RESEARCH ARTICLE OPEN ACCESS

Burial Process of Broza with Application of Efficient Microorganisms

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ABSTRACT
The sugarcane harvest represents a technological challenge because only the sugar stalks are used and the rest are residues of agricultural crops or bushes, for which different investigations have been carried out to take advantage of this residue and give it adequate environmental and economic management.
The objective of the study is to evaluate the degradation of the weed incorporated in the sugarcane rows during the cultivation process and to determine the post-harvest effects on field yields.
It was concluded that the application of efficient microorganisms allows generating a greater habitat for the decomposition process of this matter, occurring continuously with adequate humidity. In addition, the costs in this process of burying the weeds are cheaper compared to the traditional one.
Keywords – brushwood, microorganisms, cane.

Date of Submission: 15-06-2021 Date of Acceptance: 30-06-2021

I. INTRODUCTION

Sugarcane cultivation is of worldwide relevance; its high biomass production per unit area requires the use of heavy machinery for harvesting and transportation. It is currently harvested green or burned, manually or mechanized [1].

Sugarcane harvesting represents a technological challenge because only the sugar stalks are used and the rest are agricultural harvest residues or brushwood, which is why different research has been carried out to take advantage of this residue and give it an adequate environmental and economic management [2].

For this reason, it is proposed to evaluate and determine a methodology for the incorporation of brushwood in the field in order to take advantage of the organic matter in the soil and subsequently to the crop.

The objective of the study is to evaluate the degradation of the brush incorporated in the sugarcane rows during the cultivation process and to determine the post-harvest effects on field yields.

II. PROCEDURE

The study will be conducted in 11 fields with in-furrow brush incorporation. The techniques differed in some fields, as they were adapted to each one during the course of the study.

Protocols were drawn up for each field indicating the quarters, plan and incorporation technique to facilitate the final evaluation of the harvest, comparing them with their witnesses, which would be the other unincorporated quarters.

Fields:
1.- San Patricio.
2.- Manzueto.
3.- Huarangal.
4.- Estacada.
5.- Huarangal.
6.- Pampa Callana.
7.- Manzueto.
8.- San Patricio.
9.- Milagro.
10.- Molle.
11.- Pampa Ballena.

Brush degradation was evaluated by applying efficient microorganisms in each of the fields. The trial began 24 hours after the end of cane cutting. Monitoring was carried out during the cultivation period, up to one week prior to harvest.

Brush pile:
The windrower was used to obtain bales and re-stacked to form piles 30 to 40 cm high 2 x 1 to the side of the stock.

Soil preparation:
The windrower must trample one side of the acequiado, likewise, it must pass 3 times to arrive and incorporate to the ditch.
Then, the microorganisms were added at a rate of 1

m 3 per hectare.
The capping machine must pass over the brush, and on its return it must cover with the flange of soil that was left on either the right or left side.

Microbiological analysis:
- Biomass counts:
Biomass counts, and cellulose degradation, were carried out fifteen days after the application of the microbial consortium.

- Potency index:
Serves to determine enzymatic efficiency qualitatively.

Chemical analysis:
The following analyses were performed: determination of reducing sugars, determination of moisture, determination of pH, determination of Lignin and determination of organic matter.
Prior to these analyses, the samples were prepared as follows: they were washed to remove any traces of soil and roots. They were then dried at room temperature for 2 days and ground using a grinder.

- Determination of reducing sugars:
In a beacker beaker, 1 gram of sample, previously washed, dried and ground, was weighed and made up to 100 ml with distilled water. Then it was placed in a magnetic agitator for 30 minutes with temperature of 50°C. It was then filtered to approximately 10 ml. Subsequently, 0.5 ml of sample was taken in a test tube with 0.5 ml of distilled water, left to boil for 5 minutes and then cooled for 3 minutes. At the end, 5 ml of distilled water was added for reading in the spectrophotometer at 530 nm.

- Moisture determination:
The empty crucible (1) was weighed, 1 gram of sample was added to the crucible and placed in the muffle at 105°C for 12 hours. At the end of evaporation, the crucible was placed in a desiccator for 15 minutes. The crucible was removed from the desiccator and the second weight (2) was taken.

