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# THIOBENCARB PHYTOTOXICITY TO RICE AS AFFECTED BY METHOD OF NAPHTHALIC ANHYDRIDE APPLICATION

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## ABSTRACT

**The phytotoxicity of thiobencarb (S-4-chlorobenzyl diethylthiocarbamate) to IR-36 and RD-19 rice cultivars using different methods of NA (1, 8-naphthalic anhydride) application was evaluated under greenhouse conditions. IR-36 cultivar showed greater response to the method of NA application than RD-19. Seed treatment with the antidote provided the best protection to IR-36 seedlings. In RD-19 cultivar, either broadcast application on soil surface or surface application followed by incorporation into the soil was as effective as seed treatment in decreasing thiobencarb phytotoxicity. This cultivar appeared to require less NA to obtain protection, and this requirement could always be met in any method of application. The minimum NA requirement for IR-36 was probably higher, and seed treatment was the only method which satisfied such requirement.**

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**KEY WORDS:** Rice. IR-36 and RD-19 cultivars. Phytotoxicity. Thiobencarb. Naphthalic anhydride application. Seed treatment. Protection.

## INTRODUCTION

Naphthalic anhydride or NA (1, 8-naphthalic anhydride) is one of the crop protectants which have been developed to improve herbicide selectivity. This chemical can selectively protect crop plants from carbamate and thiocarbamate herbicides like thiobencarb (S-4-chlorobenzyl diethylthiocarbamate) without reducing their effectiveness for weed control.

NA can either be used as a seed treatment or applied to the soil. Several reports indicate that the method of application largely determines the effectiveness of NA as a crop protectant (Guneyli, 1971; Chang *et al.*, 1973a; Spotanski and Burnside, 1973; Blair, 1978). It is also probable that the response of different species or even cultivars may vary with the mode of NA application.

This paper presents the response of thiobencarb-susceptible (IR-36) and tolerant (RD-19) rice cultivars to different methods of applying NA.

## MATERIALS AND METHODS

Two rice (*Oryza sativa* L.) cultivars which have been previously reported to be susceptible and tolerant to thiobencarb injury, namely IR-36 and RD-19 (earlier known as BKN 6986-147-2), respectively, were used in this study.

Seeds were sown in the upper 2 cm portion of soil contained in earthen pots. Naphthalic anhydride or NA was applied either to the seeds or to the soil. Seed treatment was done by shaking seeds with NA at the rate of 0.5 g of active ingredient (a.i.) per 100 g of seeds in a plastic bag before planting. NA powder was applied to the soil in two ways, i.e., broadcast on the soil surface, and surface application followed by incorporation into the soil. The soil application rate of NA used was 0.6 kg/ha. Thiobencarb was sprayed to the soil at the rate of 6 kg/ha at planting. The first group of control plants was not treated with thiobencarb nor NA, while the second group was treated with thiobencarb.

Observations were made on root and shoot length of rice at 1 and 2 weeks after planting as well as fresh and dry weights at 2 weeks after planting. The study was conducted using the randomized complete block design (RCBD) with four replications per treatment. Statistical analyses were made based on Duncan's Multiple Range Test (DMRT).

## RESULTS AND DISCUSSION

The effect of variation in method of NA application on the height of IR-36 and RD-19 rice plants sprayed with thiobencarb at planting is presented in Table 1. Treatment of IR-36 seeds with NA nullified the effect of thiobencarb on shoot elongation both at 1 and 2 weeks after planting (WAP). The two other methods, i.e., broadcast on soil surface and surface application followed by incorporation into the soil, seemed ineffective in counteracting thiobencarb phytotoxicity. The plants in these treatments had the same degree of growth inhibition as those treated with thiobencarb alone.

In RD-19 cultivar, the untreated control plants were the tallest whereas those treated with thiobencarb in the absence of NA were greatly reduced in height. Among the different methods of antidote application, only seed treatment appeared to provide protection to the plant. However, no significant differences were noted among the three methods used. At 1 WAP, the two ways of NA soil application were ineffective in preventing thiobencarb injury. The plants in these treatments exhibited the same degree of growth inhibition as the herbicide-treated control. Hence, improper antidote application might be tantamount to its non-usage in

Table 1. Height of IR-36 and RD-19 rice plants at 1 and 2 weeks after planting (WAP) as affected by thiobencarb treatment and method 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) | 67.0 a | 51.4 a | 271.6 a | 240.3 a |
| Control (without NA, thiobencarb at planting) | 30.3 c | 32.5 b | 130.5 c | 134.2 b |
| Seed treatment with NA (0.5% w/w) before planting + thiobencarb at planting | 53.5 ab | 41.2 ab | 231.4 ab | 183.8 ab |
| Broadcast on soil surface (0.6 kg NA/ha) at planting + thiobencarb at planting | 32.4 c | 36.9 b | 144.0 c | 181.7 ab |
| Surface application fb[2] incorporation into soil (0.6 kg NA/ha) at planting + thiobencarb at planting | 40.7 bc | 39.0 b | 166.6 bc | 185.8 ab |

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

[2] fb - followed by

herbicide-treated plants.

Two weeks after planting, the plant height in all methods of application did not vary and was statistically similar to the untreated check. This might indicate that as the plants grow older, the protective effect of NA becomes more apparent by decreasing thiobencarb phytotoxicity. At this stage of growth, the manner of application seemed unimportant in RD-19 cultivar whereas in IR-36, the three methods used were not equally effective. It appears that RD-19 can tolerate the adverse effect of thiobencarb with NA treatment regardless of method of application. In IR-36 cultivar, the manner of application seemed important because only the seed treatment provided adequate protection.

