# Distribution and Abundance of the Invasive Plant Species *Chromolaena odorata* L. in the Zamboanga Peninsula, Philippines

Lina T. Codilla and Ephrime B. Metillo

*Abstract*— **The ecology of the highly invasive plant species *C. odorata* is poorly studied in the Philippines in spite of the fact that it is hard to eradicate, a nuisance in plantations, and known to harm farm animals and decimate forage and native plant species. In order to determine the abundance and distribution of the species and its possible relationship with local ecological factors, we estimated in 75 transect lines the percentage cover of *C. odorata* and other plant species growing around it, and concurrently determined soil parameters (soil type, pH, total nitrogen, total phosphorus, total potassium, and % organic matter) in three Provinces of the Zamboanga Peninsula, Southern Philippines. Multivariate Canonical Correspondence Analysis (CCA) revealed no significant relationship between soil parameters and the abundance of *C. odorata* suggesting eurytopy to edaphic conditions. Peak abundance of *C. odorata* was associated with coconut, banana, mango, gemelina and mahogany plantation environments, and reduced abundance of native plant species. This study shows that *C. odorata* is highly adaptive and a potential threat to native plant biodiversity and agro-ecosystem sustainability, and that its distribution seems to be supported by plant monoculture system.**

*Index Terms*— ***Chromolaena odorata* L., invasive plants, biodiversity, multivariate analysis, community ecology.**

## I. Introduction

*Chromolaena odorata* (L.) King and Robinson 1987, a species of Asteraceae Family and known in English as Siam weed, is a perennial shrub, native to Central and South America [1]. Reported as one of the world's most invasive, it is considered to be a serious weed in central and western Africa, India, Australia, Pacific Islands, and Southeast Asia [2]. It is one of the most important invader species in the savanna biome in South Africa [3]. This species has a wide tolerance to various climates, having already invaded five continents including Asia, North and South America as well as North and South Africa [4]. It can quickly establish and expands rapidly at the onset of the rainy season [5] and smother plant crops, forestry and native vegetation [6], [7]. The geographical distribution of *C. odorata* is known to be limited to regions within 30° N and 30° S latitudes in areas with a rainfall of >200cm and where air temperature ranges from 20°C-37°C [8].

According to Awanyo [9], *C. odorata* is viewed as a major agricultural sustainability problem in many tropical countries. It was recognized as the most problematic weed in coconut plantations in Sri Lanka as early as 1944, and became a problem in rubber, palm oil, tea, coffee, cashew, teak and other plantation crops in Asia since then [10]. It is unpalatable and may cause death if ingested by domesticated animals [11]. Having displaced forage plant species, *C. odorata* threatens subsistence cattle farming in West Timor [12]. Through shading and allelopathy, *C. odorata* reduces vegetation heterogeneity in grasslands and forests [13]. The plant's ability to thrive in a wide variety of soils in the tropics, and its short juvenile stage, flowering in dry season, prolific seed production, and strong ability to resprout after burning during land preparation all contribute to its invasiveness [14], [15], [16].

Despite these background information, its distribution, abundance and impacts are least studied in the Philippines. Without a clear intervention program from the national government, local farmers are left to address a least understood weed infestation problem while trying to mitigate the adverse impact of chromolaena invasion on their livelihood. Hence, this study has two aims: the first is to determine the distribution and estimate the abundance of the species in the Zamboanga Peninsula of Mindanao, Southern Philippines, in order to come up with a baseline information about its level of invasion in the area; and the second is to utilize multivariate techniques to determine the possible relationship between selected soil parameters and other plant species with the abundance of *C. odorata*.