The following calculation was made:

$$\frac{(2)-(1)}{\text{sample weight}} * 100 = \%\ \text{Dry matter}$$

$$100 - \%\ \text{sample weight} = \%\ \text{Humidity}$$

- Determination of lignin
In a 250 ml beaker, 1 gram of sample was weighed and 15 ml of sulfuric acid was added, stirring it for 2 hours. Then it was transferred to a balloon adding 600 ml of distilled water, then it was placed to boiling for 4 hours, the loss of sample was avoided by placing the refrigerant. Later it was left to rest for 4 hours and the supernatant was eliminated to be washed twice with 500 ml of water. At the end, the precipitate was filtered on filter paper previously weighed (1) and placed in a Petri dish previously weighed (2) and then taken to the muffle at 105°C for 2 hours.
Once the drying was finished, it was placed in a desiccator for 15 minutes and then weighed (3).
The following calculation is made:

$$\frac{(3)-(2)-(1)}{\text{sample weight}} = \%\ \text{Lignin}$$

- Determination of organic matter:
The sample obtained from the moisture analysis was taken and placed in the muffle at 550°C for 12 hours. At the end of calcination, the muffle was allowed to cool to 200°C, then the crucible was placed in a desiccator for 15 minutes. Finally, the second weight (3) was taken.
The following calculation is made:

$$100 - \frac{(3)-(1)}{(2)-(1)} * 100 = \%\ \text{Organic matter}$$

(1) : Weight of empty crucible
(2) : Weight of the crucible plus the sample after evaporation at 105°C.

III. RESULTS

The 11 fields were monitored for 12 to 13 months. The removal of 9 to 10 samples was carried out randomly within the field, depending on the hectares tested for this process.

Table 01: Fields buried with brush and application of efficient microorganisms.

Nº	FIELD	FIELD 2	HAS	CUT TYPE	TAS/HAS	REMARKS	DOSAGE (M^3/Hect)	APPLIED AMOUNT
1	S. PATRICIO	1425 S. PATRICIO	9.75	MACHINING	1.54	M.O. APPLIED.	0.5	4.875
2	ESTACADA	1404C ESTACADA	5.19	MACHINING	0.96	M.O. APPLIED.	0.5	2.595
3	MANZUETO	1718 MANZUETO	1.63	MANUAL	3.68	M.O. APPLIED.	1	0.815
4	HUARANGAL	1620 HUARANGAL	44.52	MACHINING	0.85	M.O. APPLIED.	0.5	22.26
5	PAMPA CALLAN	518A PAMPA CALLAN	5.74	MACHINING	0.87	M.O. APPLIED.	0.5	2.87
6	ALAMEDA – B	1434 ALAMEDA – B	25.7	MANUAL	0.86	CTEL 1 APPLIED.	0.5	2.3
7	MANZUETO	1704 MANZUETO	26.69	MACHINING	1.09	M.O. APPLIED.	1	26.69
8	MILAGROS	2204 MILAGROS	2.00	MANUAL	1.50	M.O. APPLIED.	0.5	1
9	S. PATRICIO	1467A S. PATRICIO	13.33	MANUAL	1.05	M.O. APPLIED.	0.5	6.665
10	MOLLE	1402C. MOLLE	22.64	MANUAL	0.66	M.O. APPLIED.	0.5	11.32
11	V. BARATO	1516A V. BARATO	16.13	MACHINING	0.74	M.O. APPLIED.	0.5	8.065
12	V. BARATO	1516A V. BARATO	36.93	MACHINING	0.76	NO M.O. APPLIED.		
							TOTAL	89.455

HAS = HECTARES. TAS/HAS = TONS/HECTARES. M.O. = MICROORGANISMOS.

Table 02: cost of burying brushwood in manual cutting and cutting mecanizado.

