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STUDIES ON INTERACTIONS OF THE PETROLEUM DERIVATIVES (PROPANIL - SO_2) WITH HERBICIDE AND INSECTICIDE ON BARNYARDGRASS ADN RICE

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SUMMARY

Pot experiments were carried out to estimate the efficiency of the synthesized petroleum aromatic derivative (propanil - SO_2) as herbicide either separately or in combination with commercial herbicide thiobencarb and insecticides (Carbaryl, Carbofuran and Malathion) on barnyardgrass (Echinochloa crus - galli (L.) P. Beauv) and /or rice (Oryza sativa cv Giza 176).

The determination of the effectivenes of propanil - SO_2 in controlling barnyardgrass showed no significant results. After application of propanil - SO_2 with thiobencarb the injury symptoms appeared on the treated seedlings of either barnyardgrass or rice were nearly similar to those sprayed with thiobencarb alone.

The interaction effects between propanil - SO_2 and the examined insecticides showed slight reduction in rice dry weight and grain yield ranged from 1 - 3% after the application of the insecticides 1 to 4 days before and after propanil - SO_2 treatment respectively The abtained data was not significant.

The vegetative growth and yield of rice plants were less injured when the time interval between insecticides and propanil treatment increased.

Rice plants were not affected by the application of the used insecticides plus proparil - SO_2 .

INTRODUCTION

Chemical weed control is a miracle of our technological age and it has been at the fore front in technological achievement. It involves knowledge in the fields of chemistry and biology (Ashton and Crafts, 1981).

New and better herbicides are being continuously synthesized and developed. Yields of cereals, soybeans, cotton, sugar beet, and in any other crops have increased in some cases 100% after application of synthetic organic herbicides (Ashton & Crafts, 1981).The herbicides are classified into two major groups inorganic and organic.

Propanil is a member of amide herbicides. It is especially valuable in rice culture because of its high selectivity. Rice plants are 40 times more tolerant of propanil than barnyardgrass (Matsunaka, 1965). The resistance of rice to propanil has been attributed to the ability of these species to degrade propanil more rapidly then most weed species (Adachi, et. al. 1966).

Chemical weed control in direct - seeded rice demands astrict herbicides application timing because rice and weeds are of the same grawth stage (De Datta and Bernasor, 1973). The ideal herbicides for weed control in rice

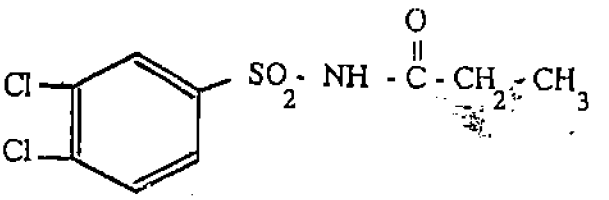
combines high selectivity and efficacy with safe application methods (Hassan et al , 1990).

Interaction between herbicides and insecticides were reported by (Smith and Tugwell, 1975 and Mukhopadhyay and sen, 1981). It was hound that the organophosphate and carbamate insecticides interact with the herbicide propanil to increase injury to rice (Bowling and Hudgins, 1966).

The aim of the present study was to test the efficiency of the synthesized propanil SO_2 as herbicides either separately or in combination with commercial herbicide and insecticide on the growth of barnyardgrass and rice.

MATERIALS AND METHODS

Preparation of N-propanil 3, 4 - dichlorobenzene sulphonamide (propanil SO_2)



This compound was prepared in three steps:

A. Mixing 1,2 dichlorobenzene with Cl SO_3 H in a solvent of CH cl_3 (Stewart, 1922).

B. The produced dichlorobenzene sulphonyl chloride was treated with NH_4 OH according to (Somasekhara, 1968) to prepare 3,4- dichlorobenzene sulphonamide. C. 3,4 - dichlorobenzene sulphonamide (0.005 mol) was mixed with propionyl chloride (0.007 mal) and glacial acetic acid (5 ml) on boiling bath. The solid product was filtered, dissolved in Na HCO_3 .

acidified with glacial acetic acid and crystallized by ethanal to produce N-propionyl 3,4 - dichlorobenzene sulphonamide (El-Dib, 1978).

Commercial herbicides and insecticides used

Pesticides	Common	Chemical name	Trade name	Formulation
Herbicides	Propanil	3,4 - dichloropropionanilide	Stam F -34	EC
	Thiobencarb	S [(4 - chlorophenyl) methyl] diethyl caarbamothioate.	Saturn 50%	EC
Insecticides	Carbaryl	1-naphthyl methyl carbamate	Siven 85%	WP
	Carbofuran	2,3 dihydro - 2 - 2 - dimethyl - 7 - benzofuranyl methyl carbamate.	Furadan 5%	G
	Malathion	o,o- dimethyl phosph orodithioate ester of diethyl mercaptosuccinoate.	Malathion 80%	EC

Ec = Emulsifiable

WP = Wittable Powder

G = Granules

pot experiment:

The experiments were carried out at Rice Research and Training Centre, Sakka, Kafr El-Sheikh under greenhouse conditions (average temperature 28 + 2 C during the day time and 18 C at night). seeds were abtained from the same Research Centre.

