PROGRESS

Promoting Green Deal Readiness in the Eastern Partnership Countries

Strawberry cultivation technology

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1. Strawberry (**Fragaria ananassa Duch**). : velue, distribution, and origin
2. Strawberry cultivation technology
3. Climatic challenges
4. Best practices for sustainable strawberry production

The economic importance of the crop

It is one of the leading soft fruits in the world and in Ukraine

Advantages of the crop:

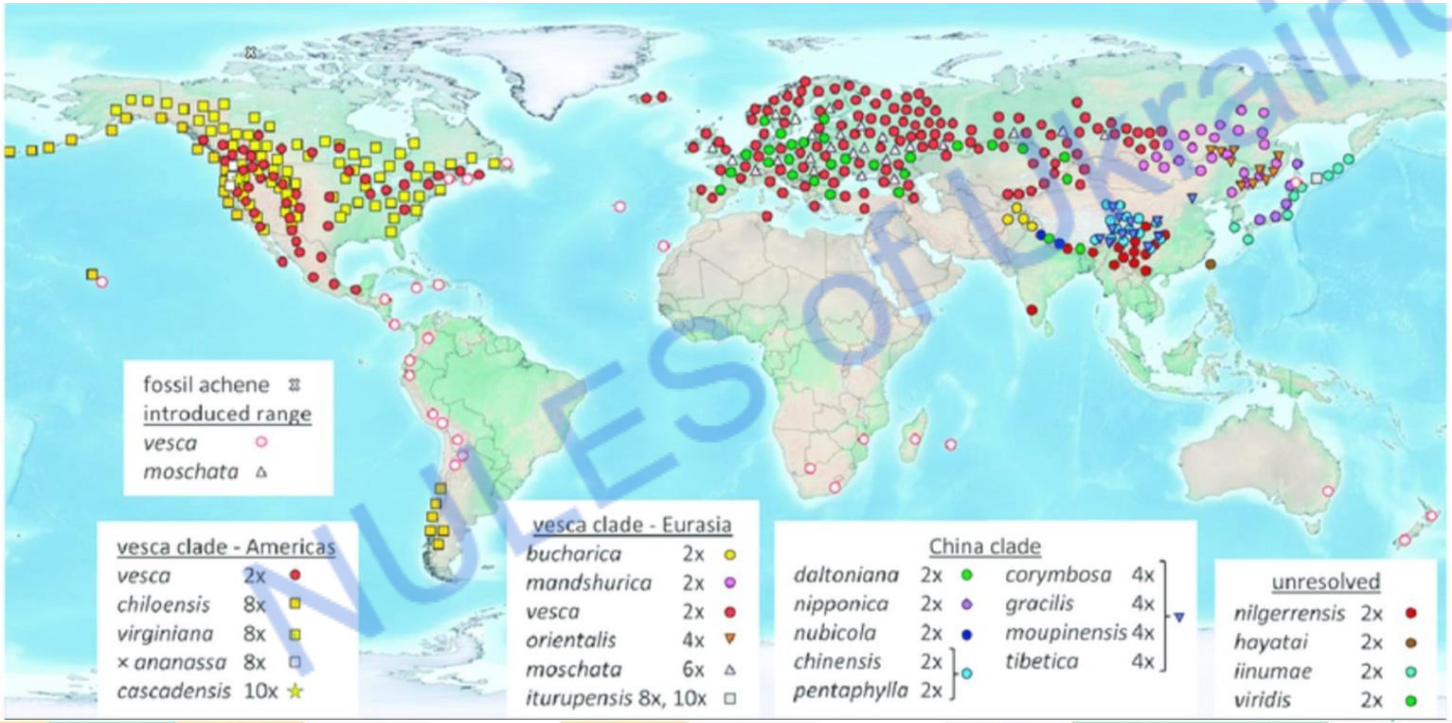
- excellent flavor
- the first berry of the season
- early bearing
- high yield
- suitability for industrial processing
- high demand and profitability

Botanical description

Order Rosales
Family Rosaceae
Subfamily Rosoideae
Genus Fragaria
Comprises 30 species; the most common are 8

- F. vesca (2n=14) Donor of winter hardiness, early ripening, and berry aroma
- F. viridis, F. collina (, 2n=14)
- F. orientalis (2n=28) Source of winter hardiness and early ripening
- F. moschata, F. elstior (2n=28) Source of winter hardiness and resistance to diseases and pests
- F. virginia F. virginiana, (2n=56). Donor of winter hardiness and powdery mildew resistance
- F. chiloensis (2n=56). Donor of disease and pest resistance
- F. ovalis (2n=56). Donor of winter hardiness
- F. grandiflora, F. ananassa (2n=56). Includes over 2,500 varieties.

