SPRAY VOLUME FOR THE CONTROL OF WEEDS IN SUGAR CANE

By

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Abstract

THE OBJECTIVE of this work was to evaluate the efficacy of different volumes of water for the application of imazapic in sugarcane and its effect on soil coverage and operational capacity. The minimum possible volumes applied by the sprayer (70 to 80 L/ha), 100, 150, 200 L/ha were compared to the processing plant's standard (250 or 300 L/ha) in commercial fields with areas varying between 8 and 10 ha, at three periods within the crop season. During the applications, the parameters for operational capacity analysis were analysed. Soil coverage was evaluated by means of water-sensitive sampling and quantification through image analysis. Weed control was evaluated, on a visual basis, up to 150 days following application. All the treatments were efficient in controlling weeds up to 150 days following the treatments. The surface ranged from 8.34 to 51.81% and the gain in operational performance from 4.18 to 29.80%. Thus, imazapic applied with spray volumes from 70 L/ha, with a soil coverage of 8.34%, efficiently controlled the weeds in sugarcane when applied either at the beginning, in the middle, or at the end of the crop season, providing gains up to 29.80% in the application operational performance.

Introduction

By definition, pesticide application technology is the use of scientific knowledge to provide the correct usage of the biologically active product in the target, as required, in an economic way with minimal contamination of other areas (Matuo, 1990). Although it involves knowledge in different areas, the application technology is often restricted to the adoption of a spray volume per hectare, or at most to a volume associated with a specified droplet size. When technicians or producers are asked why they are using so many litres per hectare, the answers are often 'I do not know' or 'because this is the most used one'. The volumes that have been used are almost never based on preliminary coverage, deposition and control evaluations or tests. Despite the little importance that has been assigned to it, the volume of water for pesticide application is currently one of the main items involved in the operating cost of phytosanitary treatments.

Sugarcane is not exempted from this rule. Despite the large areas and quality of the sprayers that have been used, particularly by the processing plants or big producers, the most commonly used volumes for herbicide application are pre-established, regardless of all the involved factors, and range from 200 to 300 L/ha. The fact that the application volume (L/ha) does not directly influence the biological result, once the amount of water per unit of area has been determined to facilitate the distribution of the active substance over the target surface (soil, straw or plant), with the necessary coverage, is simply not considered in the set up process. The reduction of the spray volume used for herbicide application will increase the equipment operating capacity, and can thus be an essential tool in reducing the application costs, besides the environmental gain associated with a decrease in water consumption. Proving the latter has been the objective of PROVAR – *Programa de Valorização da Água em Pulverizações Agrícolas,* a partnership between the Engineering and Automation Center of the Agronomic Institute (CEA/IAC), BASF S.A. and the sugarcane processing plants of the State of São Paulo.

Material and methods

The trials were conducted in commercial fields of six partner processing plants in the State of São Paulo: Buriti, Colorado, Santa Elisa Vale, Pedra, São Martinho and Cruz Alta. In all trials, the spraying equipment was similar to that used for commercial application, and was calibrated to deliver the following volumes: as little as possible applied by the sprayer (70 to 80 L/ha), 100, 150, 200 L/ha and the processing plant's standard (250 or 300 L/ha). The standard conditions, as well as the treatments used in each of the trials, are described in Table 1.

While establishing the treatments, the type of spraying nozzle and the class of the droplet size were kept unchanged and compared to the standard adopted by the processing plants. Only the flow and the working pressure of the nozzles were changed to adjust to the different volumes. The lowest pressure considered in the establishment of the minimum application volume was 1.5 bar as, with pressures close to 1.0 bar, failures are likely to occur in spraying once it is very close to the anti-dropping device opening pressure; the latter will prevent the system from working appropriately and, thus, negatively affecting the quality of the application. Furthermore, nozzles using 100 mesh sieves were not considered as they could increase the risk of retaining products in the filters, affecting the operational efficiency.

Table 1—Equipment, sprayers set up and treatments data.

