

Climate-Resilient Flower Varieties for Modern Farming

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INTRODUCTION

Floriculture is one of the fastest-growing sectors of modern agriculture, contributing significantly to employment generation, landscaping, environmental beautification, and export earnings. Flowers are cultivated for cut flowers, loose flowers, essential oils, ornamental gardening, and decorative uses. However, climate change has become a major challenge due to rising temperatures, irregular rainfall, drought, floods, salinity, and increased pest and disease incidence, all of which reduce flower yield and quality. Climate-resilient flower varieties are capable of tolerating these stresses while maintaining productivity and ornamental value. Combined with protected cultivation, precision irrigation, and integrated nutrient management, these varieties support sustainable floriculture, conserve natural resources, and enhance farmers' income under changing environmental conditions.

Climate Change and Its Impact on Floriculture

Climate change affects floriculture in several ways:

1. Rising Temperature

Rising temperatures have a significant negative impact on floriculture crops. Excessive heat reduces flower size, fades color intensity, diminishes fragrance, and shortens vase life. Heat stress disrupts physiological processes, resulting in poor bud development, flower bud abortion, and reduced flowering. Sensitive ornamentals may also experience leaf scorching, lower market quality, and decreased overall productivity.

2. Irregular Rainfall

Irregular and unpredictable rainfall creates serious challenges in floriculture. Insufficient rainfall causes moisture stress, while excessive rainfall leads to waterlogging. Both conditions adversely affect root development, reduce nutrient absorption, and impair plant growth. As a result, flower production, quality, and overall crop performance decline, leading to lower market value and economic returns for growers.

3. Drought Stress

Drought stress is a major consequence of climate change in floriculture. Insufficient water availability limits photosynthesis, nutrient transport, and cell expansion, resulting in stunted plant growth. It reduces the number and size of flowers, weakens color intensity, and lowers overall quality. Prolonged drought also shortens flowering duration and significantly decreases the commercial value of ornamental crops.

4. Flooding and Waterlogging

Flooding and waterlogging severely affect flower crops by saturating the soil and reducing oxygen availability around the roots. Poor aeration impairs root respiration and nutrient uptake, leading to yellowing, wilting, and stunted growth. Excess moisture also promotes fungal diseases such as root rot and wilt, ultimately reducing flower quality, yield, and marketability.

5. Increased Pest and Disease Incidence

Rising temperatures and changing humidity levels create favorable conditions for the rapid multiplication of insects, mites, fungi, bacteria, and viruses. As a result, flower crops become more vulnerable to severe infestations and disease outbreaks. Increased pest and disease pressure reduces plant vigor, damages blooms, lowers flower quality, and raises production costs due to greater reliance on control measures.

6. Salinity Stress

Salinity stress is becoming increasingly important in floriculture due to the use of saline irrigation water and the accumulation of salts in the soil. Excess salts interfere with water absorption, nutrient uptake, and metabolic activities within plants. This results in poor germination, stunted growth, leaf burn, reduced flowering, and lower flower quality, ultimately decreasing market value and profitability.

7. Extreme Weather Events

Extreme weather events such as storms, heat waves, frost, hail, and cyclones cause severe damage to floriculture crops. Strong winds and

heavy rains can break stems, destroy flowers, and reduce marketable yield. Heat waves and frost adversely affect flowering and flower quality, while cyclones may lead to complete crop loss. These events result in substantial economic losses and disrupt the supply chain of ornamental products.

Characteristics of Climate-Resilient Flower Varieties

Climate-resilient flower varieties possess a range of adaptive traits that enable them to maintain growth, flowering, and quality under unfavorable environmental conditions such as heat, drought, salinity, flooding, and increased pest pressure. These characteristics are essential for ensuring stable and profitable floriculture in the face of climate change.

1. Heat Tolerance

Heat-tolerant varieties can withstand high temperatures without significant reduction in flower production, size, color, or vase life. They maintain normal physiological processes and continue flowering even during hot weather.

Examples: Heat-tolerant varieties of marigold, zinnia, and sunflower.

2. Drought Resistance

These varieties perform well under limited water availability by conserving moisture and using water efficiently.

Key Features:

- ❖ Deep and extensive root systems
- ❖ Reduced transpiration rate
- ❖ Thick or waxy leaves
- ❖ Efficient stomatal regulation

3. Waterlogging Tolerance

Some flower crops can tolerate temporary flooding by maintaining root respiration and reducing damage caused by low oxygen conditions in the soil.

4. Salinity Tolerance

Salinity-tolerant varieties continue to grow and flower in soils or irrigation water containing higher salt concentrations. They regulate ion balance and maintain normal metabolic activities.

