EU NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: *Pennisetum setaceum* (Forssk.) Chiov.
Author: Deputy Direction of Nature
Risk Assessment Area: Europe

Draft: 14.05.2015

Peer reviewed by: Elias Danas (Research group transfer of research & development. Univ. Almeria)
Filip Verloove. Botanist. Botanic Garden of Meise. Nieuwelaan 38. B-1860 Meise. BELGIUM

Date of finalisation: 15/07/2016

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	Spain (including Baleares and Canarias islands), France, Italy (including Sardania and Sicily) and Malta (EPPO, 2014). Also in Portugal (Valdes & Scholtz, 2009) and Cyprus (information from Cyprus).
2. In how many EU member states has this species currently established populations? List them.	Spain (including Baleares and Canarias islands), France, Italy (including Sardania and Sicily) and Malta (EPPO, 2014). Also in Portugal (Valdes & Scholtz, 2009). In Cyprus it is still in early invasion stage (information from Cyprus).
3. In how many EU member states has this species shown signs of invasiveness? List them.	It is a high invasive species in Canarias, (Sanz Elorza, M. et al, 2004) and is considered an important emerging invader in some areas of continental Europe such as Almería in Iberian peninsula (Salinas, J. et al, 2011).
4. In which EU Biogeographic areas could this species establish?	Mediterranean and Macaronesian biogeographic areas.
5. In how many EU Member States could this species establish in the future [given current climate] (including those where it is already established)? List them.	It is established in Spain, France, Italy, Malta, Cyprus and Portugal. It probably could also adapt to mediterranean climatic condition present in Greece, Croatia, Slovenia and macaronesian semi-arid condition in Madeira and Azores archipelagoes (Portugal). In general, it could be invasive in the warm temperate and dry and hot summer zone (Csa) taking in consideration the clasification by Kottek et al (2006).
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	Greece, Croatia, Slovenia and Madeira and Azores archipelagoes (Portugal). Globally, it is invasive in most of Africa where it is not native, United States (Arizona, California, Louisiana, Colorado, New Mexico, Florida and Tennessee), Mexico, Australia, New Zealand, Indonesia and the Pacific Islands (Sanz Elorza et al., 2004). Taking in consideration the article *by* Rubel F.and M. Kottek (2010) it is very possible that this species will be able to establish also along all the Balkan coast, south Bulgaria and south UK. But, on a climate change scenario and knowing its presence in Lousiana, Colorado and Tennesse all Europe may be invaded.

SECTION A – Organism Information and Screening		
Stage 1. Organism Information	**RESPONSE** **[chose one entry, delete all others]**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	*Pennisetum setaceum* (Forssk.) Chiov. Eng: Fountain Grass Spa: Plumero, rabo de gato, pasto de elefante	It is a species of the *Poaceae* family included in the *Poales* order. Yes, this species can be adequately distinguished from other entities of the same rank. Despite being recognized as a taxonomically distinct species, it should be noted that no skilled people could be confused with other species of the same genus specially with *P. alopecuroides*.
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)		
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	Yes.	*P. Setaceum* has been the object of a Weed Risk Assessment done by PIER (Pacific Islands Ecosystems at Risk) concluding that the species represents a high risk -the score obtained was 26, a species representing risk when the score reaches 7-. (CABI, 2015) Also is listed as a category one invasive species in South Africa (PlantZAfrica, 2012).
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	They are entirely valid.	
5. Where is the organism native?	Northern African from Morocco to Arabic peninsula reaching Zambezi Valley to the South (EPPO, 2014).	
6. What is the global distribution of the organism (excluding Europe)?	The species is native to Morocco, Algeria, Tunisia, Libya, Egypt, Israel, Eritrea, Ethiopia, Djibouti, Kenya, Sudan, Somalia, Tanzania, Zambia and Zimbabwe in Africa and Lebanon, Oman, Saudi	

