

Native and Introduced Species for Naturalistic Landscape in Saudi Arabia

GEOFF RICKS*

*Department of Landscape Architecture, School of Environmental Design,
Faculty of Engineering, King Abdulaziz University, Jeddah, Saudi Arabia.*

ABSTRACT. 1. A selection of native species and introduced species suitable for naturalistic landscape design in Saudi Arabia is given, together with details of these species' physical appearance and growth characteristics, their cultural requirements and environmental tolerances, the methods and ease of propagation, and their potential for design use.

2. The reasons for the apparent reluctance to use native plants more frequently and the attitude towards naturalistic designs are discussed.

1. Introduction

Over the last 15 to 20 years the value of including suitable native species in amenity landscape schemes has become much more apparent: their tolerance of local environmental conditions and their capacity to sustain and encourage a wide variety of wildlife are two of the commonest justifications for their use.

In the difficult, arid climate of Saudi Arabia, distinct advantages are to be gained from incorporating some native, or locally suited, species into a design because of their ability to flourish under local growing conditions and for their superior tolerance to the extremes of heat, desert winds, drought or saline conditions that can exist. Native species often show a lower maintenance requirement than introductions and many possess a minimal irrigation demand when established, a particularly

* *Present address:* Director, Environment, RPS CAIRNS, The Environmental Consultancy, 16/1 Timberbrush, Leith, Edinburgh EH6 6QH, U.K.

significant factor in a country whose aim is to conserve and maximise the effective use of its water resources.

Native species can also give a landscape scheme a local identity and flavour, especially if it includes plants traditionally associated with the area and which may have some local economic or practical value.

Above all, native species form part of the national resource, and their use should be further encouraged, even though some are already regularly included within planting programmes in the Kingdom.

2. Native Species

A fundamental difficulty lies in identifying the country's indigenous species, for Saudi Arabia's central position at the junction of a number of historic trade routes linking Europe, Asia and Africa has inevitably led to the introduction of many new plants by traders and travellers from these parts of the world. The circumstances surrounding such introductions, including the species concerned, are frequently obscure, so that the question of whether a species has arrived by these means, has been introduced by natural agencies, or is truly 'native', cannot always be satisfactorily resolved.

Unfortunately, the standard reference, Migahid's *Flora of Saudi Arabia*, gives no indication of the origins of the species it contains, and a number, including, for example, *Azadirachta indica*, *Cupressus sempervirens*, *Eucalyptus camaldulensis*, *Morus nigra*, *Gossypium arboreum*, *Ricinus communis*, *Clitoria ternatea*, *Cynodon dactylon*, *Arundo donax* and *Phragmites australis* seem certain to have been introduced from neighbouring regions in the historic or very recent past^[13, 14]. Indeed, some species recently introduced, such as *Prosopis juliflora*, are so well adapted to local conditions that it must be only a matter of time before they spontaneously spread into suitable natural locations throughout the country.

Because of these limitations, and in order to provide a practical, working definition, a species has been considered to be native if it is described in the 2nd edition of Migahid's *Flora*^[1].

3. Useful Native and Introduced Species

By using the above definition, it is possible to present 86 species that merit inclusion in landscape work (Table 1). This list is not intended to be definitive, further species will certainly be added in the future (and some may be deleted) as practical experience and expertise in the use of native species throughout the Kingdom increases. It should be regarded purely as part of the first steps towards the fuller integration of native plants into design work in the country.

Each of the species has been chosen on the basis of its physical appearance and growth characteristics, its cultural requirement and environmental tolerances, its ease of propagation, and potential for design use: qualities that enable the landscape architect to effectively incorporate them into his designs. Full details of all these

characteristics are given in the Table.

The decision to emphasise these attributes, rather than any relationships with the other plants and animals in their natural habitats, was essentially a practical one: investigations relating to the species' ecology in Saudi Arabia are more or less non-existent, and there is very little useful information concerning the species in other areas^[2-8].

Of the species shown in Table 1, some 23 are commonly used in the country today, although in a survey of Jeddah nurseries carried out between 1985 and 1986, only 12 of these could be found on a regular basis. The number of species already used is therefore small, especially by comparison with the range typically available in Europe or North America. But, as the palette of conventional landscape species is also small (perhaps comprising only 200-250 species in all), the 23 types represent about 10% of the total.

It is clear that this proportion could be increased in the future: and with species that would significantly broaden the variety and enrich the quality of plants available for design work. Whilst the species have not been specifically chosen for their ecological value, they are representative of the major natural habitats in the Kingdom, and it is not unreasonable to expect they will encourage local wildlife where they are used, although the extent of this cannot be predicted at present.

4. Growing Conditions

An initial survey of the region can quickly establish the most important species that occur naturally and form the basis for the species choice in subsequent work. Whilst not precluding the introduction of species from other areas or parts of the country, which can be very successful if they are carefully chosen, the final result should ideally reflect the nature of the local plant communities. Irrespective of which species are actually used, it is critical that they receive suitable growing conditions.

4.1. Natural Habitats

The details of natural habitats given in Table 1 refer to the general conditions where the species normally occurs, rather than its geographical distribution within the country. Migahid^[1] has divided the Kingdom into 9 phytogeographical zones and provided details of the occurrence of each species in these zones, but as the intention of landscape work is to create favourable growing conditions, it will often be possible to grow species in areas where they do not normally grow. A good example is *Euphorbia balsaminifera*, which typically grows on mountain slopes above 2000m in the southern Asir, yet flourishes in protected areas in Jeddah at sea-level^[5]. Suitable edaphic and micro-climatic conditions are more important than the geographical area.

4.2. Soil

Most arid-zone soils are poorly developed and characterised by a high proportion of coarse sand and gravel with only limited amounts of the finer silt and clay particles.

All of the species in Table 1 can grow well in such coarsely textured, freely draining, well aerated soils, but some, including *Adenium*, *Combretum*, *Cupressus*, *Juniperus*, *Olea*, *Aerva*, *Argemone*, *Carissa* and *Dodonaea* also thrive under rocky, mountainous conditions, where the stony soil is shallow or found in pockets between boulders or outcrops of bedrock. Others such as the acacias, both palms, *Azadirachta*, *Eucalyptus*, *Ficus salicifolia*, *Prosopis*, *Abutilon* and *Calotropis* are well suited to the poorer draining silty soils found in alluvial areas. A few species, such as *Eucalyptus*, *Gossypium* or *Suaeda* are able to tolerate soil conditions with a very high water table, whilst *Tamarix*, *Arundo*, *Phragmites* and *Typha* will survive more or less permanent inundation. *Atriplex* and *Limonium* are particularly impressive as they are able to withstand inundation by sea-water whilst *Cornulaca* and *Zygophyllum* are not adversely affected by salt spray. Soil pH affects the availability of certain plant micro-nutrients, and unless supplemental fertiliser is added, most species suffer from the effects of shortages of iron, copper, zinc or manganese if the soil pH exceeds pH 7.5. However, many of the native species, for example *Acacia tortilis*, *Azadirachta*, *Eucalyptus*, *Melia*, *Tamarix*, *Atriplex*, *Capparis*, *Dodonaea*, *Retama* and *Asphodelus* are not affected in this way and are especially useful under alkaline conditions.

Soil salinity can also impose severe restrictions on plant growth, but most of the species considered here have a good to high tolerance of salinity. Those species with a lower tolerance (less than 2500 ppm) generally occur in leached, well drained soils where high salt concentrations do not accumulate and may require regular irrigation to maintain soil leaching and prevent the build-up of excess levels of salts in the soil.

4.3. Water Requirements

No plant can survive in the absence of water, and all species require sufficient to satisfy their physiological needs. This is particularly important in the period following planting or when the plants are young, for it is then that they are most vulnerable to a shortage of water, even though the majority of species are able to tolerate drought to a greater or lesser degree once they are established.

However, some species, such as *Bacopa*, *Arundo*, *Phragmites* and *Typha* naturally grow in wet, marshy areas and always require regular supplies of water to survive, whilst others, for example *Cordia*, *Morus*, *Hypericum*, *Clitoria* and *Gynandiris* are less water demanding but still need to be provided with moist soil conditions.

Although physiological characteristics and adaptations determine the actual requirement for water, the extent of the plant's root system plays an important part in its supply. Those species with particularly long, deep roots (phreatophytes) can often flourish without any significant surface supply of water once they are established and their roots have grown deep enough to occupy and exploit the zone of moist soil just above the water table. Such species are particularly valuable, for under suitable ground water conditions they may only need conventional irrigation for a limited period after planting.

4.4. Wind

Wind is a more or less constant factor in arid areas and, in general, native species are far less susceptible to wind damage such as defoliation or stunted growth than many introduced species. This can be extremely valuable in exposed desert areas where native species can provide effective shelter-belts to improve the micro-climate and allow more sensitive species to be planted.

