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EFFECT OF MULCH TYPES ON 1,3-DICHLOROPROPENE + CHLOROPICRIN RETENTION AND NUTSEDGE (*CYPERUS* SPP.) CONTROL

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Abstract. **Field trials were conducted to examine the effect of different 1,3-dichloropropene + chloropicrin (Inline™) concentrations and mulch types on the fumigant retention and nutsedge control. Inline concentrations were 600, 800, 1000, 1200, and 1400 ppm. Mulch types were: a) Pliant High Barrier™ white on black, b) IPM Bromostop™ white on black, c) Pliant™ Metallized, and d) Klerk's™ green virtually impermeable film (VIF). Soil air in the beds was sampled at 1, 2, 3, 4, 6 and 7 days after Inline injection. During the first 3 days, the Klerk's VIF and IPM Bromostop had the highest fumigant retention. With 1400 ppm of Inline, Klerk's VIF, IPM Bromostop, and Pliant Metallized had 120%, 41%, and 76% more retention, respectively, than Pliant High Barrier white on black. With the same Inline concentration, Klerk's VIF, IPM Bromostop, and Pliant Metallized had 7, 2.5, and 4 times less nutsedge, respectively, 12 weeks after injection than Pliant High Barrier.**

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In Florida, tomato (*Lycopersicon esculentum* Mill.) is commonly grown with plastic mulch and fumigated with methyl bromide (MBr), which has allowed growers to reduce the incidence of most soilborne pests and weeds. However, weeds such as purple and yellow nutsedge (*Cyperus rotundus* L. and *C. esculentum* L., respectively) have the ability to penetrate plastic films when allowed to grow uncontrolled.

Until 2004, MBr has been used extensively to manage nutsedge species under mulch. However, this fumigant will be phased out at the beginning of 2005 in agreement with the Montreal Protocol and the Clean Air Act (Watson et al., 1992). Currently, one of the main alternatives to replace MBr is the combination of 1,3-dichloropropene and chloropicrin (1,3-D + Pic). This combination has been reported to control these weeds when complemented with preemergence herbicides such as halosulfuron, pebulate, and metolachlor (Stall and Gilreath, 2002). However, the addition of these herbicides can increase production costs and personnel toxicity risks. Therefore, it is desirable to improve 1,3-D + Pic efficacy on nutsedge to reduce herbicide dependency. This could be achieved by increasing the time of exposure of the weed reproductive structures to the fumigant.

The application of 1,3-D + Pic can be achieved by injecting the gas formulation with chisels into the soil or through the application of the emulsifiable formulation (Inline™) in the drip-irrigation lines. The current tendency is to increase drip-applied 1,3-D + Pic, since it reduces application costs and personnel protection equipment. Unfortunately, Florida spodosols allow little lateral movement of this fumigant before volatilization through the mulch with either application technique, resulting in poor nutsedge control on bed shoulders. Therefore, increased fumigant retention needs to be addressed to improve efficacy.

The most widely used plastic film in tomato fields is the low-density polyethylene mulch, which allows rapid fumigant volatilization, thus reducing time of exposure. Other plastic films with different physical properties (color, thickness, and porosity) could reduce the amount of 1,3-D + Pic that is lost through volatilization, which might result in increased nutsedge control, as well as reduced fumigant rates, production costs, and environmental concerns. The objective of these studies was to determine the influence of mulch films on 1,3-D + Pic retention and nutsedge control.

Materials and Methods

Two field trials were conducted during Fall 2003 and Spring 2004 at the Gulf Coast Research and Education Center of the University of Florida in Bradenton. The soil was classified as Eau Gallie fine sand (Alfic Haplaquods, sandy, siliceous, hyperthermic) with 1.0% organic matter and pH 7.3. Selected fields were heavily infested by yellow and purple nutsedge at approximately 150 plants per m^2. Different fields were used for each season. Treatments were distributed within a split-split plot design with five replications. Inline concentrations (600, 800, 1000, 1200, and 1400 ppm) were the main plots, whereas mulch types were the subplots. Mulch types were: a) Pliant High Barrier™ white on black (Pliant Corp., Schaumburg, Ill.), b) IPM Bromostop™ white on black (Industria Plastica Monregalese, Mondovi, Italy), c) Pliant™ Metallized, and d) Klerk's™ green virtually impermeable film (VIF; Klerk's Plastics, Hoogstraten, Belgium). These factor and level combinations resulted in twenty possible treatments.