Distribution area in the world

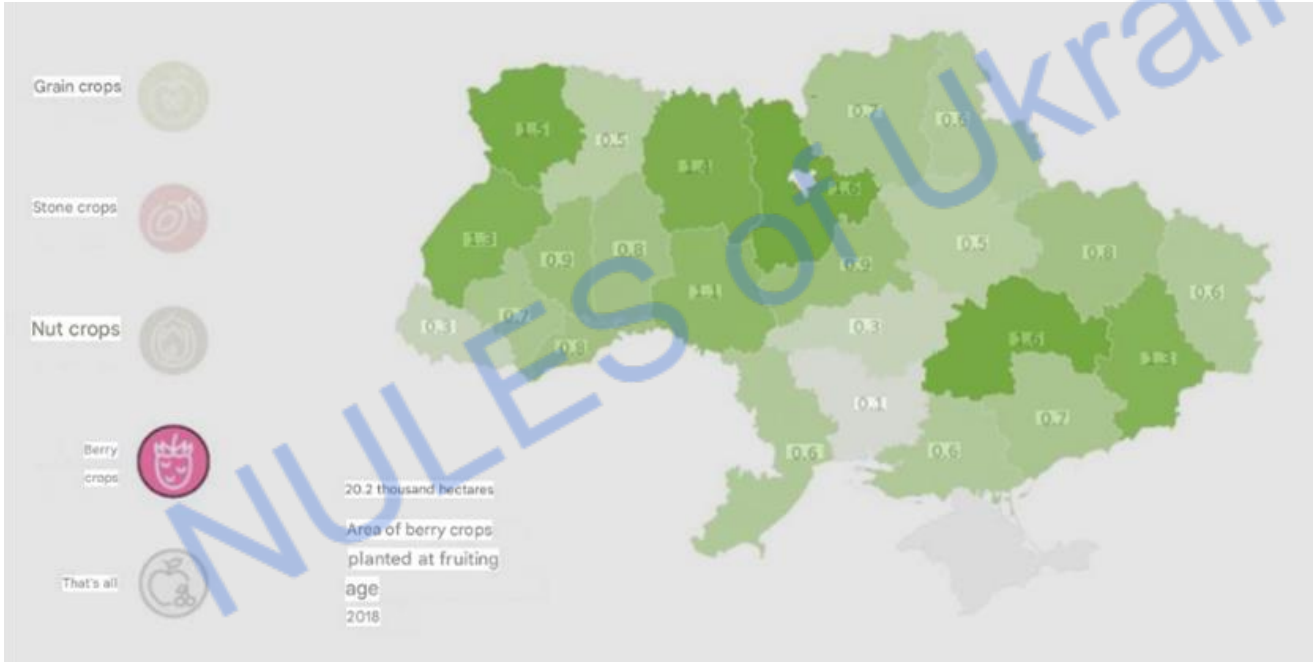


World production of garden strawberries

Country	Production (Tons)	Production per Person (Kg)	Acreage (Hectare)	Yield (Kg / Hectare)
China	3,389,620.19	2.432	129,046	26,266.8
United States of America	1,211,090	3.695	19,992	60,578.7
Turkey	669,195	8.281	18,676	35,831.8
Mexico	542,890.63	4.352	11,905	45,601.6
Egypt	470,913.1	4.83	12,579	37,436.9
Spain	360,570	7.728	7,220	49,940.4

- China is the largest strawberry producer in the world with 3,389,620.19 tonnes production per year.
- United States of America comes second with 1,211,090 tonnes yearly production.
- With 669,195 tons of production per year, Turkey is the third largest producer of strawberry.
- United Kingdom, with 114,614 tonnes of production per year is ranked at 15.
- Ukraine takes the 22 place

