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Cenchrus americanus - environmental weed risk assessment 2022

Department of Primary Industries and Regional Development, Western Australia

Department of
Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

Environmental weed risk assessment

Pearl millet (*Cenchrus americanus*)

Family: Poaceae

Synonyms: *Pennisetum glaucum* (L.) R. Br.*, Pennisetum americanum* (L.) Leeke

Common names: Pearl millet, bulrush millet, yellow foxtail

Cultivars include: Pearler, Maxa, Lawrence, Katherine, Siromill

Assessment prepared by: Chris Munday (DBCA) and Geoff Moore (DPIRD)

Assessment reviewed by: Bruce Cook, Greg Keighery

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Species summary:

Pearl millet (*Cenchrus americanus*) is a robust annual grass used for both animal feed and for human consumption. It most likely originates from Sahelian Africa where it has been domesticated for more than 4,000 years. Pearl millet is an important staple food in hot, semi-arid regions of Africa and India due to its tolerance of high temperatures, moisture stress and infertile soils. However, it can also grow rapidly when there are short periods of favourable conditions (Andrews and Kumar 1992, Cook *et al*. 2005).

Pearl millet is a tall, upright annual grass tillering from the base with erect stems 150-300 cm in height and 10-20 mm in diameter. It grows on a wide range of soils, but prefers well drained soils as it has a low tolerance of waterlogging. It can develop an extensive root system and has good drought tolerance (Muchow 1989). Pearl millet is grown for grain in areas receiving as low as 125mm rainfall per annum, but most commonly 250-750mm, while the minimum average annual rainfall for forage crops is 500mm (Cook *et al*. 2005). It requires warm to high temperatures for optimum germination (33-35°C), tillering (21-24°C) and growth (30-35°C) (Cook *et al*. 2005).

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) describe pearl millet as a C4 grass able to; “survive and produce grain even in the least fertile soils in the driest regions and in the hottest climates” (ICRISAT 2017). It can be used as a grain crop, grazed directly or cut for hay, silage or green chop. In Australia it is usually grown as a fast growing high nutritive value summer forage crop. In the WA rangelands pearl millet has been grown in field trials and occasionally in commercial crops. There is interest in growing it under irrigation or under rainfed conditions (dryland) for direct grazing or fodder production.

Six non-indigenous and one native species (*C. elymoides)* from the genus, *Cenchrus,* are recorded in Western Australia (WA) (Hussey *et al.* 2007). Western Australian Herbarium (1998–) describes pearl millet as alien to WA, naturalised and present in IBRA (Interim Biogeographical Regions of Australia) regions including Dampierland and the Geraldton Sandplains.

Note: In the Tropical Forages Database (Cook *et al*. 2005), Pearl millet is reported to have an ‘Extremely low’ weed risk – as the weedy form is now considered a separate species (refer to Tropical Forages Database – Pearl millet).

“A weedy form of the species, colloquially called shibra, is now considered a separate species, *Pennisetum sieberianum* (Schltdl.) Stapf & C. E. Hubb., which along with *P. glaucum* and the wild progenitor of both species, *Pennisetum violaceum* (Lam.) Rich. (also referred to as *Pennisetum glaucum* (L.) R. Br. subspecies *monodii* (Maire) Brunken), are included in section *Penicillaria*. Four races, *typhoides, nigritarum, globosum* and *leonis* are recognised within *P. glaucum*” (Cook *et al*. 2005).

Figure 1 The distribution of pearl millet (*Cenchrus americanus*) in Australia from the Australasian Virtual Herbarium (https://avh.ala.org.au/)

Section 1: Invasiveness

1. Does the species have a documented environmental weed history?

a) Is an environmental weed in Australia

b) Is an environmental weed overseas

c) Species not known to be an environmental weed but there are environmental weed species in the genus

d) Genus has no known environmental weeds

There are many species in this genus identified as weeds outside Australia. There are six non-indigenous species from this genus recorded in Western Australia (WA), several of which were introduced as pasture species but now have a weed history in the state. These include the perennial species buffel grass (*C. ciliaris*) and Birdwood grass (*C. setiger*), established as a fodder plants in rangeland pastoral areas and described as serious weeds of wetlands and watercourses from Geraldton to the Pilbara with buffel grass extending into the Kimberley and adjacent desert (Hussey *et al*. 2007). Burr grass (*C. echinatus)* is described by Petheram and Kok (1991) in 'Plants of the Kimberley region of WA' as a common weed of yards and roadsides that should be eradicated wherever possible. *Cenchrus brownii* and *C. incertus* are described as introduced species that have become troublesome weeds which occur in many parts of South Africa (Bromilow 2001).