Beds were then formed (0.15 m tall by 0.75 m wide), pressed, and covered with the mulch films. Experimental units were a single bed of 5.10 m long (approximately 3.8 m^2). Drip irrigation was provided according to the water requirements of the crops. Seepage irrigation was used to maintain the water table at 45 cm deep in the experimental sites, simulating as close as possible tomato growers conditions. Two drip irrigation lines (T-Tape, T-Systems International, San Diego, Calif.) with emitters each 0.30 m were placed 0.30 cm apart and centered on the bed tops centers. Irrigation flow was approximately 5.6 L per min per 100 m of row. The fumigant concentrations were achieved by mixing the given amount of the product in a delivery volume of 100 m^3 water.

Soil air samples under plastic mulch were measured using a Gastec Model GV-100 gas sampling pump, equipped with appropriate detector tubes (Gastec Corporation, Ayase-City, Japan), at 1, 2, 3, 4, 6, and 7 d after treatment (DAT). Purple nutsedge population densities were determined at 2, 5, 10, and 12 weeks after treatment (WAT) by counting emerged plants within each treatment. Data collected was analyzed with the General Linear Model procedure to determine interactions between the two factors, whereas regression analysis was used to characterize the dependency of each variable with the fumigant concentrations (SAS, 1999). Pearson correlation was used to determine the association between nutsedge densities and 1,3-D + Pic retention in the soil.

Results and Discussion

Nutsedge densities. There were no significant season by treatment interactions for any of the variables. Therefore, data from only one of the trials will be discussed. For each of the nutsedge sampling dates, there were significant mulch by 1,3-D + Pic concentration interactions. At 2 WAT, three linear regression equations characterized the response of the weed with respect to 1,3-D + Pic concentrations (Fig. 1a). The regression equations showed that the Pliant High Barrier film had the highest weed density, regardless of the fumigant concentration. There were no nutsedge density differences between the IPM Bromostop and the Pliant Metallized films, whereas the Klerk's VIF mulch had the lowest weed populations. In all cases, nutsedge density decreased as the fumigant concentration increased. Based on the predicted nutsedge densities, with the lowest 1,3-D + Pic concentration, the Pliant High Barrier mulch had 2.0, 2.0, and 2.7 times more nutsedge than the IPM Bromostop, Pliant Metallized, and Klerk's VIF mulches, respectively. Similar nutsedge control patterns were observed at 4 WAT (Fig. 1b).

At 10 WAT, each mulch type had different nutsedge densities across 1,3-D + Pic concentrations (Fig. 1c). With 600 ppm of 1,3-D + Pic, the Pliant High Barrier mulch had a predicted weed density of 109 plants per m^2, in contrast with 53, 18, and 8 plants per m^2 for the IPM Bromostop, Pliant Metallized, and Klerk's VIF mulches, respectively. With Pliant High Barrier film, nutsedge control efficacy improved as the fumigant concentration increased, with all films providing excellent control (≤10 plants per m^2) with 1400 ppm of 1,3-D + Pic. These tendencies also occurred at 12 WAT, where Klerk's VIF had the lowest predicted nutsedge densities throughout the fumigant concentrations (Fig. 1d).

