Postemergence weed control in pigeon peas with glyphosate shielded treatments[1]

Nelson Semidey, Luis Almodóvar and Essaú Orengo-Santiago[2]

ABSTRACT

The efficacy of glyphosate [N-(phosphonomethyl) glycine] as post-directed (shielded) treatment in combination with preemergence metribuzin was evaluated in two experiments conducted at the Lajas Substation in 1984–85 and 1985–86. Glyphosate at 0.41, 0.84 and 1.64% on v/v basis did not cause phytotoxicity to pigeon pea in 1984–85. A very low toxicity (1.25%) occurred in 1985–86. Weed control by preemergence metribuzin (0.62 kg ai/ha) plus two post-directed applications of glyphosate ranged from good (79%) to excellent (97%) at 7 weeks after planting and 95 to 100% of control after 11 weeks in 1984–85. In 1985–86 weed control by this herbicide sequence was similar to that of 1984–85 both at 7 and 17 weeks after planting. Excellent pod yields were obtained with metribuzin plus glyphosate treatments in 1984–85. The highest yield (7,806 kg/ha) was obtained with metribuzin at 0.62 kg ai/ha plus glyphosate at 1.64% treatment. This yield exceeded significantly only that of the metribuzin alone treatment (6,363 kg/ha). There were no significant differences in yield among treatments in 1985–86. Pigeon pea yield ranged from 4,123 kg/ha in the metribuzin alone treatment to 6,170 kg/ha with metribuzin at 0.62 kg ai/ha plus glyphosate at 1.64% concentration.

INTRODUCTION

Metribuzin [4-amino-6-(1.1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5 (4H)-one] and promethryn [2-4-bis (isopropylamino)-6-methylthio-s-triazin] are preemeergence herbicides registered for weed control in pigeon peas in Puerto Rico (1). At present, no postemergence herbicides are registered for pigeon peas. Under certain soil type and water management conditions either metribuzin or prometryn could cause crop injury (2, 4, 5). Postemergence herbicides are thus needed under conditions of unfavorable weather, hilly terrain and specific soils where preemergence chemicals neither work properly nor remain in the effective soil zone.

In recent studies, preemergence oxyfluorfen [2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluromethyl) benzene] at 0.33 kg ai/ha plus two post-directed applications at 0.25 kg ai/ha of the same herbicide was efficient for weed control with low phytotoxicity to pigeon peas, and good yields

[1]Manuscript submitted to Editorial Board 11 February 1987.

[2]Assistant Researcher, Agronomist and Professor, Department of Crop Protection; Assistant Horticulturist and Administrator of the Lajas Substation, Agricultural Experiment Station, University of Puerto Rico, Mayagüez Campus.

were obtained (8). Glyphosate applied post-directed at 5 weeks after planting (at 0.20%, 0.41% and 0.84% v/v concentrations) in combination with preemergence metribuzin (0.56 kg ai/ha) provided excellent weed control in pigeon peas; phytotoxicity was not detected and good yields were obtained in a San Antón soil (Mollisol) in 1980 (3). However, glyphosate at the same concentrations applied postemergence 3 weeks after planting without a preemergence herbicide treatment caused significant stand reduction to pigeon peas in 1983 (3).

Even though glyphosate is a nonselective herbicide, it can be used selectively against most weed species, depending on the timing and manner of its application (9). In many vegetable crops, glyphosate can be used as a pre-plant treatment against actively growing weeds, but only before the emergence of crops (1).Thus, directed spraying of glyphosate in plantains, tomato and sweet pepper plants is effective (6, 7). In the present study two experiments evaluated the efficacy of glyphosate as a post-directed shielded spray in sequence with preemergence metribuzin in order to improve crop selectivity for subsequent registration of this chemical in pigeon peas.

