The Interaction Between N Fertilizers and Avadex BW[1]

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Inorganic nitrogen is commonly applied to Saskatchewan soils either as NH_4^+ and NO_3^- salts or as urea. Triallate and nitrogenous fertilizers are usually applied simultaneously or sequentially. The applied nitrogen, due to its close physical proximity to the triallate, may alter triallate efficacy. Since no reports on the effect of applied nitrogenous fertilizer upon triallate efficacy could be found in the literature, experiments were conducted to 1) determine if triallate efficacy was changed by application of nitrogenous fertilizers and 2) provide information about any modification of triallate efficacy by nitrogenous fertilizer.

GENERAL EXPERIMENTAL

Plastic pots 15 cm in diameter and 15 cm deep were used in all experiments and the potting procedure was similar in all experiments. The soil used to fill the bottom of the pot, designated as the root zone (Fig. 1) consisted of the air-dry equivalent of 1250 grams of oven dry soil and was ground to aggregates less than 1 cm by a Royer soil grinder. Except where otherwise stated this soil was composed of the top 15 cm of a Bradwell Ap horizon from a summerfallow field and supplemented with 175 ppm N as NH_4NO_3, 30 ppm P as KH_2PO_4, 87 ppm K as KH_2PO_4 and K_2SO_4 and 20 ppm S as K_2SO_4. The root zone soil filled the pot to a depth of approximately 9 cm after it was leveled and brought to field capacity by the addition of distilled water. A polyethylene layer, penetrated by 10 drink straws, was then placed on top of the root zone soil and was shaped to the walls of the pot in such a way as to form a cup which would hold the shoot zone soils. The drink straws, approximately 25 mm long and 7 mm in diameter, were pressed into the root zone soil until more or less 5 mm of the straw was protruding from the plastic into the shoot zone area. One seed of Avena sativa var. Harmon, pregerminated 2 days, was placed root end down in each of the 10 drink straws of each pot. The shoot zone soil was then placed on top of the seeds and packed lightly. The pots were covered with a clear polyehtylene cone to prevent evaporation and placed in the environmental chamber. At the end of one week the cone was removed and replaced with a plastic layer punctured in the appropriate places to allow the seedling oats to emerge. All waterings were conducted from the pot bottom by placing distilled water into the saucer.

The shoot zone soil consisted of the equivalent of 625 g of oven dry soil. The soil was air-dried and sieved through a 2 mm screen. The proper amount of soil for one pot was weighed into a polyethylene bag, treated with the required inorganic salt solution and mixed four days prior to being placed into the pot. The salt was applied with adequate deionized water to bring the soil moisture content to a point where only 20 ml of water was required to reach a predetermined moisture content. The salt treated soil was allowed to equilibrate at room temperature before triallate was applied in a 20 ml aliquot. The triallate solution was thoroughly mixed with the soil and was allowed to equilibrate for two days at room temperature before being placed into the shoot portion

