Study on protective measures against diseases of almonds caused by fungi: A case study in Tashkent region of Uzbekistan

D Yuldosheva1*, O Khujaev1, R Gulmurodov2, and Sh Gulmurodova2

1Research Institute of Forestry, 111104 Tashkent, Uzbekistan
2Tashkent State Agrarian University, 100140 Tashkent, Uzbekistan

*Email: flora111191@gmail.com

Abstract. Among the fruit trees, almond has a special place and is an ancient and traditional type of fruit crop for many countries of the world. Leading research centers around the world have conducted research to study the prevalence, development, damage, and control measures of the almond tree fungi Stigmina carpophila and Monilinia cinerea, which cause widespread perforated spot and moniliosis burns. As a result, it was possible to preserve the almond crop lost under the influence of these diseases. Even today, research aimed at developing effective measures to control the fungal diseases of the almond tree remains relevant.

1. Introduction
Almond is a fruit tree belonging to the group of nut crops. But from a botanical point of view, since it belongs to the bean fruit trees, its diseases and the causative agents of these diseases are also the same as those of these crop species. Therefore, in order to fully reveal the biology of almond diseases and the fungi that cause them, information was also provided on the diseases of bean fruit trees.
Usually the yield of almonds is very low and almond orchards suffer from many pests and diseases [1]. But in recent years, the introduction of modern technologies in almond cultivation (drip irrigation, planting high-yielding varieties, etc.) has allowed to increase its yield and quality [2]. The use of these technologies has led to an increase in almond yields as well as a resurgence of new phytosanitary or existing old problems. The most important of these is to increase the damage of existing diseases and the emergence of new ones. In particular, these technologies have made almonds more susceptible to fungal infections. Pathogenic fungi infect almond flowers, fruits, leaves, twigs, stems and main tree trunks [3]. The roots and stems of peach and plum hybrids, which serve as a graft for almonds, can be damaged by diseases caused by various fungi. While some of these diseases occur in nurseries themselves and cause great damage, more diseases are observed in almonds, which cause a decrease in yield and deterioration of quality throughout the growing season of the plant [4]. While some of these diseases are recorded annually, leading to reduced yields, others have been found to cause significant damage in the years leading up to the development of the disease.
These diseases are found in all legumes except almonds, and because their pathogens are the same, they have also been reported in some literature relating to these crop species. Burning of almond flowers occurs everywhere where this type of crop is grown. Under the influence of this disease not only the almond blossoms are burned, but also its fresh cave fruits are damaged, and brown rot is observed in them. The flesh (bark) of the fruits of legume trees loses a large part of the crop as a result of rot due to this disease. The disease is caused by M.fructicola Winter (Honey) and M.cinerea Bonord species belonging to the genus Monilia belonging to the genus Ascomycota [5, 6, 7].
These two species of fungi are important as pathogens. Among them, M. cinerea is more prevalent, and this pathogen has been recorded in areas with slightly cooler and higher humidity, especially in spring times. The first signs of the disease begin with the burning of flower buds. Subsequent burns are observed in the corolla, nodule, and bouquet. Sick flowers wither, turn brown and fall off. Some are preserved by sticking to the rod. The sporodoxia of the pathogenic fungus develops in the affected flowers, especially in the inflorescences. The leaves around the flower wither, and the twigs wither. Light brown sores appear under the bark of the affected branch. Such lesions surround the twig, and the leaves turn brown and hang on the twig as they wither.

In spring, conidia, which are the product of asexual reproduction of the fungus on damaged flowers, twigs and fruits. The M. cinerea species produces the most spores when the temperature is 100°C [8]. The M. fructicola species, on the other hand, produces apothecia with ascospores [9]. Temperature and humidity play an important role in the development of burn disease of almond flowers [10]. The disease develops rapidly in the temperature range of 4-300°C, especially when there is a lot of precipitation during the flowering of almonds, and the most favorable temperature for its development is 250°C. Almonds bloom from a temperature of 150°C. Conidia of the fungus that causes burns germinate for 3-5 hours at a temperature of 20°C and after 7-8 hours have the property of damaging almond blossoms. In such flowers the symptoms of the disease appear after 3–6 days.

In the U.S., captan, captafol, and cumin fungicides used throughout the year against almond-infested diseases of Monilinia laxa, Botrytis sp, and C. carphophilum have yielded effective results [11]. These fungicides preserved the almond crop. These pathogens severely damaged almond leaves, twigs and fruits. Effective results were obtained when treating diseased almond trees with the above fungicides during flowering and after flowering. All three of these diseases have been observed to develop strongly when there is heavy rainfall. In the U.S. state of California, where rainfall is high, these characteristics of disease-causing fungi are always taken into account. But because the San Joaquin Valley is located in the southern United States, it is observed that the damage from the above diseases of almonds is low here. Many farmers use almond-containing chemical compounds against these diseases.

