

## SHORT COMMUNICATION

## Risk Analysis - A Biosecurity Tool to Assess Weed Potential of a Plant

Mool Chand Singh<sup>1</sup>, NT Yaduraju<sup>2</sup> and Madhu Bala Priyadarshi<sup>3</sup>

<sup>1</sup>Division of Plant Quarantine, National Bureau of Plant Genetic Resources, New Delhi-110012

<sup>2</sup>International Crop Research Institute for Semi Arid Tropics, Patancheru-502319

<sup>3</sup>AKMU Cell, National Bureau of Plant Genetic Resources, New Delhi-110012

(Received: 19 March 2013; Revised: 21 April 2013; Accepted: 17 May 2013)

Seeds and planting materials of different plant species are being imported into India. Many of these have the potential to become agricultural or environmental weeds and this risk needs to be assessed before allowing their entry. Weed risk assessment method was judged on its ability to correctly reject weeds and accept non-weeds. Out of 170 plants tested, a total of 40% plants were classified as serious weeds, 30% as common weeds and remaining 30 % were non weeds. The system is designed to be operated by plant quarantine officers. The weed risk assessment system with explicit scoring of biological, ecological and geographical attributes is a useful tool for detecting potentially invasive weeds in other areas of the world.

**Key Words:** Plant quarantine, Seeds, Score, Weed, Weed risk assessment

The implementation of New Policy on Seed Development by the Government of India has provided stimulus for the import of seeds of various crops from all over the world. This has increased the risk for the introduction of exotic weeds into India. Weeds have major impacts on economies and natural environments worldwide including India. Many of these weeds have been purposely introduced as new crops or as ornamentals. To counter the threat to agriculture or the environment from new plants, regulatory authorities have a statutory responsibility to ensure that all plants proposed to be imported, which are not already established, be evaluated for their potential to damage the productive capacity or environment of the country. Quarantine in India officially came into operation with the passing of the Destructive Insects and Pests Act (DIP Act) in 1914. Plant Quarantine (Regulation of Import into India) Order 2003, of the Destructive Insects and Pests Act (1914) provides a legislative framework for the application of measures to prevent the introduction or spread of insect-pests and diseases affecting plants. Effective plant quarantine is important for the protection of the biodiversity of the natural environment and agricultural productivity. Infestation of agricultural system has the potential not only to incur costs in controlling pests and losses in production, but also to restrict access to export markets,

if the pest has the potential to contaminate the marketable product. There are many approaches to predicting weed potential (Mack, 1996), but there is an urgent need of an objective, credible and publicly acceptable risk assessment system to predict the weediness of the new plant introductions.

An acceptable weed risk assessment system should satisfy a number of requirements. It should be calibrated and validated against a large number of plants already present in the recipient country and representing the full spectrum of plants likely to be encountered as imports into that country. It must discriminate between weeds and non-weeds, such that the majority of weeds are not accepted, non-weeds are not rejected, and the proportion of plants requiring further evaluation is kept to a minimum. As international trade agreements require that prohibited plant should fit in the definition of a quarantine pest before they can be excluded by quarantine regulations (Singh *et al.*, 2005), the system must be passed on explicit assumption and scientific principles so that country cannot be accused of applying unjustified non-tariff trade barriers. Ideally the system should be capable of identifying which land use system the plant is likely to invade, to assist in an economic evaluation of its potential impacts. Finally, the system must be cost effective. This Weed Risk Assessment (WRA) system for

\*Author for Correspondence: E-mail: [mcsingh@nbpgr.ernet.in](mailto:mcsingh@nbpgr.ernet.in)

India is designed in consultation with the weed scientists of Australia during the first author's advanced training at the University of Queensland, Brisbane, Australia.

The WRA system is designed to run on Microsoft Excel 2007 and it may be run on a Windows. The basis of the WRA is the answers to 49 questions based on the main attributes and impacts of weeds. These are combined into scoring system which in the absence of any evidence to the contrary, gives an equal weightage to nearly all questions. These cover a range of weedy attributes in order to screen for plants that are likely to become weeds of an environment and /or agriculture. The questions are divided into three sections producing identifiable scores that contribute to the total score. Most questions are answered, as yes, no or don't know.

Biogeography consists the documented distribution, climate preferences, history of cultivation, and weediness of a plant elsewhere in the world, i.e. apart from the proposed recipient country. Weediness elsewhere is a good predictor of a plant becoming a weed in new areas with similar environmental conditions (Forcella and Wood, 1984). The questions concerning the history of cultivation recognizes the important human component of propagule pressure (Williamson and Fitter, 1996), but such data are obviously never available for the proposed new country. The global distribution and climate preferences, where these are available, are used to predict a potential distribution in the recipient country. Undesirable attributes are characteristics such as toxic fruits and unpalatability, or invasive behaviour, such as a climbing or smothering growth habit, or the ability to survive in dense shade. Biology/ ecology are the attributes that enable a plant to reproduce, spread and persist (Noble, 1989) such as whether the plant is wind dispersed or animal dispersed, and whether the seeds would survive through passage of an animal's gut. Availability of information is often very limited for new species which can restrain the utility of screening systems. To ensure that at least some questions were answered for each section, the WRA system requires the answer to two questions in section A, two in section B and six in section C before it will give an evaluation and recommendation. The recommendation can be compared with the number of questions answered as an indication of its reliability which obviously improves as more questions are answered.

