CARIBBEAN FOOD CROPS SOCIETY

22

Twenty Second Annual Meeting 1986

St. Lucia

Vol. XXII

CONTROL METHODS OF JOINTVETCH AND WATERPRIMROSE IN RICE

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ABSTRACT

A trial was conducted at the Gurabo Substation, Gurabo, Puerto Rico, to evaluate different methods (biological, manual and chemical) for controlling jointvetch (**Aeschynomene sensitiva** Sw.) and waterprimrose /**Ludwigia erecta** (L.) H. Hara/ in rice. The sequential applications of either propanil /N-(3,4-dichlorophenyl) propanamide/ or thiobencarb /S-(4-chlorophenyl) methyl diethylcarbamothioate/ as an early postemergence, followed by a mixture of 2,4-D /2,4-dichlorophenoxy) acetic acid/ and bentazon /3-(1-methylethyl)-(1H)-2,1,3-benzothiadiazin-4-(3H) one 2,2-dioxide/ were found to be the two best treatments. Both treatments outyielded all others except the weeded check. However, no significant economic gain in terms of gross income and net return was evident for the aforementioned treatments. The sequential application of propanil followed by Collego™ (a mycoherbicide) gave only fair weed control and produced a poor yield with low economic gain. Manual weeding produced the higher yield, but with the least net return due to the high cost of weeding.

INTRODUCTION

Jointvetch (**Aeschynomene sensitiva** Sw.) and waterprimrose (**Ludwigia erecta** (L.) H. Hara) are two troublesome weeds present in rice fields in Puerto Rico. Both weeds are difficult to control as they are highly resistant to propanil and 2,4-D. Consequently, they compete severely with rice plants during the mid- to late-growing seasons. They also interfere with harvesting. Recent advances in the use of fungi for biological weed control have opened a new avenue for integrated weed control research. The integration of biological control with other control methods, is one aspect of weed control research which merits special attention. The objectives of this study were to compare different methods, either alone or in combination, for controlling jointvetch and waterprimrose, and to determine the economic feasibility of these methods for possible adoption by farmers.

REVIEW OF LITERATURE

Manual weeding is an old method of controlling weeds in rice fields, and is still practiced by farmers in Asian countries. In the United States, chemical control is the standard practice in rice cultivation (Smith et al., 1977). Propanil has been the standard herbicide in the past two decades and continues to be a leading herbicide in rice production (Weed Science of America, 1982). Other herbicides such as molinate, thiobencarb, oxadiazon, and bifenox have also been widely used. It is evident that chemical weed control has contributed immensely to the control of a wide variety of weeds. However, jointvetch and waterprimrose are two troublesome weeds not completely controlled by chemical means. In 1969, Daniel et al.

(1973) discovered an endemic anthracnose disease of north jointvetch incited by the fungus **Colletotrichum gloeosporioides** (Prenz.) Sacc. f. sp. **aeschynomene**. Testing of this fungus was performed by Daniel, Templeton and others (Boyette et al., 1979; Smith et al., 1973; TeBeest & Brumley, 1978; Templeton et al., 1979). Recently, the Upjohn Company has developed a dry formulation of **Colletotrichum gloeosporioides** f. sp. **aeschynomene** for jointvetch control marketed under the trade name of "Collego". This mycoherbicide has been tested commercially in Arkansas with good results for two consecutive years. The recent introduction of bentazon has further broadened the weed control spectrum in rice production (Anon., 1976). In Puerto Rico, considerable intensive rice production research has been conducted on fertilization, varieties, planting season, evapotranspiration, production costs and pest control (Abruña & Lozano, 1974, 1977; Lozano & Abruña, 1977, 1981, 1982a, b; Ramírez et al., 1975; Silva & Vicente-Chandler, 1982). Weed control research in Puerto Rico has been limited to chemical methods (Liu et al., 1986; Liu & Lozano, 1986).

