure 28, tomato + potato + pepper, tomato + potato and tomato, potato + onion are the most frequently cultivated crops at the respective rates of 36%, 28% and 17%. Whereas, tomato only, tomato + pepper and tomato + garlic are cultivated less with respective rates of 8%, 5% and 6%.

II.1.2.5. Cultivated tomato varieties

Tomato varieties cultivated by the farmers in our study are represented in the following figure:

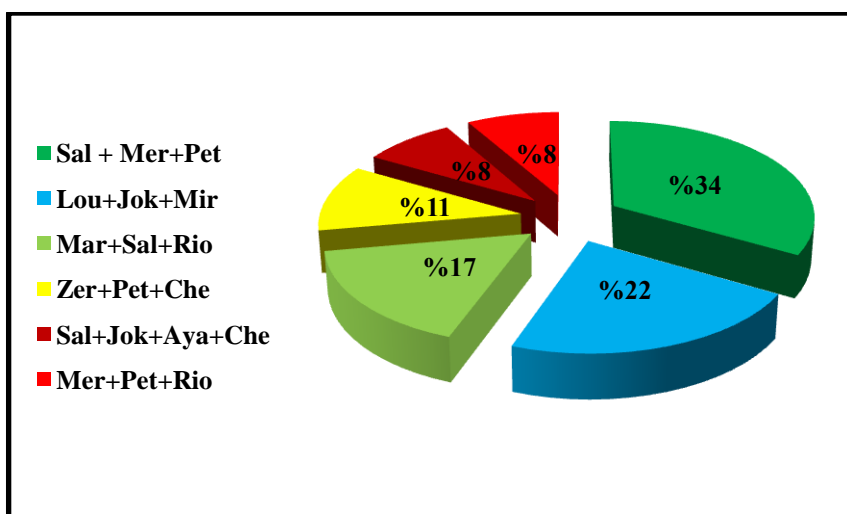


Figure 29. Tomato varieties cultivated

The most common varieties cultivated by the farmers in our study are: Salima (H1) + Mercure (H1) + Petra (H1), Loubana (H1) + Joker (H1) +Chebli (H1), Maria (H1) + Salima (H1) +Rio-grande (H1), and Zeralada (H1) +Petra (H1)+Aya (H1) with respective percentages of the order of 34%, 22%, 17% and 11%.

II.1.2.6. Reasons for choice

Figure 30 shows the reasons for choice of tomato varieties by farmers

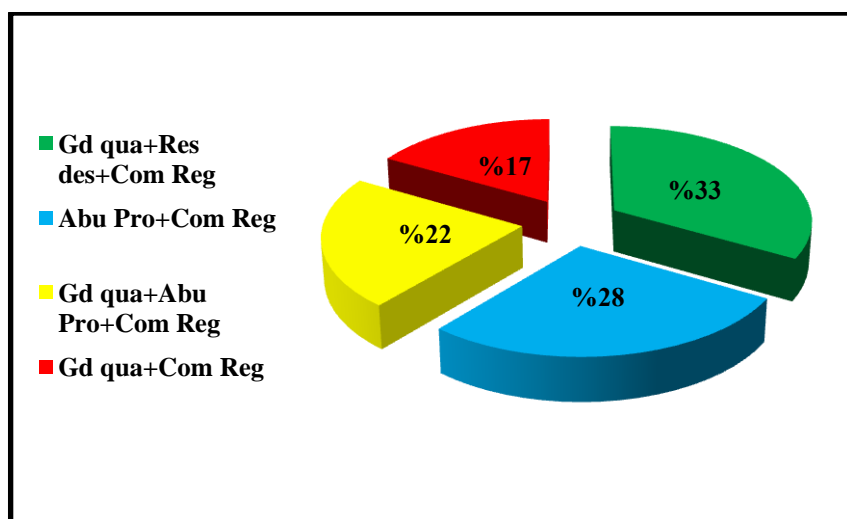


Figure 30. Reasons for choice of tomato varieties

According to the results obtained, 33% of farmers choose these varieties for their good quality + resistant to diseases + commensurate with the nature of the region, 28% of them choose it for their abundant production+ commensurate with the nature of the region, 22% of these prefer it for their good quality + abundant production+ commensurate with the nature of

the region and the rest of them (17%) choose it for their good quality + commensurate with the nature of the region.

II.1.2.7. Agricultural cycle

Farmers' responses regarding the agricultural cycle are illustrated in Figure 31.

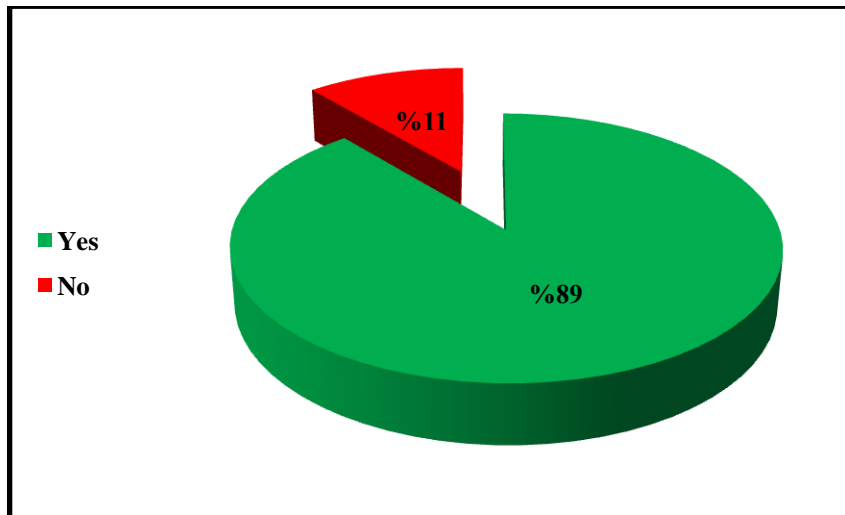


Figure 31. Follow of agricultural cycle

The majority of farmers questioned (89%), have followed the agricultural cycle **each year** while only 11% have not followed an agricultural cycle.

II.1.3. Technical field works

II.1.3.1. Tilling of the soil

The answers regarding the tilling of the soil are shown in figure 32.

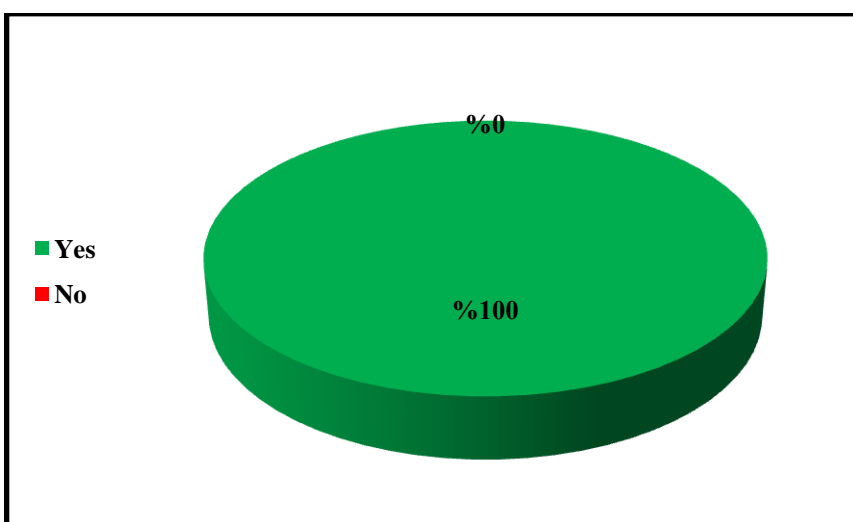


Figure 32. Tilling of the soil

All of farmers questioned, are tilling their land.

II.1.3.2. Type of tillage

Figure 33 shows the type of tillage practiced by farmers participating in this study

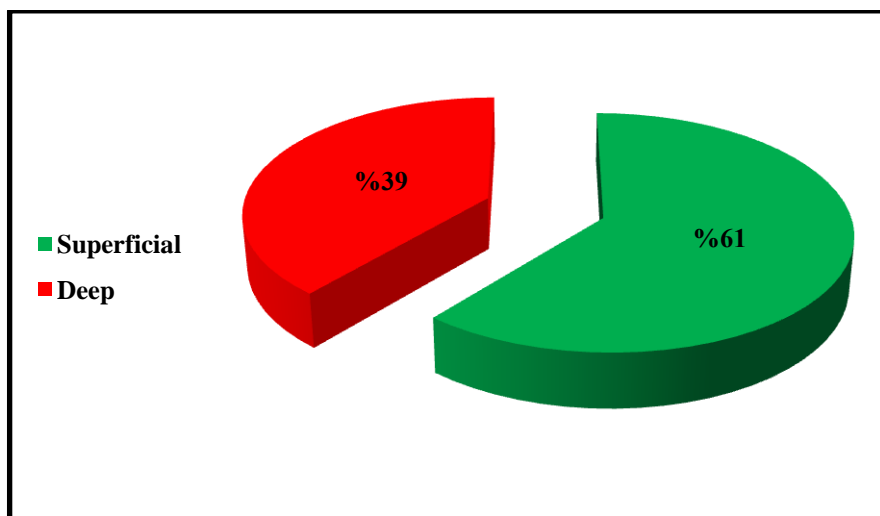


Figure 33. Type of tillage

The results show that more than half (61%) of farmers practice superficial tilling while 39% of them practice deep tilling.