1402C MOLLE	*679.2 Tn total whole brush (manual harvesting)*						
LABOR	HOURS	PLAN TARIFF	TT S/.	Cost/Ha S/.	Cost/Tn	ha/hr	hr/ha
EBMA windrowing	38.3	109.4	4190.02	185.07	6.17	0.6	1.69
EBMA trenching	21.5	263.9	5673.85	250.61	8.35	1.1	0.95
EBMA brush incorporation	23.7	109.4	2592.78	114.52	3.82	1.0	1.05
EBMA Brush Embedding EBMA	15	67.5	1012.50	44.72	1.49	1.5	0.66
Application of microorganisms EBMA	11.8	214.6	2532.28	111.85	3.73	1.9	0.52
EBMA Trench Covering	11.7	165.2	1932.84	85.37	2.85	1.9	0.52
			S/. 17934.27	S/.792.15	S/.26.40		5.39

Table 03: Cost of the traditional way of brush management.

1516A VENDE BARATO	*1326.5 Tn total whole brush (manual harvest)*						
LABOR	HOURS	PLAN TARIFF	TT S/.	Cost/Ha S/.	Cost/Tn	ha/hr	hr/ha
Windrowing EBMQ	40.3	109.4	4408.82	83.09	3.32	0.6	1.69
Trench opening EBMQ	36.6	263.9	9658.74	182.03	7.28	1.1	0.95
Brush placement EBMQ	40	67.5	2700.00	50.89	2.04		
Brush incorporation EBMQ	53.8	109.4	5885.72	110.93	4.44	1.0	1.05
Brush Embedding EBMQ	5.2	214.6	1115.92	21.03	0.84	1.5	0.66
Application of microorganisms EBMQ	20.5	165.2	386.60	63.83	2.55	1.9	0.52
Trench Covering EBMQ	9.1	166.2	1512.42	28.50	1.14	1.9	0.52
			S/. 28668.22	S/.540.30	S/. 21.61		5.39

TT: Total Tons. Cost/Ha. Cost/hectare. Cost/Tn: Cost/Ton. Ha/hr: hectares/hours. Hr/Ha: Hectares/Hours.

Table 04: Cost per Ton and Hectare of burying of brushwood

1205 STO DOMINGO	90 Tn total of whole brush (manual harvesting)						
LABOR	HOURS	PLAN TARIFF	TT S/.	Cost/Ha S/.	Cost/Tn	ha/hr	hr/ha
Excavation	25.9	144.0	3729.60	1243.20	41.11	0.12	8.63
Brush pile	7.9	100.0	790.00	263.33	2.93	0.38	2.63
			4519.60	1506.53	44.37		

1415B CANOA	100 Tn total whole brushwood (manual harvest)						
LABOR	HOURS	PLAN TARIFF	TT S/.	Cost/Ha S/.	Cost/Tn	ha/hr	hr/ha
Whole brush loading	15.167	110.98	1683.17	420.79	16.83	0.26	3.79
Unloading of whole brush	5.6	110.98	621.46	155.37	6.21	0.71	1.40
Whole brush transport	13.466	69.52	936.11	234.03	9.36	0.30	3.37
	3.983	165.24	658.17	164.54	6.58	1.00	1.00
			3898.91	974.73	38.99		

1415B CANOA	100 Tn total whole brushwood (manual harvest)						
LABOR	HOURS	PLAN TARIFF	TT S/.	Cost/Ha S/.	Cost/Tn	ha/hr	hr/ha
Whole brush loading	4.2	110.98	466.10	266.34	10.65	0.42	2.40
Unloading of whole brush	1.6	110.98	177.56	101.46	4.06	1.09	0.91
Whole brush transport	5.6	69.52	389.29	222.45	8.90	0.31	3.20
	2.5	165.24	413.11	236.06	9.44	0.70	1.43
			1446.06	826.32	33.05		

The analyses evaluated were reducing sugars, moisture, organic matter and lignin, as shown in Tables 05 and 06.

Table 05: Analysis of the fields at the beginning of the brush burial process.