5. Pest and Disease Resistance

Resistant varieties are less susceptible to insects, mites, fungi, bacteria, and viruses, reducing crop losses and lowering dependence on chemical pesticides.

6. Early Maturity

Short-duration varieties complete their life cycle quickly, helping them escape heat waves, drought, frost, or other adverse weather events.

7. High Yield Stability

These varieties provide consistent flower yield and quality across different seasons and changing climatic conditions.

8. Better Nutrient Efficiency

Climate-resilient varieties efficiently absorb and utilize available nutrients and water, ensuring optimal growth even under resource-limited conditions.

Importance of Climate-Resilient Flower Varieties

Climate-resilient flower varieties play a crucial role in ensuring sustainable and profitable floriculture under changing environmental conditions. They maintain consistent flower production despite stresses such as heat, drought, salinity, and flooding. By reducing crop losses, these varieties enhance farmers' income and economic stability. Their tolerance to pests and diseases lowers the need for pesticides and irrigation, thereby reducing

production costs. Reduced chemical use also supports environmental conservation by minimizing pollution and protecting beneficial organisms and biodiversity. Moreover, resilient varieties produce high-quality flowers with longer shelf life, increasing export opportunities and market competitiveness. Overall, they are essential tools for adapting modern floriculture to the challenges of global climate change.

Major Climate-Resilient Flower Crops and Varieties

1. Marigold (*Tagetes* spp.)

Tagetes is one of the most climate-resilient flower crops widely grown in tropical and subtropical regions. It is highly tolerant to high temperatures and can perform well under drought conditions due to its efficient water-use ability. Marigold also possesses natural pest-repellent properties and adapts successfully to a wide range of soil types, including relatively poor soils. Important varieties include Pusa Narangi Gaiinda, Pusa Basanti Gaiinda, African marigold hybrids, and French marigold varieties. The crop is widely used in loose flower markets and garland making. It requires less water, performs well under high temperatures, and provides stable yields with good flower quality, making it an ideal climate-resilient flower crop.



2. Chrysanthemum (*Chrysanthemum morifolium*)

Chrysanthemum morifolium is a highly adaptable ornamental flower crop capable of tolerating moderate climatic stresses. It performs well under variable temperature conditions and exhibits good recovery after periods of environmental stress. The crop also possesses improved resistance to several

common diseases, helping maintain flower quality and yield. Important climate-resilient varieties include Pusa Chitraksha, Pusa Kesari, Arka Swarna, and Arka Ravi. Chrysanthemum is widely cultivated for cut flowers, loose flowers, and pot plants. Its versatility, attractive blooms, and resilience make it an excellent choice for sustainable and climate-smart floriculture systems.



3. Rose (*Rosa* spp.)

Rose is one of the most important commercial flower crops, and modern breeding programs have emphasized heat tolerance and disease resistance to enhance climate resilience. Improved rose varieties can withstand higher temperatures, use water more efficiently, and show resistance to major diseases such as

Powdery mildew and Black spot. Important climate-resilient varieties include Grand Gala, First Red, Top Secret, and Taj Mahal. Under protected cultivation, technologies such as drip irrigation and greenhouse production further improve stress tolerance, flower quality, and yield, making roses a highly profitable and climate-smart crop.



4. Gerbera (*Gerbera jamesonii*)

Gerbera jamesonii is one of the most popular cut flowers in protected floriculture and is widely cultivated in greenhouses. It is well adapted to controlled environments, where temperature, humidity, and irrigation can be precisely managed. Gerbera shows tolerance to moderate heat stress and produces flowers

with excellent color, shape, and extended vase life. Important climate-resilient varieties include Dana Ellen, Rosalin, Savannah, and Balance. Its high market demand, attractive blooms, and improved flower longevity make gerbera an ideal crop for climate-smart and commercially profitable floriculture.



5. Gladiolus (*Gladiolus grandiflorus*)

Gladiolus grandiflorus is a highly valued ornamental flower crop known for its attractive spikes and broad adaptability. It exhibits moderate drought tolerance, enabling it to perform satisfactorily under limited moisture conditions. Its relatively short growth duration helps the crop escape adverse weather, while its ability to grow in different

soil types enhances resilience. Important climate-resilient varieties include American Beauty, White Prosperity, Candyman, and Friendship. Gladiolus is widely cultivated for cut flower production and landscape use, offering excellent market value and dependable performance under changing climatic conditions.



