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Different Irrigation Regimes Influence Phytotoxicity of Prometryn to Pigeon Peas [*Cajanus cajan* (L.) Millsp.] in Four Soils¹

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ABSTRACT

Four greenhouse experiments were conducted in 1981-82 to determine the effect of different irrigation regimes on the phytotoxicity of prometryn [2,4-bis(isopropylamino)-6-(methylthio)-s-triazine] in four soils. The fresh weight of pigeon pea plants treated with prometryn at rates of 2.24 and 3.36 kg/ha was greatly reduced in San Antón soil (Mollisol) as the irrigation regime increased to a maximum. This finding confirms our assumption that excessive irrigation has contributed to the aggravated prometryn injury to pigeon pea plants. However, no significant fresh weight reduction was noted in Corozal (Ultisol), Coto (Oxisol) and Fraternidad (Vertisol) clays under increased irrigation regimes. Precaution should be taken not to overirrigate the soils having a texture similar to that of San Antón. To avoid crop injury precaution should also be taken not to use prometryn for weed control in pigeon peas during the prolonged rainy months of September to November.

INTRODUCTION

In 1974, Abrams and Juliá³ compared mechanical, cultural and chemical methods for weed control in pigeon peas. They reported that chemical weed control resulted in the highest yield of all three control measures studied. The chemical control measure they used included prometryn at 3.3 kg ai/ha as a preemergent and paraquat at 1.18 L/ha as a postemergent. In a later study, Almodóvar-Vega and Vélez-Báez⁴ evaluated metribuzin [4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5 (4H) one], prometryn and chloramben (3-amino-2,5-dichlorobenzoic acid) for weed control in pigeon peas. Prometryn was one of the best preemergent herbicides; it provided excellent weed control with no apparent crop

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³ Abrams, R. and F. J. Juliá, 1974. Effect of mechanical, cultural and chemical weed control on yield and yield components of pigeon peas (*Cajanus cajan* (L.) Millsp.), J. Agric. Univ. P.R. 58 (4): 466-72.

⁴ Almodóvar-Vega, L. and A. Vélez-Báez, 1980. Evaluation of Metribuzin, Prometryn and Chloramben for weed control on pigeon peas (*Cajanus cajan* (L.) Millsp.), J. Agric. Univ. P.R. 64(1): 29-32.

injury. The use of prometryn for weed control in Puerto Rico has subsequently been authorized. The recommended rate ranges from 2.24 to 3.36 kg/ha, depending on the organic matter and clay content present in the soil. Phytotoxicity of prometryn to pigeon peas at those rates of application is not normally expected. However, severe crop injury and eventual death of pigeon pea plants were encountered in a fertilizer experiment in the Santa Isabel region.⁵ As said experiment was under intensive irrigation practice, it was thought that excessive irrigation might have contributed to the unexpected prometryn toxicity to pigeon peas. Therefore, in an attempt to confirm our previous assumption, a greenhouse experiment simulating the rates of prometryn application and irrigation regime was established in a San Antón soil collected in a adjacent field affected by the fertilizer experiment. Three other greenhouse experiments with similar experimental designs were later expanded to include Corozal, Coto and Fraternidad clay soils.

MATERIALS AND METHODS

Approximately 2 metric tons of San Antón soil (Mollisol), Corozal clay (Ultisol), Coto clay (Oxisol) and Fraternidad clay (Vertisol) were collected from sites with no known history of diuron or prometryn application. A detailed description of their taxonomic characteristics is provided by Lugo-López and Rivera.⁶ The above-mentioned soils were air-dried, pulverized, and transferred to 5-gal glazed porcelain crocks. A randomized complete block design with four replications was used for all greenhouse experiments. Ten to 15 seeds of pigeon pea cultivar 2B-Bushy were planted in each container. Prometryn at the rates of 2.24 and 3.36 kg/ha was applied as a preemergent. Fifty ml of the herbicide suspension was sprayed to the soil surface the day after planting the seeds. A small spraying can with added compressed air was used for herbicide application. All pots received an initial irrigation of 25.4 mm of simulated rain immediately after the seeds were planted. This water was needed to provide sufficient moisture for their germination. The different quantities of irrigation (6.4, 12.7, 25.4 and 50.8 mm weekly) were applied from the second week on. The above specified quantities of simulated rain were applied in three increments instead of only once every week. The check pots were handweeded twice when the weeds were small. The number of pigeon pea plants surviving the herbicide treatment was recorded periodically. At the end of the 7th week, the plants were uprooted, rinsed with water and their fresh weights recorded for phytotoxicity evaluation.

