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Frequency of Herbicide Applications to Coffee Groves[1]

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ABSTRACT

Dowpon, Roundup, Gramoxone and mixtures of Karmex with Dowpon or Gramoxone applied with different frequency were evaluated for weed control in young sun-grown coffee trees at Adjuntas Agricultural Experiment Substation, located at lat. 18° N. and long. 66°48' W., and at an elevation of 588 m. Gramoxone (0.95 L/ha) applied at one- or two-month intervals provided excellent weed control. Dowpon at 5.65 and 11.30 kg/ha was equally effective on grasses but ineffective on broadleaves. Roundup (1.90 L/ha) provided good weed control without producing detrimental effects on tree growth and yield. The addition of Karmex to the Gramoxone or Dowpon solution to increase effectiveness in control is questionable. Tree mortality was higher and coffee yield lower when Karmex was added to the solution than when either Gramoxone or Dowpon was used alone.

When Dowpon was applied at a rate of 11.30 kg/ha, coffee production was significantly higher than production of the remaining treatments, except for that of the application of 5.65 kg/ha of Dowpon at 12-week interval. The production of the latter plots was significantly higher than that of plots in which Karmex (2.26 kg/ha) was added to the Dowpon (5.65 kg/ha) or the Gramoxone solution (0.95 L/ha) and applied each at 12-week intervals. Coffee yield when the weeds were controlled by Roundup (1.90 L/ha) or Gramoxone (0.95 L/ha) was significantly higher than that when Karmex (2.26 kg/ha) was added to the Gramoxone solution and applied every 12 weeks.

INTRODUCTION

Coffee production in Puerto Rico for 1977–78 was 13,150,000 kg, with a farm value of $46.8 million. From the economic point of view, coffee was the second in importance among all agricultural crops in the Island. Coffee contributed 9.3% of the total agricultural gross income of the Island during that year.

Around 52,000 hectares are devoted to coffee production mainly in the mountainous region. An average of 8,000 persons were employed in coffee

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production during 1977-78. Nevertheless, fluctuations on labor requirements ranged from 3,000 in April to 14,000 at the harvesting season. During the past 10 years a constant decrease in employment has taken place.

During the past few years, the number of new coffee plantations established has increased significantly. This has been mainly due to a strong governmental agricultural program that calls for the establishment of new coffee groves using the latest production, and protection techniques in order to restore the coffee industry.

Weeds still constitute a critical problem in young sun-grown coffee plantations. The use of 1.22 m × 3.05 m planting distance provides an ample space for the luxuriant growth of weeds. Thus, weed control is a very expensive operation if herbicides are not used. The competition between the weeds and the young trees for water and nutrients is one of the limiting factors in the establishment of new coffee plantations. Consequently, the presence of weeds can cause a high mortality on recently transplanted seedlings.

Especially during the rainy season, weeds frequently have to be eliminated by hand. But labor is very expensive, scarce and undependable. Besides, the method is not effective because the underground parts of the weeds left in the soil germinate soon afterwards and in some cases, weeds are spread, as in the case of *Commelina diffusa, Dieffenbachia seguine,* and *Colocasia* sp.

Information is urgently needed to determine the frequency with which labeled herbicides can be safely applied to control the weeds after transplanting the seedlings. A systemic weed control program will help the farmer to reduce the costs involved in establishing new plantations. Also, the proper use of herbicides will increase coffee production, thus making the operation more profitable.

The most desirable herbicide should be a contact or systemic one that could provide good weed control under a wide range of climatic conditions and locations while the coffee plantation becomes well established (2, 3, 4). These herbicides kill the weeds while the damage to coffee trees is avoided by directing the spray to the weeds (1, 5).

MATERIALS AND METHODS

A field experiment was conducted at the Adjuntas Substation, located in the Central Humid Region of Puerto Rico, from April 1975 to August 1978. The experimental site is located at lat. 18° 11′ N., and long. 66° 48′ W., and at an elevation of 588 m. The soil is an Orthoxic Tropohumults, clayey, oxidic, isohyperthermic. The total rainfall recorded for the period in which the experiment was active was 571.72 mm, ranging from 162.30 mm in 1975 to 150.30 mm in 1978. An average monthly rainfall of 18.03,

12.52, 12.82, and 13.46 mm were recorded for 1975, 1976, 1977, and 1978, respectively.

