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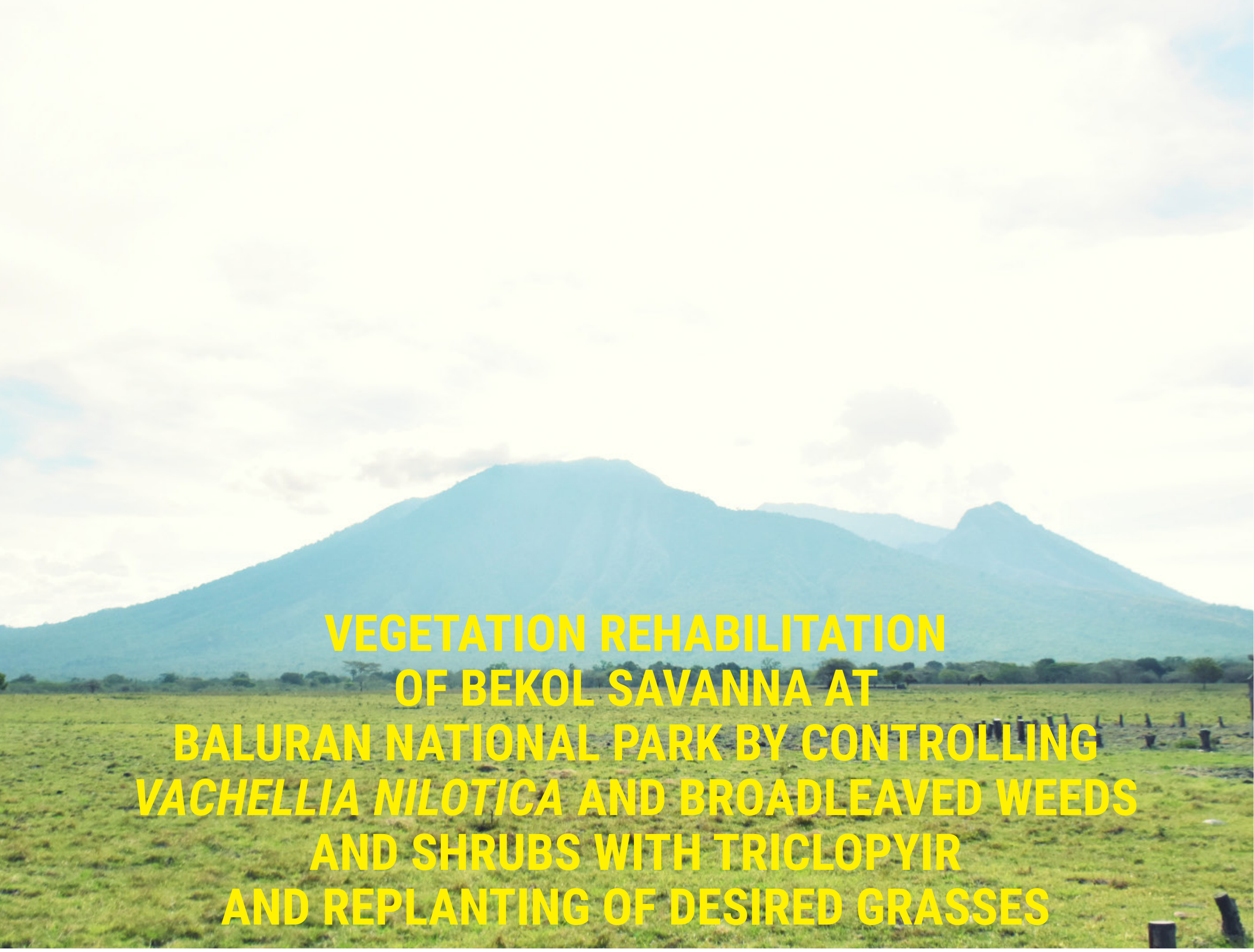

VEGETATION REHABILITATION OF BEKOL SAVANNA AT BALURAN NATIONAL PARK BY CONTROLLING *VACHELLIA NILOTICA* AND BROADLEAVED WEEDS AND SHRUBS WITH TRICLOPYIR AND REPLANTING OF DESIRED GRASSES

Soekisman Tjitrosemito[1*], Ragil Irianto[2], Garsetiarsih[2], Titiek Setyawati[2], Atok Subiyakto[2], Adi Susmianto[2]

[1]Affiliate Scientist, SEAMEO BIOTROP. Jalan Raya Tajur Km 6, Bogor

[2]Researcher at the Indonesia Forest Research and Innovation Center, Jln. Gunung Batu 5, Bogor

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***Corresponding author:**
s.tjitrosemito@biotrop.org

ABSTRACT

Research works were carried out from 2012 – 2015 to investigate the vegetation rehabilitation by controlling broadleaved shrubs, shrubs and trees of *Vachellia nilotica* (the reviewed name of *Acacia nilotica*) and planting desired grasses The treatments combined 3 factors. Factor 1, was the way to apply triclopyr formulated as GARLON 670 EC to control trees of *V. nilotica*, (1) by brushing the solution of 1% GARLON 670 EC dissolved in diesel oil on the stump of *V. nilotica* after cutting using a chainsaw, and by (2) Brushing 1% solution of GARLON 670 EC at the base of intact standing tree of *V. nilotica*, from above the ground up to 30 cm height. Factor 2, was grasses (1) *Dichanthium caricosum*, and (2) *Polytrias amaura* planted ad 1 x 1 m^2. Factor 3 was fertilization on, (1) planted grasses were fertilized with compost derived from goat feces at 100 gr/ single chunk planted, and (2) without fertilizer. The results indicated that grass grew better under the treatment of killing *V. nilotica* by cutting and brushing with 1% GARLON 670 EC dissolved in diesel oil, while fertilizing *D. caricosum* was much better to than of *P. amaura*.