Bayer CropScience in Europe describe *Pennisetum glaucum a*s "a serious weed in most crops of both temperate and tropical zones, annual and perennial, including vegetables, tree crops and grassland, plant of disturbed ground, roadsides and waste places, reaching elevations up to 300 m" and becoming less sensitive to many herbicides (Bayer CropScience 2017), although this reference may refer to the weedy form, *Cenchrus sieberianus*.

Pearl millet is described as alien to WA, naturalised (Randall 2017) and present in IBRA (Interim Biogeographical Regions of Australia) regions including Dampierland and the Geraldton Sandplains (Western Australian Herbarium (1998–), although *Cenchrus sieberianus* the 'weedy' form is not listed.

2. What is the ability of the species to successfully establish and compete with other plants, especially amongst intact native vegetation?

a) High - species can establish and displace intact native vegetation

b) Moderate - species can establish amongst intact native vegetation, but may not displace the native vegetation

c) Low - species can only establish where there is little or no competition or in areas where the native vegetation is in poor condition or has been disturbed

d) Very low - species can only successfully establish in vegetation which has been highly disturbed (e.g. roadsides, degraded or cleared areas)

e) Don't know

Pearl millet originated in Sahelian–Africa and is well adapted to conditions in northern WA, being a warm season annual grass which is tolerant of high temperatures and periods of moisture stress. Pearl millet can grow in low rainfall areas and on poor nutrient soils, in part due to its extensive root system. Good seed germination occurs when soil temperatures are above 18°C and the seedlings have good vigour which enables them to compete with fast-growing ephemeral grasses and broadleaf plants.

3. Grazing tolerance and palatability

a) Unpalatable (or toxic), rarely grazed

b) Will persist under heavy continuous grazing due to plant structure or has limited palatability

c) Tolerant of grazing as, in general, only young growth (annuals) or young re-growth (perennials) is grazed or plants are only occasionally browsed

d) Readily grazed during the wet season with some preferential grazing, during the dry season

e) Preferentially grazed at all growth stages; or has low tolerance to grazing and plants are easily killed. Plant numbers decline over successive years.

f) Don't know

Pearl millet can be grazed eight weeks after sowing and can be continually or rotationally grazed, although over-grazing may result in delayed growth or plant death (McCartor and Rouquette 1977, Newman *et al*. 2017). When compared with continuous grazing a rotational system favours efficiency of forage utilisation and better regrowth. Palatability declines when the plants are more than 1m high and may also decrease in drought affected crops (Cook *et al*. 2005, Pastures Australia 2017). The nutritive value declines markedly after seed production, in part due to the low leaf to stem ratio (Newman *et al*. 2017).

4. What is the species' ability to persist as a long-term sward or stand without management?

a) Plant numbers increase substantially with successive reproductive cycles to form a near monoculture over a significant area

b) Plant numbers remain at a steady level, persisting as a significant component of a mixed sward/stand

c) Plant numbers decline slowly over successive years so that it becomes a minor component of the vegetation

d) Plant numbers decline rapidly over successive years so that only occasional plants can be found

e) Don't know

Pearl millet is reported as naturalised in Australia (Randall 2017) and also as naturalised in WA (Western Australian Herbarium 1998–).

In a series of field nurseries established under irrigation in the west Kimberley and Pilbara, pearl millet was sown as both a treatment and also as a double row buffer around each of the four trial sites. The pearl millet established well in both the trials and the buffers and displayed vigorous early growth. Under irrigation the plants set seed, but after they senesced the plots and buffer rows were quickly re-colonised by native species. In the second year there were very few pearl millet recruits despite the good seed-set in year one (G. Moore unpublished data).

5. Is the plant likely to spread or rapidly colonise a site?

a) High risk – plants with a history of spreading rapidly with many plants successfully establishing under favourable conditions

b) Medium risk – some plants will spread outside the planted area and successfully establish under favourable conditions

c) Low – No or minimal spread of sown species outside the planted area a few plants will spread and successfully establish within 100m of the planted area under favourable conditions.

d) No spread of sown species more than 10m outside the planted area

e) Don't know

Pearl millet can establish a self-sustaining and persistent population under some conditions and is reported as naturalised (Randall 2017) in Australia and also as naturalised in WA (Western Australian Herbarium (1998–). However there is no information in the literature to suggest rapid colonisation. Results from field trials in northern WA where a few isolated plants established up to 10m from the original planting are further evidence of minimal spread (G. Moore unpublished data).

