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Sustainable Gardening in Arid Climates: Efficient Strategies for Plant Selection, Water Management and Soil Treatment in Las Vegas, Nevada

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Abstract

Gardening in Las Vegas faces significant challenges due to its arid climate, limited water supplies, extreme temperatures and special soil conditions. This article combines practical approaches for sustainable residential gardening in arid environments, emphasizing the importance of appropriate plant selection and irrigation management. Based on the literature, we found that gardeners can achieve maximum water efficiency and enhance plant growth by choosing drought-resistant plant varieties and using precision irrigation methods. Our findings indicate the benefits of drip irrigation and weather-based irrigation controllers that significantly reduce irrigation volumes while maintaining plant health. Soil management practices, including adding organic matter and mulching, are emphasized to improve soil quality and moisture retention. This study examines shading and interplanting practices that moderate environmental stress and promote biodiversity. These practices promote sustainable gardening, enable food production, and sustain ecological balance in arid cities. This review article summarizes a guide for backyard gardeners in Las Vegas and similar arid climates to overcome environmental barriers while promoting sustainable urban agriculture.

Introduction

In arid locations around the world, challenges such as extreme heat, poor soil quality, poor water quality, water scarcity, pest infestations, strong winds and limited growing seasons (due to water scarcity) pose significant obstacles to thriving agriculture and gardening (Naorem et al., 2023; Lewandrowski et al., 2021). These environmental factors, characteristic of desert ecosystems, create a complex web of constraints that impact plant growth, crop yield and overall ecosystem functioning (Golla, 2021). An ecosystem is a community of living organisms which, interact with their environment. For instance, in regions such as Las Vegas and Nevada, where annual rainfall averages about 4 inches (10 cm), water management becomes a critical concern for urban landscaping and agricultural practices (NIDIS, 2025). The combination of these factors necessitates innovative approaches to land management to achieve sustainable food production and maintain gardens in desert cities.

The extreme climate conditions of Las Vegas generate multiple restrictions that affect plant growth and ecosystem operations. Organisms with specific adaptations survive in environments with high temperatures and strong solar radiation (Schafer, 2016). The poor soil quality (high salinity, pH greater than 8.0 and elevated boron levels) with low organic matter content and limited nutrient availability complicate the gardening efforts. These challenges are compounded by climate change, with Las Vegas experiencing a temperature rise of 5.6 F, since 1977, with frequent extreme heat events (McAfee et al., 2021). Also, intense and less recurrent rainfall further complicates gardening practices (McAfee et al., 2021; Yu et al., 2023). Las Vegas's average annual rainfall of about 4 inches (10 cm) provides a negligible contribution to plant water needs in most gardens. The decreased flow of the Colorado River alongside falling Lake Mead levels directly affects regional water availability. Even with existing difficulties, sustainable gardening proves both practical and essential for strengthening urban biodiversity and food security while reducing the urban heat island effect (EPA, 2016). Sustainable gardening can thrive in this challenging environment, even as Las Vegas recorded temperatures of 117 F for three consecutive days in 2024, peaking at 120 F. This article demonstrates the best options for arid-thriving plant species and irrigation systems, along with soil amendment strategies suitable for Las Vegas's arid climate. We can adopt sustainable gardening to thrive in this challenging environment by focusing on these key aspects.

The following sections will cover:

1. Selecting drought-tolerant and native plant species suitable to Las Vegas's climate
2. Adoption of water-efficient irrigation systems and management practices
3. Enhancing soil quality using organic amendments and mulching techniques
4. Utilizing innovative gardening techniques such as interplanting and shading

By addressing these aspects, this publication aims to provide a comprehensive guide for residents, urban planners and horticulturists in Las Vegas and similar arid regions to create and maintain sustainable gardens that are both environmentally friendly and resilient to the challenges posed by the local climate (Zeynoddin et al., 2023; Bramley et al., 2008).