INTRODUCTION

The ecosystems of Bekol savanna and other savanna in Baluran National Park rest on a long dry season with a limited water supply during the wet season; this monsoonal area supports the growth of grasses with small trees here and there to form savanna ecosystems. The ecosystem constitutes its foodweb with its main herbivores are banteng (*Bos javanicus*), beside deers, buffaloes, jungle fowl and peacocks, with their carnivors of wild dog and previously also extinc javan tiger. During the colonial time the area was kept as a prestine ecosystem; in the wetter surrounding area they established teak forest plantation with a high quality teak timber production. After independence the teak forest plantation was managed by PERHUTANI, the estate forest plantation. Savannas in Baluran National Park (especially Bekol savanna) undergoes regular fire annually. The management of PERHUTANI, looking at a huge teak leaves litter deposited in the teak forest floor, worried that those biomass fuel will be ignited by the enchroaching savanna fires. It may create a fire disaster in the teak forest plantation. Apprehasive about the possibility of disaster, in 1969 the manager of nearby PERHUTANI decided to plant *V. nilotica* as a fire break about 2 km along the fench separating the teak forest plantation from Bekol savanna (Alikodra,1987). During this writing there was a heated discussion about the origin of the *V. nilotica* seeds planted along that fench. Some workers claimed that they were involved in planting of *V. nilotica* and admited they picked up pods from neaby areas. However they did not know who brought the original *V. nilotica* seed to the areas.

V. nilotica (syn. *Acacia arabica*), was imported from India in the 19th century studied in Bogor Botanical Garden for a possibility of producing "gum" (arabic acid) a product which was valued expensively at that time. It was common in the world to market *Acacia* gums collected from many kinds of *Acacia* , therefore, the quality varied considerably. The colonial botanists must have expected that *A. arabica* would produce a good quantity of arabic gum. The research indicated that *A. arabica* grew well, but produced only a small amount of low quality gum, and the experimental works were soon terminated. The colonial botanists must have thought that *V. nilotica* was a good plant and never thought of invasive whatsoever, and some of the seeds were sent to Palu (Central Sulawesi) some to Bali and some to Timor. Later on it was shown in the literature that *Acacia* producing a good quality of arabic gum was *Acacia senegalensis* not *V. arabica* (syn. *Acacia nilotica*).

The *V. nilotica* fench as a fire brake worked well, preventing fire from enchroaching the teak forest plantation, and it found suitable environment, plenty of sunshine supporting its rapid growth and proliferation. It also enjoyes a symbiotic relationship with local herbivores to spread its seeds all over the place in the park to become terribly invasive. During the dry season when soil moisture went down really low, and air temperature soared high almost all vegetation were dried out, and those herbivores suffered from lack of herbage and under full stress of thirsty. In this condition riped, matured pods of *V. nilotica* were shed, and dropped on the savanna floor. The wondering hungered and thirsty herbivores found those pods palatable and they eat gregariously to quench their hunger and thirst. Those pods turned out to be nutricious, containing high fat and protein. The pods were digested well, however most the the seeds were undamaged after going through herbivores digestive tract, and were excreted intact in the feces of those herbivores. The seeds even enjoyed a good moist and fertile growing media supporting their successful germination. This perfect symbiotic relationship indeed supports a rapid distribution of *V. nilotica* in the park, forming a dense canopy of *V. nilotica*, shading the grasses out.

In 1980's a little bit more than 10 years after fench planting, the rapid expansion of *V. nilotica* drew an attention of the park manager to control it. The approach was to cut the stem manually and burnt the plant biomass. The stum, instead of dying, coppiced profously changing the single stem into multistem *V. nilotica* plant creating a thick canopy preventing a greater proportion of light penetration. The reduction of light penetration reduced the growth of *Dichantium caricosum*, a highly preffered grass by herbivors, and competed out by *Brachiaria reptans, Sclerachne punctata* in some areas also Oplimenus compositu, shade tolerant grasses. The situation become worse, because this low light intensity also preferred broadleaved weeds to come (Germer, 2003), such as *Achiranthes aspera, Bidens biternata Hyptis suaveolens, Eleutherantera ruderalis, Flemengia lineata, Ocimum canum, Thespesia lampas, Vernonea cymosa,* etc. It seemed the approach was inappropriate. Chemical control using 2,4-D, triclopyr and glyphosate were also tried unsuccessfully, due to a limited knowledge on herbicidal mode of actions and applications. The mechanical control using bulldozer to uproot *V. nilotica* proved to be successful. About 125 ha savanna in the Bekol was cleared of standing *V. nilotica* trees, and become a site for visitors to watch inhabiting fauna sepecially banteng. However it could not recover *D. caricosum*, and worse the cleared savanna was now dominated by those broadleaved weeds especially *T. lampas, V. cymosa*, and *F. lineata*.

Those above descriptions were a rough picture of Savanna in Baluran National Park. A recent vegetation map (Setiabudi et al., 2013) indicated that there were at least 7 different degree of *V. nilotica* invasions from a full *V. nilotica* canopy coverage to sparse *V. nilotica* distribution, covering a total area of more than 6000 ha. Under those different degree of invasions there were a wide variation of vegetation composition, from only small grasses and other vegetation, followed by a dense herbs or shrubs with a thin shade tolerant grasses, and to sparse *V. nilotica* distribution, with a perrenial grass *D. caricosum* was still dominant producing excellent herbage. So there were at least 3 problems that must be overcome to rehabilitate those savanna: (1) to eradicate or control *V. nilotica*, (2) To eradicate or control herbs and shrubs to facilitate the recovery of grasses, and (3) to replant grasses where they were absent or at much lower composition than herbs and shrubs. This experiment was aimed at rehabilitating savanna vegetation at Bekol.

Recent Fidings

From the recent vegetation map developed by Setiabudi et al. (2013), a greater part of *V. nilotica* invasions was followed by the growth of herbs and shrubs underneath. A smaller portion of *V. nilotica* invasion with full canopy of *V. nilotica* created almost bare without vegetation was inadvertently induced by unsuccessful control of *V. nilotica* which allowed the stump to sprout 6-13 buds to grow into new stems. To prevent the stump from sprouting it must be killed and this can be done by applying tryclopyr (formulated as GARLON 670 EC) disolved in diesel oil. An experiment conducted in June and evaluated in November 2012 on *V. nilotica* trees that were cut and the stumps were immediately brushed with Garlon 670 EC diluted in diesel oil using a soft paint brush showed successfuly killed *V. nilotica* (Table 1).

