

TIME OF NAPHTHALIC ANHYDRIDE APPLICATION AND ITS INFLUENCE ON THIOBENCARB SELECTIVITY IN RICE

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ABSTRACT

A greenhouse experiment was conducted to determine thiobencarb (S-4-chlorobenzyl diethylthiocarbamate) toxicity to IR-36 and RD-19 rice cultivars as affected by the time of NA (1,8-naphthalic anhydride) application. Both cultivars responded similarly to time and sequence of NA and thiobencarb application. Application of both NA and thiobencarb at planting was the least injurious to the plants and appeared to be the most promising treatment. NA treatment at planting followed by thiobencarb at 3 days after planting seemed a good alternative if simultaneous application is not possible. These results imply that the antidote must be applied at the same time or ahead of the herbicide to reduce if not prevent herbicide damage to rice.

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KEY WORDS: Naphthalic anhydride. Antidote. Time of application. Thiobencarb. Herbicide. Selectivity. Rice.

INTRODUCTION

Thiobencarb (S-4-chlorobenzyl diethylthiocarbamate) is a herbicide generally recommended to control weeds associated with rice. However, crop damage due to this herbicide is occasionally observed in certain rice cultivars.

Reports of Smith (1971), Henry (1972) and Parker and Dean (1976) showed that injury due to thioben-

carb and other thiocarbamate or carbamate herbicides can be prevented or eliminated through the use of crop protectants or antidotes like NA (1,8-naphthalic anhydride). The use of these chemicals can widen the selectivity or margin of safety of herbicides. Thus, the herbicides will be more selective in their mode of action.

The effectiveness of NA as a crop protectant appears to be

dependent on time of application. Treatment with 0.5% NA prior to planting dramatically decreased the injurious effect of the herbicide 5328 (cis-2,5-dimethyl-1-pyrrolidine carboxanilide) on corn, sorghum and cotton (Holm and Szabo, 1974).

Research results on the use of another antidote, R-25788 (N,N-diallyl-2,2-dichloroacetamide) also strongly suggest that antidote treatments can only be effective if applied at a certain time (Blair, 1978; Burt and Buzio, 1979). It is therefore crucial to determine the right time of antidote application so as to obtain maximum protection against the herbicide.

This study presents the effect of time of application on the protective ability of NA against thiobencarb damage to IR-36 and RD-19 rice cultivars.

MATERIALS AND METHODS

Seeds of 2 cultivars of rice (*Oryza sativa* L) which differ in their response to thiobencarb treatment, namely IR-36 (susceptible) and RD-19 (tolerant) were planted and grown in earthen pots with soil. The time of NA application relative to thiobencarb treatment served as the treatments. The treatments were: a) simultaneous application of NA and thiobencarb at planting, b) application of NA at planting followed by (fb) thiobencarb at 3 days after planting (DAP), and c) spraying of thiobencarb at planting fb by NA treatment at 3 DAP. The rate of NA used was 0.6 kg/ha whereas thiobencarb was applied at the rate

of 6 kg/ha. Control plants either had no herbicide and antidote treatment or treated with thiobencarb alone.

The data collected were plant height at 1 and 2 weeks after planting (WAP) as well as fresh and dry weights at 2 WAP. The randomized complete block design (RCBD) with 4 replications per treatment was used in this study. The different treatment means were compared using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The order and time of NA and thiobencarb application were varied to determine their effects on the growth of rice. Statistical analysis of combined data of the 2 rice cultivars indicated no significant interaction between cultivars and treatments. However, significant differences were observed among the various times of NA application.

There was a reduction in height of all IR-36 plants treated with thiobencarb with or without NA at 1 WAP (Table 1). The untreated check produced the tallest plants and only the plants applied simultaneously with NA and thiobencarb at planting were comparable to this check. After 1 week, the plants seemed unaffected by the sequence of antidote and herbicide application, i.e., whether NA or thiobencarb was applied at planting or at 3 DAP. Regardless of which chemical was applied first, both treatments caused marked growth inhibition just like the herbicide-treated control. This implies that a

Table 1. Height at 1 and 2 weeks after planting (WAP) of IR-36 and RD-19 rice plants as affected by thiobencarb treatment and time of NA application.