6. Will the species establish and reproduce in low-nutrient Australian soils without the addition of fertiliser or inoculant?

a) Establishment, growth and reproduction uninhibited in low-nutrient soils

b) Establishment, growth and reproduction reduced in low-nutrient soils

b) Establishment, growth and reproduction severely diminished in low-nutrient soils

c) Establishment, growth and reproduction unlikely in low-nutrient soils without soil additives

d) Don't know

Pearl millet prefers well drained soils, but is able to grow in a wide range of soil types. It can develop an extensive root system that provides drought tolerance and increases its ability to grow in low nutrient soils. It is has some salt tolerance once established, but is sensitive to waterlogging (Cook *et al*. 2005). However, pearl millet responds well to fertiliser with increased vigour and biomass production (Shahin *et al*. 2013) and displays signs of nutrient deficiency on soils with marginal fertility.

7.1 How likely is long-distance dispersal (>100m) by flying animals (birds, bats)?

a) Common

b) Occasional

c) Unlikely

d) Don't know

The seed has no structures to adhere to feet or feathers. The seed is readily eaten by birds, but there is no information to suggest that viable seed can be spread in this way.

7.2 How likely is long-distance dispersal (>100m) by stock, native and/or feral animals?

a) Common

b) Occasional

c) Unlikely

d) Don't know

In certain conditions the seed may be carried in mud on hooves or the feet of grazing animals, but the seed has no specific adaptations to adhere to skin, hair or fur.

7.3 How likely is long-distance dispersal (>100m) to by water?

a) Common

b) Occasional

c) Unlikely

d) Don't know

Seed could be moved by surface water and would readily germinate once deposited, but there is no information that this forms a significant dispersal pathway.

7.4 How likely is long-distance dispersal (>100m) by wind?

a) Common

b) Occasional

c) Unlikely

d) Don't know

The seed of some varieties is small and can be shaken from the plant and may be locally distributed by wind when ripe. However, any dispersal by wind is likely to be much less than 100m.

8.1 How likely is long-distance dispersal (>100m) accidentally by people and vehicles?

a) Common

b) Occasional

c) Unlikely

d) Don't know

Spread of the seed is possible in mud and soil on boots, vehicles and machinery.

8.2 How likely is long-distance dispersal (>100m) accidentally through the movement of produce or materials for infrastructure?

a) Common

b) Occasional

c) Unlikely

d) Don't know

Seed may be distributed in produce when pearl millet is grown as a fodder crop to be cut and carried. It may volunteer in subsequent crops, becoming a contaminant of that crop when it is harvested and transported.

9.1 What is the species' minimum generation time?

a) <1 year

b) 2-3 years

c) >3 years to never

d) Don't know

Pearl millet is an annual forage species.

9.2 What is the species' average seed set in a favourable season?

a) High

b) Low

c) None

d) Don't know

Seed set will vary between varieties and seasonal conditions but 400-800 seeds per plant, 2500 seeds per square meter and seed yields of 600-800 kg/ha have been reported (Anon 2017, Bayer CropScience 2017, Newman *et al.* 2017).

9.3 What is the species' seed persistence in the soil seedbank?

a) >5 years

b) 2-5 years

c) <2 years

d) Don't know

Not known. Bayer CropScience (2017) report that the seeds may be dormant at maturity requiring 2 - 4 months before they can germinate.

9.4 Can the species' reproduce vegetatively?

a) Yes – rapid

b) Yes – slow

c) No

d) Don't know

Propagation is usually by seed but pearl millet is an annual grass which can have multiple stems. Adventitious roots can be produced at the nodes which each also have a bud from which a new stem can arise. Rooted stems could potentially form separate plants if detached but this is unlikely.

Section 2: Impacts

1. Could the species reduce the biodiversity value of a natural ecosystem, either by reducing the amount of biodiversity present (diversity and abundance of native species), or degrading the visual appearance?

a) The species could significantly reduce biodiversity such that areas infested become low priorities for nature conservation and/or nature-based tourism

b) The species could have some effect on biodiversity and reduce its value for conservation and/or tourism

c) The species would have marginal effects on biodiversity but is visually obvious and could degrade the natural appearance of the landscape

d) The species would not or would have little effect on the affect biodiversity or the appearance of natural ecosystems

e) Don't know

Pearl millet varieties are multi-stemmed and can reach two to four meters in height so that plants could be conspicuous. No reports however were found of pearl millet invading native habitats in northern Australia.