6. Zinnia (*Zinnia elegans*)

Zinnia elegans is one of the most climate-resilient ornamental crops and is especially well suited to hot and dry environments. It exhibits excellent heat tolerance and strong drought resistance, allowing it to maintain vigorous growth and abundant flowering during summer. The crop grows rapidly, requires minimal care, and performs reliably

under limited irrigation. Important climate-resilient varieties include Dreamland Series, State Fair Mix, and Zahara Series. Zinnia is ideal for summer cultivation, landscaping, and cut flower use. Its low maintenance requirements, vibrant blooms, and stable performance make it an excellent choice for climate-smart Floriculture.



7. Petunia (*Petunia hybrida*)

Petunia × atkinsiana (commonly referred to as *Petunia hybrida*) is a widely cultivated ornamental plant that has been extensively bred for improved heat tolerance and extended flowering. Modern varieties continue to bloom profusely under high temperatures and show moderate drought resistance, making them suitable for changing climatic conditions.

Petunias also tolerate urban pollution and perform well in containers, hanging baskets, and landscape beds. Important climate-resilient varieties include Wave Series, Supertunia Series, and Opera Supreme. Their continuous flowering, vibrant colors, and adaptability make petunia an ideal choice for climate-smart ornamental horticulture.



8. Orchid (Orchidaceae Family)

Orchidaceae includes many commercially important ornamental plants, and several modern hybrids are well adapted to changing climatic conditions. These orchids tolerate fluctuations in humidity and temperature and perform exceptionally well under protected cultivation systems such as greenhouses and shade houses. They also use water efficiently

and produce long-lasting, high-value flowers. Important climate-resilient orchid types include Dendrobium, Phalaenopsis, and Cattleya. Their superior flower quality, extended vase life, and adaptability to controlled environments make orchids an excellent choice for climate-smart and export-oriented floriculture.



Breeding Approaches for Climate Resilience

1. Conventional Breeding

Conventional breeding involves selecting and crossing plants that naturally possess desirable traits such as drought, heat, salinity, and disease tolerance. The best-performing offspring are further selected over successive generations to develop improved climate-resilient varieties. This method is economical, environmentally safe, and widely accepted because it relies on natural genetic variation without introducing foreign genes, making it a trusted and sustainable approach for crop improvement worldwide.

2. Hybridization

Hybridization involves crossing genetically diverse varieties or species to combine desirable traits such as heat tolerance, drought resistance, salinity tolerance, and superior ornamental characteristics like flower color, size, and longevity. The resulting hybrids often exhibit improved adaptability, vigor, and aesthetic quality, making them ideal for climate-resilient floriculture and modern commercial cultivation.

3. Mutation Breeding

Mutation breeding involves exposing seeds, buds, or other plant materials to radiation or chemical mutagens to create genetic variations. Some induced mutations enhance tolerance to drought, heat, salinity, and diseases. This technique helps develop improved flower varieties with better stress resistance, novel traits, and higher adaptability to changing climatic conditions.

4. Marker-Assisted Selection (MAS)

Marker-Assisted Selection (MAS) uses DNA markers linked to stress-tolerant genes to identify desirable plants at early growth stages. This approach enables faster breeding, precise selection, and improved efficiency by reducing dependence on field screening and accelerating the development of climate-resilient and high-performing flower varieties.

5. Genetic Engineering

Genetic engineering introduces specific genes associated with heat tolerance, disease resistance, and drought resistance into flower crops. This technology enables the development of improved varieties with enhanced adaptability to adverse

environmental conditions, reduced production losses, and better ornamental quality, supporting sustainable and climate-resilient floriculture under changing weather conditions.

6. Biotechnology and Tissue Culture

Micropropagation and tissue culture help produce disease-free and uniform planting material.

Modern Farming Practices Supporting Climate Resilience

1. Protected Cultivation

Protected cultivation involves growing flower crops in structures such as greenhouses, shade nets, and polyhouses to shield them from extreme weather conditions. These systems provide controlled temperature, better humidity management, and reduced pest incidence, resulting in improved flower quality, higher productivity, and year-round cultivation under changing climatic conditions.

2. Drip Irrigation

Drip irrigation delivers water directly to the root zone of flower crops in a precise and efficient manner. It saves water, reduces disease spread by minimizing leaf wetting, and improves nutrient-use efficiency through fertigation. This technology enhances plant growth, flower quality, and productivity while conserving valuable water resources.

3. Mulching

Mulching involves covering the soil surface with organic materials such as straw and crop residues or with plastic films. It conserves soil moisture, regulates soil temperature, suppresses weeds, and reduces erosion. This practice improves root growth, enhances water-use efficiency, and helps flower crops withstand drought and temperature stress.