	Arabia, Syria and Yemen in Asia. *P. Setaceum* have been introduced to Swaziland and South Africa (Africa), Indonesia (Asia), Bermuda, Arizona, California, Colorado, Florida, Hawaii, Louisiana, New Mexico, Oregon and Tennessee (USA), Guadeloupe and Puerto Rico (Caribean), New South Wales, Queensland (Australia), Fiji, French Polynesia, Guam, New Caledonia, New Zealand, Palau (Oceania).	
7. What is the distribution of the organism in Europe?	Spain (Baleares and Canarias islands), France, Italy (Calabria, Sardinia and Sicily from Bella, S. et al, 2015), Algarve region of Portugal (Invasive Plants in Portugal, 2013), Cyprus and Malta.	In the Iberian Peninsula the species was found for the first time in 1989 in Alicante. In the Canarias Islands was introduced in the 70´s (Sanz-Elorza et al., 2004). Nowadays it is spreading and colonising many areas in Canary, Balearic Islands and warm areas of the Iberian Peninsula (Sanz Elorza, M. et al, 2004). In Cyprus it is found in disturbed areas, but not yet widely spread.
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	It is widely distributed all over the world as an invasive species. In Hawaii it is considered among the ten invasive alien species more harmful and in Canarias islands it is one of the most problematic invasive plants (Sanz Elorza, M. et al, 2004). It establishes monoespecific grasslands in many different habitats, but is particularly problematic in dry grasslands and early successional habitats where increases fire frequency and colonizes the burnt land because of its pirophile character (Benton, 2009). It competes very effectively for the acquisition and use of resources even in low-availability grounds (González-Rodríguez, A.M., 2010) and is able to use a higher proportion of water than native soil (Cordell & Sandquist, 2008).

		It presents C4 metabolism, which, together phenotypic plasticity, may be the basis of its high potential invader.(Williams et al. 1995; Sweet & Holt 2015). The causes are perhaps more complex, and are related to seasonal niche segregation and its effect in the medium term, as they seem to suggest results from Sweet & Holt (2015). It reduces nature species diversity and moisture availability to surrounding plants and can alter nutrient-cycling (FloraBase, 2012). In Spain, it replaces a number of species such as – but not only- *Hyparrhenia hirta*, *Hyparrhenia sinaica*, *Cenchrus ciliaris*, *Aristida adscensionis* ssp. *coerulescens* grasses and *Argyranthemum lidii* (EN category in IUCN, 2012) (Dana et al. 2003, González-Rodríguez et al. 2010; González-González et al. 2013). The increase in fire frequency in areas invaded by fountain grass can affect ground nesting birds and other animals (EPPO, 2015).
9. Describe any known socio-economic benefits of the organism in the risk assessment area.	The species generates economic benefits related to horticulture trade.	These benefits are probably very low, since, so far, the species is not broadly represented in nurseries stocks.

SECTION B – Detailed assessment			
PROBABILITY OF ENTRY			
Important instructions: • Entry is the introduction of an organism into Europe. Not to be confused with spread, the movement of an organism within Europe. • For organisms which are already present in Europe, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.			
QUESTION	**RESPONSE [chose one entry, delete all others]**	**CONFIDENCE [chose one entry, delete all others]**	**COMMENT**
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	Few	High	The plant is used as a landscape ornamental plant, and for soil stabilisation (EPPO, 2014). The horticulture trade of the species is relevant to their translocation between territories although there are important restrictions on this trade in several countries. The species has colonized wide areas of Canarias islands by specimens proceeding from plants introduced with ornamental purpose. Seeds may also be dispersed by vehicles, machinery, equipment and livestock (Joubert & Cunningham, 2002). Further, it can be used by landscape designers for planting in roads margins (Dana et al, 2005).
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	Seed dispersal by vehicles and machinery Besides, the species is still being used by private and public sectors (councils,		The species was introduced at Europe by the trade of ornamental plants. At present, the seed dispersal of vehicles and machinery is the main pathway of the species in Spain. In Cyprus, it escaped from private gardens.

	hotels, etc.). It would be worthy to evaluate the importance of seed exchange between countries through internet forum.		
Pathway name:	Seed dispersal by vehicles and machinery		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	Accidental	High	The entry of seeds in the wheels of the vehicles or stuck to other parts of them or to the machinery are accidental pathways.
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	Moderately likely	Low	Any machinery contacting *Pennisetum setaceum* could transport an important amount of seeds.
1.5. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.	Likely	High	Seeds are highly resistant and keep the germinative ability for 6 years (Sanz Elorza, M. et al, 2004). Seed production is sometimes reported as very high, with 80% of viable seeds (Nonner, 2005).
1.6. How likely is the organism to survive existing management practices during passage along the pathway?	Likely	Low	Measures to cleaning machinery could reduce the risk of entry of the species but they are not a hundred per cent effective.
1.7. How likely is the organism to enter Europe undetected?	Very likely	High	It is quite difficult to detect the seeds of *Pennisetum setaceum* in contaminated machinery or equipment.

