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Impact of *Chromolaena odorata* invasion on diversity, dry matter yield and soil mineral contents in pasture area

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Introduction

A major constraint to livestock production in tropical countries is the scarcity and fluctuating quantity and quality of year around forage supply. During the rainy season, tropical forage species grow at very fast rates, with forage yields often exceeding animal requirements. If not cut or fed to animals, during the dry season such forage becomes fibrous and lack of most essential nutrients required by animals. In densely populated country like Indonesia, lacks of forage supply are aggravated by the high conversion of grassland to cash crop and invasion of alien weeds into pasture area.

Since introduced to Indonesia in the turn of the twenty century, *Chromolaena odorata* invasion has transformed forest, grassland and savanna ecosystems. Its fast growing, highly competitive for nutrients and allelopathic traits making this weed can be forming a dense stand that reducing grazing area and lowering productivity of forage species. Its bitter tasting and high levels of nitrate (Sajise *et al*., 1974) making this plant to be avoided by livestock and increases its competitiveness in pasture area. In Maiwa pasture, during dry season, where the pasture has been heavily infested by *Chromolaena*, many livestock dies because of starvation.

Exotic species invasion and overgrazing can drive declines in biodiversity and grassland ecosystem functioning. Biodiversity is known to have a stabilizing effect on productivity through asynchrony between species. There is a lack of study concerning impact of *Chromolaena* invasion on vegetation and soil characteristics in pasture area. The present study examines the impact of *Chromolaena* invasion on diversity, dry matter yield of vegetation and soil mineral contents in pasture area.

Materials and Methods

Study site: The study was conducted during the peak of dry season (July 2014) and peak of wet season (March 2015) in Maiwa pasture, Enrekang regency South Sulawesi, Indonesia (3^{o}33'57" S, 119^{o}47'31"E) at about 1300 m above sea level. The climate of the area is tropical monsoon characterized by one rainy season (November to June) and one dry season (July to November). The annual average rainfall was 2426 mm with a daily average temperature of approximately 27.34^o C. The soil texture was clay loam.

Data collection: Most Maiwa pasture has been invaded by *Chromolaena odorata* with covering about 40% of the pasture area. In this study, 38 pairs of adjacent 2 x 2 m vegetation plots, viz. *Chromolaena* dominant/invaded plots and *Chromolaena* free plots (open areas), were sampled. In each vegetation type, one quadrat (1 x 1 m) was placed randomly and density, frequency, and dry matter yield of each species inside the quadrat were counted and calculated. Inside of each quadrat, soil samples were collected at the top soil depth 10 cm for soil analysis. The non invaded plots was chosen as to have as similar site conditions as possible to the invaded plot, which could be assumed with reasonable certainty due to the invaded plot being located in close proximity to the invaded plots (distance 2-3 m).

Methods used to calculate ecological indices: Richness was measured by the method of Margalef's index and Menchinick's Index richness, diversity used the method of Shannon-Weiner index and Simpsom's Diversity Index and evenness used the method of Pileau's Index of Evenness.

Statistical analysis: For determining the significance of paired treatment (invaded and non invaded), student's t test was used.

Results and Discussion

Biodiversity: Indices of richness, diversity and evenness are presented in Table 1.

Table 1. Number of species, richness, diversity and evenness index of plants in un-invaded and invaded areas.

Parameters	Un-invaded areas	Invaded areas	Percentage of increase
Total species	19.00	29.00	36.00
Margalef's Index Richness	0.83	1.22	46.00
Menchinick's Index Richness	0.23	0.33	43.00
Shannon–Wiener's Diversity Index	1.50	2.13	42.00
Simpsom's Diversity Index	0.21	0.29	0.38
Pileou Evenness Index	7.62	10.51	42.00

A total 29 species of plants, most of them were alien plants collected from the area during the study. All species of plants found in un-invaded areas also were found in invaded areas, however there were some species that only restricted in invaded areas. In contrast to widely reported, invasion of *Chromolaena* into pasture highly increased its richness and diversity index (Table 1).

The higher values of species richness and diversity index in invaded areas shows that plant communities in invaded areas are heterogeneous in nature and have more number of species than in non-invaded areas. Presence of some species (*Crotolaria juncea, Lantana camara, Melastoma malabathricum* and *Philantus niruri*) which found only in invaded areas certainly contributed to the high richness and diversity in invaded areas. Our findings are in acontrary to the report of Zachariades and Goodal (2002) that *Chromolaena* affects biodiversity through physical smothering, allelopathy and its high plant biomass. This might be due to differences in density of *Chromolaena* in both study. In our study, *Chromolaena* was not too dense and ample light still available for plants growing under the weed. Our field observation in the neighbor sites revealed that very rare of plants can grow under dense thicket of *Chromolaena* plant.

