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Biological Control of Invasive Weed Species: Nigerian Experience

¹R.A. Adebayo and ²U.O. Uyi

¹Department of Crop, Soil and Pest Management,
School of Agriculture and Agricultural Technology,
Federal University of Technology Akure, Ondo State

²Department of Zoology, Ambrose Alli University, P.M.B. 14 Ekpoma, Nigeria

Abstract: Absolute and complete free movement of goods and humans across all borders of the world has permitted some species to take dominance outside their country of origins. These species are termed as Invasive Alien Species. Invasive weed species are those weeds that have extensive recruitment into a population without human intervention. They are also termed as plant invaders, as alien plants that invade and oust native vegetations. Invasive weed species have however, impacted negatively on their new area of invasion leading to untold hardship on the people particularly the poor resource farmers, the biodiversity including entomofauna and phytoflora. Most of these weed species smother out the native species forcing them into extinction while others produce allelopathic substances that clear off other species around them. Several control measures have been used mostly chemical but have not actually give the desired results instead more problems were created such as environment and human contamination, development of resistance, resurgence and high cost of procurement. Biological control has been effective on many occasions though its result is slow, costly in short- run but cost effective and self perpetuating at long-run. It has been used against alien species in several countries of the world including America, Australia, New Zealand, United Kingdom and South Africa in Africa continent. Though some countries in Africa have implemented programmes on biocontrol of several alien weed species, some including Nigeria have not fare well in this regard. This review intends to discuss biological control of Siam weed, *Chromolaena odorata* (L.) [Asteraceae: Euptoriae] and Water Hyacinth, *Eichhornia crassipes* (Mart.) Solmes in Nigeria, the progress made, the challenges, prospects and recommendations for further improvement.

Key words: Entomofauna, phytoflora, invasive, alien, allelopathic, species

INTRODUCTION

As a result of absolute and complete free movement of goods and humans across all borders of the world not mind their benefits has also in away permitted some species (particularly vertebrates, insects, pathogens and weeds) to take dominance outside their country of origins. These species are termed Invasive Alien Species. Coblentz (2002) defines an invasive species as one that has extensive recruitment into a population without human intervention. Stirton (1979) defines plant invaders as alien plants that invade and oust native vegetations, while Mack (1989) classifies any new entrant to a territory as an invader.

Corresponding Author: R.A. Adebayo, Department of Crop, Soil and Pest Management,
School of Agriculture and Agricultural Technology,
Federal University of Technology Akure, Ondo State, Nigeria

Invaders have also been referred to as exotics, colonisers, xenophytes, neophytes or simply weeds (Joshi, 2001; Coblentz, 2002). When these weed species colonised new areas they usually out compete the native species by spreading rapidly thereby reducing or completely changed the species diversity of the area (De Rouw, 1995; Norgrove, 2007). Invasive alien species are recognised as one of the greatest biological threats to our planet's environmental well being and negatively impacts on local ecosystems and the species of which they are composed (Wayne, 2004). Invasive species can, therefore, be said to be exotic, often colonising organisms that exhibit weedy behaviour. This behaviour seldom manifesting itself in their native environment, where they exist in competition or association with a complex of closely associated species (McFadyen, 1991). Natural movements of species into most areas are uncommon. Most exotics arrive in association with human activity: transport, agriculture, tourism, etc. (Coblentz, 1990; Di Castri, 1989) The transport of most organisms around the world has not been strictly controlled and has usually not required evidence that the organisms will not cause negative impacts in the areas where they were introduced in the past. Plant introductions have increased greatly in the last three decades, which will inevitably lead to increased weed problems after a time lag typically of 50 years (Hughes, 1995). Most exotics, once established are permanent. Eradication is possible in a few instances, but only at great expense and effort. Most others require control, which may be said to be successful when the plant no longer exceeds a threshold level determined by the objectives of the managers. Others may not be controllable by any practical means (Coblentz, 1990, 2002; Groves, 1989).

This review discussed biological control attempt of alien species, Siam weed, *Chromolaena odorata* (L.) [Asteraceae: Euphorbiae] and Water Hyacinth, *Eichhornia Crassipes* (Mart.) Solmes in Nigeria, the progress made, the challenges, prospects and recommendations for further improvement.

