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Insect Growth Regulators (IGRS) Performance against the Rice Weevil *Sitophilus oryzae* (L.)

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ABSTRACT :

In the laboratory, ten insect growth regulators (IGRS) triflumuron 5% EC, chlorfluazuron 5% EC, Dowco 439 5% EC, hexaflumuron 5% EC, teflubenzuron 5% EC, flufenoxuron 5% EC, fenoxycarb 25% WP, MV 678 48% EC, R-20458 48% EC and dofenapyn 50% EC were evaluated for residual effects as protectants against the rice weevil, Sitophilus oryzae (L). The IGRS were applied at 1, 10, 50 and 100 ppm on a wheat grain obtained either directly from the field or sterilized before treatment. The residual bioeffect of these IGRS were evaluated at 3, 6, 12, and 18 months post treatment.

When the sterilized wheat grain was treated, all the IGRS controlled completely the insects till 18 months post treatment except R-20458. The effect of these materials was not pronounced when they were applied to a wheat grain obtained directly from the field especially with the low concentration of 1 ppm.

Key words : IGRS, Sitophilus, Rice Weevil.

INTRODUCTION

Encouraging results with the insect growth regulators against different insects of stored products (Eisa 1987, Ammar 1988 and Ammar 1990), coupled with both low required doses and low mammalian toxicity (Wilcox and Coffey 1978) supported their validity to be developed for use as grain protectants. Also, studies were carried out to clear their residual activity to preclude insect damage to the commodity during the storage period. Early diflubenzuron was found to protect stored wheat against insect infestation for up to 40 weeks at 20°C and 44 weeks at 35°C (Carter, 1975), and this compound gave 100 % control at 2 weeks to 12 weeks post-treatment intervals (Mian and Mulla 1982). Also, Ammar (1988) studied residual bioactivity of three insect growth regulators against Sitophilus oryzae (L.), and revealed that a concentration as low as 5 ppm of hexaflumuron (XRD 473) may give effective protection of stored wheat grain for a period of at least 8 months.

This research is carried out to determine how to utilize this ability of the insect growth regulators to protect the wheat grain as long as possible. Then different IGRs are tested during a period up to 18 months.

MATERIALS AND METHODS

The wheat grain used in this study had no previous history of treatment with chemical pesticides. The first treatment of the insect growth regulators was applied to the grain obtained from the field. The other treatment was applied to a sterilized wheat grain kept in the deepfreezer for at least one week before treatment. The moisture content of the grain commodity was determined and tempered to 13.5% moisture by drying with forced air at 40°C immediately after it was removed from cold storage using Mian and Mulla (1982 b) formula as following :

A = W (R - P) F, where A = amount of water (ml) to be added per 454 g of grain, W = quantity of grain (g), R = percent moisture present in the grain and F = a factor of 5.19 equivalent to 1% increase in moisture level per 454 g of grain. The rice weevil, Sitophilus oryzae (L.), adults were obtained from a laboratory culture that had no prior history of exposure to insecticides.

The tested insect growth regulators are : SIR 8514 (triflumuron)5% EC, IKI 7899 (chlorfluazuron) 5% EC, Dowco 439 5% EC, XRD 473 (hexaflumuron) 5% EC, CME 134 (teflubenzuron) 5% EC, SH 777 (flufenoxuron) 5% EC, RO 13-5223 (fenoxycarb) 25% WP, Pro Drone (MV 678) 48% EC, R-20 458 48% EC, and CGA 29-170 (dofenapyn) 50% EC. The organophosphate, malathion (carbophos) 57% EC was used for comparison. Four concentrations (1, 10, 50 and 100 ppm) were tested for each compound and was each repeated four times. Each concentration was applied to three types of wheat grain : (a) clean sterilized wheat grain and the insects were added after treatment (b) clean wheat grain obtained from the field and the insects were added after the treatment (c) clean sterilized wheat grain and no insects were added after the treatment. The sterilized wheat grain was obtained by keeping the grain obtained immediately from the field in the deepfreezer at -20°C for not less than one week and it was left in the normal temperature for 24 hrs before each treatment. For treating the wheat, a grain sample of 500 g was taken in a ca. One litre mason jar which was placed securely in a rotary tumbling unit (Mulla and Axelord, 1960). The unit was maintained at a speed of 45 rpm regulated by a powerstat. Then 25 ml solution of IGR in distilled water, corresponding to the required concentration in the grain, was sprayed onto the grain by the procedure of Mian and Mulla (1982 a). At the end of the spray operation the samples were kept rotating in the unit for an extra 15 min. using the forced air for more dryness. To allow further time for evaporation of the moisture, the treated samples were left overnight in open jars under room temperature. Next day the samples were stored in sealed glass jars in the laboratory. The treatment was carried our once for each concentration at the beginning of the experiment. For bioactivity studies, Sitophilus oryzae was used as bioassay test insects and they were 1-2 week old adults. After 14 days of oviposition the survived parent weevils were removed and the jars kept at 27 $\pm$ 2^{o}C and 65% $\pm$ 5% RH. The insects were counted in each jar at 3, 6, 12 and 18 month periods and the counted insects were discarded. Data obtained on the intensity of infestation by F1 of the insect in all treatments were transformed into percent control by applying the equation % control achieved = (1 - t/c) x 100 where t is infestation in treatment and c is infestation in the check. The percentage of viable grains was determined at each sampling period for each container. Four groups of 25 grains were placed on wet filter papers in petri dishes and examined for germination after 7 days. If a grain exhibited any visible germ growth, it was counted as having germinated.