MATERIALS AND METHODS

The experiment was established on a Coloso silty clay (fine, mixed, non-acid, isohyperthermic Aeric Tropic Fluvaquents) at the Gurabo Substation. The layout of the experiment was a randomized complete block with four replications. The first part of the experiment was devoted to jointvetch control and the second part included waterprimrose control. The rice cv. Mars was planted December 15, 1985 on each plot (3.1 x 3.1 m). The rice seeds were broadcast over the soil surface and incorporated with a rake. The jointvetch seeds were planted on the first half of the area and waterprimrose on the second half. All plots except the weeded check received an early postmergence treatment of either propanil at 3.36 kg ai/ha or thiobencarb at 4.48 kg ai/ha on December 17, 1985. A portable CO_2 sprayer was used, and the volume rate was 514 l ha^{-1} at 2.7 kg cm^{-2}. The rice field was permanently flooded until three weeks before harvest. A second herbicide application including a mixture of 2,4-D at 1.12 ka ai ha^{-1} and bentazon at 1.12 kg ai ha^{-1} was made on January 10, 1986. Collego™ was applied twice (January 31 and February 14, 1986) at the rates recommended by the manufacturer (234 mls ha^{-1} (component a) and 0.34 kg ha^{-1} (component b). The weeded check was hand weeded thrice (January 31, February 24 and March 14, 1986). The time spent on each handweeding was recorded. The first fertilizer application, using a 15-5-10 analysis at 454 gms per plot, was made on January 2,1986. The second fertilizer application using the same analysis and application rate was made five weeks later. Malathion at a rate of 5 ml per gallon of water was applied for insect control(February 14,1986). A mixture of benomyl and malathion (1.12 kg ai/ha + 2.34 l/ha) was applied on March 3, 1986 as a preventive measure for leaf blight (**Pyricularia oryzae**) and for insect control. Weed control ratings were made periodically. The rice was harvested by cutting the plants about 10 cm. above the soil surface (April 22 and 23, 1986) when the grain had an average of 20 per cent moisture.

The gross income derived from the different treatments was calculated by multiplying the adjusted rough rice weight by the farm level price. The adjusted rough rice weight was obtained by deducting 15 per cent for foreign materials and excessive moisture from the field weight. The farm

level price was $12.26 per hundredweight (including a $2.00 subsidy). The estimated total costs of rice production used in this study, consisted of the estimated total cost without the herbicide treatment, plus the additonal costs due to the treatments. As the experiment was conducted on small plots, the costs of production estimated at the experimental level were extremely high, so it was decided to use Ferreira-González's (1985) cost data which is more recent compared with the data in Lloréns et al (1978). Ferreira-González's data was adjusted to a hectare basis and then inflated to reflect current producers' price levels in order to get a more realistic estimate. The resulting figure represents the adjusted cost excluding herbicide related costs. The additional cost includes all herbicide or manual labor costs. The net return for each treatment was obtained by substracting from the gross income the estimated total cost of production.

RESULTS AND DISCUSSION

The predominant grasses encountered in the plots included jungle rice (**Echinochloa colonum** (L.) Link.), finger grass (**Chloris inflata** Link.), crab grass (**Digitalia sanguinalis** (L.) Scop.) and goose grass (**Eleusine indica** (L.) Gaertn.). The broadleaved weeds were wild bush bean (**Macroptilium lathyroides** L.), purslane (**Portulaca oleracea** L.), niruri (**Phyllanthus niruri** L.), eclipta (**Eclipta alba**(L.) Hassk.), spreading dayflower (**Commelina diffusa** Burn. f.), mexican weed (**Caperonia palustris** (L.) St.Hil.), morning glory (**Ipomoea tiliacea** (Willd.) Choisy), jointvetch (**Aeschynomene sensitiva** Sw.) and waterprimrose (**Ludwigia erecta** (L.) H. Hara). As jointvetch and waterprimrose became prevalent during the mid- to late-growing season of rice, the early weed control evaluation was limited to grasses and broadleaved weeds as a group. The first application of either propanil or thiobencarb gave good initial control of both grasses and broadleaved weeds at the first evaluation (Tables 1 and 2). The second application of the 2,4-D and bentazon mixture improved considerably the control of broadleaved weeds with only slight improvements of grass control. This mixture provided excellent control of either jointvetch or waterprimrose at the last evaluation date. The follow-up Collego treatments gave poor control of jointvetch and did not control waterprimrose at all. The jointvetch control provided by Collego was not considered commercially acceptable. As the weeds encountered in the experimental rice field consisted of multiple species, it would be impossible to use Collego alone to control only one species of weed, leaving other predominant species intact.

The highest grain yield was obtained with the weeded check in the first part of the experiment. Propanil followed by a mixture of 2,4-D and bentazon, and thiobencarb followed by the same mixture, ranked second and third in yield. However, grain yield of these two treatments did not differ significantly from either propanil alone or thiobencarb alone. There were no significant differences in yield among different treatments in the second part of the experiment as shown in Table 2.

The highest gross income was derived from the weeded check and the least from the propanil alone treatment in the first part of the experiment (Table 3). This difference was statistically significant. The weeded check, on the contrary, reflected the least net return as it

Table 1. Effect of different herbicide treatments on the control of weeds, including jointvetch, in rice grown at the Gurabo Substation (1986)

Treatment	Weed control rating				Jointvetch	Grain yield (kg ha^{-1})
	Grasses		Broadleaved weeds			
	Jan. 10	Feb. 6	Jan. 10	Feb. 6	April 22	
1. Propanil at 3.36 kg ai/ha	90	80	73	60	0	2,316 b[1/]
2. Thiobencarb at 4.48 kg ai/ha	90	80	54	50	0	2,185 b
3. Propanil at 3.36 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha + bentazon at 1.12 kg ai/ha	90	90	69	98	95	3,202 ab
4. Thiobencarb at 4.48 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha bentazon at 1.12 kg ai/ha	90	90	50	100	95	2,940 ab
5. Propanil at 3.36 kg ai/ha followed by Collego at 234 ml/ha (component a) 0.34 kg/ha (component b)	90	80	73	53	20	2,495 b
6. Weeded check	-	95	-	95	90	3,949 a

1/ Values with one or more letters in common do not differ significantly at P - 0.05.