Las Vegas Soil Characteristics

Soil Texture

Soil texture can significantly affect water retention and nutrient availability for plants' growth. Soil can be sandy, loam, clay or something in between. In the case of sandy soil, water drains quickly, which causes low water-holding capacity and nutrient-holding capacity (Porter, 2004). Clay soil can retain water and nutrients well but may become waterlogged (restricting oxygen movement to roots. However, loamy soil provides a good balance of drainage and retention. Most of the soil profile in Las Vegas is gravelly fine sandy loam (Figure 1). Las Vegas soil typically has low organic matter content (less than 1%) and high alkalinity (pH greater than 8.0). These characteristics necessitate soil amendments for successful gardening, as the native soil is often inadequate for supporting diverse plant life without intervention (USDA, 2015).

Figure 1. Common soil layers in arid regions, with poor water retention and high alkalinity. The topsoil contains fine sandy loam with light brown hues; transitions to deeper layers rich in calcium carbonate, known as caliche; with a hardpan forming at the lowest horizon. (Idowu and Flynn, 2015). Photo credit: Cheryl Kent.

Soil Texture Test[1]

Rather than using expensive soil tests to understand the basics of your garden soil, you can run simple experiments at home. There is a technique that is called the jar test (Figure 2), which described by Whiting et al. (2011), allows for a basic assessment of soil sand, silt, and clay proportions. Gardeners can use soil texture results to adjust watering frequency. Sandy soils need more frequent irrigation, while clay soils require less.

Material:

1. A 1 quart canning jar (with lid and ring) per soil sample
2. Calgon water softener (sodium hexametaphosphate)
3. Ruler
4. ½ cup measuring cup
5. Tablespoon
6. Jar labeling material tape with pen
7. Stopwatch

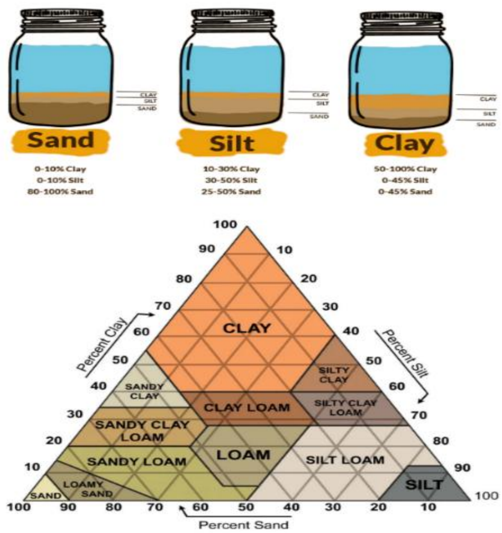

Figure 2. Classify soil based on the relative proportions of sand, silt and clay, using a jar sedimentation test.

Procedures:

1. Place a ½ cup of soil sample (clod-less and rock-free) in a 1 quart canning jar and add 1 tablespoon of Calgon with 3½ cups of water. Cap and shake the jar for **five minutes** (or put it in the mixer), and let it rest for **24 hours** until the water clears.
2. After 24 hours, use the ruler to measure the settled soil depth. The measurement represents the total depth of the soil. Then, shake it again for **5 minutes**. This time, let the jar sit for about **40 seconds**. Then, measure the settled soil again. This represents the sand layer.
3. Again, let the jar sit for 30 minutes and measure the settled soil depth. Now subtract the sand layer measurement from the current soil depth measurement to find the silt layer amount in the soil.
4. Now, add the sand and silt layer depths and subtract them by the total depth of the soil (which is measured in the first step), and you will have a clay fraction in the soil.
5. After you have the measurement, you can multiply the mm of the depth by 100% and calculate the percentage of sand, silt and clay in your backyard soil sample. Then, you can check the estimate type of your soil by looking at the soil texture triangle chart.

[1] https://extension.oregonstate.edu/gardening/techniques/analyze-your-garden-soil-home-jar-test

Soil Temperature

Soil temperature is another factor that fluctuates in the Las Vegas climate. There are significant changes in temperature between day and night. High soil temperatures increase evaporation rates and irrigation needs. Soil temperature is a crucial factor in deciding when to plant, especially for cool-season crops (Conant et al., 2004). Soil temperature fluctuates daily and decreases with depth.

The optimal soil temperatures are between 68 F and 95 F (20 C and 35 C), and if the soil temperature exceeds that range, root development, seed germination, nutrient uptake and water uptake may be decreased (Lellei-Kovács et al., 2011; Onwuka & Mang, 2018). Consequently, it reduces microbial diversity and activity, which affects nutrient cycling and organic matter decomposition (Sabri et al., 2018).