Ten treatments were replicated four times in a partially balanced incomplete block design. The Bourbon variety was planted at 4 ft (1.22 m) × 10 ft (3.05 m) apart. Each experimental plot consisted of 12 trees.

The following treatments were compared: 1) Dowpon (5.65 kg/ha) applied every 12 weeks;[3] 2) Dowpon (11.30 kg/ha) applied every 16 weeks; 3) Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) applied every 12 weeks; 4) Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) applied every 16 weeks; 5) Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) applied every 12 weeks; 6) Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) applied every 16 weeks; 7) Karmex (2.26 kg/ha) + Gramoxone (0.95 L/ha) applied every 12 weeks; 8) Roundup (1.9 L/ha) when needed; 9) Paraquat (0.95 1/ha) when needed; and 10) Check—Clean Cultivation - handweeded when needed.

Six-month-old coffee seedlings grown in plastic bags were transplanted to the field April 8, 1975. The treatments compared were applied May 29, 1975, and successively as required by the treatment differentials. When the experiment was started the experimental site was predominantly infested with *Panicum maximum, Panicum purpurascens, Digitaria sanguinalis, Paspalum conjugatum, Ipomoea tiliacea, Commelina diffusa, Solanum torvum, Solanum caribeaum, Cissus sicyoides,* and *Urena lobata.*

The 1977 crop was harvested and used as an additional criterion to measure the possible detrimental effects of the treatments (if any) on yields. Coffee berries were hand-picked every 15 days during the harvesting season.

The check plots were handweeded when needed and the weeds weighed throughout the experiment. All other plots were also handweeded at the end of the experiment and the weeds weighed.

Frequent observations were recorded on the effectiveness of each herbicide treatment and any detectable crop injury on coffee growth using the following scale:

No effect	0 point(s)
Slight weed check	1 point(s)
Moderate weed check	2 point(s)
Severe weed check, no mortality	3 point(s)
Severe weed check, 10% mortality	4 point(s)
Severe weed check, 25% mortality	5 point(s)

[3] Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

Severe weed check, 50% mortality	6 point(s)
Severe weed check, 75% mortality	7 point(s)
Severe weed check, 90–100% mortality	8 point(s)

RESULTS AND DISCUSSIONS

Tables 1, 2, 3 and 4 present the different herbicides compared, their behavior, their toxicity to coffee, and their effectiveness (weight of weeds) in the control of weeds according to the frequency and rates of application throughout the experiment. Dowpon at the rate of 5.65 and 11.30 kg/ha (treatment 1 and 2) was equally effective on grasses, especially on *Panicum maximum, Panicum purpurascens,* and *Digitaria sanguinalis.* The Dowpon treatments were ineffective against broadleaf plants. Thus, the results indicate that Dowpon should be rotated with another herbicide effective in the control of the broadleaves because of its action is limited to gramineous weeds.

Gramoxone at the rate of 0.95 L/ha (treatment 9) controlled both gramineous and broadleaf weeds. Coffee growth and yields were not affected adversely. It was necessary to make three applications at 1-month intervals to kill the weeds that were growing in the experimental plots when the experiment was started. From there on, the frequency of gramoxone application varied at intervals of 1 to 2 months between applications depending on rainfall. *Ipomoea tiliacea* was somewhat resistant to Gramoxone.

