The Ecological Characterization of Kongwa Weed (*Astripomoea hyoscyamoides)* in Kongwa district

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Abstract
Kongwa weed (Astripomoea hyoscyamoides) is a noxious weed that is known to reduce the productivity of both livestock and crops in the semi-arid areas of central Tanzania. Despite the known negative effects of the weed, its ecological characteristics is less documented. The current study characterized the ecological features of the weed in relation to land use and soil properties. The study used range inventory approach to assess influence of land use types and soil textural classes on abundance and growth of kongwa weed. Results revealed that Kongwa weed was significantly higher in grazing land compared to other land uses which was attributed to the effect of heavy grazing. The low species diversity and evenness in the grazing land was also associated to the dominance of Kongwa weed. On the other hand, low abundance of weed in bush land was attributed to limited light intensity as result of increased woody canopy. It was found that Kongwa weed preferred acidic soils (with the pH of 5.35 recorded from grazing land) that are compacted (with bulk density of 1.57g/100m3) and composed of low organic matter/carbon (0.93% recorded from grazing land). Nevertheless, low growth rate of weed in clay soil could probably due the notable high bulky density that lower infiltration rate. The study recommended further research to investigate effect of grazing

management and fertilization on growth and dominance of Kongwa weed under different soil types.

Key words: *ecological features, grazing pressure; land uses, Kongwa weed; soil properties*

Introduction

Kongwa weed (*Astripomoea hyoscyamoides Vatke verdc*) is one of the noxious species in the Convolvulaceae family commonly known to have direct effects on native plants by becoming either monopolisers or suppressors of palatable vegetation resources (Richardson et al. 2000). The displacement of native plant species by non-native plant species in their ecological habitats, contribute significantly to loss of crop and pasture yield hence accelerates economic losses to pastoralists and agro-pastoralists (Pimentel et al. 2002). Severe loss of agricultural and livestock production associated with the effect of the noxious weeds have been documented in various parts of the world (Borokini and Babalola. 2012).

About 90% of livestock production in Tanzania depends on rangelands characterized by inadequate and low quality of the natural pastures attributed by many factors including weed infestation (Mwilawa et al. 2008). Inadequate and low quality forage in many rangelands is due to replacement of desirable forages by undesirable plant species which subsequently lead to poor animal growth and productivity (Nkombe et al. 2018). For example, 10% of stocking density of cattle in Kongwa ranch has been reported to decrease yearly due to inadequate pastures mainly due to Kongwa weed infestation (Nkullo. 2013). Likewise, Kongwa weed affects grazing distribution in the grazing lands

because the livestock tends to ignore areas with a high abundance of unpalatable species like Kongwa weed. The previous study showed that 75% of livelihoods of farmers in Kongwa district have been negatively affected by infestation of Kongwa weed putting the desirable forages and crops at a competitive disadvantage and finally causing a huge reduction on natural and crop yield that is supporting the population of agro-pastoralists in Kongwa district (Nkombe et al. 2018).

Although, it has been reported that, the Kongwa weed covers more than 70% of the area of Kongwa ranch in the Kongwa District, little studies have been done on characterization of ecological features of this weed. Understanding ecological characteristics of Kongwa weed is pre-requisite step toward integrated management of this noxious weed. The current study, investigated the ecological characteristics of kongwa weeds subjected to different land use systems and soil types.

Methodology

Description of study area

The study was conducted in Kongwa district, a semi-arid central part of Tanzania. The district is located about 86 km east of Dodoma city of Tanzania. The study area receives unimodal rainfall distribution starting from December to April ranged from 500 mm to 800 mm per annum (Nkombe et al. 2018). The mean temperature is ranging from 20°C to 33°C (PORA and LGOVT. 2016). The major economic activities for the residents are subsistence farming and livestock keeping both of them are rainfall dependent. The current estimates of livestock population accessed from office of the District Council stand about 117,599 cattle, 73196 goats, 33896 sheep and 2680 donkeys. Other

animals including 3,744 dogs, 866 cats, 376,877 chickens and 5627 ducks. Three sites (Figure 1) were randomly selected for conducting field survey and research experiments includes Kongwa ranch (06.08075S and 36.44792E), Sejeli (06.05134S and 36.31467E), Ngomai (06.91317S and 36.57979E) (Fig 3.1).