II.1.3.3. Depth of tillage

Depth of tillage is shown in the figure below:

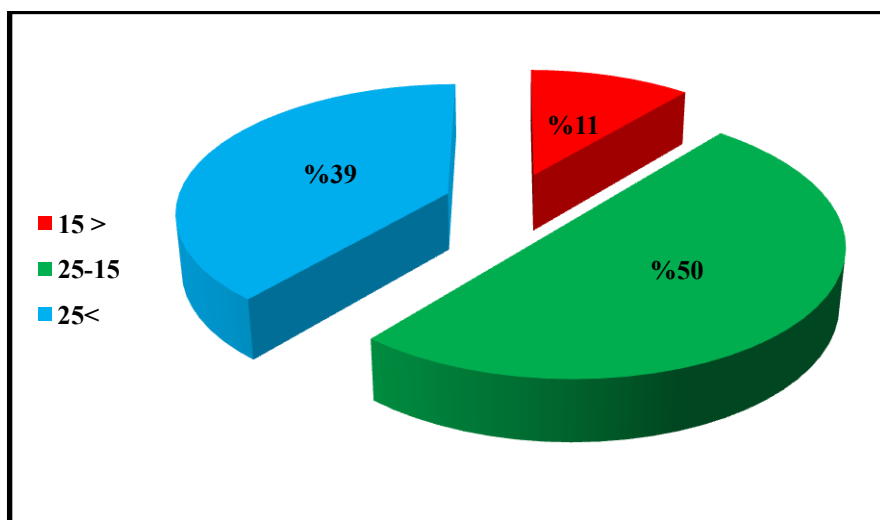


Figure 34. Depth of tillage

According to these results, the most practiced tilling depth by the farmers is between 15-25cm with 50% followed by > 25 cm with 39 and finally <15 cm with 11%.

II.1.3.3. Time of tillage

The answers regarding the time of tillage are shown in figure 35.

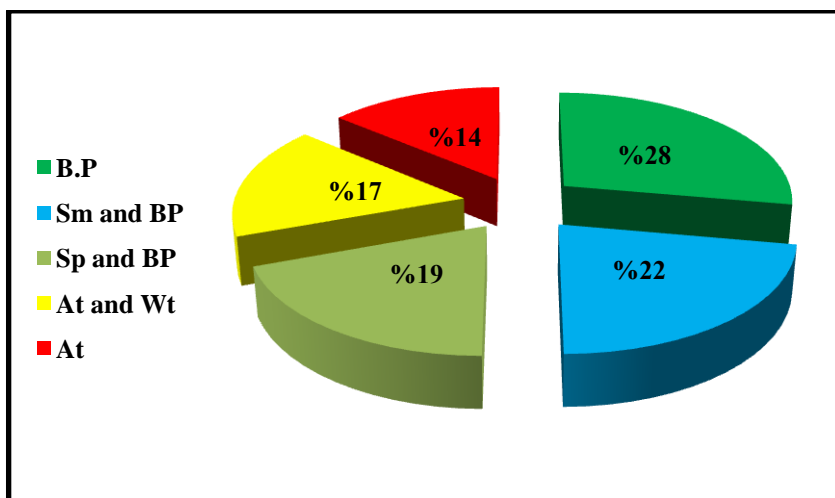


Figure 35. Time of tillage

The results show that, Farmers plow at the following times; Before Planting, Summer and Before Planting, Spring and Before Planting, Autumn and Winter, Autumn only at the respective rates of 28%, 22%, 19%, 17% and 14%.

II.1.3.4. Fertilization

Farmers' responses regarding the fertilization of their area are shown in the figure below:

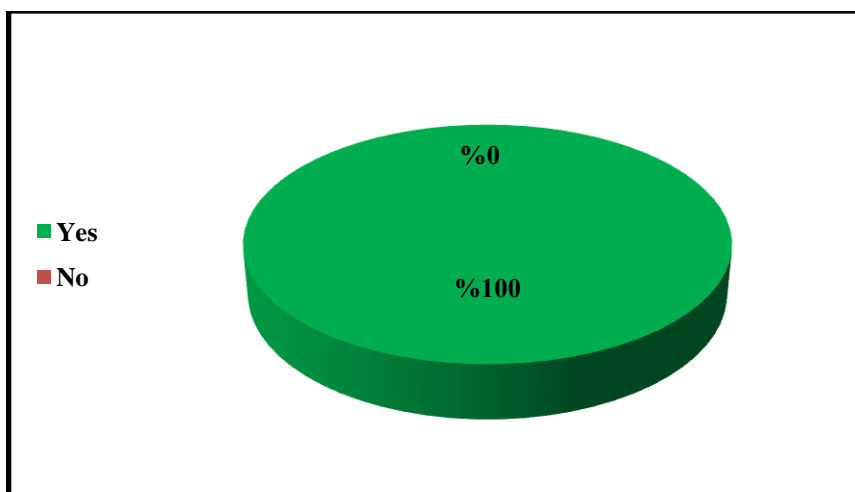


Figure 36. Fertilization

All of farmers questioned (100%), are fertilizing their land.

II.1.3.4. Fertilization type

Figure 37 shows fertilization type according to the farmers

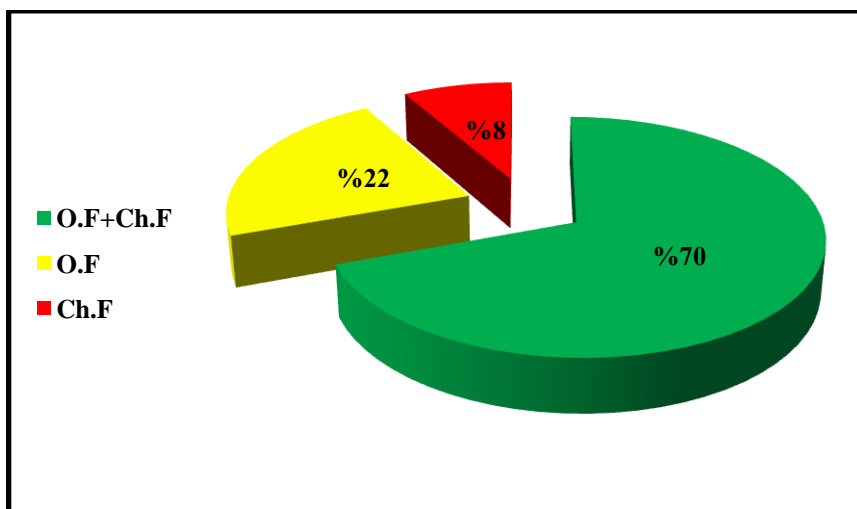


Figure 37. Fertilization type

The results show that, Most of the participating farmers in this study use in the fertilization process organic fertilizers (manure from sheep and chicken) in addition to chemical fertilizers by 70%, while 22% of farmers use only organic fertilizers, while 10% of them use only chemical fertilizers.

II.1.3.4. Chemical fertilizers used

Chemical fertilizers used are illustrated in figure 38.

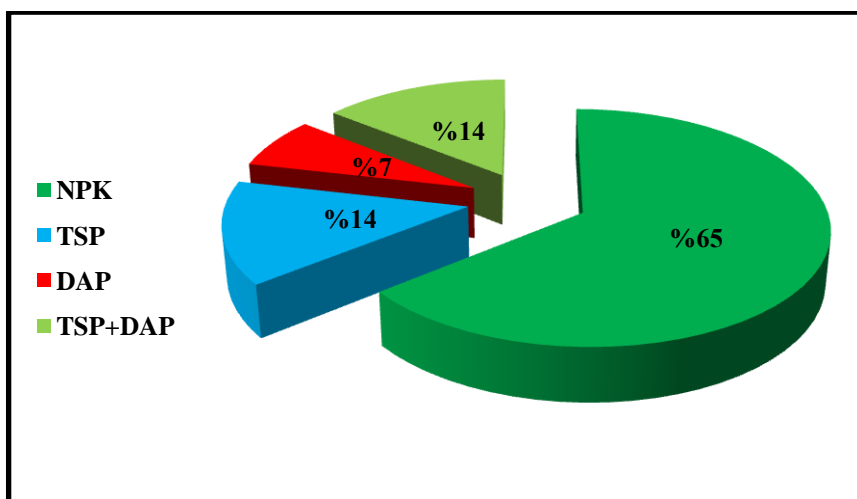


Figure 38. Chemical fertilizers used

According to the farmers' responses, we note that 65% of them use NPK like chemical fertilizers, 14% of farmers TSP and TSP+DAP, and the rest (7%) use the DAP.

II.1.3.5. Crop type

Type of culture used in our study is illustrated in the following figure.