4. Integrated Nutrient Management (INM)

Integrated Nutrient Management (INM) combines organic manures, biofertilizers, and inorganic fertilizers to supply balanced nutrition to flower crops. This approach improves soil fertility, enhances root development, strengthens plant resilience to environmental stresses, and increases flower

yield and quality while promoting sustainable and climate-smart production systems.

5. Integrated Pest Management (IPM)

Integrated Pest Management (IPM) combines cultural, biological, mechanical, and need-based chemical methods to manage pests in an environmentally safe manner. This approach reduces chemical dependency, protects beneficial organisms, minimizes pesticide residues, and improves crop sustainability, helping flower crops maintain healthy growth and superior quality under changing climatic conditions.

6. Precision Farming

Precision farming uses sensors, drones, GPS, and automated systems to monitor crop conditions and optimize water, nutrient, and pest management. This technology improves resource-use efficiency, reduces production costs, enhances flower quality and yield, and supports climate-resilient floriculture through timely and data-driven decision-making.

Role of Protected Cultivation in Climate-Resilient Floriculture

Protected cultivation plays a vital role in climate-resilient floriculture by creating a controlled environment for flower production. Structures such as greenhouses, polyhouses, and shade nets regulate temperature, humidity, and carbon dioxide levels while reducing environmental stresses such as heat, frost, heavy rainfall, and strong winds. This technology is highly suitable for crops like Rose, Gerbera, Carnation, Orchid, and Lilium. Protected cultivation enables year-round production, improves flower quality, increases productivity, and significantly reduces climatic risks, making it an essential strategy for sustainable and profitable modern floriculture.

Challenges in Adoption of Climate-Resilient Flower Varieties

The adoption of climate-resilient flower varieties faces several important challenges. The high cost of hybrid and stress-tolerant seeds limits accessibility for small and marginal farmers. Lack of awareness about suitable resilient varieties and their

management practices further restricts adoption. In many countries, research infrastructure for developing stress-tolerant floricultural crops is still evolving. Market fluctuations cause uncertainty in flower prices, affecting profitability and investment decisions. In addition, modern technologies such as protected cultivation and precision farming require technical knowledge, training, and skilled management. Addressing these constraints through research, extension services, and policy support is essential for wider adoption.

Future Prospects

The future of climate-resilient floriculture is highly promising with rapid advances in biotechnology, genomics, artificial intelligence, and precision farming. Emerging trends include the development of smart greenhouses, AI-based climate monitoring, sensor-based irrigation systems, CRISPR gene editing, and climate-smart floriculture models. These innovations will accelerate the breeding and management of stress-tolerant flower varieties. Future sustainable floriculture systems will emphasize water conservation, renewable energy use, organic flower production, and carbon footprint reduction. Together, these approaches will enhance productivity, improve environmental sustainability, and ensure the long-term resilience and profitability of modern flower farming under changing climatic conditions.

CONCLUSION

Climate change poses serious challenges to floriculture through heat stress, drought, salinity, irregular rainfall, and increased pest incidence, all of which reduce flower yield and quality. Climate-resilient varieties such as Marigold, Chrysanthemum, Rose, Gerbera,

Zinnia, Gladiolus, Petunia, and Orchid offer sustainable solutions. Combined with protected cultivation, drip irrigation, integrated nutrient management, and precision farming, these varieties enhance productivity, conserve resources, and improve farmer income. Continued research, innovation, and farmer awareness will make climate-resilient floriculture a cornerstone of sustainable and profitable modern agriculture.

REFERENCES

- Banga, S. S., & Kang, M. S. (2014). Developing climate-resilient crops. *Journal of Crop Improvement*, 28(1), 57-87.
- Kopeć, P. (2024). Climate change—the rise of climate-resilient crops. *Plants*, 13(4), 490.
- Prabhu, K. R., Kumar, A., Yumkhaibam, R. S., Janeja, H. S., Bal, K., & Talekar, N. (2023). A review on conventional and modern breeding approaches for developing climate resilient crop varieties. *Journal of Applied and Natural Science*, 15(3), 987.
- Ranjith, R., & Manikandan, P. (2025). Enhancing Climate Resilience in White Flower Agroecosystems: Sustainable Practices and Innovations. In *Navigating Climate Change: Impacts on Biodiversity and Ecosystem Resilience* (pp. 261-283). Singapore: Springer Nature Singapore.
- Shukla, S., Chaudhary, K., Phutela, S., Bhutani, R., & Shukla, S. K. (2025). Smart crop varieties and Precision agriculture: a way ahead for climate-resilient sustainable agriculture. In *Climate change and agricultural ecosystems* (pp. 435-466). Woodhead Publishing.