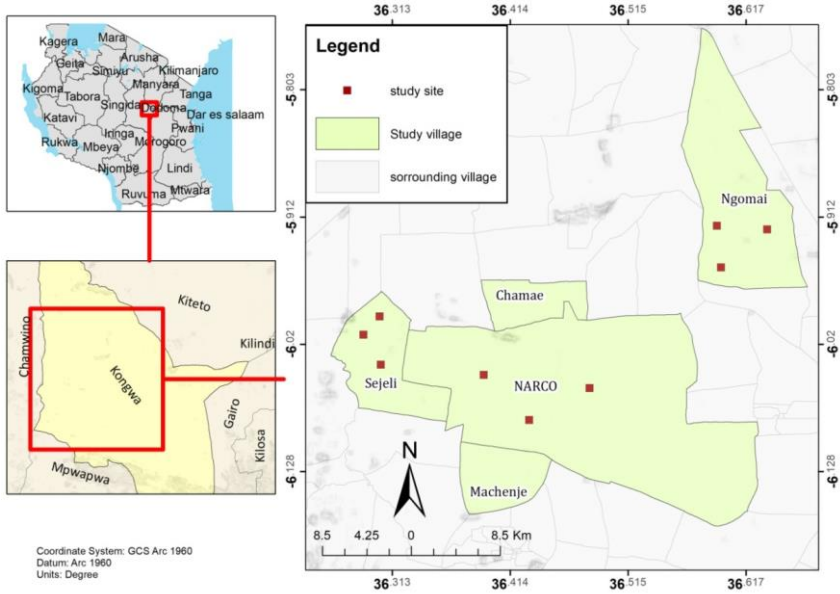


Fig1: Map showing the study sites in Kongwa district.

Research Design and Data Collection

Field survey using standard procedure of range inventory was conducted to determine the abundance of kongwa weed in relation to land use types and soil texture. Three land use types were identified namely; grazing land, crop land and bush land. The line intercept method was used to assess vegetation composition and coverage in each land use types. Three parallel line transects were established at 60 m apart started at 20 m away from the edge of each land use type to minimize edge effects. Twelve (12) stations

of 10 m were established at every 20 m to make a total of 36 sampling units for each land-use type. Tape measure stretched out along the transect lines and the point where a vertical projection of the edge of the crown or base of a plant intercepts the tape-recorded in centimetres. A quadrat of 1 m × 1 m was used as a sampling unit for determining species frequency of occurrence, abundance, and density of Kongwa weeds on the three land-use types. Each quadrat was placed at 5 m intervals along the line transect making a total of 108 quadrats for each land-use type. Plant species within a quadrat were individually identified, counted, and recorded. Plant species identification performed through guide book of weeds of East Africa, Guide to the naturalized and invasive plants of Eastern Africa, and the Natural Forestry Resources Monitoring and Assessment of Tanzania (Vesa *et al.* 2010). The samples of unidentified plant species were taken to the Sokoine University of Agriculture for identification by botanists.

The species diversity was determined using Shannon-Wiener's diversity index (H′) = - $\sum$ (ni/N) ×Ln (ni/N) N. Where, ni = is the number of individuals of each species, N = is the total number of individuals (or amount) for the site, Ln = is the natural logarithm of the number. Species richness (S) was calculated as the total number of species per quadrat. While evenness was also calculated as (J) = H'/In (H_{max}), Where H′ is Shannon-Wiener's diversity index for the quadrat and H_{max} is the natural log of species richness.

Data analysis

The R software program version 3.3.4 (R Core Team, 2018) was used to calculate species diversity, richness, and evenness data.

Vegetation ground cover, frequency of occurrence by species and density of Kongwa weed were analyzed using the General Linear Model (GLM) procedure of the Statistical analysis System (SAS. 2013). The mode used in the inventory study was Responses (% cover, frequency of occurrence and diversity indices) = General Mean + Study Sites (two villages plus Kongwa Ranch) + Land Use Types (Grazing, crop and Bush land) + Random Error. Where for Soil Texture, the adopted model was; Responses (growth attributes) = General Mean + Soil Texture + Random Error.