The effect of the synthesized herbicides propanil - SO_2 was tested either separately or in combination with desired commercial herbicides or insecticides on barnyardgrass (Echinochloa crus - galli (L.) P. Beauv) and rice (Oryza sativa)

c. Giza 176. Plants were grown in plastic pots 20 cm depth and 20 cm diameter. In each pot 4 Kg of clay loam soil was placed. Some chemical analysis of the used soil was as follows:

pH	Ec ds/m	Co_3 Meq/L	HCo_3 Meq/L	OM %	NH_4 ppm	No_3 ppm	P ppm	K ppm	Zn ppm
7.8	1.1	1.0	1.9	2.1	2.9	19.3	11	625	1.9

Fifteen seeds each of barnyardgrass and rice were planted per pot, after emergence the seedlings were thinned to 10 plants per pot. Pots were irrigated by saturating the soil several times during the early season. It was flooded first when the plants ranged from 15 to 25 cm tall. Water was maintained on the plants during the season except for draining one day before and reflooding one day after each treatment. Rice plants received 40 Kg nitrogen /fed as urea 46% at 25 days after seeding.

The synthesized propanil - SO_2 and all commercial herbicides and insecticides were used as Kg/fed in a total water emulsion of 200L/fed., with a CO_2 - pressurized back - pack sprayer at 2.11 Kg/cm^2 fitted with flat - fan spray nozzles # 1004. The boam was positioned 25 cm above each pot.

The Herbicides were applied at half -, one- two- and three- leaf stages of barnyardgrass and rice at different rates.

Growth stages of rice plants when treated with insecticides in relation to

propanil application were listed in the fallowing Table:

Application time of insecticides		Rice growth stage	
10	DBP	1	Leaf stage
7	DBP	2	Leaf stage
4	DBP	2.5	Leaf stage
2	DBP	3	Leaf stage
1	DBP	3.5	Leaf stage
1	DAP	3.5	Leaf stage
2	DAP	4	Leaf stage
4	DAP	4.5	Leaf stage
7	DAP	5	Leaf stage
10	DAP	5.5	Leaf stage

DBP = days before propanil application.
DAP = days after propanil application.

The insecticides carbaryl, carbofuran and malathion were applied at the rates of 1.2 Kg ai/fed wettable powder, 0.8 Kg ai/fed granules and 1.2 Kg ai/fed emulsifiable concentrate respectively in relation to the propanil or propanil - SO_2 treatment at the rate of 1.05 Kg ai/fed emulsifiable concentrate.

Fresh and dry weights of shoots of barnyardgrass and rice, plant height and leaf area of rice plant were recorded at 30 days after seeding. leaf area was determined using LI-3100 Area Meter. Total chlorophyll content of rice leaves were estimated at 5 days after seeding according to th procedure (Arnon, 1959).

After maturity the harvested grains were adjusted to 14% moisture (Smith, 1974). Rice grain yield in grams per pot were obtained. The total nitrogen

content of rice grains was determined (Jackson, 1967). The starch,content of rice grains was estimated using the method of (Yoschida et al.,1972).

The results were statistically analyzed and significance of treatment differences was estimated through L.S.D. (Snedecor and Cochron, 1969).

Effect of propanil, propanil - SO_2, thiobencarb and their combinations on barnyardgrass and rice:

Effective weed control programms have been developed for the most severe weeds of rice (barnyardgrass) were based primarily one the use of propanil and other herbicides (Smith et al., 1977 and Eastin, 1981).

In the present investigation we tried to compare the effects of either propanil or propanil - So with thiobencarb when applied at different stages of growth for controlling branyardgrass.

Both barnyardgrass and rice plants developed dark greed leaves and stunting within 1 - 3 days after thiobencarb application,while the plants showed scorching and stunting following the application of propanil plus thiobencarb. The symptoms were obvious at higher concentrations and when the treatments were done at the early stages of growth one - and two - leaf stage. Rice plants recovered from the injury within 7 - 15 days after treatments.

Table (1) represented that either propanil or thiobencarb caused significant reduction in fresh and dry weights of barnyardgrass at one - leaf stage. Weed injury was ranged from 16 - 87% and 28 - 64% following the application of propanil and thiobencarb respectively. The barnyardgrass - control

was decreased at late stages of growth (two - and three - leaf stage). However,propanil tank-mixed with thiobencarb provided excellent control of barnyardgrass (72 - 100%) at higher concentrations of propanil plus thiobencarb 0.35 + 1.0, 0.70 + 0.5, 0.70 + 0.75, 0,70 + 1.0, 1.05 + 0.5, 1.05 + 0.75 and 1.05 + 1.0 Kg ai/fed when applied at one - and two - leaf stage of growth.

It was clear from the experimental results that postemergence tank - mixture of propanil + thiobencarb caused an effective control of barnyardgrass more than single treatments. The phytotoxic effects were apparent when the herbicides were applied at lower stages of growth and at higher concentrations.

The obtained results were in aggrement with (Smith and Khodayari, 1985 and Khodayari et al., 1989) who reported that propanil tank - mixed with thiobencarb postemergence provided an effective control of barnyardgrass than sequential application of them.

