

Impact of Glyphosate on Weed Biomass and Growth of Coconut Seedlings in Nurseries

S.H.S.Senarathne and K.C.P.Perera

Coconut Research Institute, Lunuwila, Sri Lanka

ABSTRACT

The effects of five different weed management systems on growth of coconut seedlings were evaluated to determine an economical and effective method for controlling weeds in coconut nurseries in the low country of the wet zone in Sri Lanka. The treatments comprised of manual weeding (T_1), application of glyphosate at 1.44 kg ai/ha (T_2), 1.08 kg ai/ha (T_3), 0.72 kg ai/ha (T_4) and 0.36 kg ai/ha (T_5) applied at three-month intervals. Treatments 1 and 2 significantly reduced the weed biomass when compared to other treatments. The growth of coconut seedlings (in terms of height and girth) increased significantly ($P < 0.05$) with the application of glyphosate at 1.08 kg ai/ha (T_3) at the end of the nursery growth period. At the higher concentration (1.44 kg ai/ha) the growth of seedlings was reduced at the latter part of the experiment. Therefore, the most cost-effective treatment of controlling weeds in the study was to apply glyphosate at the rate of 1.08 kg ai/ha (31 of commercial mixture/ha). Manual weeding was neither effective nor economical.

Key words: coconut, seedling, monocotyledonous weed, glyphosate

INTRODUCTION

Coconut (*Cocos nucifera* L.) is by far the most extensively cultivated major plantation crop in Sri Lanka (Liyanage and Liyanage, 1989). It is distributed in approximately 0.444 million ha of land throughout the island (Central Bank, 2002). To establish and maintain proper plantation, a high quality coconut seedling is an essential prerequisite. Annually more than 2 million coconut seedlings are issued to the growers for their replanting program (Plantation Sector Statistical Book, 2002). Therefore, to produce high quality seedlings much attention needs to be paid during the nursery period. Coconut seedlings are raised in nurseries prior to field planting. Proper care and maintenance

of seedbeds facilitate the selection of early germinating vigorous seedlings (Peries and Everard, 1993). The inheritance studies carried out by Liyanage and Abeywardana (1957) have shown that seedling vigor is correlated with adult palm characters such as early flowering and high nut and copra yield. In the nursery, apart from irrigation, weeding is very important though expensive. Good weed management can minimize economic losses as reported by Suryaningtyas (1997) and Wibawa (1997). Seedbeds should be weed free; otherwise weeds would compete with coconut seedlings for nutrient and moisture. Each weed species has different effect on growth of plants (Eaton

et al., 1976). However, information on growth reduction of seedlings due to weed competition in the coconut nurseries in Sri Lanka is not available.

The most popular method of weeding in coconut nurseries is hand weeding, which is labor intensive and time consuming (Remison & Mgbeze, 1987). Hand weeding has not been effective, especially for weeds with underground storage organs (Pethiyagoda, 1980). Chemical weeding is also adapted by nursery growers. Glyphosate has a systemic action and it is very effective to control grass weeds in coconut nurseries such as *Imperata cylindrica*, *Cynodon dactylon*, *Panicum maximum* and *Cyperus rotundus*. These are the common weeds in coconut nurseries of the wet zone. In Sri Lanka *Cyperus rotundus* is one of the major weed species found in wet zone coconut nurseries (Gunasekara and Fernando, 1994). Glyphosate is a widely used, non-selective, foliage applied herbicide which is known to be highly toxic to *Panicum repens* (Manipura & Somarathne, 1974). Glyphosate is also a commonly used herbicide in mature coconut plantations because it is non-selective and affects a wide range of monocotyledonous and dicotyledonous annuals, biennials and perennials (Boyall, 1998). However, glyphosate can be harmful to both weeds as well as coconut seedlings. Hence the objective of this study was to identify most economical and effective method of weed control in coconut nurseries.

MATERIALS AND METHODS

The experiment was carried out during October 2002 to June 2003 in a coconut nursery located at Wennoruwa in the Low Country Wet Zone of North-Western province of Sri Lanka.

The average day temperature at the site was around 27°C and rainfall was uneven with dry spells. All the coconut seed nuts were selected from high yielding mother palms. Seed nuts were laid in the nursery beds spaced at 45cm between rows and 15cm within rows in October 2002. Each experiment plot measured 2.5m x 3.0m containing 40 seed nuts within a nursery bed. The experiment was conducted in Randomized Complete Block Design with three replicates.