## II. Materials and Methods

### *A. Plant Collection and Identification, and Abundance Estimation*

This study was conducted on July-December 2010 (rainy season) at three Provinces of Zamboanga Peninsula, namely, Zamboanga del Sur, Zamboanga del Norte and Zamboanga Sibugay (Fig. 1). Eight to ten Municipalities per Province were randomly assigned as sampling sites. Three 10-m transect lines per site were laid parallel to the right side of main thoroughfares. A total of 75 transect lines were sampled in the three Provinces. Fresh samples and photographs of each plant species were taken for identification purposes. Taxonomic identification of plants followed the publications by Francis [17] and Madulid [18]. Percentage abundance of all plant species, including *C. odorata*, was computed as the length intercepted by each species within the 10-m transect

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line. Mean biomass (kg dry weight) per $m^{-2}$ of *C. odorata* was also estimated for each site by multiplying the average dry biomass per $m^2$ of the species in five randomly selected sites with the average area occupied by *C. odorata* at each site. Plant dry biomass was determined by oven-drying all uprooted *C. odorata* at the five selected sites. The location of each site was determined using a Garmin Nuvi 200 Global Positioning System.

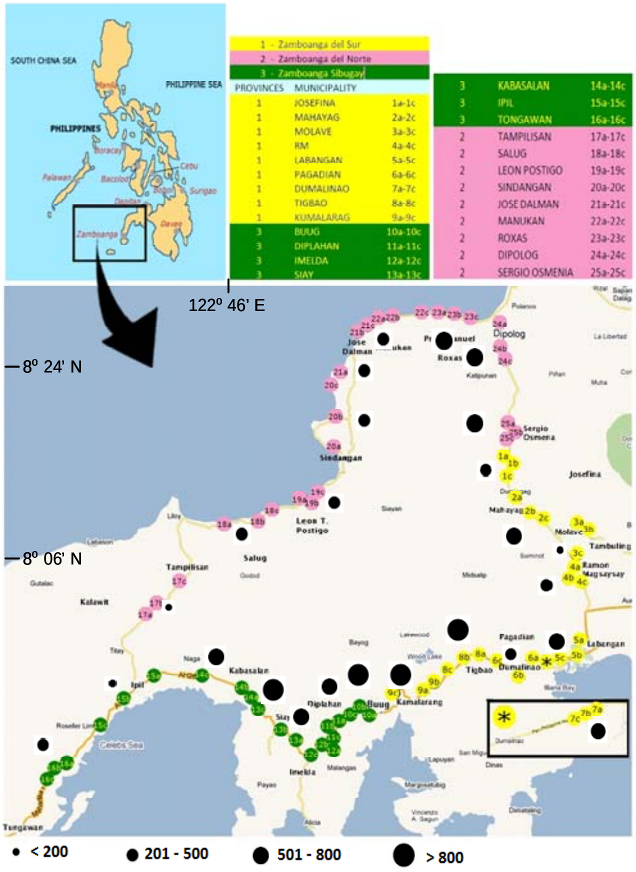


Fig. 1. Distribution and mean abundance (black dots in kg dry weight· $m^{-2}$) of *C. odorota* in the Zamboanga Peninsula. Inset is the map of the Philippines with the Peninsula enclosed in a rectangle. Sampling sites (numbered circles) 1-9, 10-17, 17-24, are parts of Zamboanga del Sur, Zamboanga Sibugay, and Zamboanga del Norte Provinces, respectively.

### B. Soil Parameters

From a sampling site, 100g of soil sample was collected, air-dried and stored in clean plastics bags. All samples were immediately brought to the soil laboratory of the Department of Agriculture, Regional Office, Zamboanga City for the analysis of pH; organic matter content; total N, P, and K; and soil type.

### C. Multivariate Analysis

The gradient length of the species-abundance data was derived using Detrended Correspondence Analysis (DCA), and if a longer gradient length (>4) was obtained, the relationship between square root-transformed environmental and % species-abundance data was analyzed using the constrained nonlinear ordination Canonical Correspondence Analysis (CCA) available in the software CANOCO version 4.5 [19]. Monte Carlo simulation was used to test for the statistical significance of the relationship, and stepwise multiple regression (Forward Selection) was used to identify statistically significant environmental variables [19]. Tukey's Honestly Significant Difference (HSD) test was used to compare means between soil parameters.