TREATMENT	PLANT HEIGHT (mm) ¹			
	1 WAP		2 WAP	
	IR-36	RD-19	IR-36	RD-19
Control (without NA and thiobencarb)	68.4ab	60.0a	211.7a	186.1ab
Control (without NA, thiobencarb at 3 DAP ²)	41.5b	36.0bc	134.0bc	138.1c
NA + thiobencarb at planting	53.9ab	51.7ab	183.3ab	188.3a
NA at planting fb ³ thiobencarb at 3 DAP	48.1b	42.9abc	159.3abc	168.9abc
Thiobencarb at planting fb NA at 3 DAP	39.2b	28.9c	113.6c	137.9c

¹Average of 4 replications. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

²DAP - days after planting

³fb - followed by

time gap in the application of NA and thiobencarb results in growth inhibition precluding any possible benefit to the plant.

After another week from planting, the plants treated with NA at planting fb thiobencarb at 3 DAP showed recovery from the growth inhibition observed earlier. They were statistically similar in plant height to the untreated check just like the treatment with NA + thiobencarb at planting. When the herbicide was applied at planting, its adverse effect was not counteracted by NA treatment at 3 DAP. Hence, plants in this treatment were the shortest. The herbicide-treated con-

trol showed less inhibition than the treatment with thiobencarb at planting fb NA at 3 DAP which suggests that the delay in thiobencarb application from planting to 3 DAP proved to be advantageous to the plants despite the absence of NA. At 2 WAP, simultaneous application of the antidote and herbicide at planting seemed better than the other treatments. However, when simultaneous application is not possible, NA should be applied ahead of thiobencarb to reduce the phytotoxic effect of the herbicide.

In RD-19 rice plants observed at 1 WAP, thiobencarb treatment at planting caused the greatest reduc-

tion in plant height despite the application of NA at 3 DAP (Table 1). The herbicide-treated check exhibited a very similar inhibition. No significant differences were noted between the untreated control and those treated with NA + thiobencarb at planting. Moreover, the application of NA at planting fb thiobencarb at 3 DAP produced plants comparable to these treatments.

Two weeks after planting, the tallest plants were obtained from those treated with both herbicide and antidote at planting. The untreated control plants were slightly shorter but still statistically comparable to this treatment. The same

degree of height reduction was noted in the herbicide-treated control plants and in the plants applied with thiobencarb at planting and with NA at 3 DAP. It appears that least herbicide phytotoxicity can be obtained if NA and thiobencarb are both applied at planting. Injury can also be lessened if NA is applied at planting and thiobencarb is sprayed at 3 DAP. These results suggest the importance of ensuring that the plants do not come in contact with the herbicide ahead of the antidote.

Spraying of thiobencarb either at planting fb NA at 3 DAP or at 3 DAP in the absence of NA brought about a significant reduction in fresh weight of IR-36 seedlings (Table 2).

Table 2. Fresh and dry weights at 2 weeks after planting (WAP) of IR-36 and RD-19 rice plants as affected by thiobencarb treatment and time of NA application.

Treatment	Fresh Weight (mg/seedling) ¹		Dry Weight (mg/seedling) ¹	
	IR-36	RD-19	IR-36	RD-19
Control (without NA and thiobencarb)	146.3a	165.7a	21.4a	25.5a
Control (without NA, thiobencarb at 3 DAP ²)	116.6b	130.1b	19.1b	20.6c
NA + thiobencarb at planting	126.1ab	157.8ab	20.9a	24.3ab
NA at planting fb ³ thiobencarb at 3 DAP	121.6ab	147.6ab	20.5ab	22.8abc
Thiobencarb at planting fb NA at 3 DAP	108.8b	128.4b	20.3ab	20.9bc

¹ Average of 4 replications. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

² DAP - days after planting

³ fb - followed by

The other 2 treatments were comparable to the untreated control. The dry weight values of the different treatments did not vary much from each other except that from the herbicide-treated control which gave the lowest weight. Apparently, NA must be applied at planting. The time of subsequent thiobencarb treatment appeared less important although results indicate that better growth response could be obtained if the herbicide was applied simultaneously with antidote at planting.