Answers to the questions provide a potential total score ranging from -14 (benign plant) to 29 (maximum

weediness) for each plant. The total score is partitioned between answers to questions considered to relate primarily to agriculture, to the environment, or common to both. The total scores are converted to one of the three possible recommendations by two critical score settings. The lower critical scores 0, separates *acceptable* plants from those requiring *evaluation*, and the higher critical score, 6, separates plants requiring *evaluation* from those that should be *rejected*. Evaluation could mean either obtaining more data or re-running the system, or undertaking further investigations such as field trails (Mack, 1996). The model was run to assess the weed potential of plants ranging from beneficial plants to serious weeds.

The answer to most of the questions in WRA is yes (y), no (n) or don't know (leave blank or?). The system translates these responses into a numerical score.

A typical score for a question is Yes=1 point, No= -1 or 0 and don't know/? =0

The questions in section's 2 and 3 (climate & weed elsewhere) of the questionnaire differ from the typical scoring in that they generate a score by a weighting system. The score given for questions 2.01 and 2.02 is used to weight the scores for 'yes' answers in the weed elsewhere questions (3.01 to 3.05). The quality of climate data greatly affects the climate match. A good climate match increases the probability that a weedy species will behave the same way in India as it does overseas. The weediness score also increases if the information used to produce the climate match is not comprehensive, due to the greater uncertainty introduced by this data.

Two other questions do not fit into the standard scoring system:

A score of 'no' for question 3.01, whether a plant has naturalized overseas, is modified by the score to question 2.05, its history of repeated export species with repeated introductions outside of their native range that have not established are a lower risk.

Questions 6.07, the minimum generative time, require the input of a numerical score. This generative time is standardized by the use of correlation factor as shown in Table.

Reproduction	Scores
< 1 to 2 years	1
Between 2 to 4 years	0
Greater than or equal to 4 years	-1

The WRA compares the total score for a species to the critical values to determine the recommendation for the species. The threshold values for the system are shown in following table.

If the plant scores less than 1	Accept the plant
If the plant scores greater than 6	Reject the plant
If the plant scores between 1 to 6	Plant requires further evaluation

The species used for the calibration of the system ranged from severe agricultural and environmental weeds to benign and beneficial plants. The WRA tallies the number of questions answered in each section. The WRA allows for a minimum number of questions in each of its three different categories. The minimum number of questions for each section is: 2 for section A, 2 for section B and 6 for section C. When using the excel spreadsheet if the minimum number of questions is not completed, a message that more information is required is posted by the system. The WRA has some capacity to suggest the type of ecosystem likely to be affected by the plant assessed. The WRA indicates if the plant is more likely to be a specific weed of agriculture or the general environment, once it has assessed the plants potential to become a weed in India. A species may be assessed to

be a weed of both categories. The partitioning helps to identify areas most at risk from the characters assessed for the species. The assessment method was tested against 170 plants representing both weeds and useful plants from agriculture and environment. The method was judged on its ability to correctly reject weeds and accept non weeds. A total of 40% plants were classified as serious weeds, 30% as common weeds and remaining 30 % were non weeds (Fig. 1).

The system identifies a wide range of weeds, and does not accept plants known to be major weeds in India. By splitting the total scores the model also allows an estimate of whether the weed is more likely to impact on agricultural or natural environment systems, which may assist regulatory authorities in making a recommendation. These features suggest that the system could be altered and still be expected to produce satisfactory results in other bio-climatic regions of the globe where protocols are lacking (Ruesink *et al.*, 1995). As the system is simple and spreadsheet based it can be used by lay people who wish to import plants and it has an educational role because it shows the effect of individual questions on the total score. The system distinguishes between many useful and non useful plants, but some useful plants can be rejected. This is expected, because planned introductions

www.IndianJournals.com  
Members Copy, Not for Commercial Sale  
Downloaded From IP - 220.227.250.219 on dated 24-Feb-2014

