Residue and Sucker Control from Two Formulations of Maleic Hydrazide (MH)*

by

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SUMMARY

Data from experiments conducted at one location in 1980 and two in 1981 showed that MH residues were greater on flue-cured tobacco after application of a K-MH (potassium salt of MH) formulation than of a DEA-MH (diethanolamine salt of MH) formulation at the same rate of active ingredient. On cured lamina mean residue values from K-MH for the two locations in 1981 were 48% and 61% greater than those for DEA-MH. There was no apparent loss of residue for either formulation during the curing process. Sucker control was less efficient with the DEA-MH than with the K-MH formulation and was associated with the level of residue in the leaf.

ZUSAMMENFASSUNG

Feldversuche (im Jahre 1980 an einem Ort und 1981 an zwei Orten durchgeführt) zeigten, daß der Gehalt an Rückständen von Maleinsäurehydrazid (MH) in Virginia-Tabak nach Applikation des Mittels in Form seines Kaliumsalzes (K-MH) auf der Basis gleicher Wirkstoffkonzentration größer war, als wenn es in Form seines

Diethanolaminsalzes (DEA-MH) angewendet worden war. Bei den zwei Versuchen des Jahres 1981 lagen die Rückstandsmengen im getrockneten Blattgewebe, wenn sie auf die Anwendung von K-MH zurückzuführen waren, um durchschnittlich 48 % bzw. 61 % über den von DEA-MH herrührenden Werten. Bei keiner der beiden Verbindungsformen wurde eine Verminderung der Rückstände während des Trocknungsprozesses beobachtet. Das Ausmaß der Hemmung des Geizenwachstums war bei Applikation von DEA-MH schwächer, als wenn K-MH angewendet wurde, und korrelierte mit dem Rückstandsgehalt des Blattgutes.

RÉSUMÉ

Des essais de plein champ (réalisés en un même lieu en 1980 et en deux endroits en 1981) ont montré que la teneur du tabac de Virginie en résidus d'hydrazide maléique (MH) après application du produit sous forme de sel de potassium (K-MH) était plus élevée qu'en cas d'application sous forme de sel diéthanoliné (DEA-MH), la concentration en agent actif étant la même. Dans le cas des deux expériences effectuées en 1981, les résidus contenus dans le tissu foliaire séché, suite à l'application de K-MH, dépassaient en moyenne respectivement de 48% et 61% les quantités obtenues avec le DEA-MH. Une diminution de la teneur en résidus au cours du séchage ne fut observée pour aucun des deux composés. L'inhibition de la croissance des bourgeons est apparue moins efficace dans le cas de l'application de DEA-MH que dans celui du K-MH, et elle est en relation avec la teneur en résidus dans les feuilles.

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INTRODUCTION

Two formulations of 1,2-dihydro-3,6-pyridazinedione (MH), that contain either the diethanolamine salt (DEA-MH) or the potassium salt (K-MH), have been used extensively throughout the tobacco growing regions of the United States for control of axillary buds (suckers) on tobacco (*Nicotiana tabacum* L.). In recent years MH use has spread to other countries where tobacco is produced, but in a few countries like Canada and Zimbabwe MH application to tobacco is prohibited. Of the two salts, the K-MH form remains available for tobacco sucker control in the United States. The DEA-MH is rapidly becoming unavailable because a decision by the U.S. Environmental Protection Agency in 1982 required additional data for the continued labeling and sale of DEA-MH for tobacco. However, no data were presented.

Field observations have shown that, at equivalent application rates of the active ingredient, the K-MH formulation often controlled suckers better than the DEA-MH (1, 2); but in some tests, sucker control from the two formulations was not different (10). The better control may be attributed to greater absorption of MH from the K-MH formulation than from the DEA-MH when the two forms were applied under identical environmental conditions. However, in early work with tomato the unformulated DEA-MH was absorbed more efficiently than the unformulated K-MH (9). MH is not readily metabolized in plants; hence, if the K-MH form is absorbed more readily into tobacco leaves than DEA-MH, less would remain on the leaf surface where weathering processes, especially rainfall, could remove or alter it. The greater absorption of K-MH also may result in higher residue at harvest than with DEA-MH. An opportunity to test this presumption occurred in 1980 in the process of producing experimental tobacco for a cooperator. Further investigations were performed at two locations in 1981 to compare the residue from the two formulations. A secondary objective was to determine if the flue-curing process altered the residue remaining from the two formulations.