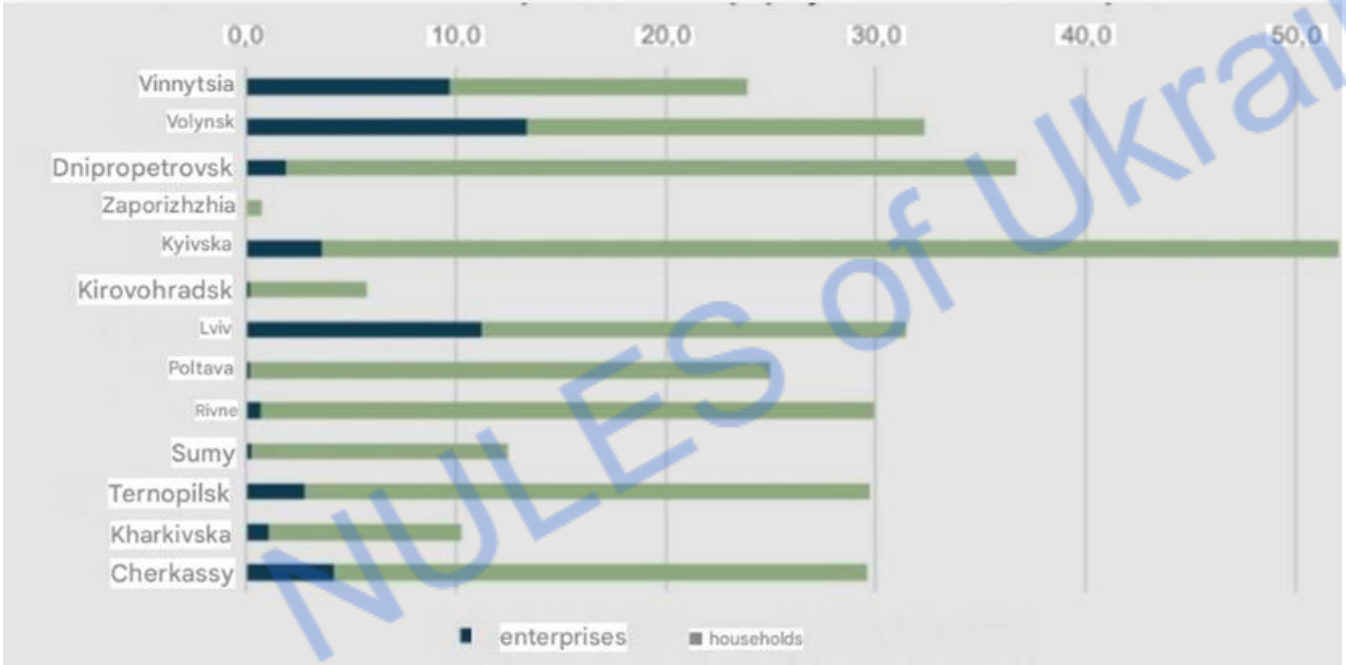
Area of small fruit cultivation in Ukraine, 2018



including 8.3 thousand hectares of strawberry plantations

https://public.tableau.com/app/profile/daani.rika/viz/shared/8X4HMGF7R

Strawberry (F. ananassa production in Ukraine, 2023



https://ief.org.ua/files/library/903/ukraine-report-output-i-ua.pdf

Export of strawberry (F. ananassa) by year

https://ief.org.ua/files/library/903/ukraine-report-output-i-ua.pdf

Factors constraining the development of garden strawberries in Ukraine

- - Military operations, the need to relocate production
- - Lack of labor resources
- - Insufficient number of available specialists with appropriate qualifications
- - Financial challenges
- - Climate risks

Morphological features of garden strawberries

- - Perennial herbaceous plant
- - Crown – 30-35 cm high, formed by leaves, flowers, runners (stolons), branch crowns, flower clusters,
- - Stomata appear only on the leaf undersides.
- - An axillary bud is produced at the base of each leaf and may develop into a runner or branch crown,
- - The leaves are arranged spirally, such that every sixth leaf is above the first.
- - Inflorescence – dichasia, in which there are 7-31 flowers
- - Flowers (in most varieties bisexual). Blooms 10-20 days
- - Berries – complex juicy grains. Ripen 25-30 days after the beginning of flowering.
- - Root system – fibrous.Adventitious roots arise from the crown primarily in late summer and fall.Lateral roots usually live one or two years; primary (adventitious) roots may live two to three years.

