

Management Of Zoysia Grass (*Zoysia Japonica*) For Lawns And Recreational Landscapes Under Pakistani Climatic Conditions

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ABSTRACT

Zoysia japonica (Korean or Japanese lawngrass) has gained prominence as a resilient, low-maintenance warm-season turfgrass for lawns, recreational areas, and landscapes across Pakistan's diverse climatic zones. This review synthesizes current knowledge on its botanical traits, morphological adaptations, and management strategies tailored to Pakistani conditions, including alkaline soils, extreme temperature variations, salinity in coastal regions, and water scarcity. Key aspects covered include establishment methods (primarily vegetative propagation via plugging, sprigging, or sodding), irrigation efficiency leveraging its C4 photosynthesis and drought tolerance, conservative fertilization regimes to minimize thatch and disease risks, integrated pest and disease management (focusing on Large Patch, white grubs, and chinch bugs), weed suppression during slow establishment, mowing practices, thatch control through aeration, and salinity mitigation in coastal areas like Karachi. The species demonstrates superior cold hardiness in highland/transition zones, heat and drought

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tolerance in lowland arid plains, and moderate salinity resistance, outperforming many alternatives in wear tolerance and aesthetic density. Challenges such as slow establishment, low soil organic matter, and fungal susceptibility under monsoon humidity are addressed through cultural, biological, and targeted chemical interventions. Improved cultivars and sustainable practices offer potential for enhanced performance amid climate pressures and urbanization.

Keywords: Zoysia Japonica, Turfgrass Management, Pakistan Climate, Warm-Season Grass, Establishment Protocols, Salinity Tolerance, Drought Resistance, Integrated Pest Management, Alkaline Soils, Lawn Maintenance

Introduction

The strategic management of turfgrass species in the South Asian context, specifically within the diverse ecological regions of Pakistan, requires a sophisticated synthesis of agrostology, soil science, and environmental physiology (Iqbal et al., 2022). As urbanization accelerates in metropolitan centers such as Lahore, Islamabad, and Karachi, the demand for resilient, aesthetically pleasing, and low-maintenance ground covers has led to a significant re-evaluation of warm-season grasses. Among these, *Zoysia japonica*, colloquially known as Korean or Japanese lawngrass, has emerged as a preeminent candidate for sustainable landscaping (Khalid, 2025). This species, characterized by its dense, carpet-like growth habit and remarkable tolerance to a spectrum of abiotic stresses, offers a viable alternative to the more traditionally used Bermuda grass (*Cynodon dactylon*) varieties (Farmonaut, 2026). However, the successful establishment and long-term persistence of *Z. japonica* in the Pakistani landscape are contingent upon a nuanced understanding of its botanical requirements and the specific challenges posed by the country's alkaline soils, extreme temperature fluctuations, and unique pest complexes (Mehran Agri, 2023).

Figure 1: Comprehensive Workflow for Zoysia Grass Management in Pakistan: From Establishment to Seasonal Care.



Botanical Profile and Morphological Development

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Zoysia japonica is a perennial, mat-forming grass belonging to the subfamily Chloridoideae. Its primary architectural strength lies in its dual-spreading mechanism, utilizing both stolons (above-ground horizontal stems) and rhizomes (below-ground stems) to colonize available space (UT Extension, 2023). This morphological configuration results in a turf density that is often superior to other warm-season species, providing an effective natural barrier against weed encroachment (Athar et al., 2022). The leaves of *Z. japonica* exhibit rolled vernation, meaning the youngest blades are circular or rolled within the leaf sheath before full extension (Loch et al., 2017). The leaf blades themselves are typically smooth, stiff, and vertical, often possessing a fringe of hairs at the ligule and a sharply pointed or tapered tip (Petrovich et al., 2021).

In the context of morphological improvement for Pakistani landscapes, research into induced mutation has provided significant insights into the species' plasticity. Studies utilizing gamma-ray irradiation have successfully identified an LD50 value of 76 Gy for single node stolons, a critical threshold for breeders seeking to develop semi-dwarf cultivars with reduced internode lengths and finer leaf textures (Singh et al., 2018). Such mutants often exhibit a horizontal growth pattern, which is highly desirable for reducing the frequency of mowing in recreational settings (Geffel et al., 2021). The leaf width in these improved populations can range from 1.74 mm to 2.39 mm, while leaf sheath lengths vary significantly depending on the mutant line ("Study of *Zoysia japonica*," 2019).

Morphological Parameters and Comparative Growth Traits

Table 1. Morphological Parameters and Comparative Growth Traits of *Zoysia japonica*

Parameter	<i>Zoysia japonica</i> Description	Comparative Notes	Source
Growth Habit	Stolons and Rhizomes	More robust than <i>Cynodon</i>	(UT Extension, 2023)
Vernation	Rolled in the bud	Distinct from folded species	(UT Extension, 2023)
Leaf Texture	Coarse to Medium-Fine	Finer than local 'Dhaka' grass	((Singh et al., 2018)
Leaf Width	2.0 mm – 4.0 mm (standard)	Variable in mutants (1.7–2.4 mm)	("Study of <i>Zoysia japonica</i> ," 2019; ".")
Leaf Length	3.0 cm – 9.0 cm (unmown)	Mown height 1–2 inches	(Farmonaut, 2026; UT Extension, 2023;
Shoot Density	~352 shoots per 100 cm ²	Higher density than <i>C. dactylon</i>	(Loch et al., 2017).
Ligule	Fringe of hairs	Diagnostic feature	(UT Extension, 2023)

The physical durability of *Z. japonica* is largely attributed to its chemical composition, characterized by elevated levels of lignin and hemicellulose. These structural carbohydrates confer high wear tolerance, making the grass an ideal choice for high-traffic areas such as football fields, golf course fairways, and public parks (Martin et al., 2020). Furthermore, the adventitious root system of the species allows

it to adapt to prolonged drought by developing deeper penetrations into the soil profile to access moisture reserves (Zhu et al., 2023).