EXPERIMENTAL PROCEDURES

The 1980 experiment was established on a Norfolk loamy sand in Johnston County, North Carolina. Plants of flue-cured tobacco (*Nicotiana tabacum* L. cv. McNair 944) were transplanted May 7, and recommended cultural practices were used throughout the growing season. Pesticides employed in the general culture of the tobacco included O-ethyl S,S-dipropyl phosphorodithioate (ethoprop) at 2.2 kg/ha, 2,6-dinitro-N,N-dipropylcumidine (isopropalin) at 1.7 kg/ha and N,N-dimethyl-2,2-diphenylacetamide (diphenamid) at 4.5 kg/ha before planting; one application of S-methyl N-[(methylcarbamoyl)oxy]thioacetimidate (methomyl) at 0.4 kg/ha and two applications of O,S-

dimethyl N-acetylphosphoramidothioate (acephate) at 0.8 kg/ha were made to the foliage during the growing season. A contact sucker control chemical [mainly 1-octanol and 1-decanol: C₈ (0.5%), C₁₀ (42%), C₁₂ (56%), C₁₄ (1.5%)] was applied July 16 at a rate of 5.7 liters/ha on all plots.

MH as the DEA-MH and K-MH formulations was applied at 2.5 and 5.0 kg/ha on July 23, 1 week after the contact agent. A back-pack sprayer equipped with a three-nozzle boom (7) was used to apply MH solutions at a diluent rate of 470 liters/ha. A heavy rain measuring 4.4 cm began falling within 2 h after spraying, and the plots were retreated with the same rates on July 24. Plots were 12.3 m long and with a row spacing of 1.2 m. The plants were spaced 0.56 m in the rows (22 plants per row). There were two guard rows between plots. The experimental design was a randomized block with two replications.

The tobacco was harvested once before MH was applied and three additional times as the leaves matured. After application of MH, each harvest was sampled by removing two 5 cm discs from the lamina of each of 100 leaves per plot. The green discs were frozen immediately and stored for residue analysis later. All leaves (the 100 from which discs had been removed plus the remainder) were cured. After curing, midribs were stripped from 50 randomly selected leaves and the aggregate lamina sample was saved for residue analysis.

The 1981 experiment was established with McNair 944 in Johnston County on a Marlboro loamy sand on May 4 and in Rockingham County, North Carolina, on an Appling sandy loam May 18, 1981. The cultural practices, application methods and sampling techniques were similar to those described above. Each formulation of MH was applied once at 2.5 kg/ha a.i. before the first harvest, and treatments were replicated four times in a randomized block design. There was one guard row between plots. Yield of cured leaf was determined and suckers were counted and weighed after the last harvest.

The analytical procedure for MH was similar to that described by Lane (6) and used recently by Hunt et al. (5) and others, except that the decolorizing charcoal step (addition of activated charcoal to the hydrazine distillate just before color development) was included as prescribed in the proposed Coresta method No. 4 (3). Residue values for both green and cured leaf are based on 13% moisture.

RESULTS AND DISCUSSION

Data from the 1980 preliminary experiment showed that MH at the 2.5 kg/ha rate resulted in residue values of the same magnitude for the DEA-MH and the K-MH formulations on both green and cured tobacco (Table 1). At the 5.0 kg/ha rate for green tobacco, the residue for the K-MH (average of 429 ppm on green lamina) was significantly greater than that for the

Table 1.
MH residue in 1980 from DEA-MH and K-MH formulations before and after curing (based on 13% moisture).

Formulation	Rate of application (kg/ha)	Harvest	Lamina*	
			green (ppm)	cured (ppm)
DEA-MH	2.5	second	132	93
		third	194	170
		fourth	95	142
		Mean (numerical)	140 c	135 b
	5.0	second	274	308
		third	314	317
		fourth	172	208
		Mean (numerical)	253 b	278 a
K-MH	2.5	second	146	107
		third	210	173
		fourth	100	110
		Mean (numerical)	152 bc	130 b
	5.0	second	489	418
		third	499	462
		fourth	399	296
		Mean (numerical)	429 a	392 a

* Numerical means within columns and with the same letter are not significantly different at the 5% level. Harvest means and the MH rate $\times$ harvest interaction were significant.

