# Oxyfluorfen: A candidate herbicide for weed control in pigeon peas[1]

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**ABSTRACT**

**Oxyfluorfen [2- chloro-1- (3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene] was evaluated throughout a series of experiments carried out from 1983 to 1986 at the Lajas Research and Development Center. In 1983 preemergence oxyfluorfen at 1.68, 3.36 and 6.72 kg ai/ha reduced significantly (P=0.05) the germination and plant height of pigeon pea cv. 2,B-Bushy. Preemergence oxyfluorfen at 1.32 kg ai/ha reduced germination of cv. Kaki by 20% in 1984–85, and by 5% in 1985–86. Oxyfluorfen at 0.33 and 0.66 kg ai/ha was found to be safe for germination of pigeon pea. There was severe injury from postemergence treatment to top of weeds and crop at 0.33 and 0.66 kg ai/ha. Phytotoxicity symptoms of pigeon pea disappeared after 9 weeks in all treated plots. The number of grass weeds was significantly reduced by Preemergence oxyfluorfen even with the 0.33 kg ai/ha rate and two direct applications of 0.25 kg ai/ha rate in both years. Broadleaf weeds were more effectively controlled by oxyfluorfen at 0.66 kg ai/ha applied over the top, followed by a direct application at 0.25 kg ai/ha. In 1984–85, the highest yield of pigeon pea (7,989 kg/ha) was obtained with oxyfluorfen at 0.33 kg ai/ha applied over-the-top plus the same herbicide at 0.25 kg ai/ha as post-directed spray. Pigeon pea yield with preemergence treatment of oxyfluorfen at 0.33 kg ai/ha plus two post-directed applications at 0.25 kg ai/ha ranked second, with 7,826 kg/ha. There were nonsignificant differences (P=0.05) in pigeon pea yields among oxyfluorfen treated plots, hand-weeded and non-weeded plots in 1985–86. Yields ranged from 6,470 kg/ha in hand-weeded plots to 4,428 kg/ha in non-weeded plots.**

## INTRODUCTION

Pigeon pea [*Cajanus cajan* (L.) Millsp.], the most widely cultivated edible legume in Puerto Rico, has declined in production during the past 3 years. In 1984–85, production was reduced to 3.4 million kg, with a farm value of $3.9 million (5). Pigeon pea plants, like other tropical crops, are subjected to weed competition, which constitutes a major cause for yield losses. In a weed-crop competition study, Díaz-Rivera et al. (6) revealed that weeds, during early growth stages, reduced initial crop growth and delayed differentiation including flowering of two pigeon pea cultivars. At the same time the elimination of weeds, at or before 28 days after pigeon pea emergence and thereafter, generally resulted in plant

[1] Manuscript submitted to Editorial Board 20 October 1986.

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recovery with normal growth and development and prevented losses in final yield. To prevent adverse effects from weed competition it is necessary to control weeds efficiently. Herbicides are recommended for pigeon pea production (1, 3).

Two preemergence herbicides are registered for use in pigeon peas in Puerto Rico (2). Under certain soil and water management conditions, prometryn and metribuzin may cause crop injury (4, 10, 11). A herbicide evaluation study with pigeon peas conducted by Riveros (12) showed that oxyfluorfen at rates of 0.75 or 1.0 kg ai/ha gave excellent initial weed control. Phytotoxicity ratings taken at 6 weeks after planting indicated that pigeon pea recovered from herbicide injury. Oxyfluorfen is a selective herbicide for weed control in several agronomic horticultural crops and various tropical fruit trees (13). It can be used either as preemergence or postemergence treatment to weeds. The objective of this research was to evaluate oxyfluorfen for efficacy and phytotoxicity in pigeon peas with goals for registration in this crop.

## MATERIALS AND METHODS

Oxyfluorfen was evaluated for weed control in pigeon peas throughout a series of experiments carried out from 1983 to 1986 at the Lajas Research and Development Center. The soil was a Fraternidad clay (Vertic udic chromusterts, very fine montmorillonitic isohyperthermic, pH from 6.5 to 5.95, and 3% organic matter content). In all cases a randomized block design was used.