It was reported by different investigators (Smith 1975, Smith et al., 1977 and Hassan and Mahrous, 1989) and confirmed by the present work, that postemergence tank - mixture of propanil with thiobencarb was most effective for controlling barnyardgrass at one - and two - leaf stage of growth, while larger barnyardgrass plants were frequently not controlled.

Tables (2,3) showed that the effect of propanil, thiobencarb and their combinations on plant height, fresh weight, dry weight,leaf area and total chlorophyll content of rice. At one - leaf stage of rice there was severe reduction on the growth parameters after the application of the herbicides. The reduction was clearly observed as the rate of herbicides increased. At one - leaf

stage of growth plant height, fresh weight, dry weight and leaf area were reduced by 61% , 55%, 54% and 72% respectively following the application of thiobencarb at 1.0 Kg. ai/fed. This injury decreased at two - and three - leaf stage of growth. Postemergence tank - mixtures of propanil plus thiobencarb enhanced the injury of rice plants greatly at lower stages of growth and at higher concentrations of the herbicides.

Propanil at 1.05 Kg ai/fed, propanil + thiobencarb at 1.05 + 0.5, 1.05 + 0.75 and 1.05 + 1.0 Kg ai/fed caused 20% reduction in the total chlorophyll content of rice leaves. This reduction was not singnificant as shown in Table (3).

Table (4) represented that rice grains harvested from plant treated with the herbicides were severely affected at the early stages of growth. When the plants ware sprayed with either propanil or thiobencarb at one - leaf stage the observed reduction in yield ranged from 29 - 54%, 29 - 56% respectively. This harmfull effect increased by using tank - mixture of both herbicides at the same stage of growth. however, the reduction in rice grain yield was not statistically significant when the plants were treated with the herbicides either alone or in combination at the late stage of growth (three - leaf staga).

The total nitrogen content, crude protein and starch content of rice grains were not significantly affected by the herbicidal treatments at all rates and times of application as illustrated in Table (4).

Results from this investigation showed that the application of propanil in combination with thiobencarb increased rice injury as compared with single

treatments. This injury was clearly observed at one - and two - leaf stage of growth and at higher rates of the combined herbicides.

Previous investigators (Smith et al., 1977, Richard et al., 1981 and Smith, 1981) found that mixtures of propanil with thiobencarb applied early postemergence injured rice moderately, but the rice recovered and the grain yield was developed which supports the data reported herein.

Some herbicides injured rice more than propanil but injury for all treatments was inconsistent (Smith and Khodayari, 1985).

Trials were made to examine the phytotoxicity of propanil - SO_2 when used in combination with thiobencarb as shown in Table (5). After application of propanil - SO_2 with thiobencarb, the injury symptoms appeared on the treated seedlings of either barnyardgrass or rice were nearly similar to those sprayed with thiobencarb alone. Postemergence application of propanil - SO_2 at 0.35, 0.70 and 1.05 Kg ai/fed, in combination with thiobencarb at 0.50, 0.75 and 1.0 kg ai/fed resulted in significant reduction in fresh and dry weights of barnyardgrass at lower stages of growth and at higher concentrations. The percent injury ranged from 74 to 77% and 41 to 44% at one - and two - leaf stage of growth respectively at higher rates of propanil - SO_2 + thiobencarb 0.70 + 1.0 and 1.05+1.0 kg ai/fed as shown in Table (5).

Propanil - SO_2 in combination with thiobencarb was also tested on the vegetative growth and the crop yield of rice at different rates and times of application as indicated in Tables (6,7 & 8). The phytotoxic effects increased at lower stages of growth (one - and two - leaf stage) and at higher rates of

propanil - SO_2 + thiobencarb 0.7 + 1.0, 1.05 + 0.50,1.05 +0.75 and 1.05 + 1.0 kg ai/fed

Rice grain yield and total nitrogen content, crude protein & starch content of rice grains as influenced by propanil - SO_2 and thiobencarb were illustrated in Table (8). There was singnificant reduction in rice grain yield ranged from 65 - 68% at one - leaf stage when propanil - SO_2 + thiobencarb applied at rates of 0.70 + 1.0 and 1.05 + 1.0 kg ai/fed respectively. However, the percent injury of the total nitrogen content, crude protein and starch content of rice grains was not significant.

Herbicides - insecticides interactions on rice:

Losses in the yield of rice crop due to weeds and insects are quite severe. Biological - control is at present perhaps impractical for large scale use to combat these pestes. Large number of investigations have been made on the use of herbicides and insecticides separately, but very few investigations have been made on the combined use of herbicides and insecticides in rice crop. Very often weeds and insects infest the rice crop at the same time (Gifford, 1973 and Smith and Seaman, 1973). Hence herbicides and insecticides are needed at about the same time and one application of these combined pesticides will help to reduce the cost of operation.Therefore, it was of great necessity to study in detail the interaction of these herbicides and insecticides combinations.

With these ideas trials were made in the present investigation to drive more knowledge about the interaction of propanil or propanil - SO_2 with some insecticides on rice when they were applied at various times and rates before or after herbicidal treatments.