Stognienko (2007) [12] studied the disease of moniliosis in bean fruit trees in the Central Black Earth region of Russia. The disease was caused by Monilia cinerea Ehrend and the fungus overwintered in the affected organs of the plants. In recent years, cherry moniliosis has been observed to cause significant damage in this region [13]. The main reason for this was believed to be climate change. It has been reported that the fungus that causes the disease overwinters on infected twigs and fruits using mycelium and conidia. It has been found that the disease progresses rapidly and the damage is great when there is a lot of rain.

Treatment of trees against moniliosis with fungicides before flowering, fundazole fungicide and humate sodium during flowering, and humate sodium or albite after flowering gave effective results.

Anatov and Gaziev (2017) [14] conducted research on the study of moniliosis burns in apricots in Makhachkala, Dagestan, Russia. Studies have shown that the prevalence of moniliosis in the absence of precipitation during apricot flowering is 8%. It was noted that the prevalence of moniliosis during apricot flowering was 90-100% in the years when the rainfall was 36 and 26 mm. 48% of the crop was lost due to moniliosis burns.

2. Research Methodology

Studies on the prevalence, development and damage of fungal diseases of almond plants were conducted in natural almond orchards in the mountainous areas of Tashkent region and on plantations in Bostanlyk, Parkent, Ahangaron, Yukorichirchik, Ortachirchik and Kibray districts. Laboratory experiments were carried out in the laboratories of the Forestry Research Institute.

2.1 Soil-climatic conditions of Tashkent region

Tashkent region of the Republic of Uzbekistan was founded on January 15, 1938 and Located in the northeast of the republic. It is bordered by the Republic of Kazakhstan to the north and northwest, the
Kyrgyz Republic to the northeast, the Namangan region to the east, the Republic of Tajikistan to the south, and the Syrdarya region to the southwest.

The northern and north-eastern parts of Tashkent region are occupied by the Western Tien Shan Mountains (Chatkal) and its tributaries (Qurama, Piskom and Ugom Mountains). The Ahangaron River flows between the Chatkal and Qurama mountains. Most of the region consists of the foothills (Chirchik-Ahangaron valley), which slopes towards the Syrdarya.

The climate of Tashkent region is sharply continental. Winters are humid, relatively warm, summers are long, hot and dry. The average temperature in January is 1.3 ° -1.8 ° C, the absolute minimum is 34 ° C (in the plains), 38 ° C (in the foothills), the average temperature in July is 26.8 ° C, and the absolute maximum is 43-47 ° C. The annual precipitation in the plains is 250 mm, in the foothills 350-400 mm, in the mountains 500 mm. Most of the rain falls in spring and winter. Only in the mountains does the snow last longer. The vegetation period is 210 days in the plains. The rivers face the Syrdarya basin. Syrdarya (middle stream, 125 km long) and its largest tributaries - Chirchik (its tributaries Piskom, Ugom and others.), Ahangaron. Its rivers are saturated with snow and glaciers. Used for irrigation of rivers, hydroelectric power stations have been built.

The soils consist of gray soil in the plain part. In the foothills (at an altitude of 500-600 m) there are mature, gray soils, in the lower slopes of the mountains (up to 1200 m) there are dark gray soils. Above it lies the true brown, then the meadow-dash soils. Meadow and swamp soils in the lower terraces of Chirchik, Ahangaron and Syrdarya and groundwater surface plains, alluvial soils in river valleys. The whole plain part of the Chirchik-Ahangaron valley is almost completely plowed. At the foothills at an altitude of 1200-1400 m there are mountain steppes, sparse pine forests and others. A characteristic part of this forest zone has been transformed into the Chatkal State Mountain-Forest Reserve.

Tashkent region grows cotton, wheat, vegetables, fruits, cereals and others. The Chirchik River, partly Ahangaron and partly Syrdarya are used to irrigate crops. Zakh, Bozsuv, Karasuv, Tashkent, Northern Tashkent and other canals receive water from the Chirchik River. Through the Tashkent canal, part of the Chirchik water flows into the low-water basin of the Ahangaron oasis.

2.2 Study on the phytosanitary status of almond orchards

To study the phytosanitary status of almond orchards, research was conducted on almond plantations that occur naturally and were established in mountainous and foothill areas. On farms, observations were made three times a year during the growing season, that is, as soon as trees open their leaves, one month after the leaves were opened, and in August-October. In doing so, samples of infected plants were brought in for laboratory testing. Disease accounting and sampling were performed diagonally, and the number of trees varied depending on the location and size of the almond grove [15].

2.2.1 A method of determining the spread of disease

The prevalence of the disease in almond trees was expressed as a percentage and was determined based on the following formula:

$$ P = \frac{n \times 100}{N} $$

in this,

\( R \) - disease prevalence, %;
\( N \) - is the number of diseased plants in the sample;
\( N \) - is the total number of plants in the sample.

