ELONGATION RESPONSE OF IR-36 AND RD-19 RICE CULTIVARS TO VARIATION IN SITE OF NAPHTHALIC ANHYDRIDE AND THIOBENCARB APPLICATION

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ABSTRACT

The effect of differential application of naphthalic anhydride or NA (1, 8-naphthalic anhydride) and thiobencarb (S-4-chlorobenzyl diethylthiocarbamate) in IR-36 and RD-19 rice seedlings was determined in pot trials under laboratory conditions. The two cultivars responded similarly to NA or thiobencarb treatment in terms of inhibited root growth when the site of application was varied. However, IR-36 cultivar exhibited greater degree of inhibition than RD-19. The effective treatment sites were the plot and mesocotyl for NA; and the root, mesocotyl and coleoptile for thiobencarb. Regardless of the site of treatment, nearly all treatments inhibited root elongation, but not shoot growth. The main target site of NA and thiobencarb appeared to be in the root.

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KEY WORDS: Rice. IR-36 and RD-19 cultivars. Laboratory experiment. Differential application. Thiobencarb. Naphthalic anhydride. Antidote. Site of treatment. Inhibition. Elongation.

INTRODUCTION

The use of antidotes like NA (1,8-naphthalic anhydride) and R-25788 (N,N-diallyl-2,2-dichloroacetamide) is usually associated with chemical weed control. These chemicals are applied to improve herbicide selectivity and reduce phytotoxicity without diminishing herbicide effectiveness against weed.

Thiobencarb (S-4-chlorobenzyl diethylthiocarbamate), which is widely used for weed control in rice, causes injury to the crop. Henry (1972) reported that NA can protect rice against damage from thiobencarb.

In their application, it is crucial to know which tissue can efficiently absorb either thiobencarb or NA, or both. The movement, effectiveness and phytotoxicity of these chemicals are very often dependent on the site of their application or placement in relation to the plant. Moreover, such information will provide a better insight on their mechanism of action.

This study was conducted to determine the sensitivity of the different tissues of IR-36 and RD-19 rice seedlings to NA and thiobencarb.

MATERIALS AND METHODS

Seeds of rice cultivars IR-36 and RD-19 (formerly known as BKN 6986-147-2), which were reported to be susceptible and resistant to thiobencarb phytotoxicity, respectively (Madrid, 1980), were pre-germinated for one week. Four uniform-sized seedlings were then transplanted in 70-cm diameter cups containing 108 g of soil. The soil was divided into 3 equal portions weighing 36 g each to correspond with the root, mesocotyl and coleoptile of the rice seedling. The treated zone was moistened with 15 ml of either 50 ppm NA or thiobencarb, while each untreated layer of the soil was moistened with the same amount of water.

The treatments consisted of exposing one part of the seedling to the antidote or herbicide while the other parts were prevented from getting in contact with the chemical. For root exposure, the bottom soil layer was treated with NA or thiobencarb while the top 2 soil layers were untreated. In the second treatment, the mesocotyl was in contact with the treated soil, with the radicle well below the treated soil. The third treatment had only the coleoptile covered with treated soil to assure its full exposure to NA or thiobencarb. A layer of activated charcoal was placed between the treated and untreated layers to ensure non-leaching of the chemicals to the untreated zone.

The root and shoot lengths before and 1 week after treatment were measured and increments in length were recorded. The treatments were replicated 4 times in a randomized complete block design (RCBD). Statistical analyses were made based on Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Naphthalic Anhydride (NA).

The effect of site of NA treatment on increment in root and shoot length of IR-36 and RD-19 rice cultivars is shown in Table 1. There was marked inhibition of root elongation in both cultivars when NA was applied to the root and mesocotyl. When the coleoptile was treated with NA, the increment in root length was comparable to that of the control. In RD-19 cultivar, root elongation of rice plants treated with NA at the coleoptile portion did not differ from those treated at the root and mesocotyl. There was no apparent effect of site of NA treatment on shoot elongation.

These results suggest that the root and the mesocotyl were the

Table 1. Increment in root and shoot length of IR-36 and RD-19 rice cultivars as affected by site of NA treatment.

Cultivar	Treated Tissue	Increment in Length (mm)[1]	
		Root	Shoot
IR-36	Control	35.6 a	164.3
	Root	17.3 b	141.2
	Mesocotyl	14.9 b	150.8
	Coleoptile	32.8 a	168.7
RD-19	Control	66.2 a	165.8
	Root	29.4 b	123.4
	Mesocotyl	31.7 b	135.9
	Coleoptile	50.6 ab	158.6

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

efficient sites of NA treatment in IR-36 and RD-19 rice cultivars. The antidote absorbed by the roots was probably not translocated elsewhere resulting in localized growth inhibition. On the other hand, NA absorbed by the mesocotyl might have been translocated because this portion contains xylem and phloem tissues which transport water and food materials broken down from the endosperm to the site of utilization. The movement of NA applied to the mesocotyl was basipetal instead of acropetal as indicated by the reduced root growth of rice seedlings. If ever downward movement occurred in NA applied to the coleoptile, the amount that reached the root was insufficient to cause root inhibition.