TABLE 1.—*Effect of herbicide and frequency of application on weeds of recently transplanted coffee trees*

Treatments	Dates 1975			
	July 9	August 15	Sept. 5	Oct. 31
1. Dowpon (5.65 kg/ha) every 12 weeks	5.75	2.50	3.75	3.00
2. Dowpon (10.3 kg/ha) every 16 weeks	3.75	1.25	1.25	1.50
3. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 12 weeks.	6.50	4.00	4.25	5.00
4. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 16 weeks.	4.75	1.75	1.75	3.00
5. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 12 weeks	6.75	3.50	2.75	4.50
6. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 16 weeks	6.00	3.00	3.50	3.50
7. Karmex (2.26 kg/ha) + Gramoxone (0.95 l/ha) every 12 weeks	7.50	4.25	4.50	5.50
8. Karmex (2.26 kg/ha) + Gramoxone (0.95 l/ha) ever 16 weeks	7.25	4.00	3.25	3.75
9. Gramoxone (0.95 l/ha) when needed	8.00	8.00	8.00	8.00
10. Check—Clean cultivation	3.00	0	8.00	2.75

TABLE 2.—*Effect of herbicide and frequency of application on weeds in recently transplanted coffee trees*

Treatments	Dates 1976									
	Jan. 7	Feb. 19	Mar. 17	May 13	June 21	July 9	Aug. 5	Sept. 10	Oct. 31	Dec. 17
1. Dowpon (5.65 kg/ha) every 12 weeks	2.50	5.75	4.50	4.25	2.25	4.00	4.50	4.00	2.25	2.25
2. Dowpon (10.3 kg/ha) every 16 weeks	5.00	5.25	5.75	3.25	2.75	4.00	4.75	2.25	3.00	1.75
3. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 12 weeks.	7.25	6.50	7.25	6.75	6.50	7.00	6.75	7.25	6.50	4.75
4. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 16 weeks.	5.25	6.25	6.25	4.75	4.00	4.75	5.50	3.75	2.50	3.75
5. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 12 weeks	5.25	5.00	5.50	5.00	4.50	4.75	5.50	6.00	5.25	5.25
6. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 16 weeks	3.25	4.25	4.25	2.75	2.75	4.00	3.50	1.75	5.00	3.25
7. Karmex (2.26 kg/ha) + Gramoxone (0.95 l/ha) every 12 weeks	7.25	7.25	7.75	7.25	6.50	6.50	6.50	6.25	6.00	6.25
8. Karmex (2.26 kg/ha) + Gramoxone (0.95 l/ha) ever 16 weeks[1]	2.00	1.50	3.50	1.75	2.00	5.00	6.50	5.75	2.75	3.00
9. Gramoxone (0.95 l/ha) when needed	8.00	6.00	8.00	7.75	7.75	7.75	7.75	7.75	7.75	7.50
10. Check—Clean cultivation—Handweeded	0	5.00	2.25	0	1.25	0.25	3.25	0	4.00	0.25

[1] Change to 1.9 L/ha of Round-up every 16 weeks, June 1976.

TABLE 3.—*Effect of herbicide and frequency of application on weeds in a young coffee plantation*

Treatments	1977										
	Jan. 12	Feb. 15	Mar. 15	April 15	May 12	July 6	Aug. 6	Sept. 7	Oct. 6	Nov. 10	Dec. 12
1. Dowpon (5.65 kg/ha) every 12 weeks	3.50	4.00	4.00	3.50	5.00	3.00	5.25	3.75	4.75	5.00	4.75
2. Dowpon (10.3 kg/ha) every 16 weeks	3.50	5.00	4.25	3.00	3.50	6.25	2.50	0.25	3.75	3.75	4.00
3. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 12 weeks.	7.00	7.75	7.75	7.50	8.00	8.00	8.00	8.00	7.75	8.00	7.75
4. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 16 weeks.	5.25	5.75	6.25	6.25	5.75	7.50	7.00	5.25	7.00	7.50	7.75
5. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 12 weeks	5.50	7.00	7.00	6.75	8.00	7.50	8.00	8.00	7.25	8.00	7.75
6. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 16 weeks	4.50	5.00	5.25	6.00	5.00	7.25	6.75	5.25	7.50	7.50	7.75
7. Karmex (2.26 kg/ha) + Gramoxone (0.95 l/ha) every 12 weeks	6.50	7.25	7.00	7.50	7.25	6.00	6.00	6.00	7.50	7.75	7.75
8. Round-up 1.9 l/ha	2.00	3.50	6.25	6.75	7.75	5.75	7.00	5.25	7.25	6.75	5.50
9. Gramoxone (0.95 l/ha) when needed	7.00	7.25	7.75	7.50	7.75	7.50	7.50	7.75	8.00	7.50	7.25
10. Check—Clean cultivation	7.00	2.00	1.50	0.25	4.25	0	0.50	5.25	5.25	2.00	0.25