The prevalence of the disease in the farm and in the district was found according to the following formula:

$$ R_0 = \frac{s \times p}{S} $$

in this,

\( R_0 \) - average prevalence of the disease in the farm or district, %;
\( s \times p \) - is the sum of the multiplications of the disease prevalence of each almond examined for the disease;
\( S \) - is the total area calculated [15].
2.2.2  A method of determining the development of the disease

The extent to which the leaves of almond trees were affected by a particular disease was determined on the
following scale:

- healthy;
- the surface is damaged up to 10%;
- the surface is damaged by 11 to 25%;
- the surface is 26 to 50% damaged;
- more than 50% of the surface is damaged

The development of diseases in almond trees was found on the basis of the following formula:

\[ R = \frac{(a \cdot b) \cdot 100}{N \times K} \]

\( R \) - disease progression, %;
\((a \cdot b)\) - the sum of the number of controlled plants multiplied by the incidence rate;
\(N\) – the total number of plants accounted for;
\(K\) - The highest score [15].

2.2.3 The disease of almond hole puncture

10 almond trees from up to 50 hectares of almond trees were examined to account for almond perforated
spot disease. If the almond area was more than 50 ha, two more almond trees were examined in addition to
every 10 more. One branch was selected from the four sides of each tree, and 25 leaves from each branch,
i.e., 100 leaves from one tree, were examined and counted.

The spread and development of the disease were determined by accounting in this way. The following scale
was used to determine disease progression:

0 – leaves healthy;
1 – the leaves have several inconspicuous small spots;
2 – on the surface of the leaves there are 1-3 spots up to 0.5 cm in diameter;
3 – on the surface of the leaves there are clearly visible spots with a diameter of 0.5-1 cm;
4 – The surface of the leaves is covered with so many spots that it is difficult to count [16]

2.2.4 A method of accounting for flour-dew disease and determining its damage

In the account of the disease, 10 trees of each variety were observed in the garden of up to 50 hectares. If
the number of trees belonging to a single species was less than 50, all existing trees were examined. If the
almond area was more than 50 ha, two of the observed trees were added for every 10 ha more area.
A total of 100 leaf samples were taken from four sides of each tree for which the disease was accounted for
and at the same height without selection. The degree of morbidity and its development were determined
using the above methods.

4 branches were selected from 4 sides of the accounted tree and 25 leaves were observed in each branch.

The degree of infestation with flour-dew disease in the observed leaves and the development of the disease
were determined using the above methods.

The degree of damage to the twigs was determined using the following scale in order to determine whether
the fungus, which causes flour-dew disease, overwintered after leaf shedding in late autumn or before buds
sprouted in early spring:

0 – healthy branches;
1 – the tip of the branch is slightly damaged;
2 – ¼ part of the branch is covered with fungal mycelium;
3 – half of the branch is covered with fungal mycelium and spores;
4 – the stem is not well developed, the third part is dry, completely covered with fungal
mycelium [15]

To determine the damage of flour-dew disease, the difference between the lengths of 10 diseased branches
of each of the varieties and 10 branches of a healthy tree of these varieties was measured.
The following scale was used to determine the degree of contamination of almond leaves with flour-dew disease:

1 point – there are several spots on the leaf plate;
2 point – leaves have fused spots, leaf surface covered with 50% dust;
3 point – the leaf surface is completely covered with spots and dust

2.2.5 A method of isolating pure cultures of pathogenic fungi and determining their type

For this, we often used starvation agar-agar (20 g of agar-agar per 1 L of water), sometimes Czapek's medium or KSA. Streptomycin (1 g / l) or penicillin (1 g / l) or a mixture thereof (0.5 g + 0.5 g / l) in a warm (45-50 ° C) nutrient medium before pouring into Petri dishes with a diameter of 9-10 cm against bacterial growth ) or ciprofloxacin (0.5-1.0 g / l). In the analysis of some samples, in addition to antibiotics, a 50% solution of fundazole was added to the culture medium (4 mg / l).

Segments (2–4 mm in length) with small, separate spots on the affected leaves were cut with sterile scissors10 or more segments are prepared from each sample and washed in tap water for 1-2 hours, then in distilled sterile water with the addition of Silvet Gold SFM (1-2 drops per 100 ml of water) in a microbiological box, then held in a 0.5–1% solution of sodium hypochlorite (NaOCl) to sterilize the top. Rinse three times in sterile distilled water (30–60 seconds each), dried between sterile filter papers, and then implanted using sterile tweezers over the nutrient medium in Petri dishes (placed 5–10 segments in 1 container). Planted Petri dishes were incubated at room temperature (20–25 °C) or in a phytotron (20–24 °C in light between 4–5 and 10 klk for 12 h and 15–20 °C in dark for 12 h) for 7 ± 3 days.

Segments of pathogenic fungi, spore-forming organs formed on them were first examined under a microscope directly in petri dishes (80-120X), then a drug was prepared from them in a vial, examined under a large lens (40X) and signs of fungi were noted.

Leaf segments that were free of other parasitic and saprophytic fungi and contained only spore-forming members of this fungus were used to isolate the pure culture of a particular pathogenic fungus. Such segments were previously marked with a marker on the back of the petri dish (based on careful microscopic imaging). A portion of the mycelium and spores were then transplanted over the segment into KSA or KDA medium using a sharp microbiological needle at the tip.