1,3-D + Pic soil retention. The interaction between 1,3-D + Pic concentration and mulch type influenced fumigant retention. Throughout the different sampling periods, 1,3-D + Pic

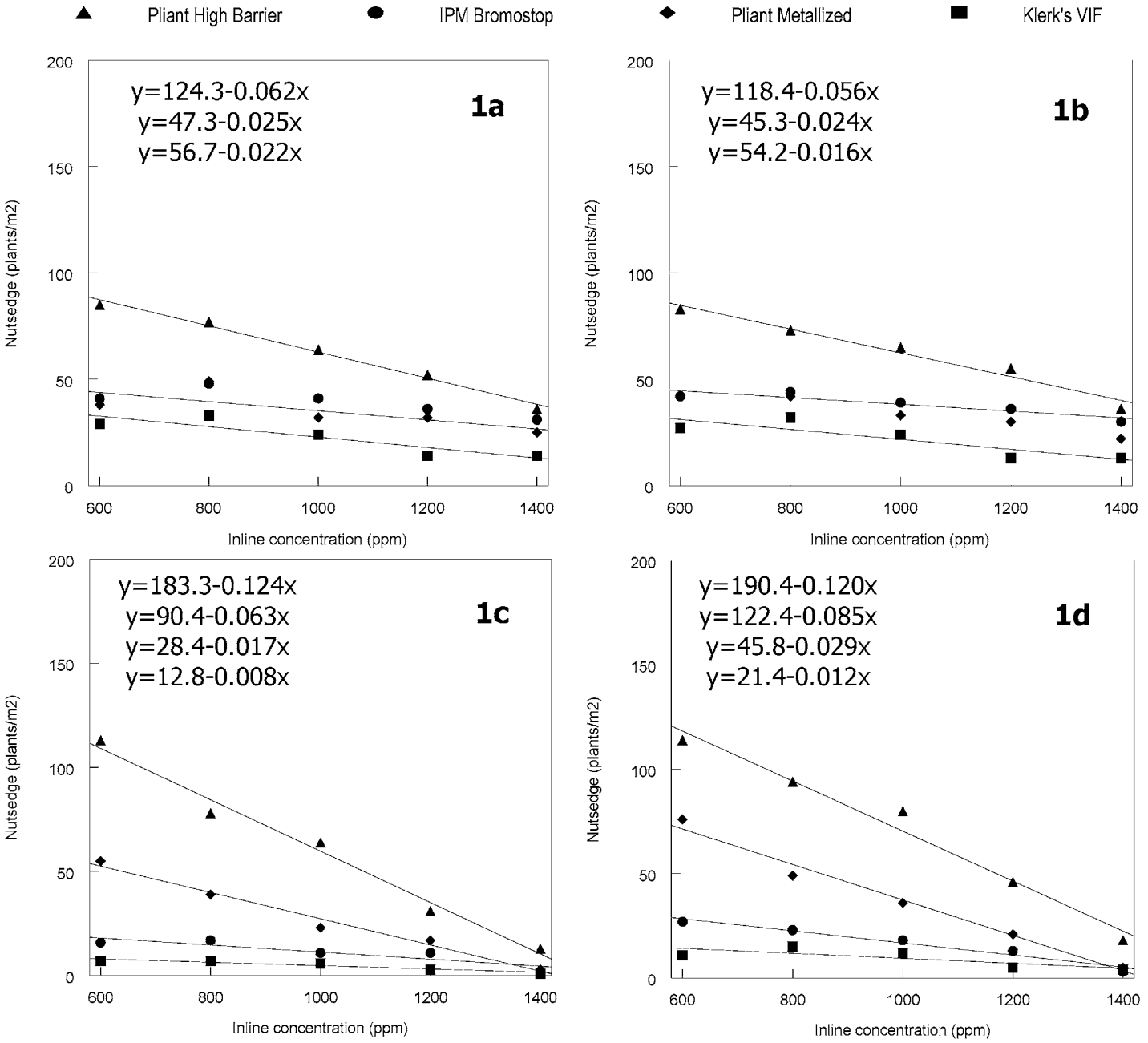

Fig. 1. Relationship between different concentrations of the emulsifiable formulation of 1,3-dichloropropene + chloropicrin (Inline™) and nutsedge (*Cyperus* spp.) densities at 2, 5, 10, and 12 weeks after treatment (Figs. 1a, 1b, 1c, and 1d, respectively) under different mulch films.

concentrations increased as applied concentration increased. At 1 DAT, the Klerk's VIF film had the highest 1,3-D + Pic concentration regardless of the applied fumigant concentration, followed by the IPM Bromostop, Pliant Metallized, and Pliant High Barrier mulches (Fig. 2a). When 600 ppm of the fumigant were applied, the Pliant High Barrier, IPM Bromostop, Pliant Metallized, and Klerk's VIF films had retained 17, 47, 27, and 61% of the injected 1,3-D + Pic, respectively. These retention percentages increased as fumigant concentration increased.