⁵ Irizarry-Irizarry, H., Personal communication, Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P.R.

⁶ Lugo-López, M. A. and L. H. Rivera, 1976. Taxonomic classification of the soils of Puerto Rico, 1975, Univ. P.R., Agric. Exp. Strn., Bull. 245: 1-32.

RESULTS AND DISCUSSION

Table 1 shows the properties of the four soils used in this experiment. According to soil texture, San Antón loam is one of the light-textured soils used in this study. The effect of prometryn on fresh weight of pigeon pea plants, as influenced by different regimes in this soil is depicted graphically in figure 1. Under the lowest irrigation regime of 6.4 mm weekly, pigeon pea seed had barely germinated and their growth was

TABLE 1.—*Properties of four soils used in the pigeon peas greenhouse experiments*

Soil name	Organic matter %	CEC meq/100 g	pH	Texture		
				Sand %	Silt %	Clay %
Corozal clay	2.5	17	4.4	28.50	43.00	28.50
Coto clay	3.4	14	5.1	56.00	24.00	20.00
Fraternidad clay	2.2	36	6.3	29.20	28.80	42.00
San Antón	1.4	26	7.6	45.28	30.00	24.72

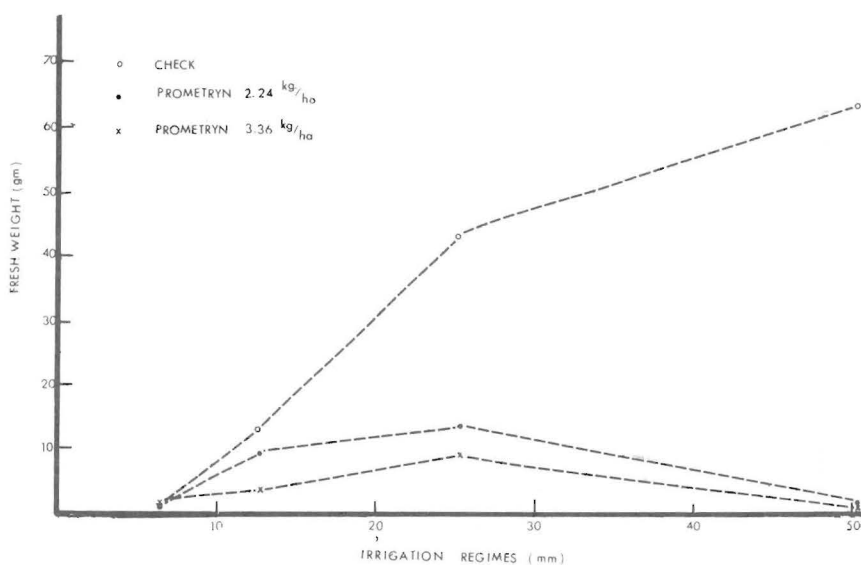


FIG. 1.—Effect of prometryn on the fresh weight of pigeon pea plants as influenced by different irrigation regimes in San Antón soil.

greatly retarded. With all treatments, including the check, yield was very low. As the irrigation regime was increased to 12.7 mm weekly, fresh weight of the plants increased slightly; the check showed the highest fresh weight gain. As the irrigation water was increased to 25.4 mm, the check plants showed a continued increase in fresh weight, whereas plants treated with prometryn at both rates had gained very little in

fresh weight. As the irrigation was further raised to 50.8 mm, most of the prometryn-treated plants were killed, with their fresh weight drastically reduced. In the meantime check plants showed the highest fresh weight gain. When the fresh weight data of pigeon peas derived from San Antón soil were subjected to statistical analyses, there was a highly significant interaction between prometryn concentrations and irrigation

TABLE 2.—Analysis of variance of fresh weight of pigeon pea plants data derived from a phytotoxicity study of Prometryn in a San Antón soil

Source of variation	Degree of freedom	Sum of squares	Estimate of variance	F
Prometryn concentrations	2	2,553.92	2,553.92	275.94*** ¹
Irrigation regimes	3	901.95	901.95	97.45**
Prometryn × irrigation	6	780.78	780.78	84.36**
Replication	2	14,58	14,58	1.57
Error	22	9.26	9.25	
Total	35	12,731.16	12,731.16	

¹ Significant at the 1% probability level.