Propanil or propanil - SO_2 and insecticides interactions on rice:

Observations indicated that leaf chlorosis and necrosis of rice plants were less as the time interval between insecticides and propanil treatment increased. The rice recovered from the interacting effects within a 5 - week period after propanil treatment. Older rice plants recovered more quickly than younger ones.

Propanil is widely used as a selective herbicide for controlling barnyardgrass in rice and usually causes no significant injury to rice plants. However certain insecticides interact adversely with propanil result in phytotoxic injury to rice plants.

The above observations were in agreement with those reported by (Smith and Tugwell, 1975 and Khodayari et al., 1986). The application of propanil plus carbofuran caused yellowing and burning of rice leaves but rice recovered about five weeks after application (Mukhopadhyay and Sen, 1981).

Synergistic phytotoxicity was apparent on rice plants when propanil was applied one day after carbaryl treatment where most rice plants were killed. Slight injury was noticed on plants treated with propanil two weeks after carbaryl treatment (Yih et al., 1968 b).

Table (9) showed that all insecticides (carbaryl, carbofuran and malathion) interacted with propanil at all times of application. Their interactions injured rice vegetatively. The degree of injury is influenced both by the type and the application time of the used insecticides in relation to the propanil application. The reduction in rice dry weight expressed as percent proved an

excellent indication of phytotoxicity. The synergistic effects in rice resulting in dry weight loss from 39% to 69% when the isecticides were applied 4 days to 1 day before or after propanil treatment respectively. Injury was lowered from 28% to 0% with time intervals of 7 to 10 days before or after propanil application.

After recovery of the vegetatively injured rice plants, grain yield was developed. Rice grain yield was reduced as the same trend observed in rice dry weight as shown in Table (9).

The phytotoxic symptoms exhibited by rice plants following the interaction of insecticides and propanil may be attributed to the inhibiting effect of the insecticides on the activity of rice arylacylamidase enzyme which detoxifies propanil causing loss of selectivity in rice.

Results of previous researchs obtained by different investigators (Bowling and Hudgins, 1966, Bowling and Flinchum, 1968 and Yih et al., 1968 a) indicated that the degree of rice plants injury was directly correlated with the degree of propanil hydrolyzing-enzyme inhibition caused by certain insecticides. The basis for the interaction between propanil and certain insecticides appeared to be an inhibition of rice arylacylamidase enzyme which metabolizes propanil to non - toxic compounds 3,4 - dichloroaniline and propionic acid (Frear and Still, 1968, Matsunaka, 1968, El-Refai and Mowafy, 1973 and Matsunaka, 1981).

A mixture of propanil at 3 lb/acre and carbaryl at 0.5 lb/acre were applied to rice 4 inches tall caused 55% injury, compared with 5 and 0% injury from either propanil or carbaryl respectively (Smith, 1968).

Table (10) represented the interaction effects between propanil SO_2 and the examined insecticides. Slight reduction was observed in rice dry weight and grain yield ranged from 1% to 3% after the application of the insecticides 4 days to 1 day before or after propanil SO_2 treatment respectively. The obtained data was not significant.

CONCLUSION:

The results from the present study revealed that the response injury of barnyardgrass and rice to tested herbicides depends on the leaf - stage of growth at which they were applied. It is preferable to apply the herbicides at one - or two - leaf stage of barnyardgrass to achieve maximum control. However, it is safe to use herbicides after three - leaf stage of rice to avoid any phytotoxic effect.

The synthesized herbicides need knowledge in the fields of chemistry and biology and at least observational experience in the responses of common weeds and crops to them. Also weed and crop ecology and appreciation of the factors determining selectivity of the new herbicides are very important.

Generally herbicides must be applied at lowest rates by which maximum control of weeds is achieved.

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Table 1: Effect of propanil , thiobencarb and their combinations on the fresh and dry weights of barnyardgrass (Echinochloa crus-galli) at 30 days after seeding .

Herbicides	Rate of application Kg ai / fed	Fresh weight (g / pot)						Dry weight (g / pot)					
		Leaf stage & % reduction						Leaf stage & % reduction					
		1 lf	%	2 lf	%	3 lf	%	1 lf	%	2 lf	%	3lf	%
Control (untreated)	-	21	0	21	0	21	0	3.67	0	3.51	0	3.69	0
Propanil	0.35	17.6	16	19.4	8	19.7	6	3.1	16	3.24	8	3.47	6
	0.70	4.6	78	7.8	63	12.5	41	0.8	78	1.3	63	2.13	42
	1.05	2.8	87	3.1	85	7.5	64	0.4	89	0.56	84	1.37	63
Thiobencarb	0.5	15.2	28	20.4	3	21.	0	2.69	27	3.40	3	3.69	0
	0.75	11.5	45	19.7	6	20.2	4	2.0	46	3.32	5	3.55	4
	1.0	7.5	64	16.8	20	18	14	1.3	65	2.8	20	3.15	15
Propanil + thiobencarb	0.35 + 0.5	14.5	31	19.8	6	20.8	1	2.53	31	3.38	4	3.60	2
	0.35 + 0.75	11.2	47	19.1	9	18.3	13	1.95	47	3.20	9	3.22	13
	0.35 + 1.0	5.9	72	14.8	30	15	29	1.03	72	2.45	30	2.63	29
Propanil + thiobencarb	0.70 + 0.5	3.5	83	7.0	67	11.7	44	0.60	84	1.17	67	2.05	44
	0.70 + 0.75	2.8	87	6.6	69	11.5	45	0.53	86	1.10	69	2.02	45
	0.70 + 1.0	2.3	89	5.9	72	11.3	46	0.40	89	1.03	71	2.0	46
Propanil + thiobencarb	1.05 + 0.5	2.0	91	6.4	70	8.9	58	0.34	91	1.08	69	1.59	57
	1.05 + 0.75	1.9	91	6.2	71	7.6	64	0.31	92	1.05	70	1.28	65
	1.05 + 1.0	0.0	100	0.0	100	6.6	69	0.0	100	0.0	100	1.2	68
$L.S.D_{0.05}$		1.9		1.3		1.7		0.32		0.14		0.23	

