

Invasion Risk Assessment of Exotic Plant *Praxelis clematidea* in Zhengzhou

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Abstract To reduce the harms of plant invasion, the risk assessment for biological invasion of exotic species (including intentionally introduced species and accidentally introduced species) is particularly important. Through data review, investigation research and expert consultation, risk assessment system and standard for exotic species invasion in Zhengzhou region was established. Risk of *Praxelis clematidea* was assessed, in order to provide a reference for possible biological invasion of exotic plants in Zhengzhou.

Key words Plant invasion; Risk assessment; *Praxelis clematidea*; Zhengzhou

Praxelis clematidea, belonging to *Praxelis*, Asteraceae, is an annual herb, completely hairy, with capitulum, 25–30 florets, and achene. In the 1980s, *P. clematidea* was first discovered in Hong Kong Special Administrative Region (HKSAR) of China^[1]. It was found in Shenzhen in the 1990s, then successively found in Guangzhou and other regions^[2]. Now, it has distributed in Macao, Fujian, Guangdong, Guangxi, Hainan, Taiwan, Hong Kong, Yunnan, etc. In August 2014, the Ministry of Environmental Protection and the Chinese Academy of Sciences jointly issued *Announcement of List of Exotic Invasive Specie in China (third batch)*, and *P. clematidea* was included.

Although there is no report of *P. clematidea* invasion into Zhengzhou, the geographical environment in Zhengzhou is suitable for habitat of exotic species. As an invasive plant, *P. clematidea* seeds are likely to be mixed in introduction process of other crops, or make long distance transmission with ornamental plants. Li et al.^[3] suggested that invasive species in Zhengzhou presented the characteristics of wide region, multiple ecosystem and various species. Therefore, it is necessary to carry out risk assessment of biological invasion of *P. clematidea*, to understand the risk of its biological invasion. Through data review, investigation research and expert consultation, risk assessment system and standard for exotic species invasion in Zhengzhou region was established. Risk of biological invasion of *P. clematidea* was assessed, in order to provide a theoretical reference for possible biological invasion of *P. clematidea* in Zhengzhou.

1 Construction of Ecological Risk Assessment System for Exotic Plant Invasion into Zhengzhou

1.1 Framework of risk assessment system There are three stages in invasion process of exotic plant, including introduction stage, colonization and population construction stage (delayed

stage), diffusion and damage^[4]. A real biological invasion depends on accumulation of probabilities in different invasion stages. According to the geographical features of Zhengzhou, as well as current research achievements on invasion risk assessment of exotic species^[5–11], we put forward the framework and method for invasion risk assessment system of exotic plants in Zhengzhou area. The index system consisted of six primary indexes and 18 secondary indexes. The weights of various indexes in the system were determined by analysis hierarchy process. The assessment score of the entire index system was 100 points, and various indexes were given corresponding scores according to different weights. The assessment system had detailed hierarchical description on 18 indexes, and the corresponding description level was regulated with different evaluation scores.

1.2 Hierarchical description and score of indexes

1.2.1 The possibility of introduction accounts for 15%.

1.2.1.1 Possibility of intentional transmission (4%). (1) No possibility of intentional introduction (0 point); (2) Possible of intentional introduction (2 points); (3) Proven intentional introduction (4 points).

1.2.1.2 Possibility of unintentional transmission (3%). (1) It is not easy to transmit unintentionally (0 points); (2) It is likely to spread with human vehicles for transportation (2 points); (3) Proven unintentional transmission behavior or easily carried by vehicles for transportation (3 points).

1.2.1.3 Introduction scale (4%). (1) The introduced number basically has no practical significance (0 point); (2) Introduced by one-time personal behavior, and the introduced number is very small (1 point); (3) Introduced by limited time such as group behavior, and the introduced number is small (3 points); (4) Possibly introduced by many times, and the introduced number is large (4 points).

1.2.1.4 Introduction management (4%). (1) Have been listed as current quarantine control objects with effective prevention and control measures in invasion area, and current management measures are able to intercept them (0 point); (2) Have been listed as quarantine control objects, but due to insufficient attention, current management measures can not intercept them completely

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(2 points); (3) Have not been included in quarantine control objects because of no relevant regulations or requirements, and they may be introduced under the existing exotic species management means (4 points).

1.2.2 The possibility of colonization accounts for 15%.

1.2.2.1 Adaptation of introduced species in local area (5%).

(1) Do not adapt to the local environment, and completely unable to survive (0 point); (2) Adapt to the local environment (3 points); (3) Completely adapt to the local environment (5 points).

1.2.2.2 Breeding characteristics of introduced species (10%).

(a) Capable of seed reproduction and vegetative reproduction; (b) Can reproduce for more than one time throughout the year, and flowering period is longer; (c) Produce a large number of seeds, and each plant can produce more than 1 000 grains of seed; (d) Has faster growth rate than local plants, and quickly enter mature and reproduction period; (e) Vegetative organs such as root and stem are easily to generate new plant when fractured physically; (f) Have strong stress resistance, without strict requirements on growth environment; (g) Seeds can maintain the germination force for more than a year; (1) Do not show the above reproductive characteristics obviously, or just perform one kind of above reproductive characteristics (1 point); (2) Display one kind of above reproductive characteristics obviously (2 points); (3) Display two kinds of above reproductive characteristics obviously (4 points); (4) Display three kinds of above reproductive characteristics obviously (6 points); (5) Display four kinds of above reproductive characteristics obviously (8 points); (6) Strongly display more than four kinds of above reproductive characteristics (10 points).