In the 1983 experiment, plots were 3.7 × 6.1 m. Planting distance was 0.75 m between rows and 15 cm between plants. Pigeon pea cv. 2,B-Bushy was planted September 14, 1983. Oxyfluorfen at the rates of 1.68, 3.36 and 6.72 kg ai/ha diluted in 415 L/ha was applied with a hand-pump sprayer a day after planting. Prometryn at 3.36 kg ai/ha was applied similarly on the same date. Hand-weeded plots were hoed at 3 and 6 weeks after planting.

In the 1984–85 and 1985–86 experiments, although plots were the same size as in 1983, planting distance was 0.9 m between rows and 30 cm between plants. The 1984–85 experiment was planted July 31, 1984 and the 1985–86 on June 26, 1985. Pigeon pea cv. Kaki was planted in both experiments.

In the 1984–85 experiment, oxyfluorfen at 0.33, 0.66 and 1.32 kg ai/ha rates was applied to the soil 3 days after planting, with a spray volume of 340 L/ha. Rates of Oxyfluorfen were adjusted according to manufacturer recommendations. The field was overhead irrigated twice with approximately 1.2 cm of water 1 day after planting and 1 day after herbicide application. Thereafter furrows were irrigated twice to supplement rainfall. At 5 and 8 weeks after planting plots treated with oxyfluorfen preemergence received directed postemergence applications of oxyfluor-

fen at 0.25 kg/ha between rows. Oxyfluorfen over-the-top treatments, at 0.33 and 0.66 kg ai/ha, were sprayed 4 weeks after planting, followed by a direct application to weeds at 0.25 kg ai/ha at 8 weeks. Hand-weeded plots were hoed 4 and 8 weeks after planting. Data on crop phytotoxicity and weed control (weed counts in 0.5 $m^2$) were recorded 4 and 10 weeks after planting. Mature-green pigeon pea pods were harvested January 8 and 21, 1985.

In the 1985–86 experiment, oxyfluorfen at the same rate of the 1984–85 experiment was applied 2 days after planting with a spray of 225 L/ha. Sprinkler irrigation was applied as in the 1984–85 experiment. The first direct postemergence application of oxyfluorfen at 0.25 kg ai/ha was made 3 weeks after planting, and the second at 7 weeks. Oxyfluorfen over-the-top treatments, at 0.33 and 0.66 kg ai/ha were sprayed the same dates. Hand-weeded check plots were also hoed 3 and 7 weeks after planting. Weed control data and phytotoxicity were evaluated 3 and 9 weeks after planting. Mature green pods were harvested in four pickings from January 4 to March 11, 1986.

## RESULTS AND DISCUSSION

Table 1 shows the data on the effect of oxyfluorfen and prometryn on pigeon pea germination, plant height and weed control in 1983. Oxyfluorfen at 1.68, 3.36 and 6.72 kg ai/ha significantly reduced germination and plant height. However, johnsongrasss (*S. halepense*), horse purslane (*T. portulacastrum*), junglerice (*E. colonum*) and morning glory (*I. tiliacea*) were controlled with oxyfluorfen at the three rates. At 6 weeks, prometryn at 3.36 kg ai/ha was effective for the control of horse purslane, junglerice and morning glory, but less effective for johnsongrass control.

TABLE 1.—*Effect of oxyfluorfen and prometryn and preemergence on pigeon pea germination (2 weeks), plant height (2 weeks) and weed control (6 weeks) in 1983*

| Treatment | kg ai/ha | Germination (%)[1] | Pigeon pea height (cm)[1] | Weed control ratings (%)[2] | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | A | B | C | D | E | F |
| Prometryn | 3.36 | 95 a | 131 a | 73 | 97 | 97 | 87 | 0 | 0 |
| Oxyfluorfen | 1.68 | 53 b | 110 b | 93 | 100 | 100 | 70 | 0 | 33 |
| Oxyfluorfen | 3.36 | 13 bc | 77 c | 93 | 100 | 100 | 97 | 0 | 83 |
| Oxyfluorfen | 6.72 | 14 c | 30 d | 100 | 100 | 100 | 100 | 0 | 100 |
| Hand-weeded check | — | 90 a | 132 a | 100 | 100 | 100 | 100 | 100 | 100 |
| Non-weeded check | — | 100 a | 119 ab | 0 | 0 | 0 | 0 | 0 | 0 |
| C V (%) | | 18 | 9 | | | | | | |

[1] Means followed by the same letter do not differ significantly at the 5% level; Duncan's multiple range test.