Table 1 showed that even control, without any herbicide treatment reduced sprouting almost 40%. This was due to inconsistency of plants in the field during dry season, as it was noticed that some trees with cut stump under no herbicide treatment was found also dead, it was simply due to the soil environmental variability as the condition was so dry. The valuable results of the experiment were indicated by these data that herbicide concentration from 1.5 – 12 ml triclopyr in 100 ml diesel oil reduced the sprouting ability of cut stump of *V. nilotica* by more than 80%, in other word the concentraion of triclopyr as Garlon at 1.5 ml/100 ml diesel oil or about 1.5% (by volume) was sufficient to kill *V. nilotica* trees . A higher concentration up to 12 ml/100 ml gave a better result almost killed the tree but still leaving 7% to be retreated again.

The impact of different stump height on the survival of *V. nilotica* stump was shown in Table 2 indicating that the stump height of 10 cm was the best in reducing the ability to survive by almost 90%. It is realised that brushing 10 cm height stump with herbicides is a back breaking jobs, therefore, the supervisor must be able take care and ensure that the herbicide solution is delivered correctly and consistently, attended from time to time to ensure that stumps are treated immediately after cutting.

When *V. nilotica* was successfuly controlled herbs and shrubs, the second problem still dominated the vegetation and competed grasses out. The following was the composition of vegetation under *V. nilotica* with medium canopy coverage measured in term of SDR (Summed Dominance Ratio). See Table 3.

Table 3 indicated that the vegetation composition was dominated by herbs and shrubs such as *E. ruderalis*, *H. suaveolens*, *Bidens biternata*, *Achiranthes aspera*, *Aeschynomene indica*, even also climbing *Ipomoea alba*, leaving only less than 25% grasses *Oplismenus compositus* and *B. reptans* that were shade tolerant but less palatable to herbivores. Although the vegetation composition varied greatly under the variable *V. nilotica* canopy, a considerable proportion herbs and shrubs was common. It was important therefore to control them to allow grasses to recover or to replant selected grasses. An experiment conducted during wet season of February 2013 application of triclopyr (formulated as GARLON 670 EC) at 1.0 lt/ha sprayed using knapsack sprayer in 400 lt water, 0.2% Agristick using T-jet nozzle calibrated at High Pressure successfuly controlled those herbage and shrubs (see Table 4).

Table 1. The sprouting percentage of *V. nilotica* stump after triclopyr applications (Tjitrosoedirdjo et al., 2013)

	Triclopyr application (g/lt)				
	0	**1.5**	**3**	**6**	**12**
% stum sprouting	63.1[a]	19.4[b]	15.5[b]	14.0[b]	6.6[c]

NB. Numbers followed by the same letter did not differ significantly at 5%

Table 2. The sprouting percentage of *V. nilotica* stum after triclopyr applications (Tjitrosoedirdjo et al., 2013)

	Treatments (stump height)		
	10 cm	15 cm	30cm
% stump sprouting	11[a]	27[b]	35[c]

NB. Numbers in one column followed by the same letter did not differ significantly at 5%

Table 3. Vegetation composition in the Bekol savanna during the wet season of February 2013 under the medium canopy of *V. nilotica* (Tjitrosoedirdjo et al., 2013).

No	Species	Family	SDR	No	Species	Family	SDR
1	*Achiranthes aspera*	Amarantaceae	2.86	13	*Ipomoea alba*	Convolvulaceae	6.29
2	*Aeschynomene indica*	Fabaceae	3.65	14	*Ipomoea sp.*	Convolvulaceae	2.92
3	*Bidens biternata*	Asteraceae	9.11	15	*Merremia emarginata*	Convolvulaceae	0.52
4	*Brachiaria reptans*	Poaceae	3.59	16	*Mimosa diplotrica*	Fabaceae	1.04
5	*Ceyrasia tripolia*	Vitaceae	0.69	17	*Ocimum canum*	Lamiaceae	0.57
6	*Centrosema sp.*	Fabaceae	0.56	18	*Oplismenus compositus*	Poaceae	20.9
7	*Cleome gynandra*	Capparidaceae	1.60	19	*Phyllanthus debilis*	Euphorbiaceae	0.45
8	*Commelina sp.*	Commelinaceae	0.47	20	*Phyllanthus niruri*	Euphorbiaceae	1.95
9	*Corchorus clitorius*	Tiliaceae	2.10	21	*S'dling V. nilotica*	Fabaceae	0.53
10	*Digera arvensis*	Amaranthaceae	0.45	22	*S'dling A. indica*	Meliaceae	1.38
11	*Eleutherantera ruderalis*	Asteraceae	26.0	23	*Thespesia lampas*	Malvaceae	0.95
12	*Hyptis suaveolens*	Lamiaceae	11.6	24	*Vernonia cymosa*	Asreraceae	0.55
			T o t a l				**100**

Table 4. The efficacy of foliar spray of some selective herbicides for herbs and shrubs applied during the wet season of February 2013. (Tjitrosoedirdjo et al., 2013)

N0	Treatments	Impact on herbs and shrubs and grasses	
		Percent coverage of herbs and shrubs	Percent Coverage of Grasses
1	Fluroxypir, 0,75 l/ha	10.58[b]	83.23[a]
2	Triclopyr, 0.5 l/ha	21.79[b]	62.58[b]
3	Triclopyr 1.0 l/ha	7.66[b]	80.52[a]
4	2,4-D 1.0 l/ha	12.71[b]	78.13[ab]
5	2,4-D 2.0 l/ha	8.69[b]	80.52[a]
6	Control	58.79[a]	32.48[c]

NB. Numbers in a column followed by the same letter did not differ significantly at 5%

MATERIALS AND METHODS

With the above information an experiment under the FORIS project was designed to follow up further in overcomming the problems of rehabilitating vegetation in savanna of Baluran National Park. The general way of killing *V. nilotica* and controlling the dominating herbs and shrubs were known, i.e. by using trilopyr (formulated as GARLON 670 EC) at 1.5-12.0 ml/100 ml of diesel oil brushed using soft painting brush on stump immediately after cutting. While those herbs and shrubs growing in between grasses can be selectively controlled using fluroxypir (STARENE), 2,4-D (LINDOMIN), mainly triclopyr formulated as GARLON 670 EC at 1.0 lt/ha sprayed at 400 lt water mixed with Agristick as surfactan at 0.2 % solution.