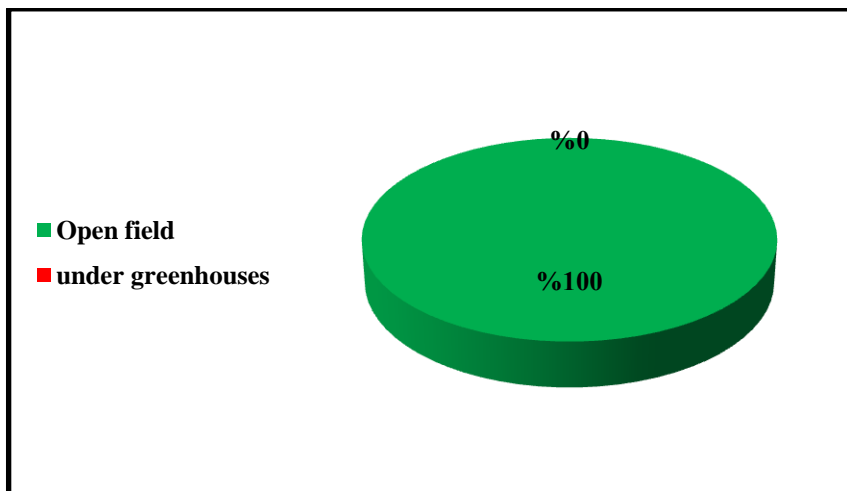


Figure 39. Crop type used

100% of farmers interviewed grow tomatoes in the open field,

II.1.3.6. Irrigation method

Figure 40 shows the irrigation method used by farmers in this study

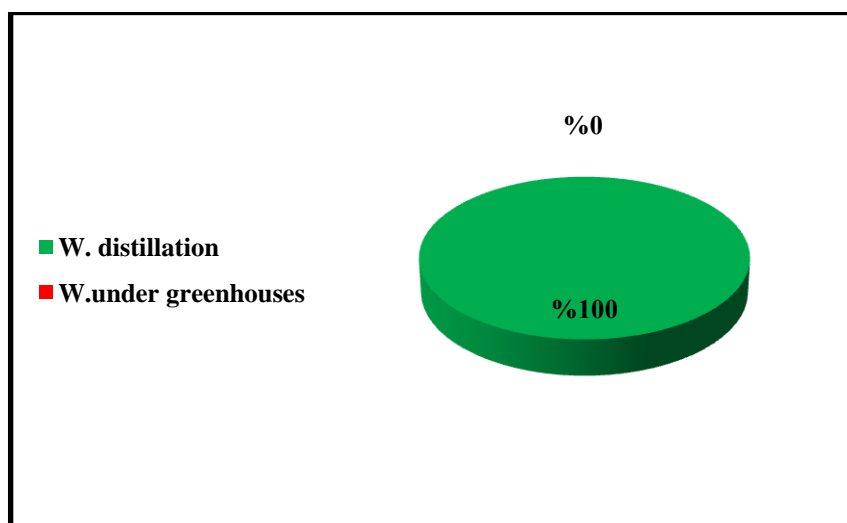


Figure 40. Irrigation method used

All farmers interviewed use the drip watering system and, they all use wells and groundwater for irrigation

II.1.3.7. Use of herbicides

Figure 41 shows the Herbicide use according to the farmers' responses

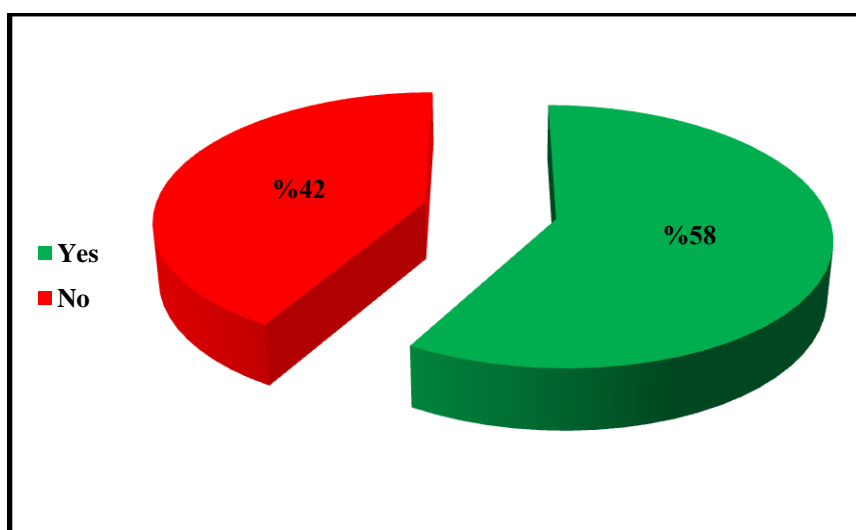


Figure 41. Herbicides use

The results show that more than half (58%) of farmers use Herbicide whereas 42% of them do not use Herbicides.

II.1.3.8. Type of herbicide used

Table 07 summarizes the herbicides used by farmers, their commercial name and their dose per hectare.

Table 07. Herbicides used by farmers (commercial name, dose and stage)

Trade Name	The ratio	Quantity per hectare	stage
VAPCOR®	35%	300 g/he	After planting
SENCORAL®	25%	0,5 Kg/he	After planting
SELECT®	10%	1l/he	Before planting
GOAL®	10%	1l/he	After planting
VAPCOR®+ GOAL® +SENCORAL®	10%	300 g/he / 1l/he / 0,5 Kg/he	After planting
TRAXOS®	5%	1l/he	After planting
GRAMOXONE®	5%	1l/he	Before planting
VAPCOR®+ BASAGRAN	5%	300 g/he / 1l/he	After planting

According to the table, VAPCOR® is the herbicide most used by the farmers surveyed with a percentage of 35% followed by SENOCORAL® with a percentage of 25% and to a lesser extent other herbicides such as SELECT®, GOAL® , TRAXOS®, GRAMOXONE® with percentages of 10 to 5%.

II.1.3.9. Use of pesticides as a preventive measure

Farmers' responses regarding the use of pesticides as a preventive measure are shown in the figure 42.

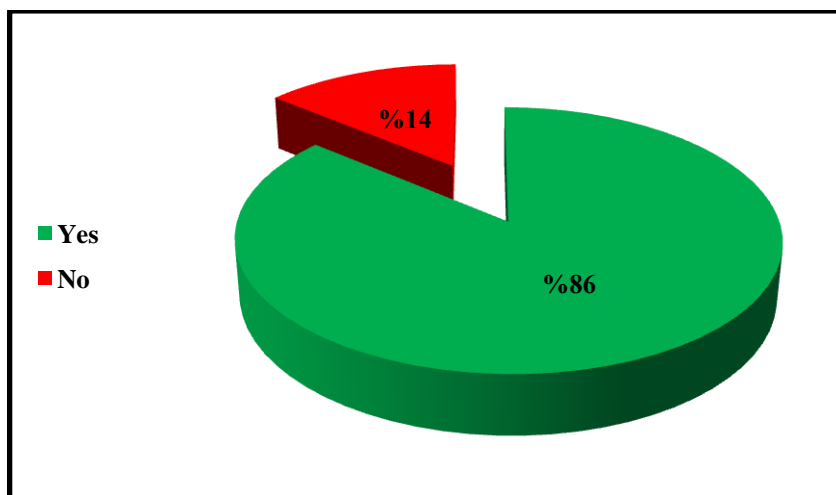


Figure 42. Use of pesticides as a preventive measure

According to these results, the most of farmers surveyed (86%) use pesticides as a preventive measure. However, a few of them (14%) do not use the pesticide as a preventive measure.

II.1.3.10. Type of pesticides used as a preventive measure

Table 08 summarizes pesticides used by farmers, their commercial name and their dose per hectare.

Table 08. Pesticides used by farmers (commercial name, dose and stage)

Trade Name	The ratio	Quantity per hectare	stage
PREVICUR _N ®	42%	200ml/he	After planting
VALLETTE®	11%	1 Kg/he	After planting
SCOR® VALLETTE®	11%	0,5 l/he/1 Kg/he	After planting
SCOR®	8%	0,5 l /he	After planting
TRASOL®+ TACHIGAZOL®	8%	1l /he /1l /he	After planting
ARTIVA®+ VALLETTE®	8%	250ml/he / 1Kg/he	
PREVICUR _N ® VALLETTE®	6%	1l/he	After planting
PROPLANT®	3%	1l/he	After planting
BELTANOL®	3%	1l/he	After planting

According to table 8, 42% of farmers questioned use PREVICUR ® as a preventive measure followed by VALLETTE® and SCOR®+ VALLETTE® with a percentage of 11%. In addition to the use of other pesticides, but in small proportions, such as: SCOR® TRASOL®+ TACHIGAZOL®, ARTIVA®+ VALLETTE® and PROPLANT®

II.1.4. Fungal diseases

II.1.4.1. Fungal diseases that affected tomato crops

The most important fungal diseases that affected tomato crops during these 2 years according to the farmer are shown in the figure 43.