Figure 1 (according to V.F. Belov and I.I. Chukhlyaev, 1983). Structure of a strawberry bush 1 horn; 2- perennial rhizome; 3-peduncle; 4- leaf; 5- cord-like vegetative shoot (whip, mustache); 6- rosette; 7- apical bud; 8- axillary bud; 9- lateral roots; 10- adventitious root of the horn.

Requirements for growing conditions

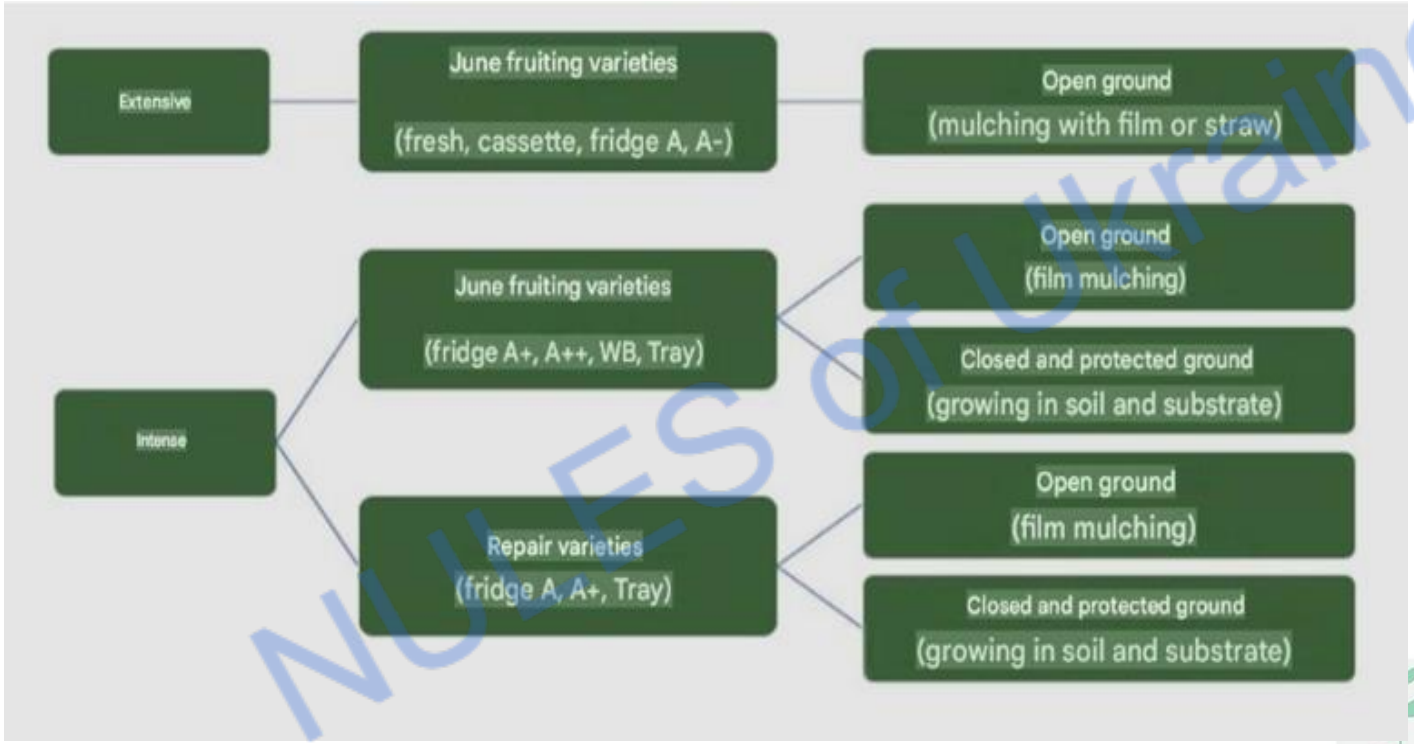
Temperature. The optimum air temperature is 16-23°C, and the soil temperature is 13-20°C. In winter, plants can suffer from freezing. During flowering, when temperatures drop to minus 1.5-4°C, 10-70% of flowers die.