The experimental design was factorials with 3 factors, first factor was the methods of applying triclopyr, (1) by brushing 1% GALON 670 EC, diluted in 100 ml diesel oil on stump of *V. nilotica* after cutting, and (2) brushing 1% GALON 670 EC, diluted in 100 ml diesel oil at the base of standing *V. nilotica* tree from the ground surface up to about 30 cm ; the second factor was planting palatable grasses, i.e. (1) *D. caricosum* and (2) *P. amaura*: and the third factor was fertilizer using compost derived from feces of goat, i.e. (1) with compost and (2) without compost. The experimental treatments were a combination of 23 factors giving a total of 8 treatments and replicated 4 times. There were 32 plots each measuring 7 x 7 m^2. The treatments were randomized going through the first factor, followed by the second and third factor. After completing the designated treatments, all the 32 plots were sprayed with 1 lt GARLON 670 EC/ha using knapsack sprayer calibrated to deliver 400 lt of water/ha, added with 0.2% Agristick as a surfantant using T-jet nozzle and High pressure. (This spraying is not an experimental treatment, but only to adopt the previous good results that was able to reduce the coverage of shrubs and broadleaved weeds). Three days after spraying, grass treatments (*D. carisoum* and *P. amaura*) were applied and planted spaced at 1 x 1 m^2, using pieces of grass sod. The following day, the fertilizer treatments were applied as top dressing of a bucket of mature compost (about 100 gr) at designated plots. The last applied treatments were cutting trees of *V. nilotica* followed by brushing 1% GARLON 670 dissolved in diesel oil on cut stump, and brushing 1% GARLON 670 on standing trees from the ground surface up to 30 cm height. Those plots were fenched with 4 lines of barb wire nailed on 2 m poles of *V. nilotica* trees spaced at 10 m away around the plots to prevent a possibe disturbance from animals. The experimental lay out was displayed in Figure 1.

The selected area was slightly undulating, representing a typical area under the shade of *V. nilotica* invasion of medium canopy in Bekol savanna. Under the shade of *V. nilotica* was dominated by herbs and shrubs, although some areas were noticably bare (outside the treatment areas). Tree months after treatment applications the surviving *V. nilotica* trees (indicated by resprouting from standing trees or stumps) were counted, as variables to measure the efficacy of triclopyr applications The vegetation compositions under *V. nilotica* of each treatments were sampled using quadrate measuring 1 x 1 m^2, repeated 5 times in a non destructive method. All the species and their densities were recorded. The data on species composition in each treatments were subjected to cluster analysis. The coverage of grasses were measured in each samples and differentiated from that of herbs and shrubs and utilized to measure grass the recovery

This cluster analysis is based upon the distance between two vegetation compositions that are generated the following way:

d (i, j) = 1- IS, where d (i,j) is the distance between treatment i and j for i,j = 1,2.....8.

While IS is an Index of similarity of Czekanowski (1913) :

$$\frac{2 \sum \min (x_i, y_i)}{\sum (x_i + y_i)}$$

Where x_i and yi are a number of species i.

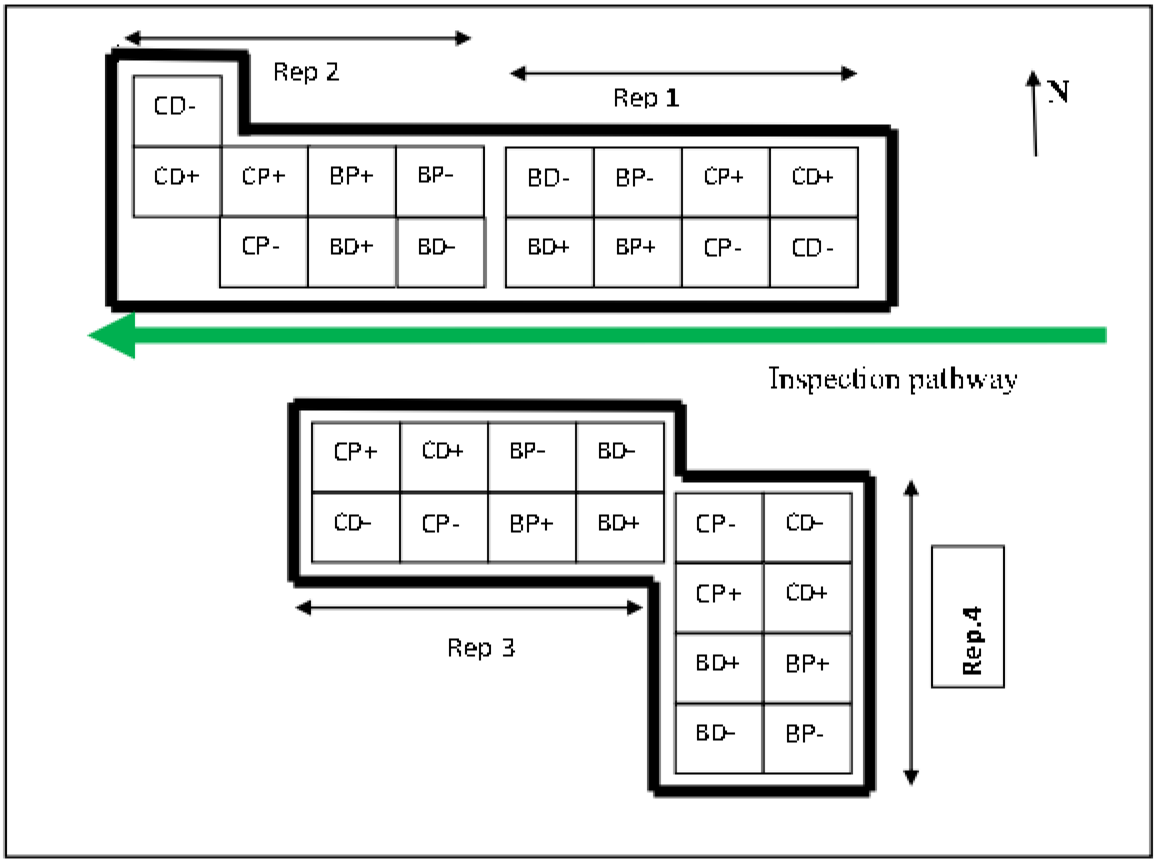

Figure 1. Experimental layout of treatments in the field; **factor I,** Control of *V. nilotica* trees, **C** = cut the tree and the stump brushed with triclopyr at 1.5 ml/l00 ml dissolved in diesel oil; **B** = brushed at the base of standing *V. nilotica* trees with triclopyr at 1.5 ml/l00 ml dissolved in diesel oil; **factor II**, planted grasses, **D** = *Dicanthium caricosum*, **P** = *Polytrias amaura*; **factor III**, + = with a bucket (100 g) of compost, - = without a bucket (100 g) of compost.