Application conditions	Processing plant					
	Sta Elisa Vale	Pedra	Guarani /Cruz Alta	Colorado	São Martinho	Pedra / Buriti
Tractor						
Brand/Model	MF 2585	Uniport	Parruda	John Deere 6300	MF 292	Valtra BM 100
Speed (km/h)	10	15	12	8.2	6.9	10
Sprayer						
Brand/Model	FMCopling			Falcon Vortex	Albatroz	Falcon
Tank capacity (L)	1400	2500	2000	1400	1800	1400
Nozzles	TTI 11003	AVI 11005	TTI 11004	AVI 11003	AVI 11004	AI 11004
Nozzles on the boom	27	69	55	27	24	29
Spacing between the nozzles (m)	0.50	0.35	0.5	0.50	0.63	0.50
Spray volume (L/ha)	200	250	300	250	200	200
Drop size	XC	VC	XC	C	VC	VC
Treatments						
250/300 L/ha						
Nozzle		AVI 11005	TTI 11005/300	AVI 11003		
Droplet size		VC	XC	C		
200 L/ha						
Nozzle	TTI 11003	AVI 11004	TTI 11004	AVI 110025	AVI 11004	AI 11004
Droplet size	XC	VC	XC	C	VC	VC
150 L/ha						
Nozzle	TTI 11003	AVI 11004	TTI 11004	AVI 11002	AVI 11003	AI 11003
Droplet size	XC	VC	XC	C	VC	VC
100 L/ha						
Nozzle	TTI 11002	AVI 11002	TTI 11002	AVI 110015	AVI 11002	AI 11002
Droplet size	XC	VC	XC	C	VC	VC
Minimum						
L/ha	70	74		70		78
Nozzle	TTI 11002	AVI 11002		AVI110015		AI 11002
Droplet size	XC	VC		C		VC

(1) C = Coarse, VC = Very Coarse and XC = Extremely Coarse

The applications were conducted in the Beginning (June–July), Middle (August–September) and End (October–November) of the crop season and the environmental conditions were monitored, but not controlled, in an attempt to represent the real application conditions. During spraying, the temperature ranged between 20–35, 18–39 and 21–35^{o}C, the relative humidity between 19–65, 15–80 and 15–87%, and the wind speed between 0.3–6, 0.1–7.1 and 0.4–4.4 m/s, respectively to

Beginning, Middle and End applications. Imazapic (Plateau) was standardised as the herbicide to be used in all the areas, so that it did not constitute a source of variation, with doses ranging between 140 g/ha and 240 g/ha, according to the soil texture and weeds population.

Each treatment, represented by a spraying volume, was established in a commercial stand with approximately 10 hectares of cane harvested either in green (application over straw) or after burning (application over the soil).

In trials carried out at the beginning of the crop season, for each treatment, an untreated area was maintained without application with a width corresponding to the extension of the spraying boom by 10 m length. In the other trials, 3 similar areas were maintained untreated, in order to evaluate the weeds that were present.

In order to allow a soil coverage analysis and subsequently relate it to the control, 6 water-sensitive paper leaves were placed under the spray boom in the treated area, 3 of them were placed under the right boom and 3 under the left sprayer boom.

After spraying, the papers were stored into paper bags duly identified and forwarded to the laboratory for coverage analysis. In the laboratory, the water-sensitive papers were digitised through a ‘scanner’ and the images obtained were analysed with the image analysis IDRISI software, in order to determine the coverage percentage from colour contrast, in compliance with the method developed and evaluated by Firveda *et al.* (2002).

To assess the efficacy of the different treatments on weed control, untreated and selected sampling points were assigned total or specific coverage percentage scores for the species at 30, 60, 90, 120 days after the application; and, where possible depending on the culture size, also at 150 days after the application.

The scores were individually assigned by each of the 3 duly-trained observers. Five sampling points were randomly chosen, by walking between an untreated area and the other within the parcel, following the W pattern.

The observers attributed a general coverage percentage score between 0 to 100% for the weed population observed in the parcel, 0 corresponding to the absence of infestation and 100% to total area infestation (general coverage related to the observed area). Subsequently, five species were identified in the parcel and a visual grading of specific frequency was assigned to the individual weeds, the sum of the five grades reaching 100%. The data collected were used for the calculation of the percentage control. The control scores were submitted to variance analysis according to the design proposed and, when significant differences were observed, the averages were compared by Tukey test at 5% probability.

During the entire operation, in order to allow the economic comparison based on the adoption of the different volumes that have been considered, the times related to refilling the sprayer with the spray solution, carrier manoeuvres, emptying the spraying tank, the time required to move from refilling to the application areas were collected, in addition to the measurement of the stand’s length.