Lighting. Moderately light-loving plants.

Moisture supply. Plants use the most water during flowering, fruiting and during the period of mass formation of flanges.

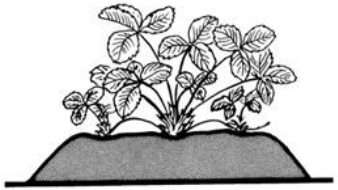
Soils. Grow and bear fruit on all main types of soils of medium density, light loamy and sandy loam composition.

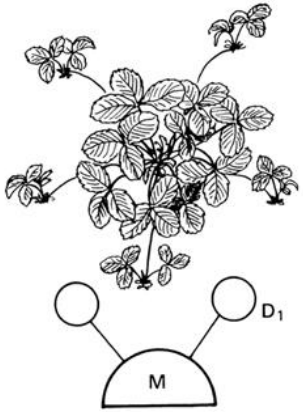
Nutrition. With one centner of berries, 1.4 kg of nitrogen, 0.3 kg of phosphorus, 1.7 kg of potassium are removed from the soil.



Selection of Technology

Extensive technology





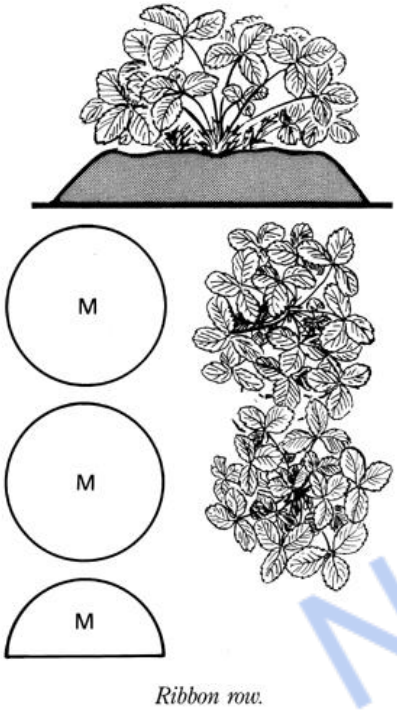
Spaced matted row.

	Option 1	Option 2
Landing	September	April
Varieties	June varieties	
Planting material	Freshly Dug Plants	Freshly Dug Plants , frigo-A
Irrigation	drip or sprinkling	
Mulching	straw	
Harvesting	June next year (within 3-5 weeks)	
Plantation use	year of planting + 2-3 years of fruiting	

Extensive technology with sprinkling

Extensive technology
Straw mulching

Intensive technology



Ribbon row.

Intensive technology

	Option 1	Option 2
Landing	April-May	March-April
Varieties	June varieties	remontant varieties
Seedling	frigo-A+, frigo-WB	frigo-standard
Irrigation	drip	drip (and sprinkling)
Mulching	straw or film	film
Harvesting	60 days after planting (within 3-4 weeks)	starting in July of the year of planting (for 8-12 weeks)
Plantation use	year of planting and 1-2 years of fruiting	year of planting and (+ 1 year of fruiting)

Advantages and disadvantages of strawberry growing technologies

- **Extensive**
- low costs for creating plantations
- better survival of plants in snowless winters
- complicated weed control
- more difficult to harvest
- loss of plants due to possible flooding
- soil compaction in the CS zone (heavy soils)
- high moisture loss due to evaporation

- **Intensive**
- weed control
- Easy harvesting
- plant protection in case of flooding
- less soil compaction in the KS zone
- less moisture loss from evaporation
- risk of soil freezing in ridges
- higher preparation costs (ridge formation, mulch film)

The main stages of creating strawberry plantations

- - Farm planning. Technology selection
- - Facility infrastructure development
- - Selection of assortment and ordering of planting material
- - Soil preparation
- - Cutting of ridges and installation of irrigation system (fertigation)
- - Planting and care of plantations
- - Harvesting and sale of the harvest

Planting material – freshly dug plants

Planting material – FRIGO plants

Planting material – plug plants (TRAY PLANTS)