A study by Conant et al. (2004) emphasized the importance of soil temperature in determining planting times, especially for cool season crops in arid regions such as Las Vegas. The research highlighted that soil temperature is a crucial factor in seedling emergence and early plant growth, with implications for irrigation scheduling and overall garden management.

Plant Adaptations to Arid Environments

Desert plants reduce abiotic stress[2] through specialized adaptations developed over evolutionary time. Extreme temperature is one of those stressors that cause the awakening of defense mechanisms in plants. Table 1 shows how plants employ various physiological and morphological adaptations to cope with high temperatures and water scarcity in arid environments. The visible signs serve as valuable indicators for growers, enabling them to assess their plants' stress levels and adjust their care practices accordingly.

Morphological Adaptations

Morphological adaptations involve physical changes in plant structure to minimize water loss and maximize resource efficiency. Overall, these adaptations cause a reduction in overall plant size, flower production and subsequent seed/fruit yield. One example is "leaf modifications" in plants, which include reduction in the leaf size, leaf rolling, leaf folding and altering leaf angle (smaller leaves minimize water loss through transpiration) (Ehleringer, 1986; Hashem & Mohamed, 2020). Another way plants adapt is to develop "protective surfaces." Desert plants create waxy[3], hairy or spiny leaf surfaces (to trap air and insulate the plant) (Khan et al., 2018; Lewinsohn et al., 1991; Shepherd & Wynne Griffiths, 2006). Other forms of adaptation are to create special cells to increase "water storage" in stems and leaves. Spherical or cylindrical shapes are another strategy that plants develop to decrease surface area. Also, the creation of deep root systems allows plants to access water in the deepest parts of the soil (Hashem and Mohamed, 2020; Khan et al., 2018). Overall, the limited water and nutrients cause a reduction in overall plant size. (Farooq et al., 2009).

Physiological Adaptations

Over time, some plants have evolved to develop Crassulacean Acid Metabolism (CAM), which collects CO_2 at night to minimize the water loss during photosynthesis, that occurs in the day. Also, many plants regulate their stomatal activity by reducing the number of stomata having sunken

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[2] Abiotic stress is the negative impact of nonliving environmental factors on a plant's growth and development. These factors can include drought, salinity, extreme temperatures, flooding, nutrient deficiency, metal toxicity and ultraviolet radiation.

[3] Epicuticular wax

stomata[4]. Flowering patterns may also be altered (Sherrard & Maherali, 2006). During heat stress, plants sometimes accumulate natural compounds (such as sugars) to retain water, such as how salt slows evaporation. Some plants also produce cost-effective osmolytes instead of concentrating harmful ions such as sodium. This is a remarkable water-saving strategy in which plants concentrate natural sugars and salts inside their cells. This helps the cells hold onto water more strongly and keeps plants firm and upright, even during drought, which lowers the rate of evaporation. Many desert plants stay plump and sturdy when everything else wilts. Also, plants are allocating more resources to root development to access deeper water. This act is like digging a deeper well during drought conditions (Fahad et al., 2017; Zotz et al., 2021).

Behavioral Adaptations in Plants

Behavioral adaptations in plants refer to strategic changes in growth patterns and the timing of life cycle events that help them survive and reproduce under challenging conditions such as drought. In some situations, plants try to escape drought by completing their life cycle during favorable seasons. Sometimes, they close their stomata to maintain high water potential. Some have high-stress tolerance to endure the low tissue water potential. Some desert plants can function even when extremely dry, similar to how a cactus survives for months without rain. While regular garden plants would die from dehydration, these desert specialists can remain dormant and spring back to life when water returns (Khan et al., 2018; Fahad et al., 2017).

Table 1. Plants' physical changes in arid environments. Indicators for gardeners to assess plant stress and adjust care practices.