RESULTS AND DISCUSSION

Data in Table (1) illustrate the effect of the different insect growth regulators that were used as

Table 1. Residual bioactivity of different insect growth regulators as protectants against the rice weevil when applied to sterilized wheat grain using four concentrations (ppm).

Materials	% control of F progeny at the following intervals of the treatment															
	3				6				12				18 months			
	1	10	50	100	1	10	50	100	1	10	50	100	1	10	50	100
Triflumouron	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Chlorfluazuron	100	100	100	73	100	100	100	100	100	100	100	100	100	100	100	100
Dowco 439	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hexaflumuron	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Teflubenzuron	100	100	100	100	100	82	100	100	100	100	100	100	100	100	100	100
Flufenoxuron	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Fenxycarb	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MV 678	48	64	48	100	100	100	100	100	100	100	100	100	100	100	100	100
R-20458	100	100	100	100	36	27	+	+	68	81	+	+	100	100	64	23
Dofenapyn	28	100	100	100	82	100	100	100	100	100	100	100	88	100	100	100
Carbophos	17	100	100	100	73	100	100	100	56	100	100	100	100	100	100	100

control agents against the rice weevil. When these IGRs were added to sterilized wheat grains, then containers were infested with parent insects and later on at 3, 6, 12 and 18 months insect present were counted and discarded. All the IGRs tested achieved a complete control for the parental insects and also the following generation except with MV 678 and R-20458. Because the IGRs were applied to a sterilized wheat grain, the generation, if obtained, was due only to the parents. Materials affected these insects either by inducing mortality or by their effects on the fecundity. Eisa (1987) when tested the effect of five IGRs (diflubenzuron, Dowco 439, triflumuron, hexaflumuron and chlorfluazuron), on the Callosobruchus chinensis. She reported that the percent reduction in the adult emergence were remarkably influenced by all IGRs when they were tested at 0.1, 1, 10, and 100 ppm.

In general some tested IGRs were better than Malathion - a compound often used to prevent infestation of stored products by insects (Storey et al. 1982). With wheat grain that were sterilized malathion offered a complete control except with 1 ppm at 3,6 and 12 months post-treatment. Malathion effect was even less when the grain was obtained from the field and not sterilized. The findings that indicate the effectiveness of IGRs over Malathion could be developed further in search of still better materials. Most convential residual spray treatments in current use will kill insects but certain aspects of their performance are critical to the success of the treatment. Hence, because these materials are not harmful in the environment (Wilcox and Coffey, 1978), and if they have good residual effect this will offer the possibility of using these IGRs as protectants for the wheat grain against the rice weevil. Since the length of time over which an insecticide deposit remains effective is extremely important hence the objective of many treatments is to maintain a kill of insects over a period of time.

In table (2), the wheat grain obtained from the field was treated directly before storage. Triflumuron, teflubenzuron and flufernoxuron achieved complete control for the rice weevil in comparison with the check till 18 months post-treatment. Fenoxycarb at 1 ppm failed to control this insect, and the insect numbers were more than the control, the same result was obtained with hexaflumuron. On the other hand, as previously described in table (1), when the sterilized wheat grain were treated with fenoxycarb, it controlled completely the rice weevil till 18 months post treatment.

The effects of IGRs when applied to the grain obtained from the field seemed to be lower than their effects when they were applied to a sterilized wheat grain. This may be due to the presence of different stages inside the grain either as larvae or pupae or/as eggs on the surface. The relative potency of these IGRs against the rice weevil is due to the relative penetration of these insecticides and their persistence in the grain. Kramer et al. (1981) evaluated the effect of the insect growth regulator, fenoxycarb in the laboratory against 12 species of stored product beetles and moths. They showed that fenoxycarb suppressed F1 progeny of nine coleopteran at 10 ppm or lower levels, when applied to wheat based media. Also, Mian and Mulla (1983) reported that

Table 2. Residual bioactivity of different insect growth regulators as protectants against the rice weevil when applied to wheat grain obtained from the field using four concentrations (ppm).