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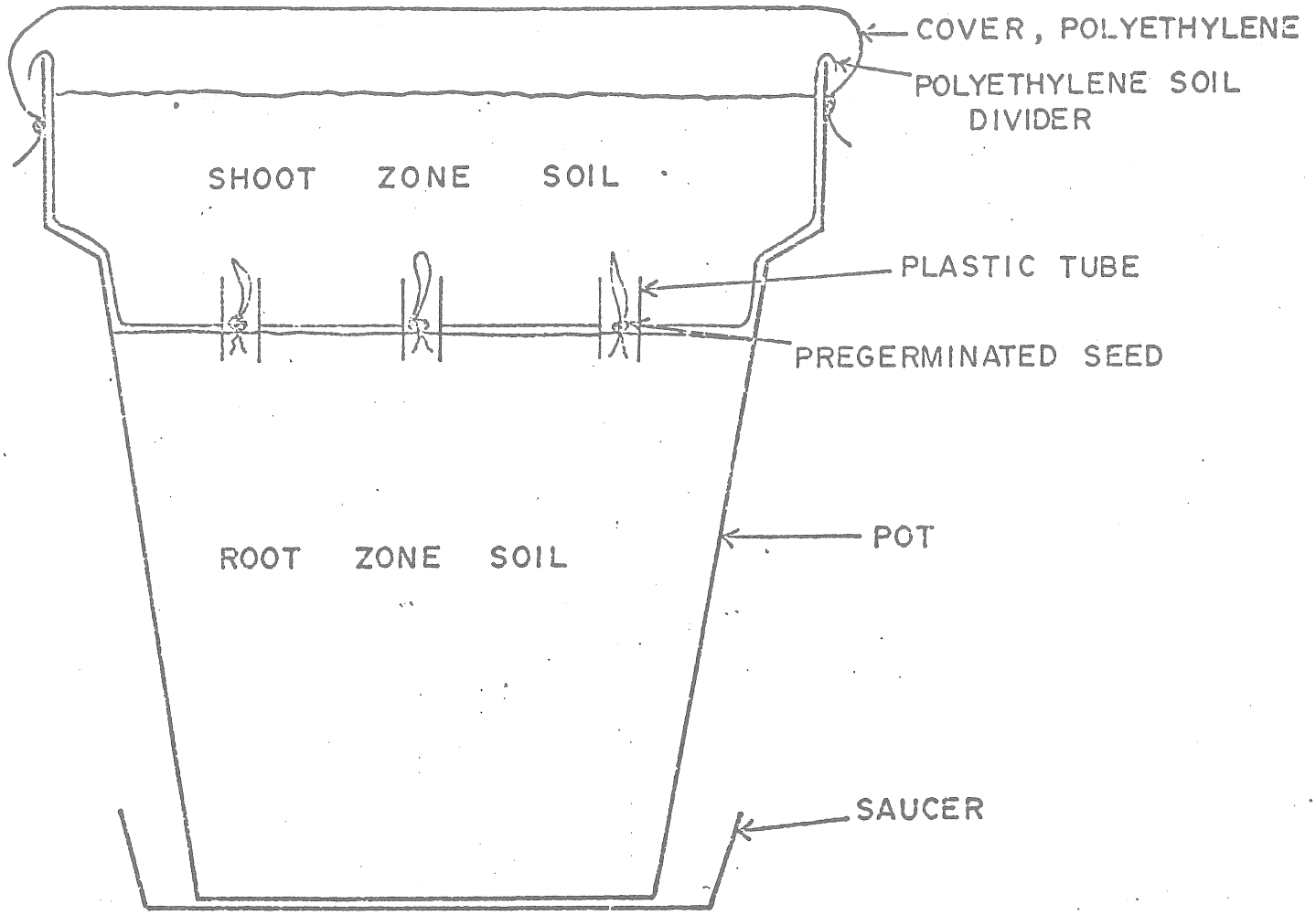

Figure 1. Soil and seeding arrangement in the pots.

of the pot. Thus, a shoot zone soil with specific moisture content, triallate concentration and inorganic nutrient concentration was placed into every pot.

The environmental conditions were similar for all experiments with a day length of 18 hours and night of 6 hours at 21.1°C and 15.6°C, respectively. The light intensity during the day was 1400 ft candles at 45 cm and the relative humidity was constant at 65%. The pots in the growth chamber were arranged into blocks corresponding to triallate rate. The pots within each block were randomized and the blocks were rotated into new positions in the growth chamber every week. The plants were harvested at 28 days and plant counts were made. The dry matter yield per pot was determined after drying the aboveground plant material for two days at 65°C.

RESULTS AND DISCUSSION

The results indicate that no soil amendment had any effect upon plant survival (Table 1) nor dry matter yield per pot (Table 2). When triallate was applied in the absence of any soil amendment, plant count and dry matter yield per pot decreased with increasing triallate rate. Plants emerged more slowly through shoot zone soils treated with triallate than through soil without triallate.

At 0.12, 0.22, and 0.36 ppm triallate addition of 350 ppm N as NH_4Cl resulted in increased triallate efficacy as measured by plant count and dry matter yield reduction over the respective treatments which received similar rates of triallate but no nitrogen. Significant reduction in plant survival was found at the 0.12 and 0.22 ppm rates of triallate. For all triallate rates, the dry matter yields in pots receiving both triallate and NH_4Cl were significantly reduced from the dry matter yields where similar rates of triallate but no nitrogen were applied.