This cluster analysis is based on a simple minimum distance or the nearest neighbor method (McGarigal et al., 2000). The main input in the algorithm for this minimum distance is the matrix of distances between treatments. The algorithm of the minimum distance method is solved as follows:

1. In this experiment, there are 8 treatments, represented by 8 different vegetation compositions (species); there will be a square matrix of 8 x 8 dimensions with IS between treatments as its member. The IS matrix above must be changed into a matrix of distance D = d {i, j} with 8 x 8 dimensions.
2. Select the smallest distance pair to be combined from the D matrix. For example, the smallest distance is d {x, y}, which means that the treatments or vegetation composition x and y are the most likely to be combined because they have similar composition.
3. As the minimum distance is d = {x, y} so vegetation compositions of x and y may be combined into a new vegetation composition and named the vegetation composition of (x, y). After combination, it is important to adjust the D matrix in the following way:
   a. Delete column and row related to vegetation composition of x and y,
   b. Add a row and column containing the value of vegetation composition distance (x, y) and the remaining vegetation compositions.
   c. The distance value among community pairs (x, y) and z is determined by following this formula: d {(x,y), z } = min {d (x, z), d (y, z)}.
   d. Steps b and c are repeated seven times until all the vegetation compositions are combined into one.

It is important to record the vegetation composition identity and the minimum distance when combined.

RESULTS AND DISCUSSIONS

The evaluation carried out 3 months after the application of triclopyr as 1% GARLON 670 EC diluted in diesel oil brushed on the stump, no regrowth was recorded from the stump. However, under the treatment of brushing at the base of standing trees, some of treated trees, although leaves were shed, branches started to resprout, trees were not killed. It seemed the concentration was not enough. The surviving trees were re treated again with the same concentration to kill them all.

The species composition under *V. nilotica* canopy 3 months after treatments were presented in Table 5. These vegetation (species) compositions were the result of foliar application of triclopyr as 1 lt GARLON 670 EC/ha was promising. The growth of herbs and shrubs were reduced leaving only *Bidens biternata, Eleutheranthera ruderalis, Vernonea cymosa*. These herbs are members of Asteraceae capable of producing small capsellas with pappus which are easily blown by the wind. However they are quite susceptible to selective herbicides such as triclopyr, fluroxypir or 2,4-D. Other shrubs such as *Jatropha gossypiifolia, Thespesia lampas, Ocimum canum, Achyranthes aspera, Hyptis suaveolens* are more difficult to control, also other climbing vines such as *Merremia emarginata, Calopogonium mucumoides*, especially *Mucuna*, and *Flemengia lineata* the noxious stoloniferous herb. The rate of triclopyr as 1lt GARLON EC/ha may be too low, 2 lt GARLON 670EC/ha will be better in killing a greater part of those herbs and shrubs, therefore providing opportunity for grasses to recover. The growth of grasses becoming dominant, especially *B. reptans*.

The above experimental results will help to solve the problems of killing those nuisance standing herbs and shrubs, but still leaving a considerable number of seed in the ground. However if the control of these herbs and shrubs are consistantly carried out before they produce viable seeds, in four years most of those herbs and shrubs would have considerably been reduced, at the same time grasses would again dominate the savanna. These herbs and shrubs dry out during dry season (June – November) at the peak of dry season some of the areas are burnt, almost all those herbs and shrubs would have died away. However at the beginning of wet season seeds of herbs and shrubs will germinate and grow prolifically competing grasses out. At approximately January/February (depending upon the outset of rainy seson) these herbs and shrubs should be sprayed with triclopyr or fluroxypir or 2,4-D to kill those herbs and shrubs.

The results of cluster analysis of those 8 different species compositions were presented in Figure 2. It was easily noticed that the vegetation compositions in all 8 different treatments were dominated by *B. reptans*. This dendrogram provides a very interesting results. When the line of 50% similarity is taken as the criteria to differentiate the vegetation compositions, i.e., if IS < 50% those vegetation compositions differ one from the other; if IS>50% the 2 compared species compositions do not differ one from the other. Under this criteria the whole 8 communities were similar, because the value of IS combining all vegetarion composition was less than 50%. It was interesting, the foliar application of triclopyr at 670 g.ai/ha on those herbs and shrubs during the wet season was effective in controlling them, and provided an opportunity for grasses to recover (greater coverage). However if we utilize a line of 80% of similarity simply to seperate the species compositions, those 8 communities are split into 2, i.e. vegetation type I consisting of composisition CD-, CP+, CD+, CP- and BD+ representing the application of 1% GARLON 670 EC on stump while type II consisting of composition BP+, BD- and BP- representing the application of 1% GARLON 670 EC at the base of standing tree.

The impact of *V. nilotica* control using different method of 1% GARLON 670 EC application, not only directly impacting on the regrowth of *V. nilotica* but also affected the recovery of grasses as shown in Table 6. The treatment application of 1% GARLON 670 EC on stump, induced the grass recovery greater ($P \leq 0.05$) than the application at the base of standing tree.

The cuting of *V. nilotica* trees followed killing the stumps by applying 1%GARLON 670 EC directly on the stump removed the canopy shade, increased the availability of sun light for grasses to photosynthesize. By removing *V. nilotica* trees also reduced the evaporative demand of soil water, therefore the availability of soil water was better. These conditions supported a good growth of grasses. While the application of 1% GARLON 670 EC at the base of *V. nilotica* tree did not kill those trees immediately, presumably water traspiration stayed high reducing the soil moisture and reducing sun light for photosynthesis for grasses Table 6. The grass coverage as effected by the application of GARLON 670 EC on *V. nilotica*

However the biomass of planted *D. caricosum* and *P. amaura* 4 months after planting and fertilization presented a more complicated data. See Table 7.