1.2.3 The possibility of diffusion accounts for 20%.

1.2.3.1 Transmission media and transmission distance (7%).

(a) Spread by wind; (b) Spread by water; (c) Spread by animal and human; (1) Can not spread by the above media, difficult to make long distance transmission (0 point); (2) Can spread by one of the above media, and make long distance transmission (3 points); (3) Can spread by two of the above media, and make long distance transmission (5 points); (4) Can spread by two or more of the above media, with wide range of diffusion, and make long distance transmission (7 points).

1.2.3.2 The trend of diffusion (5%). (1) The survival habitat or possible diffusion area suitable for invasive species in local area is less than 1% (1 point); (2) The survival habitat or possible diffusion area suitable for invasive species in local area is less than 5% (3 points); (3) The survival habitat or possible diffusion area suitable for invasive species in local area is greater than 10% (5 points).

1.2.3.3 Popularity (5%). (a) Strong enjoyment; (b) Longer flowering period; (c) Fragrant potpourri; (1) Do not display the above characteristics remarkably (0 point); (2) Display one of the above characteristics remarkably (1 point); (3) Display two of the above characteristics remarkably (3 points); (4) Display the above three characteristics remarkably (5 points).

1.2.3.4 Natural enemy (3%). (1) Effectively restricted by

natural enemies in invasive area (0 point); (2) There are natural enemies, but the restriction effect is not obvious (2 points); (3) No effective restriction by natural enemies in invasive area (3 points).

1.2.4 Have successfully invaded, and the distribution in invasive area accounts for 10%.

1.2.4.1 The area of lands that have been successively invaded (6%). (1) Only scattered distribution of invasive species in local area (1 point); (2) The distribution area in local area is greater than 300 m² (4 points); (3) Have widely invaded in local area, and satisfy at least one distribution standard as follows (6 points): (a) overall cumulative invasion area is greater than 4 000 m²; (b) there are five or more invasion areas, and each area is greater than 300 m²; (c) there are five or more invasion areas, and each area basically covers regional ecological communities.

1.2.4.2 Proportion that has caused serious impact in invasion area (4%). (1) The invasion area with serious impact is less than 1% of the total area (1 point); (2) The invasion area with serious impact is less than 5% of the total area (2 points); (3) The invasion area with serious impact is less than 10% of the total area (3 points); (4) The invasion area with serious impact is greater than 15% of the total area (4 points).

1.2.5 History of invasion and species type (10%).

1.2.5.1 History of invasion of the species at home and abroad (6%). (1) Invasive species has no history of invasion in other regions (0 point); (2) Invasive species is only reported in other areas at home or abroad (4 points); (3) Invasive species has been reported both at home and abroad (6 points).

1.2.5.2 Species with potential invasion harm (4%). (1) No species (0 point); (2) Annual herbs (1 point); (3) Biennial herbs or lianas (2 points); (4) Perennial woody or vines (4 points).

1.2.6 Harm and influence accounts for 25%.

1.2.6.1 Influence on components of ecological system or systematic ecological factors (9%). (a) Strong water absorption capacity and excessive evaporation reduces water utilization of local species; (b) Withered stems and leaves increase the incidence rate of local fire; (c) Corrosive effect of stems and leaves change the local landforms; (d) Produce obvious nutrition competition with local crops; (e) Reduce photosynthetic capacity of local crops; (f) Change soil salinity, alkalinity and pH; (1) No influence on components of local ecological system and systematic ecological factors (0 point); (2) Have slight influence on various components of local ecological system and systematic ecological factors, but the effect is relatively slow and unobvious (3 points); (3) One of the above influences is significant (5 points); (4) Two of the above influences are significant (7 points); (5) Two or more of the above influences are obvious, with irreversible changes on local habitat (9 points).

1.2.6.2 Impact on local species (8%). (a) Allelopathy of organ infusion of plants is obvious; (b) Have obvious survival competition with some local species; (c) Distant hybridization with some local species reduce the genetic stability of rare species; (d) Rapid reproduction and diffusion ability occupy the habitat of

local species; (e) Plant juices and pappus are harmful to human and animals; (1) The above influences are slight, or do not produce influences (0 point); (2) Produce certain impact on local species through one of the above modes (2 points); (3) Produce impact on local species through two of the above modes (4 points); (4) Produce impact on local species through three of the above modes (6 points); (5) Produce serious impact on one or more local species through more than three of the above modes (8 points).