CHROMOLAENA ODORATA AND ITS IMPACT IN NIGERIA

Chromolaena odorata, a neotropical Asteraceae introduced to many parts of the tropics is considered to be one of the most aggressive invasive plants in tropical and sub-tropical areas (McFadyen, 1991; Witkowski and Wilson, 2001). In Western Africa the plant was accidentally introduced with forestry seeds in Nigeria in 1937 and was deliberately introduced to Ivory Coast in 1952 to control *Imperata* sp. following a recommendation by the famous botanist Auguste Chevalier. *Chromolaena odorata* (L.) King and Robinson were first reported in Nigeria in 1937, probably introduced through the importation of contaminated seeds of *Gmelina arborea* Roxb. to (Enugu) Nigeria from Sri Lanka and it has since spread to various parts of the southern states especially in the last two decades. In these areas, it is becoming a serious weed of plantation and arable agriculture (Ivens, 1974; Ogundola and Liasu, 2007). *Chromolaena odorata* is now widespread in the Southern parts of Nigeria, being present in more than 20 of the 36 states. The weed dominates by colonizing the forest margins, rangelands, plantations and arable crop farms (Osariyekemwen *et al.*, 2008). *C. odorata* continues its invasion through the South Western Nigeria with all the six States well infested. The impacts of *C. odorata* invasions have always been evaluated in terms of effect on agriculture though recently concerns have been raised about decline biodiversity resulting from its colonization. *C. odorata* achieved the dominance of its colony by introducing allelopathic compounds which smoother out other species. Several workers have reported crop losses as large as 70-85% due to competition by weeds (Parker and Fryer, 1975). Weeds cause economic losses both in terms of shortfalls from potential production

created by their presence and in terms of the costs of the input used in their control (Auld, 1969). In Nigeria, *C. odorata* is a weed in both arable and plantation crops thus making farming difficult for the poor resource farmers and consequently increasing the cost of production thereby making agriculture a non-profitable venture. Particularly affected are cocoa, oilpalm, coffee, rubber, maize and cassava fields. Other areas include abandoned fields, roadsides, riverbanks, cleared lands and forest margins. It is usually controlled by uprooting, slashing and burning, brushing or by use of herbicides such as Gramoxone, Atrazine and Glyphosate. *C. odorata* is also known to suppress other weeds and serves as an alternate host of *Aphis spiraecola* Patch, nymphs of the variegated grasshopper, *Zonocerus variegatus* and a breeding ground for the adults (Uyi and Aisagbonhi, 2009). Its potential as a fire hazard has been reported in Asia and the Pacific (Muniappan and Marutani, 1988), Thailand (Napompeth *et al.*, 1988) and in India (Ambika and Jayachandra, 1990). Spread of *C. odorata* has been implicated in recent extensive bush fires on plantation and abandoned farm lands in Nigeria. Farmers in South Western Nigeria spend much of their time and money on the control of the Siam weed (Personal Communication).

WATER HYACINTH, *EICHHORNIA CRASSIPES* (MART.) SOLMES AND ITS IMPACTS IN NIGERIA

Water hyacinth, *Eichhornia crassipes* (Mart.) an aquatic weed is an invasive species which has been reported in water bodies of several West African countries including Ghana, Benin, Togo, Cot' d'Ivoire, Cameroon and Nigeria inclusive. The floating water hyacinth is a tropical bulbous plant of the lily family, Pontederiaceae. A glabrous aquatic herb with submerged stem rooted in substrate. The family contains 21 species distributed into six genera and all of them are well suited to the tropical environment. Gopal and Sharma (1981) said water hyacinth is considered to be the most problematic aquatic plant in several parts of tropics and sub-tropics. Akinyemiju and Imevbore, 1990 reported that the weed entered Nigeria's lagoon system in 1984 while Ikusemiju (1985) reported that incursion of water hyacinth into the Nigerian coastal waters was first discovered in 1984. The source of this weed to Nigerian water has been traced to the Porto-Novo creek in Benin Republic through the Badagry creek in Nigeria that connects the two countries (Akinyemiju, 1987). He reported that the weed has found its ways into the riverine coastal creeks of Lagos, Ogun, Ondo and Delta States. The sporadic incursion of this weed has hindered navigation, fishing activities of the artisanal fisheries sector and altered the ecological balance of the aquatic systems of the affected areas (Balogun *et al.*, 1997). Work done in Kenya also reported that invasion of the weed has created socio-economic problem and health problems for lakeside residents along Lake Victoria's shoreline (Mailu, 2001). Problems associated with this massive infestation, among others, included obstruction of urban, rural and industrial water intake points, reduced fishing and hence fish exports, increase in human diseases and a reduced industrial output due to frequent interference with hydropower generation (Akinyemiju, 1987). They are devastating on Nigeria water ways, impacting negatively on socio-economics of the resident of the coastal lines. Dense mats of water hyacinth degrade rivers, wetlands and dams and limit their utilization.

CONTROL OF INVASIVE WEED SPECIES

Despite the progress made in weed science over the last 40 years, weeds remain one of the major constraints to agricultural production in developed and developing countries.

Losses caused by weeds in the developing world are still at least 15% annually (Labrada, 1992). Despite the real progress made in weed management, several weed species continue to interfere seriously with crops, reducing their yields and quality and farmers are still not aware of the basic elements of rational weed management. New weed control methods introduced in the developing world have been implemented in many cases without taking account of prevailing local weed flora, its composition and characteristics (Labrada, 1992). In several places, three to four years after these introductions new troublesome species still thrive, causing subsequent crop losses in affected areas. Since the invasion of *Chromolaena odorata* and *Eichhornia crassipes* in Nigeria several attempts at controlling them has been made. Some methods have however been so difficult and time consuming, manual weeding i.e., by hand and simple tool, may consume as much as 70% or more of the farmer's time and energy during the cropping season (Wrigley, 1969). They are usually controlled by uprooting, slashing and burning, brushing or by use of herbicides such as Gramoxone, Atrazine and Glyphosate. However, use of chemical has resulted in negative side effects on crop growth, applicator and the environment. Also, heavy herbicidal requirements and hilly terrain have posed major impediments to the use of chemical control (Mohammed and Nour, 1986). High costs also significantly reduce the suitability of this method. Chemical control is also rarely effective in the long term (Erasmus, 1988; Moore, 2002). The same method except manual or mechanical removal, floating booms to limit spread has also been used for the control of water hyacinth with the same resultant effects in Nigeria.