Significant variations in fresh and dry weights of both cultivars occurred under different methods of NA application (Table 2). Seed treatment with NA protected IR-36 plants from thiobencarb phytotoxicity. When broadcast on the soil surface or applied on the surface followed by incorporation into the soil, NA appeared less effective in protecting the plants from herbicide action. The untreated control plants obtained the highest fresh and dry weights whereas the lower values were noted in thiobencarb-treated seedlings. The fresh and dry weights in all treatments appeared unaffected by the different methods of NA application. The effect of the treatments may be magnified at later stages.

The fresh and dry weight data in RD-19 cultivar followed the same pattern as those on plant height at 2 WAP. Regardless of the manner of application, NA prevented any decrease in dry matter. The values obtained in the various NA treatments were statistically comparable and were all different from that of the herbicide-treated control.

These observations confirm earlier reports that NA applied as seed dressing is more effective than the other methods of application in decreasing herbicide damage. Spontanski and Burnside (1973) found that application of NA as seed treatment to sorghum at 0.5% w/w was very effective in reducing alachlor (2 chloro-2′,6′-dimethyl-N-methoxymethyl acetanilide) injury. In glasshouse experiments, corn was protected from subsequent barban (4-chloro-2-butynyl *m*-chlorocarbanilate) damage by dressing

**Table 2.** Fresh and dry weights of IR-36 and RD-19 rice plants at 2 WAP as affected by thiobencarb treatment and method 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) | 152.0 a | 168.9 a | 23.1 a | 25.8 a |
| Control (without NA, thiobencarb at planting) | 112.6 c | 121.7 b | 18.5 b | 20.1 b |
| Seed treatment with NA (0.5% w/w) before planting + thiobencarb at planting | 144.2 ab | 147.9 ab | 21.7 ab | 24.0 a |
| Broadcast on soil surface (0.6 kg NA/ha) at planting + thiobencarb at planting | 115.1 bc | 138.0 ab | 19.9 ab | 23.0 ab |
| Surface application fb[2] incorporation into soil (0.6 kg NA/ha) at planting + thiobencarb at planting | 118.5 bc | 148.5 ab | 20.8 ab | 24.2 a |

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

[2]fb - followed by

seeds with NA (Blair, 1978). The results of Chang *et al.* (1973a) indicated that NA was effective in protecting corn from the damage of EPTC (S-ethyl dipropylthiocarbamate) as seed treatment, but was ineffective when applied to the soil. Guneyli (1971) claimed that NA seed application provided corn with complete protection against EPTC injury, while application of the antidote to the root zone and soil surface resulted in only 5 and 12% protection, respectively.

However, the effect of method of application in relation to the effectiveness of another antidote, R-25788 (N,N-diallyl-2,2-dichloroacetamide), seems inconsistent. Miller *et al.* (1978) claimed that this antidote reduced wheat injury due to barban in the field and greenhouse but the effect of R-25788 was stronger when applied as seed dressing than in liquid form for tank mixture. R-25788 used in combination with EPTC as seed treatments or as mixed sprays protected corn from herbicide injury in growth room and field trials (Chang *et al.*, 1972). The same researchers (1973b) demonstrated significant reduction in toxicity of 10 out of 22 herbicides tested to corn with application of R-25788 in the soil as preplant-incorporated treatment. Blair (1978) noted that the antidote, either as seed dressing or mixed in the spray tank with the herbicide, protected maize from barban injury. Furthermore, EPTC damage to corn was decreased when R-25788 was applied as seed treatment, as an incorporated soil spray, or in nutrient solution in quartz and nutrient culture (Chang *et al.*, 1973a). These results imply that the efficacy of R-25788 does not depend on the mode of application. On the contrary, the protective ability of NA seems largely dependent on how it is applied.

It is interesting to note that the growth of both cultivars was significantly inhibited by the application of thiobencarb at planting in the absence of NA. However, the difference in the degree of growth inhibition exhibited by the two cultivars seems to prove the existence of a difference in cultivar tolerance to thiobencarb. IR-36 cultivar (susceptible) showed 54.8 and 52.0% inhibition in plant height at 1 and 2 WAP, respectively, whereas RD-19 cultivar (tolerant) exhibited only 36.8 and 44.2% inhibition.

The growth response of the 2 cultivars, particularly at 2 WAP, to the different methods of NA application, appears to be another evidence that they really differ in their tolerance to thiobencarb. IR-36 was sensitive while RD-19 seemed insensitive to method of NA application. Seed treatment with the antidote provided the best protection for IR-36 cultivar. This implies that it is necessary for NA to be absorbed ahead of thiobencarb and coating the seeds with NA makes this possible. In this method of application, the antidote can gain immediate entry into the plant and exert its protective effects, enabling the plant to tolerate the phytotoxicity of thiobencarb. Soil application might not give this advantage to NA because both the antidote and herbicide are in the soil solution. Both may be absorbed equally or at the same rate, but IR-36 may need more NA molecules to get protection from thiobencarb injury. Hence in IR-36, the method of NA application is important so as to ensure that more NA molecules come in contact with the plant ahead of the herbicide. In RD-19 cultivar, all three methods of NA application used were equally effective, which suggests that only the presence of NA was necessary to prevent phytotoxicity. The minimum amount of NA required to give protection in RD-19 was always met in any method of application. Thus, the minimum NA requirement may be lower for RD-19 than for IR-36.

Based on the above results, seed treatment with NA was the most promising. However, it seems that the greater protection obtained by plants with NA seed treatment could not only be attributed to the method but also to the amount applied. The recommended rates of NA for seed treatment (0.5%) and for soil application (0.6 kg/ha) which were used in this study are apparently not comparable. Thus, it might be interesting to find out the response of plants if the same rates are to be used.

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