Cost of weed control - delayed harvesting after ripening and during the dry season on a tropical sugarcane plantation in Indonesia

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Abstract Weed control in a tropical sugarcane plantation such as Gunung Madu is the third largest production cost. Little information exists about weed control after harvest in artificially-ripened fields and in the dry season. The aim of this work was to evaluate the cost of weed control at those two times. Two investigations were initiated. In 2014 the cost of weed control was determined following two harvest strategies, cane harvested 28-34 days after ripening (zone A) and cane harvested 35-42 days after ripening (zone B). The second experiment was conducted during the dry season in August 2015 and included three treatments (manual, chemical, no control) in areas with weed ground coverage ≤ 10% and ≥ 10%. The results of the first trial showed that the amount of herbicide and cost of weed control in zone A were about 15% and 10%, respectively, lower than zone B. Moreover, the sugarcane growth in zone B was not suppressed by delaying harvesting. In the second trial, chemical and manual weed control of weeds were not significantly different. However, the cost of manual control was lower than the chemical control when weed ground coverage was > 10%. These findings emphasize that from a weed-control perspective, artificially ripened fields should be harvested less than 35 days after ripener application, and manual weed control in dry season can be more efficient than chemical control if weed pressure is high.

Key words Sugarcane, ripener, weeding cost, duration, manual weeding

INTRODUCTION

Weed control is the third highest production cost after fertilizers and fossil fuels at the Gunung Madu sugarcane plantation in Indonesia. At least IDR 12.5 billion are allocated every year to cover the cost of weed control on the plantation. With rising production costs and an unpredictable national economy, efficiency of chemical application is one of the most important ways of improving the financial situation and enhancing plantation productivity.

Ripeners have been applied to improve sugarcane quality on the Gunung Madu plantation since 2000. Although glyphosate has been used for this reason, there is an awareness of possible negative effects to ratoon regrowth (Viator et al. 2011). Silva and Caputo (2012) summarized the negative impact of glyphosate, one of which is a reduction in germination of ratoon crops. Consequently, the slower canopy development results in an extended period of bare soil with prolonged exposure to sunshine. Favourable environmental conditions including sunshine, adequate rainfall, warm temperature and less sugarcane canopy support rapid and intensive weed growth. A similar condition occurs if harvesting is delayed. The growth rate and density of weeds will affect the cost of weed control. Therefore, it is necessary to evaluate the cost of weed control during such circumstances.

We conducted two trials to evaluate the cost of weed control when harvesting was delayed and during the dry season.

MATERIALS AND METHODS

Experiment 1

The first experiment was based on a survey conducted over 1 year initiated in the 2013-2014 season. Information about individual blocks was recorded. It included the date of ripener application, date of harvest, the amount and cost of subsequent herbicide applications, and the height of the ratoon cane 3 months after harvest. The data were separated according to harvest date, namely cane harvested 28-34 days after the ripener (<35 DAR) was applied (Zone A) and 35-42 days after the ripener (>35 DAR) was applied (Zone B).
Experiment 2

The second experiment was carried out in August 2015 to coincide with the dry season. Treatments included chemical weeding (paraquat), manual weeding and no-weeding (control). These treatments were replicated four times in a randomized block design. The plot size was 20 rows x 72 m, with double rows spaced in a 130-80 cm configuration. Weed ground cover was measured before application, and then at 1 and 4 weeks after application. Sampling plots (1 m x 1 m) established to measure weed ground coverage were divided into four parts, each part assumed as 25% of coverage. Weed ground coverage sampling was repeated four times in each treatment plot. Total weeding cost was calculated and based on the weed ground coverage (0 - > 25%).

RESULT AND DISCUSSION

Experiment 1

The data in Figure 1 indicate that a prolonged delay in harvest (>35 DAR) did not affect significantly the height of the ratoon cane or the weed ground cover 3 months after harvest. A possible explanation could be that the glyphosate residue from the previous year was moved into the basal buds inhibiting tillering and stem elongation by several physiological processes (Viator et al. 2011; Silva and Caputo 2012).

Despite the increased weed ground coverage due to the delayed harvest (> 35 DAR) not being statistically significant, the amount of herbicide used and weeding cost were affected (Fig. 2). Herbicides used and weeding cost per hectare in zone A were, respectively, 14.7 and 10.1% less than in zone B. These results showed that the co-operation between ripening and harvesting programs on the plantation is important to ensure optimized result in the production targets, including the cost effectiveness of weeding.

![Plant height (cm) and Weed ground coverage (%)](image1)

**Fig. 1.** Average height of plants in the ratoon and weed ground coverage 3 months after harvest.

![Herbicides used (L/ha) and Weeding cost per hectare (IDR)](image2)

**Fig. 2.** Average use herbicides and weeding costs.
Experiment 2

Manual weeding in the dry season gave similar successful results to chemical weeding for suppressing weeds and maintaining control until 4 weeks after application (Table 1). This result was assisted by favorable environmental conditions. There was no rainfall recorded during the trial and maximum air temperature varied between 34° and 37°C. Weeds that persisted under hot and dry weather were likely to become a problem in the subsequent wet season. Therefore, we assume that if we can control the weed properly in the dry season, the growth of weeds would be suppressed and be easier to control at the beginning of the wet season.