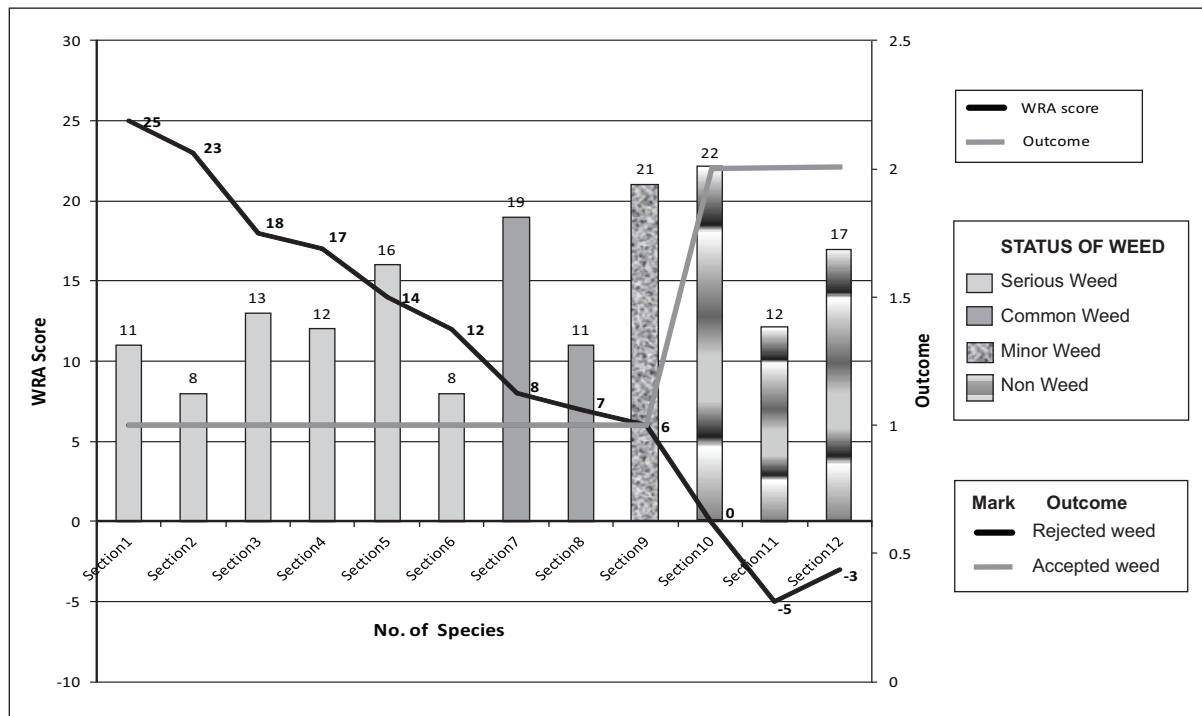


Fig. 1: Weed species assessed through WRA, their score, status and outcome

are chosen for their ability to survive (Ruesink *et al.*, 1995), and the questions asked by the system are based primarily on biological and ecological criteria which identify attributes common to both useful agricultural plants and weeds (Lonsdale, 1994). These may differ only in a small number of characteristics within any single life form (Perrins *et al.*, 1992). Where a plant may have significant economic benefits, a further evaluation of its weediness potential may include experimental studies (Williamson, 1993; Scott and Panetta, 1993). Economic value should be scored in a transparently separate exercise and balanced against weediness in appropriate risk assessment evaluations (Singh *et al.*, 2005).

It is concluded that the Weed Risk Assessment System with explicit scoring of biological, ecological and geographical attributes is a useful tool for detecting potentially invasive weeds in other parts of the world and should be used in Indian Plant Quarantine to assess the plants before issue of the Import Permit.

#### Acknowledgement

The authors are grateful to Dr. KC Bansal, Director and Dr. PC Agarwal, Head, Plant Quarantine Division, National Bureau of Plant Genetic Resources, New Delhi for providing necessary facilities and encouragement.

#### References

- Forcella F and TJ Wood (1984). Colonization potentials of alien weeds are related to their native distribution-implications for plant quarantine. *J. Aust. Inst. of Agric. Sci.* **50**: 35-41.
- Lonsdale WM (1994). Inviting trouble: introduced pasture species in northern Australia. *Aust. J. Ecol.* **19**: 345-354.
- Mack RN (1996). Predicting the identity and fate of plant invaders: emergent and emerging approaches. *Biological Conservation* **78**: 107-121.
- Noble IR (1989). Attributes of invaders and the invading process: terrestrial and vascular plants. In: (JA Drake, HA Mooney, FD Castri, RH Groves, FJ Kruger, M Rejmanek and M Williamson, eds), *Biological Invasions: A Global Perspective*, Chichester: John Wiley, pp 301-310.
- Perrins J, M Williamson and A Fitter (1992). A survey of differing views of weed classification: implications for regulating introductions. *Biological Conservation* **60**: 47-76.
- Ruesink JL, IM Parker, MJ Groom and PM Kareiva (1995). Reducing the risks of nonindigenous species introductions. *Bioscience* **45**: 465-477.
- Scott JK and FD Panetta (1993). Predicting the Australian weed status of southern African plants *Journal of Biogeography* **20**: 87-93.
- Singh MC, S Gnansambandham and PS Chandurkar (2005). Weeds as quarantine pests. *Plant Protection Bull.* **57**: 1-3.
- Williamson M (1993). Invaders, weeds and the risk from genetically manipulated organisms. *Experientia* **49**: 219-224.
- Williamson M. and FD FitterX (1996). The characteristics of successful invaders. *Biological Conservation* **78**: 163-170.