Physical Change	Description	Examples	References
Leaf Wilting	Leaves lose turgor and droop	Tomatoes, peppers	Jaleel et al., 2009
Leaf Rolling	Leaves curl inward to reduce surface area	Corn, sorghum	Kadioglu et al., 2012
Reduced Leaf Size	Smaller leaves minimize water loss	Desert plants	Poorter et al., 2012
Increased Root: Shoot Ratio	More root growth relative to shoots	Many desert plants	Bogeat-Triboulot et al., 2007
Sunscald[5] on Fruits	White/yellow blisters on sun-exposed sides	Tomatoes, peppers, apples	Schrader et al., 2001
Fruit Cracking	Splitting of fruit skin due to irregular water uptake	Tomatoes	Measham et al., 2012
Blossom End Rot	Dark, sunken lesions on fruit bottom	Tomatoes	Ho et al., 1998
Leaf Chlorosis	Yellowing of leaves due to chlorophyll breakdown, often linked to iron or nitrogen deficiency	Various crops	Jaleel et al., 2009
Thickened Cuticle	Waxy layer on leaves becomes thicker	Cacti, succulents	Yeats & Rose, 2013
Increased Trichome Density	More leaf hairs to reduce water loss	Desert plants	Bickford, 2016

[4] Sunken stomata are located beneath the epidermis of a plant's leaves, rather than being directly visible on the leaf surface.
[5] Sunscald is a type of damage that can occur to plants and trees when they are exposed to too much heat and sunlight. It can appear on fruits as white or yellow blisters or on leaves as yellow or white lesions.

Knowing these adaptations and stress indicators is key to gardening successfully in arid environments such as Las Vegas. This knowledge helps gardeners choose suitable plant species and adopt effective care practices that will enhance plant health and productivity even in difficult environments.

Selecting Drought-Tolerant Plants for Las Vegas Gardens

Selecting drought-tolerant plants is essential for creating a sustainable and attractive garden in Las Vegas's arid climate. The region's challenging conditions, including extreme heat, intense sunlight, and limited rainfall make choosing species that naturally thrive in it important. Shrubs such as cloud sage offer low-maintenance options for privacy and color, while ornamentals such as aloe vera add texture and support pollinators. For edible gardens, vegetables such as okra are well-suited to summer heat and drought. Fruit trees, including pomegranate and fig, are adapted to arid environments and provide shade and harvests. Finally, trees such as the Mediterranean fan palm contribute structure, shade and wildlife habitat, rounding out a resilient plant palette for desert landscapes (Table 2).

Table 2. Drought-tolerant plants for Las Vegas gardens.

Plant Type	Example Species/Varieties	Notes/Best Uses	References
Shrubs	Cloud Sage (*Leucophyllum frutescens*), Oleander (*Nerium oleander*), Dwarf Olive (*Olea europaea 'Montra'*)	Low-maintenance, privacy, color	SNWA, 2021
Ornamentals	Aloe Vera (*Aloe barbadensis*), Sedum (*Sedum* spp.), Echeveria (*Echeveria elegans*), Yarrow (*Achillea millefolium*)	Texture, color, pollinator-friendly	Arizona Department of Water Resources, 2015
Vegetables	Okra (*Abelmoschus esculentus*), Sweet Potatoes (*Ipomoea batatas*), Eggplant (*Solanum melongena*), Peppers (*Capsicum annuum*)	Summer crops, heat-drought-tolerant	Saeed et al., 2023
Fruit Trees	Pomegranate (*Punica granatum*), Fig (*Ficus carica*), Pecan (*Carya illinoinensis*), Black Walnut (*Juglans nigra*)	Edible, shaded, adapted to arid conditions	Arizona Department of Water Resources, 2015
Trees	Vitex (*Vitex agnus-castus*), Mediterranean Fan Palm (*Chamaerops humilis*), Guava (*Psidium guajava*)	Shade, structure, wildlife habitat	Mickelbart & Jenks, 2010

Strategies for Cultivation in Arid Environments

Some factors to consider when planning residential gardens include the type of irrigation and timing, soil texture, plant needs and pest control.

Efficient Irrigation Methods

The main takeaway of efficient irrigation techniques is reducing water usage, which increases desert sustainability. Efficient irrigation reduces water usage, lowering bills and maintenance while enhancing sustainability. One method of avoiding water evaporation through irrigation techniques is simply using the right tools at the right time. The key is to look at daily, seasonal and weather changes to adjust your irrigation based on plant water needs. For example, early morning or late-evening watering minimizes quick evaporation (Ahmed et al., 2023). Also, plants classified as low-water users may consume more if overirrigated, so careful management is essential.