2.2.6 A method of accounting for moniliosis of the almond plant

Moniliosis burns of almond flowers were calculated 2–4 weeks after the trees began to bloom. In carrying out this work, 50 trees of each variety were examined. Disease of trees was determined on the following scale:

0- healthy tree;
1- moniliosis burns on the tree are very rare;
2- 1/5 of the flowers are damaged;
3- 1/3 of the flowers and more are damaged;
4- 2/3 of the flowers and more are damaged;

To determine the infestation score of the flowers in the trees, two rods of the third order were taken from each tree, and it was determined by simple observation that the flowers in them were infested with moniliosis burns.

For the detection of moniliosis in the fruit, 50 fruits were taken from each of the 10 trees selected without selection.

Their incidence of moniliosis was determined on the following scale:

0- healthy fruits;
1- Fruits have small, inconspicuous small spots;
2- Fruits have 1-3 spots with visible diameter up to 0.5 cm;
3- Fruits have obvious spots with a diameter of 0.5-1 cm;
4- Fruits have many visible spots up to 1 cm in diameter and more.

In this case, the damage to the fruit was found as a percentage [16].

2.2.7 A method for determining the prevalence of moniliosis
To determine the prevalence of moniliosis in seeded fruit trees, 10 trees of each variety were counted from orchards up to 50 hectares, and 2 trees per 10 hectares if the area of the garden was more than that. The following formula was used to calculate the number of infected trees from the total number of trees examined:

\[ P = \frac{n \times 100}{N} \]

In this case,
- \( P \) - is the prevalence of the disease, in %;
- \( n \) - is the number of diseased plants among the counted plants;
- \( N \) - is the total number of plants counted [16].

2.2.8 A method for determining the incidence of moniliosis
The amount of surface area of affected organs of seeded fruit trees infected with moniliosis was determined on a 5-point scale or as a percentage:
0- Plant organs are healthy;
1- up to 10% of plant organs are affected;
2- Plant organs are affected by 11-25%;
3- 26-50% of plant organs are affected;
4- More than 50% of plant organs are affected [16].

2.2.9 A method for determining the decrease in yield under the influence of moniliosis
Decreased productivity of seeded fruit trees due to moniliosis was found on the basis of the following formula [15];

\[ B = 100 \frac{(A - a)}{A} \]

In this case,
- \( B \) - yield loss in %;
- \( A \) - is the number of healthy plants;
- \( a \) - the yield of diseased plants

3. Research Results
For the experiments, the fungicides included in the "List of pesticides and agrochemicals approved for use in agriculture of the Republic of Uzbekistan" were tested in the laboratory against pure cultures of pathogenic fungi. To this end, various consumption rates of fungicides included in this list and recommended against moniliosis of seeded and leguminous fruit trees and porous spot diseases of bean fruit trees, but not tested for these diseases of almonds, are pure against fungal pathogens of perforated spots and moniliosis isolated from damaged almond tree was tested. In the experiment Difen Super, 55% n.nuk, Kantor, k.e.k (B) (200 g / l), Medeya, m.e 80 g / l, Saprol, 20% em.k (200 g / l), Score 250, em.k (250 g / l), Strobi, 50% s.d.g (500 g / kg), Topaz, 10% em.k (100 g / l), Horus, s.d. g (750 g / kg) concentrations of such fungicides were used (Table 1).

In the vegetation experiments conducted in 2019, 10 diseased almond trees were selected for each experimental option in the application of fungicides against almond perforation and moniliosis burns, and the effectiveness of the drugs was determined. It was noted that the biological efficacy of fungicides used against almond perforated spot diseases in these variants was 67.8–91.0% (Table 2).
The same situation was observed in vegetative experiments on the use of fungicides against almond moniliosis, i.e., in these variants the highest efficiency was found in the varicose variants before and after flowering, and their biological efficiency was 61.5-87.3% (Table 3).

| Fungicides name | active substance | concentration ratio | zone of action of fungicides, mm |
|----------------|-----------------|---------------------|----------------------------------|
| Difen Super, 55% | diphenocanazole + thiamethoxam | 0.01 | – | – |
| (n.kuk) | | 0.02 | – | – |
| | | 0.025 | 2.5 | 2.0 |
| Cantor k.e.k. (B) | cyprodinil | 0.1 | – | – |
| (200 g / l) | | 0.15 | 2.0 | 1.5 |
| | | 0.2 | 2.5 | 2.0 |
| Medea, m.e. 80 g / l | difenocanazole + flutriafol | 0.05 | – | – |
| | | 0.1 | 2.5 | 2.0 |
| | | 0.15 | 3.0 | 2.5 |
| Saprol, 20% em.k. (200 g / l) | triforin | 0.05 | – | – |
| | | 0.1 | 1.5 | 1.0 |
| | | 0.15 | 2.0 | 1.5 |
| Score 250, em.k. (250 g / l) | difenocanazole | 0.01 | – | – |
| | | 0.02 | 2.5 | 2.0 |
| | | 0.03 | 3.5 | 3.0 |
| Strobe, 50% s.d.g. (500 g / kg) | kresoxim-methyl | 0.015 | – | – |
| | | 0.02 | 2.5 | 1.5 |
| Topaz, 10% em.k. (100 g / l) | penconazole | 0.05 | – | – |
| | | 0.1 | 3.5 | 3.0 |
| | | 0.15 | 3.5 | 3.5 |
| Horus, s.d.g. (750 g / kg) | cyprodinil | 0.02 | – | – |
| | | 0.03 | 2.5 | 1.5 |
| | | 0.04 | 4.0 | 3.5 |