1.8. How likely is the organism to arrive during the months of the year most appropriate for establishment?	Likely	High	Any month could mean an appropriate period for the establishment of the species because seeds are highly resistant and keep the germinative ability for much time (Sanz Elorza, M. et al, 2004).
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	Likely	Medium	*P. setaceum* has invaded a large number of countries with different types of climates, from California to Hawaii, Canary Islands, semi-arid southeastern Spain, lands under influence of atlantic ocean (SW Spain), East coasts of Spain and Baleares.... It is outcompeted by other plants in wetter sites (EPPO, 2012). This species cannot tolerate freezing temperatures (CABI, 2015).
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	Likely	High	The species is already present in Italy, France, Spain Portugal and Malta and it is very common in North Africa. So, it is easy the translocation of seeds in contaminated machinery and equipment.
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into Europe based on all pathways (comment on the key issues that lead to this conclusion).	Likely	High	The principal pathway for entry is by contamination of machinery or equipment with seeds of the plant but horticulture trade could be a way of entry into Europe if there are no control mechanisms necessary to avoid the traslocation of plants and seeds. Currently, the high exchange of garden seeds among garden plants fans, facilitated by online forum is also of great concern for Europe (Lenda et al. 2014).

PROBABILITY OF ESTABLISHMENT			
Important instructions: • For organisms which are already well established in Europe, only complete questions 1.15 and 1.21 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
1.12. How likely is it that the organism will be able to establish in Europe based on the similarity between climatic conditions in Europe and the organism's current distribution?			
1.13. How likely is it that the organism will be able to establish in Europe based on the similarity between other abiotic conditions in Europe and the organism's current distribution?			
1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe? Subnote: gardens are not considered protected conditions			
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	Spread	very high	*P. setaceum* is able to grow in a diverse range of habitats such us rocky and semiarid dry soils, xerophile shrubbery, cultures, non-saline coastal areas (Sanz Elorza, M. et al, 2004) and also in natural grasslands (EPPO, 2014) It often grows in disturbed areas such as roadsides (FloraBase, 2012).
1.16. If the organism requires another species for critical stages in its life cycle then how likely is the organism to			

become associated with such species in Europe?			
1.17. How likely is it that establishment will occur despite competition from existing species in Europe?			
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in Europe?			
1.19. How likely is the organism to establish despite existing management practices in Europe?			
1.20. How likely are management practices in Europe to facilitate establishment?			
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	Moderately likely	Medium	*Pennisetum setaceum* is hard to contain or control. It is a fast growing species and it has a high dispersal ability. It sprouts well from roots, has a high resistance to drought and can tolerate a wide range of soils (Sanz Elorza, M. et al, 2004). The species has been subjected to eradication plans in Canary islands. In Tenerife and Gran Canaria efforts to eradicate have failed but in La Palma it has been almost completely eliminated (Sanz Elorza, M. et al, 2004). Some of these situations may have had more to do with political commitment and contribution of media, than with the real possibility of control given the biology of the species.
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?			
1.23. How likely is the capacity to spread of the organism			

to facilitate its establishment?			
1.24. How likely is the adaptability of the organism to facilitate its establishment?			
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?			
1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in Europe? (If possible, specify the instances in the comments box.)			
1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in GB but is established because of continual release, is an example of a transient species.			
1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).			