DEA-MH (average of 253 ppm on green lamina). The corresponding means for cured lamina were not significantly different, but the spread was rather large and the difference approached significance. In this experiment the measured values for the residue from the K-MH formulation on cured lamina were generally lower than those for green lamina.

In 1981, the MH residue from the K-MH formulation was greater than that from the DEA-MH at both locations (Tables 2 and 3). On cured lamina the weighted average for K-MH at the Johnston County and Rockingham County locations was, respectively, 48% and

Table 2.
MH residue in 1981 from DEA-MH and K-MH formulations before and after curing (based on 13% moisture).

Chemical	Harvest	Johnston County*		Rockingham County*	
		green (ppm)	cured (ppm)	green (ppm)	cured (ppm)
DEA-MH	first	86	78	130	122
	second	25	23	134	128
	third	13	13	70	83
	fourth	20	<10	76	84
	fifth	15	16		
	Mean (numerical)	32	27	103	104
K-MH	first	87	80	143	142
	second	30	27	194	195
	third	19	20	140	165
	fourth	19	16	135	150
	fifth	31	30		
	Mean (numerical)	37	35	153	163
Significance level of means		0.12	0.02	<0.01	<0.01

* The values for harvests were significant at 0.01 level for both green and cured lamina at both locations. The interaction F values were not significant at the 0.05 level.

61% greater than that for DEA-MH. Although data from the 1980 experiment suggested that a loss of K-MH occurred during curing (Table 1), this effect was not confirmed in 1981; and the residue from neither formulation was affected by flue curing (Table 2).

In 1980, residues remaining on cured lamina from the 2.5 kg/ha rate of the DEA-MH and the K-MH formulations averaged 135 and 130 ppm, respectively (Table 1). In 1981, residues for the Johnston County site were exceptionally low and the values for the Rockingham County location were approximately four to five times greater than those for Johnston County (Tables 2 and 3). Variations of this magnitude are not unusual and may be attributed to differences in the amounts and times of rainfall as well as the time between MH application and harvest (4, 8).

The residue values in Tables 1, 2 and 3 are for lamellar tissues only. The residue for whole leaves was known from previous research to be about 0.77 times that in the lamina (unpublished data). Thus, the residues in Tables 1 and 2 should be multiplied by 0.77 to obtain an estimate of the concentration on a whole-leaf basis. Published values have often been based on the whole leaf (5).

Recovery of the applied MH was estimated from yields and residues by harvests. The percentages are based on an application rate of 2.5 kg/ha. Total recovery amounted to 1.6 and 2.5 %, respectively, for the DEA-MH and K-MH formulations at the Johnston County location and 5.3 and 8.2 %, respectively, for the DEA-MH and K-MH formulations at the Rockingham

Table 3.
Weighted average residue (over harvests) from application of DEA-MH and K-MH formulations at two locations in 1981.

Chemical	Johnston County (ppm)	Rockingham County (ppm)	Means (ppm)
DEA-MH	21	101	61
K-MH	31	163	97
Control*	<10	<10	<10
Significance level	0.06	0.03	<0.01

* Values for controls were omitted from the analysis of variance.

Table 4.

Sucker control after application of DEA-MH and K-MH formulations at two locations in 1981.

Chemical	Johnston County* (%)	Rockingham County* (%)
DEA-MH	50	95
K-MH	80	98
Significance level	0.02	0.08

* The weight of suckers from plots that received one application of the contact sucker control chemical but no MH was used as a base to calculate percent control.

County location. The difference in the amounts directed toward the plants and the amounts recovered reflected incomplete deposit of the MH at application, losses from wash-off by rainfall, photodecomposition on the leaf surface, and translocation of absorbed MH into plant parts not harvested.

The data on control of suckers in Table 4 confirmed results of Collins et al. (1, 2). The percent control was greater for the K-MH formulation than for the DEA-MH. The more effective control of tobacco suckers with the K-MH formulation can be explained by the greater absorption of MH which is reflected in the higher residue levels. If enough DEA-MH formulation were used to provide sucker control equivalent to that obtained with a given rate of the K-MH, the residue from the two formulations would likely be more similar. Furthermore, with the K-MH formulation less total MH would be added to the environment.

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