4.5. Temperature

All of the species in Table 1 cope with the high summer temperatures found in the Kingdom, but the response to lower temperatures is not so straightforward for some species can experience problems during the cooler winter months. A few, such as *Albizia*, *Ricinus*, *Clitoria* and *Lippia* are susceptible to frost damage, and *Cynodon* is subject to chilling injury at temperatures below 10°C. On the other hand, some of the species that naturally occur in mountainous areas are favoured by a winter climate where the nights are especially cool, *i.e.*, below 10°C. Thus *Cupressus* grows well in the central region around Riyadh, yet performs poorly in the area around Jeddah where the winter night-time temperature rarely falls to less than 15°C.

5. Propagation

As so few of the species in Table 1 are commercially available at the present time, there is very little choice but to propagate most of the material required. Almost all the species can be grown from seed, and some can also be propagated from cuttings and layers, through offsets, or by division. Propagation is generally easier than one might expect, and as subsequent growth and development is often rapid, material can be ready for planting out after as little as 1-3 months.

5.1. Seed

It is advisable to collect seeds as soon as the fruits have ripened, before they have hung on the plant for any appreciable time, so as to minimise predation. The seeds of *Eucalyptus* are an exception and should be collected from fruits 6-9 months after flowering. Subsequent storage must be in a cool, dry place, but as germination seems to be far more reliable and predictable with freshly gathered seed, any storage period is best kept to a minimum.

A germination of most species can be achieved very readily in a 75/25% mixture of clean, sweet sand and sieved peat moss. Tall, narrow pots, at least 10-15 cm deep, rather than conventional shallow trays, allow better initial root development and make later potting-on much easier. The majority of seeds can be sown untreated, but some require a pre-treatment before they will germinate.

Thus the seeds of *Juniperus* must be stratified (-4°C for 30-35 days), and other species, especially from the family *Leguminosae*, should be scarified (either mechanically or with hot water). The seeds of the palm, *Hyphaene*, unless sown when very fresh, need to be soaked in water for about 30 days before sowing, and this species,

along with *Phoenix*, *Azadirachta*, *Melia* and *Juniperus*, is characterized by having seeds that are extremely slow to germinate, perhaps taking as long as 1-2 months.

Judging from the number of native species that colonise existing landscape areas and show active regeneration, both presumably as a result of the natural distribution of seed, direct seeding could prove to be extremely valuable. It would also have the distinct advantage that species with a fast-growing taproot, such as the Leguminaceous trees, will almost certainly establish themselves faster than if they are transplanted from pots where early root development is unavoidably more restricted.

At present there is little experience of this technique, the only species that is regularly used is *Cynodon*, sown at the rate of 3-5 g/m² to create grassed areas. In most circumstances seed would be broadcast by hand and requires mixing with fine, dry sand to increase its bulk and make an even distribution easier to achieve. The actual sowing rate for other species depends upon the individual seed characteristics (such as size/weight) and the final effect intended, but will generally be within the range 5 to 30 g/m². There is no information concerning rates of predation, nor loss of seed viability after sowing, but with fresh seed it is probably realistic to expect no more than a 30% survival rate. Trickle or properly controlled sprinkler irrigation is preferred to flood or hand methods as the latter may disturb the soil surface through their higher application rates, and detrimentally affect the establishment of the young seedlings.

5.2. Cuttings

A number of species can be successfully propagated from cuttings, which generally root quickly and easily in a coarse sand mixture, especially if a proprietary rooting hormone powder is used. Once rooted, the cuttings can be transferred to an 80/20% sand and peat mixture to grow on. Their development is usually rapid, and many cuttings are large enough to be planted out 2 to 3 months later.

The type of cutting required depends upon the species. For instance: heeled tip cuttings (*Cissus* and *Cupressus*), softwood tip cuttings (*Ficus*, *Olea*, *Juniperus*, *Atriplex*, *Dodonaea* and *Rhazya*), semi-hardwood cuttings (*Moringa* and *Carissa*), softwood cuttings (*Lavandula* and *Calotropis*, but water the latter sparingly), or hardwood cuttings (*Tamarix* and *Tamarindus*). Rooted stem cuttings of the prostrate ground-cover species (*Bacopa*, *Cressa*, *Lippia*, *Heliotropium* and *Portulaca*) and rooted suckers of *Azadirachta* and *Zizyphus* are successful. If the soil is kept moist, thin *Tamarix* branches, 30-40 cm long, will root directly in their final positions.

5.3. Layering

This is not usually a practical proposition unless the 'mother' plant is located in an area where it will not suffer from interference. *Cordia* responds well to layering, and air layering of young branches is very successful with all species of *Ficus*.

5.4. Division and Offsets

With the exception of *Cynodon* (most conveniently propagated from seed), the

grasses and sedges are best propagated from the division of the underground rhizome mass of the mature plant. *Iris* can also be propagated in the same way, and *Pancreatium* produces subterranean corms that can be separated and potted or planted out individually. Many succulents spread by offsets, small plants growing laterally from the base of the adult plant. The offsets can easily be removed and replanted when small. Both palms produce offsets at the base of their trunk, but these are usually left to grow to a reasonable size (perhaps a metre or more in height) before they are separated.

Collecting the material required for propagation can prove to be a problem through the interference of the local community, many of whom will not fully appreciate why the plant material is being gathered. This particularly applies in rural areas, and it is wise to always contact the local Emir or Mayor and the Chief of Police to explain the reason for the visit. The recruitment of any labourers required should always be carried out locally, but it is sensible to elicit local help for this to prevent misunderstandings.

6. Using Native Species

At the present time in Saudi Arabia there is very little significance given to a species' native status. If native species are used in design work it is because they have been judged in design terms to be more suitable for the job than other horticultural species currently available. This emphasis seems unlikely to change in the near future, at least in the private sector, so the acceptability of the species in Table 1 will be determined by their ability to satisfy existing landscape demands rather than their inherent ecological value.

This is partly a reflection of the genuine local preference for those horticultural species, well known to both client and practitioner, which can begin to create something of the lushness and allure of the idealised 'Islamic garden', but also represents a failure on the part of most designers and contractors to fully appreciate the true potential of many 'wild' plants in the country. These are commonly ignored because of their unfamiliarity and often considered to be of little consequence: deficient in aesthetic appeal of limited functional value. Whilst this impression does apply to many species, the selection in Table 1 shows it need not always be the case. In full flower *Delonix elata*, *Hypericum revolutum* or *Euryops arabicus* can visually match any of the horticultural species, and many natives possess superior functional characteristics because of their tolerance for local environmental conditions. Encouragingly, the support given to the few native species already in current use suggests that the incorporation of additional species into conventional design work is largely a question of time as further species become known and prove their practical value.

The attitude towards naturalistic designs, however, is rather different. Much of the apparent 'customer resistance' is a reaction to the idea of producing 'yet more desert', and it is certainly true that many natural plant associations are not particularly attractive, especially when viewed through the whole of the year and compared with

the results of conventional landscape. Most communities are notable for their seasonal nature and the limited number of species and individuals, giving them their open character with a high proportion of bare ground to vegetation. Even in those areas where high accumulations of plants occur, cover values can frequently be less than 50%, often with visually unappealing species. In view of the success of the intensive use of the lush, ornamental species it is hardly surprising that the attitude to native planting of this sort can be less than encouraging. If a naturalistic approach is to become accepted there have to be some fundamental changes in what is expected from such designs, which must be considered less in terms of their aesthetic effects, and instead, a greater emphasis placed on ecological, functional and practical factors, characteristics that reflect the varied nature of natural landscape and the natural forces that shape and control its development.

In many respects the seasonal changes in natural communities highlight the practical problems, for these changes are related to the seasonal variations in water supply and there is little experience of the management of water supplies to local plant communities in the Kingdom. As a general rule the composition and extent of existing communities reflect the ability of natural water supplies to sustain them, and anywhere sufficient water is found (even if it is only transient) vegetation of some form will be present. Water supply also determines the life history of many species. A large number are annuals, surviving from one wet season to the next as seeds in the soil seed bank, so avoiding those periods when water is in shortest supply, whilst others survive dry periods by defoliating or restricting water use by physiological mechanisms that reduce growth rates.

Consequently, increases in the number of plants in the community or any changes in its composition and structure must be supported by corresponding changes in the amount of water provided, irrespective of whether this is simply the encouragement of existing species or the introduction of new types to enhance the community. The means of supplying the extra water can technically be accomplished very easily by a variety of methods ranging from semi-natural rainwater harvesting to completely automated irrigation systems (although the acceptability of the latter could be questioned). More important, the long-term effects of supplementing natural rainfall or providing water for a longer period in the year upon the nature of the community are largely unknown at present. How will species composition and vigour be affected? Will more competitive species be encouraged at the expense of those less competitive (but perhaps equally valuable in design terms)? What of the life histories of some species, how will these be altered? Can the soil resource maintain the community over an extended period? Without a great deal of empirical research into the behaviour of communities and their ecosystems it will be impossible to answer such questions and begin to manage the communities with confidence or attempt to construct them from scratch. Much needs to be done.