Climatological Adaptability across Pakistani Regions

Pakistan's geographic diversity creates a multifaceted climatic landscape, categorized into four primary zones: Highland, Lowland (Indus Plain), Arid, and Coastal. Each of these zones presents distinct challenges for turfgrass management, and *Z. japonica* exhibits varying degrees of suitability across these regions (Khalid, 2025.).

The Highland and Potohar Regions

In the northern highlands and the Potohar Plateau (encompassing cities like Islamabad and Rawalpindi), the climate is characterized as humid subtropical. These areas experience hot, humid summers and cold winters where temperatures frequently drop to near or below freezing (Carr et al., 2025). *Zoysia japonica* is particularly well-suited for this "transition zone" due to its exceptional cold hardiness compared to other warm-season grasses like St. Augustine or Seashore Paspalum (Jin et al 2022). The physiological response of *Zoysia* to cold is mediated by significant transcriptomic shifts. Research has identified thousands of differentially expressed genes (DEGs) that are up-regulated during cold acclimation, including those responsible for the synthesis of late embryogenesis abundant (LEA) proteins, calcineurin B-like interacting protein kinases (CIPK), and heat shock proteins (HSP) (Hao et al., 2018). These molecular adaptations allow the grass to survive temperatures as low as -15 degrees C in some instances, although it will enter winter dormancy and turn a golden-brown color once frost arrives (Mahendradhani, 2023).

The Lowland Plains and Arid South

The Indus Plain, including metropolitan hubs like Lahore, Faisalabad, and Multan, features a semi-arid to arid climate with sweltering summers (Muzammil, 2024). During the peak of summer (May and June), the "Loo" winds and temperatures exceeding 45 degrees C pose a severe risk of desiccation. While *Z. japonica* thrives in full sun and heat (ideally 27 to 35 degrees C), it requires supplemental irrigation in these regions to maintain its vibrant green color (Sun, 2019). If water is withheld, the grass enters a survival-oriented dormancy, reviving quickly once hydration is restored (Cohen et al., 2019).

Coastal Suitability and Salinity Tolerance

Along the southern coastline, particularly in Karachi, the climate is modified by sea breezes, resulting in high humidity and relatively uniform temperatures. Here, the primary challenge is not temperature but salinity. *Zoysia japonica* is classified as a halophytic species, showing significant resilience to salt stress compared to many other monocots (Gulzar et al., 2003).

Table 2. Growth Response of *Zoysia japonica* to Varying Salinity Levels

Salinity Level (mM NaCl)	Growth Response of <i>Zoysia japonica</i>	Survival/Mortality Observations	Source
0 - 100	Optimal growth; high shoot/root biomass	100% survival; vibrant color	(Uddin et al., 2012; Gulzar et al., 2003)
200	Sustained growth; minimal leaf firing	100% GLCA (Green Leaf Canopy Area)	(Uddin et al., 2012)
300 - 400	Significant growth reduction; stunted height	75-85% GLCA; high mortality in sensitive lines	(Uddin et al., 2012)
> 600	Severe stunting; leaf discoloration	High mortality; only extreme halotypes survive	(Gulzar et al., 2003)

In coastal Karachi, where soil salinization is prevalent, salt-tolerant *Z. japonica* cultivars utilize mechanisms such as ion exclusion at the root level and the maintenance of a high potassium-to-sodium ($K^+:Na^+$) ratio in the leaf tissue to preserve osmotic balance (Ashraf et al., 2023). Studies on local coastal grasses like *Urochondra setulosa* in Karachi demonstrate that while extreme salinities (above 600 mM) cause stunting, the inherent adaptability of halophytic grasses allows for their use in coastal stabilization and low-quality water irrigation (Gulzar et al., 2003).

Edaphic Factors and Soil Management in Pakistan

The performance of *Z. japonica* is intimately linked to the physical and chemical properties of the soil. Pakistani soils are predominantly alkaline, with pH values typically ranging between 7.4 and 8.7. This alkalinity, combined with high calcium carbonate content, can limit the availability of essential micronutrients like iron and manganese (Mehran Agri, 2023).

Soil Classification and Texture Analysis

The Indus Plain is largely composed of alluvial soils, which are rich in minerals but variable in texture. In urban landscapes, these are often modified using "Bhal sand" a fine-textured river silt to improve the physical structure of the root zone (Adams, 2008).

Table 3. Comparative Soil Attributes for *Zoysia japonica* in Pakistan

Soil Attribute	Pakistani Average (Urban/Arid)	Ideal for <i>Zoysia japonica</i>	Source
pH Level	7.4 – 8.8 (Alkaline)	6.0 – 7.0 (Slightly Acidic)	(UT Extension, 2023)
Organic Matter	< 1.0% (Very Poor)	2.0% – 4.0%	(Mehran Agri, 2023; Shahzad et al., 2021)
Electrical Conductivity	0.86 – 3.43 dS/m	< 2.0 dS/m (for non-coastal)	(Mehran Agri, 2023)
Dominant	Aridisols, Entisols	Mollisols	(Mehran Agri, 2023)

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Orders		(preferred but rare)	
Phosphorus Status	Low to Medium	High (for establishment)	(UT Extension, 2023; Farmonaut, 2026)

Addressing the Organic Matter Crisis

A critical constraint in Pakistani turf management is the profound deficiency of soil organic matter (SOM). High ambient temperatures accelerate the microbial decomposition of organic residues, leading to levels frequently below 1% (Haseeb et al., 2025). To establish *Z. japonica* effectively, the integration of organic amendments is mandatory. Farmyard manure (FYM), poultry manure, and compost are the most common local interventions (Farooqi et al., 2024).