Table : 2 Effect of propanil , thiobencarb and their combinations on plant height, fresh weight and dry weight of rice (Oryza sativa) cv Giza 176 at 30 days after seeding.

Herbicides	Rate of application Kg ai / fed	Plant height (cm / plant)						Fresh weight (g / pot)						Dry weight (g / pot)					
		Leaf stage & % reduction						Leaf stage & % reduction						Leaf stage & % reduction					
		1 lf	%	2 lf	%	3 lf	%	1lf	%	2 lf	%	3lf	%	1lf	%	2lf	%	3lf	%
Control (untreated)	-	28	0	28	0	28	0	13	0	13	0	13	0	2.35	0	2.29	0	2.30	0
Propanil	0.35	24	14	28	0	28	0	11.6	11	12.9	1	13	0	2.1	11	2.31	0	2.33	0
	0.70	21	25	26.7	5	28	0	9.2	29	12.2	6	12.9	1	1.7	28	2.17	5	2.31	0
	1.05	13	54	23	18	26.9	4	5.2	60	10.9	16	12.5	4	0.95	60	1.9	17	2.22	4
Thiobencarb	0.5	18	36	28.1	0	28	0	9.5	27	13.5	0	13.7	0	1.7	28	2.34	0	2.36	0
	0.75	13	54	27.8	1	27.9	0	7.8	40	13	0	13.1	0	1.4	40	2.32	0	2.31	0
	1.0	11	61	27.3	3	27.8	1	5.9	55	12	8	12.9	1	1.08	54	2.11	9	2.28	1
Propanil + thiobencarb	0.35 + 0.5	17	39	27.9	0	28	0	7.0	46	12.9	1	13	0	1.3	45	2.29	0	2.31	0
	0.35 + 0.75	12	57	27.5	2	27.7	1	6.1	53	12.5	4	13	0	1.1	53	2.23	3	2.30	0
	0.35 + 1.0	10	64	26.9	4	27.4	2	4.9	62	12.1	7	12.9	1	0.9	62	2.10	8	2.28	1
Propanil + thiobencarb	0.70 + 0.5	15	46	26.5	5	27.6	1	5.9	55	12.6	3	13.2	0	1.08	54	2.23	3	2.32	0
	0.70 + 0.75	11	61	26.4	6	27.3	3	4.9	62	12.4	5	12.9	0	0.95	60	2.20	4	2.30	0
	0.70 + 1.0	9	67	25.2	10	26.5	5	3.8	71	10.4	20	11.4	12	0.68	71	1.8	21	2.0	13
Propanil + thiobencarb	1.05 + 0.5	10	64	23.1	18	27	4	2.0	85	9.21	29	11.4	12	0.33	86	1.6	30	2.0	13
	1.05 + 0.75	8	71	22.9	18	26.4	5	1.8	86	9.0	31	11.1	15	0.30	87	1.57	31	1.95	15
	1.05 + 1.0	7	75	22.2	21	26.2	6	1.38	89	8.5	35	10.9	16	0.28	88	1.48	35	1.90	17

Table 3 : Effect of propanil , thiobencarb and their combinations on leaf area and total chlorophyll content of rice (Oryza sativa) cv Giza 176.

Herbicides	Rate of application Kg ai / fed	Leaf area (cm^2 / pot) at 30 days after seeding						Total * chlorophyll mg/g fresh wt.	
		Leaf stage & % reduction							
		1 lf	%	2 lf	%	3 lf	%	2lf	% red
Control (untreated)	-	96	0	96	0	96	0	5	0
Propanil	0.35	83	14	96	0	97	0	6	0
	0.70	61	37	89	7	96	0	5	0
	1.05	34	65	69	28	95	1	4	20
Thiobencarb	0.5	68	29	92	4	98	0	6	0
	0.75	44	54	90	6	97	0	6	0
	1.0	27	72	89	7	95	1	5	0
Propanil + thiobencarb	0.35 + 0.5	63	34	90	6	96	0	6	0
	0.35 + 0.75	41	57	89	7	95	1	5	0
	0.35 + 1.0	21	78	87	9	94	2	5	0
Propanil + thiobencarb	0.70 + 0.5	57	41	89	7	95	1	5	0
	0.70 + 0.75	39	59	89	7	94	2	5	0
	0.70 + 1.0	20	79	82	15	93	3	4	20
Propanil + thiobencarb	1.05 + 0.5	23	76	66	31	93	3	4	20
	1.05 + 0.75	20	79	64	33	91	5	4	20
	1.05 + 1.0	10	90	63	34	90	6	4	20
L.S.D$_{0.05}$		11		8		N.S		N.S	