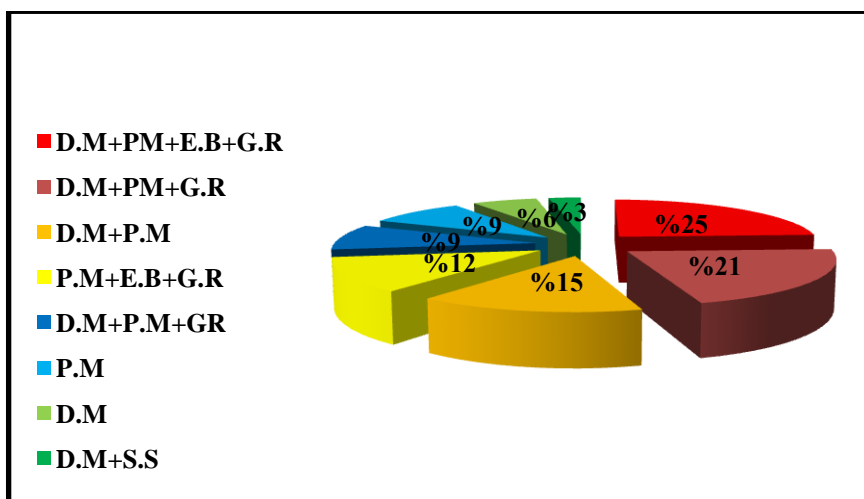


Figure 43. Important fungal diseases that affected tomato crops

The fungal diseases of tomatoes most frequently observed in these two years by farmers in our study are: Downy Mildew+Powdery Mildew+Early Blate+Gray Rot, Downy Mildew+Powdery Mildew +Gray Rot and Downy Mildew+ Powdery Mildew with respective percentages of the order of 25%, 21%, 15% and 12%.

II.1.4.2. Symptoms

The distribution of tomato fungal disease symptoms according to the farmers interviewed is illustrated in the table below.

Table 09. Distribution of farmers' responses according to the nature of the symptoms

Symptoms	The ratio
Yellowing of leaves + white down sporulation on lower leaf surfaces+ Leaves covered by white powder+ grey furry mould covering stems, leaves and fruits	40%
Yellowing of leaves + Leaves covered by white powder +Brown and black spots on fruits+ grey furry mould covering stems, leaves and fruits	21%
white down sporulation on lower leaf surfaces	18%
Leaves covered by white powder	15%
Root rot+ Seedling cracking	6%

According to farmers' responses, the most common symptoms are : Yellowing of leaves + white down sporulation on lower leaf surfaces+ Leaves covered by white powder+ grey furry mould covering stems, leaves and fruits, Yellowing of leaves + Leaves covered by white powder +Brown and black spots on fruits+ grey furry mould covering stems, leaves and fruits, white down sporulation on lower leaf surfaces, Leaves covered by white powder and Root rot+ Seedling cracking avec des pourcentages with respective percentages of 40%, 21%, 18%, 15% and 6%.

II.1.4.3. Favorable conditions

Favorable conditions for the appearance of fungal diseases of tomato according to farmers' responses are shown in the figure 44.

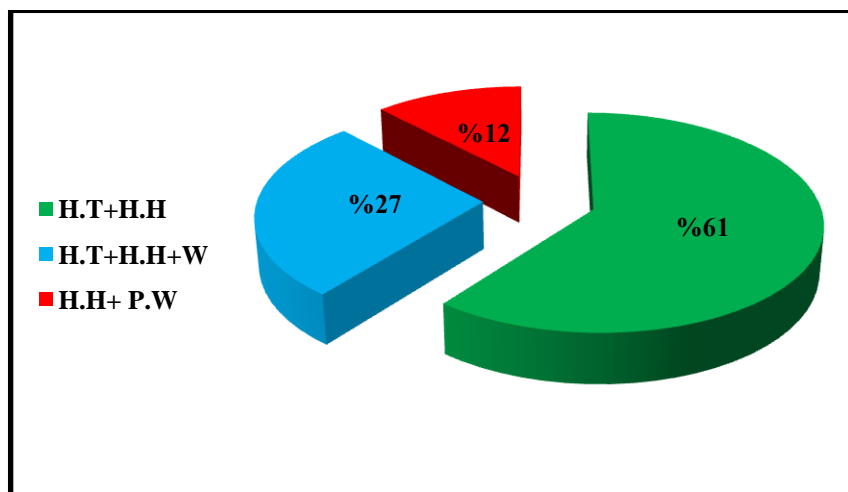


Figure 44. Favorable conditions for the appearance of fungal diseases of tomato

The results show that, 61% of farmers report that High Temperature + High Humidity are the most causes of fungal diseases in tomato crops followed by High Temperature + High Humidity+Wind with 27% and finally ,High Humidity+ Presence of Weeds with 12%.

II.1.4.4. Type of pesticides used as a curative measure

Table 10 summarizes pesticides used by farmers, their commercial name and their dose per hectare.

Table 10. Pesticides used by farmers as a curative measure (commercial name, dose and efficiency)

Trade Name	The ratio	Quantity per hectare	Efficiency
BELTANOL®	17%	1l/he	+++
PREVICUR®	12%	200ml/he	++
SCOR®	12%	200ml/He	+++
TRASOL®+PELTHIO	11%	1l/he /1Kg/he	++ /++
PELTHIO ®	9%	1kg/he	++
TACHIGAZOL®	9%	1l/he	++
SCOR® TACHIGAZOL	6%	200ml/he / 1l/he	+++ / ++
AMISTAR TOP®	6%	200ml/he	+++
PREVICUR®+ALLETTE FLASH®+PHYTO FOSIE®	6%	200ml/he/1Kg/he /1Kg/he	+++ / ++ /++
Fosetyl-Alminum®	6%	250ml/he	+++
PHYTO FOSIE®	3%	1Kg/he	++
ARTIVA®	3%	250ml/he	+++

According to table 10, BELTANOL®, PREVICUR ®, SCOR® and TRASOL®+PELTHIO are the most used pesticides as a curative measure with respective rates of: 17%, 12%, 12% and 11%. In addition to the use of other pesticides, but with low percentages, such as: PELTHIO ® AMISTAR TOP®, PHYTO FOSIE®,.....

II.1.4.5. Date of appearance of fungal diseases in tomato

Figure 45 shows dates of appearance of fungal diseases in tomato

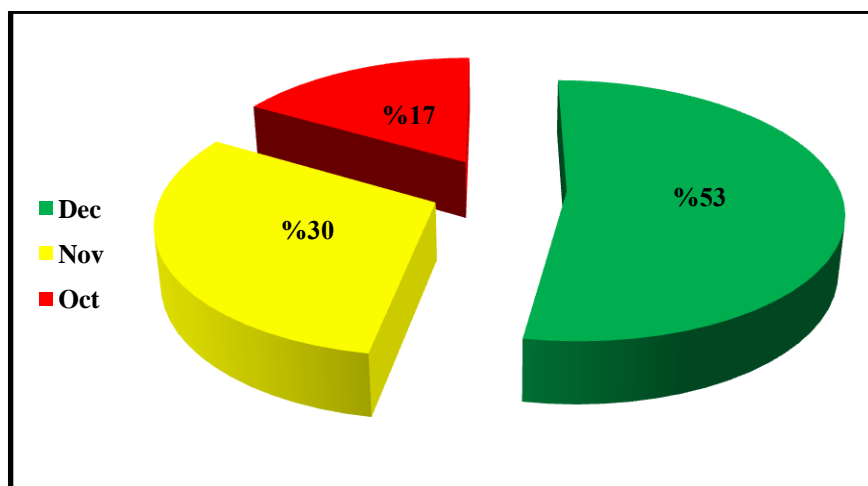


Figure 45. Dates of appearance of fungal diseases in tomato

The results show that, more than half (53%) of farmers report that fungal diseases in tomato appears in December, followed by those who said it appears in November with 30%. While a small percentage of them (17%) confirmed that it appears in October.

II.1.5. Use of pesticides

II.1.5.1. Use protective clothing while spraying

According to farmers' responses the use protective clothing while spraying are shown in the figure 46.

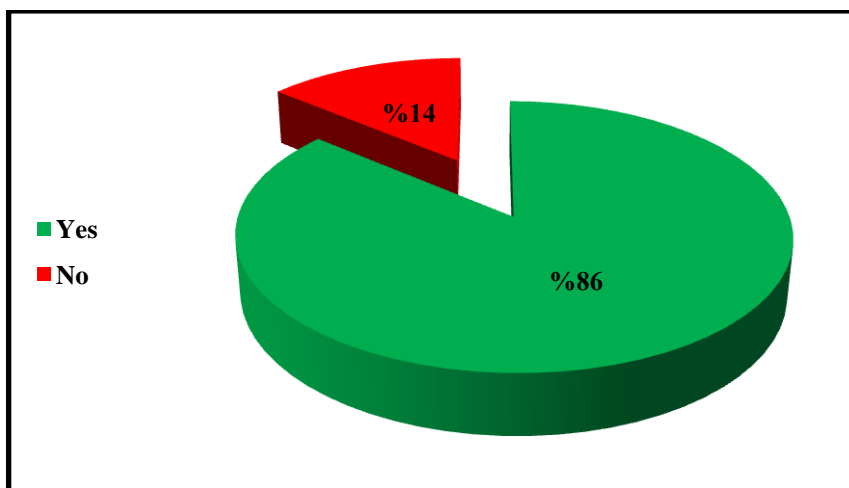


Figure 46. Use protective clothing

According to the results obtained, 86% of farmers use protective clothing while spraying of fungicide. Whereas 14% of them do not use protective clothing.