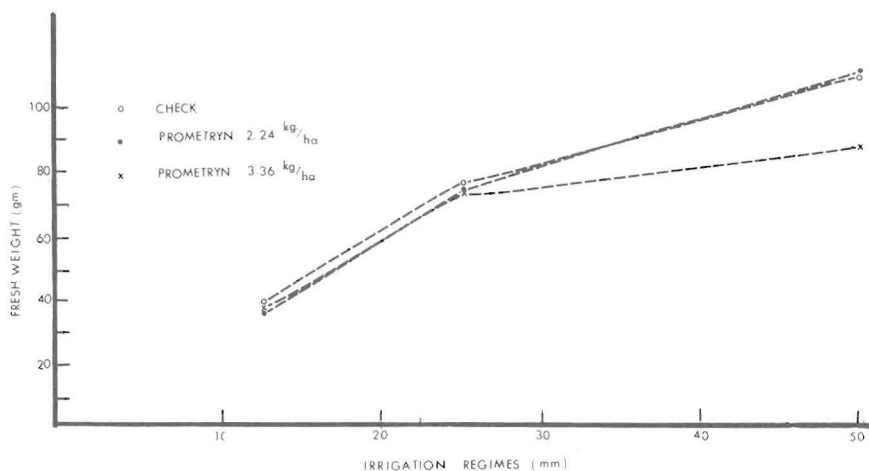


FIG. 2.—Effect of prometryn on the fresh weight of pigeon pea plants as influenced by different irrigation regimes in Corozal clay.

regimes (table 2). All the above data confirm our previous assumption that excessive irrigation has adversely contributed to prometryn toxicity in the pigeon pea plants in San Antón soil. Apparently, prometryn at 3.36 kg/ha as used in the Santa Isabel fertilizer experiment was too high a rate under an excessive irrigation regime. On the basis of the finding from the present study, it appears that prometryn is highly toxic even at

the lower rate of 2.24 kg/ha if more than one inch of irrigation water is applied weekly.

Figures 2, 3, and 4 show the effect of prometryn on the fresh weight of pigeon pea plants as influenced by different regimes of irrigation in Corozal, Coto, and Fraternidad soils. The fresh weight of plants grown in these three soils increased with increased irrigation water when prometryn was applied at a lower rate of 2.24 kg/ha. The fresh weight in the three soils showed only a slight decrease under the highest irrigation regime when prometryn was applied at 3.36 kg/ha.

In a previous adsorption study of prometryn by a soil similar to these four soils,⁷ the authors found that the soils in increasing order of adsorption of prometryn were San Antón, Coto clay, Fraternidad clay

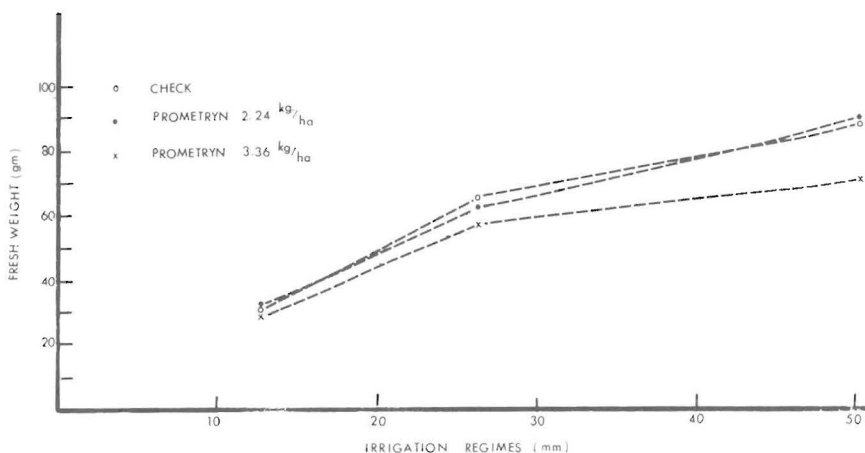


FIG. 3.—Effect of prometryn on the fresh weight of pigeon pea plants as influenced by different irrigation regimes in Coto clay.