Application of 350 ppm N as HNO_3 to the soil prior to addition of triallate resulted in similar plant counts to those obtained from the treatments which received equivalent rates of triallate but no nitrogen. Dry matter yields obtained on soils treated with HNO_3 did not differ significantly from the dry matter yields obtained when the respective rates of triallate were applied in the absence of HNO_3 except at the 0.36 ppm triallate rate which was found to be significantly lower.

HCl applied prior to addition of triallate and at a rate of H^+ ions equal to HNO_3 at 350 ppm N and the same amount of Cl^- ions as NH_4Cl at 350 ppm N resulted in similar plant counts as the zero nitrogen treatments receiving similar rates of triallate. The dry matter yields showed somewhat variable results. At 0.12 ppm triallate, addition of HCl prior to triallate application resulted in a significantly higher dry matter yield than that recorded for the treatment which received triallate only. At 0.22 ppm triallate the dry matter yields were not significantly different than those recorded for zero nitrogen treatments receiving triallate. At 0.35 ppm triallate, addition of HCl resulted in a significant dry matter yield reduction over the zero nitrogen soils.

Table 1. Effect of nitrogen source on efficacy of triallate as measured by plant count in growth cabinet studies.

Triallate Rate ppm	Salt Rate Equivalent to 350 ppm N			
	0	NH_4Cl	HNO_3	HCl
0.00	10A	9.8A	10A	10A
0.12	7.0B	4.0D	7.3B	7.3B
0.22	5.5C	3.0DE	5.8BC	6.0BC
0.36	2.8DE	1.5E	2.0E	2.0E

Table 2. Effect of nitrogen source on efficacy of triallate as measured by dry matter yield in growth cabinet studies (g/pot).

Triallate Rate ppm	Salt Rate Equivalent to 350 ppm N			
	0	NH_4Cl	HNO_3	HCl
0.00	5.80U	5.87U	5.69U	5.90U
0.12	3.43W	1.46Y	3.33W	4.24V
0.22	2.76WX	1.56Y	2.71WX	2.38X
0.36	1.54Y	0.62Z	0.66Z	0.57Z

Duncans Multiple Range Test. Means not followed by the same letter differ significantly at the 5% level of probability.

All means are averages of 4 replicates initially containing 10 pregerminated seeds of Avena sativa var. Harmon.

The conductivity and pH of the shoot zone soils were read one week after seeding (Table 3) to determine soil conditions encountered by the emerging plants at a time when they would have been most influenced to triallate. Application of NH_4Cl to the shoot zone soil resulted in a slight reduction (0.3 pH unit) and applications of HCl and HNO_3 produced reductions of 0.80 and 0.88 pH units, respectively compared to the control soil. The conductivities recorded for the treatments

indicate that addition of equal amounts of salt as NH_4Cl, HNO_3 and HCl produced similar conductivities. The conductivities recorded for the soils which received NH_4Cl, HNO_3, and HCl were on the average 5 mmhos/cm higher than the soil which received only triallate.

Table 3. Effect of chemical amendment upon soil properties.

Soil Property	Chemical Amendment			
	0	NH_4Cl	HNO_3	HCl
pH	6.70	6.40	5.82	5.90
Conductivity, mmhos/cm	0.94	6.33	5.97	6.45

The NH_4^+ ion appears to be responsible for increased triallate efficacy which occurred when the equivalent of 350 ppm N was applied to the soil as NH_4Cl prior to triallate addition. Application of HCl which supplied the same amount of Cl^- ions as in NH_4Cl produced no significant effect upon plant count and no consistent effect on plant dry matter yield. This would indicate that neither the Cl^- nor the H^+ ion effectively altered triallate efficacy. Thus, it may be reasoned that if the Cl^- ion is not effective in altering triallate efficacy but NH_4Cl is effective, the NH_4^+ ion must be responsible.

Application of NO_3^- ion to the soil at a rate equivalent to 350 ppm N, prior to addition of triallate caused no change in triallate efficacy. Neither plant count nor dry matter were consistently reduced when HNO_3 was applied to the soil prior to addition of triallate. The H^+ ion and the NO_3^- ion can thus be considered not to affect triallate activity. The possibility of H^+ ion offsetting any potential of NO_3^- to alter triallate activity can be argued against because neither H^+ or Cl^- of HCl affected triallate efficacy.