The use of FYM in Pakistan is widespread, with an estimated 1.5 million tonnes of nutrients available annually, though a significant portion is diverted for use as fuel. Poultry manure, while higher in nutrient density, must be used with caution to avoid ammonia toxicity and salt accumulation (Ashworth et al., 2020). Additionally, the sugar industry provides "filter cake," a nutrient-rich byproduct that can serve as an excellent organic amendment for turf establishment. For sports fields and golf courses where drainage is paramount, sand-dominant root zones are often amended with moss peat or zeolite to enhance water retention without compromising aeration (Blunkell et al., 2013).

Establishment Protocols and Propagation Strategies

The establishment of *Zoysia japonica* is a deliberate process, as the species is notoriously slow to fill in compared to Bermuda grass. In Pakistan, vegetative propagation remains the standard, as seed germination is slow (taking 14 to 30 days) and requires precise moisture control that is difficult to maintain during the high-evapotranspiration months (Habib, 2017).

Timing and Site Preparation

The optimal window for planting *Zoysia* in Pakistan is from late March to early June, coinciding with rising temperatures that stimulate active growth. Planting should ideally occur when soil temperatures are consistently above 21 degrees C (70 degrees F) (Cohen et al., 2019.).

Soil Testing and Amendment: A comprehensive soil analysis should be conducted at least one month prior to planting to determine the need for lime or sulfur to adjust pH (Iticha et al., 2024).

Tilling and Grading: The soil should be tilled to a depth of 4 to 6 inches, incorporating organic matter and a starter fertilizer (e.g., an 8-pound application of 12-12-12 per 1,000 square feet) (DeJong-Hughes et al., 2017).

Moisture Stabilization: The seedbed should be moist but not waterlogged at the time of planting (Du et al., 2021).

Vegetative Planting Methods

Table 4. Vegetative Planting Methods for Zoysia Establishment in Pakistan

Method	Description	Advantages in Pakistan	Disadvantages
Sodding	Solid rolls of mature turf	Instant results; weed suppression	High cost; potential for 'layering'
Plugging	2-3 inch cores on 6-12 inch centers	Economical for large areas	Slowest establishment (1-2 years)
Sprigging	Stolon/rhizome sections in furrows	Lowest material cost	Requires intensive irrigation (3-4x/day)
Seeding	Broadcasted seeds (1-2 lbs/1000 ft ²)	Genetic diversity	Highly susceptible to bird predation

For recreational landscapes in Pakistan, plugging is often the most cost-effective compromise. Plugs should be spaced 6 inches apart for a faster grow-in, and it is vital to ensure that the top of the plug is flush with the soil surface to prevent drying out (Sharma, 2021). For northern regions where the growing season is shorter, the use of polyethylene covers can help warm the soil and accelerate the establishment of new stands (Luoranen et al., 2023).

Irrigation Dynamics and Water-Use Efficiency

Zoysia japonica is lauded for its high water-use efficiency, utilizing the C4 photosynthetic pathway to minimize transpirational losses. In the semi-arid conditions of Lahore and Islamabad, an established *Zoysia* lawn typically requires 1 to 1.5 inches of water per week, including rainfall (Zhu et al., 2023).

Managing the Monsoon Season

The Pakistani monsoon (late June to September) presents a unique management challenge. While the rains reduce irrigation needs, they also bring high humidity and the risk of standing water. *Zoysia japonica* is intolerant of waterlogging, which can predispose the turf to fungal outbreaks such as Large Patch (Wang et al., 2024.).

Drainage: Proper site grading is essential to ensure water moves off the surface. In heavy clay soils common in parts of Sindh and Punjab, core aeration should be performed annually in early summer to improve infiltration (Ejaz et al., 2023).

Irrigation Timing: To minimize leaf wetness, irrigation should be scheduled for the early morning (between 5 AM and 9 AM). Evening watering is strictly discouraged as it creates an ideal microclimate for pathogenic fungi (Vishwakarma et al., 2024).

Visual Indicators: Management should be based on plant cues rather than a rigid calendar. A bluish-gray leaf color, visible footprints after walking, or curled leaf blades indicate the immediate need for hydration (Khalid, 2025).

Nutritional Requirements and Fertilization Regimes

Nutrient management for *Zoysia japonica* in Pakistan must be conservative. Over-fertilization, particularly with excessive nitrogen, leads to rapid thatch accumulation and increases the incidence of insect infestations (UT Extension, 2023.).

Macronutrient Ratios and Application Timing

The annual nitrogen requirement for *Zoysia* is relatively low, typically 1.5 to 2 pounds of actual nitrogen (N) per 1,000 square feet. In the Pakistani climate, this should be applied in three or four split applications during the active growing season (May through August) (Shaikh, 2017).