At 2 DAT, Klerk's VIF and IPM Bromostop had the highest retention rates of 26 and 20%, respectively, when the lowest 1,3-D + Pic concentration was applied (Fig. 2b). As applied fumigant concentration increased to 1400 ppm, the Pliant High Barrier, IPM Bromostop, Pliant Metallized, and Klerk's VIF films had retained 8, 26, 14, and 31% of the applied 1,3-D + Pic, respectively. At 3 and 4 DAT, the same described tendencies were observed on fumigant retention among the different mulch types, where Klerk's VIF and IPM Bromostop mulches had the highest 1,3-D + Pic concentrations in the soil air samples (Figs. 2c and 2d). Fumigant concentrations under the mulches at 6 and 7 DAT followed the same trends as for 4 DAT (data not shown).

Correlations between 1,3-D + Pic retention under plastic mulch and nutsedge control at 12 WAT indicated that there was a strong association between these two variables during the first 4 DAT (Table 1). In most cases, correlation coefficients (r) were -0.85 or lower. Although, at 2 DAT three out of four of the mulch types had r values of -0.97 or less, the r value for the Klerk's VIF was only -0.87, which indicated that

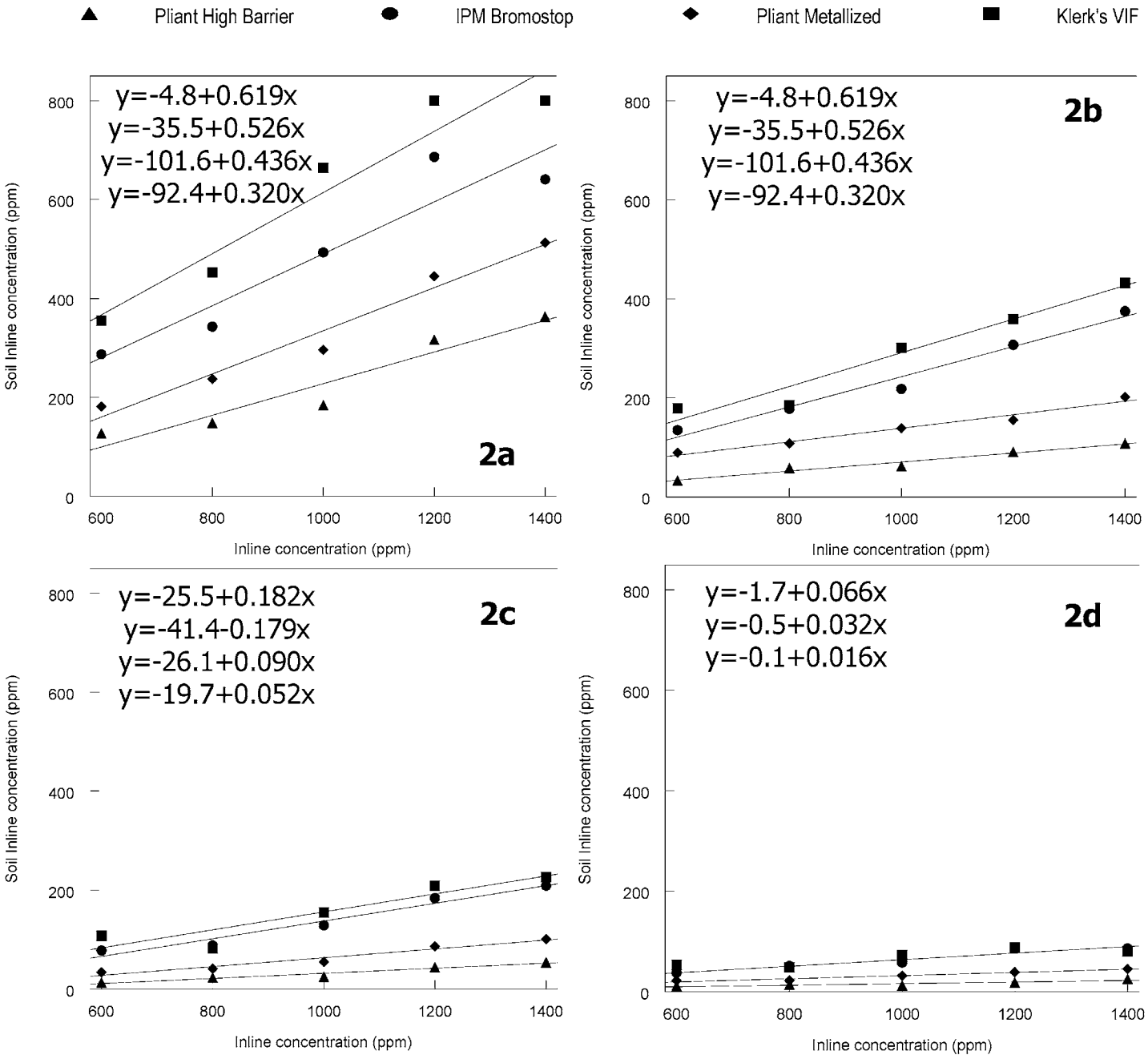

Fig. 2. Relationship between different concentrations of the emulsifiable formulation of 1,3-dichloropropene + chloropicrin (Inline™) and soil fumigant retention at 1, 2, 3, and 4 days after treatment (Figs. 2a, 2b, 2c, and 2d, respectively) under different mulch films.

the overall values across all mulch types at 3 WAT ($r \leq -0.94$) could express the association between the two variables stronger than at 2 WAT. In other words, the 1,3-D + Pic concentration found in the soil air under each mulch type at 3 DAT could predict at least 94% of the times, the nutsedge control level at 12 WAT.