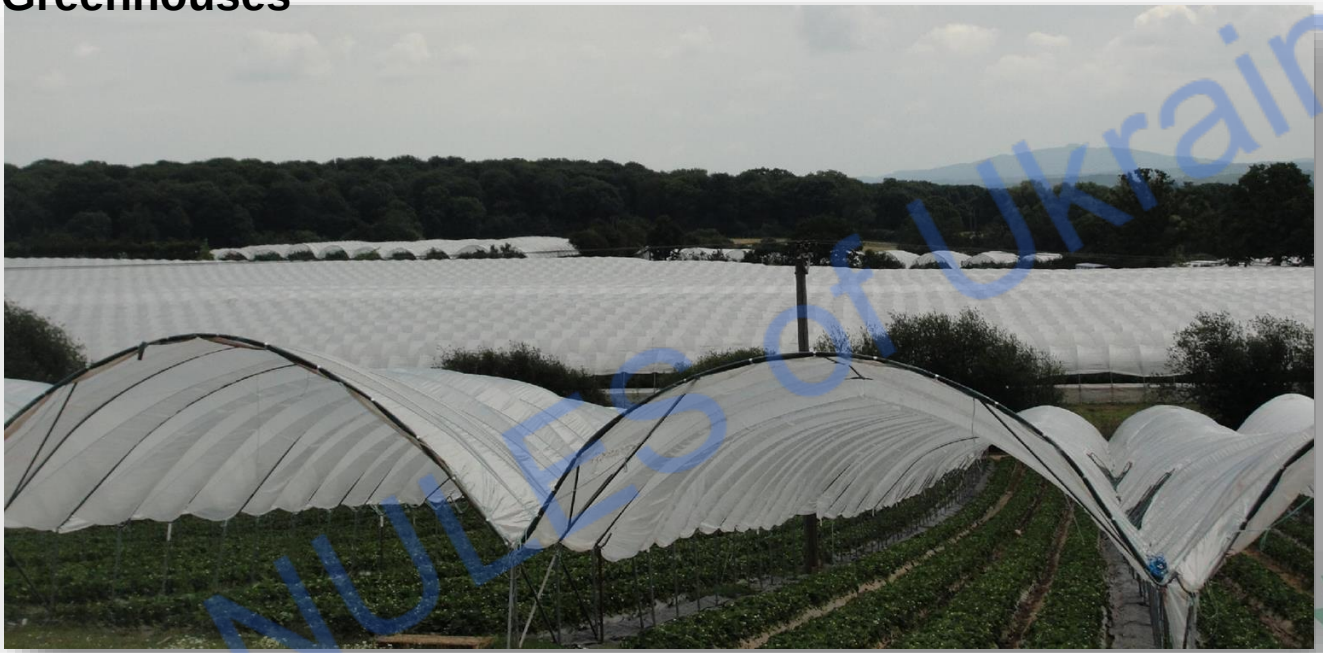
Soil preparation elements

- Soil analysis
- Soil pest detection and control
- Weed control
- Fertilization

Strawberry growing technology: plasticulture production systems

Young strawberry plantations

Technology of growing strawberries in Plastic Tunnels and Greenhouses



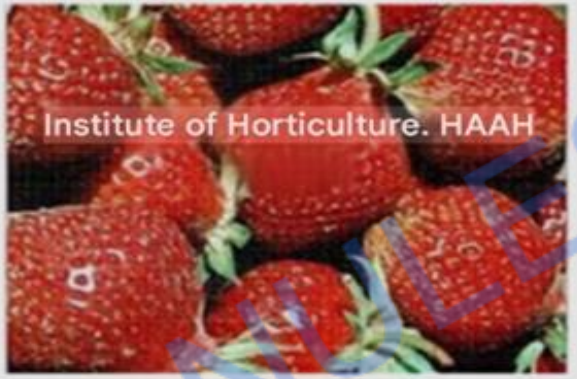
Growing strawberries using Table-Top technology

Groups of varieties by type of fruiting

KSD - Summer (June, non-remontant, ordinary) varieties

They belong to short-day plants, forming generative buds during a day of 13-14 hours.

Rozana Kyivska



Day-neutral varieties (remontant)

Generative buds are laid when the day length is 16-17 hours.