BIOLOGICAL CONTROL OF INVASIVE WEED SPECIES IN NIGERIA

Considering the enormous side effects of conventional control methods particularly chemical method, efforts are targeting towards more sustainable and self-perpetuating means of controlling the alien species. Biological control offers the most promising solution for *C. odorata* invasions amongst a range of beetles, flies, butterflies and moths, but research needs to be supported to identify the most efficient species to control this weed (Wise *et al.*, 2007). The first biological control programme for *C. odorata* in West Africa was when the leaf feeding moth *Pareuchaetes pseudoinsulata* Rego Barros and the seed feeding weevil *Apion brunneonigrum* Beguin-Billecocq were imported, bred and released in Ghana and Nigeria in the early 1970s but neither species established (Cock and Holloway, 1982; Uyi *et al.*, 2009). The release in Nigeria was carried out in palm plantation at the Nigerian Institute for Oil Palm Research (NIFOR), Benin, Nigeria. The failure of the bioagent to establish was not at the time known but experience and necessary materials needed were grossly inadequate. Recently, pupae of *Pareuchaetes pseudoinsulata* Rego Barros, a defoliating arthropod were recovered on the *Chromolaena* in Benin a source close to the release site of the early 1970s (Personal Communication). This has reawakened the hope of successful establishment of the moth in Nigeria.

In the sub region especially in West Africa, efforts were made at tackling menace of water hyacinth. This culminated in the formation of Joint Task Force on the control of the aquatic invasive water weeds. A regional project involving Benin, Mali, Niger and Nigeria, was started in October, 2000, for (1) providing training in methods of floating weed surveillance and in the rearing of the weevils *Neochetina* sp. and other natural enemies of Water Hyacinth; (2) the introduction of biological control agents in the country and the establishment of units for their rearing; (3) the creation of a database on the levels of infestation of aquatic weeds in the basin of Niger River and on the establishment, population levels and impact of the natural enemies released; (4) the organization of a network for

cooperation on the control of Water Hyacinth in the countries affected and (5) the formulation of a draft long-term project for further submission to donors (FAO, 1997). Biological control is probably the most important and essential for the long-term, sustainable control of water hyacinth. South Africa has done very well in this regard; they have implemented several control strategies against invasive weeds using bioagents including insects and pathogens.

In Nigeria, a phytophagous weevil, *Neochetina eichhornia* (Coleoptera: Curcutionidae) was released in Nigeria in 1994 and 1995 but the extent of its establishment was not known. Though some institutes still has the cultures of these weevils while scattered information are published occasionally on their biology and performance in the laboratory. Surveys carried out in South Western States indicated establishment of the weevils on the water hyacinth but are not effectively controlling the weed at the time and integrated management was advised (Adedire, Personal Communication). These alien species continue to spread and ravage our land every day, it is therefore reinstated that conducive environment be provided for high level research in biological control measures.

BIOLOGICAL CONTROL IN NIGERIA: PROGRESS, CHALLENGE, PROSPECTS

It has been proved beyond reasonable doubt that biocontrol is not only self-perpetuating but sustainable, economical at long run, feasible and environment friendly. The fact about Nigeria shows lagging in the effort to implementing this laudable method of controlling the invasive species. The challenges are numerous; it ranges from lack of government wills at implementing suitable policies, gross inadequate funds for pioneer researches, inadequate skilled/experienced scientists in the field of biocontrol and possibly mismanagement of meagre resources. The prospects are limitless opportunities provided all stake-holders are seriously pursuing the course. The invasive species judging from the successes achieved around the world could be curtailed to the areas of present invasion consider less of eradication.

CONCLUSION

In conclusion, considering the implications of allowing the invasive species to continue to colonize our land will not only put burden on the poor resource farmers which constitute more than 80% of population in the tropics and subtropics thus reducing agricultural production but will also negatively continue to impact on both entomofauna and phytoflora thereby greatly reducing our native resources. It is thus opined that every concerned institutions should hold up to their responsibilities at curbing the menace of the alien species invading our lands.

RECOMMENDATION

That government at all levels should encourage scientists through implementation of policies on Biocontrol, training and retraining to increase capacity in this field, collaborate with international organizations for more free flow of information on biocontrol, arrange conferences, seminars and workshops for indigenous scientists, create database to collect and collate the invasive alien species for proper management strategies.

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