European Network for the Durable Exploitation of Crop Protection Strategies

IA3 activity: human resource exchange
SA3.2 sub-activity: foster the participation of research teams from INCO target countries

ENDURE Grants for INCO scientists

Final activity report

(The form has to be filled in and sent to the activity leader – message should be sent to his p.a. federica.piccolo@ibaf.cnr.it – within 15 days after the end of the visit)

1. Information about researcher and sending partner

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Supervisor name*:

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*Supervisor information only for PhD student, post-doc and junior researchers

2. Information about hosting partner

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Aarhus University, Denmark

Institute/Department/Research Unit: Dept of Integrated Pest Management

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3. Information about the visit

Duration: 3 Months

Starting date: 4 September 2010

Ending date: 2 December 2010

4. Description of the activities and outcomes

Background and context: *Cymbopogon afronardus* in Uganda's cattle corridor is characterized as a weed, a colonizer and an invader and conceptually regarded as a pest of natural and planted pastures. As a weed it grows where it is not desired, as a colonizer it appears in the early stages of succession series and as an invader it spreads into areas where it is not native. Its wide and successful distribution in the Uganda cattle corridor may be attributed to lack of natural enemies in the new habitat therefore spreading easily and quickly. However, its biological and environmental factors that regulate its persistence and growth have received little attention. Also how these factors contribute to its invasive nature have not been investigated, yet they are essential in designing informative management strategies. Thus, the research carried out at the ENDURE hosting institution focused on the biological and environmental factors that regulate persistence and growth of *C. afronardus* and how these factors contribute to its invasive nature.

Objective: The local pastrolists in Uganda's rangelands practice burning of pastures in the dry season to allow reguvenation of new tender shoots after the onset of rains. However the temperatures generated during these fires could play a role breaking the dormancy of *C. afronardus* seeds. Also the weed exudes aromatic oils from its leaves that can be implicated in herbage growth suppression. Thus our objectives were;

1. To acess the effect of temperature and temperature duration to seed dormancy and germination of *C. afronardus*.
2. To acess the allepathic effects of *C. afronardus*, on the germination of *Cyperus rotundus (a weed grass)* and *Lolium perrene (a fodder grass)*.
   Note: *Brachiaria decubens* was the preferred fodder grass for the experiment as it is a common pasture grass in the Uganda rangelands, but failed to germinate in time during the ENDURE Mobility period.

Activities carried out

Activity 1: **Assessment of the effect of temperature and temperature duration on seed dormancy and germination of *C. afronardus.***

Ten seeds were planted in soil in Petri dishes and subjected to, 40, 60, 80 and 100^{0}C in 4 replicates in a hot air oven. Each temperature treatment was subjected to the seeds for 5, 10 and 20 seconds. The seeds were

placed in an incubator at 30^{0}C, for 7 days (T_1) then at 24 degrees for 40 days (T_2), with light of 16 hours a day. After two months the seeds were subjected to 4 hours of 45^{0}C temperature then 24^{0}C temperatures for 3 days (T_3). The seeds were then incubated at 24 ^{0}C for 4 days. The out come is illustrated in Table 1 and Figure 1 below.

Outcome:

Table 1: Cymbopogon treatment for breaking seed dormancy

Temperature	Duration(sec)	T_1, Germination %	T_2, Germination %	T_3, Germination %
40	5	0	0	2.5
	10	0	0	5
	20	0	0	5
60	5	0	0	10
	10	0	0	2.5
	20	0	0	17.5
80	5	0	0	0
	10	0	0	0
	20	0	0	0
100	5	0	0	0
	10	0	0	0
	20	0	0	0
Control		0	0	2.5

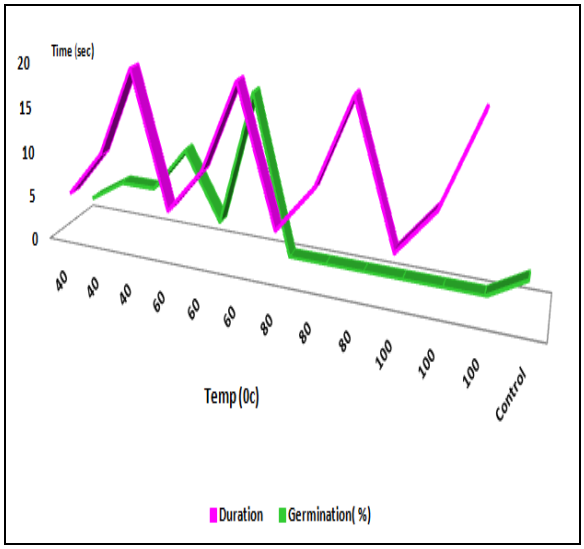

Figure 1: Initial temperature duration for breaking seed dormancy of *C. afronardus*

Conclusion: The *C.afronardus* seeds were generally not viable and germination very erratic. However, our results suggest that oscilating temperatures as those experienced with rangeland burning may have an effect in breaking the dormancy of *C. afronardus* seeds, promoting its inavsion.