Table 5. Recommended Seasonal Fertilization Schedule for *Zoysia* in Pakistan

Month	Nutrient Target	Recommended Fertilizer/Ratio	Rate (lbs N per 1000 ft ²)
May (Post-Greenup)	Recovery from dormancy	16-4-8 (Slow Release)	0.5 – 1.0
Late June	Summer vigor	15-0-10 or 12-4-8	0.5
Mid-August	Stress tolerance	5-0-20 (Potassium-rich)	0.5 (as K)
Late Sept (Optional)	Winter hardening	0-0-60 (Muriate of Potash)	1.0 (as K)

The use of slow-release nitrogen sources is critical in the high-temperature environments of the Indus Plain to prevent leaching and "luxury consumption" by the grass. Potassium (K) plays a vital role in regulating stomatal conductance and enhancing the plant's resistance to heat and drought; thus, high-potash applications are recommended in the late summer and early autumn (Farmonaut, 2026)

Micronutrients and Alkaline Soil Corrections

Because Pakistani soils are often calcareous, iron chlorosis (yellowing of the leaves) is a common symptom of iron deficiency caused by high pH (Saleem et al., 2023). Foliar applications of chelated iron or ferrous sulfate can provide a temporary "green-up" without stimulating excessive top growth. For long-term management, elemental sulfur can be applied to lower the soil pH, though this must be done gradually to avoid burning the root system (Hussain, 2017.).

Phytosanitary Management: Diseases and Fungal Pathogens

The dense canopy of *Zoysia japonica* can trap moisture, creating a habitat for several destructive fungi. In the Pakistani context, disease management is primarily focused on the transitional months of spring and autumn (Benelli et al., 2018).

Large Patch (*Zoysia* Patch)

Caused by the fungus *Rhizoctonia solani*, Large Patch is the most significant biotic threat to *Zoysia* turf. The disease manifests as circular patches of thinning, brown grass that can range from a few inches to several feet in diameter. During active outbreaks, the margins of the patches often exhibit a brilliant orange or bronze "firing" (Ahamad et al., 2024).

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Mechanism: The fungus infects the leaf sheaths and crowns during periods of cool, wet weather, typically when soil temperatures are between 18 and 21 degrees C (Bradley et al., 2003).

Cultural Control: Improving drainage, reducing nitrogen in the early spring/late fall, and keeping the thatch layer below 0.5 inches are the most effective preventative measures (Brandt et al., 2015).

Chemical Intervention: In severe cases, preventive fungicides like Azoxystrobin, Propiconazole, or Thiophanate-methyl should be applied in the fall when soil temperatures drop to 21 degrees C (Abo Ogiela et al., 2020).

Other Fungal Pathogens

Table 6. Common Fungal Pathogens and Environmental Triggers for Zoysia Turf

Disease	Causal Agent	Symptoms	Environmental Trigger
Dollar Spot	Sclerotinia homoeocarpa	Small, silver-dollar spots	Low N; high humidity; cool nights
Rust	Puccinia zoysiae	Orange/yellow pustules	High humidity; slow growth
Pythium Blight	Pythium spp.	"Greasy", water-soaked spots	Excessive heat + wetness
Brown Patch	Rhizoctonia solani	Irregular brown patches	Night temps > 20 degrees C + wetness

Rust is frequently observed on Zoysia during the humid monsoon months in Punjab. While generally cosmetic, it can be mitigated by increasing nitrogen fertility to encourage rapid leaf turnover. For Pythium and other blights, local Pakistani brands like 'Amistar Top' (Azoxystrobin + Difenoconazole) or 'Polyram' (Metiram) are commonly used by landscape managers (Shah et al., 2023).

Insect Pests and Integrated Pest Management (IPM)

The high silica content of Zoysia japonica leaf blades makes it less palatable to some insects, but several pests remain a threat in the warm Pakistani climate (Mohammad et al., 2025).

Major Insect Complexes

White Grubs: These are the larvae of various beetles (e.g., Scarab beetles) that feed on the root system, causing the turf to die in irregular patches that can be easily pulled away from the soil. In Pakistan, they are most active from July to September (Brandenburg et al., 2020).

Chinch Bugs (Blissus spp.): These tiny insects suck the sap from the grass stems, injecting a toxin that causes the grass to yellow and die. Damage is most severe in hot, dry weather and often starts near concrete edges (driveways/sidewalks) where heat is radiated (Simon et al., 2024).

Armyworms and Cutworms: These voracious eaters can defoliate large areas of turf overnight during the monsoon season (Beehag et al., 2016).

Control Strategies in Pakistan

The Pakistani agrochemical market offers a variety of solutions for turf pests. Companies such as Syngenta, Bayer, and local players like the Ali Akbar Group and Evyol Group provide both systemic and contact insecticides (Abbas et al., 2018.).

Competitive Dynamics and Weed Suppression

One of the primary advantages of *Zoysia japonica* in Pakistani landscapes is its ability to outcompete other plant species once established. Its lateral spread and dense canopy "choke out" many common weeds. However, during the initial establishment phase (which can take two to five years if sprigged into an existing lawn), weed control is critical (Sultana et al., 2024).

Common Weed Competitors in Pakistan

Native Grasses: *Cynodon dactylon* (Bermuda grass) is the most aggressive competitor. Because Bermuda grows faster than *Zoysia*, it can easily overtake a newly planted *Zoysia* stand if not suppressed (Song, 2012).

Grassy Weeds: Annual Bluegrass (*Poa annua*), Crabgrass (*Digitaria*), and Goosegrass (*Eleusine indica*) are prevalent in the Indus Plain (Brewer et al., 2021).

Sedges: Purple Nutsedge (*Cyperus rotundus*) is a perennial problem in the heavy, moist soils of Punjab and Sindh (Mumtaz et al., 2019).