Drip or Low-Volume Irrigation

Drip irrigation can save 50% to 70% of water consumption compared to conventional irrigation methods. It minimizes water loss by providing water directly to the roots of the plants (Jones et al., 2020; Yang et al., 2023). Consistent moisture levels support healthier plants and deeper root growth, rendering them more resilient to drought stress (Yang et al., 2023). One of the most significant advantages of drip irrigation is that it can be automated and calibrated precisely, so residential gardens receive the ideal amount of required water (Miller & Clark, 2018). However, it requires regular maintenance to prevent emitter clogging from mineral deposits or debris.

Sprinkler Irrigation Using Smart Controllers

Some devices, such as weather-based irrigation controllers (WBICs) and soil moisture sensors (SMS), can improve irrigation efficiency. According to studies, WBICS can reduce water usage by up to 51% in research plots and approximately 30% in residential yards (Dukes, 2020). In the wet season, SMS users can save up to 90% of water, while in the dry season, the device can save up to 55% of water. Both devices make it possible to adjust watering according to weather conditions and soil moisture (Ray and Majumder, 2024).

For efficient irrigation management in arid environments such as Las Vegas it is important to select the right nozzle type for different plants. Drip emitters or bubblers are ideal for shrubs, trees and vegetable beds because they deliver water directly to the root zone, minimizing evaporation and runoff (Chidavaenzi et al., 2021; Smeenk, 2011; Slocombe, 2015).

For lawns and large groundcovers, rotary nozzles or rotors are recommended. They provide slow, even water distribution and are especially effective on slopes or clay soil, helping to prevent waste and runoff. Fixed arc spray nozzles are best for areas with uniform shapes, while adjustable arc nozzles are helpful for irregularly shaped beds, though fixed arc nozzles generally offer more efficient and even coverage. The best time to irrigate is early morning, when lower temperatures and reduced wind minimize evaporation and help water reach plant roots effectively (Hill et al., 2000; Koeller & Linda, 2005).

Watering Guidelines in Clark County

Based on the Las Vegas Valley Water District's new legislation in 2024, the drip irrigation schedule should be:

- High flow (emitters from 5 to 20 gallons per hour): one cycle of 20 to 40 minutes each watering day

- Low flow (emitters from 1 to 4 gallons per hour): one cycle of 30 to 90 minutes each watering day

Edible crops need less water than grass. Irrigation should be based on the season and plant water needs:

- Summer (May 1 – August 31): Watering is prohibited between 11 a.m. and 7 p.m. and is not allowed on Sundays.
- Spring and fall (March 1 - April 30, September 1 - October 31): Watering is limited to three days per week.
- Winter (November 1 – February 28): Watering is restricted to one day per week.

Mulching

While irrigation techniques and timing are crucial in vegetation planting, other practices also reduce water usage and boost smart irrigation (Smart irrigation refers to technologies like soil moisture sensors or weather-based controllers that optimize watering schedules.) Applying mulch around plants helps retain soil moisture, suppresses weeds and regulates soil temperature. Organic mulches, such as wood chips, also enhance soil quality during decay (Al-Omran et al., 2010; Jiménez et al., 2005; Smith et al., 2020). It has been found that using mulch can decrease water evaporation (loss from the soil) to as low as 24% compared to uncovered soil (Figure 3).

Research indicates that the ideal mulch thickness varies by garden area and mulch type. For flower beds, 2 to 3 inches is recommended; for trees and shrubs, 3 to 4 inches; and for vegetable gardens, 1 to 2 inches (Cregg, 2013; McClure, 2024). Scientific studies show that applying organic mulch at rates of 0.25–0.50 kg/m² (roughly 2 to 5 cm thick) is efficient for water and soil conservation in arid and semiarid urban regions (Wang et al., 2021; Westerfield, 2010). Mulch should be applied in spring or fall, and it's important to keep mulch a few inches away from plant stems and tree trunks to prevent rot (Cregg, 2013; McClure, 2024).