MATERIALS AND METHODS

Two experiments with Kaki cv. pigeon pea were conducted at the Lajas Substation during 1984–85 and 1985–86 growing seasons. The 1984–85 experiment was planted in July 31, 1984, and the 1985–86 in June 26, 1985. Both experiments were established in a Vertisol soil (23.6–28.5% sand, 8.5–32.0% silt and 44.4–63.0% clay) with pH 5.95 in 1984–85 and pH 5.56 in 1985–86. Soil organic matter content was 3.0% in both experiments. Experimental plots consisted of four rows (6.1 m long and 0.9 m apart) arranged in a randomized complete block design with five treatments and four replications. Pigeon pea seeds were spaced 30 cm in the row. In both experiments the whole experimental area was treated with metribuzin at 0.62 kg ai/ha the day after planting and then irrigated overhead with approximately 1.5 cm of water. Total rainfall was 794 mm in the 1984–85 experiment and 859 mm in 1985–86. Furrow irrigation was applied once in August to supplement rainfall in both growing seasons.

1984–85

In 1984–85, glyphosate at 0.41%, 0.82% and 1.64% v/v concentrations was first applied at 5 weeks after planting, followed by a second application 4 weeks later. A hand-pump sprayer with a protective shield above the nozzle tip with approximately 1.0 kg per cm^2 pressure was used to avoid drift of glyphosate solutions. A spray volume of 225 L/ha of herbicide solution was used for each application. Hand-weeded check was weeded at 6 weeks after planting. Weed counts in 0.5 meter square and

phytotoxicity evaluations were recorded at 7 and 11 weeks after planting. Percentage weed control data was calculated from weed counts on glyphosate treated plots compared to those of metribuzin (alone) treatment. Pigeon pea pods (mature-green) were harvested twice (8 and 21 January 1985).

1985–86

In the 1985–86 experiment, glyphosate at the same concentrations as those of the 1984–85 experiment was first applied at 5 weeks after planting followed by a second application 8 weeks later. A spray volume of 450 L/ha of herbicide solution was used during the first application and 225 L/ha for the second. Hand-weeded check was weeded at 3 and 7 weeks after planting. Weed counts in 0.5 meter square and phytotoxicity evaluations were recorded at 5, 7 and 17 weeks after planting. Percentage weed control data was calculated from initial weed counts recorded at 5 weeks versus subsequent weed counts made at 7 and 17 weeks in each plot, respectively. Pigeon pea pods were harvested in four pickings from 4 January 1986, to 11 March 1986.

RESULTS AND DISCUSSION

The predominant weed species in the experimental area at first glyphosate application were spurge (*Euphorbia heterophylla* L.) and itchgrass (*Rottboellia exaltata* L. f.) with mean population densities of 14.6 and 6.8 plants/0.5 m^2, respectively. Table 1 shows the effects of different herbicide treatments on phytotoxicity, weed control and yield of Kaki pigeon pea during 1984–85. Since preemergence metribuzin was applied, the first glyphosate application was not conducted until 5 weeks after planting. No phytotoxicity on pigeon pea was detected because precautions were taken to prevent glyphosate drift. Weed control provided by metribuzin (0.62 kg ai/ha) in sequence with the first application of glyphosate at 0.41%, 0.82% and 1.64% concentrations was from good (79%) to excellent (97%) after 7 weeks. Preemergence metribuzin plus a second application of glyphosate at the same concentrations improved weed control with 95% to 100% control up to 11 weeks.

Table 1 also shows the yields of mature-green pods of Kaki pigeon peas recovered in 1984–85. Excellent crop yields were obtained with preemergence metribuzin in sequence with two glyphosate applications at 0.41%, 0.84% and 1.64% concentrations, similar to the yield obtained with metribuzin plus handweeding. The highest pigeon pea yield (7,806 kg/ha) was obtained with metribuzin plus glyphosate at 1.64%. It outyielded significantly that of metribuzin (alone) treatment.

1985–86

The predominant weed species at first glyphosate application were spurge (*E. heterophylla*), morning glory [*Ipomoea tiliacea* (Wild.)