TABLE 4.—*Effect of herbicide and frequency of application on weeds in a young coffee plantation*

Treatments	Dates 1978								Trees		Weight of weeds
	Feb. 6	Mar. 12	Apr. 7	May 1	June 5	July 11	Aug. 2	Aug. 31	Dead	Injured	
											Kg
1. Dowpon (5.65 kg/ha) every 12 weeks	5.25	5.75	5.25	4.50	4.50	3.00	5.75	6.00	2	2	252.8
2. Dowpon (10.3 kg/ha) every 16 weeks	5.75	7.50	6.00	4.50	1.25	3.75	2.25	2.50	0	1	242.6
3. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 12 weeks.	7.00	8.00	8.00	7.25	8.00	7.50	8.00	8.00	11	8	14.6
4. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 16 weeks.	6.50	7.75	7.50	7.00	3.75	7.50	7.50	6.75	8	7	60.8
5. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 12 weeks	6.50	8.00	7.75	6.25	7.25	7.00	7.75	8.00	3	7	12.9
6. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 16 weeks	6.25	8.00	8.00	6.75	3.50	6.50	6.75	5.25	4	3	417.4
7. Karmex (2.26 kg/ha) + Gramoxone (0.95 l/ha) every 12 weeks	5.75	7.75	7.50	6.75	7.75	6.50	7.50	7.50	23	12	69.6
8. Round-up (1.9 l/ha)	2.00	8.00	8.00	8.00	6.50	7.75	8.00	8.00	0	1	10.0
9. Gramoxone (0.95 l/ha) when needed	5.75	7.75	8.00	7.75	7.75	7.75	8.00	8.00	1	2	6.1
10. Check—Clean cultivation	2.25	0.25	7.00	2.50	0.25	3.25	0.25	5.50	0	4	9417.7

Karmex applied in combination with Gramoxone or Dowpon showed similar results (treatments 3, 4, 5, and 6). It killed the weeds, but coffee growth was also adversely affected. A high percentage of tree mortality or seriously injured trees was observed. Therefore, the use of Karmex on recently transplanted or in young coffee plantations is not advisable. Weed control was the same when either 1.13 or 2.26 kg/ha was applied at 12- or 16-week intervals.

Roundup applied at the rate of 1.95 L/ha every 16 weeks effectively controlled gramineous and broadleaf weeds without adversely affecting coffee growth and yield.

Coffee production was significantly higher when Dowpon was applied at the rate of 11.30 kg/ha every 16 weeks than that of the remaining treatments, excepting the application of 5.65 kg/ha of Dowpon at 12-week intervals (table 5). The production of the latter was significantly higher than that in which 2.26 kg of Karmex was added to 5.65 kg of Dowpon (treatment 3) or to 0.95 liter of Gramoxone per hectare applied at 12-week intervals (treatment 7). Thus, coffee yield was reduced significantly when 2.26 kg of Karmex was added to the Dowpon or Gramoxone solution.

The coffee yield was significantly higher when Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) was applied at either 12- or 16-week intervals (treatments 5 and 6) as compared to the yield obtained when Karmex (2.26 kg/ha) + Gramoxone (0.95 L/ha) was applied at 12-week intervals

TABLE 5.—*Coffee production as affected by the frequency of herbicide application*