* At 45 days after seeding

Table 4 : Effect of propanil , thiobencarb and their combinations on grain yield and total nitrogen , crude protein & starch content of rice-grains(Oryza sativa) cv Giza 176.

Herbicides	Rate of application Kg ai / fed	Grain yield (g / pot)						Toual nitrogen		Crude Protein		Starch content	
		Leaf stage & % reduction						mg / g grain					
		1 lf	%	2 lf	%	3 lf	%	2 lf	% red	2 lf	% red	2lf	%red
Control (untreated)	-	41	0	40	0	41	0	21	0	125	0	43	0
Propanil	0.35	29	29	39	3	41	0	20	5	125	0	42	2
	0.70	28	32	38	5	39	5	18	14	113	10	40	7
	1.05	19	54	37	8	38	7	18	14	113	10	40	7
Thiobencarb	0.5	29	29	40	0	42	0	19	10	119	5	42	2
	0.75	25	39	39	3	41	0	18	14	113	10	40	7
	1.0	18	56	39	3	39	5	17	19	106	15	40	7
Propanil + thiobencarb	0.35 + 0.5	18	56	38	5	42	0	19	10	119	5	41	5
	0.35 + 0.75	9	78	37	8	41	0	18	14	113	10	40	7
	0.35 + 1.0	7	83	36	10	39	5	17	19	106	15	40	7
Propanil + thiobencarb	0.70 + 0.5	8	81	37	8	41	0	18	14	113	10	40	7
	0.70 + 0.75	7	83	36	10	40	2	18	14	113	10	40	7
	0.70 + 1.0	6	85	34	15	39	5	17	19	106	15	39	9
Propanil + thiobencarb	1.05 + 0.5	4	90	32	20	40	2	18	14	113	10	40	7
	1.05 + 0.75	3	93	31	23	39	5	17	19	106	15	39	9
	1.05 + 1.0	2	95	30	25	39	5	17	19	106	15	39	9
L.S.D$_{0.05}$		3		6		N.S		N.S		N.S		N.S	

Table 5 : Effect of propanil - SO_2 , thiobencarb and their combinations on the fresh and dry weights of barnyardgrass (Echinochloa crus-galli) at 30 days after seeding .

Herbicides	Rate of application Kg ai / fed	Fresh weight (g / pot)						Dry weight (g / pot)					
		Leaf stage & % reduction						Leaf stage & % reduction					
		1 lf	%	2 lf	%	3 lf	%	1 lf	%	2 lf	%	3lf	%
Control (untreated)	-	23	0	23	0	23	0	3.89	0	3.97	0	3.91	0
Propanil SO_2	0.35	23.1	0	23.2	0	23.6	0	3.90	0	3.99	0	3.93	0
	0.70	22.8	1	22.7	1	22.9	0	3.84	1	3.93	1	3.90	0
	1.05	21.5	7	21.9	5	22.5	2	3.65	6	3.79	5	3.85	2
Thiobencarb	0.5	15.9	31	21.5	7	22.9	0	2.7	31	3.65	8	3.90	0
	0.75	13.3	42	21	9	22.1	4	2.3	41	3.60	9	3.81	3
	1.0	7.1	69	18.5	20	21.5	7	1.19	69	3.15	21	3.69	6
Propanil-SO_2 +thiobencarb	0.35 + 0.5	15	35	21.2	8	22.5	2	2.55	34	3.60	9	3.83	2
	0.35 + 0.75	12.7	45	20.5	11	22.1	4	2.17	44	3.54	11	3.71	5
	0.35 + 1.0	6.9	70	17.6	23	21	9	1.15	70	3.07	23	3.57	9
Propanil-SO_2 +thiobencarb	0.70 + 0.5	14	39	21	9	22.1	4	2.4	38	3.63	9	3.74	4
	0.70 + 0.75	12.2	47	20.4	11	21.5	7	2.05	47	3.52	11	3.64	7
	0.70 + 1.0	5.9	74	13.5	41	20.5	11	1.0	74	2.34	41	3.40	13
Propanil-SO_2 +thiobencarb	1.05 + 0.5	13.3	42	20.5	11	22.1	4	2.3	41	3.54	11	3.71	5
	1.05 + 0.75	11.5	50	18.7	19	21.5	7	1.95	50	3.20	19	3.59	8
	1.05 + 1.0	5.3	77	12.9	44	20.3	12	0.9	77	2.22	44	3.33	15
$L.S.D_{0.05}$		2.91		3.15		N.S		0.31		0.47		N.S	

Table :-6 Effect of propanil-SO_2 , thiobencarb and their combinations on plant height, fresh weight and dry weight of rice (Oryza sativa) cv Giza 176 at 30 days after seeding.