Herbicide Selectivity and Caution

Chemical weed control in *Zoysia* must be handled with precision. Pre-emergence herbicides like Pendimethalin or Oxadiazon should be applied in mid-February to prevent summer annuals (Craft et al., 2023). Post-emergence control of broadleaf weeds (e.g., using 2,4-D or Dicamba) should be avoided when temperatures exceed 30 degrees C to prevent phytotoxic injury to the *Zoysia*. For sedge control, Halosulfuron is the preferred selective agent for *Zoysia* lawns (Chhetri et al., 2023).

Mowing and Canopy Maintenance

Proper mowing is the cornerstone of a healthy *Zoysia* lawn. *Zoysia japonica* should ideally be maintained at a height of 1 to 2 inches (Hutchens et al., 2024).

The One-Third Rule: To avoid physiological shock, never remove more than one-third of the leaf blade in a single mowing session (Powers, 2020).

Mower Choice: While rotary mowers are common, reel mowers are preferred for the lower heights typical of professional golf course fairways or high-end residential lawns to provide a cleaner cut on the stiff leaf blades (Lettner, 2014).

Grass-cycling: Leaving clippings on the lawn (grass-cycling) can return significant amounts of nitrogen and other nutrients to the soil, potentially reducing fertilizer requirements by 25% (Freeman et al., 2021).

Thatch and Compaction Management

Thatch is a layer of organic material living and dead stems, rhizomes, and roots that accumulates between the green vegetation and the soil surface. While a thin layer of thatch (less than 0.5 inches) provides cushioning and insulation, excessive thatch is a major problem for *Zoysia* in Pakistan (Evers et al., 2025).

Cultural Remedies

Core aeration is the most effective way to manage both thatch and soil compaction in Pakistani urban soils. This involves removing small cores of soil, which allows oxygen, water, and nutrients to reach the root zone. In the Indus Plain, aeration should be performed annually in June or July, when the grass is growing vigorously enough to recover quickly (Weaver et al., 2022). For severe thatch problems, vertical mowing (power raking) can be used to physically remove the organic debris, though this is a stressful process for the grass and should only be done in early summer (Ejaz et al., 2023).

Salinity Management and Coastal Landscape Integration

For landscapes in Karachi and along the Makran coast, the choice of *Zoysia japonica* must be weighed against its more salt-tolerant cousins and competitors. While *Z. japonica* handles moderate salinity, Seashore Paspalum (*Paspalum vaginatum*) is often preferred for sites with extreme salt exposure or those irrigated with high-salinity effluent (Uddin et al., 2012).

Comparative Coastal Performance

Table 7. Comparative Performance of Coastal Turfgrass Species

Grass Type	Salt Tolerance	Aesthetic Tone	Establishment Speed	Drought Tolerance
Seashore Paspalum	Very High	Bright/Lime Green	Fast	Moderate
<i>Zoysia matrella</i>	High	Dark Green	Slow	High
<i>Zoysia japonica</i>	Moderate-High	Light/Medium Green	Moderate-Slow	High
Hybrid Bermuda	Moderate	Dark Green	Very Fast	High

In coastal Karachi, where groundwater can have an EC_w (Electrical Conductivity of water) exceeding 4.0 dS/m, management must focus on "leaching" salts. This involves applying a "leaching fraction" extra water beyond the plant's needs to flush sodium ions below the root zone (Sun, 2019). The application of calcium-containing materials like gypsum is also essential to displace sodium from the soil exchange complex, thereby preventing soil dispersal and maintaining soil structure (Mehran Agri, 2023).

Economic and Aesthetic Considerations

From an economic perspective, *Zoysia japonica* offers long-term savings for Pakistani municipalities and homeowners. While the initial cost of sod or plugs is higher than Bermuda grass, the reduction in mowing frequency, fertilization needs, and herbicide use provides a significant return on investment (Athar et al., 2022). Aesthetically, the grass provides a "manicured" and "manila" look that is highly prized in ornamental gardens and premium golf facilities (Petrovich et al., 2021).

Figure 1: Strategic Assessment of *Zoysia japonica*: A Cost-Benefit Analysis for Pakistani Landscapes.

 Advantages & Disadvantages of <i>Zoysia japonica</i>	
 Advantages	 Disadvantages
 Excellent wear resistance and recovers from foot traffic. Ideal for active lawns.	 Slow establishment; takes longer to fill in from seed or plugs.
 Drought-Tolerant once established, requires less watering.	 High initial establishment costs (sod/plugs are expensive).
 Less fertilizer needs compared to other turfgrasses.	 Early browning and dormancy in cold winters; loses color first.
 Tolerates moderate shade better than many warm-season grasses.	 Can develop thatch if not maintained well, requiring careful management.
 Requires less frequent mowing due to slower vertical growth.	

Future Outlook and Sustainability

The future of *Zoysia japonica* in Pakistan lies in the adoption of improved cultivars such as 'Empire', 'Zeon', or 'Zenith', which offer better shade tolerance and faster establishment rates than the common "Korean grass" currently sold in local nurseries (Ashraf et al., 2023). Furthermore, the development of sustainable irrigation practices, including the use of treated greywater and smart irrigation sensors, will be critical as water scarcity intensifies in the region (Luoranen et al., 2023).