The gain in operational capacity, calculated based on the time required to spray one ha, was analysed considering the following formula proposed by Matuo (1990):

$$t = \frac{10000}{Vp \, . \, L} + \frac{10000 \, . \, TV}{C \, . \, L} + \frac{d \, . \, v}{Vd. \, Ca} + \frac{Tr \, . \, V}{Ca}$$

where:

t	=	Time required to spray 1 hectare (min/ha).
Vp	=	Spraying speed (m/min).
L	=	Width of the spraying area (m).

Tv = Turn time (min).
C = Length of the treatment area (m).
D = Total covered distance in each refilling (m).
V = Spraying volume (L/ha).
Vd = Forward speed for refilling (m/min).
Ca = Tank capacity (L).
Tr = Time for tank refilling (min).

Results and discussion

A sample of the surface coverage obtained by each of the different treatments is shown in Figure 1.

According to data obtained (Table 2), soil coverage ranged from 8.34 to 51.81%, and the coverage of the control could be compared with the other treatments.

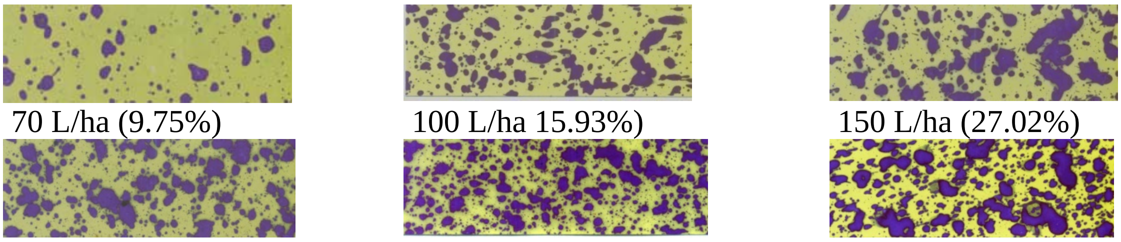

Fig. 1—Examples of surface coverage obtained from the water-sensitive papers for the different treatments and processing plants.

Table 2—Coverage means obtained from the water-sensitive papers in the different treatments, processing plants, and application timing.

Processing plant	Coverage	Droplet[1]	Treatments (L/ha) Min	100	150	200	250	300
			Mean coverage (%)[2]					
Colorado	Green	C	8.65	14.94	28.42	45.78	50.87	
Colorado	Burnt	C	8.84	15.09	24.26	40.12	48.05	
Cruz Alta	Green	XC		18.89	21.31	30.26		40.80
Sta Elisa	Green	XC	8.77	17.45	30.40	35.46		
Sta Elisa	Burnt	XC	8.34	16.63	28.29	44.36		
São Martinho	Green	VC		13.09	32.63	34.15		
Pedra	Burnt	VC	13.22	16.74	22.50	38.73	51.81	
Buriti	Green	VC	10.70	14.57	28.32	34.86		

(1) C = Coarse, VC = Very Coarse and XC = Extremely Coarse
(2) Mean coverage of Beginning, Middle and End phases

The visual control evaluations have not shown significant differences for any of the considered volumes, application timing or processing plant. Thus, soil coverage up to 8.34%, such as those obtained in the coverage evaluation, was sufficient to reach the maximum efficacy of the herbicide.

It should be noted that imazapic is a high solubility herbicide and, therefore, has high redistribution capacity in soil solution and penetration in straw. It may be that such coverage would not be applicable to some very low solubility herbicides.

The mean operational data of the three application times are described in Table 3.

Table 3—Identification of the operational mean data of the three herbicide application timings in sugarcane.

Analysed item	Processing plant							
	Buriti	Colorado		Cruz Alta	São Martinho	Vale do Rosário		Pedra
	Green	Green	Burnt	Green	Green	Green	Burnt	Burnt
Filling (min)	15.53	4.28	6.91	7.35	8.27	11.30	15.32	7.41
Manoeuvre (min)	0.47	0.42	0.33	0.28	0.30	0.35	0.29	0.45
Dry the Tank (min)	64.5	76.00	68.37	60.88	77.81	76.46	86.29	55.64
Shot (min)	7.51	7.27	5.68	6.01	10.28	9.48	6.33	6.63
Moving to the area (min)	4.65	5.92	4.78	4.33	5.79	4.72	3.42	3.84
Stand length (m)	564.00	550.00	560.00	501.25	553.00	541.00	405.00	656.00

The operational capacities at the three timings of application, considering the mean data obtained from each processing plant, are presented in Table 4.

The operational capacities were not very different between the processing plants, except for Cruz Alta and Pedra where the ready-to-use spray-mixture system has already been adopted, with considerably reduced filling and filling moving times.