1.2.6.3 Impact on economy and other aspects (potential) (8%). (a) Destroy innate natural landscape of local area, and reduce ecological tourism value; (b) Reduce utilization value of land and water in local area; (c) Change community structure of local species, and reduce its ecological value; (d) Seriously affect at least one kind of local economical crops; (e) Affect physical and mental health of local residents; (1) Have no significant impact on local regional economy and other aspects (1 point); (2) Produce slight impact on one of the above aspects (2 points); (3) Produce significant impact on one of the above aspects (4 points); (4) Produce significant impact on two of the above aspects (6 points); (5) Produce significant impact on two or more of the above aspects (8 points).

1.2.7 The feasibility of control accounts for 15%.

1.2.7.1 Prevention and control methods and effects (5%). (1) Prevention and control method is simple, mature, and can eradicate invasive species for a long time (1 point); (2) Effective prevention and control methods have good short-term effect, but with easy relapse (3 points); (3) There is no effective prevention and control method, or with poor prevention and control effect (5 points).

1.2.7.2 Effect of prevention and control process on local species (5%). (1) Basically have no negative impacts on local species (1 point); (2) Have little impact on local species (3 points);

(3) Prevention and control process has serious impact on local species, or even with biological substitution^[12] (5 points).

1.2.7.3 Time and cost for prevention and control (5%). (1) Prevention and control process is fast, with low cost (1 point); (2) Less manpower and investment within a year can control it within a smaller harm scope (2 points); (3) More manpower and investment in three years can control it within a smaller harm scope (3 points); (4) Manpower and investment for over five years can control it within a certain harm scope (4 points); (5) Cause irreversible damage, and can not restore the original habitat (5 points).

The assessment system can evaluate the species that have successfully invaded into Zhengzhou, and the species that have not yet been introduced or do not cause invasion damage. And the main difference for assessment is the selection of the fourth primary index. For the exotic plants that have successfully invaded into Zhengzhou and caused invasion damage, the index described in **1.2.4** could be used for assessment; for the species that have not been introduced or do not cause invasion damage, the index described in **1.2.5** could be used for assessment. Moreover, the index described in **1.2.2.1** is a restrictive index, if the assessment for the secondary index is the first term that do not adapt to the local environment, and completely unable to survive, it can be determined the exotic species has no invasion risk in Zhengzhou area.

1.3 Risk assessment criteria of invasive plants in Zhengzhou area Through assessment of 18 secondary indexes in six primary indexes, the total score of the exotic plant is the final score of its evaluation. Referred to risk classification methods of exotic plants at home and abroad, the risk grades of exotic plants are distinguished. The standard is as follows: 0–30 points, third grade; 30–60 points, second grade; 60–100, first grade (Tab. 1).

Tab. 1 Risk assessment standard of exotic plants in Zhengzhou area

Comprehensive point	Risk grade	Risk level	Management measure
0–30	Third grade	Low risk	Invasion risk is low, and it is allowed to introduce under supervision
30–60	Second grade	Medium risk	There is certain risk of invasion, more relevant information must be obtained, and appropriate prevention and monitoring measures must be taken
60–100	First grade	High risk	There is high risk of invasion, and it is prohibited to introduce

Tab. 2 Invasion risk assessment results of *P. clematidea* in Zhengzhou area

No.	Assessment index	Points of index	Score	Proportion of score in points of index//%
1	Possibility of introduction	15	8	53
2	Possibility of colonization	15	15	100
3	Possibility of diffusion	20	12	60
4	History of invasion and species type	10	8	80
5	Harm and impact	25	23	92
6	Feasibility of control	15	12	80
7	Comprehensive evaluation	100	78	78

2 Risk Assessment of *P. clematidea*

Through field survey, data collection and literature retrieval, related data and information of *P. clematidea* were obtained, including its ecological habits, introduction pathways, genetic and breeding characteristics, diffusion modes, harm, prevention and treatment

method and effect. Based on these data and information, the invasion risk of *P. clematidea* in Zhengzhou area was evaluated.

On the basis of the above methods, the invasion risk of *P. clematidea* in Zhengzhou area was evaluated, and the results are shown in Tab. 2. The invasion risk score of *P. clematidea* in

Zhengzhou area was 78 points, so its risk was first grade according to risk assessment standard, with very high risk of invasion, which must be prohibited to introduce. Meantime, according to the proportion of various scores in points of index, it is not hard to find that once *P. clematidea* is introduced unintentionally, the possibility of colonization (100%) and diffusion (60%) is very high, the harm is very serious (92%), and the prevention and control effect (80%) is especially poor. Therefore, relevant departments should attach great importance to *P. clematidea*, strictly implement relevant policies and regulations, and strengthen monitoring of *P. clematidea*, to nip the invasion in the bud.

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(Continued from page 42)

ety improvement, while characters of offspring such as early maturity, high sugar, high yield, high quality and multi-resistance should be considered in selection of sugarcane varieties suitable for sugar production^[16–17].

After inoculation, there was no incidence in combinations Pma 98-40 × Yunrui 05-649, Yacheng 93-26 × Yunrui 05-733 and Yunrui 05-283 × Q199, whether they are really immune to brown stripe disease still needs to be verified through further inoculation.

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