II.1.5.2. Compliance with the recommended amount of fungicide

Figure 47 shows the compliance with the recommended amount of fungicide by farmers of this study

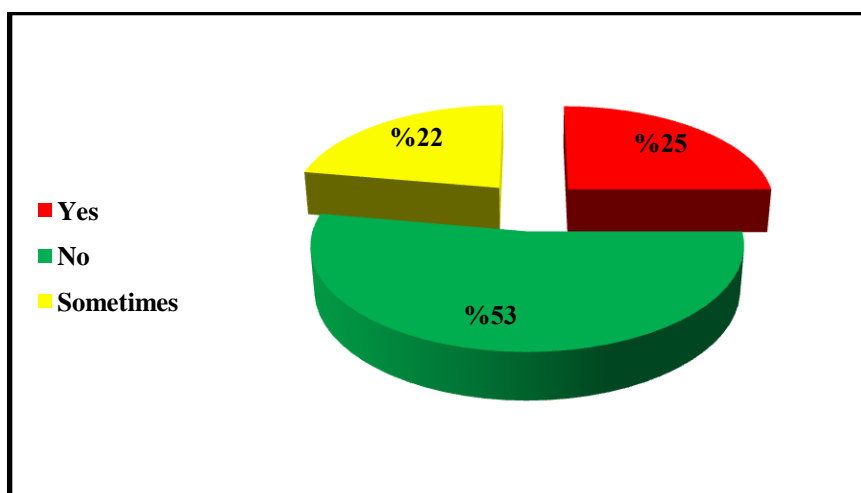


Figure 47. Compliance with the recommended amount of fungicide

More than half (53%) of farmers report that they do not exceed the recommended amount of pesticide. while, 25% of them say that they sometimes exceed the recommended

amount of pesticide. However, 22% of farmers report that they exceed the recommended amount of pesticide.

II.1.5.3. Management of packaging of pesticide used

The figure 48 shows the distribution of farmers according to the answers given regarding how to deal with empty pesticide packaging.

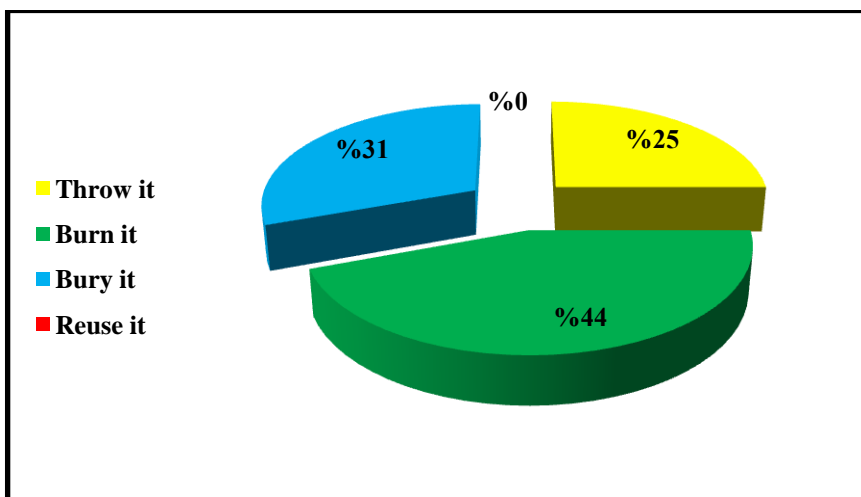


Figure 48. Management of packaging of pesticide used

During our investigation, we found that 44% of farmer burne the packaging and 31% of them bury empty packaging. However, 25% of farmer throw it in the trash.

II.1.5.3. Respecting deadlines before harvest

The rate of respecting deadlines before harvest is illustrated in figure below

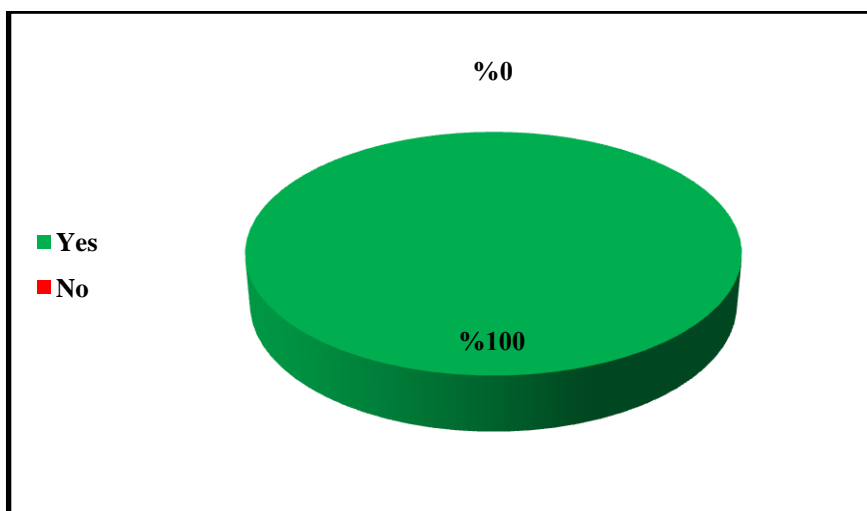


Figure 49: Rate of respecting deadlines before harvest

According to the results of our survey, 100% of farmers say that they respect the time between the last pesticide application and the harvest.

II.1.5.4. Safety period

The safety period according to farmers s reponse is shown in the figure 50.

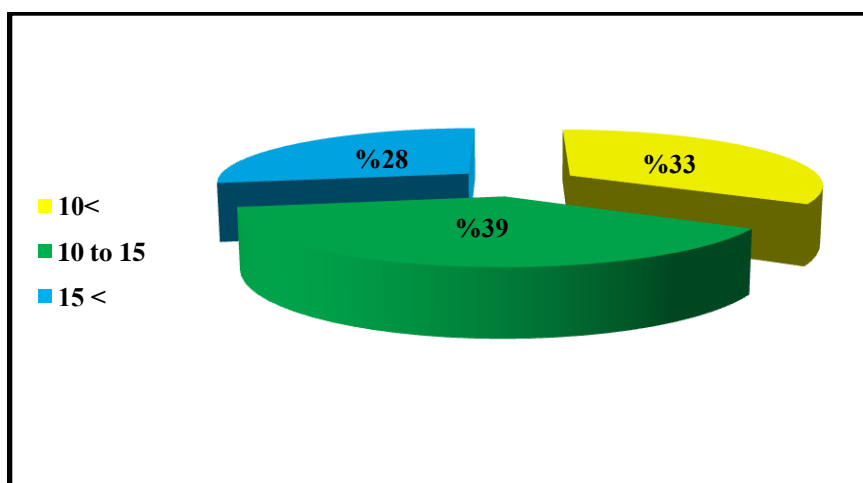


Figure 50. Safety period

Figure 50 shows that 39% of farmers applied a safety period of 10 to 15 days between the last application of pesticides and the harvest; 33% of farmers waited for 2 weeks before starting the harvest and 28% of them applied a safety period of 10 days.

II.1.5.5. Training on the use of pesticides

Rates of training on the use of pesticides is illustrated in figure below

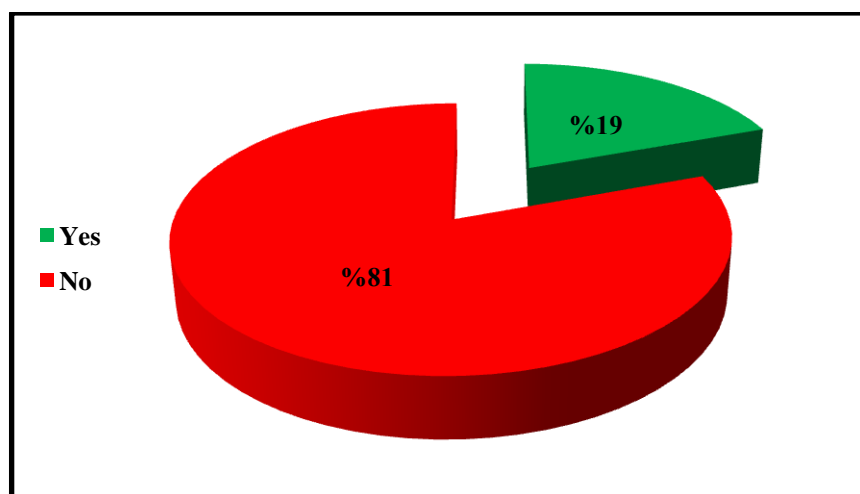


Figure 51. Training on the use of pesticides

We found that among the 36 farmers interviewed only 19% of them have received training on good pesticide practices, while the majority of them, 87% have not received any type of training on good practice of phytosanitary products (Figure 51).