## III. Results

*Chromolaena odorata* was found in open well-drained ground like dry and exposed slopes, roadway gullies, and in abandoned fields and pastures throughout the Zamboanga Peninsula. Essentially all sites have already been invaded with *C. odorata*, and the area occupied by the species at these sites ranged from 680 to 9325 $m^2$. The average density we recorded was 10-15 mature shrubs $m^{-2}$. Our mean dry weight biomass estimate ranged from 175.44 - 2405.85 kg · $m^{-2}$ with largest colonies found in Southern sites (Fig. 1). Thirty six plant species were recorded as associates of *C. odorata* (Table 1). Except for very tall species like coconuts and plantation trees, other plant species associates had very low percentage abundance (e.g., shrubs had percentage cover of < 3%).

Soil characteristics varied between sampling areas (Table 2). Loam soil type was common in all sites. Mean soil pH in the sampling sites was acidic which ranged from 5.41 - 6.30. Mean organic matter was fairly low (0.9 - 1.62%). Total nitrogen was within the range of 0.05 - 0.80 ppm. Total phosphorus was lowest in Zamboanga Sibugay and total potassium was lowest in Zamboanga del Norte.

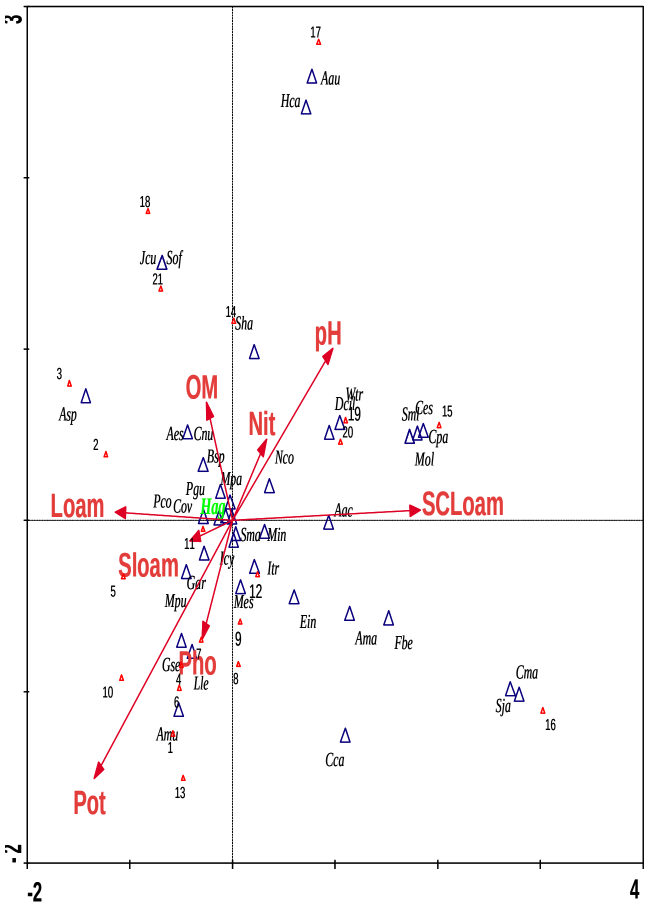


Fig. 2. Canonical Correspondence Analysis (CCA) triplot showing the relationship between selected soil parameters (arrows) and % abundance of *C. odorota* (Hag) and associated plant species. Small triangles represent sampling sites. Big triangles represent plant species (see Table 1 for species codes). Soil parameters: pH, organic matter (OM), nitrogen (Nit), phosphorus (Pho), potassium (Pot), soil types: loam (Loam), sandy-loam (Sloam), sandy-clay-loam (SCLoam).