**Figure 1. Infection of almonds with moniliosis**

Experiments were carried out to find effective options for the use of selected fungicides in different sequences and at different times for the application of almonds against perforated spots and moniliosis burns. In experiments, the highest efficacy against almond perforation was observed in the variant treated with Horus fungicide before flowering, Topaz after flowering and again 15 days after the second treatment with Topaz fungicide, and the biological efficiency was found to be 94.0% (Table 4). In terms of biological
efficiency, the biological efficiency of the variants using Horus-Score-Score and Horus-Horus-Horus fungicides in the same sequence was 91.9%, and the biological efficiency of Horus-Horus-Score spraying was 90.6%. In the same sequence, the biological efficiency in the standard variant sprayed with Bordeaux fluid was 84.9% (Table 4).

Fungicides that have shown high biological efficacy against almond perforated spot disease have shown similarly high biological efficacy against moniliosis burn disease. It was found that the biological efficiency of the experimental variant using Horus-Topaz-Topaz fungicides was 88.1%. The next place in terms of biological efficiency of fungicides in the above sequence was occupied by the variant in which the Horus-Score-Score fungicides were used, with a biological efficiency of 85.9%. The biological efficacy of Horus-Horus-Horus fungicides was 84.3% when used, and the biological efficiency was 84.0% when Horus-Horus-Score was used. In the reference variant, the biological efficiency was 79.4% when Bordeaux fluid was sprayed in a similar sequence.

![Figure 2. damage to the almond by a perforated stain](image)

**Table 2.** Biological efficacy of fungicides used against almond moniliosis (vegetation experiments in 2019)

| Fungicides used in the experiment | Concentration of fungicides | Concetration of fungicides | Uniformity of fungicides | Options for the use of fungicides | Before flowering and after flowering | Biological efficacy, % |
|----------------------------------|-----------------------------|-----------------------------|--------------------------|----------------------------------|-------------------------------------|------------------------|
|                                  | Control (no fungicide spraying) | -                           | -                        | -                                | -                                   | -                      |
|                                  | Bordeaux fluid (standard)     | 1.0                        | 90 kg / ha                | Copper sulphate                  | 27.6                                | 84.7                   |
|                                  | DMEn Super, 15%               | 0.025                      | 0.25 kg / ha              | Copper sulphate                  | 7.4                                 | 8.3                    |
|                                  | Center, 5%                    | 0.15                       | 1.5 kg / ha               | Copper sulphate                  | 9.2                                 | 14.5                   |
|                                  | Medea, 80 g / l               | 0.1                        | 1.01 kg / ha              | Copper sulphate                  | 11.0                                | 17.2                   |
|                                  | Topaz, 10% em.k (200 g / l)   | 0.1                        | 1.01 kg / ha              | Copper sulphate                  | 12.4                                | 19.3                   |
|                                  | Score, 15% em.k (250 g / l)   | 0.09                       | 0.3 kg / ha               | Copper sulphate                  | 5.7                                 | 10.1                   |
|                                  | Snub, 15% em.k (500 g / l)    | 0.02                       | 0.2 kg / ha               | Copper sulphate                  | 11.2                                | 18.5                   |
|                                  | Topaz, 10% em.k (100 g / l)   | 0.1                        | 1.01 kg / ha              | Copper sulphate                  | 4.9                                 | 7.9                    |
|                                  | Horus, 0.1 g (750 g / kg)     | 0.04                       | 0.3 kg / ha               | Copper sulphate                  | 4.7                                 | 6.8                    |

As a result of the experiments, the highest efficacy of fungicides tested against perforated stains was recorded in farm “7” located in the plain region, where the prevalence of the disease was 3.7%, development 1.6% and biological effectiveness 90.9% (Table 4). In the default option, the figure was 76.6%. In the control, the prevalence of the disease was 39.8% and the development was 17.5%. The lowest rate was recorded in the mountainous region, where the prevalence of the disease was 5.6%, development 2.8% and biological efficiency 87.1%. The biological efficiency in the Bordeaux liquid spray
default variant was 73.3%. In the control, the prevalence of the disease was 53.4%, the development was 21.7%. In the foothills, the prevalence of the disease was 5.7%, development 2.3% and biological efficiency 88.2%. In the sample, the figure was 75.8%. It was noted that the prevalence of the disease was 41.6% and the development was 19.5% in trees that did not use the fungicide taken as a control for this variant.