[2] Weed species and density (plants/0.5 $m^2$) in non-weeded check were as follows: A = *Sorghum halepense* (15); B = *Trianthema portulacastrum* (246); C = *Echinochloa colonum* (58); D = *Ipomoea tiliacea* (30); E = *Cyperus rotundus* (33); F = *Euphorbia heterophylla* (6).

TABLE 2.—*Effect of pre- and post-emergence application of oxyfluorfen on pigeon pea germination and crop phytotoxicity during 1984–85 and 1985–86*

| Treatment | kg ai/ha | % germination | | Phytotoxicity[1] | | Symptoms |
|---|---|---|---|---|---|---|
| | | 1984–85 | 1985–86 | 1984–85 | 1985–86 | |
| Oxyfluorfen | 0.33 (pre)[2] + 0.25 (post)[3] | 95 | 100 | 0.1 | 0.85 | Light burning and malformation on primary leaves. |
| Oxyfluorfen | 0.66 (pre)[2] + 0.25 (post)[3] | 95 | 100 | 0.7 | 0.35 | Light burning and malformation on primary leaves. |
| Oxyfluorfen | 1.32 (pre)[2] + 0.25 (post)[3] | 80 | 95 | 2.4 | 1.20 | Light burning and malformation on primary leaves. |
| Oxyfluorfen | 0.33 (post)[4] + 0.25 (post)[3] | 100 | 100 | 4.7 | 3.62 | Severe damage on top, burning. |
| Oxyfluorfen | 0.66 (post)[4] + 0.25 (post)[3] | 97 | 100 | 4.7 | 3.62 | Severe damage on top, burning. |
| Hand-weeded check | ——— | 98 | 100 | 0.0 | 0.00 | No visible effect. |
| Non-weeded check | ——— | 100 | 100 | 0.0 | 0.00 | No visible effect. |

[1] Mean ratings of four replications, with *0* representing no visible effect and *10* complete stand kill at fourth week after planting.
[2] Preemergence application.
[3] Postemergence application directed between rows.
[4] Postemergence over the top.

Neither herbicide was effective against purple nutsedge (*Cyperus rotundus* L.). Spurge (*E. heterophylla*) was effectively controlled by oxyfluorfen only at 3.36 and 6.72 kg ai/ha. In 1983, Hepperly and Rodríguez (8) determined from foliage samples that pigeon pea was affected by the fungus *Alternaria* spp. at the blooming stage. Approximately 75% of the pigeon pea flowers dropped. Therefore, the experiment was discontinued and no yield data was recorded.

Table 2 shows the effects of pre and postemergence oxyfluorfen treatments on pigeon pea germination and crop phytotoxicity in the 1984–85 and 1985–86 growing seasons. Oxyfluorfen at 1.32 kg ai/ha affected pigeon pea germination by 20% in 1984–85 and by only 5% in 1985–86. Slight leaf burning was recorded during the fourth week when preemergence oxyfluorfen at 0.33 and 0.66 kg ai/ha was applied. These preemergence rates were safe for germination of pigeon pea. Severe injury to the top part of the plants resulted from oxyfluorfen over-the-top treatments at 0.33 and 0.66 kg ai/ha. Phytotoxicity symptoms of the crop disappeared after 9 weeks in all experimental plots in each growing season.

Table 3 shows weed counts and weed control ratings during 9 to 10-week periods. Grass weeds were significantly reduced by preemergence treatments of oxyfluorfen at the three rates, plus two direct applications at 0.25 kg ai/ha in both years. Oxyfluorfen over-the-top treatments at 0.33 and 0.66 kg ai/ha plus a direct application at 0.25 kg ai/ha were ineffective against grassy weeds. The number of broadleaf weeds was also reduced by preemergence treatment at the three rates plus two direct applications at 0.25 kg ai/ha, but again to a lesser extent than grass weeds. In non-weeded plots the predominant weed species and plant density averages per 0.5 $m^2$ during 1984–85 growing season were spurge, 14.7; itchgrass (*Rottboellia exaltata* L. f.), 6.2; and junglerice, 5.7. Figures for 1985–86 were spurge 68.7; junglerice, 14.7; corchorus (*Corchorus aestuans* L.), 12.7; itchgrass, 6.2; and morning glory, 4.0. Spurge seems to be tolerant to oxyfluorfen; a high population density was recorded on treated plots. Although other broadleaf weeds were controlled by oxyfluorfen, the presence of spurge in treated plots reduced overall broadleaf weed control as a whole. On the basis of weed control percentages, preemergence oxyfluorfen at 0.33, 0.66 and 1.32 kg ai/ha, plus 0.25 kg ai/ha directed postemergence, was more effective against grassy weeds than broadleaf weeds.