TABLE I: MEAN PERCENT ABUNDANCE (±SD, N = 7) OF PLANT SPECIES THAT GROW WITH *C. ODORATA* AT DIFFERENT SAMPLING AREAS IN ZAMBOANGA PENINSULA. CODES FOR EACH SPECIES ARE USED IN THE MULTIVARIATE CANONICAL CORRESPONDENCE ANALYSIS.

| Species | Common Name | Code | Zamboanga Sibugay | Zamboanga del Sur | Zamboanga del Norte |
|---|---|---|---|---|---|
| *Acacia auriculaeformi* L. | acacia tree | Aau | 0.00 | 0.00 | 0.95 ± 2.52 |
| *Andropogon aciculatus* Retz. | love Grass/amorsiko | Aac | 0.00 | 0.71 ± 1.89 | 0.71 ± 1.31 |
| *Athyrium esculentum* Retz. | fern | Aes | 0.00 | 0.48 ± 1.26 | 0.72 ± 0.89 |
| *Alocasia macrorrhiza* L. | elephant ear/badiang | Ama | 0.00 | 0.48 ± 1.26 | 0.14 ± 0.38 |
| *Annona muricata* L. | guyabano | Amu | 0.48 ± 1.26 | 0.00 | 0.00 |
| *Amaranthus spinosus* L. | kulitis | Asp | 0.48 ± 1.26 | 0.00 | 0.00 |
| *Bambusa spinosa* Roxb | bamboo | Bsp | 0.00 | 1.90 ± 3.39 | 0.95 ± 2.52 |
| *Chrysophyllum caninito* L. | star apple | Cca | 0.00 | 0.95 ± 2.52 | 0.00 |
| *Colocasia esculenta* L. | gabi | Ces | 0.00 | 0.00 | 0.24 ± 0.63 |
| *Citrus maxima* Merr. | pomelo | Cma | 0.00 | 0.00 | 0.95 ± 2.52 |
| *Cocos nucifera* L. | coconut | Cnu | 9.90 ± 4.72 | 9.04 ± 9.51 | 9.29 ± 9.13 |
| *Carica papaya* L. | papaya | Cpa | 0.00 | 0.00 | 0.95 ± 2.52 |
| *Digitaria ciliaris* Retz. | crabgrass | Dci | 0.00 | 0.00 | 0.24 ± 0.63 |
| *Eleusine indica* L. | yardgrass/palagtiki | Ein | 0.00 | 1.19 ± 1.59 | 0.95 ± 1.89 |
| *Ficus benjamina* L. | balete | Fbe | 0.24 ± 0.63 | 0.00 | 0.95 ± 2.52 |
| *Gmelina arborea* Roxb. | gemilina tree | Gar | 10.39 ± 4.61 | 8.09 ± 4.23 | 2.95 ± 3.85 |
| *Gliricidia sepium* Jacq. | madre de cacao | Gse | 2.05 ± 2.13 | 3.10 ± 3.52 | 0.00 |
| *Hyptis capitata* Jacq. | knobweek/butones | Hca | 0.00 | 0.00 | 0.24 ± 0.63 |
| *Imperata cylindrica* L. | cogon grass | Icy | 1.91 ± 2.24 | 5.47 ± 4.68 | 3.09 ± 4.35 |
| *Ipomoea triloba* L. | kamu-kamote | Itr | 0.00 | 0.48 ± 1.26 | 0.00 |
| *Jatropha curcas* L. | tuba-tuba | Jcu | 0.00 | 0.00 | 0.14 ± 0.38 |
| *Leucaena leucocephala* L. | ipil-ipil | Lle | 1.67 ± 2.15 | 2.86 ± 1.58 | 0.00 |
| *Manihot esculenta* Crantz | cassava | Mes | 1.19 ± 2.49 | 0.00 | 0.48 ± 1.26 |
| *Mangifera indica* L. | mango tree | Min | 0.86 ± 1.86 | 2.86 ± 2.84 | 2.38 ± 3.83 |
| *Moringa oleifera* | malungay | Mol | 0.00 | 0.00 | 0.48 ± 1.26 |
| *Musa paradisiacal* | banana | Mpa | 3.57 ± 2.62 | 6.67 ± 3.47 | 7.63 ± 5.09 |
| *Mimosa pudica* L. | makahiya grass | Mpu | 0.24 ± 0.63 | 0.48 ± 1.26 | 0.00 |
| *Nephrolepis cordifolia* L. | sword fern | Nco | 0.00 | 0.48 ± 1.26 | 0.48 ± 1.26 |
| *Paspalum conjugatum* | carabao grass | Pco | 6.43 ± 5.04 | 3.57 ± 3.90 | 3.09 ± 3.25 |
| *Psidium guajava* L. | guava | Pgu | 0.62 ± 1.25 | 0.71 ± 1.31 | 0.48 ± 1.26 |
| *Sorghum halepense* L. | batad-batadan | Sha | 0.00 | 1.67 ± 4.42 | 4.29 ± 4.07 |
| *Stachytarpheta jamaicensis* L. | bastard vervain | Sja | 0.00 | 0.00 | 0.48 ± 1.26 |
| *Swietenia mahagoni* L. | mahogany tree | Sma | 4.05 ± 4.51 | 4.53 ± 3.15 | 5.24 ± 7.17 |
| *Syzygium malaccense* L. | tambis | Sml | 0.00 | 0.00 | 0.24 ± 0.63 |
| *Saccharum officinarum* L. | sugarcane | Sof | 0.00 | 0.00 | 0.14 ± 0.38 |
| *Wedelia trilobata* L. | yellow dots | Wtr | 0.00 | 1.67 ± 3.19 | 3.33 ± 8.81 |
| *Chromolaena odorata* L. | hagonoy | Hag | 54.29 ± 6.86 | 39.3 ± 11.02 | 46.60 ± 15.35 |