Results and Discussion

Vegetation characteristics in the three land use types

The range inventory revealed that Kongwa weed was significantly higher in grazing land when compared to other land uses. Crop land and bush land were found to have less percentage coverage of Kongwa weed compared to other vegetation types (Table 3.1). Abundance of Kongwa weed in grazing land was associated to the effect of grazing pressure. According to Tang et al. (2020), grazing intensity increases spatial distribution of seeds on the ground. Movements of grazing animals facilitate distribution of Kongwa weed seeds through their hooves and fecal materials. On the other hand, less abundance of Kongwa weed in bush land was attributed to suppression of herbaceous vegetation by encroached woody species. Woody plants have ability to change the microclimate thereby modifying availability of resources to other species (Tang et al. (2020). Kongwa weed has less competitive ability for light, moisture and nutrients when compared to encroaching bushes.

Table 1: Vegetation cover and Abundance of Kongwa weed (*Astripomoea hyoscyamoides)* in three land use types

Vegetation	% Cover				
	Grazing	**Crop**	**Bush**	**SE±**	**P-Value**
Astripomoea hyoscyamoides	38.7[a]	1.9[b]	1.7[b]	8.8	0.04
Forage	19.5[a]	8.2[b]	10.3[a]	3.5	0.13
Forbs	1.1[a]	1.1[a]	1.7[a]	0.9	0.85
Other weeds	17.2[b]	30.8[a]	27.2[ab]	3.1	0.05
Litter	0.5[b]	0.0[b]	7.7[a]	1.3	0.01
Bare	16.4[c]	54.7[a]	26.9[b]	7.8	0.03
Tree/shrub canopy	6.7[b]	3.2[c]	24.5[a]	4.6	0.04
Total	100	100	100		

*Values with same letter within a row are not significantly different at 5%

The study also revealed that, the density of Kongwa weed was significant higher in the Kongwa ranch Kongwa when compared to surrounding villages. Increasing abundance of weed in the ranch could be attributed to high population of grazing animals in the ranch.

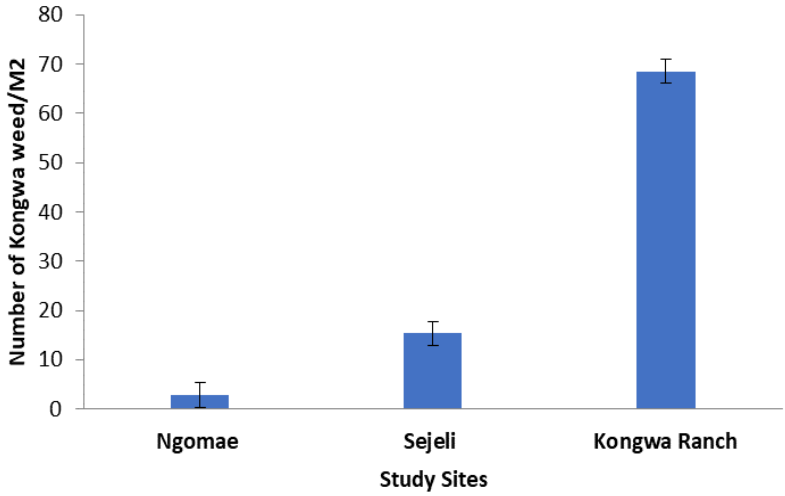


Figure 2: Abundance of Kongwa weed in three study sites

Influence of Kongwa weed on species composition

Figure 3 presented the abundance of the Kongwa weed in three different land use types. About 86 weed count per transect was recorded in Grazing land when compared to the average of 2.3 and 0.7 counts per transect recorded from crop and bush land respectively.