In the meantime, however, the opportunity to use native species in design work should be taken whenever this is possible and practical. This will enable the species to become more familiar and their attributes better understood and recognised by all

concerned with the provision of new landscape works. Until then, it will not be possible to fully exploit the advantages of using this natural resource in environmental design.

References

- [1] **Migahid, A.M.**, *Flora of Saudi Arabia*, 2nd Edition, Riyadh University Press, Riyadh (1978).
- [2] **Adams, R., Adams, M., Willens, A. and Willens, A.**, *Dry Lands: Man and Plants*, Architectural Press, London (1978).
- [3] **Batanouny, K.H.**, *Ecology and Flora of Qatar*, University of Qatar (1981).
- [4] **Daoud, H.S. and Al-Rawi, A.**, *Flora of Kuwait*, KPI, London (1985).
- [5] **Sturdy, R.**, Native and adapted species for amenity planting in the western region of Saudi Arabia. *Final report*, SANCST research contract AR-01-045, Riyadh (1982).
- [6] **Tackholm, V.**, *Student's Flora of Egypt*, 2nd Edition, Cairo University Press, Cairo (1974).
- [7] **Walter, H.**, *Ecology of Tropical and Subtropical Vegetation*, Van Nostrand Rheinhold Co., New York (1971).
- [8] **Zohary, M.**, *Geobotanical Foundations of the Middle East*, Vols I and II, Gustav Fischer Verlag, Stuttgart (1973).
- [9] **Kwei, T.**, *Landscape Plants in the United Arab Emirates*, published by Teresa Kwei, New York (1978).
- [10] **Van Ollenbach, O.W.**, *Planting Guide to the Middle East*, Architectural Press, London (1978).
- [11] **Ricks, G.R.**, *Landscape Plant Manual for Saudi Arabia*, King Abdulaziz University Press, Jeddah, in press (1988).
- [12] **US Corps of Engineers**, *The Arid Green*. US Corps of Engineers, Middle East Division (1978).
- [13] **Collenette, S.**, *An Illustrated Guide to the Flowers of Saudi Arabia*, M.E.P.A./Scorpion, London (1985).
- [14] **Mandaville, J.**, *The Flora of Eastern Saudi Arabia*, Kegan Paul, London & N.C.W.C.D., Riyadh (1990).

TABLE 1. Useful native and introduced species.

**Common in Jeddah nurseries 1985-86;

*Also used in landscape work.

(●) : Probably introduced.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
PALMS						
<i>Hyphaene thebaica</i> PALMAE Dohm palm	Spreading palm; 15m × 8-10m; dichotomous branches and clusters of large grey-green fan-shaped leaves at the ends; large, hard fruits; slow growing.	Alluvial areas in <i>wadis</i> .	Sandy or silty soil; salinity tolerance 25000 ppm; drought resistant, phreatophytic; wind resistant; frost tolerant; sun or shade.	Offsets or fresh seed after 30 days in water.	Accent; contrast; good canopy when massed.	11, 5, 6, 12
<i>Phoenix dactylifera</i> ** PALMAE Date palm	An erect palm; 25m × 10-12m; spreading grey-green leaves up to 4m long; familiar dates on female trees; slow growing.	Areas of deep alluvial soils.	Sandy or silty soil; salinity tolerance 25000 ppm; drought resistant, phreatophytic; wind resistant; frost tolerant; full sun.	Offsets or fresh seed.	Accent; specimen; good canopy when massed; mature trees can be transplanted.	11, 7, 5, 12
TREES						
<i>Acacia arabica</i> * (●) LEGUMINOSAE Gum arabic tree	Rounded canopy; 12m × 8m; small, dull green bipinnate leaves; bright yellow 'puff-ball' flowers; pods grey-white, constricted; fast growing; spiny.	Alluvial areas in <i>wadis</i> .	Sandy or silty soil; salinity tolerance 8000 ppm; drought resistant, phreatophytic; wind resistant; not frost tolerant; full sun.	Fresh, scarified seed; self propagating.	Produces a dense canopy when mature and provides a good screen, shelter-belt or background.	10, 11, 5, 12
<i>A. farnesiana</i> ** (●) LEGUMINOSAE Sweet acacia	Spreading canopy; 6m × 4-8m; small, bright green bipinnate leaves; very fragrant, yellow 'puff-ball' flowers; pods very dark brown, swollen; slow growing; spiny.	Sandy areas in <i>wadis</i> .	Sandy soils; salinity tolerance 10000ppm; drought tolerant, phreatophytic; wind resistant; frost tolerant; best in full sun.	Fresh, scarified seed.	Specimen or avenue tree especially for walkways.	10, 11, 12
<i>A. seyal</i> LEGUMINOSAE —	Rounded canopy; 10m × 8m; small, dull green bipinnate leaves; fragrant, yellow 'puff-ball' flowers; bark greenish, covered with a reddish, powdery deposit; fast growing; spiny.	Alluvial areas in <i>wadis</i> .	Sandy or silty soil; salinity tolerance not known, probably low; drought tolerant; wind resistant; full sun.	Fresh, scarified seed.	Desert shelter-belts; background planting.	5

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>A. tortilis</i> LEGUMINOSAE Camel thorn	Flat-topped, spreading crown, often from multiple trunks; 7-10m × 7-12m; very small grey-green bipinnate leaves; white or pale cream 'puff-ball' flowers; twisted pods; medium growth rate; spiny.	Sandy, silty or stony areas in <i>wadis</i> .	Sandy or silty soil to pH 9-5; salinity tolerance 2000 ppm; drought resistant, phreatophytic; wind resistant; frost tolerant; full sun.	Fresh, scarified seed; self-propagating.	Desert shelter-belts; barriers.	3, 11, 12
<i>Adenium obesum*</i> APOCYNACEAE Desert rose	Small tree or large shrub with an open canopy and bulbous, swollen base to the trunk, 5m × 3m; bright green, leathery, shiny leaves; conspicuous pink to red trumpet flowers; slow growing.	Rocky, mountainous areas, and the stony edges of <i>wadis</i> .	Well drained sandy or stony soil; salinity tolerance 5000 ppm; drought resistant, phreatophytic; wind resistant; frost tolerant; full sun.	Fresh seed or tip cuttings.	Specimen or accent, especially in gardens or patios; semi-mature trees can be transplanted.	5, 12
<i>Albizia lebbek*</i> (●) LEGUMINOSAE Sirris	Spreading, rounded crown; 20m × 15m; large, bright green pinnate leaves; conspicuous, fragrant, greenish-white 'puff-ball' flowers; flat, straw-coloured pods with seeds that rattle; fast growing.	Alluvial areas in <i>wadis</i> .	Sandy or silty soil to pH 8-0; salinity tolerance 6000 ppm; water demanding; brittle branches, not wind resistant; frost tolerant, but may defoliate; sun or shade.	Fresh scarified seed.	Specimen; produces a dense screen and canopy; leaf and pod litter may be a nuisance.	10, 11, 5, 12
<i>Azadirachta indica**</i> (●) MELIACEAE Neem	Rounded canopy, often with 2 or 3 entwined trunks; 18m × 10-12m; large, bright green pinnate leaves in bunches at the end of branches; small, white, fragrant flowers; purple berry-like fruits; fast growing.	Alluvial areas in <i>wadis</i> .	Sandy or silty soil to pH 8-5; salinity tolerance 6000 ppm; drought resistant, phreatophytic; hot, salty winds cause defoliation; frost causes die-back; full sun.	Fresh seed, but slow to germinate.	Excellent canopy; use in avenues and as a screen or background planting.	10, 11, 5
<i>Combretum molle</i> COMBRETACEAE -	Large, irregularly shaped tree; 12m × 10m; leaves pale green, elliptic, small; inconspicuous, yellow flowers in pendant spikes; winged fruits; slow growing.	Rocky, mountainous areas.	Sandy or stony soil; low salinity tolerance; drought tolerant; phreatophytic; wind resistant; frost tolerant; full sun.	Seed.	Produces a good canopy when shaped; dense screen or background.	11, 5
<i>Cordia myxa</i> (●) EHRETIACEAE -	Small, rounded canopy; 5-8m × 5m; leaves dark green, large, ovate, rather coarse, sometimes hiding the bunches of	Widespread in sandy areas.	Sandy soil; salinity tolerance not known, probably low; water demanding; wind resistant; frost	Seed or layering.	Good canopy when mature; useful in small spaces, courtyards or	9, 1, 11