TABLE II. MEAN SOIL PARAMETERS (± SD, N = 7) AND SOIL TYPE AT THREE SAMPLING SITES IN THE ZAMBOANGA PENINSULA. VALUES WITH THE SAME SUPERSCRIPT LETTERS ARE NOT SIGNIFICANTLY DIFFERENT (TUKEY'S TEST, $p > 0.05$).

| Soil Factors | Zamboanga Sibugay | Zamboanga del Sur | Zamboanga del Norte |
|---|---|---|---|
| pH | $5.41^a \pm 0.13$ | $5.25^a \pm 0.19$ | $6.30^b \pm 0.20$ |
| organic matter (%) | $1.62^a \pm 0.16$ | $0.90^b \pm 0.06$ | $1.50^a \pm 0.17$ |
| total nitrogen (ppm) | $0.08^a \pm 0.01$ | $0.05^b \pm 0.01$ | $0.08^a \pm 0.01$ |
| total phosphorus (ppm) | trace | 10.14 ± 0.43 | 0.23 ± 0.04 |
| total potassium (ppm) | $500^a \pm 29.30$ | $425^b \pm 29.66$ | $250^c \pm 29.33$ |
| soil type | loam | sandy-loam | sandy-clay-loam |

The gradient length output by DCA was 4.1, and this prompted the use of the constrained CCA. No significant relationship between soil parameters and vegetation with both first ($F = 1.46$, $p > 0.57$) and all canonical axes ($F = 1.08$, $p > 0.25$) were generated by CCA. These results suggest that *C. odorata* has no specific preference for soil parameters and types. The CCA triplot further shows that the species tends to be of maximal abundance in the presence of plantation species, including: *Musa paradisiaca* (banana), *Cocos nucifera* (coconut), S*wietenia mahagoni* (mahogany tree), *Mangifera indica (mango)*, and *Gmelina arborea* (gemilina) (Fig. 2).

## IV. Discussion

The heavy infestation of *C. odorata* in various areas of Zamboanga Peninsula seems to be favored by an acidic soil and the range of soil parameters measured in this study. Soil pH is not a limiting factor in the germination and growth of *C. odorata* because it can grow in a wide range of pH, between 4 to 8, and is adapted to a wide range of soil conditions which is a common characteristic for many weed species [10].

This study reveals that the unutilized lighted spaces in between plantation trees are mainly occupied by *C. odorata* supporting the findings that this species preferred open sunny habitats and was conspicuously absent in dense shady forests [20]. The high abundance in our sampling sites was not unexpected because sites had ideal exposure to sunlight which is needed for germination, seedling growth, flowering and fruiting of the species. Thus, open spaces in plantations may need to be planted with shade-adapted high value crops (e.g. cacao and coffee) to preclude invasion of *C. odorata*.