Table 1. Weed ground cover associated with weed management treatments at 0-4 weeks after weed control. Means within the same week with the same letters are not different (p<0.05) by LSD test.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weeks after control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Chemical weeding</td>
<td>9.88 a</td>
</tr>
<tr>
<td>Manual weeding</td>
<td>9.25 a</td>
</tr>
<tr>
<td>No-weeding (control)</td>
<td>10.50 a</td>
</tr>
<tr>
<td>CV (%)</td>
<td>17.46</td>
</tr>
</tbody>
</table>

Manual weeding was cheaper than chemical weeding with > 10 % weed ground cover (Table 2). However, we recognize that manual weeding is not widely appropriate due to a dwindling work force. A similar problem was reported by Singh and Bhosale (2014) who compared mechanical to manual weeding in India. However, our results indicate that manual weeding may still be effective in some circumstances such as when workers are available, for spot-controlling areas, in drought seasons and when there are limited supplies of herbicides.

Table 2. Weed control cost (IDR) based on weed ground coverage on the trial plots.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Ground coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Chemical weeding</td>
<td>55,125</td>
</tr>
<tr>
<td>Manual weeding</td>
<td>64,650</td>
</tr>
<tr>
<td>Cost differences</td>
<td>(9,525)</td>
</tr>
</tbody>
</table>

CONCLUSIONS

Our project has resulted in information about the cost efficiency of weed control linked to harvest time for artificially-ripened sugarcane and controlling weeds in the dry season. Delaying harvest > 35 days after ripening did not affect the subsequent sugarcane growth but did increase the amount of herbicides and the weeding cost by about 15% and 10%, respectively, compared to the cane harvested < 35 days after ripening. Manual weeding was more cost effective than chemical weeding when there was >10% weed coverage. More work needs to be done to confirm the applicability of these results at commercial scales.

REFERENCES


Coût de la maîtrise des mauvaises herbes – récolte retardée après l’application d’un maturateur et pendant la saison sèche sur une plantation de canne à sucre en Indonésie

Résumé. La maîtrise des mauvaises herbes dans une plantation de canne à sucre en zone tropicale comme celle de Gunung Madu représente le troisième poste de coût. Peu d’informations sont disponibles quant à la maîtrise des mauvaises herbes dans les champs après qu’ils aient été mûris artificiellement et pendant la saison sèche. L’objectif de ce travail était d’évaluer le coût de la maîtrise des mauvaises herbes dans ces deux situations. Deux enquêtes ont été initiées. En 2014 ce coût a été évalué en suivant deux stratégies de récolte après maturation, des cannes récoltées 28-34 jours après maturation (Zone A) et des cannes récoltées 35-42 jours après maturation (Zone B). Le second essai a été conduit durant la saison sèche en août 2015 et comportait trois traitements (manuel, chimique et aucun contrôle) dans des zones où le recouvrement du sol par les mauvaises herbes était ≤ 10% et ≥ 10%. Les résultats du premier essai ont montré que la quantité d’herbicides et le coût de la maîtrise des mauvaises herbes dans la zone A ont été inférieurs à ceux de la zone B, respectivement d’environ 15% et 10%. Mais la croissance de la canne à sucre de la zone B n’a pas été réduite par la récolte retardée. Le coût du sarclage manuel a été inférieur à celui de la maîtrise chimique quand le recouvrement du sol par les mauvaises herbes était > 10%. Ces résultats soulignent, en ce qui concerne la maîtrise des mauvaises herbes, que les champs mûris artificiellement doivent être récoltés moins de 35 jours après l’application du maturateur, que le sarclage manuel des mauvaises herbes pendant la saison sèche peut être plus efficace que le traitement chimique si la pression des mauvaises herbes est importante.

Mots-clés: Canne à sucre, maturateur, coût du désherbage, période, sarclage manuel

Costo de control de malezas - retraso en la cosecha después de la maduración y durante la estación seca en una plantación tropical de caña de azúcar en Indonesia

Resumen. El control de malezas en una plantación tropical de caña de azúcar como Gunung Madu es el tercer rubro en importancia de los costos de producción. Existe poca información sobre el control de malezas en los campos después de la cosecha de la caña madurada con madurador y en la estación seca. El objetivo de este trabajo fue evaluar el costo del control de malezas en esas dos épocas. Se realizaron dos trabajos de investigación. En 2014 el costo del control de malezas se determinó siguiendo dos estrategias de cosecha, caña cosechada a los 28-34 días después de la maduración (zona A) y caña cosechada a los 35-42 días después de la maduración (zona B). El segundo experimento se llevó a cabo durante la estación seca en agosto de 2015 e incluyó tres tratamientos (manual, químico, sin control) en áreas con cobertura de malezas ≤ 10% y ≥ 10%. Los resultados de la primera prueba mostraron que la cantidad de herbicida y el costo de control de malezas en la zona A fueron aproximadamente 15 y 10% más bajos, respectivamente, que la zona B. Además, el crecimiento de caña de azúcar en la zona B no fue afectado por retrasar la cosecha. En el segundo ensayo los tipos de control de malezas manual y químico no fueron significativamente diferentes. Sin embargo, el costo del control manual fue menor que el control químico cuando la cobertura del suelo era > 10%. Estos resultados hacen hincapié en que desde una perspectiva de control de malezas, los campos madurados artificialmente deben cosecharse en menos de 35 días después de la aplicación del madurador, y el control manual de malezas en la estación seca puede ser más eficiente que el tratamiento químico de malezas si la presión de malezas es alta.

Palabras clave: Caña de azúcar, madurador, costo de deshierbe, duración, escarda manual