The higher plant number and diversity of invaded areas might be attributed to escaping plants from livestock trampling and defoliation because livestock have difficulty to graze among multi stemmed *Chromolaena* so that it rarely graze under the weed stand. Furthermore, the weeds that dominant under *Chromolaena* were apparently avoided by livestock because of their low palatability or thorny so they can escape herbivory. Those plants can escape the stress of grazing and may not weakened and their competitive and reproductive ability are not impaired. .

Dry matter yield: Dry matter yields of plants are presented in Table 2.

Table 2. Dry matter yield (kg/ha) of plants in un-invaded and invaded areas

Plants	**Un-invaded**	**Invaded**	**Total Percentage**
Grasses	375,0	118,5	493.5 54.90
Legumes	108.0	114.0	222.2 24.72
Weeds	18.5	164.8	183.3 20.39
Total	501.5	397.3	898.8
Percentage	55.80	44.20	

From Table 2 it can be seen that the most dominant plants was grasses, followed by legumes and weeds. The grasses was dominant in un-invaded areas, while legumes and especially weeds were dominant in invaded areas.

Enhanced growth legumes and weeds under invaded areas may be attributed to two factors. Besides by escaping from herbivory as mentioned above, it also due to their photosynthetic pathway. Legume and weed are include C3 photosynthetic pathway plants that fairly resistant to lower light intensity and lower temperature found under *Chromolaena* stand. Conversely, grasses are C_4 plants that grow best under higher light intensity and temperature found under open conditions.

In this study, the total dry matter of grasses and legumes in open and invaded areas was 483 and 232.5 kg/ha, respectively (Table 2). If it is assumed all grasses and legumes in this study are edible to animals and *Chromolaena* cover is 50%,, it indicated that *Chromolaena* invasion reduced available forage by 51.86%. This value is rather large and to use pasture area more effectively, the spread and growth of *Chromolaena* need be checked and controlled

Soil mineral contents: Soil mineral contents are presented in table 3.

Table 3. Soil mineral contents of un-invaded and invaded areas

Elements	Un-invaded	Invaded areas	Percent of increase
Organic Carbon (%)	2.51	2.33	- 7.17
Nitrogen (%)	0.14	0.19	35.71
C/N	18.00	12.00	- 22.22
P_2O_5 (ppm)	10.30	9.60	- 6.79
K (ppm)	0.22	0.24	9.09
Ca (cmol (+) kg^{-1}	5.33	5.32	- 0.18
Mg (cmol (+) kg^{-1}	3.54	3.65	31.07
K (cmol) (+) kg^{-1}	0.22	0.24	9.09
Na (cmol) (+) kg^{-1}	0.11	0.13	18.18

From the table 2, it can be seen that some minerals like N, K, Mg, K and Na were higher in invaded areas than in un-invaded areas. This observation was in agree with Tondoh *et al.* (2003) that soil fallowed to *Chromolaena* revealed a rise in total N (36.7%), and Mg (140.3%) in the first 10 cm of soil beneath the weed. The increase of N soil under *Chromolaena* stand might be associated with capability of the weed to fix atmospheric N with the help of free living fixer bacteria in the root surface and its rhizosphere soil, enabling it to live luxuriantly in the poor soils (Ambika, 2014).

Conclusion

In conclusion, although *Chromolaena* invasion reduced forage availability, it does not harm pasture ecosystem and even, it improves ecosystem functioning by increasing species number, richness, biodiversity and some soil mineral contents,

References

Ambika, S. R. 2014. Ecological adaptation of *Chromolaena odorata* (L.) King and H. Robinson. Department of Botany, Banglore University, India Available: www.ehes.cdu.edu/chromolaena/ proceedings/fourth/ambika 1 htm.

Sajise, P.E., P.E. Palis, N.V. Lales and J.S. Lales. 1974. Flowering behavior, pattern of growth and nitrate metabolism of *Chromolaena odorata*. *Phil.Weed Sci.Bull.* 1 : 17 – 24.

Tondoh, J.E., A.W. Kone, J.K N'Dri and D. Brune. 2003. *Changes in soil quality after subsequent of Chromolaena odorata fallowas in humis savannah*, Ivory Coast. Catena, 101 : 99 – 107.

Zachariades, C. and J. M. Goodal, 2002. Distribution, impact and management of *Chromolaena* odorata in Southern Africa. *Proceeding of the fifth International Workshop on Biological Control and Management of* Chromolaena odorata, Durban, South Africa. 23 – 25 Oct, 2001. Zachariades, C., R. Muniappan and L.W. Strathie (eds). APR – PRRI (2002), pp. 34 – 39.