Several workers have reported that the chemical degradation rate of pesticides is different when the chemical environment of the soil is changed. Triazines, for example, are more rapidly dehalogenated at low pH values (Russell et al., 1968) while the organophosphate insecticide malathion is more rapidly degraded in soils with basic pHs (Walker and Stojanovic, 1973). The addition of NH_4Cl, HNO_3 and HCl change the ion ratios on the cation exchange and since HNO_3 and HCl cause pH reductions of up to 0.8 units (Table 3), it is advisable to discuss whether or not triallate efficacy is being influenced by chemical degradation.

Changes in chemical degradation did not appear to occur when triallate was applied to soils treated with NH_4Cl, HNO_3 and HCl. Plant counts and dry matter yields (Tables 1 and 2) remained generally unchanged when HNO_3 and HCl were applied indicating that a reduced pH value did not affect degradation. The treatments receiving NH_4^+ had lower plant counts and dry matter yields than the zero nitrogen treatments indicating that triallate degradation was not increased by NH_4^+. These results are in accord with those of Smith (1969) who found that triallate was chemically stable for 24 weeks when stored in buffered solutions of pH 4.0 to pH 8.0 and Smith and Fitzpatrick (1970) who concluded that strong acids and bases were needed to decompose triallate.

Knusli et al. (1969) and Geissbuhler (1969) concluded that inactivation of triazines and ureas respectively was greatest where conditions were optimal for microbial growth. Hance (1973) found that addition of inorganic nutrient salts stimulated microbial degradation of atrazine but not linuron. It is possible that NH_4^+ supplied as NH_4Cl and NO_3^- supplied as HNO_3 may stimulate microbial growth which would result in differential decomposition of triallate under growth cabinet conditions and in a soil held at 15 percent moisture.

Results presented in Tables 1 and 2 indicate that this stimulation of microbial growth by applied nutrient, should it have occurred, did not effect triallate efficacy during the time span involved in the experiment. This can be concluded since application of NH_4^+, a nutrient, actually increased triallate efficacy while decreased efficacy would be expected if microbial degradation were stimulated. Application of HNO_3 produces no change in triallate efficacy again indicating that no significant microbial degradation occurred due to addition of NO_3^-. If microbial degradation due to increased nitrogen were responsible for any alteration or triallate efficacy it would be expected that both NH_4^+ and NO_3^- would produce similar changes in triallate efficacy and they did not.

Rates of microbial degradation of triallate may be affected by soil pH. Corbin and Upchurch (1967) found that vernolate was less active at pH 7.5 than at pH 4.3 and concluded increased microbial activity at pH 7.5 compared to pH 4.3 was responsible. Their experiment was conducted over a period of 2 weeks.

Soil pH did not alter triallate efficacy during the time span involved in the experiment reported herein. This can be concluded since the values for plant count and dry matter yield are similar on the soil receiving no amendment, pH 6.70, and the soils treated with HNO_3 and HCl, pHs 5.82 and 5.90, respectively. The NH_4Cl treated soil has a pH similar to the check (Table 3) and it is the only soil upon which triallate efficacy is increased.

Applied salts have been found to influence herbicide adsorption. Abernathy and Davidson (1971) working with prometryne and fluometuron found that fluometruon adsorption was decreased and prometryne adsorption was increased by increasing $CaCl_2$ concentrations of leachate from 0.01N to 0.5N. Application of NH_4Cl, HNO_3 and HCl to soil prior to triallate addition greatly increased the salt concentration of soil solution as

shown by increased conductivity (Table 3). This increase in salt concentration would appear to be large enough to affect triallate sorption.

From the data presented in Tables 1, 2 and 3 it may be concluded that increased salt concentration did not change triallate efficacy. Plant count and dry matter yield of check and soil treated with HNO_3 and HCl did not differ significantly and consistently through any given rate of triallate. Furthermore, if salt concentration caused differential adsorption, NH_4Cl, HNO_3, and HCl would be expected to affect equally triallate activity since they were applied at equal salt concentrations and this did not happen.

All arguments just presented support the conclusion that NH_4^+ ion alone is responsible for increased triallate efficacy, when NH_4^+ containing materials are added to soil with triallate. Other data, using NH_4NO_3, $(NH_4)_2SO_4$, and urea, but not reported herein also supports this conclusion.

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