2. Does the species have a history of, or potential to reduce the establishment of other plant species?

a) The species can significantly inhibit the establishment of other plants (e.g. regenerating native vegetation) by preventing germination and/or out-competing seedlings, and/or the species forms a monoculture over a large area

b) The species can inhibit the establishment of other plants may become dominant.

c) The species can cause some minor displacement by inhibiting establishment, but will not become dominant.

d) The species does not inhibit the establishment of other plants.

e) Don't know

Pearl millet seed may readily germinate and produce vigorous seedlings, but there is no evidence that these will succeed in competition or that established plants reduce the establishment of other species.

3. Could the species alter the structure of native ecosystems at risk of invasion from this species by adding a new strata level?

a) Will add a new strata level, and could reach medium to high density

b) Will add a new strata level, but at low density

c) Will not add a new strata level

d) Don't know

Pearl millet varieties are multi-stemmed and can reach two to four meters in height so that plants could be conspicuous. No reports however were found of pearl millet invading native habitats in northern Australia.

4. Could or does the species restrict the physical movement of people, animals, and/or water?

a) Species infestations could become impenetrable throughout the year, preventing the physical movement of people, animals and/or water

b) Species infestations could significantly slow the physical movement of people, animals and/or water throughout the year

c) Species infestations could slow the physical movement of people, animals and/or water at certain times of the year or provide a minor obstruction throughout the year.

d) Species infestations have no effect on physical movement

e) Don't know

Pearl millet is an annual preferring sandy, well-drained soil. It is intolerant of waterlogging. Although it may be planted as a single species crop there is no evidence that it would form a dense monoculture in the native environment and restrict physical movement.

5. Does the species have, or show the potential to have, a major effect on fire regime?

a) Major effect on frequency and/or fire intensity

b) Moderate effect on frequency or fire intensity

c) No effect

d) Don't know

As a sown crop pearl millet can produce large amounts of dry matter over the growing season which declines in palatability as it matures and senesces. However, as a weed of the natural environment the density will most likely be very low, so it will have negligible effect on fire intensity.

6.1 Is the species toxic to animals, have spines or burrs, or host other pests or diseases that could impact on native fauna and flora?

a) Yes - plant poisonous or other adverse factors present

b) No – plant is not poisonous, does not produce burrs or spines or harbour pests or diseases

Pearl millet can accumulate high levels of nitrates which can be dangerous, even fatal to ruminant animals. If high levels of nitrogen fertiliser are combined with a stress on the crop such as drought, disease, low temperatures or trampling then millet can accumulate toxic (fatal) nitrate levels, which remain even after cutting for hay (Andrews and Kumar 1992, Newman *et al*. 2017, Minson *et al*. 1993). If the forage is made into silage these levels are usually reduced. Low levels of nitrate may also affect production.

In native vegetation where soil nitrogen is usually low then the accumulation of high nitrate levels in the plant is less likely.

6.2 Could the species provide food or shelter for pest animals?

a) Yes – more than the native vegetation provides

b) No – similar or less shelter than the native vegetation

c) Don’t know

When grown as a crop pearl millet can produce copious amounts of seed which provides a ready food source for native and introduced seed eating birds. The nutritious vegetation (multi-stemmed annual grass 1-4m in height) could provide additional feed for native and feral grazing animals. However, as a weed in the natural environment the plant density will most likely be very low and as a result it will not provide more food or shelter than the native vegetation.

7.1 Does the species have, or show the potential to have, a major effect on nutrient levels in intact native vegetation?

a) Will significantly increase soil nutrient levels

b) Will significantly decrease soil nutrient levels

c) Will have minimal effect on soil nutrient levels

d) Don’t know

Pearl millet is tolerant of a wide range of soil conditions although preferring light well drained soils. It is also moderately tolerant of saline soils. The large root system and vigorous growth enables it to access and deplete the available nutrients in the soil and also allows it to establish in low nutrient soils. In a cropping situation it can deplete the soil nutrients, but as a weed of the natural environment at a low density will have minimal impact.

7.2 Could the species reduce water quality or cause silting of waterways?

a) Could significantly reduce water quality or cause silting or alteration of flow of waterways

b) May have some effect on water quality or silting of waterways in some ecosystems

c) Minor or no effect on water quality

d) Don't know

Pearl millet has a low tolerance of waterlogging and wet soils and is unlikely to affect water quality or cause silting of waterways.