PROBABILITY OF SPREAD			
Important notes: • Spread is defined as the expansion of the geographical distribution of a pest within an area.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
2.1. How important is the expected spread of this organism in Europe by natural means? (Please list and comment on the mechanisms for natural spread.)	Major	High	The plant flowers between March and September in Canary islands and reproduces by seeds. It reaches maturity in the first year, and produces seeds every year. Each plant may produce on average 100 seeds dispersed by wind which may remain viable in the soil for 6 years or longer. Apomixis (asexual seed formation) may occur. (EPPO, 2015). Seeds are dispersed mainly by wind and water (Rahlao et al., 2010). Livestock are also a vector for the movement of seeds (Halvorson and Guertin 2003). The species has a high dispersal ability to spread and invade natural areas far from its original location (Salinas, J. et al, 2011).
2.2. How important is the expected spread of this organism in Europe by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	Major	High	The plant is used as a landscape ornamental plant, and is used for soil stabilisation (EPPO, 2015) Seeds may also be dispersed by vehicles, machinery and equipment (Joubert & Cunningham, 2002). Further, air turbulences at roads enhance the dispersal of the seeds (Dana et al, 2005).
2.3. Within Europe, how difficult would it be to contain the organism?	Difficult	High	The species is hard to contain because it has a very high ability to spread and the long lived seeds of the plant make the control extremely difficult (EPPO, 2014). In Tenerife and Gran Canaria efforts to eradicate it have failed (Sanz Elorza, M. et al, 2004).
2.4. Based on the answers to questions on the potential for establishment and spread in Europe, define the area endangered by the organism.	Dry conditions, usually linked to low lands in	Very high	The species is not able to survive in areas with some humidity. In Spain the species does not usually grow above 200 meters (Salinas, J. et al, 2011).

	Mediterranean and Macaronesian region		These indications are also considering to Portugal, and in any case, it should be pointed out that the species has been found in Hawaii at 2000 meters. This species can reach high altitudes especially in south-face, but just in case of low humidity conditions.
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of Europe were the species could establish), if any, has already been colonised by the organism?	0-10	High	
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0-10	Medium	The species has a high invasive potential but the ban on trade in Spain and the eradicating measures planned should limit its expansion in a short term. It is considered however that it is very difficult to answer this question nor from a scientific or technical point of view since what is required are relative values with respect to the total area of possible colonization and this may be very broad (possibly more than we might suppose). In Spain the species is finding in well-preserved dune systems. It would be necessary to have a database of confirmed presences and absences (absences being due to the inadequacy of habitat, not due to not arrived yet) to be modelled with some criteria-and still, the models are always orientations-. In southern USA *P.setaceum* coexist with *Stipa*, which can happen of course also in Spain, as habitats become saturated. *Stipa* grasslands surface is very broad in the Mediterranean area and quite similar to some other steppe habitats where *P. setaceum* may invade in the future. A reply to this question is provided, as it is necessary to proceed with risk assessment, but it is considered that it is not possible

			to answer the question with exact figures.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Europe? (Please comment on why this timeframe is chosen.)	10	low	In 10 years the results of the eradication programs should be clear.
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	0-10	low	It depends on the eradication programs but it is important to note that the endangered area in Spain is very extensive.
2.9. Estimate the overall potential for future spread for this organism in Europe (using the comment box to indicate any key issues).	Moderately	Medium	Few studies estimate the rate of expansion of the species but considering its invasive potential and the difficulty to eradicate it could expand rapidly along its potential expansion area.

PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in Europe separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range, including the cost of any current management?	Major	High	It is a very aggressive plant forming monospecific stands and out competing native plants by reducing available space, water and nutrients (EPPO, 2015). The species also raises fuel loads, and becomes extremely inflammable, increasing the intensity and spread of fire, resulting in severe damage to native dry forest species non adapted to extreme fire regimes and generating big economic loses (EPPO, 2015). Furthermore, *Pennisetum setaceum* may increase their coverage after fire. The conservation of native plants and restoration of burnt land has a moderate economic impact. Also, chemical and mechanical measures to control this species are very costly economically (Sanz Elorza, M. et al, 2004). In addittion, it should be considered the occupation of dry crops, grazing pastures and firewalls, and associated costs.
2.11. How great is the economic cost of the organism currently in Europe excluding management costs (include any past costs in your response)?	Moderate	Medium	There is not available current data about the economic cost caused by the organism. The expansion of the species creating monospecific formations could eliminate natural pastures for livestock.