Treatments	Cwt/acre	Kg/ha	Farm value acre ($177.90/cwt)
1. Dowpon (5.65 kg/ha) every 12 weeks	19.10 ab[1]	2158.30	$3397.89
2. Dowpon (11.30 kg/ha) every 16 weeks	22.62 a	2556.06	4024.09
3. Dowpon (5.65 kg/ha) + Karmex (2.26 kg/ha) every 12 weeks.	9.22 cd	1041.86	1640.23
4. Dowpon (5.65 kg/ha + Karmex (2.26 kg/ha) every 16 weeks.	13.67 bc	1544.71	2431.89
5. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 12 weeks	13.69 bcd	1546.97	2435.45
6. Dowpon (5.65 kg/ha) + Karmex (1.13 kg/ha) every 16 weeks	15.02 bc	1697.26	2672.05
7. Karmex (2.26 kg/ha) + Gramoxone (0.95 l/ha) every 12 weeks	4.59 d	518.67	816.56
8. Roundup (1.90 kg/ha) every 16 weeks	15.39 bc	1739.07	2737.88
9. Gramoxone (0.95 l/ha) when needed	16.80 bc	1898.40	2988.72
10. Check—Handweeding when needed	11.39 bcd	1287.07	2026.28

[1] Values followed by one or more letters in common do not differ significantly at the 5% probability level.

(treatment 7). Coffee yield was significantly higher when the weeds were controlled by Roundup (1.90 L/ha) or by Gramoxone at the rate of 0.95 L/ha when needed (treatments 8 and 9 respectively) as compared to the yield obtained when Karmex (2.26 kg/ha) + Gramoxone (0.95 L/ha) was applied at 12-week intervals.

The yield differences among treatments 1, 8, 9, and 10 were not statistically significant. Nevertheless, a comparison of the farm crop value of $1371.61, $711.60, and $962.44 (resulting from the use of Dowpon (5.65 kg/ha every 12 weeks), Roundup (1.90 L/ha), and Gramoxone (0.95 L/ha), respectively), with the value of the handweeded crop indicates that the use of those herbicides was beneficial to coffee growth and yield. It should be pointed out that handweeding labor costs were much higher than the labor costs in the herbicide applications.

RESUMEN

Con el fin de determinar la eficacia de varios herbicidas en plantaciones de café recién establecidas a pleno sol, y su efecto sobre el desarrollo de los cafetos y el rendimiento de café, se realizó un experimento en la Subestación de Adjuntas, localizada en lat. 18°11′ N, y long. 66°48′ 0 y a una altitud de 588 m. El experimento se inició en abril de 1975 y concluyó en 1978. Se comparó el efecto de la frecuencia de aplicaciones de los herbicidas Dowpon, Gramoxone, Roundup y mezclas de Karmex con Dowpon o Gramozone.

Dowpon aplicado a razón de 5.65 y 11.30 kg/ha cada 12 ó 16 semanas respectivamente, fue muy eficaz en las gramíneas pero no en las plantas de hojas anchas. Aplicaciones periódicas de Gramoxone a razón de 0.95 L/ha cada 1 o 2 meses controló las malas hierbas con excepción del bejuco de puerco (*Ipomoea tiliacea*), sin afectar adversamente el crecimiento de los cafetos. Roundup (1.90 L/ha) las controló muy bien sin causar efecto detrimental a los cafetos. Karmex (1.13 ó 2.26 kg/ha) mezclado con 0.95 L/ha de Gramoxone ó 5.65 k/ha de Dowpon también fue muy eficaz pero fue tóxico a los arbustos. En términos generales, el uso de herbicidas disminuyó significativamente la incidencia de malas hierbas.

Los cafetos sembrados en las parcelas tratadas con 11.30 kg/ha de Dowpon produjeron significantivamente más café que los sembrados en las parcelas tratadas con los otros herbicidas con excepción de los que se trataron con 5.65 kg/ha de Dowpon. No hubo diferencias estadísticas significativas entre la producción de las parcelas tratadas con 5.65 kg/ha de Dowpon, 0.95 L/ha de Gramoxone, 1.90 L/ha de Roundup y la de las parcelas en que las malas hierbas se suprimieron con machetes. No obstante, los cafetos en las parcelas tratadas con Dowpon, Gramoxone y Roundup produjeron más café que los sembrados en las parcelas

tratadas con Karmex mezclado con Dowpon o Gramoxone o los sembrados en las parcelas en las que las malas hierbas se controlaron con machete.

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