**Table 3.** Biological effectiveness of the use of fungicides in farms of different regions against almond moniliosis (production experiments, 2020)

| Region          | Farm name     | Terms of application of fungicides | Of the disease | Biological efficiency, % |
|-----------------|---------------|------------------------------------|----------------|--------------------------|
|                 |               | until flowering                     | after flowering| 15 days after the second treatment |                     |
|                 |               | fungicide                           |                | disease spread, % | development, % | index, % |                     |
|                 |               | name                                | consumption rate | name | consumption rate | name | consumption rate | |
| Mountains       | Farm 4        | Horus                               | 0.4 kg/ha c.e.t. | Topaz | 1.0/1 kg | Topaz | 1.0/1 kg | 2.6 | 1.1 | 0.05 | 83.9 |
| foothills       | Farm 2        | Horus                               | 0.4 kg/ha c.e.t. | Topaz | 1.0/1 kg | Topaz | 1.0/1 kg | 3.2 | 1.4 | 0.04 | 84.9 |
| the Plateau     | Farm 7        | Horus                               | 0.4 kg/ha c.e.t. | Topaz | 1.0/1 kg | Topaz | 1.0/1 kg | 2.3 | 1.0 | 0.02 | 87.9 |

**Table 4.** Biological efficacy of fungicides applied in different sequences against almond perforated spot disease (vegetation experiments in 2019)

| Experiment options | Terms of application of fungicides | I | II | III |
|--------------------|------------------------------------|---|----|-----|
|                    | Until flowering                     | 36.2 | 5.1 | 85.9 | 84.9 |
|                    | After flowering                     | 22.3 | 3.6 | 85.9 | 83.9 |
|                    | 15 days after the second treatment  | -   | -   | 85.9 | 84.9 |

- Control (no fungicide sprayed)
- I - Bordeaux fluid - II Bordeaux fluid - III Bordeaux fluid (standard)
- I Horus - II Horus - III Horus
- I Horus - II Horus - III Topaz
- I Chorus - II Topaz - III Topaz
- Topaz
- I Topaz - II Topaz - III Topaz
- I Horus - II Horus - III Scor
- I Chorus - II Scor - III Scor
- I Scor – II Scor – III Scor
- I Topaz - II Topaz - III Scor
- I Topaz - II Score - III Scor
Table 5. Biological effectiveness of fungicides used in the production of almonds against perforated spot disease (Burchmullo State Forestry, Bostanliq district in 2020)

| Disease          | Biological efficiency, % | Disease | Biological efficiency, % |
|------------------|--------------------------|---------|--------------------------|
|                  | Spread, %                | Development, % | Index, %  |
| Terms of application of fungicides |                       |          |                          |
| Until flowering  |                          |          |                          |
| Fungicide name   | Consumption rate         | Fungicide name | Consumption rate |
| Horus w.d.g.     | 0.4 kg / ha              | Topaz emulsion.conc. | 1.0 l / ha |
|                   |                          | Topaz emulsion.conc. | 1.0 l / ha |
| Horus w.d.g.     | 0.4 kg / ha              | Scor emulsion.conc. | 0.3 l / ha |
|                   |                          | Scor emulsion.conc. | 0.3 l / ha |
| Default          |                          | 10.2     | 4.6                      |
| Default          |                          | 10.2     | 4.6                      |
| Control (no fungicide sprayed) | 47.9          | 20.4     | 9.8                      |

The best performance was also observed in the plain region in the experimental variant in which fungicides were used against almond tree moniliosis. At the same time, the prevalence of the disease was 2.3%, development 1.0% and biological efficiency 87.9%. In the ethanol variant sprayed with Bordeaux liquid, the figure was 75.3%. In the control, the prevalence of the disease was 17.9%, the development was 8.1%. The lowest rate was recorded in the mountainous region. In this variant, the prevalence of the disease was found to be 2.6%, development 1.8%, and biological efficacy 83.9%, and in the default variant 72.3%. In control, the prevalence of the disease was 25.7% and the development was 11.2%. In the foothills, the prevalence of the disease was 3.2%, development 1.4% and biological efficiency 84.9%, and in the default variant this figure was 73.1%. In the control, the prevalence of the disease was 19.5%, the development was 9.3%. In these experiments, the highest efficiency was recorded in the plain region. The highest biological efficacy was found in the plain region when fungicides were applied in different regions against almond perforated staining and moniliosis burns. Based on the results of the experiment, the application rate of Horus fungicide was 0.4 kg / ha before flowering, and 1.0 l / day after application of Topaz fungicide 15 days after flowering and after the second treatment, regardless of the region of the almond tree against perforated spot and moniliosis burns (Table 5). It is recommended to process twice with the consumption rate.

3.1 Cost-effectiveness of fungicides used against almond perforation and moniliosis burns

In the Burchmullo State Forestry of Bostanlyk district of Tashkent region against the diseases of almond perforated staining and moniliosis burns Horus s.d.g. and the cost-effectiveness of the use of Topaz em.k fungicides were also studied. To do this, all the economic indicators of the use of fungicides against the above diseases of almonds were taken into account. In this case, the cost of all agro-technical measures in the cultivation of almonds, the yield of the crop, the cost of disease control, the yield saved due to control measures and its cost were calculated.