2.12. How great is the economic cost of the organism likely to be in the future in Europe excluding management costs?	Major	Medium	If the species is not eradicated or if it establish in other areas will likely produce high economic cost due to reduction of natural pastures for livestock mainly for sheep and goats in sparse forests and non forestry lowlands. There should be taken into account also the risk of fire, loss of biodiversity, disruption of the landscape.
2.13. How great are the economic costs associated with managing this organism currently in Europe (include any past costs in your response)?	Major	High	Cost evaluation of these management actions is not available but eradication programs, control measures and actions for the recovery of land and native species affected by *Pennisetum setaceum* should be high.
2.14. How great are the economic costs associated with managing this organism likely to be in the future in Europe?	Major	High	If the species is not eradicated or if it establish in other areas, damages and control measures reported in points 2.11 and 2.12 will be probably increased. Small infestations may be managed by uprooting plants by hand and destroying the inflorescences in order to prevent seed dispersal. Removal by hand may need to be repeated several times per year. Extensive infestations of fountain grass are probably best controlled with the help of herbicides, especially those with some systemic activity (Benton, 2009). A future integrated strategy to control the species should take into account coordination between authorities with responsibility (roads, towns, regions) surveillance to detect new emerging outbreaks and direct control (chemical or physical) in many locations. Regarding the latter case, it could include periodic roadblocks to carry out control measures, agreements with private proprietaries who have it on their lands. As in many localities they are on cliffs, it should include working with climbers. And add the cost of divulgation and awareness.
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding	Major	High	The species has important effects on the native flora, including endangered species because of its high

Europe?			capacity colonizing. It also raises fuel loads, and becomes extremely inflammable in winter, increasing the intensity and spread of fire (EPPO, 2015). In Hawaii it is considered one of the more harmful species. It occupies vast areas in many different habitats where increases fire frequency and colonizes the burnt land because of its pirophile character increasing its dominancy.. It reduces nature species diversity and moisture availability to surrounding plants and can alter nutrient-cycling (FloraBase, 2012).
2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) currently in Europe (include any past impact in your response)?	Major	High	In Canary islands it eliminates native pastures of *Hyparrhenia hirta*, *Cenchrus ciliaris* and *Aristida adscensionis* ssp. *coerulescens* (Salinas, J. et al, 2011). Furthermore, it increases the intensity and spread of fire, resulting in severe damage to native species non adapted to extreme fire regimes (EPPO, 2014). In Macaronesia, it is known to affect endangered species such as *Argyranthemum lidii* on the island of Gran Canaria, the Canarias islands, Spain (IUCN, 2012). On the other hand, there are important evidences of the great capacity of expansion of the species in inland areas of the peninsula Ibérica near to Levante´s shore (Salinas, J. et al, 2011). In addition, in the Algarve territory of Portugal, it has been demonstrated its high capacity colonizing natural areas and eliminating native species of plants (Invasive Plants in Portugal, 2013). Otherwise, fires that follow invasions impact ground nesting birds and terrestrial animals and have the ability to change the structure of vegetation.

2.17. How important is the impact of the organism on biodiversity likely to be in the future in Europe?	Major	Medium	The uncontrolled expansion of the species, could have important effects on the native flora, including endangered species.
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism currently in Europe (include any past impact in your response)?	Major	High	Together with native species replacement (Cordell & Sandquist 2008), it reduces moisture availability to surrounding plants and can alter nutrient-cycling (FloraBase, 2012). It causes changes in the hydrological regime, dynamics of nutrients and minerals available, light, changes in salinity or pH, etc. (Sanz Elorza, M. et al, 2004). It also raises fuel loads, and becomes extremely inflammable in winter, increasing the intensity and spread of fire (EPPO, 2014). The impact on ecosystem services could occur mainly because the species increase the risk of fire and therefore, would affect to the properties of soil and indirectly to its ecosystem services related such as erosion control or fertility. Also it should be considered the elimination of natural pastures for livestock. Some other impacts have been studied in Cordell & Sandquist (2008): -On the islands of Hawaii *Pennisetum setaceum* dominates the understorey of the few remaining fragments of native dry forests and is contributing to the degradation of this once diverse ecosystem. In this study, it is examined the impacts of *Pennisetum setaceum* on water use and productivity of the dominant native canopy tree, *Diospyros sandwicensis*. - Over a 3-year period, measurements were made on tree growth rates, and physiological and morphological responses of the most common dry forest native tree,*D.*