The treatments were Manual weeding (T_1), Glyphosate application at 1.44 kg ai/ha (T_2), 1.08 kg ai/ha (T_3), 0.72 kg ai/ha (T_4), 0.36 kg ai/ha (T_5) and T_6 - No weed control. Glyphosate was applied uniformly over the plot using a hand sprayer at three months intervals starting from October 2002 and ending in May 2003.

Weed biomass: The weed biomass was collected every month from 0.25m x 0.25m quadrates from four random points per plot. The weeds were separated into species and dried to constant weight at 80 °C for five days from October 2002 to May 2003.

Coconut seedling girth and height: Ten coconut seedlings were selected randomly and plant height and stem girth (base of the seedling) were measured.

Data analysis was conducted using Analysis of Variance (ANOVA) using Statistical software and the significance was tested using the Least Significant Differences (LSD) ($P=0.05$) (SAS Institute 1999).

RESULTS AND DISCUSSION

Effect of different glyphosate concentrations on weed biomass: Major weed

species in this site were *Imperata cylindrica*, *Panicum repens*, *Cynodon dactylon*, *Chloris barbata*, *Mimosa pudica*, *Urena lobata*, *Croton hirtus*, *Allmania nodiflora*, *Mitracarpus villosus*, *Tephrosia purpurea*, *Vernonia cinerea*, *Tridax procumbens*, *Sida acuta*, *Scoparia dulisis*, *Stachytarpheta jamaicensis* and *Hyptis suaveolens*. Weed biomass was lowest in plots which received 1.44 kg ai/ha and 1.08 kg ai/ha of glyphosate respectively (Fig. 1). At the lowest concentration of glyphosate (0.36 kg ai/ha) (T_5) and in manual weeding (T_1) treatments were not sufficient to suppress the weed population satisfactorily. However, Glyphosate application at 1.44 kg ai/ha (T_2), 1.08 kg ai/ha (T_3) and 0.72 kg ai/ha (T_4) were found to be

parts could not be destroyed. Therefore, weeds appeared within a very short period of time. However, dicotyledonous weeds were very easy to control manually. Boyall (1979) showed that when glyphosate was applied; it is translocated to underground rhizomes and destroys all-visible buds. Therefore, the best method of eradicating monocotyledonous weeds is the application of glyphosate. Seed bank of weeds in the soil creates new weed populations, which predominantly comprise of dicotyledonous weeds.

Effect of glyphosate on coconut seedling growth: Glyphosate 1.08 kg ai/ha (3 l/ha) significantly increased ($P < 0.05$) the height and girth of seedlings compared to other treatments

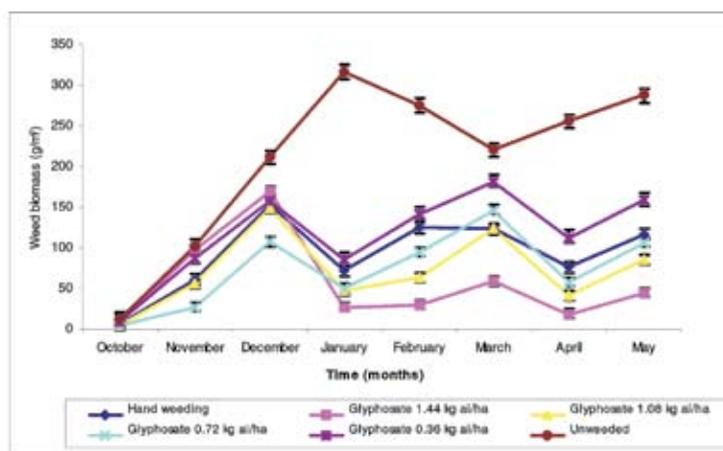


Figure 1: Effect of treatments on weed biomass (g m^{-2})

effective in reducing both monocotyledonous and dicotyledonous weeds.

When manual weeding, fast re-growth, especially monocotyledonous weeds was observed, as under ground vegetative plant

(Tables 1 & 2). This increase started from the latter part of the nursery growth period with the reduced competition of weeds for soil moisture and nutrients.