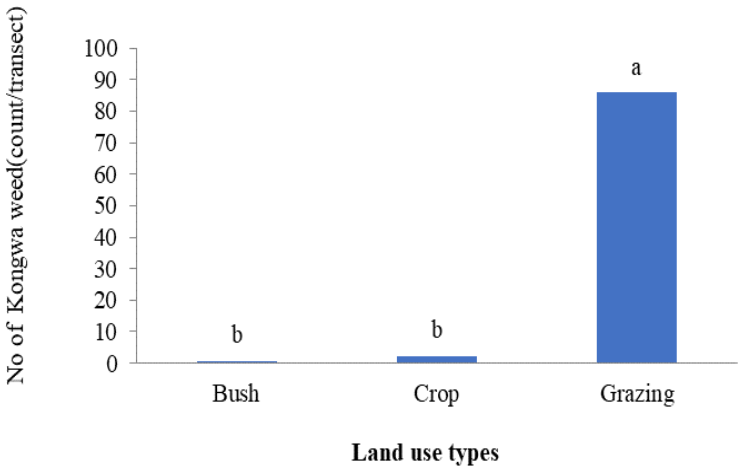


Figure 3: The abundance of the Kongwa Weed in three land use types

The dominance of Kongwa weed in the grazing land has negatively affect species diversity and evenness (Table 2). Significantly less Shannon Diversity index was recorded from Grazing land which implies high dominance of one of few species. According to Gurevitch et al. (2006) the dominance of particular species influences spatial and temporal variability of plant communities and compositional stability. It is therefore evident that, dominating of Kongwa weed in grazing land reduces significantly diversity of other species. Gurevitch et al. 2006, stated that, the dominance of one or few species the lower the diversity of the community tends to be.

Table 2: Species composition in different land use types

Parameters	Bush (n = 9)	Crop (n = 9)	Grazing (n = 9)	P-value
Shannon Diversity index	1.86 ± 0.34	2.17 ± 0.17	1.47 ± 0.74	0.066
Richness	10.89 ± 3.37	12.0 + 1.22	13.44 ± 2.88	0.20
Evenness	0.79 ± 0.10	0.87 ± 0.06	0.56 ± 0.26	0.004

Source: computed from field data, 2021

Effect of soil property on Kongwa weed

Soil property found to have direct effect on growth of Kongwa weed. Clay soil had significant low growth of Kongwa weed when compared to loamy and combination of sandy and loamy (Figure 4). Low growth of weed in clay soil could probably due to poor infiltration rate associated to compacted soil particles.

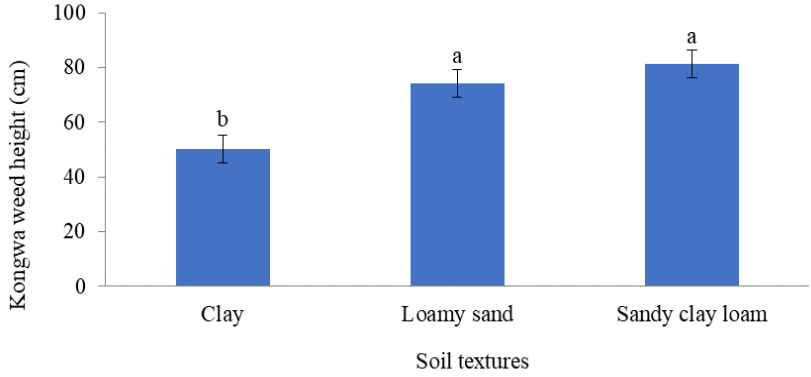
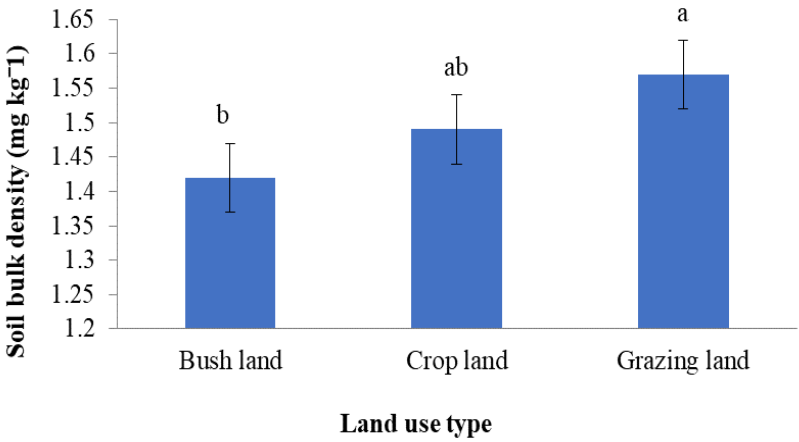