Conclusion

Zoysia japonica stands out as a highly suitable and sustainable turfgrass option for Pakistan's varied ecological and urban landscapes, providing dense, durable, aesthetically pleasing coverage with significantly lower long-term maintenance demands compared to traditional species like Bermuda grass. Its exceptional tolerance to abiotic stresses including heat, drought, moderate salinity, and cold in transition zones combined with efficient water and nutrient use, positions it ideally for water-

scarce regions, high-traffic recreational sites, and coastal stabilization efforts. Successful adoption, however, depends on overcoming establishment delays through proper vegetative propagation timing, addressing edaphic constraints via organic amendments and pH adjustments, implementing conservative fertilization to prevent excessive thatch and pest issues, and employing proactive cultural and IPM strategies against prevalent diseases (e.g., Large Patch) and insects. In coastal Karachi and similar saline environments, while it performs well up to moderate salinity levels, integration with leaching practices and occasional comparison to more halophytic alternatives like Seashore Paspalum remains prudent. Looking forward, the promotion of advanced cultivars (e.g., 'Empire', 'Zeon', 'Zenith') with improved shade tolerance and faster establishment, alongside smart irrigation technologies and greywater reuse, will enhance its role in sustainable urban greening and climate-resilient landscaping across Pakistan. With informed management, *Zoysia japonica* can deliver substantial economic, environmental, and aesthetic benefits for homeowners, municipalities, and sports facilities in the face of ongoing urbanization and environmental challenges.

References

- Adams, W. A. (2008). An overview of organic and inorganic amendments for sand. International Society for Horticultural Science. https://ishs.org/ishs-article/783_10/
- Gulzar, S., Khan, M. A., & Ungar, I. A. (2003). Salt tolerance of a coastal salt marsh grass. *Communications in Soil Science and Plant Analysis*, 34(17–18), 2595–2605. <https://doi.org/10.1081/CSS-120024787>
- Khalid, S. (2025, February 25). The ultimate guide to lawn grass in Pakistan: Types, care, and maintenance. Sapphire Builders. <https://sapphireassociate.com/guide-to-lawn-grass-in-pakistan/>
- Mehran Agri. (2023, May 7). Organic matter status of Pakistan soils and its management. <https://mehranagri.com/2023/05/07/organic-matter-status-of-pakistan-soils-and-its-management/>
- Shahzad, K., Lal, R., & Meddich, A. (2021). Management of soil physical health and carbon dynamics in maize cultivated field through organic amendments. ResearchGate. <https://www.researchgate.net/publication/341352615>
- Study of *Zoysia japonica* morphological improvement and breeding by induced mutation using gamma ray irradiation. (2019). *Bangladesh Journal of Botany*, 48(1). <https://www.bdbotsociety.org/public/article/2019%20March/22.pdf>
- Uddin, M. K., Juraimi, A. S., Ismail, M. R., Hossain, Md. A., Othman, R., & Abdul Rahim, A. (2012). Physiological and growth responses of six turfgrass species relative to salinity tolerance. *The Scientific World Journal*, 2012, 1–10. <https://doi.org/10.1100/2012/905468>
- University of Tennessee Extension. (2023). Zoysiagrass (Publication No. W159-H). <https://utia.tennessee.edu/publications/wp-content/uploads/sites/269/2023/10/W159-H.pdf>
- Zhu, Y., Fu, Q., Zhu, C., Li, Y., Yuan, F., Sun, X., & Fu, J. (2023). Review on physiological and molecular mechanisms for enhancing salt tolerance in turfgrass. *Grass Research*, 2023(25). <https://doi.org/10.48130/GR-2023-0025>
- Iqbal, M. A., Khalid, S., Ahmed, R., Khan, M. Z., Rafique, N., Ijaz, R., ... & Sheikh,

- U. A. A. (2022). Underutilized grasses production: new evolving perspectives. In *Grasses and Grassland-New Perspectives*. IntechOpen.
- Athar, T., Fatima, H., Khan, M. K., Pandey, A., Shahid, S., Hamurcu, M., & Gezgin, S. (2022). Potential Role of Turfgrasses and Understorey Vegetation for Mitigating the Changing Climate. In *Climate Change Alleviation for Sustainable Progression* (pp. 347-367). CRC Press.
- Loch, D. S., Ebina, M., Choi, J. S., & Han, L. (2017). Ecological Implications of Zoysia species, distribution, and adaptation for management and use of zoysiagrasses. *International Turfgrass Society Research Journal*, 13(1), 11-25.
- Petrovich, K. E., Vladimirovna, S. M., Stolbovaya, M., & Kolpak, E. (2021). The edges of the leaf blade. The main forms of the leaf blade. How it works. *Gas*.
- Singh, S., Gill, M. I. S., & Arora, N. K. (2018). Induction of variants in guava (*Psidium guajava* L.) through irradiation of budsticks by gamma rays. *Agricultural Research Journal*, 55(2), 347-350.
- Geffel, M. (2021). Landscape design through maintenance: Field case studies in parametric mowing. *Landscape Journal*, 39(2), 1-16.
- Martin, F. M., Dommang, F., Lavallée, F., & Evette, A. (2020). Clonal growth strategies of *Reynoutria japonica* in response to light, shade, and mowing, and perspectives for management. *NeoBiota*, 56, 89-110.
- Carr, T. Q., Hutchens, W. J., Patton, A. J., Braun, R. C., McFadden, D., & Richardson, M. D. (2025). Management strategies for preventing and recovering from zoysiagrass winterkill. *Crop, Forage & Turfgrass Management*, 11(2), e70050.
- Jin, H. X., Jiang, M., Yang, J. F., Wu, Z. H., Ma, L. L., Wang, C. C., ... & Chen, S. (2022). A survey of enhanced cold tolerance and low-temperature-induced anthocyanin accumulation in a novel *Zoysia japonica* biotype. *Plants*, 11(3), 429.
- Hao, X., Wang, B., Wang, L., Zeng, J., Yang, Y., & Wang, X. (2018). Comprehensive transcriptome analysis reveals common and specific genes and pathways involved in cold acclimation and cold stress in tea plant leaves. *Scientia Horticulturae*, 240, 354-368.
- Mahendradhani, G. A. A. R. (2023). Karakter ekstrakulikuler dalam upaya pengembangan karakter tk kumara bhuana: ekstrakulikuler dalam upaya pengembangan karakter tk kumara bhuana. *Pratama Widya: Jurnal Pendidikan Anak Usia Dini*, 8(1), 35-45.
- Muzammil, M. (2024). Sustainable Water Resources Management Strategies and Its Implications in the Irrigated Areas of the Indus Basin of Pakistan (Doctoral dissertation, Justus Liebig University Giessen).
- Cohen, I., Netzer, Y., Stheim, I., Gilichinsky, M., & Tel-Or, E. (2019). Plant growth regulators improve drought tolerance, reduce growth and evapotranspiration in deficit irrigated *Zoysia japonica* under field conditions. *Plant Growth Regulation*, 88(1), 9-17.
- Ashraf, M., Muhammad, F., Hidayat, J. W., Yaseen, M., Ayyaz, M., Ahmed, W., ... & Ahmed, K. (2023). Comparison of salinity tolerance between *Avicenna marina* and *Rhizophora mucronata* Karachi coast, Pakistan. *Journal of Bioresources and Environmental Sciences*, 2(3), 89-99.