Figure 3. Mulching variations. 1. Wood chips: Commonly used to help retain moisture in the soil and improve its quality over time. 2. Gravel: Effective for water conservation and preventing soil erosion, particularly useful in arid environments with cacti and other succulents. 3. Straw mulch: Helps reduce evaporation, keep soil cool and suppress weed growth. Straw blows around in windy weather. Photo credit: Azadeh Alizadeh.

Selection of Efficient Plan and Plant-Grouping

After balancing out irrigation and improving the soil condition, the next step on the planting checklist is selecting seasonal plant variety. Choosing between cool-season and warm-season plants is important. (For more information link 1.) Planting vegetation species with similar water and nutrient demand together can increase resource use efficiency and thus increase system productivity. So-called hydrozoning (Figure 4) is crucial in dry regions where water is limited (Hilaire et al., 2008). Hydrozoning is a grouping of plants with similar water, sun and soil needs in a landscape (Asbjornsen et al., 2011; Sun et al., 2012). This method of irrigation is more efficient, as water is not wasted. It is essential (particularly in dry regions, where water use efficiency is crucial) to classify plants as extremely low, low, moderate and high-water users (Hoy et al., 2021; Sun et al., 2012).

Figure 4. Hydrozoning. 1. The left zone features edible vegetation (leafy greens, tomato shrubs and pepper plants) with drip irrigation lines laid on the ground. 2. The right zone contains drought-tolerant succulents such as agave and aloe, also with drip irrigation lines on the ground. Photo credit: Azadeh Alizadeh.

Benefits of strategic plant grouping:

- Improved water use efficiency
- Enhanced nutrient cycling
- Increased biodiversity
- Better pest and disease management

Studies have demonstrated that proper plant grouping can lead to more resilient and productive agroecosystems in arid environments (Golaa, 2021; Schmidts et al., 2019).

Table 3. Spring-fall planting sequences for backyard gardens in Las Vegas

Crop	Spring Planting	Fall Planting	Maturity Rates
Fruiting Vegetables Tomatoes Peppers Eggplant	Late February – Early March	N/A	Moderate (60-80 days), except eggplant, which has low rate (80 or more days)[6]
Leafy Greens Lettuce Malabar Spinach Kale	February – Early March	September – October	Quick rate (30-60 days)
Brassicas Broccoli Cabbage Cauliflower	February (transplants)	August – September (seeds)	Slow (80 or more days), except broccoli, which has moderate rate (60-80 days)
Root Vegetables Carrots Beets	February – March	September – October	Carrot has moderate rate (60-80 days); beets have quick rate (30-60 days)

Interplanting

Interplanting, also called companion planting or intercropping, is an approach to co-cultivation distinct plant species to enhance plant growth and productivity and the overall ecosystem of health by improving biodiversity. Interplanting techniques are:

- Row intercropping: Cultivating different crops in separate rows.
- Strip intercropping: Planting crops in wider strips or bands.
- Mixed intercropping: Cultivating multiple crops together without a systematic row arrangement.
- Relay intercropping: Introducing a second crop into a standing crop before harvest.

Previous studies showed that companion planting improves soil available nutrients and enzyme activities. Also, it enriches microbial species diversity and reduces soilborne diseases (Gao & Zhang, 2023). Another study showed that intercropping improves productivity in food and agriculture systems (Toker et al., 2024). Growing corn and soybeans together produced more food than growing each crop separately in over a third of the tested gardens. This “plant partnership bonus” (transgressive overyielding) happens because different plants can share resources more efficiently when grown together. Corn grows tall, while soybeans use space below, and soybeans add nitrogen to the soil that benefits the corn. Various fields of maize and soybean showed transgressive overyielding[7] in 36% of intercropping cases (Li et al., 2023).

[6] https://agrilifeextension.tamu.edu/library/gardening/texas-home-vegetable-gardening-guide/

[7] Transgressive overyielding is when the productivity in mixture is larger than the maximal productivity of the constituent species (Gravel et al., 2012).