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Cupressus sempervirens</i> * GUPRESSACEAE (●) Cypress	small, scarlet, trumpet flowers; slow growing. Dense, columnar conifer; 10-15m × x 2-5m; small, dark green leaves appressed to the branches; brown, woody cones; medium growth rate.	Poor, rocky soils in mountainous areas with cool winters.	tolerant; sun or shade. Poor shallow soil in drainage good; salinity tolerance 3000 ppm; drought tolerant, phreatophytic; wind resistant; frost resistant; full sun.	Seed or heeled tip cuttings.	patios; sheds leaves continuously. Effective accent or contrast, excellent for avenues or screens; best in areas with a cool winter.	11, 12
<i>Delonix elata</i> LEGUMINOSAE	Small, spreading canopy; 5-8m × 5m; blue-green bipinnate leaves; large, showy flowers with 4 white petals, 1 lemon yellow, and many red stamens; small, flattened pods.	Rocky, mountainous areas.	Free draining sandy or silty soil; salinity tolerance 3500 ppm; drought resistant; wind resistant; frost resistant; full sun.	Scarified seed; self-propagating.	Excellent specimen or accent.	11, 5
<i>Eucalyptus camaldulensis</i> ** MYRTACEAE (●) Red gum	Upright tree with irregularly arranged, spreading branches; 20-25m × 10-18m; grey-green, linear-lanceolate, fragrant leaves; small, cream, 'fluffy' flowers; very fast growing.	Alluvial areas in <i>wadis</i> .	Any soil to pH 11.5, tolerates flooding; salinity tolerance 13000 ppm; drought tolerant; phreatophytic; wind resistant; frost tolerant; full sun.	Seed from fruits 6-9 months after flowering.	Effective screen or part of a shelter-belt; roots are invasive.	1, 11, 5, 12
<i>Ficus pseudosycamorus</i> MORACEAE Sycamore fig	Rounded crown with branches that arch to the ground; 12-15m × 8m; conspicuous dark green leaves that are undivided or 3-lobed; small, pear-shaped figs, black when ripe; medium growth rate.	Rocky, mountainous areas and inland <i>wadis</i> .	Sandy soil; salinity tolerance 5000 ppm; drought tolerant, phreatophytic; wind resistant; frost tolerant; full sun or partial shade.	Seed; tip cuttings; air layering.	Can be an effective specimen; provides good screen or background planting.	1, 11, 12
<i>F. salicifolia</i> MORACEAE Willow-leaved fig	Irregular branched, rounded canopy; 15m × 8-10m; shiny, dark green, linear-lanceolate, pendant leaves; creamy figs that gradually darked to red; medium growth rate.	Alluvial soils in rocky, mountainous areas.	Sandy or silty soil; Salinity tolerance 4000 ppm; drought tolerant, phreatophytic; wind resistant; frost tolerant; sun or shade.	Seed; tip cuttings; air layering.	An effective screen or canopy if the crown is lifted	1, 11, 5, 12

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>F. vasta</i> MORACEAE	Large, irregularly shaped tree; broad, dark green, ovate leaves up to 20cm across; figs large, up to 2cm in diameter.	Wadis and rocky areas.	Sandy or silty soil; salinity tolerance not known, possible medium; water demanding; wind resistant; full sun.	Seed; tip cuttings; air layering.	Shelter-belt; background planting.	5
<i>Juniperus excelsa</i> CUPRESSACEAE Juniper	Pyramidal-shaped conifer, sometimes large, multi-stemmed shrub; 5-12m × 5-8m; small, dull green, inconspicuous leaves closely appressed to the branches; round cones, reddish-brown when mature; slow growing.	Well drained soil in rocky and mountainous areas.	Any well drained soil; salinity tolerance 500 ppm; drought tolerant, phreatophytic; wind resistant; frost resistant; full sun.	Stratified seed, slow germination; tip cuttings.	An effective screen; provides a good canopy at maturity if the crown is lifted.	1, 11, 12
<i>Melia azedarach</i> * (●) MELIACEAE Persian lilac	Rounded canopy; 12-15m × 7m; large, dark green, imparipinnate leaves; large, lax panicles of small, fragrant, lilac flowers; clusters of dark yellow berries; fast growing.	Well drained alluvial areas.	Sandy or silty soil to pH 9-5; salinity tolerance 7000 ppm; drought tolerant, phreatophytic; brittle branches, not wind resistant; frost resistant; full sun or partial shade.	Seed, but slow to germinate.	Needs cool winter.	10, 11
<i>Moringa aptera</i> * (●) MORINGACEAE Ban tree	Irregular, upright shape, with a mass of criss-crossed branches; 5-15m × 4-6m; bright green, bipinnate leaves; numerous, fragrant, conspicuous, creamy-white flowers in terminal racemes; large 3-angled pods; fast growing.	Sandy and alluvial areas, cliff sides.	Sandy soil; salinity tolerance 2000 ppm; drought tolerant but may defoliate; brittle branches; not wind resistant; not frost tolerant; best in full sun.	Seed; semi-hardwood tip cuttings self-propagating.	Gives a light shade or screen; produces a large amount of leaf and fruit litter.	1, 11
<i>Morus nigra</i> (●) MORACEAE Mulberry	A spreading tree; 10-12m × 8m; large, dark green, ovate leaves; greenish flowers; familiar mulberry fruit; slow growing.	Sand and alluvial areas.	Any well drained, nutrient-rich soil; salinity tolerance 2000 ppm; water demanding; wind resistant; frost tolerant; full sun.	Seed or hardwood cuttings of ripe wood.	Produces a good canopy when mature; an effective screen or background planting. Needs cool winter.	1, 12
<i>Olea chrysophylla</i> OLEACEAE Arabian olive	Bushy tree; 10m × 6m; thick, silvery-grey, lanceolate leaves; small, greenish-yellow flowers; small, purplish berries; fast growing.	Mountainous areas.	Sandy or gravelly soil; salinity tolerance 1500 ppm; drought tolerant; wind resistant; frost resistant; full sun.	Seed; tip cuttings.	Dense screen; shelter-belt.	1, 12

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Prosopis spicigera</i> (●) LEGUMINOSAE Mesquite	Large, spreading canopy; 15-20m × 10-12m; feathery, pendant, bipinnate leaves; bright yellow flowers in cylindrical spikes; thin, brown, curved pods; numerous spines; fast growing.	Sandy and alluvial areas.	Sandy or silty soil; salinity tolerance 4500 ppm; drought resistant, phreatophytic; wind resistant; frost tolerant; full sun.	Scarified seed; self-propagating.	Tolerates harshest desert conditions; screen; shelter-belt; good canopy when mature.	9, 11
<i>Tamarindus indica</i> * LEGUMINOSAE Tamarind	Large tree with flattened, spreading crown; 20m × 10m; dark green, pinnate leaves; showy, creamy flowers in loose racemes; dark brown, edible, swollen pods; slow growing.	Sand and alluvial areas.	Sandy soil, salinity tolerance 4000 ppm; water demanding; wind resistant; frost tolerant; full sun or partial shade.	Scarified seed; hardwood cuttings.	Excellent specimen or canopy tree; dense screen.	1, 10, 11
<i>Tamarix aphylla</i> T. <i>nilotica</i> ** (●) TAMARICACEAE Athel tree	Small trees, often bushy and irregular in outline, difficult to distinguish the species; 3-9m × 2-8m; leaves insignificant, dull grey-green, closely appressed to the branches; small white or pinkish flowers in terminal spikes; very fast growing.	Alluvial areas, saline <i>sabkhs</i> .	Sandy or silty soil to pH 11.5, will tolerate a high water table or inundation; salinity tolerance 19000 ppm (<i>T. aphylla</i>), 16000 ppm (<i>T. nilotica</i>); drought resistant, phreatophytic; wind resistant; frost resistant; full sun.	Seed; hardwood cuttings; self-propagating.	Grows in the harshest conditions; excellent for shelter-belts, screens or background planting; also soil stabilisation and reclamation.	3, 10, 11, 5, 12
<i>Zizyphus spina-christi</i> ** RHAMNACEAE Sidder SHRUBS	Spreading tree with irregular, rounded crown; 6-18m × 2-15m; shiny, dark green, ovate leaves with 3 prominent veins; small, insignificant, yellowish flowers; small, edible, apple-like fruits; spiny; fast growing.	Alluvial areas.	Sandy or silty soil; salinity tolerance 8000 ppm; drought tolerant, phreatophytic; wind resistant; frost resistant; full sun.	Seed; rooted suckers; self-propagating.	Good in exposed locations for screens or shelter-belts; background planting; canopy gives deep shade when mature.	1, 3, 11, 5, 12
<i>Abutilon pannosum</i> MALVACEAE	Erect and spreading stems and branches, 1-3m × 1-2m; glaucous-green to yellow, ovate, velvety leaves; large, showy flowers, yellow with a dark blotch in the centre; schizocarp with black mericarps; fast growing.	Sandy and alluvial areas.	Sandy, or silty soil; low salinity tolerance; drought tolerant but may defoliate; needs some protection from strongest winds; frost tolerant; full sun.	Seed; self-propagating.	Makes an effective screen, baffle or light barrier.	3, 11, 5