Table 2. Effect of different herbicide treatments on the control of weeds, including waterprimrose, in rice grown at the Gurabo Substation (1986)

Treatment	Weed control rating					Grain yield (kg ha^{-1})
	Grasses		Broadleaved weeds		Waterprimrose	
	Jan. 10	Feb. 6	Jan. 10	Feb. 6	April 22	
7. Propanil at 3.36 kg ai/ha	90	75	63	40	0	3,156 a[1/]
8. Thiobencarb at 4.48 kg ai/ha	90	75	42	30	0	3,249 a
9. Propanil at 3.36 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha + bentazon at 1.12 kg ai/ha	90	85	58	98	95	4,788 a
10. Thiobencarb at 4.48 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha + bentazon at 1.12 kg ai/ha	90	85	49	85	90	4,759 a
11. Propanil at 3.36 kg ai/ha followed by Collego at 234 ml/ha (component a) 0.34 kg/ha (componen t B)	90	75	60	50	0	3,432 a
12. Weeded check	-	95	-	95	85	4,968 a

1/ Values with one or more letter in common do not differ significantly at P = 0.05.

Table 3. Effect of herbicide treatments to control weeds in rice on the gross income, production cost, and net return (Gurabo Substation - 1986)

Treatment	Gross income ($/ha)	Adjusted cost ($/ha)	Additional cost due to treatment ($/ha)	Total cost ($/ha)	Net return ($/ha)
1. Propanil at 3.36 kg ai/ha	532.08 b[1]	1,161.47	49.96	1,211.43	-679.35 b[1/]
2. Thiobencarb at 4.48 kg ai/ha	501.91 b	1,161.47	59.30	1,220.77	-718.86 b
3. Propanil at 3.36 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha + bentazon at 1.12 kg ai/ha	735.67 ab	1,161.47	129.23	1,290.70	-555.03 b
4. Thiobencarb at 4.48 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha + bentazon at 1.12 kg ai/ha	675.32 ab	1,161.47	138.57	1,300.04	-624.72 b
5. Propanil at 3.36 kg ai/ha followed by Collego at 234 mls/ha (component a) 0.34 kg/ha (component b)	573.25 b	1,161.47	110.50	1,271.97	-698.72 b
6. Weeded check	907.33 a	1,161.47	13,815.73	14,977.20	-14,069.87 a

1/Values with one or more letters in common do not differ at the 5% level of probability (Duncan Multiple Range Test).

Table 4. Effect of different herbicide treatments to control weeds in rice on the gross income, production cost, and net return (Gurabo Substation - 1986)

	Treatment	Gross income ($/ha)	Adjusted cost ($/ha)	Additional cost due to treatment ($/ha)	Total cost ($/ha)	Net return ($/ha)
7.	Propanil at 3.36 kg ai/ha	725.12 a[1/]	1,161.47	49.96	1,211.43	-486.41 a
8.	Thiobencarb at 4.48 kg ai/ha	746.42 a	1,161.47	59.30	1,220.77	-474.35 a
9.	Propanil at 3.36 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha + bentazon at 1.12 kg ai/ha	1,099.99 a	1,161.47	129.23	1,290.70	-190.71 a
10.	Thiobencarb at 4.48 kg ai/ha followed by a mixture of 2,4-D at 1.12 kg ai/ha + bentazon at 1.12 kg ai/ha	1,092.68 a	1,161.47	138.57	1,300.04	-207.36 a
11.	Propanil at 3.36 kg ai/ha followed by Collego at 234 mls/ha (component a) 0.34 kg/ha (component b)	788.47 a	1,161.47	110.50	1,271.97	-483.50a
12.	Weeded check	1,141.48 a	1,161.47	13,815.73	14,977.20	-13,835.72 b

[1/]Values with one or more letters in common donot differ at 5% level of probability (Duncan Multgiple Range Test).

involved an appreciable additional cost for hand weeding. None of the other treatments produced any significant differences in net return. The highest gross income in the second part of the experiment (Table 4) was again from the seeded check. There were no significant differences in gross income among the other treatments. The same results were obtained with net income.

All treatments in this study produced negative net returns. The apparent lack of a profitable margin could be attributed to bad timing for growing rice during the winter months. As a result, yield was low with accompanying low gross income. However, data from these trials showed a trend for either propanil or thiobencarb as an early post followed by a mixture of 2,4-D and bentazon to produce a higher margin of profit than all other treatments. Manual weeding alone proved to be the least profitable treatment.

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