The only study on NA uptake was undertaken by Guneyli (1971) who found that root application of the antidote was inhibitory to the first primary root of corn. His results further suggested that the antidote may also be absorbed by the shoot.

The studies of Gray (1975) on the site of action of thiocarbamate herbicides and their antidotes in corn revealed that the most effective site for applying R-25788 to counteract EPTC (S-ethyl dipropylthiocarbamate) injury was on the roots. However, exposing the meristematic region of the shoots to antidote vapor gave some degree of protection. Blair (1978) also stated that R-25788 was ineffective when applied to the foliage and it must reach the soil to provide protection from barban damage.

Thiobencarb.

The elongation of roots and shoots of IR-36 and RD-19 seedlings as affected by the site of thiobencarb is presented in Table 2. Regardless of the treated tissue, a significant reduction in root length was

Table 2. Increment in root and shoot length of IR-36 and RD-19 rice cultivars as affected by site of thiobencarb treatment.

Cultivar	Treated Tissue	Increment in Length (mm)[1]	
		Root	Shoot
	Control	41.3 a	145.6
	Root	10.2 b	163.2
IR-36	Mesocotyl	15.6 b	166.3
	Coleoptile	23.1 b	152.0
	Control	62.3 a	168.0
	Root	30.7 b	142.4
RD-19	Mesocotyl	20.7 b	157.4
	Coleoptile	32.8 b	135.7

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

observed with thiobencarb. As in the case of NA treatment, thiobencarb application did not affect shoot growth. The two cultivars exhibited identical responses to the treatments.

The above observations indicate that thiobencarb was absorbed by the root, mesocotyl and coleoptile. However, the herbicide was moved basipetally and accumulated in the roots irrespective of the treated tissue. Hence, the resulting phytotoxic symptom was retardation of root growth. The root, the mesocotyl and the coleoptile all seemed to be efficient sites for thiobencarb.

Other studies have shown that thiocarbamates are efficiently absorbed through the coleoptilar node and from there are translocated to the apical meristem. More severe injury to barnyardgrass was observed by Dawson (1963) when EPTC was placed in the shoot zone rather than in the root zone. The developing leaves within the coleoptile were the consistent sites of injury and the injury symptoms were never observed in the roots. Appleby *et al.* (1965) obtained similar results with EPTC and propham (isopropyl carbanilate) wherein the shoot zone of oats was more sensitive than the root. In sorghum, the meristematic region of the shoot before emergence was more sensitive to DCPA (dimethyl 2,3,5,6-tetrachloroterephthalate) and chlorpropham or CIPC (isopropyl N- (3-chlorophenyl carbamate) than the other regions of the shoot (Nishimoto and Warren, 1971) while according to Baker 1960), the mesocotyl is the more efficient site of the absorption of CIPC. Surface application of CIPC selectively controlled barnyardgrass in drilled rice by inhibiting the elongation of barnyardgrass mesocotyl.

The root appeared to be an equally important site of uptake for carbamates and thiocarbamates. Contrary to the report of Appleby *et al.* (1965) on propham, Burt and Corbin (1978) found that the herbicide was primarily absorbed by the roots of oats and corn, and was translocated throughout the plant. However, intact leaf surface did not absorb the herbicide in appreciable amounts.

The results obtained in this study do not concur with most published reports on site of uptake of other carbamates and thiocarbamates. This could be attributed to the difference in efficiency of absorption sites as affected by species. Different plant species vary in their response to treatment with EPTC and probably with other thiocarbamates. Moreover, the part of the plant exposed to the herbicide seems to determine the degree of herbicide injury. Oliver *et al.* (1968) reported that barley was more tolerant to EPTC than wheat, while oats, sorghum and giant foxtail were most susceptible to EPTC at 0.28-1.68 kg/ha. The root was the major site of uptake in barley, but injury to the other species from root exposure was equal to or slightly less than that from shoot exposure. The seed, or the first 2-4 mm of shoot, or both, were more sensitive in wheat than in barley. Gray and Weierich (1969) obtained similar results. Exposure of roots of barley (*var.* Blue Mariot), oats (*var.* California Red), barnyardgrass, annual ryegrass, wheat, rice (*var.* Belle Patna), cotton and yellow nutgrass caused more injury than shoot exposure. Shoot exposure caused slightly more injury than root exposure to Johnson grass, sorghum (hybrid Amak R-10) and peas. They also noted that seed exposure caused severe injury in some species but not in others. Their results disproved the claim of other workers that only shoot exposure to EPTC led to injury. The above studies also pointed out the significance of root uptake.

The two cultivars followed the same pattern of response to NA or thiobencarb but the degree of root inhibition was greater in IR-36 than in RD-19. The effective treatment sites of the antidote (root and mesocotyl), and the herbicide (root, mesocotyl and coleoptile) likewise did not differ in either cultivar. The inhibition of root elongation observed in almost all treatments regardless of treated tissue suggests that the root is the main target site of NA and thiobencarb.

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