and Corozal clay. It appears that there is a direct relationship between the adsorptive capacity of different soils for prometryn and the likelihood of injury to pigeon pea under excessive irrigation regimes. The San Antón soil, having the least prometryn adsorptive capacity, presented greater risk of causing crop injury. On the other hand, soils having high prometryn adsorptive capacity, such as Fraternidad and Corozal clays, were safe even if there was excessive irrigation. Upchurch⁸ suggested that the activity of a herbicide in a soil with readily available soil moisture might be enhanced in contrast to a herbicide activity in a soil where soil

⁷ Liu, L. C. and H. R. Cibes-Viadé. 1983. Adsorption of Fluometuron, Prometryn, Metribuzin and 2,4-D by soils. *J. Agric. Univ. P.R.* 57(4): 286-95.

⁸ Upchurch, R. P. 1966. Behavior of herbicides in soil. *Residue Reviews* 16: 46-85.

moisture is normal for good plant growth. The herbicide experiment on pigeon peas conducted by Almodóvar-Vega and Vélez-Báez⁴ included the same (3.3 kg/ha) of prometryn in a Fraternidad soil. Since the experiment was under normal irrigation regime, no crop injury was noted during the course of this trial. However, under an excessive irrigation regime, increased availability of prometryn could occur in the soil with low adsorptive capacity such as San Antón. This situation might cause increased transpiration to move more herbicide into the plant. Consequently, the plants are more susceptible to the phytotoxic effect of the herbicide.

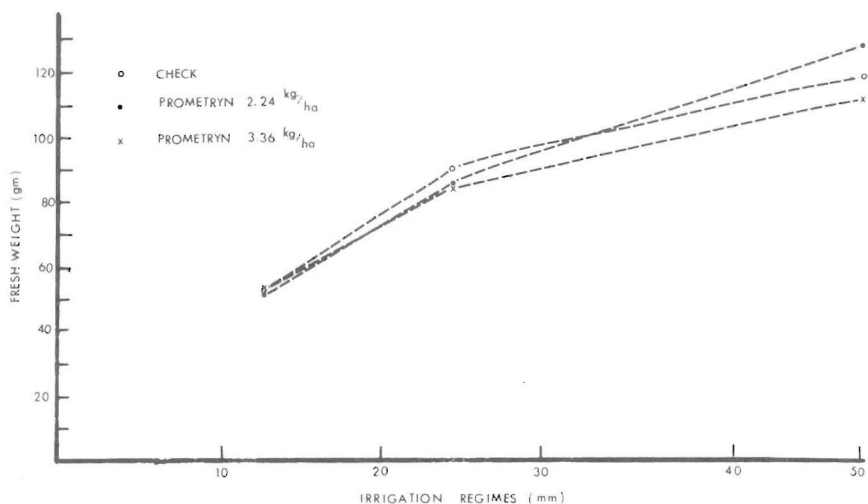


FIG. 4.—Effect of prometryn on the fresh weight of pigeon pea plants as influenced by different irrigation regimes in Fraternidad clay.

On the basis of our present finding, it would seem advisable to caution local pigeon pea growers not to overirrigate those soils with a texture similar to that of San Antón after the prometryn application. In order to avoid unwarranted crop injury, precaution should also be taken not to use prometryn for weed control in pigeon pea in light-textured soils during the prolonged rainy months of September to November.

RESUMEN

Se realizaron cuatro experimentos de invernadero para determinar el efecto de diferentes niveles de riego sobre la fitotoxicidad del herbicida Prometryn en cuatro suelos. El peso fresco de plantas de gandul tratadas con el herbicida a razón de 2.24 y 3.36 kg/ha disminuyó en el suelo San Antón. Este hallazgo confirmó nuestra presunción de que el riego excesivo haya contribuido a la fitotoxicidad del Prometryn en el gandul. Sin

embargo, no hemos encontrado una disminución significativa en el peso fresco del gandul en suelos Corozal, Coto y Fraternidad regados excesivamente. Para prevenir daño al gandul se deben tomar las siguientes precauciones: 1) no regar excesivamente en suelos que tengan una textura similar a la del suelo San Antón; 2) no usar Prometryn para controlar yerbajos en siembras de gandul durante la época de lluvia prolongada de septiembre a noviembre, para evitar daños innecesarios.