Herbicides	Rate of application Kg ai / fed	Plant height (cm / plant)						Fresh weight (g / pot)						Dry weight (g / pot)					
		Leaf stage & % reduction						Leaf stage & % reduction						Leaf stage & % reduction					
		1 lf	%	2 lf	%	3 lf	%	1 lf	%	2 lf	%	3 lf	%	1lf	%	2lf	%	3lf	%
Control (untreated)	-	29	0	29	0	29	0	17	0	17	0	17	0	2.87	0	2.89	0	2.89	0
Propanil-SO_2	0.35	29	0	29.1	0	28.9	0	17.1	0	17.1	0	17.3	0	2.90	0	2.88	0	2.89	0
	0.70	28.4	2	28.6	1	28.8	1	16.5	3	16.6	2	16.8	1	2.81	3	2.83	2	2.86	1
	1.05	28	3	28.4	2	28.5	2	16.1	5	16.3	4	16.5	3	2.74	5	2.79	4	2.81	3
Thiobencarb	0.5	16.8	42	29	0	29.1	0	12.3	28	16.4	4	17	0	2.06	28	2.77	4	2.89	0
	0.75	13.4	54	28.1	3	28.8	1	9.9	42	16.0	6	16.6	2	1.7	41	2.73	6	2.83	2
	1.0	10.7	63	28.1	3	28.4	2	7.0	59	15.5	9	16.3	4	1.18	59	2.63	9	2.79	4
Propanil-SO_2 +thiobencarb	0.35 + 0.5	16.2	44	28.9	0	29	0	12.0	29	16.3	4	16.8	1	2.03	29	2.78	4	2.86	1
	0.35 + 0.75	13.0	55	28.2	3	28.8	1	9.7	43	16.0	6	16.6	2	1.65	43	2.73	6	2.83	2
	0.35 + 1.0	10.1	65	28	3	28.3	2	6.8	60	15.3	10	16.1	5	1.15	60	2.63	9	2.74	5
Propanil-SO_2 +thiobencarb	0.70 + 0.5	15.9	45	28.8	1	29.3	0	11.5	32	16.0	6	16.5	3	1.98	31	2.73	6	2.81	3
	0.70 + 0.75	12.2	58	28.2	3	28.5	2	9.5	44	15.9	7	16.1	5	1.65	43	2.69	7	2.74	5
	0.70 + 1.0	9.5	67	27.9	4	28.4	2	6.5	62	15.3	10	15.8	7	1.10	62	2.59	10	2.70	7
Propanil-SO_2 +thiobencarb	1.05 + 0.5	15.0	48	28.4	2	29	0	11.0	35	15.8	7	16.3	4	1.89	34	2.70	7	2.78	4
	1.05 + 0.75	11.8	59	28	3	28.5	2	8.7	49	15.6	8	16.1	5	1.48	48	2.66	8	2.75	5
	1.05 + 1.0	9.2	68	27.8	4	28	3	6.0	65	15.2	11	15.9	7	1.01	65	2.59	10	2.69	7
L.S.$D_{0.05}$		3.4		N.S		N.S		2.71		2.3		N.S		0.42		0.37		N.S	

Table : 7 Effect of propanil-SO_2 , thiobencarb and their combinations on leaf area and total chlorophyll content of rice (Oryza sativa) cv Giza 176.

Herbicides	Rate of application Kg. ai / fed	Leaf area (cm^2 / pot) at 30 days after seeding						Total * chlorophyll mg/g fresh wt.	
		Leaf stage & % reduction							
		1 lf	%	2 lf	%	3 lf	%	2lf	% red
Control (untreated)	-	103	0	103	0	103	0	5	0
Propanil-SO_2	0.35 0.70 1.05	104 102 100	0 1 3	103 102 101	0 1 2	103 102 101	0 1 2	6 6 5	0 0 0
Thiobencarb	0.5 0.75 1.0	61 35 27	41 66 74	98 97 95	5 6 8	103 102 101	0 1 2	6 5 5	0 0 0
Propanil-SO_2 +thiobencarb	0.35 + 0.5 0.35 + 0.75 0.35 + 1.0	57 32 26	45 69 75	97 95 94	6 8 9	102 102 101	1 1 2	6 5 5	0 0 0
Propanil-SO_2 +thiobencarb	0.70 + 0.5 0.70 + 0.75 0.70 + 1.0	56 30 25	46 71 76	96 95 93	7 8 10	102 101 100	1 2 3	6 5 4	0 0 20
Propanil-SO_2 +thiobencarb	1.05 + 0.5 1.05 + 0.75 1.05 + 1.0	55 27 24	47 74 77	96 94 93	7 9 10	101 101 100	2 2 3	5 5 4	0 0 20
L.S.$D_{0.05}$		9		N.S		N.S		N.S	

* At 45 days after seeding

Table 8 : Effect of propanil - SO_2, thiobencarb and their combinations on grain yield and total nitrogen, crude protein & starch content of rice grains(Oryza sativa) cv Giza 176.