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Acacia ehrenbergiana</i> LEGUMINOSAE -	Long, spreading stems and branches; 2-4m × 1-5m; very small, dull green, bipinnate leaves; rich yellow, 'puff-ball' flowers; clusters of dark brown, curved pods; slow growing; very spiny.	Sandy and alluvial areas.	Sandy or silty soil; low salinity tolerance; drought resistant, phreatophytic; wind resistant; frost tolerant; full sun.	Fresh, scarified seed, but slow; self-propagating.	Makes an impenetrable barrier, e.g. at the edge of a shelter-belt; valuable on exposed, difficult sites.	3, 11, 5
<i>Aerva javanica</i> AMARANTHACEAE -	Low undershrub; 0.5-0.8m × 0.2-0.8m; small, grey-green, elliptic leaves; mass of minute flowers in large, white, woolly spikes, 10-15cm long; fast growing.	Sandy and alluvial.	Poor sandy or stony soil; salinity tolerance not known, probably medium; drought resistant; wind resistant; frost tolerant; full sun.	Seed; self-propagating.	Attractor, contrast or accent; one of the best 'white' plants available.	3, 11, 5
<i>Astragalus sieberi</i> LEGUMINOSAE -	Low, mounding shrub with white, woolly stems; 0.5- × 1.0m; long, grey-green pinnate leaves; yellow flowers in short racemes; woody pods; spiny; slow growing.	Silty, alluvial areas in wadis.	Sandy or silty soil; salinity tolerance 2000-5000 ppm; drought tolerant; wind resistant; frost tolerant; full sun.	Scarified seed; self-propagating.	An effective low barrier; interesting ground-cover.	3, 12
<i>A. spinosum</i> LEGUMINOSAE -	Low; 0.5-1.0m × 1.0m; long and short pinnate leaves that form hard spines that shedding leaflets; flowers with conspicuous, inflated pink/white calyx; spiny; slow growing.	Sandy soils in rocky areas.	Sandy soil; salinity tolerance not known, may be medium; drought tolerant; wind resistant; frost tolerant; full sun.	Scarified seed; self-propagating.	An effective low barrier.	1, 5
<i>Atriplex farinosa</i> CHENOPODIACEAE -	Spreading, sometimes procumbent; 1m × 2-3m; glaucous, farinose leaves with large auricles; small, inconspicuous flowers in terminal or axillary spikes; slow growing.	Coastal sands above high-water.	Sandy soil to pH 11.5; high salinity tolerance, withstands inundation with sea-water, c. 40000 ppm; drought resistant; wind resistant; frost tolerant; full sun.	Seed, but with difficulty.	Sand binder for reclamation and soil stabilisation in coastal areas.	11, 5
<i>A. halimus*</i> (•) CHENOPODIACEAE Shrubby orache	Dense, erect, much branched; 2m × 2-3m; silvery-white, ovate or triangular leaves; small, inconspicuous flowers in axillary spikes; slow growing.	Coastal areas.	Sandy or silty soil to pH 11.5; salinity tolerance 28000 ppm; drought resistant; wind resistant; frost resistant; full sun.	Seed; softwood tip cuttings.	Use as a low screen or barrier in saline or non-saline soils; effective accent or contrast.	11, 5, 12
<i>Cadaba glandulosa</i> CAPPARACEAE	Dense, rounded; 1-2m × 1-3m; dark green, rounded leaves covered by short,	Rocky and stony areas.	Poor quality, well drained soil; salinity tolerance not known,	Seeds rare; cuttings	An impressive desert shrub that remains green	1, 11

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Calotropis procera</i> ASCLEPIADACEAE -	glandular hairs; small flowers with a single yellow ligulate nectary and green exerted stamens; fruit rare; very slow growing. Large, much branched, forming loose clumps: 3-4m × 2-3m; large, broadly ovate, glaucous, fleshy leaves; small greeny-white flowers in terminal or axillary clusters; globose, spongy fruits filled with brown seeds and long, silky hairs; fast growing.	Well drained sandy and alluvial areas.	probably low; drought resistant, phreatophytic; wind resistant; full sun. Well drained sandy or silty soil; salinity tolerance 6000 ppm; drought resistant, phreatophytic winds; frost tolerant; full sun, light shade.	difficult to root. Seed; soft-wood cuttings (don't overwater); self-propagating.	under the worst growing conditions; accent or contrast. Useful in dry areas as a light screen; baffle or background; pruning and tidying required.	11, 5
<i>Capparis decidua</i> CAPPARACEAE -	Dense, erect shrub with numerous, dark green, criss-crossed, leafless branches, forming large thickets; 2-5m × 2-6m; conspicuous, small, red flowers, with 1 larger, helmet-shaped sepal; red fruits; slow growing.	Well drained sandy and alluvial areas.	Well drained sandy or silty soil; salinity tolerance not known, may be low; drought resistant, phreatophytic; wind resistant; frost resistant; full sun.	Seed.	Useful in desert areas as part of a shelter-belt or barrier; sand stabiliser.	11, 5
<i>C. spinosa</i> CAPPARACEAE -	Low, mounding, densely branched from the base with erect, spreading and procumbent branches; 1-5.5m × 2-3m; green, ovate leaves ending in a prickle; showy, white or white/pink flowers, numerous exerted stamens; pear-shaped red fruits; slow growing.	Rocky, mountainous areas.	Well drained sandy or stony soil to pH 9.5; salinity tolerance 3500 ppm; drought tolerant, phreatophytic; wind resistant; frost resistant; full sun.	Seed; self-propagating.	Best as a sprawling shrub over rocks, or from planters.	11, 5, 6
<i>Carissa edulis</i> APOCYNACEAE -	Dense, much branched; 0.5-0.8m × 1-2m; blue-green, ovate, leathery leaves; small flowers with white, reflexed petals and a pinkish tube; small, reddish-purple fruit; spiny; slow growing.	Rocky, mountainous areas.	Well drained sandy or gravelly soil; salinity tolerance 2000 ppm; drought tolerant; wind resistant; frost tolerant; full sun.	Tip or semi-hardwood cuttings.	An effective accent or contrast, especially amongst rocks; low barrier or ground-cover.	1, 12
<i>Cassia italica</i> LEGUMINOSAE -	Spreading herbaceous or semi-hardwood branches from a woody base; 0.5m × 1-1.5m; blue-green, pinnate leaves; small,	Sandy and alluvial areas.	Well drained sandy, silty or stony soil, salinity tolerance 5000 ppm; drought tolerant, but may	Scarified seed; self-propagating.	Effective contrast when massed because of its leaf colour; sand binder.	3, 1, 11, 12

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Dodonaea viscosa</i> ** SAPINDACEAE Hopseed bush	bright yellow flowers in a short raceme; curved pods with a darker, raised crest; fast growing. Large, erect; 1-4m × 1-3m; shiny, green, spatulate leaves becoming leathery with age, prominent mid-rib; small, inconspicuous flowers; attractive reddish-brown to purple winged capsule; fast growing.	Stony soils in mountainous areas.	defoliate; wind resistant; frost tolerant; full sun. Sandy or gravelly soil to pH 8.5; salinity tolerance 7000 ppm; drought tolerant, phreatophytic; wind resistant; frost resistant; best in full sun, tolerates partial shade.	Fresh seed; tip cuttings.	Makes an excellent formal hedge; can be used as a background.	11, 5, 12
<i>Euphorbia balsamifera</i> ssp <i>adenensis</i> EUPHORBIACEAE -	Low, mounding, white or grey stems and branches; 0.5-1.0m × 1-2m; small, glaucous, semi-succulent leaves; small, greenish-yellow flowers; small, red capsules; slow growing.	Rocky, mountainous, areas.	Well drained sandy or gravelly soil; salinity tolerance not known, may be low; drought tolerant, but may defoliate; wind resistant; frost resistant; full sun.	Seed; tip cuttings with difficulty.	Accent or contrast; very effective amongst rocks.	11, 5
<i>Euryops arabicus</i> COMPOSITAE -	Low, rounded; 0.4-0.8m × 0.5-1.5m; bright green, linear leaves densely arranged on the branches, bright yellow, 'daisy' flowers; medium growth rate.	Stony soils in mountainous areas.	Well drained sandy or gravelly soil; salinity tolerance not known, may be low; drought tolerant; wind resistant; frost tolerant; full sun.	Seed; self-propagating.	Effective accent or contrast; a colourful ground-cover.	1, 11
<i>Gossypium arboreum</i> MALVACEAE (●) Cotton	Large shrub with erect branches; 1-3m × 2-3m; large, dark to bright green, palmate leaves with 3-7 lobes; showy, lemon yellow or red-purple flowers; rough, egg-shaped capsule full of white, cottony seed-mass; fast growing.	Sandy and alluvial areas.	Sandy or silty soil; tolerates a high water table; salinity tolerance 8000 ppm; drought tolerant; wind resistant; frost tolerant; best in full sun; grows well in partial shade.	Fresh seed; self-propagating.	An attractive accent that can be used as a light screen. Needs regular trimming.	11, 5
<i>Hypericum revolutum</i> GUTTIFERAE -	Large, spreading; 2-6m × 1-5m; dark green, lanceolate leaves dotted with translucent glands; flowers showy, a rich yellow with numerous stamens; small brown capsules; slow growing.	Sandy loams in mountainous areas.	Nutrient-rich sandy soil; salinity tolerance low; water demanding; wind resistant; frost tolerant; full sun.	Seed.	A colourful screen or background.	11, 5