TABLE 1.—*Effect of preemergence metribuzin and two directed postemergence applications of glyphosate on phytotoxicity, weed control and yield of Kaki pigeon peas in 1984–85*

Treatment[1]	Phytotoxicity[2]		Weed control[3]		Yield of mature-green pods (kg/ha)[4]
	7 weeks	11 weeks	7 weeks	11 weeks	
			%		
Metribuzin (0.62 kg ai/ha) / Glyphosate (0.41% v/v)	0	0	79	95	7,692 ab
Metribuzin (0.62 kg ai/ha) / Glyphosate (0.82% v/v)	0	0	86	100	7,623 ab
Metribuzin (0.62 kg ai/ha) / Glyphosate (1.64% v/v)	0	0	97	96	7,806 a
Metribuzin (0.62 kg ai/ha) / Handweeding	0	0	100	0	7,107 ab
Metribuzin (0.62 kg ai/ha)	0	0	0	0	6,363 b
CV (%)					11.6

[1]Metribuzin was applied at planting and glyphosate directed postemergence at 5 and 9 weeks after planting.

[2]Mean rating of four replications, with 0 representing no visible effect and 100 complete stand kill.

[3]Based on weed counts (plants/0.5 m²) recorded on plots 7 and 11 weeks after planting compared to standard metribuzin (0.62 kg ai/ha) as check treatment.

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

Choisy], johnsongrass (*Sorghum halepense* L.), itchgrass (*R. exaltata*) and junglerice [*Echinochloa colonum* (L.) Link]. Their population densities (plants/0.5 m² before glyphosate application) at 5 weeks ranged as follows: spurge 67.2–117.5, morning glory 0.7–4.0, johnsongrass 0.2–3.7, itchgrass 0.7–2.0 and junglerice 0.2–1.7 plants/0.5 m², respectively. Table 2 shows the effect of different herbicide treatments on phytotoxicity, weed control and yield of Kaki pigeon pea in 1985–86. Phytotoxicity of glyphosate at 0.82% and 1.64% v/v concentrations was very low (1.25% stand kill) after 7 weeks. No phytotoxicity was detected after 17 weeks. Weed control by metribuzin (0.62 kg ai/ha) in combination with glyphosate (at the three concentrations) was from good (79%) to excellent (91%) after 7 weeks, similar to that of the 1984–85 experiment. Preemergence metribuzin plus handweeding gave satisfactory weed control (77%) up to 7 weeks, but the unweeded treatment had poor control. Preemergence metribuzin plus second application of glyphosate at three concentrations gave excellent weed control (94–99%) up to 17 weeks.

Table 2 also shows the yields of mature-green pods of Kaki pigeon pea harvested in 1985–86. The yields were somewhat lower than in 1984–85 because the excessive rainfall adversely affected normal blooming. Data were similar to those reported previously in a recent study (8). There were no significant differences (P=0.05) in yield between treat-

TABLE 2.—*Effect of preemergence metribuzin and two directed postemergence applications of glyphosate on phytotoxicity, weed control and yield of Kaki pigeon peas in 1985–86*

Treatment[1]	Phytotoxicity[2]		Weed control[3]		Yield of mature-green pods (kg/ha)[4]
	7 weeks	17 weeks	7 weeks	17 weeks	
			%		
Metribuzin (0.62 kg ai/ha) / Glyphosate (0.41% v/v)	0.0	0	79	94	5,875 a
Metribuzin (0.62 kg ai/ha) / Glyphosate (0.82% v/v)	1.25	0	91	99	6,170 a
Metribuzin (0.62 kg ai/ha) / Glyphosate (1.64% v/v)	1.25	0	86	98	5,876 a
Metribuzin (0.62 kg ai/ha) / Handweeding	0.0	0	77	40	5,783 a
Metribuzin (0.62 kg ai/ha)	0.0	0	23	72	4,123 a
CV (%)					22.2

[1]Metribuzin was applied at planting and glyphosate directed postemergence at 5 and 13 weeks after planting.

[2]Mean ratings of four replications, with 0 representing no visible effect and 100 complete stand kill.

[3]Based on weed counts (plants/0.5 m^2) recorded on plots 7 and 17 weeks after planting compared to initial counts at 5 weeks after planting where 0 = no control and 100 = complete weed control.

[4]No significant differences (P=0.05) on yields were detected.

ments. Pigeon pea yields ranged from 4,123 kg/ha in the metribuzin (alone) treatment to 6,170 kg/ha at metribuzin in sequence with glyphosate at 1.64% concentration. This finding suggests that glyphosate did not cause phytotoxicity to pigeon peas.