II.2. Discussion

Tomato is the second most important vegetable crop next to potato. In El oued, tomato serves as a cash crop for many farmers. However,, tomato is vulnerable to infection by number of diseases, the most important of which are the fungal diseases such as early blight, powdery mildew, late blight and gray rot. Theses diseases can reduce yields of the crop significantly. the objectives of the study were to determine the major fungal diseases of tomatoes and document farmers' knowledge of these diseases and their control measures in six municipality of El Oued region.

II.2.1. Population characteristics

The results show that the surveyed farmers are 100% male, and this is due to the nature and traditions of the region, where men are the only specialized group in the field of agriculture. Farmer in this study have different educational levels ranging from average to university with the predominance of the secondary level and the university level. However, the level of education has a more or less remarkable effect; because it can directly influence the development and improvement of agricultural techniques. According to Kaoua (2001) the level of education constitutes an indication of openness to modern farming techniques but also the keeping of accounts capable of helping agriculture in its decisions. Most of the farmers included in our study are young people, because agriculture requires muscular effort and great efficiency.

II.1.2.Characteristics of culture

We note the importance given to tomato cultivation on the farms surveyed. The total areas of the farms surveyed are different sizes, thus the areas of tomatoes cultivated are proportionately vast. the products are exclusively oriented towards marketing, 100% of the farm's products are intended for local or national markets for sale. According to the results obtained,, tomato + potato + pepper and onion are the most frequently cultivated crops in the study region, in fact, the tomato and the potato are from the same family so they have many common pathogens, on the other hand, Marguerie (2011) mentioned that the greater the diversity of families within a farm, the more the problems of telluric pathogens will have a chance of being better controlled.

The most common varieties cultivated by the farmers in our study are: Salima (H1) + Mercure (H1) + Petra (H1), Loubana (H1) + Joker (H1) +Chebli (H1), This result is comparable to the results recorded by Gharaissa and Askri (2020).In a survey on the tomato situation in the El-Oued region they reported that Salima, Petra, Mercur, Aya, Maysaloun, Farida are the most varieties of tomato in the El Oued region. The use of these varieties for

economic and technical reasons such as, Favorable market for these varieties and less expensive and the resistance to diseases and pests. Easy adaptation to climatic and edaphic conditions.

The majority of farmers questioned, have completed the agricultural cycle each year. The tomato is very demanding in elements, and sensitive to various fungal diseases such as late blight, powdery mildew, early blight,..... To prevent their spread, it is essential to practice crop rotation. The objective of the rotations is to avoid the accumulation in the soil of spores of phytopathogenic agents and secondarily of pest larvae (Schröder *et al.*, 2015).

II.1.3. Technical field works

More than half of farmers practice superficial tilling. Before planting, tilling depth by the farmers is between 15-25cm. Tillage changes soil's physical and chemical properties, thus, affecting the fungal community structure (Jirout *et al.*, 2011). Storey *et al.* (2006) also showed that most of the pathogenic fungi existed in the 0–5 cm profile in NT sandy loam soil. Therefore, this process contributes to reducing the fungi that cause diseases in tomato crops. Most of the participating farmers in this study use in the fertilization process organic fertilizers (manure from sheep and chicken) in addition to chemical fertilizers, and most of them use NPK like chemical fertilizers. NPK are used in the soil to supplement the materials necessary for plant growth in all its cycles and to correct the insufficiency of organic matter. This result is comparable to the results recorded by Ouattara (2016) in Burkina Faso in his study on the characterization of market gardening production systems and analysis of the determinants of soil fertility under market garden crops in the Houet province (Burkina Faso) which reported that mineral fertilization is practiced by 98.96 % of market gardeners and organic fertilization is frequently associated with it (91.67%). The average annual quantity of mineral fertilizers (NPK + urea) used is 693.94 kg/ha.

Drip technology is used by all farmers in the Oued souf region, it is a very effective and compatible economical method of irrigation because it saves electrical energy and water and the determination of weeds and saves irrigation time and helps good distributions fertilizers but the big problem is the blocking of holes by sand and limestone. This is the technique preferred by most specialists in the field, and this result is confirmed by the study carried out by (Gharaisa and Askri, 2020).

Weeds are considered as reservoirs for destructive plant pathogens, insect vectors that transfer pathogens from one plant to another, or both. Farmers do not practice manual weeding techniques, which partly justifies the high demand for herbicides. Farmers apply chemicals because they are effective and easy to apply.

For the control measures taken by farmers, they are preventive and curative to ensure the best in quantity and quality, but they prefer the chemical method because it is effective and requires the least effort.

II.1.4. Fungal disease of tomato

For this purpose, we have identified five fungal diseases, these are odium; downy mildew, gray rot, *Alternaria* and split plants and verticillium wilt. odium, gray rot, downy mildew, are the diseases that have affected almost all tomato plots. Early blight attacked some plots, all these diseases most often occurred around December and November. The results of this survey are comparable to the results of Kaouachi (2020) who reported that downy mildew, gray rot and seedling crack are the main fungal diseases recorded in the El Oued region with different percentages depending on the station, similarly, Rahmouni (2020) in a study on pests in tomato crops in the wilaya of Adrar found that *Alternarium*, gray rot, powdery mildew and *Fusarium* wilt are the main fungal diseases recorded on the tomato cultivation. Indeed, several factors can be at the origin of fungal diseases, namely repeated humidity, temperature, poor soil quality, vulnerability of certain varieties, etc. Rotem and Palti, (1969) reported that irrigation methods can also have significant effects on the development of plant diseases, hence Nischwitz et al. (2004) suggested that drip irrigation may contribute to a higher incidence of smut rot disease on melons. In the other hand the most common symptoms are : Yellowing of leaves + white down sporulation on lower leaf surfaces+ Leaves covered by white powder+ grey furry mould covering stems, leaves and fruits,. These symptoms are characteristic symptoms of the diseases found. These results are comparable to the results of Rahmouni (2020) who reported according to the diseases identified such as, the presence of a white down on the underside, yellowing of the leaves, brown and damp rots. ,.....

According to our results, BELTANOL®, PREVICUR ®, SCOR® and TRASOL®+PELTHIO are the most used pesticides as a curative measure on the other hand Ouchebbouk and Zibani-Amokrane (2015) recorded that Aliette Flash followed by Manèbe are the fungicides most used either for preventive or curative purposes in the regions of Tizi-Ouzou, Bouira and Boumerdes, also Aissat (2008) reported that dithiocarbamates (Manèbe, Zinèbe, etc.) are the most used fungicides; their use is systematic in the majority of farms surveyed in the wilaya of Bejaia. Indeed, there are multiple names on the market for products whose active ingredient or mode of action is the same. The choice of a fungicide is made according to their purchase price and their effectiveness.

II.1.5. Use of pesticides

In our survey, all the farmers who interviewed us respected the dosage of the products used. Our results are comparable to those obtained by Yaiche Temam (2019) in Biskra, who reported that 86% of respondents respect the recommended doses, however 14% do not pay attention to the doses. The use of pesticides, even at respected doses, is not without danger for the environment (they are a major factor affecting biological diversity, as well as habitat loss and environmental change). climate, they are notably toxic for humans, that this would in fact correspond, just to respecting the doses approved by the regulations or by the manufacturer itself, without any real reduction in the intensity of use of the latter.

From our study, it appears that 86% of farmers protect themselves against 14% who do not adopt any protection. Our results are almost inversely proportional to those obtained by Cisse et al. (2006) note that in all the sites studied, more than 85% of market gardeners do not have any protective equipment. the use of protective clothing, which is very recommended (Nilsson, 1996), Ignorance regarding the harmful effects of pesticides, high cost, no availability of these equipments and their discomfort are the raisons evocated by vegetable growers interviewed. This is in according with studies carried out in other countries (Cole et al., 2002; Issa et al., 2006).

Proper pesticide waste disposal is also an important part of responsible pesticide use. Accidental release or uncontrolled discharge of pesticide waste into the environment can harm people and contaminate the environment (Damalash et al., 2008). In this study, 44% of farmer burn the packaging and 31% of them bury empty packaging. However, 25% of farmer throw it in the trash. These results are comparable to the WADE result (2003) in Togo where 20% of farmers send their packaging to a landfill. Burning packaging in the open air results in the emission of greenhouse gases, notably CO₂, methane (CH₄) and nitrous oxide (N₂O).

All of farmers in our study say that they respect the time between the last pesticide application and the harvest and they applied a safety period of 10 to 15 days. Even in his study, Wade (2003) reported that most of the market gardeners surveyed know that they must respect the DAR, also, Cisse et al. (2006) show that the average waiting period adopted by producers is between 10 and 14 days. the duration before harvest. Indeed, the duration before harvest depends on the phytosanitary product, it is mentioned on the packaging of each product. It must be respected to avoid possible accumulation of pesticide residues in agricultural products. Therefore, non-compliance with recommended dosages and deadlines before harvest therefore constitute risk factors for consumers, due to the presence of residues higher than acceptable standards for foodstuffs.