7.3 Does the species have, or show the potential to have, a major effect on the soil watertable below intact native vegetation?

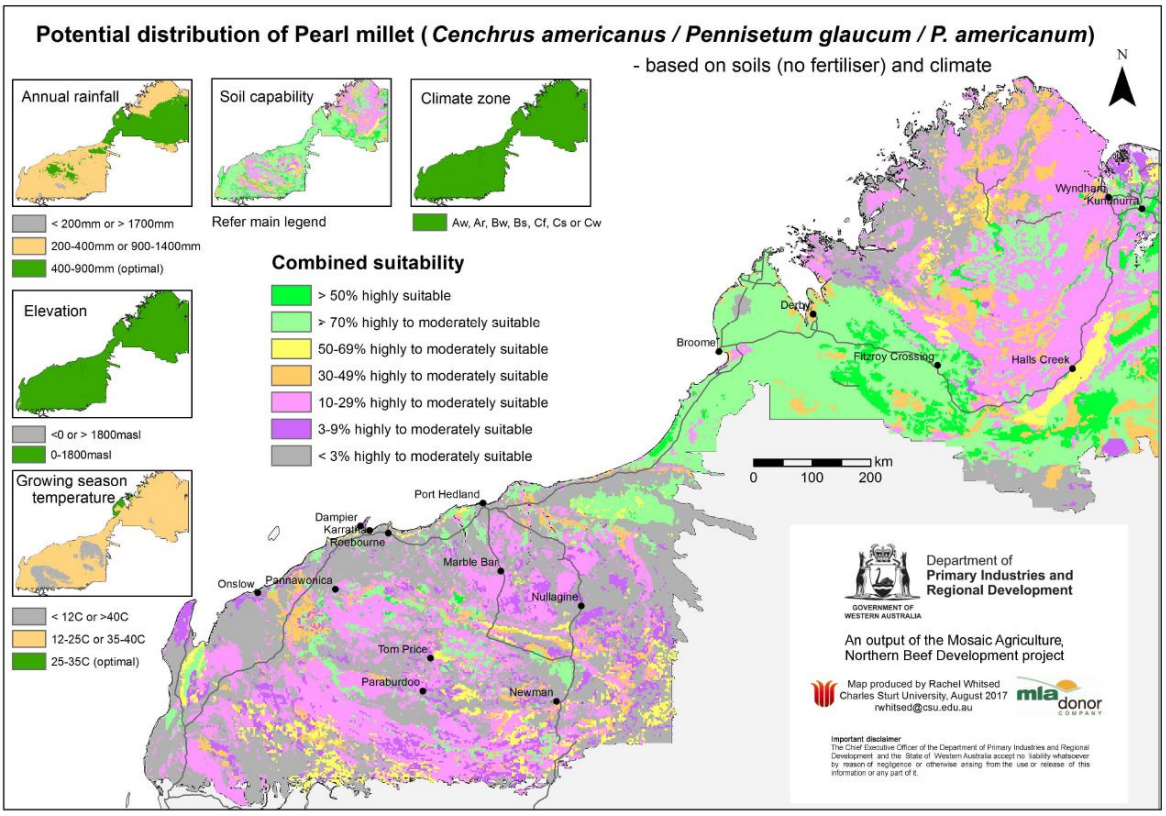
a) Yes – can significantly lower the watertable and/or reduce groundwater recharge to the watertable

b) No - will have little or no impact on hydrology

c) Don't know

The large and dense root system allows pearl millet to extract water efficiently and contributes to its drought tolerance, but it would not use more water than native vegetation with a shrub or tree strata.

Potential distribution



Region	Area of suitable soils and climate	Potential distribution score
Kimberley	14.9Mha	8.0
Pilbara	4.1Mha	6.0
Gascoyne – Goldfields	N/A	–

Overall weed risk assessment

The overall weed risk assessment (WRA) is calculated from Equation 1.

Equation1: Invasiveness (0-10) x Impacts (0-10) x Potential Distribution (0-10) = Weed risk score (0-1000)

Region	WRA calculation*	Overall score	WRA rating
Kimberley	3.9 x 0.5 x 8.0	**15.6**	**Negligible to low**
Pilbara	3.9 x 0.5 x 6.0	**11.7**	**Negligible to low**
Gascoyne – Goldfields			**Negligible to low**

***** Invasiveness (0-10) x Impacts (0-10) x Potential Distribution (0-10) = Weed risk score (0-1000)

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