The preemergence applications of metribuzin at the rate of 0.62 kg ai/ha contributed to the improved yields of pigeon pea as the initial weed competition was reduced in all plots. The use of preemergence metribuzin in sequence with directed-shielded treatments of glyphosate prevented the herbicide from coming in contact with the pigeon pea foliage, thus improving weed control and yield. On the basis of our results, post-directed glyphosate applications have to be used for weed control in pigeon peas in sequence with a preemergence herbicide such as metribuzin to reduce the initial weed population and facilitate glyphosate application. The ideal timing of first glyphosate application is around 5 weeks after planting to exploit the differences in growth stages between pigeon pea (tall plants) and weed seedlings (small plants). A protective shield at low pressure (1.0 kg per cm^2) helps prevent crop injury.

RESUMEN

Desbroce posemergente en gandules con aplicaciones en directo de glifosato

La eficacia del glifosato como tratamiento posemergente en directo en combinación con metribuzin aplicado preemergentemente se midió en dos experimentos en la Subestación de Lajas, uno en 1984–85 y otro en 1985–86. Las aplicaciones en directo de glifosato a concentraciones de 0.41%, 0.82% y 1.64% v/v no causaron fitotoxicidad al gandul en 1984–85 y muy baja toxicidad (1.25%) en 1985–86. El desbroce preemergente con metribuzin (0.62 kg p.a./ha.) en combinación con dos aplicaciones directas posemergentes de glifosato fluctuó de bueno (79%) a excelente (97%) a las 7 semanas después de la siembra y de 95% a 100% después de 11 semanas en el experimento de 1984–85. En 1985–86 el desbroce con la combinación de los dos herbicidas fue similar al de 1984–85 tanto a las 7 semanas como a las 17 después de la siembra. Se obtuvieron excelentes rendimientos de gandul en vaina con metribuzin combinado con los tratamientos de glifosato en el 1984–85. El rendimiento más elevado (7,806 kg./ha.) se obtuvo con metribuzin combinado con glifosato a 1.64%. Este rendimiento superó (P=0.05) únicamente al tratamiento de metribuzin solo, con el que se obtuvieron 6,363 kg./ha. En el experimento de 1985–86 no hubo diferencias significativas en el rendimiento del gandul entre los tratamientos estudiados. El rendimiento fluctuó de 4,123 kg./ha. con el tratamiento de metribuzin sólo a 6,170 kg./ha. con la combinación de los dos herbicidas a la concentración de 1.64%.

LITERATURE CITED

1. Acín-Díaz, N., H. O'Farrill-Nieves y R. Montalvo-Zapata, 1984. Plaguicidas con permiso de uso en hortalizas. *Plaguicidas al Día.* 5 (2): 3–5.
2. Almodóvar-Vega, L. and P. L. Chavarría, 1974. Mobility and persistence of atrazine and metribuzin in four soils from Puerto Rico. *J. Agric. Univ. P. R.* 58: 379–80.
3. Almodóvar, L., N. Semidey and I. Reyes, 1980–83. Annual Progress Reports, Project H-173 (Pigeon peas). Agric. Exp. Stn., Univ. P. R.
4. Liu, L. C., 1984. Different irrigation regimes influence phytotoxicity of prometryn to pigeon peas [*Cajanus cajan* (L.) Millsp.] in four soils. *J. Agric. Univ. P. R.* 68: 315–21.
5. —— and H. Irizarry, 1982. Phytotoxicity to four vegetables of residues levels of prometryn and diuron in soil. *J. Agric. Univ. P. R.* 66: 238–39.
6. ——, J. A. Rodríguez-García and N. Semidey-Laracuente, 1981. Glyphosate for weed control in plantain. *J. Agric. Univ. P. R.* 65: 317–25.
7. Semidey, N. and L. Almodóvar, 1987. Glyphosate on tomato and sweet pepper yields. *J. Agric. Univ. P. R.* 71 (2): 235–38.
8. —— and ——, 1987. Oxyfluorfen, a candidate herbicide for weed control in pigeon peas. *J. Agric. Univ. P. R.* 71 (3): 277–285.
9. Weed Science Society of America, Herbicide Handbook. 5th ed, 309 West Clark St., Champaign, Illinois 61820.