Nº	FIELD	Months of testing	DNS	Humidity %	Organic Matter %	Lignin	cm of brush
1	Alameda Ensayo	1	89	12	62	31	65
2	Alameda Testigo	1	95	10	59	34	65
3	Estacada Ensayo	1	96	12	55	37	65
4	Estacada Testigo	1	93	12	56	36	65
5	Huarangal Ensayo	1	95	14	57	34	65
6	Manzueto A	1	96	7	51	38	60
7	Molle Ensayo	1	92	15	56	36	65
8	Pampa Callana Ensayo	1	94	10	50	33	60
9	Pampa Callana Testigo	1	90	9	51	34	60
10	Vende Barato Ensayo	1	93	12	52	39	65
11	Vende Barato Testigo	1	89	10	50	35	65
12	Campo San Patricio	1	91	14	61	37	60
13	Campo Milagros	1	92	13	60	38	60

DNS: 3,5-dinitrosalicilico. Method for the determination of sugars

Nº	FIELD	Months of testing	DNS	Humidity %	Organic Matter %	Lignin	Differential lignin	cm of brush	cm of degraded brush
1	Alameda Ensayo	1	98	12	62	25	15	6	59
2	Alameda Testigo	1	95	10	59	29	20	5	60
3	Estacada Ensayo	1	96	12	55	28	19	9	56
4	Estacada Testigo	1	93	12	56	31	24	5	60
5	Huarangal Ensayo	1	95	14	57	28	19	6	59
6	Manzueto A	1	96	7	51	24	11	14	46
7	Molle Ensayo	1	92	15	56	31	18	5	60
8	Pampa Callana Ensayo	1	94	10	50	27	16	6	54
9	Pampa Callana Testigo	1	90	9	51	28	17	6	54
10	Vende Barato Ensayo	1	93	12	52	34	18	5	60
11	Vende Barato Testigo	1	89	10	20	31	17	4	61
12	Campo San Patricio	1	91	14	61	33	20	4	56
13	Campo Milagros	1	92	13	60	33	21	5	55

Table 06: Analysis of the final fields of the brush burial process.

IV. DISCUSSION OF RESULTS

The degradation of the brushwood incorporated in the sugarcane rows was evaluated during the cultivation process.

The results of the DNS, moisture and organic matter analyses were constant at the beginning of the brush burial process and at the end of the process.

This demonstrates that the application of microorganisms in consortium accelerates the unfolding of bonds.

Another of the evaluation points was the biometry of the fields, in order to determine if the crop would be affected in this process. The results and the follow-up revealed that it does not directly affect the crop, since in the evaluations carried out there is no significant difference.

This work also analyzed a possible sustainable technological solution with the use of new techniques that consider the integral harvesting of mechanized green sugarcane [3]. This technology would reduce the costs of the traditional way by 62%, which is evident in Tables 02 and 03. Table 02 details the cost of burying brushwood in manual cutting and mechanized cutting, in which the independent procedures such as trench opening, incorporation and arrangement of brushwood, application of microorganisms and trench covering are detailed. Table 03 shows the costs of the traditional way of handling brushwood, detailing the costs in the areas of destination after transfer of the brushwood (loading, unloading and transport). Evidently, it is shown that the costs of burying brush in manual and mechanized cutting are less expensive than the traditional procedures. Likewise, the results show that the cost of burying brush in manual cutting and mechanized cutting differ by 5.38 soles per ton, with mechanized cutting being the most economical option.

Therefore, the use of this new technology would provide benefits such as the incorporation of organic matter and reduced transportation costs. However, there would also be environmental benefits, since this process avoids burning and is eco-friendly. The burning of sugarcane produces pollution in the atmosphere, and when it is not burned completely, it generates carbon monoxide (CO), an extremely toxic gas whose effects deteriorate the ozone layer. It also has an impact on the nitrogen content of the soil, which impoverishes the soil and destroys the organic matter needed by plants [4].

We can conclude that the process of burying brush with the application of efficient microorganisms represents a technology with multiple environmental and economic benefits, compared to the traditional process and method.

However, the lignin analysis showed an average of 35.54 at the beginning of the 35.54 at the beginning of the brushwood burial process and 29.38 at the end of the process. In this parameter, it is important to consider that its way of unfolding and integrating into smaller carbon chains is very difficult, so it could harden or not disappear from the soil, preserving its concentration.

V. CONCLUSIONS

1.- The application of efficient microorganisms allows to generate a greater habitat for the decomposition process of this matter, occurring in a continuous way with adequate humidity.
2.- The analyses indicate the complete decomposition of this organic matter, since it could be used at some point by the crop.
3.- In this trial it is concluded that the brushwood is 100% degraded before the end of the crop, in an average of 6 months to 10 months.
4.- The costs in this process of burying the brushwood are cheaper compared to the traditional one.

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