Abundance and successful invasion is most likely influenced by the biology of the species (e.g., the allelopathic ability and rapid reproduction and growth of *C. odorata*) rather than by local edaphic conditions. Highly invasive plant species combine reproductive, competitive and dispersal traits [21]. The highly invasive *C. odorata* grows aggressively and, suppresses other vegetation by easily forming a thick cover at a short time [22], and accumulates soil-borne fungi that act as pathogens on native plants [23]. The robustness of the species was demonstrated by its rapid regrowth at the onset of rainy season following a moderate El Niño in February to May 2010 where most *C. odorata* were found to be wilting in several areas of the Zamboanga Peninsula.

The maximum estimated abundance of mature *C. odorata* individuals (15 $m^{-2}$ or 1.5 x $10^4$ $ha^{-1}$) in this study may be rated low compared to those reported in Ghana (15 - 173 x $10^4$ $ha^{-1}$ [9]). Nonetheless, such level of abundance already has a corresponding cost to farm owners who regularly remove the weed from their farms. On average, a farm owner pays about US$5 (August 2011 exchange rate: PhP42.00 to US$1.00) per 500 $m^2$ per day per laborer to slash the weed out from their farms. The cost doubles if uprooting individual weed is involved. Subsistence farmers usually cannot afford to hire laborers, so productive farming time is lost to weeding *C. odorata*.

In conclusion, this study has shown that *C. odorata* has infested the three Provinces of the Zamboanga Peninsula because its life history is supported by soil and climatic properties of the area, and the occurrence of plantation species. The invasiveness of *C. odorata* may be attributed to the production of large quantities of propagules and its capability to suppress the native vegetation. Apart from incorporating weed management in farming systems, total harvesting and exploiting positive attributes (e.g. bioactive compounds [24], fallow plant for acidic soils [25]) of the species may be best immediate management options.

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## References

[1] M. P. Mgobozi, M. J. Somers, and A. S. Dippenaar-Schoeman, "Spider responses to alien plant invasion: the effect of short- and long-term Chromolaena odorata invasion and management," Journal of Applied Ecology, vol. 45, no. 4, pp. 1189-1197, August 2008.

[2] R. C. McFadyen, "Chromolaena in East Timor: history, extent and control. Chromolaena in the Asia-Pacific region," in Proc. of the 6th International Workshop on Biological Control and Management of Chromolaena, Cairns, Australia, 2003, pp. 8-10.

[3] D. M. Richardson, and B. W. van Wilgen, "Invasive alien plants in South Africa: how well do we understand the ecological impacts?" South African Journal of Science, vol. 100, no. 1&2, pp. 45-52, January/February 2004.

[4] D. J. Kriticos, T. Yonow, and R. E. McFadyen, "The potential distribution of Chromolaena odorata (Siam weed) in relation to climate," Weed Research, vol. 45, no. 4, pp. 246-254, August 2005.

[5] H. Lin, M. Cao, P. C. Stoy, and Y. Zhang, "Assessing self-organization of plant communities - a thermodynamic approach," Ecological Modelling, vol. 220, no. 6, pp. 784-790, March 2009.

[6] R. C. McFadyen, and B. Skarratt, "Potential distribution of Chromolaena odorata (siam weed) in Australia, Africa and Oceania," Agriculture, Ecosystems and Environment, vol. 59, no. 1-2, pp. 89-96, August 1996.

[7] I. A. W. Macdonald, "Alien trees, shrubs and creepers invading indigenous vegetation in the Hluhluwe–Umfolozi Reserve Complex in Natal," Bothalia, vol. 14, no. 3&4, pp. 949-959, September 1983.

[8] J. A. Timbilla, and H. Braimah, "Highlights from work done on Chromolaena odorata in Ghana," in Proc. of the Second International Workshop on Biological Control and Management of Chromolaena odorata, Bogor, Indonesia, 1991, pp. 105-112.