The growth response of RD-19 cultivar in terms of fresh and dry weights was very similar in pattern to the plant height data (Table 2). Marked decrease in weight was observed when thiobencarb was applied without NA at 3 DAP (herbicide-treated control) and when it was applied at planting fb NA treatment at 3 DAP. The subsequent NA application in the latter treatment appeared ineffective in preventing thiobencarb injury. The plants which were applied simultaneously with the antidote and herbicide at planting as well as those treated with NA at planting fb thiobencarb at 3 DAP responded similarly to the untreated check plants.

The data presented indicate that IR-36 and RD-19 cultivars did not differ in their response to time and sequence of NA and thiobencarb application. Generally, severe injury was observed in the herbicide-treated control plants wherein thiobencarb was applied at 3 DAP in the absence of NA. Ali (1979) reported similar phytotoxic effect of the application of thiocarbamate herbi-

cides butylate (S-ethyl diisobutylthiocarbamate), EPTC and vernolate (S-propyl dipropylthiocarbamate) at sowing time on rice plants. Almost the same degree of growth inhibition was exhibited by plants sprayed with thiobencarb at planting and then treated with NA at 3 DAP. The plants seemed unable to recover from immediate herbicide injury such that the subsequent treatment with the antidote did not decrease the phytotoxicity. The simultaneous application of NA and thiobencarb at planting was the least injurious to the plants. This appears to be the most promising treatment. However in case concurrent application is not possible, a good alternative is NA treatment at planting and later thiobencarb spray at 3 DAP. These observations imply that herbicide application must not, as much as possible, come ahead of antidote treatment in order to lessen if not prevent herbicide damage to the plants. This sequence of application may enable the plant to absorb NA first such that the antidote could exert its effects before possible thiobencarb damage. NA might reduce or prevent injury caused by thiobencarb in the same manner as that reported on EPTC.

Guneyli (1971) found that NA increased the absorption of ^{14}C -EPTC by maize seedlings and stimulated EPTC metabolism probably by activating the enzyme system that breaks down EPTC. This is similar to the mechanism suggested by Lay et al. (1975) for the protective effect of R-25788 against EPTC by inducing rapid

detoxification of thiocarbamate sulfoxides formed by oxidation of the thiocarbamate. Similarly, Holm and Szabo (1974) found that NA did not alter the uptake of labelled cisanilide or DS 5328 (cis-2,5-dimethyl-1-pyrrolidine carboxanilide) in maize but enhanced the rate of conversion of the herbicide molecule in maize tissue to water-soluble non-herbicidal metabolites. Murphy (1972), however, presents the contrasting view that NA does not affect EPTC metabolism within maize plants. Rather, NA interferes with the action of the herbicides on lipid metabolism. Wilkinson and Smith (1975) showed that EPTC, NA, R-25788 and allidochlor (N,N-diallylchloroacetamide) all interfere with the incorporation of ^{14}C -labelled acetate into fatty acids and that the inhibition by EPTC at 10^{-5}M was countered by NA and R-25788 at 10^{-7}M .

The above results confirm the findings of other workers on this aspect of antidote application.

Guneyli (1971) applied NA at 0, 1, 2 and 4 days and found that protection by the antidote was not complete after the second day of application. Antidote was most protective when applied at 0 and 1 day after subjecting corn to 13.4 kg/ha rate of EPTC. He further noted that the antidote was most effective during the first 48 hours of seedling development when the shoot development of corn was used as a criterion for antidote action at 13.4 kg/ha rate of EPTC. The injurious effect of the herbicide DS 5328 on corn, sorghum and cotton was dramatically decreased by seed treatment with 0.5% NA prior to planting (Holm and Szabo, 1974). Using R-25788, Blair (1978) reported that if applied up to 7 days prior to spraying or up to one day after, soil-drench treatment of this antidote successfully countered barban damage. Only partial protection was obtained when application was delayed to 2 or 3 days after barban.

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