- Haseeb, M., Ayub, A., & Nawaz, A. (2025). Impact of Climate Change on Organic soil: A Comprehensive Literature Review. *Construction Technologies and Architecture*, 17, 233-239.
- Farooqi, Z. U. R., Sohail, M., Alserae, H., Qadir, A. A., Hussain, T., Ilic, P., ... & Zafar, Z. (2024). Management of soil degradation: A comprehensive approach for combating soil degradation, food insecurity, and climate change. *Ecosystem Management: Climate Change and Sustainability*, 55-78.
- Ashworth, A. J., Chastain, J. P., & Moore Jr, P. A. (2020). Nutrient characteristics of poultry manure and litter. *Animal manure: production, characteristics, environmental concerns, and management*, 67, 63-87.
- Blunkell, C., Esteves, L. S., Walters, G., Foord, J., Mooney, J., Evans, G., & WILLIAMS, A. (2013). Portsmouth and Thames Gateway: Coastal Environmental Resources and Users. *SECOA FP7 Research Project*, 3(1), 407-470.
- Habib, U. (2017). Cold tolerance in warm season turfgrasses: a thesis presented in partial fulfilment of the requirements for degree of Doctor of Philosophy in Plant Science at Massey University, Palmerston North, New Zealand (Doctoral dissertation, Massey University).
- Cohen, I., Netzer, Y., Sthei, I., Gilichinsky, M., & Tel-Or, E. (2019). Plant growth regulators improve drought tolerance, reduce growth and evapotranspiration in deficit irrigated *Zoysia japonica* under field conditions. *Plant Growth Regulation*, 88(1), 9-17.
- Iticha, B., Mosley, L. M., & Marschner, P. (2024). Combining lime and organic amendments based on titratable alkalinity for efficient amelioration of acidic soils. *Soil*, 10(1), 33-47.
- DeJong-Hughes, J., & Daigh, A. L. M. (2017). Tillage implements, purpose, and ideal use. *Upper Midwest tillage guide. Part, 2*.
- Du, X., He, W., Wang, Z., Xi, M., Xu, Y., Wu, W., ... & Kong, L. (2021). Raised bed planting reduces waterlogging and increases yield in wheat following rice. *Field Crops Research*, 265, 108119.
- SHARMA, A. R. (2021). *MEDICINAL AND AROMATIC PLANTS RESEARCH CENTER* (Doctoral dissertation, TRIBHUWAN UNIVERSITY).
- Luoranen, J., Riikonen, J., & Saksa, T. (2023). Damage caused by an exceptionally warm and dry early summer on newly planted Norway spruce container seedlings in Nordic boreal forests. *Forest Ecology and Management*, 528, 120649.
- Wang, L., Yuan, Y., & Kim, J. (2024). Molecular Genetic Insights into the Stress Responses and Cultivation Management of Zoysiagrass: Illuminating the Pathways for Turf Improvement. *Agriculture; Basel*, 14(10).
- Ejaz, K., & Ashraf, M. (2023). Water Productivity and Economic Feasibility of Growing Rice and Wheat on Beds in Central Punjab, Pakistan. *Pakistan Council of Research in Water Resources (PCRWR)*, Islamabad, 53.
- Vishwakarma, P. K., Chander, S., & Nimbolkar, P. K. (2024). Efficient water management tactics for mitigating fruit crop diseases. *Applied Fruit Science*, 66(2), 771-779.
- Shaikh, S. S. (2017). Grass Establishment, Weed Populations and Soil Microbial