No significant differences ($P=0.05$) in crop yields were detected among oxyfluorfen treated plots in either year (table 4). Excellent pod yields were obtained from all treatments in 1984–85. The highest yield of pigeon pea (7,989 kg/ha) was obtained in plots treated with oxyfluorfen at 0.33 kg ai/ha applied over the top. The yield obtained with preemergence oxyfluorfen at 0.33 kg ai/ha + 0.25 kg ai/ha post-directed

TABLE 3.—*Effect of oxyfluorfen on weed number and control during 9–10 week after planting Kaki pigeon pea in 1984–85 and 1985–86*

| Treatment | kg ai/ha | Number of grassy weeds in 0.5 meter square[1] | | | Number of broadleaf weeds in 0.5 meter square[1] | | |
|---|---|---|---|---|---|---|---|
| | | 1984–85 | 1985–86 | % Control[2] | 1984–85 | 1985–86 | % Control[2] |
| Oxyfluorfen | 0.33 (pre)[3] + 0.25 (post twice)[4] | 6.8 c | 2.5 c | 79 | 18.3 bc | 49 a-d | 48 |
| Oxyfluorfen | 0.66 (pre)[3] + 0.25 (post twice)[4] | 3.3 cd | 2.5 c | 87 | 11.3 bcd | 16 b-d | 79 |
| Oxyfluorfen | 1.32 (pre)[3] + 0.25 (post twice)[4] | 1.0 cd | 0.2 c | 97 | 8.5 cd | 13 b-d | 83 |
| Oxyfluorfen | 0.33 (post)[5] + 0.25 (post)[4] | 26.3 a | 43.0 a | 0 | 17.0 bc | 82 a | 34 |
| Oxyfluorfen | 0.66 (post)[5] + 0.25 (post)[4] | 22.8 ab | 47.0 a | 0 | 16.0 bc | 67 a-c | 35 |
| Hand-weeded check | ——— | 2.0 cd | 0.2 c | 95 | 3.3 d | 4 d | 85 |
| Non-weeded check | ——— | 19.0 b | 25.2 b | 0 | 29.0 a | 102 a | 0 |
| C V (%) | | 23.3 | 38.5 | 40.8 a | 70 a | | |

[1] Means followed by the same letter do not differ significantly at P=0.05; Duncan's multiple range test.

[2] Average control of 2 years.

[3] Preemergence application.

[4] Postemergence application directed between rows.

[5] Postemergence application over the top.

TABLE 4.—*Yield of Kaki pigeon pea treated with oxyfluorfen at Lajas in 1984–85 and 1985–86*

| Treatment | kg ai/ha | Yield of mature green pods (kg/ha)[1] 1984–85 | 1985–86 |
|---|---|---|---|
| Oxyfluorfen | 0.33 (pre)[2] + 0.25 (post twice)[3] | 7,826 ab | 5,694 a |
| Oxyfluorfen | 0.66 (pre)[2] + 0.25 (post twice)[3] | 6,879 abc | 5,871 a |
| Oxyfluorfen | 1.32 (pre)[2] + 0.25 (post twice)[3] | 7,184 abc | 5,896 a |
| Oxyfluorfen | 0.33 (post)[4] + 0.25 (post)[3] | 7,989 a | 5,695 a |
| Oxyfluorfen | 0.66 (post)[4] + 0.25 (post)[3] | 7,318 abc | 5,896 a |
| Hand-weeded check | ——— | 6,627 bc | 6,470 a |
| Non-weeded check | ——— | 6,546 c | 4,428 a |
| C V (%) | | 10.6 | 25.6 |

[1] Means followed by the same letters do not differ significantly at P=0.5; Duncan's multiple range test.

[2] Preemergence application.

[3] Postemergence application directed between rows.