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Lavandula dentata</i> LABIATAE Lavender	Low, fragrant, numerous upright stems and branches; 0.4-0.8m × 0.2-0.5m; the greyish-green, linear, crenate leaves are bunched at the base of flowering branches; numerous small, blue-purple flowers in terminal spikes; slow growing.	Sandy soils in rocky, mountainous areas.	Sandy soil; salinity tolerance 2000 ppm; drought tolerant; wind resistant; frost tolerant; full sun.	Softwood cuttings.	Good accent or low barrier, especially where the fragrance of bruised leaves will be obvious. Needs cool winter.	11, 5, 12
<i>Maerua crassifolia</i> CAPPARACEAE Tree caper	Large shrub or small tree with dense, arching branches; 2-7m × 1-4m; small, thick, greyish leaves in bunches; yellow flowers with white, exerted stamens; mealy, yellow-green, jointed pod; slow growing.	Rocky or alluvial areas.	Sandy or silty soil; salinity tolerance 2500 ppm; drought resistant, phreatophytic; wind resistant; frost tolerant; full sun.	Fresh seed.	Makes an effective screen or barrier; useful for background planting.	1, 11, 5, 12
<i>M. oblongifolia</i> CAPPARACEAE -	Low, sprawling shrub, with arching branches; 1-1.5m × 1-5m; glaucous to dark green, lanceolate leaves; greenish-yellow flowers with numerous, exerted, white stamens; large, intricately lobed and jointed, reddish-brown pod; slow to medium growth rate.	Sandy and alluvial areas.	Sandy or silty soil; salinity tolerance not known, may be medium; drought resistant, phreatophytic; wind resistant; frost tolerant; full sun or partial shade.	Fresh seed.	Good low barrier or ground-cover, especially in difficult conditions.	11, 5
<i>Ochradenus baccatus</i> RESEDACEAE -	Dense, rounded, numerous erect branches; 1-2m × 1-2m; small, yellow-green, linear leaves; bright yellow flowers clustered in terminal racemes; flattened fruit; fast growing	Sandy soils in rocky, mountainous areas.	Well drained sandy soil; salinity tolerance not known, probably low; drought tolerant; wind resistant; frost tolerant; full sun.	Seed; self-propagating.	Accent or low barrier.	1, 11
<i>Ocimum basilicum</i> ** LABIATAE Basil	Upright, aromatic shrub; 0.7-1.5m × 0.2-0.6m; pale green, ovate leaves; small white or purple flowers in pyramidal, terminal racemes; fruit is small nutlets within the persistent calyx; fast growing.	Sandy and alluvial areas.	Sandy or silty soil; low salinity tolerance; drought tolerant; wind resistant; frost tolerant; best in full sun, but tolerates partial shade.	Seed; self-propagating.	Excellent maintenance-free barrier, especially near paths or steps, where fragrance of bruised leaves is obvious.	1, 11, 5
<i>Peganum harmala</i> ZYGOPHYLLACEAE -	Upright shrub with numerous herbaceous branches; 0.7-1.0m × 0.5-0.8m; dark green leaves, deeply and irregularly di-	Sandy soils in rocky, mountainous	Well drained sandy soil; salinity tolerance not known, probably low; drought tolerant; needs	Seed or division.	Effective accent when massed.	1, 11

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Retama raetam</i> LEGUMINOSAE Arabian broom	vided; showy, white flowers at the ends of the branches; round capsule; fast growing. Numerous, criss-crossing, erect, leafless, green stems; 1-3m × 2-4m; clusters of white 'pea' flowers with pink veins; small, leathery pods; fast growing.	areas. Sand dune areas.	protection from wind; frost tolerant; full sun or partial shade. Sandy soil to pH 8.5; salinity tolerance 3500 ppm; drought resistant; wind resistant; frost tolerant; full sun.	Scarified seed; self-propagating.	Good sand binder; useful for desert reclamation and soil stabilisation.	1, 12
<i>Rhazya stricta</i> APOCYNACEAE Harmal	Upright, much branched; 0.5-1.0m × 0.5-1.5m; deep green, lanceolate leaves with a distinct mid-rib, slightly leathery; small, white flowers in axillary clusters; pairs of curved, brown follicles; slow growing.	Gravelly and sandy areas in <i>wadis</i>	Well drained sandy or gravelly soil; salinity tolerance 3000 ppm; drought resistant; phreatophytic; wind resistant; frost tolerant; full sun.	Fresh seed; tip cuttings.	Valuable in exposed conditions; stabilises soil; not grazed, gives evergreen cover.	1, 11, 5
<i>Ricinus communis</i> * EUPHORBIACEAE Castor oil plant	Soft-wooded, short-lived shrub or small tree, umbrella-shaped, open canopy; 2-6m × 1-4m; large, palmate, toothed leaves; greenish or reddish flowers in long terminal clusters; brown, spiny capsules; fast growing.	Sandy and alluvial areas.	Sandy or silty soil; salinity tolerance 6500 ppm; drought resistant; protect from wind; killed by frost; full sun.	Scarified, fresh seed; self-propagating.	Useful short-term accent, low screen or barrier; whole plant is toxic, especially the seeds.	11, 5
<i>Salvadora persica</i> SALVADORACEAE - CLIMBERS	Large shrub forming dense thickets; 1-3m × 2-10m; pale green, oblong, slightly leathery leaves; small, inconspicuous, greenish-white flowers in terminal panicles; small red or purplish berries; medium growth rate.	Sandy and alluvial areas.	Sandy or silty soil; salinity tolerance not known, may be medium; drought tolerant; wind resistant; frost tolerant; full sun.	Seed.	A good screen; desert shelter-belt; stabilises soil.	1, 5
<i>Clioria ternatea</i> ** LEGUMINOSAE Butterfly pea	Slender, dense, vigorous twiner, reaching a height and spread of 3-6m; bright green, imparipinnate leaves; conspicuous 'pea' flowers, bright blue with a central splash of yellow; small pods; fast growing.	Sandy and loamy soils in mountainous areas.	Sandy soil; salinity tolerance 1500 ppm; water demanding; protect from wind until established; killed by frost; best in full sun, tolerates partial shade.	Scarified, fresh seed.	Climbs well on wires, strings or chain-link fences.	1, 11, 5
<i>Cissus rotundifolius</i> VITACEAE	Low, semi-succulent; 1-2m in height and spread; glaucous leaves, fleshy and	Sandy soils in rocky,	Well drained sandy soil; salinity tolerance not known, probably	Seed; heeled tip.	Not a very strong climber; good forming a mounding	11, 12