Figure 4: Effect of soil texture on Kongwa weeds height among three soil textures

Like other weeds, Kongwa weeds found to tolerate poor soil condition such as the high bulk density recorded from grazing

land (Figure 5). The abundance of Kongwa weed in grazing land is an indication of characteristics of invasive species that tolerate poor conditions and thrives in disturbed and marginalized land. Kaurajian (2021) reported that, abundance of the weed species are considered as immune response of the poor ecosystem.



Conclusion

The current study revealed that, land use types respond differently in terms of the distribution and intensity of kongwa weed infestation. In the context of land use types, grazing lands were noted to have significant abundance of kongwa weed which was associated to facilitated seed dispersal due to animals' movements. On the other hand, less abundance of kongwa weed in bush land was attributed to effect of low light interception due to extended crown coverage. The relatively lower species diversity in the areas that were highly encroached by kongwa weed is an indication dominance of the Kongwa weed which suppresses other species. Finally, the study revealed low growth of weed in the clay soil, which implies that soil with high concentration of clay is not favourable for kongwa weed. Therefore, the study recommended for further studies on chemical

composition of the kongwa weed, its allelopathic effects and its nutritional values if any.

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References

Borokini, T. I. and Babalola, F. D. (2012). Management of invasive plant species in Nigeria through economic exploitation: Lessons from other countries. Management of Biological Invasions 3: 45 – 55.

Gurevitch J. Scheiner S. M and Fox G. A. (2006). The Ecology of Plant (2nd ed.). Sinauer Association Inc. Massachusetts. 574 pp.

Kaurajian A. (2021). Weeds and Seeds: Building Wild Resilience through Ungardening. Pollinator, Gardening. https://www.pollinator-pathway.org/post/weeds-and-seeds-building-wild-resilience-through-ungardening.

Mwilawa, A. J., Komwihangilo, D.M. and Kusekwa, M. L.(2008). Conservation of forage resources for increasing livestock production in traditional forage reserves in Tanzania. African Journal of Ecology 46:85-89.

Nkombe, B., Sangeda, A., Sibuga, K., and Hermansen, J. (2018). Assessment of Farmers Perceptions on the Status of

Astripomoea hyoscyamoides (Kongwa Weed) Invasiveness in Central Tanzania. *Journal of Plant Sciences and Agricultural Research* 1(2: 11).

Nkullo.O.A, (2013). The role of Kongwa ranch to link smallholder beef producers to profitable market, Dissertation for ward of MSc degree at Van Hall Larenstein University of Applied Science, Wageningen. Netherlands. 62pp.

Pimentel, D., Lach, L., Zuniga, R. and Morrison, D. (2002). Environmental and economic costs associated with non-indigenous species in the United States. Biological Invasions. CRC, Boca Raton London 285-303.

Richardson, D.M., Pysek, P., Rejmánek, M., Barbour, M. G., Panetta, F. D. and West C. J. (2000). Naturalization and invasion of alien plants: Concepts and definitions. Diversity and Distributions 6: 93–107.

Tang, J., Busso, C. A., Jiang, D., Wang, Y., Wu, D., Musa, A. and Miao, C. (2016). Seed burial depth and soil water content affect seedling emergence and growth of Ulmuspumila var. sabulosa in the Horqin Sandy Land. Sustainability 8(1): 1- 68.

Vesa, L., Malimbwi, R., Tomppo, E., Zahabu, E., Maliondo, S., Chamuya, N., Nssoko, E., Otieno, J., Miceli, G. & Kaaya, A. 2010. NAFORMA Field Manual: biophysical survey. Dar es Salaam, Tanzania: Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism 96.