Activity 2: **Assessment of allepathic effects of *C. afronardus*, on the germination of *Cyperus rotundus* and *Lolium perenne*.**

The initial extract was prepared from leaves of air dried *C. afronardus* leaves in a proportion of 1 g leaves/10ml of 70% alcohol. The mixture was left to macerate for 15 days after which the extract was filtered and dilutions prepared. The first dilution, 1cH was prepared from 0.2 ml of extract in 100ml distilled water. Dilutions prepared were 3cH, 6cH, 12cH, 24cH and 30cH (Figure 2).

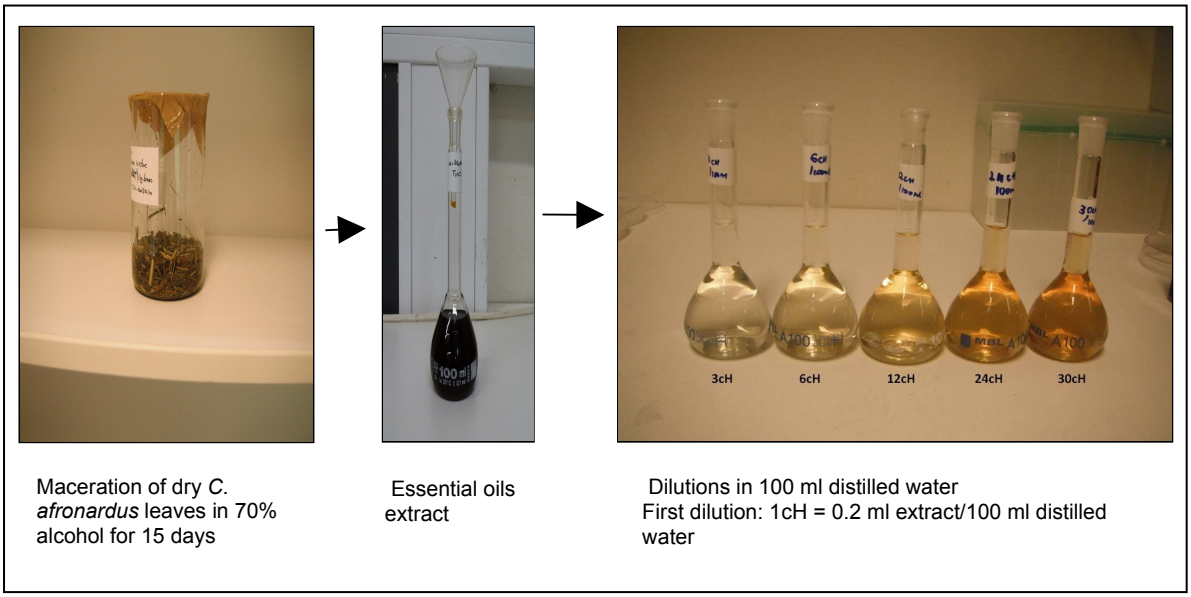

Figure 2: Extraction of essential oils from dry *C. afronardus* leaves

25 seeds of both *Cyperus rotundus* and *Lolium perenne* were distributed in Petri dishes covered by Whatman#1 filter paper imbibed with 2ml of different dilutions (3cH, 6cH, 12cH, 24cH and 30cH) and water (control) and spread on benches at room temperature. The experimental design was totally randomized and

included 6 repetitions. *Lolium perenne* was left to germinate for 5 days and *Cyperus rotundus* for 7 days. Variables essayed were: Percentage of germination (G%), Germination index (GI), root length and shoot length by graded ruler, dry biomass (DW) by analytic scale and vigour index (VI). Data were analyzed by SAS program to assess significant differences between the different dilutions from the control.

Outcome: For *C. rotundus*, G%, GI, root length and VI, all doses were significantly different from the control. There was no significant difference between shoot length of doses 3cH with the control. There were no significant differences between the different does and the control for DW (Table 2). For *L. Perrene*, G%, GI, shoot lentgh, root length and VI, all doses were significantly different from the control. There were no significant differences between the different doses and the control for DW (Table 3). Table 4 shows the non linear regression analyses at ED_{50}. In general *C. rotundus* is more susceptible (lower ED50 values) than *L* perrene.