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
-	rounded; small, greenish-yellow flowers; red berries; climbs by twining tendrils; fast growing.	mountainous areas.	low; drought tolerant; protect from the strongest winds; frost tolerant; full sun or partial shade.		ground-cover or spilling over boulders or from planters.	
<i>Rosa abyssinica</i> ROSACEAE	Thorny, shrubby 'scrambler', that can reach a height and spread of 2-4m; glossy, dark green leaves with pale undersides, imparipinnate and roughly toothed; fragrant, creamy white flowers with numerous yellow stamens; red-orange fruit, the 'hip'; fast growing.	Sandy soils in mountainous areas.	Sandy soil; salinity tolerance not known, probably low; water demanding; cuttings wind resistant; frost tolerant; full sun or partial shade.	Seed; cuttings.	Must be supported unless allowed to form a dense thicket.	1, 11
-						
GROUND-COVERS and HERBS						
<i>Argemone mexicana</i> (●) PAPAVERACEAE	Erect annual herb; 0.5-1.0m tall; irregularly lobed, spiny, glaucous green leaves; large pale yellow to orange flowers; ovoid, brown, prickly capsule; fast growing.	Sandy soils in mountainous areas.	Well drained sandy or gravelly soil; salinity tolerance not known, probably low; water demanding; wind resistant; frost tolerant; full sun.	Seed; self-propagating.	Makes an attractive accent when massed; sow in the autumn; toxic.	1, 11
-						
<i>Artemisia monosperma</i> COMPOSITAE	Procumbent, forming low mounds as the stems root at the nodes; 0.5-0.7m tall; slightly fragrant dark green, dissected leaves; small yellow-brown flowers in pyramidal panicles; fast growing.	Sand dune areas.	Well drained sandy, gravelly or silty soil; salinity tolerance 3500 ppm; drought tolerant; wind resistant; frost tolerant; full sun.	Seed; cuttings.	Produces an attractive mounding ground-cover.	1, 12
-						
<i>Asphodelus fistulosus</i> LILIACEAE	Erect, short-lived annual herb; up to 0.3m tall; dense basal rosette of long, thin, hollow, green leaves; flowering stems bear numerous small, white, star-shaped flowers with a red or purple band at the back of each perianth segment; fast growing.	Sand and alluvial areas.	Sandy or silty soil to pH 9.0; salinity tolerance 3800 ppm; water demanding, dies back in summer if not irrigated; wind resistant; frost tolerant; full sun or partial shade.	Seed; self-propagating.	Attractive carpet when massed; can hydroseed (17-20g/m ²); valuable for soil stabilisation.	1, 11, 12
-						
<i>Bacopa monnieri</i> SCROPHULARIACEAE	Semi-aquatic perennial with creeping, herbaceous, criss-crossing stems; small, rounded, slightly fleshy leaves; white,	Wet areas in wadis.	Moist sandy soil; salinity tolerance not known, may be medium; water demanding,	Cuttings.	Produces a dense mat of interwoven stems.	1, 5
-						

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Blepharis ciliaris</i> ACANTHACEAE -	bell-shaped, attractive flowers; fast growing. Thistle-like, perennial herb; up to 0.3m tall; glaucous, spiny, dissected leaves; rich blue flowers in a dense terminal spike or in the leaf axils; fast growing.	Sandy and stony areas.	needs regular irrigation; wind resistant; frost tolerant; best in shade but tolerates full sun. Well drained sandy or gravelly soil; salinity tolerance not known, may be low; drought tolerant; wind resistant; frost tolerant; full sun.	Seed; self-propagating.	Mass plant for the spectacular colour of the flowers; low barrier.	1, 11
<i>Convolvulus hystrix</i> CONVOLVULACEAE -	Low, mounding shrub, 0.3-0.6m high, with arching, spiny branches that can spread 3-10m across the ground; small, grey-green leaves; small, funnel-shaped, pale sky blue flowers; fast growing.	Sandy and alluvial areas.	Sandy or gravelly soil; salinity tolerance not known, may be medium; drought tolerant; wind resistant; frost tolerant; full sun or partial shade.	Seed; self-propagating.	Useful for covering a large area with a low maintenance species; sand binder.	1, 11, 5
<i>Cornulaca aucheri</i> (●) CHENOPODIACEAE -	Prostrate, annual herb with numerous branches producing a tangled mass of stems less than 0.2m high, densely covered by small, spiny blue-green leaves; few flowers; fast growing.	Alluvial areas.	Sandy or silty soil; high salinity tolerance; drought resistant; wind resistant; frost tolerant; full sun.	Seed; self-propagating.	Unusual appearance; the leaf texture gives much fine detail.	1, 11
<i>Cressa cretica</i> CONVOLVULACEAE -	Mat forming, much branched perennial; small grey-green, sessile leaves crowded along the stem, small, white, fragrant flowers in dense terminal spikes; fast growing.	Saline sandy areas.	Sandy or silty soil; high salinity tolerance; drought tolerant; wind resistant; frost tolerant; full sun.	Seed; cuttings; self-propagating.	Dense, mat-like growth; useful in saline areas.	3, 1
<i>Datura stramonium</i> SOLANACEAE Thornapple	Stout, annual herb with strong stems; 0.6-1.0m tall; large, dark, dark green, ovate leaves that fall as the plant ages; large, showy, white, trumpet flowers; conspicuous, greenish, spiny capsule; fast growing.	Sandy and alluvial areas.	Sandy or silty soil; salinity tolerance not known, probably low; drought tolerant, but may lose leaves; protect from wind; frost tolerant; full sun.	Seed; self-propagating.	Effective accent when massed; good for infill planting; fruit toxic.	9, 1, 11, 5
<i>Gynandiris sisyrinchium</i> IRIDACEAE	Herbaceous perennial with green, strap-like, linear leaves that arise from the	Moist desert sands and	Moist, well drained, nutrient-rich, sandy soil; salinity toler-	Seed; division of	Spectacular effect when massed; can hydroseed	

TABLE I. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
-	tuberous base and reach a height of 0.5m; lilac-blue or purple flowers, the outer segments with white or yellow at the base, in 2-4 flowered racemes; fast growing.	alluvial areas.	ance 2000 ppm; water demanding, defoliates under drought conditions; protect from wind; frost tolerant; full sun.	root tubers; self-propagating.	(20g/m ²); naturalising, Jeddah too hot.	
<i>Heliotropium bacciferum</i> BORAGINACEAE	Dense undershrub with erect and procumbent branches forming mounds up to 0.4m high; small, dark green, rough, hairy leaves; small, white flowers arranged in an arching, scoroid cyme; slow growing.	Sandy and alluvial areas.	Sandy or silty soil; salinity tolerance 13000 ppm; drought tolerant; wind resistant; frost tolerant; full sun.	Seed; stem cuttings; self propagating.	Excellent mounding ground-water, especially in saline areas; sand binder.	1, 11, 12
<i>Lippia nodiflora</i> VERBENACEAE	Creeping, procumbent perennial, rooting at the nodes, the ends of the branches ascending to 0.2m; bright green, oblanceolate leaves, serrate at the tip; tiny, white or pink flowers in dense, ovoid heads; slow growing.	Sandy areas.	Sandy soil; low salinity tolerance; water demanding; wind resistant; frost causes die-back; full sun or partial shade.	Rooted stem cuttings.	Good visual substitute for grass, but will not tolerate very much trampling; clip to encourage new growth at the base.	11, 5
<i>Limonium axillare</i> PLUMBAGINACEAE	Densely branching, spreading shrub; 0.3-0.5 x 1.0-1.5m; thick, grey-green, spatulate leaves, crowded along the stems; numerous, small, pale pink or purplish flowers, in a flattened terminal panicle; slow growing.	Coastal areas.	Sandy or silty soil to pH 10; salinity tolerance 13000 ppm; drought tolerant, but best if soil kept moist; wind resistant; killed by frost; full sun.	Seed; self-propagating.	Useful in coastal areas, withstands salt spray and occasional inundation; can hydroseed (20g/m ²); sand binder.	11, 12
<i>Pancratium maximum</i> AMARYLLIDACEAE Desert daffodil	Perennial herb with a basal rosette of bright green, upright, linear leaves, up to 0.3m long; short-lived, spectacular, white flowers with a corona bearing the stamens; fast growing.	Sandy and rocky desert areas.	Well drained, sandy soil; low salinity tolerance; water demanding; wind resistant; frost tolerant; full sun.	Division of the bulb mass.	Spectacular effect when mass planted and allowed to naturalise.	1, 11
<i>Portulaca oleracea</i> PORTULACACEAE	Fleshy, spreading herb with ascending stems to 0.2m; rounded, green-purplish leaves; clusters of small, yellow flowers in	Sand and alluvial areas.	Sandy or silty soil; medium salinity tolerance; drought tolerant; wind resistant; frost tolerant; full	Rooted stem cuttings;	Useful infill ground-cover between larger species. Invasive weed in irrigated	1, 11