Table 1. Pearson correlation coefficients (r) between nutsedge (*Cyperus* spp.) density at 12 weeks after treatment and 1,3-dichloropropene + chloropicrin (1,3-D + Pic) concentration in soil air under different mulch types at 1, 2, 3, and 4 days after treatment (DAT).

	Mulch types			
1,3-D + Pic sampling	Pliant High Barrier	IPM Bromostop	Pliant Metallized	Klerk's VIF
1 DAT	-0.89	-0.88	-0.91	-0.79
2 DAT	-0.97	-0.99	-0.99	-0.87
3 DAT	-0.99	-0.97	-0.97	-0.94
4 DAT	-0.94	-0.92	-0.97	-0.85

These findings conclusively prove that 1,3-D + Pic activity on nutsedge can be improved with the use of more retentive mulch films (Klerk's VIF and IPM Bromostop), which cause longer fumigant retention, thus improving effective dosage. Furthermore, commercial recommendations for Inline applications suggest that approximately 330 $L \cdot ha^{-1}$ should be applied in 100 m^3 of water, rendering a concentration of about 1300 ppm, which appears to be excessive to control nutsedge when high-retention mulch is used. As demonstrated by these trials, 600 ppm of the fumigant provides acceptable nutsedge control for 12 weeks when utilized in conjunction with either of the aforementioned mulch films.

Literature Cited

SAS Institute. 1999. SAS/STAT user's guide. Version 8. SAS Institute, Cary, N.C.

Stall, W. M. and J. P. Gilreath. 2002. Weed control in tomato, p. 55-58. In W. M. Stall (ed.). Weed management in Florida fruits and vegetables, 2002-2003. Vance Publishing. Tampa, Fla.

Watson, R. T., D. T. Albritton, S. O. Anderson, and S. Lee-Bapty. 1992. Methyl bromide: Its atmospheric science, technology and economics. Montreal Protocol Assessment Suppl. United Nations Environmental Programme on behalf of the contracting parties to the Montreal Protocol. Nairobi, Kenya.