Herbicides	Rate of application Kg ai / fed	Grain yield (g / pot)						Total nitrogen		Crude Protein		Starch content	
		Leaf stage & % reduction						mg / g grain					
		1 lf	%	2 lf	%	3 lf	%	2 lf	% red	2 lf	% red	2lf	%red
Control (untreated)	-	37	0	36	0	36	0	21	0	125	0	43	0
Propanil-SO_2	0.35	37	0	38	0	38	0	20	5	125	0	43	0
	0.70	36	3	35	3	37	0	20	5	125	0	43	0
	1.05	35	5	35	3	35	3	19	10	119	5	42	2
Thiobencarb	0.5	26	30	37	0	38	0	19	10	119	5	41	5
	0.75	22	41	35	3	36	0	18	14	113	10	40	7
	1.0	15	60	34	6	35	3	17	19	106	15	40	7
Propanil-SO_2 +thiobencarb	0.35 + 0.5	25	32	36	0	37	0	19	10	119	5	41	5
	0.35 + 0.75	21	43	35	3	35	3	18	14	113	10	40	7
	0.35 + 1.0	14	62	34	6	35	3	17	19	106	15	40	7
Propanil-SO_2 +thiobencarb	0.70 + 0.5	23	38	35	3	36	0	18	14	113	10	41	5
	0.70 + 0.75	19	49	35	3	35	3	18	14	113	10	40	7
	0.70 + 1.0	13	65	34	6	35	3	17	19	106	15	39	9
Propanil-SO_2 +thiobencarb	1.05 + 0.5	21	43	35	3	35	3	18	14	113	10	40	7
	1.05 + 0.75	18	51	34	6	35	3	18	14	113	10	40	7
	1.05 + 1.0	12	68	34	6	34	6	17	19	106	15	39	9
L.S.$D_{0.05}$		5		N.S		N.S		N.S		N.S		N.S	

Table: 9 Rice dry weight (30 days after seeding) and grain yield as influenced by propanil and insecticides interactions .

Time of * insecticide application	Carbaryl				Carbofuran				Malathion			
	Dry wt. (g/pot)	% red.	Grain yield (g/pot)	% red.	Dry wt. (g/pot)	% red.	Grain yield (g/pot)	% red.	Dry wt. (g/pot)	% red.	Grain yield (g/pot)	% red.
Control (untreated)	4.25	0	58	0	4.25	0	58	0	4.25	0	58	0
10 DBP	3.9	8	54	7	4.05	5	55	5	4.16	2	57	2
7 DBP	3.08	28	51	12	3.29	23	52	10	3.59	16	55	5
4 DBP	2.0	53	32	45	2.2	48	34	41	2.6	39	40	31
2 DBP	1.5	65	29	50	1.6	62	31	47	1.78	58	37	36
1 DBP	1.3	69	22	62	1.5	65	25	57	1.7	60	31	47
1 DAP	1.65	61	33	43	2.14	50	38	35	2.14	50	41	29
2 DAP	1.74	59	35	40	2.11	50	40	31	2.42	43	44	24
4 DAP	2.28	46	39	33	2.6	39	45	22	2.48	42	49	16
7 DAP	3.8	11	52	10	3.9	8	51	12	3.83	10	55	5
10 DAP	3.9	8	55	5	4.1	4	54	7	4.25	0	58	0
L.S.D 0.05	4		3		4		3		4		3	

* DBP = days before propanil application
DAP = days after propanil application

Table: 10 Rice dry weight (30 days after seeding) and grain yield as influenced by propanil-SO_2 and insecticides interactions .

Time of * insecticide application	Carbaryl				Carbofuran				Malathion			
	Dry wt. (g/pot)	% red.	Grain yield (g/pot)	% red.	Dry wt. (g/pot)	% red.	Grain yield (g/pot)	% red.	Dry wt. (g/pot)	% red.	Grain yield (g/pot)	% red.
Control (untreated)	3.19	0	50	0	3.17	0	50	0	3.17	0	50	0
10 DBP	3.2	0	52	0	3.18	0	52	0	3.18	0	51	0
7 DBP	3.16	1	51	0	3.16	0	51	0	3.13	2	50	0
4 DBP	3.15	1	50	0	3.15	1	50	0	3.11	2	49	2
2 DBP	3.12	2	49	2	3.11	2	49	2	3.09	3	49	2
1 DBP	3.08	3	48	4	3.07	3	49	2	3.07	3	48	4
1 DAP	3.1	3	48	4	3.08	3	48	4	3.08	3	49	2
2 DAP	3.14	2	49	2	3.12	2	49	2	3.12	2	49	2
4 DAP	3.16	1	49	2	3.15	1	50	0	3.1	2	50	0
7 DAP	3.19	0	50	0	3.15	1	51	0	3.14	1	50	0
10 DAP	3.20	0	51	0	3.17	0	52	0	3.17	0	51	0
L.S.D 0.05	N.S		N.S		N.S		N.S		N.S		N.S	

* DBP = days before propanil - SO_2 application

DAP = days after propanil - SO_2 application