There was an indication that biomass of *D. caricosum* (L). A. Camus during the 4 months growth was higher than that of *P. amaura* ($P \leq 0.01$). However the way to apply GARLON 670 EC to kill *V. nilotica* wether directly brushed at the base of the tree or on stump, as well as the fertilization treatments did not effect the *D. caricosum* nor *P. amaura* growth. The experimental area contributed to the high variability of the growth of planted grasses. *D. caricosum* is a creeping stoloniferous perennial with blue-tinged stems and fine pointed leaves, 4–20 cm long, 2–6 mm wide. Stolons can grow to 1.5–2 metres; nodes are generally hairless. Slender seed stems grow to 45 cm. 1–3 racemes, usually 2, 2–10 cm long, on a many-jointed rachis. Spikelets paired, one sessile and one stalked. Spikelets are all very close together and overlap each other. Only the sessile spikelet has an awn, 1–2.5 cm long. It is native to India, Sri Lanka, Myanmar, Thailand, Indonesia and Papua New Guinea.

It may be planted from seed or stolons. Seed is awned and hence difficult to harvest and clean mechanically. De-awned seed is less likely to clump but the spiralled awn may help the seed to bury itself when wetted. Not easy to establish from seed, although in time it would spread from a relatively low density to form a close sward under suitable conditions. Planting stolons with nodes gives faster establishment but requires follow-up rainfall and is more labour intensive.

Dry matter production around 10–12 t/ha/year DM but very poor production during the dry season. In Fiji, production is highest in March at about 1,000 kg/ha/week and lowest from July–September at about 200 kg/ha/week. In Guadeloupe, it produced up to 40 kg/ha/day DM during the wet season, but none during the 5 months of dry season. Animal production up to 100 kg/ha/yr of LWGs from unimproved grassland at a stocking rate of 2.5 steers/ha may be possible; 150 kg/ha/yr with legumes (sown *Macroptilium atropurpureum* and *naturalised Desmodium heterophyllum*) and superphosphate. Animals may lose weight during the dry season because of lack of growth of grass.

P. amaura is also known as Jawa grass, Batiki Bluegrass, Indian muraina grass, the name *P. amaura* (Buse) O. Kuntze experienced a considerable taxonomic evaluation producing a numerous names more than 20 ones, and all were considered as illigimite ones, it should be named as *Polytrias indica* (Houtt.) Veldkamp. It is native to West Africa (from Senegal to Cameroon), Seychelles, the Indian Subcontinent, southern China, Southeast Asia, New Guinea, Fiji, and Micronesia. It is also cultivated as a lawn grass and in Indonesia is very popular as soccer field.

Table 5. The composition of plant species under the *V. nilotica* canopy 3 months after treatments of triclopyr to control *V. nilotica* and herbs as well as shrubs and planted with grasses (*D. caricosum* and *P. amaura*) with and without fertilizer (compost)

No	Species	CD+	CD-	CP+	CP-	BD+	BD-	BP+	BP-
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	*Abelmuchus ficulneus*	0	0	0	0.05	0.05	0	0	0
2	*Abutilon indicum*	0.35	0.1	0	0.1	0	0.40	0.10	0.6
3	*Acacia nilotica seedling*	0.20	0.20	0.15	0.25	0.15	0.05	0.10	0.2
4	*Acalypa indica*	0	0	0	0	0.2	0	0	0
5	*Achyranthes aspera*	1.75	0.80	1.0	0.15	1.35	1.2	1.15	1.6
6	*Achyranthes sp*	0	0	0.05	0.05	0.25	0	0	0
7	*Aeschiomene americana*	0.20	0.1	0	0.30	0.05	0	0	0
8	*Azima sermentosa*	0	0	0	0	0	0	0.05	0.05
9	*Azadirachta indica*	0.1	0.05	0.15	0.05	0.6	0.35	0.45	0.3
10	*Brachia reptans*	39.65	42.65	38.05	42.40	35.85	27.60	22.75	25.45
11	*Calopogonium mucunoides*	0.05	0.30	0	0.05	0.05	0.10	0	0.1
12	*Capparis sepiaria*	0	0	0	0	0.05	0	0	0
13	*Chloris dolichostachya*	0.50	0.40	3.35	0.9	1.65	2.15	1.4	0.9
14	*Chromolaena odrata*	0	0	0.05	0	0	0	0	0
15	*Cleome aspera*	0.30	0	0.05	0	0	0.1	0.05	0.15
16	*Columella trifolia*	0.05	0	0.25	0.2	0.05	0	0	0
17	*Corchorus sp.*	0.15	0.3	0.25	0	0.4	0.1	0.3	0.15
18	*Bidens biternata*	11.30	13.4	5.85	11.55	9.39	3.55	3.25	8.70
19	*Eleuntheranthera ruderalis*	11.45	10.10	7.55	14.60	13.95	9.40	3.25	6.25
20	*Euphorbia hirta*	0.05	0	0	0	0	0	0	0

No	Species	CD+	CD-	CP+	CP-	BD+	BD-	BP+	BP-
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
21	*Hedyotis corimbosa*	0.05	0.1	0.05	0.05	0.40	0.55	1.7	0.65
22	*Hisbiscus penduriformis*	0.25	0	0.05	0	0	0	0.1	0.1
23	*Hyptis suaveolens*	1.00	0.70	0.25	0.55	0.10	0.40	0.1	0.05
24	*Hyptis sp*	0	0	0	0	0	0	0	0.2
25	*Indigofera sumatrana*	0	0	0	0	0	0.05	0	0.05
26	*Jatropha gossypifolia*	0	0.50	0.05	0	0	0	0	0
27	*Merremia emarginata*	0	0	0.70	0.45	2.15	0.1	0	1.05
28	*M. gemella*	4.9	3.35	1.6	2.5	4.25	3.95	3.50	2.8
29	*Melothria moderaspatama*	0	0	0	0	0	0.05	0	0.05
30	*Mimosa invisa*	0	0.15	0.3	0.15	0.2	0.05	0.1	0
31	*Ocimum americanum*	0.25	0.05	0.05	0	0.55	0.70	0	0.4
32	*Opliemenus burmanii*	2.40	0	0	0	0	2.65	5.25	4.25
33	*Phylanthus urinaria*	0.05	0	0.05	0.1	0.05	0.05	0.15	0.15
34	*P. vareigatus*	0.15	0.1	0.15	0.15	0.35	0.25	0.30	0.05
35	*Portulaca oleraceae*	0	0	0	0	0.10	0.05	0.05	0.05
36	*Randia spinosa*	0	0	0	0	0	0.05	0	0
37	*Sida acuta*	0.05	0.05	0	0	0	0	0.05	0.05
38	*Sida cordifolia*	0	0	0	0	0	0	0	0
39	*Thephesia lampas*	1.05	1.95	1.85	1.65	0.45	0.40	0.30	0.35
40	*Vervonea cymosa*	0	0	0	0	0.20	0.25	0.25	0.25
41	*Wisadula periplocifolia*	0	0.05	0	0	0	0	0	0
	Total	**74.35**	**75.40**	**48.05**	**76.25**	**72.29**	**54.50**	**44.70**	**54.3**