Murano

As of 2026, 50 strawberry varieties are included in the "State Register..." - domestic selection (4) and introduced (46)

Varieties of strawberry (June-Bearing)

KLODIA® CIVH725

Aprica®

Florence

Honeoye

Strawberry varieties (DN)

Murano®

San Andreas

Malga® SG134

Climate change

- Natural meteorological phenomena in the warm period of the year (heavy rains, thunderstorms, tornadoes, squalls, hail)
- Change in the nature of precipitation during the growing season (decrease in frequency and increase in intensity of their precipitation)
- Increase in the frequency and intensity of late spring frosts
- Lack of stable snow cover
- Excessive insolation in summer
- Droughts during the growing season

Climate change and risks for strawberry production

Rising average temperatures and heat stress

- Air and soil temperature is a limiting factor that determines phenology, yield and product quality.
- Shift in the timing of strawberry plants passing through phenological phases and their duration: vegetation begins 10–14 days earlier.
- Changes in the physical characteristics of garden strawberries
- Impact on pollen growth and development and yield
- Content of biochemical substances in fruits
- Reduction of the dormancy period

Climate change and risks for strawberry production

Cold waves, frosts and risks to vegetation

- At the early stage of strawberry plant growth, low temperatures can change cell permeability, reduce photosynthetic capacity and negatively affect the growth, development and yield of the crop.
- Significant economic losses in strawberry cultivation in Ukraine are caused by late spring frosts.
- A sharp decrease in temperature (to –10°C and below) in the absence of snow cover in November-December can damage generative buds, which are laid in the fall in KSD varieties).
- Winter minimums: the critical temperature for the strawberry root system is –8... –10°C in the soil layer. Without snow, freezing of the soil to this depth leads to the complete death of the plantations

Humidification mode

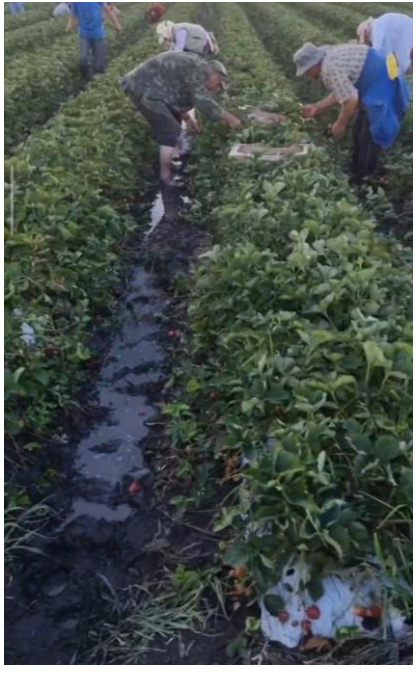
Precipitation deficit and soil drought

- Lack of moisture in the soil during flowering leads to poor berry setting, during fruiting - to fruit shrinkage and reduced yield, in the autumn period - to a weakening of the formation of generative organs.

- The water content in the soil is a factor that affects not only the growth and development of strawberry plants, but also the yield and quality of fruits.

Excessive rainfall

- Excessive rainfall and, as a result, increased air humidity, often leads to the development of fungal diseases in strawberry plantations.
- The most common consequences are soil erosion, washing out plants, or soil washing over them.
- Rainfall can also seriously damage flowers during flowering.
- Precipitation in the form of hail can cause the greatest damage to the plantation during flowering and fruiting.
- Excessive rainfall leads to a deterioration in taste, keeping quality and transportability



Snow cover as a factor in overwintering

Snow cover as a factor in overwintering

- Snow cover plays a key role in temperature regulation, acting as a natural insulator, protecting soil and vegetation from extreme low temperatures.
- Insufficient snow cover can lead to plant frost heaving and affect the flowering phenophase in spring.
- Changes in snowmelt patterns can lead to changes in water availability in spring.