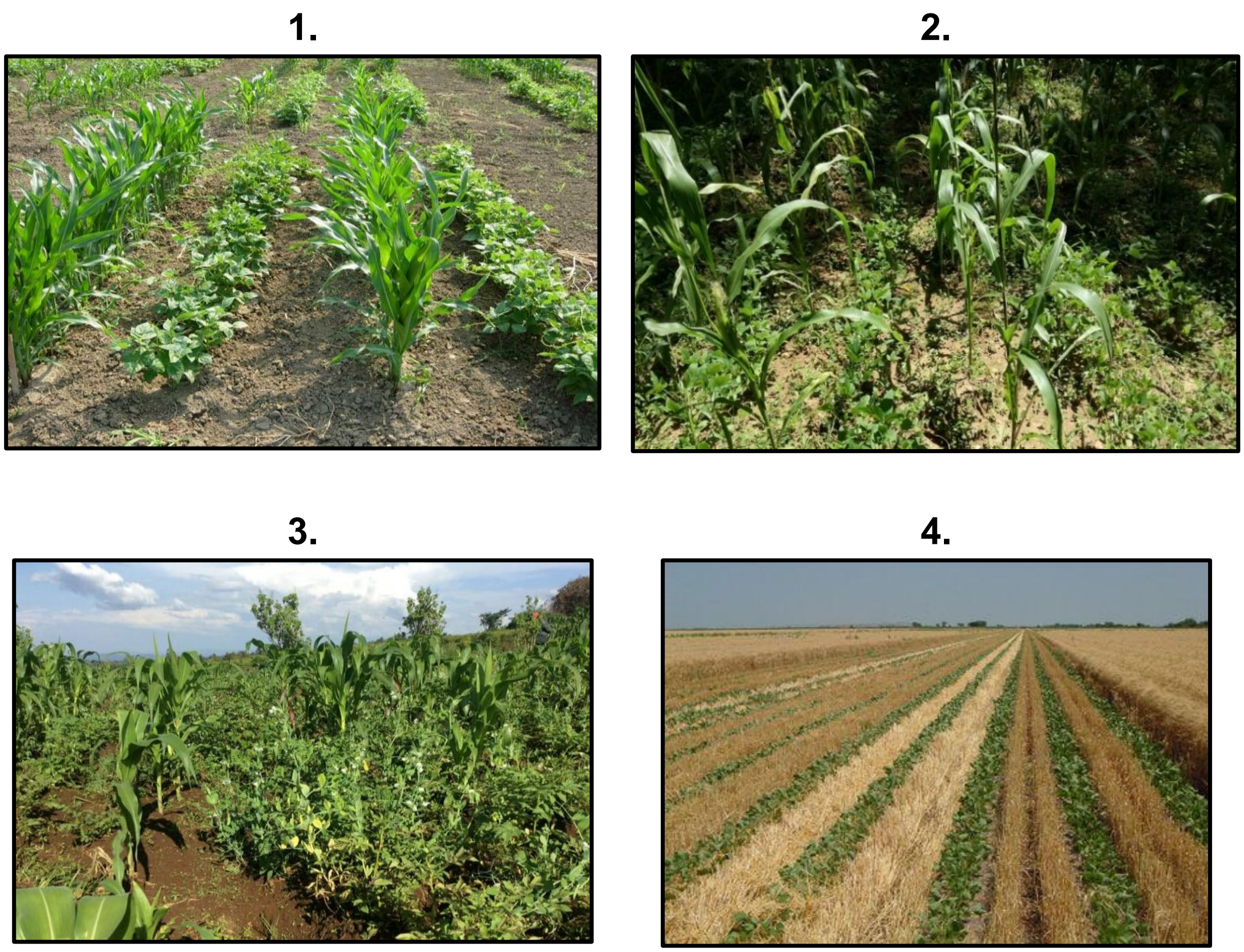

Figure 5. Interplanting. 1. Row intercropping: Two plant species are cultivated in separate alternate rows (corn with climbing bean) (Photo credit: Lithourgidis et al., 2011). 2. Strip intercropping: Stripes of two or more rows of one species are among stripes or a row of other species (Photo credit: Mandal, 2022). 3. Mixed intercropping: Multiple crop species are grown together in the same field without a distinct row pattern (potato, maize and bean) (Photo credit: PotatoWorld.eu, 2021). 4. Relay intercropping: Two plants are cultivated in the same field with different growing periods in single growing season (e.g., wheat and soybean). The first crop (taller) at a more mature stage and the second crop (shorter) at an earlier growth stage (Photo credit: Dennis & John, 2003).