			sandwicensis, growing with an understorey dominated by *Pennisetum setaceum*, and on trees growing in plots maintained free of grasses. - Analysis of stable oxygen isotope ratios indicated that trees growing in the absence of *Pennisetum setaceum* used a higher proportion of water from shallow soil sources. They also sustained higher mid-day water potentials, especially during drier periods. At the leaf level, no significant differences were found in gas exchange measurements between *Diospyros sandwicensis* trees growing with or without *P. setaceum*. However, trees growing without *Pennisetum setaceum* had 30% lower leaf mass per unit area and 40% higher diameter growth than trees growing with *Pennisetum setaceum*. - These results demonstrate that invasion by *Pennisetum setaceum* has a pronounced negative impact on resource acquisition and use by the dominant native tree of this dry forest ecosystem. Although tree death due to these impacts would be much slower than through more immediate processes such as fire and grazing, the article suggests that long-term conservation of ecosystems threatened by invasions, such those in Hawaiian dry forests, will ultimately require active management of the invading species.
2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism likely to be in Europe in the future?	Major	Medium	The alterations reported in point 2.18 will be increased due to the species has a high colonizing ability.
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism currently in Europe?	Moderate	High	In Spain, the species affects important protected natural areas in Andalucía, Comunidad Valenciana and especially in Canary islands, invading LIC and ZEPA

			belonging to the Nature 2000 network. The species has been found in 30% of all protected natural areas of the islands (Salinas, J. et al, 2011).
2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism likely to be in the future in Europe?	Major	Medium	Many of the habitats that could be colonized by the species are included in Spain in a local, national or European site of nature conservation.
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	Minor	Medium	Generally, grasses don´t have a high genetic plasticity and there are not native species closed to *Pennisetum* that could have their genetic nature modified.
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	Major	Medium	*Pennisetum setaceum* increases the fire risk and eliminates grazing pastures which could have a hard impact on local socio-economy.
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	Minor	Medium	-It does not exist any information available of other damaging organism that could be ecologically associated with *Pennisetum setaceum*.
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box)	NA		
2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Europe?	Major	Medium	*Pennisetum setaceum* is a poor pasture grass (EPPO, 2014) that has been described as unpalatable to cattle except for young shoots in Hawaii (Motooka et al., 2003). Also few insect or fungi species were found to attack the species in Hawaii (Goergen and Daehler, 2001). Only it has been found a reference reporting herbivory by goats in Australia (Department of Primary Industries, Victoria 2012).

2.27. Indicate any parts of Europe where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	Greece and its islands, Cyprus and greater expansion in Spain (including Balearic and Canary islands), and South of France, southern half of Italy, Corsica and Sardinia, and Adriatic coasts	Medium	Macaronesian and Mediterranean islands are particularly vulnerable to new invasions of the species.

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	Likely	High	The plant is moved between different regions due to horticultural trade as a landscape ornamental plant. Seeds usually are dispersed by vehicles, machinery, equipment and livestock. The species colonizes roads, railways and disturbed areas because seeds are dispersed by the air turbulences from cars. Seeds are highly resistant. Measures to cleaning machinery could reduce the risk of entry of the species but it is quite difficult to detect the seeds in contaminated machinery or equipment. *P. setaceum* species is already present in Italy, France, Spain Portugal, Cyprus and Malta.
Summarise Establishment	Likely	High	*P. setaceum* is able to grow in a diverse range of habitats of the termomediterranean and termomacaronesian area, including disturbed areas and it has a high dispersal ability to invade natural areas, so it is extremely difficult to avoid its establishment.
Summarise Spread	Rapidly	High	Seeds are usually dispersed by wind, water, livestock and machinery. The biological characteristics of the species generate a high invasive potential ability to invade natural areas far from its original location. Considering its invasive potential and the difficulty to be eradicated, *Pennisetum setaceum* could expand rapidly along its potential area.
Summarise Impact	Major	High	*Pennisetum setaceum* generates monospecific stands and out competing native plants by reducing available space, water and nutrients. The species also raises fuel loads, and becomes extremely inflammable, increasing the intensity and spread of fire, resulting in severe

			damage to native dry forest species non adapted to extreme fire regimes. The species has important effects on the native flora, including endangered species because of its high capacity colonizing.
Conclusion of the risk assessment	High	High	This plant has shown invasive behaviour in all continents and it can be considered an emerging invader in Europe. The biological characteristics of *Pennisetum setaceum* make it a great invasive potential species. It is a popular ornamental plant and has been planted widely in areas with warm and arid climates. Seeds are dispersed by the wind, water, vehicles and livestock. The dry biomass produced by the plant increases fire frequency and spread by increasing fuel loads. It reduces moisture availability to surrounding plants and can alter nutrient-cycling. It establishes monocultures in many different habitats, but is particularly problematic in dry grasslands and early successional habitats. It increases fire frequency and the ability of fires to spread within a landscape and threatens endangered plant species Monitoring for seeds traslocations is a good practice to avoid new infestations. Mechanical treatments are effective when coverage of the species is reduced. Extensive infestations may be controlled with systemic herbicides (chemical treatments). The species has been subject to eradication plans in Islas Canarias with different results.