Table 2: Effect of concentrations of *C. afronardus* essential oils on growth of *C. rotundus*

Dose	G %	GI	DW	Shoot length	Root length	VI
0	54.00 a	8.55 a	0.0015 a	1.53 a	1.23 a	82.53 a
3 cH	31.33 b	2.53 b	0.0015 a	1.23 a	0.90 b	40.47 b
6 cH	17.33 c	0.81 c	0.0046 a	0.63 b	0.27 c	19.47 c
12 cH	4.67 d	0.13 c	0.0000 a	0.00 c	0.00 d	0.00 d
24 cH	0.00 d	0.00 c	0.0000 a	0.00 c	0.00 d	0.00 d
30 cH	0.00 d	0.00 c	0.0000 a	0.00 c	0.00 d	0.00 d

Letters refer to significance according to Duncan's Multiple Comparison Test: If letters are similar the results are not significantly different.

Table 3: Effect of concentrations of *C.afronardus* essential oils on growth of *L. perrene*

Dose	G %	GI	DW	Shoot length	Root length	VI
0	90.00 a	17.64 a	0.027 a	4.42 a	4.07 a	396.9 a
3 cH	76.00 b	15.20 b	0.026 a	2.95 b	2.67 b	240.4 b
6 cH	75.33 c	14.03 b	0.025 a	1.67 c	1.87 c	126.8 c
12 cH	50.00 d	11.97 c	0.010 a	0.17 d	0.68 d	8.5 d
24 cH	0.00 d	2.51 d	0.004 a	0.00 d	0.00 e	0.0 d
30 cH	0.00 d	0.61 d	0.000 a	0.00 d	0.00 e	0.0 d

Letters refer to significance according to Duncan's Multiple Comparison Test: If letters are similar the results are not significantly different.

Table 4. Non linear regression analyses at ED_{50} (95% confidence interval in parentheses).

	C. rotundus	*L. perrene*
Germination %	3.44 (2.07-4.82)	12.48 (12.10-12.86)
Germination index	2.11 (1.48-2.74)	21.56 (19.89-23.24)
Shoot length	4.36 (3.04-5.67)	5.25 (4.26-6.23)
Root length	3.35 (2.35-4.35)	8.01 (6.41-9.61)
Vigour Index	3.05 (2.21-3.90)	5.57 (4.70-6.44)
DW	-	9.86 (6.50-13.22)

Conclusion:

- Allelopathic effects of *C. afronardus* to other herbage do indeed occur.
- There are differences in sensitivity between species to these allelopathic effects.
- Even at very low concentrations, *C. afronardus* essential oils are very potent.
- Root growth of both species was more sensitive than shoot growth.
- For *L. perrene*, growth parameters are more sensitive than germination.

- Essential oils from *C. afronardus* can be used to inhibit emergence of important weeds such as *Cyperus rotundus.*

5. Links between visit activity and ENDURE

One of ENDURE's objectives is to identify short term solutions of optimising and reducing chemical use in existing farming systems. The aim is to mitigate negative environmental impacts and improve agricultural sustainability. The link between the visit activity and ENDURE, was to assess the possibility of identifying *C. afronardus* allelopathic properties as a potential bio-herbicide/pesticide. Some farmers in Uganda use the ash of *C. afronardus* leaves as a pesticide in the concept of indigenous technical knowledge. Plant biomass is not limited, as the weed covers 11% of the country's rangelands and spreads at a very high rate annually. Its invasive nature could be harnessed positively to provide solutions for resource poor farmers and pastoralists in Sub-Saharan Africa facing old and new constraints.

6. Impact

Added value for the researcher:

The stay in allowed me to

- Increase my knowledge in understanding the vast solutions that biological and environmental phenomena can still provide for current and future constraints in agricultural systems.
- Learn that it is possible to carry out many short term scientific experiments in a short period of time.
- Learn to use state of the art laboratory equipment to acquire more accurate data.
- Increase my enthusiasm in continuing with research concerning the development of bio-herbicides/pesticides.
- Stretch my network of multicultural experiences with one more culture; the Danish culture.
- Broaden my professional network with plant scientists in Europe by attending the final ENDURE conference in Paris, November, 2010.

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Added value for sending partner and hosting partner:

This study will enable the researcher to continue with experiments of this aspect on her return to Uganda. The aim is to offer the country with some solution towards the problems caused by this invasive weed. As an additional follow up activity, Dr. Per Kudsk has offered to continue collaborating with the sending partner institution towards the continuation of experiments, regarding allelopathic effects of *C.afronardus* on other indigenous pastures in the rangelands of Uganda. The network between the sending and hosting partners' institutions has been strengthened for future collaboration in research.

Date of submission

11 December 2010

endure
diversifying crop protection

Dr. Maurizio Sattin
IA3 activity leader

Approved