NB. **C** = cut with a chainsaw, and the stump was immediately brushed with triclopyr at 1.5 ml/l00 ml dissolved in diesel oil. **B** = brushed with triclopyr at 1.5 ml/l00 ml dissolved in diesel oil at the base of a standing tree. **D** = planted with *Dicanthium caricosum*. **P** = planted with *Polytrias amaura*. + = fertilized with a bucket of compost (100 gr)/planted sod. - = without fertilizer. The plot of each unit treatments = 7 x 7 m^2.

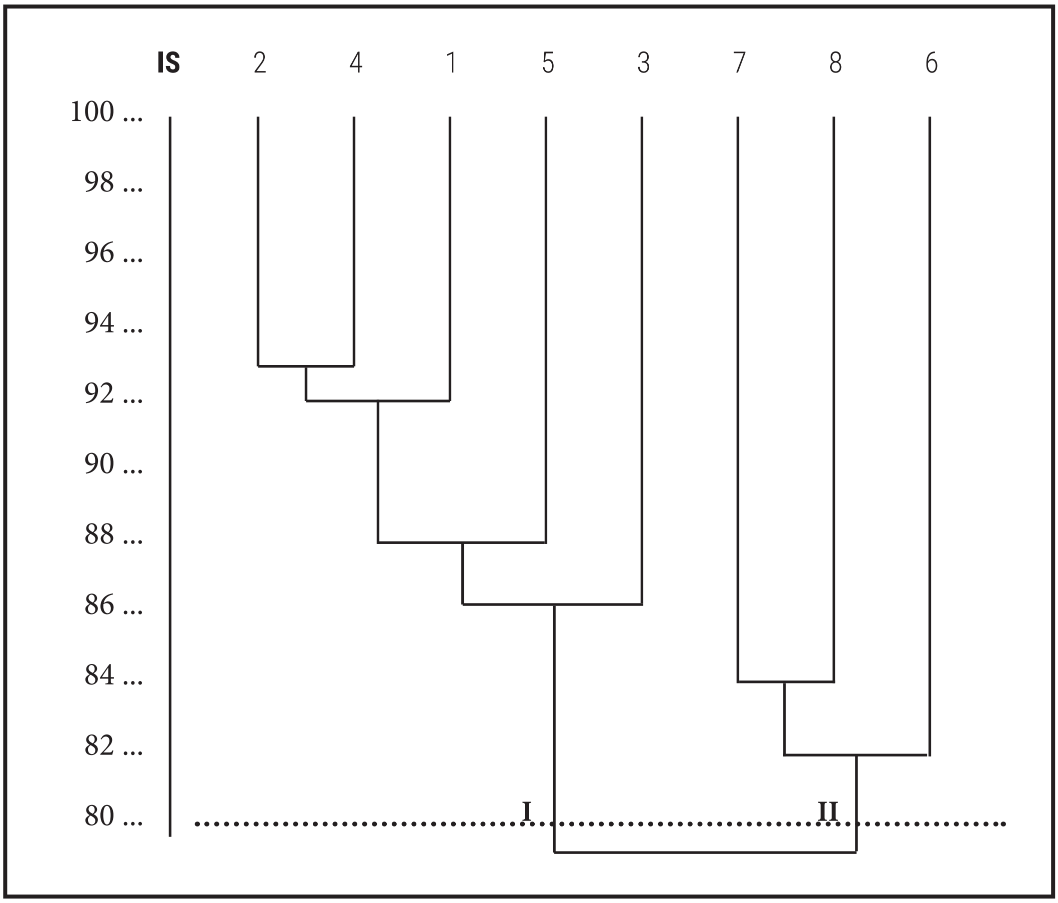

Figure 2. Dendrogram of 8 vegetation compositions under *V. nilotica* canopy 3 months after foliar application of GARLON 670 EC at 670 g.ai/ha.

Table 6. The grass coverage as affected by the application of triclopyr at 1.5 ml/l00 ml on *V. nilotica* tree

No	Treatments	% grass coverage
1	*V. nilotica* cut and brushed on stump	43.12
2	*V. nilotica* brushed standing	27.58
3	LSD (5%)	13.27

Table 7. Means of biomass of *C. caricosum* and *P. amaura* (g/m^2) as affected by the application of triclopyr at 1.5 ml/l00 ml dissolved in diesel oil to control *V. nilotica*

Application of 1.5 ml/l00 ml dissolved in diesel oil	*D. caricosum*		*P. amaura*	
	With compost	Without compost	With compost	Without compost
Brushed on stump	971.25	703.25	574.25	547.75
Brushed at the tree base	831.75	835.75	713.75	646.75

Further Sugesstion of Management

Recent analysis of vegetation in the experimental plots 3 years after treatments displayed an improvement in the vegetation composition toward the establishknet of palatable grassess mainly *D. caricosum* and *P. amaura* (See Table 8). The growth of *D. caricosum* in both condition wherther *V. nilotica* was controlled by brushing 1% garlon on cut stump or standing stem the population was similar, while that of *P. amaura* was slightly better under open condition facilitated by cuttings *V. nilotica* stump. From this analysis the vegetation was dominated by grasses, especially *B. reptans*, and reintroduced *D. caricosum*, and *P. amaura*. However *V. nilotica* grew again from seed bank in the soil.