Table 1: Effect of weed control treatments on collar girth (cm) of coconut seedlings from October 2002 to May 2003

Treatments	Time (month)				
	Feb 2003	Mar 2003	April 2003	May 2003	June 2003
T ₁ - Manual weeding	5.28	7.27	9.08	11.15	13.10
T ₂ - Glyphosate 1.44kg ai/ha	6.01	7.65	9.30	12.25	12.70
T ₃ - Glyphosate 1.08kg ai/ha	6.21	7.64	9.36	12.50	14.83
T ₄ - Glyphosate 0.72kg ai/ha	5.98	7.78	9.60	12.25	13.80
T ₅ - Glyphosate 0.36kg ai/ha	5.82	7.22	8.80	10.94	13.09
T ₆ - Unweeded control	6.02	7.32	8.02	9.96	12.30
LSD (P=0.05)	-	-	0.93	0.79	1.80
CV%	-	-	5.69	3.81	4.37

Table 2: Effects of weed control treatments on height (cm) of coconut seedlings from October 2002 to May 2003

Treatments	Time (month)				
	Feb 2003	Mar 2003	April 2003	May 2003	June 2003
T ₁ - Manual weeding	54	63	82	97	107
T ₂ - Glyphosate 1.44kg ai/ha	60	68	92	112	118
T ₃ - Glyphosate 1.08kg ai/ha	63	69	87	109	125
T ₄ - Glyphosate 0.72kg ai/ha	55	65	87	107	115
T ₅ - Glyphosate 0.36kg ai/ha	50	60	81	102	109
T ₆ - Unweeded control	47	58	78	99	109
LSD (P=0.05)	-	6	7	7	8
CV%	-	4.5	4.7	3.6	3.9

At the end of the experiment coconut seedlings in the T₃ treatment (Glyphosate at 1.08 kg a.i./ha) were tallest followed by the T₂ (Glyphosate at 1.44 kg a.i./ha) treatment. The highest collar girth increment was found in T₃ (Glyphosate at 1.08 kg a.i./ha) while the second highest increment was found in T₄ (Glyphosate at 0.72 kg a.i./ha) treatment. This indicates that T₂ (Glyphosate at 1.44 kg a.i./ha) treatment is more effective in reducing the weed population with no effect on coconut seedling growth.

Some yellow patches also appeared on leaves of seedlings sprayed with 1.44 kg ai/ha (T₂) and 1.08 kg ai/ha glyphosate (T₃). It was noted that manual weeding did not result in any significant increase in growth parameters of the coconut

seedlings compared to those in unweeded plots. There were no significant differences between seedlings in control, manual weeded and low concentration of glyphosate used (0.72 kg ai/ha and 0.36 kg ai/ha) plots. The highest growth rate of coconut seedlings was observed in the T₃ treatment (Glyphosate at 1.08 kg ai/ha) (Tables 1 & 2). The rates of seedling height and girth increase were 16.4 cm and 2.2 cm per month respectively in T₃.

Cost benefit analysis of different weed control method

The costs of different weed control methods are given in the Table 3.

Table 3: Cost analysis of different weed control treatments.

Treatments	Frequency of treatment application during the nursery period	Weeding cost per 1000 coconut seedlings in one application	Total weeding cost per 1000 coconut seedlings during the nursery period
T ₁ - Manual weeding	4	1000.00	4000.00
T ₂ - Glyphosate 1.44kg ai/ha	3	66.00	198.00
T ₃ - Glyphosate 1.08kg ai/ha	3	60.00	180.00
T ₄ - Glyphosate 0.72kg ai/ha	3	52.00	156.00
T ₅ - Glyphosate 0.36kg ai/ha	3	44.00	132.00

Include material & labor cost

Average price of commercial product of glyphosate SL Rs 400 /liter

Average labor wage: SL Rs 500/ manday

US 1\$ = Sri Lankan (SL) Rs 115

Treatments with glyphosate at 1.44 kg ai/ha and 1.08 kg ai/ha produced the lowest weed biomass, but the most cost-effective method of controlling weeds in the study was to apply glyphosate at the rate of 1.08 kg ai/ha (3 l commercial mixture per ha). Manual weeding was the most expensive. The low concentrations of glyphosate treatments such as T₄ and T₅ were

less expensive but they were not effective in controlling weeds.

CONCLUSION

Application of glyphosate at 1.08 kg ai/ha gives the most cost effective weed control method to produce good quality seedlings in coconut nurseries. Lower concentrations did not control weeds effectively in coconut nurseries.

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