[9] L. Awanyo, "Dealing with weedy problem in agriculture: the role of three agricultural land use management practices in the Forest-Savanna Ecological Zone of Ghana," Area, vol. 40, no. 4, pp. 446-458, December 2008.

[10] S. H. S. Senarathne, and U. R. Sangakkara, Influence of environmental factors on seed germination and emergence of Chromolaena odorata in coconut plantations in Sri Lanka. In: Po-Yung Lai et al. (eds). Proc. of the Seventh International Workshop on Biological Control and Management of Chromolaena odorata and Mikania micrantha, Taiwan, pp. 7-13, 2007.

[11] E. D. Aterrado, and N. S. J. Bachiller, "Biological control of Chromolaena odorata: preliminary studies on the use of the gallforming fly Cecidochares connexa in the Philippines," in Proc. of the Fifth International Workshop on Biological Control and Management of Chromolaena odorata, Durban, South Africa, 2002, pp. 137-139.

[12] A. McWilliam, "A plague on your house? Some impacts of Chromolaena odorata on Timorese livelihoods," Human Ecology, vol. 28, no. 3, pp. 451-469, April 2000.

[13] M. J. Goodall, and P. J. K. Zachariades, "Managing Chromolaena odorata in subtropical grasslands in KwaZulu-Natal, South Africa," in Proc. of the Fifth International Workshop on Biological Control and Management of Chromolaena odorata, Durban, South Africa, 2002, pp. 120-127.

[14] J. Slaats, W. Van Der Heiden, C. Stockmann, M. Wessel, and B. Janssen, "Growth of the Chromolaena odorata fallow vegetation in semi-permanent food crop production systems in South-West Côte

d'Ivoire," Netherlands Journal of Agricultural Science, vol. 44, no. 3, 179–192, November 1996.
[15] E. T. F. Witkowski and M. Wilson, "Changes in density, biomass, seed production and soil seed banks of the nonnative invasive plant, Chromolaena odorata, along a 15 year chronosequence," Plant Ecology, vol. 152, no. 1, pp. 13–27, January 2001.
[16] A. de Rouw, "The invasion of Chromolaena odorata (L.) King and Robinson (ex Eupatorium odoratum), and competition with the native flora, in a rain forest zone, south-west Cote d'Ivoire," Journal of Biogeography, vol. 18, no. 1, pp. 13-23, January 1991.
[17] J. K. Francis, Chromolaena odorata (L.) King & H.E. Robins. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, 2003.
[18] D. Madulid, A Pictorial Encyclopedia of Philippine Ornamental Plants. Bookmark, 2000.
[19] C. J. F. ter Braak and P. Smilauer, CANOCO 4.5 reference manual and CanoDraw for windows user guide. Microcomputer Power, 2002.
[20] S. R. Ambika, "Effect of light quality and intensity on emergence, growth and reproduction in Chromolaena odorata," in Proc. of the Seventh International Workshop on Biological Control and Management of Chromolaena odorata and Mikania micrantha, Taiwan, 2006, pp. 14-17.
[21] C. Joshi, et al., "Indirect remote sensing of a cryptic forest understorey invasive species," Forest Ecology and Management, vol. 225, no. 1-3, pp. 245-256, April 2006.
[22] L. Awanyo, E. M. Attuah, and M. McCarron, "Rehabilitation of forest-savannas in Ghana: the impacts of land use, shade, and invasive species on tree recruitment," Applied Geography, vol. 31, no. 1, pp. 181-190, January 2011.
[23] S. Mangla, Inderjit, and R. M. Callaway, "Exotic invasive plant accumulates native soil pathogens which inhibit native soil pathogens which inhibit native plants," Journal of Ecology, vol. 96, no. 1, pp. 58-67, January 2008.
[24] L. T. Codilla and E. B. Metillo 2011, "Potential herbicidal properties of aqueous and alcohol crude extracts from leaves of Chromolaena odorata L.," in preparation.
[25] L. S. Koutika, and H. Rainey, "Chromolaena odorata in different ecosystems: weed or fallow plant?" Applied Ecology and Environmental Research, vol. 8, no. 2, pp. 131-142, 2010.

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