The majority of farmers questioned did not have training on the method of applying pesticides. These results are comparable to those of Kanda et al (2013), who reported that the rate of market gardeners trained in the application of pesticides in their study is low and overall low. The lack of training and information for producers would constitute a source of error for pesticide under-dose or overdose during the vegetables treatment. Under-dose could lead to pest resistance and would increase further application of pesticides by growers, focusing good harvest. Thus, the cumulative effects of such exposure over long periods could constitute a significant risk to farm workers (Clarke et al., 1997),

Conclusion

Conclusion

Tomato cultivation is subject to several diseases and pests, including fungal diseases which cause significant damage and loss of yield and given the economic importance in the world and even in Algeria, It is within this framework that our study whose objective is the determination of the main fungal diseases of tomatoes in El Oued region and their periods of appearance as well as the main fungicides used by farmers for preventive and curative purposes, the results of our survey show that:

- ✚ The majority of individuals participating in this study were aged between 20 and 39 years old and all of them are males.
- ✚ The most of the farmers surveyed have own private lands.
- ✚ All farmers grow market garden crops, but in varying proportions, the most important of which are tomatoes, potatoes, peppers, and onions
- ✚ Several varieties were cultivated by farmers the most important of them are Salima (H1) + Mercure (H1) + Petra (H1) and they choose these varieties for their good quality + resistant to diseases + commensurate with the nature of the region,
- ✚ The majority of farmers have completed the agricultural cycle each year and practice superficial tilling specially before planting In addition to using NPK like chemical fertilizers and the drip watering system and, they all use wells and groundwater for irrigation
- ✚ More than half of farmers use Herbicide like VAPCOR® and SENOCORAL.
- ✚ the Most of farmers surveyed use pesticides as a preventive measure like PREVICUR, ® VALLETTE® and SCOR®
- ✚ The fungal diseases of tomatoes most frequently observed by farmers in our study are: Downy Mildew+Powdery Mildew+Early Blate+Gray Rot. With the following symptoms : Yellowing of leaves + white down sporulation on lower leaf surfaces+ Leaves covered by white powder+ grey furry mould covering stems, leaves and fruits,
- ✚ BELTANOL®, PREVICUR ®, SCOR® and TRASOL®+PELTHIO are the most used pesticides as a curative measure
- ✚ All of farmers say that they respect the time between the last pesticide application and the harvest and applied a safety period of 10 to 15 days

The results obtained in this study show that prior knowledge of diseases threatening tomato cultivation allows us to intervene upstream of these diseases to reduce their impact and to reduce the use of pesticides.

Finally, this survey was intended to be a source of information on tomato cultivation and the main fungal diseases which attack it as well as on the use of pesticides by farmers in the region. And in order to fight in an efficient and effective manner, minimize the affections of this culture as much as possible; certain precautions are necessary at different levels:

- ✚ Use resistant varieties.
- ✚ Plant healthy seeds
- ✚ opt for good cultural practices and integrated disease control in the field.
- ✚ Tomato fields must be monitored to identify problems and find optimal solutions as quickly as possible.

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Annexes

للفلاحين
ضمن مشروع انجاز مذكرة ماستر في الإنتاج النباتي

حدد (X) الإجابة المناسبة

الجنس: ذكر انثى
العمر: ≥ 60 40-59 20-39
المستوى التعليمي: لا شيء ابتدائي متوسط ثانوي جامعي
المنطقة:

طبيعة الملكية:

جماعية فردية خاص كراء
المساحة الإجمالية:

المساحة الصالحة للزراعة:

متى تقوم بالسقي: صباحا مساء ليلا
مصدر ما السقي:

طريقة السقي:

هل عندك تكوين في الفلاحة: نعم لا
ما نوع المزروعات: طماطم بطاطا فلفل بصل ثوم اخرى
ما هي أصناف بذور الطماطم المزروعة:

هل تعرف خصائص هذه الأصناف المزروعة: نعم لا
لماذا اخترت هذه الأصناف: نوعية جيدة انتاجها وفير مقاومتها للأمراض
تتناسب مع طبيعة المنطقة اخرى

هل تطبق الدورة الزراعية: نعم لا
كيف تطبقها: كل سنة كل سنتين

الأعمال التقنية على الارض

هل تقوم بحرث الارض: نعم لا
طبيعة الحرث: عميق سطحي
التوقيت: الربيع الخريف الصيف الشتاء قبل الزراعة مباشرة اخرى
.....

عمق الحرث: >25 15-25 <15
هل قمت بعملية التسميد: نعم لا

طبيرة السماد: NPK سلفات البوتاس TSP DAP اخرى
 وقت التسميد: قبل الزراعة بعد الزراعة اخرى
 مكافحة الأعشاب الضارة: نعم لا

اذا كانت الاجابة بنعم املا الجدول :

المرحلة	الكمية في الهكتار	الاسم التجاري

المرحلة: قبل الزرع: 1 بعد الزرع: 2 اثناء الحرث: 3 بعد الحرث: 4 اخرى: 5
اذكرها.....

هل تستعمل مبيدات فطرية وقائية: نعم لا

اذا كانت الاجابة بنعم املا الجدول :

المرحلة	الكمية في الهكتار	الاسم التجاري

المرحلة: قبل الزرع: 1 بعد الزرع: 2 اثناء الحرث: 3 بعد الحرث: 4 اخرى: 5
اذكرها.....

اذا كانت الإجابة بلا ماهي الأسباب :

غلاء اسعار المبيدات

عدم توفر الوسائل اللازمة

اخرى

الأمراض الفطرية:

ما هي اهم الامراض الفطرية التي اصابت محصولك خلال السنتين الاخيرتين؟

اسم المرض	
البياض الزغبي	
البياض الدقيقي	
الندوة المتاخرة	
الندوة المبكرة	
العفن الرمادي	
شق الشتلات	
اخرى	

ما هي اهم الاعراض التي لاحظتها؟

الاعراض	
اصفرار للأوراق	
عفن الجذور	
بقع بنية أو سوداء على الثمار	
بقع بصورة حلقات دائرية على الاوراق	
بقع بنية خضراء زيتية على الثمار	
بقع مسحوقية بيضاء تغطي اعلى الاوراق	
زغب أبيض	
تشقق في الشتلات	
اخرى	

حسب ما لاحظته ما هي اهم العوامل المساعدة على ظهور الامراض الفطرية؟

	الحرارة المرتفعة
	الحرارة المنخفضة
	الرطوبة العالية
	الرطوبة المنخفضة
	الرياح
	الاضاءة القوية
	نوعية البذور مع تحديد النوع الاكثر حساسية
	وجود الاعشاب الضارة
	اخرى

ماهي اهم المبيدات الفطرية العلاجية التي تم استعمالها خلال هذه السنة وحدد اكثرها فعالية؟

الاسم التجاري للمبيد	الكمية في الهكتار	الفعالية

الفعالية:- :غير فعال +: فعالية حسنة ++: فعالية جيدة +++: فعالية ممتازة

طريقة استعمال المبيد الفطري:

- هل تستعمل ملابس واقية اثناء الرش؟ نعم لا
- هل تتجاوز الكمية الموصى بها؟ نعم لا
- كيف تتخلص من بقايا المبيدات؟ رميها في الزباله حرقها جمعها ودفنها اخرى

.....

متى تقطف الثمار بعد الرش؟

- >15 j 10-15 j < 10j
- هل حضرت في تكويننا عن كيفية استخدام المبيدات؟ نعم لا

شكراً لكم على الوقت الذي استغرقتموه لإكمال هذا الاستبيان.