- Succession in Turf Grass System as Influenced by Produced Water Irrigation (Master's thesis, Qatar University (Qatar)).
- Hussain, R. S. R. (2017). Turf Grass Sod Production Utilizing Hydroponic Systems (Doctoral dissertation, Master Thesis. The College of Graduate Studies and the College of Food & Agriculture, UAEU).
- Saleem, A., Zulfiqar, A., Saleem, M. Z., Ali, B., Saleem, M. H., Ali, S., ... & Mostafa, R. M. (2023). Alkaline and acidic soil constraints on iron accumulation by Rice cultivars in relation to several physio-biochemical parameters. *BMC Plant Biology*, 23(1), 397.
- Benelli, J. J., Horvath, B. J., Womac, A. R., Ownley, B. H., Windham, A. S., & Sorochan, J. C. (2018). Large patch (*Rhizoctonia solani* AG 2-2LP) severity on Japanese lawngrass (*Zoysia japonica*) influenced by fungicide and application target site. *Crop Protection*, 106, 23-28.
- Ahamad, F., & Khan, M. R. (2024). Major Diseases of Turf. In *Diseases of Ornamental, Aromatic and Medicinal Plants* (pp. 153-181). Bentham Science Publishers.
- Bradley, D. J., Gilbert, G. S., & Parker, I. M. (2003). Susceptibility of clover species to fungal infection: the interaction of leaf surface traits and environment. *American Journal of Botany*, 90(6), 857-864.
- Brandt, J., Henderson, K., Uthe, J., & Urice, M. (2015). Integrated roadside vegetation management technical manual. Cedar Falls (IA): Tallgrass Prairie Center, University of Northern Iowa, 105.
- Abo Ogiela, H. M., & El-Shoraky, F. S. (2020). Efficacy of some Chemical Structure of Pesticides on Yield, Fruit Quality and Infection with some Diseases of. *Journal of Plant Production*, 11(4), 369-376.
- Shah, G. S., Rustamani, M. A., Khuhro, R. D., Syed, R. N., & Lodhi, A. M. (2023). Sensitivity of different isolates of *Pythium aphanidermatum* to old and novel fungicides. *Sarhad Journal of Agriculture*, 39(1), 182-192.
- Mohammad, M. Y., Jahan, A. S. S., Sujarajini, V., & Haniffa, H. M. (2025). Comprehensive review on types of pest attacks in paddy cultivation and botanical control measures. *Crop, Forage & Turfgrass Management*, 11(1), e70026.
- Brandenburg, R. L., & Baker, J. R. (2020). Major Insect Pests of Turf in the US. In *Handbook of Integrated Pest Management for Turf and Ornamentals* (pp. 219-235). CRC Press.
- Simon, J. E., Medeiros, R. D. D., Lima, A. C., Silva, E. S. D., & Dionisio, L. F. (2024). Resistance of forage grasses to *Blissus pulchellus* Montandon (Hemiptera: Blissidae). *Revista Brasileira de Engenharia Agrícola e Ambiental*, 28(8), e280700.
- Beehag, G., Kaapro, J., & Manners, A. (2016). Pest management of turfgrass for sport and recreation. CSIRO PUBLISHING.
- Abbas, A., Ali, M. A., Ahmad, A., Ali, S., Habib, A., Amrao, L., & Rehman, A. (2018). Status of Pesticides and Their Alternatives for Crop Sustainability in Pakistan. In *Developing Sustainable Agriculture in Pakistan* (pp. 485-501). CRC Press.
- Sultana, S. N., Zubayer, M., Islam, M. S., Ashab, K. R., Shanta, S. H., & Kayesh, E.

- (2024). Sustainable and ecofriendly approach to weed management. *Weed Management-Global Strategies*; IntechOpen: London, UK, 83.
- Song, E. (2012). Control of Bermudagrass (*Cynodon dactylon*) in Zoysiagrass (*Zoysia japonica*) turf by using post-emergence herbicides (Doctoral dissertation, University of Missouri--Columbia).
- Brewer, J. R., & Askew, S. D. (2021). Investigating low-dose herbicide programs for goosegrass (*Eleusine indica*) and smooth crabgrass (*Digitaria ischaemum*) control on creeping bentgrass greens. *Weed Technology*, 35(4), 604-610.
- Mumtaz, S., Hameed, M., Ahmad, F., & Sadia, B. (2019). Structural and functional modifications in osmoregulation for ecological success in purple nutsedge (*Cyperus rotundus*).
- Craft, J. M., Godara, N., & Askew, S. D. (2023). Zoysiagrass and weed response to herbicides during post-dormancy transition. *Weed Technology*, 37(3), 267-276.
- Chhetri, M., Fry, J. D., & Kennelly, M. M. (2023). Using ethephon for seedhead suppression of 'KSUZ 0802'(Innovation) zoysiagrass. *Crop, Forage & Turfgrass Management*, 9(2), e20257.
- Hutchens, W. J., Carr, T. Q., Patton, A. J., Bigelow, C. A., DeBoer, E. J., Goatley, J. M., ... & Xiang, M. (2024). Management strategies for preventing and recovering from bermudagrass winterkill. *Crop, Forage & Turfgrass Management*, 10(2), e20302.
- Powers, J. M. (2020). Turfgrass Plant Water Status Influence on Herbicide Phytotoxicity (Master's thesis, New Mexico State University).
- Freeman, T., Silvasy, T., Barber, L., Wichman, T., Momol, E., McIntyre, K., ... & Marvin, J. (2021). Recycling Organic Materials to Improve Your Florida-Friendly Edible Landscape: ENH1335/EP599, 2/2021. EDIS, 2021(1).
- Lettner, R. G. (2014). Turfgrass machinery and equipment operation. In *International Turf Management* (pp. 159-172). Routledge.
- Evers, M., de Caluwe, H., de Kroon, H., & Visser, E. J. (2025). Validating a practical methodology for thatch—mat—soil distinction in turfgrass soils. *International Turfgrass Society Research Journal*, 15(1), 30-37.
- Weaver, J. R., McCarty, L. B., Quisenberry, V. L., Hubbard Jr, L. R., Bridges, W. G., & Brown, P. J. (2022). Evaluating biological thatch control in turfgrass. *International Turfgrass Society Research Journal*, 14(1), 539-543.
- Patton, A. J. (2025). Why mow?: A review of the resulting ecosystem services and disservices from mowing turfgrass. *Crop Science*, 65(1), e21376.