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	Temperature increases.	Medium	The rise in global temperature will increase the appropriate altitude range for *Pennisetum setaceum.* Due to fire-grass cycle because of the temperature raising will benefit the presence of the species too.
3.2. What is the likely timeframe for such changes?	10 years	Low	It is an appropriate period of time to evaluate changes in the patterns of distribution of species in relation to changes in climate parameters.
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	The suitable area for establishment of the species will be increased.	Medium	The rise in global temperature favours species proceeding from tropical climates The increases of the suitability of some habitats for the colonization of *Pennisetum setaceum* will generate changes in the composition of the habitats.
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	Yes		Additional studies are necessary to know the response of the species to the climate change, its impact on the ecosystem function, soils, habitat changing etc. and how important it is for human health any possible allergy caused by the organism.

REFERENCES:

-Bella, S., Cupani, S., D´urso, V., Laudonia, S., Sinno, M. & Viggiani, G. 2015. Description of a new species of *Oligosita* Walker (*Chalcidoidea*: *Trichogrammatidae*), egg parasitoid of *Balclutha brevis* Lindberg (*Homoptera*: *Cicadellidae*) living on *Pennisetum setaceum*, from Italy. Zootaxa 4039 (4). 583-590.

-Benton N, 2009. Fountain grass: *Pennisetum setaceum* (Forsk.) Chiov. Viginia, USA: The Nature Conservancy. http://www.nps.gov/plants/alien/fact/pese1.htm

-CABI. Invasive Species Compendium. 2015. Datasheets, maps, images abstracts, and full text on invasive species of the world.

Cordell, S. & Sandquist, D.R., 2008. The impact of an invasive African bunchgrass (*Pennisetum setaceum*) on water availability and productivity of canopy trees within a tropical dry forest in Hawaii. Functional Ecology 22: 1008- 1017.

Dana, E.D., Sanz-Elorza, M., Vivas, S. & Sobrino, E., 2005. Especies vegetales invasoras en Andalucía. Consejería de Medio Ambiente, Junta de Andalucía, Sevilla.

Dana E.D., Sobrino, E. Sanz-Elorza M. 2003. Plantas invasoras en España: un nuevo problema en las estrategias de conservación. In Bañares Á., Blanca G., Güemes J., Moreno J.C. &. Ortiz S. (Eds): Atlas y Libro Rojo de la Flora Vascular Amenazada de España, Dirección General de Conservación de la Naturaleza. Madrid,,pp.110-1029. Available at http://www.magrama.gob.es/es/biodiversidad/temas/inventarios-nacionales/c5_tcm7-22147.pdf

Department of Primary Industries, Victoria, 2012. Victorian resources online: Invasive plants. Melbourne, Victoria, Australia: Department of Primary Industries. http://vro.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/lwm_pest_plants

-EPPO, 2015. PQR database. Paris, France: European and Mediterranean Plant Protection Organization. http://www.eppo.int/invasiveplants/iap_list/

-Florabase, 2013. Flora of Western Australia. Perth, Western Australia: Department of Environment and Conservation. http://florabase.dec.wa.gov.au/

-Goergen E, Daehler CC, 2001. Inflorescence damage by insects and fungi in native pili grass (*Heteropogon contortus*) versus alien fountain grass (Pennisetum setaceum) in Hawai'i. Pacific Science, 55(2):129-136.

González González, R., Reyes Betancort, J.A., Martín Reyes, R. & Barrera Acosta, J. 2013.*Argyranthemum lidii*. The IUCN Red List of Threatened Species 2013: e.T162340A5576122.http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T162340A5576122.en

-González-Rodríguez, A.M., Baruch, Z., Palomo, D., Cruz-Trujillo, G., Soledad Jiménez, M. & Morales, D., 2010. Ecophysiology of the invader Pennisetum setaceum and three native grasses in the Canary Islands. Acta Oecologica 36: 248-254.