- شكرا لتعاونكم

Table 01. Herbicides used by farmers (commercial name, Active Ingredient)

Trade Name	Active Ingredient
VAPCOR®	Mutribuzine
SENCORAL®	Métribuzine
SELECT®	Cléthodime
GOAL®	Oxyfluorène
TRAXOS®	Pinoxaden + clodinafop-pr opargyl + 1 cloquintocet-mexyl.
GRAMOXONE®	Pyridiniums
BASAGRAN	bentazone

Table 02. Pesticides used by farmers (commercial name, Active Ingredient)

Trade Name	Active Ingredient
BELTANOL®	Chinosol
PREVICUR®	Propamocarb hydrochloride
SCOR®	difénoconazole
TERRASOL®	Hymexazol
PELTHIO ®	Thiophanate –Methyl
TACHIGAZOL®	Hymexazol (Potassium Salt)
AMISTAR TOP®	Azoxystrobin and difenoconazole
ALIETTE FLASH®	Fosetyl-aluminium
PHYTO FOSIE®	Fosetyl-aluminium
ARTIVA®	Asoxystrobine
PROPLANT®	Propamocarbe - hci
VALLETTE®	Fosetyl-aluminium

Abstrat

Abstract

Tomato (*Lycopersicon esculentum L.*) is the most popular vegetable in the world, but it is vulnerable to infection by a number of diseases, the most important of which are fungal diseases. The main objective of this study is to determine the main fungal diseases of tomatoes and to document the knowledge of farmers on these diseases and their control measures in some communes of the wilaya of Oued Souf. The investigation was carried out took place in the period from July to August 2023. In total, 36 questionnaires were distributed to tomato farmers in 6 different municipalities. Our survey results show that: 67% of farmers aged between 20 and 39 years old. 39% of them having a secondary level. 78% of the farmers interviewed own their own land, all farmers cultivate market garden crops but with varying proportions. Tomatoes, potatoes and peppers are the most cultivated vegetables (36%). Tomato varieties; Salima (H1) + Mercury (H1) + Petra (H1) are the most cultivated with a percentage of 34%, more than half (61%) of the farmers practice superficial plowing of 15 to 25 cm and the majority of Among them (70%) use organic fertilizers in addition to chemical fertilizers for fertilization and all farmers use the drip system for irrigation, the majority of them use herbicides like VAPCOR® and SENOCORAL and preventive pesticides such as PREVICUR, ® VALLETTE® and SCOR®. The most frequently observed fungal diseases of tomatoes are: Downy mildew + Powdery mildew + Alternaria + Gray rot. With the following symptoms: Yellowing of leaves + sporulation of white down on leaves + Leaves covered with white powder + hairy gray mold covering stems, leaves and fruits and the use of BELTANOL®, PREVICUR ®, SCOR® and TRASOL® +PELTHIO as treatment. All agricultural surveys respect the dose of fungicide and the time before harvest. 87% of them did not receive any training on good pesticide practices. In general, farmers perceived knowledge of tomato diseases due to the losses caused by these diseases, but their knowledge on the use of pesticides was poor.

Key words: tomato, fungal diseases, pesticides, El Oued, survey, farmers.

Résumé

La tomate (*Lycopersicon esculentum L.*) est le légume le plus populaire dans le monde, mais elle est vulnérable à l'infection par un certain nombre de maladies, dont les plus importantes sont les maladies fongiques. Les principal objectif de cette l'étude est de déterminer les principales maladies fongiques de la tomate et de documenter les connaissances des agriculteurs sur ces maladies et leurs mesures de contrôle dans quelques communes de la wilaya d'Oued Souf, L'enquête s'est déroulée dans la période de Juillet à Aout 2023. Au total, 36 questionnaires ont été distribués sur les agriculteurs du tomates dans 6 communes différentes. Les résultats de notre enquête montrent que: 67% des agriculteurs âgés de 20 à 39 ans. 39% d'entre eux ayant un niveau secondaire. 78% des agriculteurs interrogés possèdent leur propre terre,tous les agriculteurs cultivent des cultures maraichaires mais avec des proportions variables. La tomate, la pomme de terre et le poivron sont les legumes les plus cultivés 36%. Les variétés de tomate; Salima (H1) + Mercure (H1) + Petra (H1) sont les plus cultivés avec un pourcentage de (34%), plus de la moitié (61 %) des agriculteurs pratiquent un labour superficiel de 15 à 25 cm et la majorité d'entre eux (70 %) utilisent des engrais organiques en plus des engrais chimiques pour la fertilisation et tous les agriculteurs utilisent le système goutte à goutte pour l'irrigation, la majorité d'entre eux utilisent des herbicides comme VAPCOR® et SENOCORAL et des pesticides à titre préventif comme PREVICUR, ® VALLETTE® et SCOR®. Les maladies fongiques de la tomate les plus fréquemment observées sont : Mildiou + Oïdium + Alternariose + Pourriture grise. Avec les symptômes suivants : Jaunissement des feuilles + sporulation de duvet blanc sur feuilles + Feuilles recouvertes de poudre blanche + moisissure grise velue recouvrant les tiges, les feuilles et les fruits et l'utilisation de BELTANOL®, PREVICUR ®, SCOR® et TRASOL®+PELTHIO comme des traitement. Toutes les agricultures enquêtes respectent la dose des fongicide et le délai avant récolte. 87% d'entre eux n'ont reçu aucune formation sur les bonnes pratiques pesticides,En général, les agriculteurs percevaient une connaissance des maladies de la tomate en raison des pertes causées par ces maladies, mais leurs connaissances sur l'utilisation des pesticides étaient médiocres.

Mots clés : tomate, maladies fongiques, pesticides, El Oued, enquête, agriculteurs.

الملخص

تعتبر الطماطم (*Lycopersicon esculentum L*) من أكثر الخضروات شعبية في العالم، إلا أنها معرضة للإصابة بعدد من الأمراض أهمها الأمراض الفطرية. الهدف الأساسي من هذه الدراسة هو تحديد أهم الأمراض الفطرية التي تصيب الطماطم وتوثيق معارف الفلاحين حول هذه الأمراض وإجراءات مكافحتها ببعض بلديات ولاية واد سوف، وقد أجريت هذه الدراسة في الفترة من من يوليو إلى أغسطس 2023. في المجمل، تم توزيع 36 استبياناً على مزارعي الطماطم في 6 بلديات مختلفة. تظهر نتائج المسح الذي أجريناه أن: 67% من المزارعين تتراوح أعمارهم بين 20 إلى 39 عاماً. 39% منهم حاصلون على المستوى الثانوي. 78% من المزارعين الذين تمت مقابلتهم يمتلكون أراضيهم الخاصة، وجميع المزارعين يزرعون المحاصيل التسويقية ولكن بنسب متفاوتة. تعتبر الطماطم والبطاطس والفلفل من أكثر الخضروات زراعة (36%).، أصناف الطماطم سليمة (H1) + ماركير (H1) + بترا (H1) هي الأكثر زراعة بنسبة 34%، وأكثر من نصف (61%) المزارعين يمارسون الحرث السطحي من 15 إلى 25 سم وأغلبية المزارعين (70%) يستخدمون الأسمدة العضوية بالإضافة إلى الأسمدة الكيماوية للتخصيب ويستخدم جميع المزارعين نظام التنقيط للرري، ويستخدم غالبيتهم مبيدات الأعشاب مثل VAPCOR® و SENOCORAL® والمبيدات الوقائية مثل PREVICUR® و VALLETTE® و SCOR®. الأمراض الفطرية الأكثر شيوعاً في الطماطم هي: البياض الزغبي + البياض الدقيقي + الندوة البدرية + العفن الرمادي. مع الأعراض التالية: اصفرار الأوراق + ظهور تبوغ أبيض على الأوراق + تغطية الأوراق بمسحوق أبيض + العفن الرمادي المشعر الذي يغطي السيقان والأوراق والثمار واستخدام BELTANOL® و PREVICUR® و SCOR® و TRASOL® + PELTHIO® كعلاج. تحترم جميع المزارعين جرعة مبيد الفطريات والوقت قبل الحصاد. 87% منهم لم يتلقوا أي تدريب على الممارسات الجيدة للمبيدات، وبشكل عام كان لدى المزارعين إدراك لأمراض الطماطم بسبب الخسائر التي تسببها هذه الأمراض، ولكن معرفتهم باستخدام المبيدات كانت متوسطة.

الكلمات المفتاحية: الطماطم، الأمراض الفطرية، المبيدات، الوادي، استبيان، المزارعين.

Abstract

Tomato (*Lycopersicon esculentum L.*) is the most popular vegetable in the world, but it is vulnerable to infection by a number of diseases, the most important of which are fungal diseases. The main objective of this study is to determine the main fungal diseases of tomatoes and to document the knowledge of farmers on these diseases and their control measures in some communes of the wilaya of Oued Souf. The investigation was carried out took place in the period from July to August 2023. In total, 36 questionnaires were distributed to tomato farmers in 6 different municipalities. Our survey results show that: 67% of farmers aged between 20 and 39 years old. 39% of them having a secondary level. 78% of the farmers interviewed own their own land, all farmers cultivate market garden crops but with varying proportions. Tomatoes, potatoes and peppers are the most cultivated vegetables (36%). Tomato varieties; Salima (H1) + Mercury (H1) + Petra (H1) are the most cultivated with a percentage of (34%), more than half (61%) of the farmers practice superficial plowing of 15 to 25 cm and the majority of Among them (70%) use organic fertilizers in addition to chemical fertilizers for fertilization and all farmers use the drip system for irrigation, the majority of them use herbicides like VAPCOR® and SENOCORAL and preventive pesticides such as PREVICUR, ® VALLETTE® and SCOR®. The most frequently observed fungal diseases of tomatoes are: Downy mildew + Powdery mildew + Alternaria + Gray rot. With the following symptoms: Yellowing of leaves + sporulation of white down on leaves + Leaves covered with white powder + hairy gray mold covering stems, leaves and fruits and the use of BELTANOL®, PREVICUR®, SCOR® and TRASOL® + PELTHIO as treatment. All agricultural surveys respect the dose of fungicide and the time before harvest. 87% of them did not receive any training on good pesticide practices. In general, farmers perceived knowledge of tomato diseases due to the losses caused by these diseases, but their knowledge on the use of pesticides was poor.

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