In all of them, the operational capacity gain was significant, ranging between 4.18 and 29.80%.

Table 4—Mean time required to spray 1 ha using different spray volumes.

Volumes	Processing plants							
	Buriti	Colorado		Cruz Alta	Vale do Rosário	São Martinho		Pedra
	Green	Green	Burnt	Green	Burnt		Green	Burnt
	Time required to spray 1 ha (min)							
Minimum	6.25	6.84	6.71		6.05	6.28		2.46
100	6.54	7.04	6.94	2.75	6.40	6.68	6.98	2.58
150	7.26	7.38	7.33	3.04	6.97	7.35	7.35	2.80
200	7.98	7.72	7.71	3.33	7.54	8.02	7.72	3.02
250/300		8.06	8.10	3.92				3.25

Conclusions

The results showed that imazapic (Plateau) applied with spray volumes from 70 L/ha efficiently controlled weeds in sugarcane when applied at the beginning, middle or end of crops. As the level of control was not adversely affected, the adoption of lower water volumes may represent reduced application operating costs for the processing plants, ranging from 4.18 to 29.80% of the total invested amount.

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EFFET DES VOLUMES DE BOUILLIE SUR LA MAITRISE DES MAUVAISES HERBES EN CANNE À SUCRE

Par

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MOTS-CLÉS: Herbicides, Technique d'Application des Pesticides, Imazapic, Gouttelette.

Résumé

L'OBJECTIF de ce travail était d'évaluer l'efficacité de différents volumes de bouillie pour l'application d'imazapic en canne à sucre, ainsi que leur taux de couverture du sol et les aspects opérationnels. Les quantités minimum applicables par le pulvérisateur (70 à 80 l/ha, 100, 150 et 200 l/ha) ont été comparées aux volumes standards qui sont de 250 à 300 l/ha; les essais ont été conduits sur des parcelles de cultures commerciales de 8 et 10 ha à trois périodes de la saison culturale. Au cours des applications, les paramètres de la pulvérisation ont été analysés. La couverture du sol a été évaluée grâce à des papiers hydrosensibles traités par analyse d'image. La maitrise des mauvaises herbes a été estimée par des contrôles visuels jusqu'à 150 jours après l'application. Tous les traitements ont été efficaces sur l'enherbement jusqu'à 150 jours après l'application. Les surfaces couvertes variaient de 8.34 à 51.81% et les performances de l'opération étaient améliorées de 4.18 à 29.80%. Ainsi, l'imazapic appliqué avec une bouillie à 70 l/ha avec une couverture du sol de 8.34% a maîtrisé efficacement les mauvaises herbes en canne à sucre que l'application soit effectuée au début, au milieu ou à la fin de la saison de culture, en apportant un gain de performance atteignant 29.80%.

VOLÚMEN DE PULVERIZACION PARA EL CONTROL DE MALEZAS EN CAÑA DE AZUCAR

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PALABRAS CLAVES: Herbicidas, Tecnología de Aplicación En Pesticidas, Imazapic, Gota.

Resúmen

EL OBJETIVO de este trabajo fue evaluar la eficacia de diferentes volúmenes de agua para la aplicación de imazapic en caña de azúcar, y su efecto en la cobertura del suelo y en la capacidad operativa. Se compararon volúmenes de aplicación, en tres diferentes períodos dentro de la estación de crecimiento, entre el mínimo posible aplicado por la pulverizadora (70 a 80 L/ha), 100, 150 y 200 L/ha, con los estándares utilizados en el cultivo (250 o 300 L/ha) en lotes comerciales con superficies de entre 8 y 10 ha. Durante las aplicaciones, se analizaron los parámetros para el análisis de capacidad operativa. Se evaluó la cobertura del suelo a través de muestreo hidro-sensible que fue evaluado utilizando análisis de imágenes. Se evaluó el control de malezas, en forma visual, hasta 150 días después de la aplicación. Todos los tratamientos fueron eficientes para el control de malezas hasta los l50 días. La cobertura tuvo un rango de 8.34 a 51.81% y la ganancia en desempeño operativo varió de 4.18 a 29.80%. De este modo, imazapic aplicado con volúmenes de aplicación de 70 L/ha, con una cobertura de suelo de 8.34%, controló eficientemente las malezas en caña de azúcar tanto en aplicaciones al inicio, mitad o final del periodo de crecimiento, generando ganancias de hasta 29.80% en la capacidad operativa de la aplicación.