The total yield of almonds and the price of the crop retained due to the application of fungicides were taken into account in the high purchase price in the market. The cost-effectiveness of measures taken against almond perforated staining and moniliosis burns is given in Tables 6 and 7.

As can be seen from Table 6, 10.2 quintals of almonds were harvested per hectare due to the application of fungicides against almond perforated spot disease. At the same time, the conditional net income was 116,100,000 soums per hectare, and the profitability was 57.3%, and the justification for one soum spent was 15.6 times. 1.1 quintals were harvested in the default variant where Bordeaux liquid was used. Net income was 83,000 soums, profitability was 12.4%, and the justification for 1 soum spent was found to be 12.4 times. The net income under control amounted to 73,800,000 soums.
Table 6. Cost-effectiveness of fungicides used against almond perforated spot disease (On the Burchmullo State Forestry, 2020)

|                             | Control | Bordeaux fluid (standard) | Horus s.d.g., and Topaz 10% emulsion conc. |
|-----------------------------|---------|---------------------------|-------------------------------------------|
| Yield, ts/ha                | 7.5     | 8.6                       | 10.2                                      |
| Preserved yield, ts/ha      | -       | 1.1                       | 2.7                                       |
| Amount of chemical consumed per 1, kg/ha or 1/lha | - | 30 | 1.Horus 0.4 g/ha 2.Topaz 1 l/ha 3.Topaz 1 l/ha |
| The total cost of the drug spent on 1 hectare, thousand soums/ha | - | 600 | 1400 |
| Tractor and salary for protection, thousand soums/ha | - | 700 | 700 |
| Total cost of protection, thousand soums/ha | - | 1300 | 2100 |
| Expenses for harvesting and transportation of additional crops, thousand soums/ha | - | 500 | 600 |
| The total cost of plant protection and additional harvest, thousand soums/ha | - | 1800 | 2700 |
| Other expenses for crop production, thousand soums/ha | 1200 | 1200 | 1200 |
| Total expenses, thousand soums/ha | 1200 | 3000 | 3900 |
| Crop yield per hectare, thousand soums | 75000 | 86000 | 120000 |
| Net income, soums | 73800 | 83000 | 116100 |
| Economic efficiency in relation to control, thousand soums/ha | - | 9200 | 42300 |
| A sum of money spent is justified, times | - | 5.1 | 15.6 |
| Profitability of protection method, % | - | 12.4 | 57.3 |

Note: In 2021, the average price of 1 kg of almonds is estimated at 100,000 soums.
- Horus was found to be worth 1,500,000 soums per kg.
- Topaz was bought for 1 liter worth 400,000 soums.
- Copper sulphate was taken as 20,000 soums per 1 kg.

Due to the use of fungicides against almond moniliosis, 9.4 tons of almonds were harvested per hectare. The net income from the event was 90,200,000 soums per hectare, the profitability was 25.6%, and the justification for one soum spent was 7.0 times. In the variant in which the standard Bordeaux liquid was used, 1.1 ts was obtained from 1 hectare. At the same time, the net income amounted to 81,000 soums, the profitability was 12.8%, and the justification for 1 soum spent was 12.8 times. The net income under control amounted to 71,800,000 soums (Table 7).

Table 7. Cost-effectiveness of fungicides used against almond moniliosis burns (On the Burchmullo State Forestry, 2020)

|                             | Control | Bordeaux fluid (standard) | Horus s.d.g., and Topaz 10% emulsion conc. |
|-----------------------------|---------|---------------------------|-------------------------------------------|
| Productivity, ts/ha         | 7.3     | 8.4                       | 9.4                                       |
| Preserved yield, ts/ha      | -       | 1.1                       | 2.1                                       |
| Amount of chemical consumed per 1, kg/ha or 1/lha | - | 30 | 1.Horus 0.4 kg/ha |

Note: In 2021, the average price of 1 kg of almonds is estimated at 100,000 soums.
The total cost of the drug spent on 1, thousand soums / ha
Tractor and salary for protection, thousand soums / ha
Total cost of protection, thousand soums / ha
Expenses for harvesting and transportation of additional crops, thousand soums / ha
Total cost of plant protection and additional harvest, thousand soums / ha
Other expenses for crop production, thousand soums / ha
Total expenses, thousand soums / ha
Crop yield per hectare, thousand soums
Net income, soums
Economic efficiency in relation to control, thousand soums / ha
A sum of money spent is justified, times
Profitability of protection method, %

|                | Horus 0.4 kg/ha | Topaz 1 l/ha | Topaz 1 l/ha |
|----------------|-----------------|--------------|--------------|
| The total cost of the drug spent on 1, thousand soums / ha | - | 600 | 1400 |
| Tractor and salary for protection, thousand soums / ha | - | 700 | 700 |
| Total cost of protection, thousand soums / ha | - | 1300 | 2100 |
| Expenses for harvesting and transportation of additional crops, thousand soums / ha | - | 500 | 500 |
| Total cost of plant protection and additional harvest, thousand soums / ha | - | 1800 | 2600 |
| Other expenses for crop production, thousand soums / ha | 1200 | 1200 | 1200 |
| Total expenses, thousand soums / ha | 1200 | 3000 | 3800 |
| Crop yield per hectare, thousand soums | 73000 | 84000 | 94000 |
| Net income, soums | 71800 | 81000 | 90200 |
| Economic efficiency in relation to control, thousand soums / ha | - | 9200 | 18400 |
| A sum of money spent is justified, times | - | 5.1 | 7.0 |
| Profitability of protection method, % | - | 12.8 | 25.6 |