Best practices for sustainable strawberry production

Nets

Functions:

- shading of plants (protection from sunlight)
- temperature reduction (by 10 degrees)
- distribution of light
- protection of plants from precipitation (hail)

Geodesic dome greenhouses

- Creates a favorable microclimate ;
- protects the plantation from adverse weather conditions
- Possibility of growing products throughout the year;
- creation of jobs for construction and maintenance;
- efficient use of land; support of biodiversity

Hydroponics

- Up to 90% water savings due to closed loop nutrient solution use
- Nutrient savings;
- Mechanization (no tractors and large machinery needed);
- Reduced need for herbicides and pesticides (no weeds and pests)
- Space savings

Aeroponics

- Provides significant water savings compared to traditional agriculture;
- resistance to adverse weather conditions;
- Saving nutrients; mechanization (no need for tractors and large machinery);
- reduced need for pesticides https://alfagro.com.ua/gidroponika-v-ukraine/

Vertical farms

- Provides significant water savings compared to traditional farming;
- Resistance to adverse weather conditions;
- Saving nutrients;
- Reducing the need for pesticideshttps://alfagro.com.ua/gidroponika-v-ukraine/

Biological fertilizers and plant protection products

- Increase in the amount of organic matter and nutrients in the soil;
- Reduce the need for pesticides;
- The product is environmentally friendly

Siderats

Sideral crops: rye, marigolds, rapeseed, clover, white mustard.

- Preventing erosion and preserving soil structure;
- improving infiltration and moisture retention in the soil;
- increasing the amount of organic matter and nutrients in the soil;
- reducing the need for pesticides

Row protection systems

- Provides protection against hail and insects;
- Creating an optimal microclimate for growth

Crop rotation (crop rotation)

Strawberries must be grown in crop rotation. Agricultural techniques without crop rotation significantly reduce yields. One option may be black steam during the previous year. Good predecessors for strawberries can be cereals,

- - Creating optimal conditions for growth;
- - Preventing the spread of pests and diseases

Mulching

- - Retains moisture in the soil;
- - Reduces the need for herbicides (suppresses weed growth);
- - Decomposition of mulch increases humus content, improves aeration and soil structure

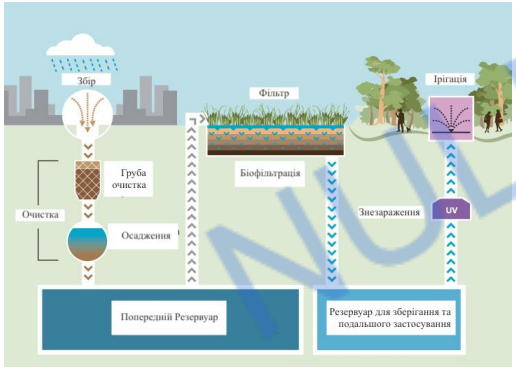
Windbreak System (trees and shrubs)

- - Snow retention and soil moisture increase;
- - Improvement of soil physical properties and increase of its fertility;
- - Prevention of soil erosion by wind and water

Precision and drip irrigation

- Water saving: drip irrigation allows you to use water more efficiently, reducing losses due to evaporation and runoff;
- Possibility of growing high quality products

Rainwater harvesting



- - Reduction of crop losses during drought by 20–30%;
- - Improvement of fruit quality due to stable water supply;
- - Reduction of water supply costs by 30–50% compared to the use of centralized sources https://iwaponline.com/washdev/article/14/12/1244/105924/Climate-change-adaptation-through-rainwater

Resistant/tolerant varieties

Roksan

- Creating optimal conditions for growth;
- Low susceptibility to diseases

Example:

- **Roxana®:** medium-late variety with high yield. Tolerant to powdery mildew and other diseases
- **Allegro:** strawberry variety resistant to fungal diseases, namely: late blight, verticillium wilt and powdery mildew

Precision farming

1.Plant health monitoring: Using IoT sensors to monitor soil and plant health, allowing for optimized fertilization and plant protection

2. Irrigation Optimization: Using precision irrigation systems, such as drip irrigation, to reduce water use and increase irrigation efficiency

3. Data Analysis: Using data analysis to determine optimal growing conditions and increase yields

Reduced pesticide use

Alternatives to pesticides:

- Biological crop protection products: use microorganisms and other natural components to control plant diseases and pests without harming the environment.

Innovative technologies: use innovative systems such as BioBee, Alta Innovation, DriftSense, Palm Robotics and BotanoHealth that help reduce pesticide use through more precise application and monitoring of plant health https://itrade.gov.il/ukraine/2024/06/03/інновації-що-допомагають-скоротити-в/

Thank you for your attention!