There are three problems after controlling *V. nilotica* that must be addressed, i.e. (1) The growth of broadleved weeds, these included climbers such such *Desmodium*, but also those having undergrown stolon such as *Flemengia lineata*, beside common fast growing weeds such as *B. biternata, V. cymosa, T. lampas*. These shrubs are able to grow in a dense population restricting the movement of animals and humans. These weeds must be sufficiently controlled. (2) The second problem is the coming back of *V. nilotica* through the germination of seed bank. It is better to kill *V. nilotica* when still young, before reaching its generative stage. The last one is (3) the growth of grasses. The introduced grasses must be prevented from being grazed by herbivores before strong enough. In our discussion CABI suggested not only to utilize the stump of *V. nilotica*, but also branches to prevent the herbivores from grassing the planted grasses until they are strong enough to stand the grazing.

During the project it was also noticed that some bruchids also attacked the seed of *V. nilotica*, it may be researched and capitalized its function to reduce *Acacia* seed from germinating. Risk analysis on invasive plant species in Baluran National Park have been done, and it should be utilized in the management of the park as directed by Aichi Biodiversity Target no 9. It is necessary then to bring to the attention of the related Directorate General to work in line with the time table as directed by Aichi Biodiversity Target No.9.

The Directorate General must be able to provide the necessary fund to carry out activities as directed by Aichi Biodiversity Targtet No 9. While the government may have difficulties in giving priority to the management of Invasive Species, the Central Research of Forestry and Innovation should display its "innovativeness" by, for example utilizing the wood of *V. nilotica* as a materials that may be utilized for making charcole . It was practised in the past and technically very good, the only necessary step, now, is to regulate and legalise the practise the monetary benefit of which must be utilized to control *V. nilotica* further. The shortage of funds experienced by the government should not become reasons for not managing these invasive plant species, because they will grow and expands further to inflick a greater damage to the society.

Table 8. Vegetation of Bekol savanna after *V. nilotica* control through mechanical cutting of trees followed by brushing garlon at 1% disolved in diesel oil, and broadleaved weeds were also controlled with foliar application of garlon at 1 lt/ha using applied 400 lt water wing o.2 a knapsack sprayer calibrated to deliver a spray volume of 400 lt/ha

N0	Species	***V. nilotica* was brushed with Garlon 1% dissolved in diesel oil**		
		Brushed on cut stump	**Brushed on standing stump**	**Means no/m²**
1	*Abutilon hirtum*	0.2	0.6	0.4
2	*Abelmoschus ficulneus*	0..01	0.06	*
3	*Acacia leucophloea*	0.01		*
4	*Acacia nilotica*	2.2	1.0	1.6
5	*Acalypha indica*	0.03	0.6	0.3
6	*Achyranthes aspera*	0.4	0.8	0.6
7	*Aeschinomene americana*	0.5	0.2	0.3
8	*Ageratum conyzoides*	0.05	0.02	*
9	*Azadirachta indica*	0.41	2.5	1.5
10	*Azima sarmentosa*	0.02	0.2	0.1
11	*Bidens biternatta*	3.46	7.2	5.3
12	*Boerhavia erecta*	0.01	0.05	*
13	*Brachiaria reptans*	89.4	33.7	61.55
14	*Calliandra* sp.	0.4	1.6	1.0
15	*Calotropis gigantea*			
16	*Capparis sepiaria*	0.04		*
17	*Cayratia trifolia*	0.1	0.1	0.1
18	*Clitoria ternatea*		0.04	*

N0	Species	*V. nilotica* was brushed with Garlon 1% dissolved in diesel oil		
		Brushed on cut stump	Brushed on standing stump	Means no/m²
19	*Commelina benghalensis*		0.01	*
20	*Corchorus aestuans*	0.3		0.15
21	*Corchorus olitorius*	0.9	0.3	0.5
22	*Corypha utan*	0.3	0.07	0.1
23	*Casia obtusifolia*	0.01		*
24	*Desmodium dichotomum*	0.9	0.7	0.8
25	*Dichantium caricosum*	9.4	9.4	9.4
26	*Dichrostachys cinerea*	0.02		*
27	*Dicliptera canescens*	0.06	0.7	0.3
28	*Echinochloa colonum*			
29	*Eleutheranthera ruderalis*	3.8	4.4	4.1
30	*Eragrostis unioloides*	0.05		*
31	*Euphorbia heterophylla*	0.05		*
32	*Euphorbia hirta*	0.01	0.1	*
33	*Flemingea linneata*	0.02		*
34	*Hedyotis pterita*	0.9		0.45
35	*Hibiscus panduriformis*	1.7	2.4	1.6
36	*Hibiscus sp.*	2.2	0.8	1.5
37	*Hibiscus vitifolius*	0.03	0.01	*
38	*Hyptis suaveolens*	0.9	1.75	1.3
39	*Hyptis* sp.	0.01	0.01	*
40	*Indigofera pratensis*	0.05	0.7	0.3
41	*Jacquemontia paniculata*	3.25	3.9	3.1
42	*Jatropha gossypifolia*	0.8	0.01	0.4
43	*Lantana camara*		0.01	*
44	*Merremia emarginata*	1.0	0.4	0.7
45	*Mimosa invisa*	0.2	0.2	0.2
46	*Mukia maderaspatana*		0.16	0.8
47	*Ocimum americanum*	2.0	2.0	2.0
48	*Passiflora foetida*		0.02	*
49	*Polytrias amaura*	16.8	10.2	13.5
50	*Phyllanthus maderaspatensis*	0.5	0.7	0.6
51	*Phyllanthus urinaria*	0.03	0.03	*
52	*Phyllanthus virgatus*	4.7	3.6	4.1
53	*Randia spinosa*	0.01		*
54	*Sida cordifolia*	0.2	0.4	0.3
55	*Synedrella nudiflora*			
56	*Vernonia cymosa*	8.3	.2.5	5.4
57	*Wisadula periplocifolia*		0.01	*
58	*Ziziphus mauritiana*	0.04	0.02	*
59	*Ziziphus oeonopholia*	0.02	0.01	*
60	*Number of species*	50	46	

CONCLUSION

It was concluded that the method of controlling *V. nilotica* by chopping *V. nilotica* trees during the dry season leaving only 10 cm stump left on the ground and directly. brushing 1 % Garlon 670 EC dissolved in diesel oil on left stump was good to provide the growth of planted grasses. Especially that of *D. caricosum*. It was also suggested to utilize the leaves of *V. nilotica* as herbage for herbivores while utilizing the wood for charcoal production.

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