Shading

Shading can significantly impact the growth and productivity of vegetables in arid regions, where managing light and temperature is crucial for plant health. However, the effects of shading can be complex and species-dependent. Studies on soybeans demonstrated that shading decreased shoot biomass and altered biomass partitioning[8], favoring stem elongation over leaf development (Wu et al., 2017). In another study on winged bean (*Psophocarpus tetragonolobus*), moderate shading increased yield compared to full sunlight, suggesting potential adaptation to partial canopy cover (Raai et al., 2020).

Research on sweet peppers by Jiang et al. (2023) in semi-arid conditions indicated that use of shading nets (green and black) have significantly higher plant growth and water-use efficiency

[8] Biomass partitioning is a process when plants allocate their resources among different organs to optimize survival, growth and reproduction.

compared to no shading. The shading nets decreased daytime air temperatures and light quality, which increased photosynthesis rates and improved growth performance such as plant height, shoot dry weight and leaf area (Mohawesh et al., 2022). For instance, moderate shading (30% to 50%) had been found to increase the concentrations of chlorophyll and some antioxidants in leafy sweet potatoes but decrease soluble sugars and total yield. This implies that shading can be beneficial for reducing stress by excessive heat and light, but it also changes plant metabolic pathways (Jing et al., 2023). These results highlight the advantages of shading strategies in arid regions by optimizing microclimate conditions to mitigate constraints on plant growth and increase resource efficiency. Shade cloth is rated by percentage of sunlight blocked (30%–90%).

To choose the right shade fabric consider the following factors:

- 30% to 40% shade: For heat-loving vegetables (tomatoes, cucumbers) and flowering plants. Shading over 30% may reduce flower production in sun-loving species such as roses or tomatoes (Schrader et al., 2001; Mohawesh et al., 2022).
- 50% shade: Suitable for herbs and general garden use (Thakur et al., 2019).
- 60% to 90% shade: For shade-loving plants (ferns, orchids) (Mahanty, 2023).
- Material:
    - Knitted HDPE is lightweight, durable and easy to cut; woven polypropylene is heavier and offers more UV protection.
    - Natural fibers such as burlap, made from jute, are biodegradable and provide moderate shading, making them suitable for temporary or eco-friendly applications (Sen et al., 2011).

Soil Management Techniques in Arid Region

Desert residential gardens must use some kind of soil management techniques to ensure successful plant growth and productivity. Some practices such as shallow tillage can break up compacted areas and improve soil porosity without causing excessive disruption of the soil structure. This method facilitates water infiltration and retention, which is critical in arid climates (Henderson, 1979). Another technique is to establish efficient water drainage in the soil that prevents waterlogging and anaerobic conditions that harm plant roots (Li, 2000). Install French drains or raised beds to improve water drainage.

High soil salinity (including boron, chloride and sodium) is one of the common challenges of arid regions soil. Strategies for salinity management include additions of chemical amendments (e.g., sulfur, gypsum), addition or improvement of drainage and addition of mulch. In calcareous Mojave soils, apply elemental sulfur to release calcium carbonate, displacing sodium. The other strategy is planting salt-tolerant crops (Wahba et al., 2019).

Conclusion

In conclusion, to have sustainability along with productivity in arid-climate gardening, some specific approaches are required, from plant selection to irrigation management. Selecting drought-tolerant plants alongside precision irrigation optimizes usage and fosters development regardless of environmental impediments. Techniques such as drip irrigation and the use of smart controllers can significantly reduce irrigation volumes while maintaining healthy plant development. Additionally, soil management practices such as adding organic matter to the soil, mulching and managing soil salinity are essential for improving soil quality and moisture retention. Implementing these strategies not only conserves water but also supports the resilience of backyard gardens against extreme temperatures and limited water availability. By integrating these practices, gardeners in Las Vegas can create thriving green spaces that contribute to local food production and ecological sustainability.

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