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>P. quadrifida</i> PORTULACACEAE -	the axils and the ends of the branches; fast growing. Prostrate, mat-forming annual; small, fleshy, purplish leaves with bunches of pale hairs at the nodes; small, inconspicuous, yellow flowers in the leaf axils; fast growing.	Sand and alluvial areas.	sun or partial shade. Sandy or silty soil; medium salinity tolerance; drought tolerant; wind resistant; frost tolerant; full sun or partial shade.	seed; self-propagating. Rootem stem cuttings; seed; self-propagating.	plantings. Valuable fine-textured, carpeting ground-cover. Invasive weed in irrigated plantings.	1, 11
<i>Rumex nervosus</i> POLYGONACEAE -	Erect, annual herb; 0.3-0.8m tall; bright green, lanceolate leaves; small, insignificant flowers in terminal racemes; large, conspicuous, rose-pink fruits, formed by the enlargement of 3 perianth segments to rounded, reticulate wings.	Stony and rocky areas.	Sandy or gravelly soil: salinity tolerance not known, probably low; drought tolerant; wind resistant; frost tolerant; full sun or partial shade.	Seed; self-propagating.	Useful accent, especially good amongst boulders; low barrier.	1, 11, 5
GRASSES and SEDGES						
<i>Arundo donax</i> (●) GRAMINAE -	Robust, vigorous reed with a stout, erect stem up to 4m tall; grey-green, lanceolate, arching leaves, in 2 ranks; inflorescence a conspicuous; plumose, branched panicle up to 0.7m long, reddish at first, but becoming white or cream; fast growing.	Wet areas.	Wet or moist sandy or silty soil; high salinity tolerance; water demanding; needs regular irrigation; protect from the strongest winds, especially during establishments; frost tolerant; full sun.	Seed; division of the rhizomes.	Striking contrast when massed; produces a light screen; dead stems and leaves can be a fire risk.	11
<i>Cynodon dactylon</i> ** GRAMINAE* Bermuda grass	Long-lived perennial with creeping stolons and rhizomes that allow spread over wide areas; leaves are soft, linear and grey-green to bright green; erect culms bear the digitately arranged spikes, that are green to purple; fast growing.	Sandy areas.	Well drained sandy soil with added nitrogen; salinity tolerance 11000 ppm; drought tolerant, but yellows without regular irrigation; wind resistant; shows chilling injury below 10°C; full	Seed; 'sprigs' of stolon or rhizome.	Best grass for general use as a lawn; tolerates trampling if well kept; overseed with <i>Lolium</i> in areas with a cool winter.	11

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Pennisetum setaceum</i> GRAMINAE Elephant grass	Vigorous, densely tufted perennial that produces clumps 0.8-1.0m × 1.0-1.5m long, narrow, bright green leaves; inflorescence a dense, conspicuous, creamy-white, plumose panicle, 0.1-0.3m long; fast growing.	Sandy and alluvial areas.	Well drained, sandy soil; salinity tolerance 3500 ppm; drought resistant but best with regular irrigation; wind resistant; frost tolerant; full sun.	Division; rooted cuttings of stolons.	Attractive; good accent or contrast; barrier when massed.	12, 12
<i>Phragmites australis</i> GRAMINAE -	Somewhat similar to <i>Arundo</i> , but the leaves are softer and the inflorescence is a one-side panicle, at first purplish, but then becoming silvery; fast growing.	Drainage ditches and wet, marshy areas.	Wet sandy or silty soil, tolerates standing water; high salinity tolerance, withstands brackish water; protect from the strongest winds, especially during establishment; frost tolerant; full sun.	Division of rhizomes.	Good accent or contrast; light screen; dead stems and leaves can be a fire risk.	11
<i>Typha domingensis</i> TYPHACEAE Bulrush	Robust rush with creeping rhizomes and erect, bright green stems and linear leaves that can reach a height of more than 2m; flowers densely crowded to produce the familiar, brown 'bulrush' spike; fast growing.	Wet, marshy areas with standing water.	Wet sandy or silty soil, best with surface standing water; salinity tolerance not known, may be medium to high; wind resistant; frost tolerant; full sun.	Division of rhizomes.	The bright green colour is a strong accent or contrast, especially when massed.	1, 11
SUCCULENTS <i>Aloe vera</i> * LILIACEAE -	Stemless, with a basal rosette of upright and spreading fleshy leaves that can reach a height and spread of 1-1.5m; leaves usually bright to glaucous green, but become red flushed if plant is short of water; flowers waxy, tubular, yellow to orange, in a raceme 0.4-0.7m long; slow growing; spiny.	Rocky, mountainous areas.	Sandy or gravelly soil; high salinity tolerance; drought resistant; wind resistant; damaged by frost; full sun or partial shade.	Seed; offsets; self-propagating.	Effective accent, contrast or barrier.	11
<i>Caralluma russeliana</i> * ASCELPIADACEAE -	Stout, leafless, with numerous erect, 4-angled, pale brown or green stems that sometimes branch; 0.9m × 0.5m; numerous dark red flowers in spherical umbels up to 10cm across, at the ends of the	Rocky, mountainous areas.	Sandy or gravelly soil; high salinity tolerance; drought tolerant; wind resistant; frost tolerant; full sun.	Seed; offsets; self-propagating.	Striking accent or contrast, especially when in flower or fruit.	11, 5

TABLE 1. Contd.

Name, family	Growth form, plant characteristics	Natural habitat	Environmental tolerances	Propagation	Design uses	References
<i>Euphorbia fractiflexa</i> EUPHORBIACEAE -	branches; fruit, a pair of erect, curved foli- cles, up to 15cm long; slow growing. Arborescent, leafless, much branched; 1- 3m × 1-4m; the 3- or 4-angled, dark green branches curved upwards like a can- delabra, the crenate margins with paired spines; slow growing.	Sandy and alluvial areas and rocks.	Sandy or silty soil; salinity toler- ance not known, may be medium; drought tolerant; wind resistant; frost tolerant; full sun.	Stem or branch cuttings.	An unusual accent; makes an effective barrier	11, 5
<i>Opuntia ficus-indica</i> * (●) CACTACEAE Prickly pear	Bold, leafless succulent up to 3m high with stems and branches made up of flat, rounded pads joined one above the other; large, conspicuous, lemon yellow flowers are produced along the edges of the upper pads; dark red or purple edible fruits; slow growing.	Rocky, mountainous areas.	Sandy or silty soil; low salinity tolerance; drought tolerant; wind resistant; frost tolerant; best in full sun, but tolerates light shade.	Seed; whole pads; self- propagating.	Striking plant, most effec- tive when massed; good barrier.	11
<i>Sansevieria ehrenbergiana</i> LILIACEAE -	Stemless, with large, dark green, erect, leathery, linear-lanceolate leaves up to 1m long that arise in rosettes from the creep- ing rhizome; numerous white flowers in a lax, axillary panicle; slow growing.	Sandy and rocky areas.	Best in moist, sandy soil; high sa- linity tolerance; drought toler- ant, but best with regular irriga- tion; wind resistant; frost causes die-back; full sun or partial shade.	Leaf cuttings.	Good accent or contrast; informal barrier.	1, 5
<i>Suaeda monoica</i> CHENOPODIACEAE -	Large, bushy shrub or small tree with erect and spreading branches, 2-4m × 1-2m; small, fleshy, linear, dull green leaves; mi- nute flowers in small axillary clusters; fruit a small nut within the persistent calyx that turns a dull red; fast growing.	Sandy and alluvial areas.	Sandy or silty soil, tolerates a high water table; salinity toler- ance 20000 ppm; drought toler- ant, phreatophytic; wind resis- tant; damaged by frost; full sun or partial shade.	Seed; root cuttings; self- propagating.	Valuable as a screen or low wind break; grows well in exposed areas.	1, 11, 5
<i>Zygophyllum album</i> ZYGOPHYLLACEAE -	Small shrub with procumbent stems and erect branches up to 0.8m; swollen, fleshy, compound leaves, each of only 2 leaflets, bluish green to bright green, but turning yellow with age; small, white flowers in the axils; yellow brown capsules; fast growing.	Sandy and alluvial areas, often near the sea.	Sandy or silty soil; high salinity tolerance; drought resistant, but may defoliate; wind resistant; damaged by frost; full sun	Seed; self- propagating.	An effective ground- cover in exposed, difficult conditions.	11, 5

النباتات المتوطنة وأعمال عمارة البيئة في المملكة العربية السعودية

جيفري ريكس*

قسم عمارة البيئة ، كلية الهندسة ، جامعة الملك عبد العزيز
جدة - المملكة العربية السعودية .

المستخلص . في هذا البحث ، تم اختيار وتقديم مجموعة من فصائل الغابات المحلية والمفيدة لأعمال عمارة البيئة بالمملكة العربية السعودية مع تفاصيل الشكل وخصائص النمو واحتياجاته ومدى التحمل للظروف البيئية المختلفة ، وطرق ومدى سهولة التكاثر ، وأخيراً إمكانيات النبات وفوائده في النواحي التصميمية .

تم التعرض في هذا البحث أيضاً لأسباب الإعراض عن استخدام النباتات المحلية بصورة أكثر انتشاراً والموقف من التصاميم الطبيعية .

* العنوان الحالي : مدير شركة آربي إس للاستشارات البيئية ، المملكة المتحدة .