-Halvorson WL, Guertin P, 2003. Fact sheet for: *Pennisetum setaceum* (Forssk.) Chiov. USGS Weeds in the West: Status of Introduced Plants in Southern Arizona Parks. Tucson, Arizona, USA: USGS Southwest Biological Science Center. http://sdrsnet.srnr.arizona.edu/data/sdrs/ww/docs/pennseta.pdf
-Invasive Plants in Portugal (2013). Pennisetum setaceum. Available at http://invasoras.pt/wp-content/uploads/2015/11/Pennisetum-setaceum_torrinha.pdf. Accessed 14/07/2016. (Invasive Plants in Portugal refers to the Project team of "Plantas Invasoras: uma ameaça vinda de fora" (Media Ciência N.º 16905), involved in the development of this webpage).

-IUCN, 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org/

-Joubert DF, Cunningham PL, 2002. The distribution and invasive potential of Fountain Grass Pennisetum setaceum in Namibia. Dinteria, No.27:37-47.

-Kottek, M., J. Grieser, C. Beck, B. Rudolf, F. Rubel, 2006: World map of the Koppen-Geiger climate classification updated. – Meteorol. Z. 15, 259–263

-Lenda M, Skórka P, Knops JMH, Moroń D, Sutherland WJ, Kuszewska K, et al. (2014) Effect of the Internet Commerce on Dispersal Modes of Invasive Alien Species. PLoS ONE 9(6): e99786. doi:10.1371/journal.pone.0099786

-Mootooka P, Castro L, Nelson D, Nagai G, Ching L, 2003. Weeds of Hawaii's Pastures and Natural Areas; an Identification and Management Guide. Manoa, Hawaii, USA: College of Tropical Agriculture and Human Resources, University of Hawaii.

-Nonner ED, 2005. Seed bank dynamics and germination ecology of fountain grass (*Pennisetum setaceum*). Hawaii, USA: University of Hawaii.

-Pacific Island Ecosystems at Risk (PIER) – Weed Risk Assessment for *Pennisetum setaceum*. http://www.hear.org/pier/wra/pacific/pennisetum_setaceum_htmlwra.htm

-PlantZAfrica, 2012. Declared weeds/invaders. Pretoria, South Africa: South African National Biodiversity Institute . http://www.plantzafrica.com/miscell/aliens6.htm

Rahlao SJ, Milton SJ, Esler KJ, Barnard P, 2010. The distribution of invasive *Pennisetum setaceum* along roadsides in western South Africa: the role of corridor interchanges. Weed Research (Oxford), 50(6):537-543. http://www.blackwell-synergy.com/loi/wre

- Rubel F. and M. Kottek. 2010. Observed and projected climate shifts 1901–2100 depicted by world maps of the Koppen-Geiger climate classification. Meteorol. Z., 19, 135-141

-Salinas, J., López, A., Cabello, J. 2011. "Expansión de la especie vegetal invasora *Pennisetum setaceum* (Forssk.) Chiov en las zonas áridas y semiáridas del levante andaluz (provincia de Almería). Informe técnico del programa de seguimiento de los efectos del cambio global en zonas áridas y semiáridas del levante andaluz. Centro Andaluz para la Evaluación y Seguimiento del Cambio Global. Dpto. Biología Vegetal y Ecología de la Universidad de Almería. 42 pp.

-Sanz Elorza M., Dana Sánchez E.D. & Sobrino Vesperinas E., eds. 2004. Atlas de las plantas alóctonas invasoras en España. Dirección General para la Biodiversidad. Madrid, 384 pp.

-Sweet L.C. & Holt J.S. 2015. Establishment Stage Competition between Exotic Crimson Fountaingrass (Pennisetum setaceum, C4) and Native Purple Needlegrass (Stipa pulchra, C3). Invasive Plant Science and Management 8(2):139-150. 2015

-Valdes B, Scholz H, 2009. Euro and Med Plantbase. Berlin, Germany: Euro and Med Plantbase. http://ww2.bgbm.org/EuroPlusMed/query.asp

-Williams D.G., Richard N. Mack & R. Alan Black. 1995. Ecophysiology of Introduced Pennisetum Setaceum on Hawaii: The Role of Phenotypic Plasticity. Ecology Vol. 76 (5): 1569-1580