[4] Postemergence application over the top.

twice was 7,826 kg/ha. However, only the non-weeded plots yielded significantly lower than the above mentioned treatments. The yield of pigeon pea in 1985–86 was somewhat lower than in 1984–85. The excessive rainfall (428 mm) in October affected normal blooming in 1985–86 and thus reduced crop yields. According to Hepperly and Rodríguez (7), water-logging of soils is a major factor limiting yields of pigeon peas.

Oxyfluorfen was found to be a potential commercial herbicide for pre and postemergence weed control on the basis of its efficacy against morning glory, a species prevalent in the experimental area, which is one of the worst weeds in pigeon pea plantations in Puerto Rico (3). In the experiments reported here crop yield was not significantly increased by oxyfluorfen probably because that herbicide's effect was masked by the inherent competitive ability of pigeon pea to overcome later weed interference. Hepperly and Rodríguez (7) reported that pigeon pea does not tolerate weeds well initially, but in later growth stages, actively suppresses weeds. Suppression has been associated also with crop allelopathic effects of pigeon peas (9). In our experiments weed control data was recorded for only a 10-week period, but the crop was harvested 12 weeks later. At present, no data is available on the importance of late weed control in pigeon peas; we suspect from research conducted in various years (unpublished data) that late weed suppression was an important factor determining final yields in plots with poor weed control.


## RESUMEN

### Oxifluorfén, un yerbicida potencial para gandules

**Tres experimentos con gandul [*Cajanus cajan* (L.) Millsp] se realizaron en el Centro de Investigación y Desarrollo Agrícola de Lajas desde el 14 de**

**septiembre de 1983 hasta el 11 de marzo de 1986. En 1983 las aplicaciones preemergentes de oxifluorfén a 1.68, 3.36 y 6.72 kg. i.a./ha. redujeron significativamente (P=0.05) la germinación y la altura del gandul var. 2,B-Bushy. Sin embargo, la yerba johnson (*S. halepense*), verdolaga de hoja ancha (*T. portulacastrum*), el arrocillo (*E. colonum*) y bejuco de puerco (*I. tiliacea*) se controlaron excelentemente. El herbicida a 1.68 kg./ha. controló eficazmente la lechecilla (*E. heterophylla*).**

**La aplicación preemergente de oxifluorfén a 1.32 kg. i.a./ha. redujo la germinación del gandul, var. Kaki, en aproximadamente 20% en 1984–85 y 5% en 1985–86. Las aplicaciones del herbicida a 0.33 y 0.66 kg. i.a./ha. no afectaron adversamente la germinación, pero las mismas concentraciones le causaron daño severo al tope del follaje al aplicarlo posemergentemente sobre las malezas y el gandul. Los síntomas de fitotoxicidad desaparecieron a las 9 semanas. Las plantas en todas las parcelas tratatas recuperaron su vigor totalmente.**

**En ambas fechas las malezas gramíneas se redujeron significativamente con las tres concentraciones preemergentes de oxifluorfén más dos aspersiones en directo del mismo herbicida a 0.25 kg./ha. Las malezas de hoja ancha se controlaron en menor grado. En la aplicación posemergente al tope a razón de 0.33 y 0.66 kg. i.a./ha. seguida por una aspersión en directo a razón de 0.25 kg. i.a./ha. no fue eficaz; a razón de 0.66 kg. controló algunas malezas de hoja ancha solamente.**

**En 1984–85 el mayor rendimiento de gandul en vaina verde (7,989 kg./ha.) se obtuvo en las parcelas tratadas con oxifluorfén a 0.33 kg. i.a./ha. aplicado posemergente sobre el follaje de las malezas y el gandul, más una aspersión en directo a razón de 0.25 kg. i.a./ha. Este rendimiento fue significativamente superior (P=0.05) a los obtenidos en las parcelas desyerbadas manualmente y en las parcelas testigo sin desyerbar. Con un tratamiento preemergente a 0.33 kg. i.a./ha. se logró una cosecha de 7,826 kg./ha. No se observaron diferencias significativas (P=0.05) en 1985–86 entre los rendimientos de las parcelas tratatas con oxifluorfén a distintas concentraciones y las parcelas testigo. Contrario al año anterior el rendimiento más alto (6,470 kg./ha.) correspondió al testigo desyerbado y el menor (4,428 kg./ha.) al testigo sin desyerbar.**

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