Materials	% control of F progency at the following intervals of the treatment															
	3				6				12				18 months			
	1	10	50	100	1	10	50	100	1	10	50	100	1	10	50	100
Triflumouron	95	97	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Chlorfluazuron	97	100	100	73	100	100	100	100	100	100	100	100	100	100	100	100
Dowco 439	26	96	100	100	39	100	100	100	0	100	100	100	53	100	100	100
Hexaflumuron	53	98	98	100	65	100	100	100	25	100	100	100	+	100	100	100
Teflubenzuron	98	100	100	100	100	82	100	100	100	100	100	100	100	100	100	100
Flufenoxuron	91	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Fenxycarb	67	100	100	100	62	100	100	100	29	100	100	100	+	100	100	100
MV 678	54	57	59	46	53	96	62	75	71	86	62	0	+	+	+	32
R-20458	71	13	49	56	46	25	26	26	30	13	30	23	+	21	+	+
Dofenapyn	35	93	96	100	66	100	100	100	50	100	100	100	11	100	100	100
Carbophos	+	82	100	100	17	92	100	100	31	53	100	100	89	+	100	100

fenoxycarb, appears a more suitable new candidate insecticide for seed grains compared to other insect growth regulators such as methoprene, diflubenzuron and triflumuron.

In general, IGRs if added to wheat without any infestation they prove active as population suppressants of stored grain insects. They are the compounds that come closest to satisfying criteria of a good grain protectant. They are relatively nontoxic to humans and other animals, do not reduce the ability of the treated seed or germination and are just as convenient to use as other chemical protectants. However, the full potential of IGRs as grain protectants must await the results of additional field trials and long term toxicological studies.

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الإستفادة بمنظمات النمو الحشرية في المكافحة والوقاية من سوسة الأرز

تم في هذا البحث استخدام عشرة من منظمات النمو الحشرية وهي :

Triflumuron - chlorfluazuron - Dowco 439 - hexaflumuron - teflubenzuron - flufenoxuron - fenoxycarb - MV 678 - R -20458 - dofenapyn .

بالإضافة إلى المبيد الفوسفوري الملاثيون للمقارنة على أساس أنه مسجل لمكافحة هذه الآفة . وتم تطبيق كل مركب بتركيزات ١ ، ١٠ ، ٥٠ ، ١٠٠ جزء / مليون كما يلي :

١- تم التطبيق على قمح من الحقل والذي ربما يكون بداخله إصابة سابقة بهذه الحشرة وبعد المعاملة أضيفت الحشرات .

٢- تم التطبيق أيضاً لهذه المواد على قمح تم تعقيمه أولا وذلك بوضعه في درجات الحرارة المنخفظة جداً (-٢٠م) لعدة شهور ثم أضيفت الحشرات بعد ذلك بعد المعاملة .

٣- استخدم قمح معقم وتم ايضا معاملته بدون إضافة أي حشرات . وقد تم عد للحشرات عند الفترات ٣ ، ٦ ، ١٢ ، ١٨ شهراً وأوضحت النتائج مايلي :

١- عند معاملة القمح المعقم وإضافة الحشرات إليه ، استطاعت كل المواد المستخدمة من تحقيق مكافحة ١٠٠٪ لكل الحشرات في كل التركيزات فيما عدا المركب R 20458 .

٢- عند استخدم قمح من الحقل لم يكن لهذه المواد تأثيرا فعالاً بنسبة ١٠٠٪ وخاصة عند التركيز الصغير (١ جزء / مليون) .

٣- عند استخدام قمح معقم تم معاملته بهذه المواد وبنفس التركيزات ظل هذا القمح خالياً من أي إصابة حتى نهاية المدة (١٨ شهراً) .

٤- عند قياس تأثير هذه المواد على نسبة الإنبات لم تؤثر أي مادة من هذه المواد بأي من التركيزات المختبرة على نسبة الإنبات ولم تنخفض نسبة الإنبات عن ٩٤٪ .

فمن هذا البحث يتضح أنه اذا تمكنا من حفظ كميات القمح المراد تخزينها عند درجة حرارة أقل من الصفر لعدة شهور وتمت معاملتها بأي من هذه المواد بتركيز ١جزء / مليون فقط فسوف نتجنب اصابتها في المخزن وبقائها خالية من أي إصابة لمدة ١٨ شهراً نظراً لأن مصدر الإصابة لها سيكون المخزن فقط وليس بداخلها أي إصابات قادمة من الحقل لانه تم القضاء عليها بواسطة الحفظ في درجات الحرارة المنخفضة بجانب أن هذه المواد لها تأثير لمكافحة أي إصابة جديدة .