Note: In 2021, the average price of 1 kg of almonds is estimated at 100,000 soums.
Horus was found to be worth 1,500,000 soums per kg.
Topaz was bought for 1 liter worth 400,000 soums.
Copper sulphate was taken as 20,000 soums per 1 kg

4. Conclusion

a) When the trees are treated with the application rate of Horus fungicide at 0.4 kg / ha before flowering, at the rate of application of Topaz fungicide at 1.0 l / ha before flowering and again at the same rate of use of Topaz 15 days after the second treatment, the biological efficiency was 88.7%.
b) In industrial experiments against moniliosis burns, the biological efficiency of almond trees at the rate of 0.4 kg / ha of Horus fungicide before flowering, and at the rate of 1.0 l / ha of Topaz fungicide after flowering and 15 days after the second treatment was 85.4 %.
c) An additional 10.2 quintals of almonds were harvested per 1 hectare due to the application of fungicides against the perforated spot disease of almonds. When applied to perforated spot disease, the conditional net profit was 116,100 soums per 1 hectare, the profitability was 57.3 %, and the justification for one soum spent was 15.6 times. The net income under control was 73,800 soums.
d) Due to the use of fungicides against almond moniliosis, 9.4 quintals of almonds were harvested per hectare. Net income from the implemented measures amounted to 90,200 soums per 1 hectare of land, profitability was 25.6%, and the justification for 1 soum spent was 7.0 times. The net income under control amounted to 71,800 soums.

References
[1] Mahhou A, Dennis FG 1992 The Almond in Morocco HortTechnology 2 488-492.
[2] Schwankl LJ et al. 1999 Microsprinklers wet larger soil volume; boost almond yield, tree growth California Agriculture 53(2) 39-43.
[3] Holland LA et al. 2020 Fungal Pathogens Associated With Canker Diseases of Almond in California Plant Disease 105(2) 1-15.
[4] Anderson PK, Cunningham AA, Patel NG, Morales FJ, Epstein PR, Daszak P 2004 Emerging infectious diseases of plants: pathogen pollution, climate change and agrotechnology drivers Trends in Ecology and Evolution 19 535-544.
[5] Byrde RJW, Willetts HJ 1977 The Brown Rot Fungi of Fruit: Their Biology and Control, Pergamon Press, New York.
[6] Fulton CE, Brown AE 1997 Use of SSU rDNA group-I intron to distinguish Monilinia fructicola from M. laxa and M. fructigena FEMS Microbiology Letters 157 307–312.
[7] Gell I, Cubero J, Melgarejo P 2007 Two different PCR approaches for universal diagnosis of brown rot and identification of Monilinia spp. in stone fruit trees J. Applied Microbiology 103 2629–2637.
[8] Tamm L, Flückiger W 1993 Influence of temperature and moisture on growth, spore production and conidial germination of Monilinia laxa *Phytopathology* **83** 1321–1326.

[9] Biggs AR, Northover J 1985 Inoculum sources for Monilinia fructicola in Ontario peach orchards *Canadian Journal of Plant Pathology* **7** 302–307.

[10] Wilson EE 1953 Apricot and almond brown rot. In: Plant Diseases: The Yearbook of Agriculture, United States Department of Agriculture, Washington.

[11] Teviotdale BL, Viveros DM, CI Mark Freeman W, Sibbett GS 1989 Effect of fungicides on shot hole disease of almonds *California Agriculture* **21-23**.

[12] Stognienko OI 2007 The causative agents of moniliosis and alternariosis of fruit crops *Plant protection and quarantine* **4** 49-50.

[13] Boldyrev MI, Camp GA 2008 Fight against cherry moniliosis and coccomycosis *Plant protection and quarantine* **1** 33-34.

[14] Anatov DM, Gaziev MA 2017 Predictive assessment of apricot moniliosis affection in fruit growing zones according to long-term data (on the example of lowland Dagestan) *Bulletin of the Ulyanovsk State Agricultural Academy* **2** 15-19.

[15] Chumakov AE, Minkevich II, Vlasov YuI, Gavrilova EA 1974 The main methods of phytopathological research, Kolos, Moscow.

[16] Dementyeva MI 1985 Plant pathology, Agropromizdat, Moscow.

[17] Hasanov BA 2019 Mycology, Tashkent State University of Publications, Tashkent.