EVALUATION OF FUMIGANT ALTERNATIVES IN FLORIDA STRAWBERRY 2015-16

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This large scale field demonstration project was funded by a Florida Strawberry Growers Research and Education Foundation grant to demonstrate and improve the performance and consistency of soil and drip applied fumigants. Field trials were conducted at the Florida Strawberry Growers Research and Education Foundation Farm in Dover, FL and at other grower field demonstration sites in Plant City, Florida. Alternative chemicals evaluated within these trials include individual and or combined uses of methyl bromide, chloropicrin, dimethyl disulfide (DMDS), and 1, 3-dichloropropene (Telone II) with use of appropriate herbicide(s). A diversity of drip fumigants were also evaluated for pest control efficacy and strawberry yield enhancement.

Methods: Two field studies focused on a co-application approach of different fumigants, herbicides, and other alternative tactics to achieve pest control efficacy and crop growth response similar to that of methyl bromide. Among the two experiments, chisel applied soil treatments included broadcast equivalent methyl bromide (67%) chloropicrin (33%) (350 lb/ta), methyl bromide (50%) chloropicrin (50%) (350 lb/ta), Telone C35 (35 gpta), Pic Clor 60 (300 lb/ta), Paladin (DMDS 79%) plus Chloropicrin (21%) (25 gpta), Paladin (DMDS 79%) plus Chloropicrin (21%) (40 gpta), in addition to five drip applied fumigants including, metam potassium (as KPam, 60 gpta), Dominus (AITC) (25 gpta); Dominus (67%) (AITC) plus Chloropicrin EC (33%) (325 lbta); Dominus (67%) (AITC) plus Chloropicrin EC (33%) (400 lbta); Paladin EC (DMDS 79%) plus Chloropicrin EC (21%) (40 gpta); at the Florida Strawberry Growers Association (FSGA) Research and Education farm in Dover, FL (**Table 1**). In addition to bed treatments, deep shank and deep drip applications of Telone II (12 gpta) or Telone EC (12 gpta) were applied to a soil depth of 15 inches to the flat either alone or in combination with Telone C35 (30 gpta) applied 10 inches deep into the raised bed at the time of bedding. In both field experiments, the highly gas retentive Raven Industries Vaporsafe® TIF was installed immediately after DMDS and methyl bromide chloropicrin applications. All fumigants were applied with commercial grower equipment. Calibration procedures were followed at each experimental location. Site gauges to confirm fumigant flow and distribution among four shanks were not installed on the 2 row fumigation rig. If they had

they would have quickly identified the plugged shank in one of the two plant rows being treated. Had the site gauges been used, bed 1 would not have received 2/3 of the desired dose and bed 2 would not have received 2X the rate of bed 1. As a result of this disparity, data for most shank treatments is not reported due to the yield and pest control variability between replicate rows within treatment plots. Certified applicators and pesticide label requirements for buffers, posting, rates of use, and personal protective equipment requirements were closely followed.

At all farm locations, beds measured 30 inches wide, 12 inches in height, with rows spaced on 4 foot centers. Actual per acre fumigant use rates represent 62.5% of the broadcast or reported per treated acre (ta) rates expressed above. At FSGA, bare root 'Festival' transplants from Canadian nurseries were planted between 4 to 5 weeks following fumigant treatment. Water and nutrients were supplied to each plant row with Netafim or TTape (0.22 gpm/100 ft or 0.45 gpm/ 100 ft row; or 0.40 gpm/100 ft row) on at least a daily/ twice daily basis (unless sufficient rainfall occurs) for much of the season. Fertigation rates were seasonally defined based on crop growth stage. Fertilization rates were generally based on a near field equivalent of 225 lbs NPK per acre per season. Other pest and disease control measures were maintained primarily on both a prophylactic and as needed basis.

Assessments of plant growth were made as appropriate during the course of the season to characterize differences in plant size, health, and vigor. Strawberry fruit were harvested (lb 240 linear ft of row) were determined on a 2 to 3 day basis from early December 2015 through March 2016. Following chemical treatment, weed densities were monitored and recorded on a periodic basis to determine any differences in weed control between fumigant treatments. All treatments were arranged within their respective experimental areas as a completely randomized block design with 4 replications per treatment. Plot sizes were 2 rows 240 feet long or 0.03 acres among the different field experiments.

In addition to the above assessments, the numbers of plants in four plant size categories were also systematically enumerated and recorded at 40 to 50 ft intervals were monitored at both FSGA experimental sites. (All data not included). Plant size categories, measured as average canopy diameter, were dead (0), small (<20 cm), medium (>20 and < 30 cm) and large (>30 cm). Cumulative differences in plant numbers and relative yield contribution within each plant size category were then used to independently compare differences between various soil fumigant treatments within hand harvest plots.

Results and Discussion:

Last year was an exceedingly hot year from an environmental temperature perspective (**Figure 1**). Two of every 3 days or 67% of the time during the period between October 11 and January 15, average air temperatures exceeded temperatures of 85°F compared to only 33% of the time during the preceding 7 year period. Degree day accumulations were significantly higher which promoted a very prolonged period of vegetative growth (foliar and roots), which the heat significantly reduced fruit production, overall yield, fruit quality, disease incidence and severity. The increased growth of foliage and reduce yield truly masked the impact of soil fumigant treatment. There were long periods during December and January in which no fruit or flowers were evident in commercial fields.

Weed densities at FSGA for the methyl bromide treatments and a number of the drip treatments were generally low, with yellow nutsedge (*Cyperus esculentus*) observed as the predominant weed species. Highest post fumigation densities of yellow nutsedge were observed in the untreated controls, which were no different (P=0.05) than either of the Dominus Chloropicrin (67%/33%) (325 lbta) and Dominus Chloropicrin (67%/33%) (400 lbta). Clearly the addition of Chloropicrin, which has poor herbicidal and nematicidal activity compromised the over Dominus treatment (**Figure 1**) when compared with the Dominus alone treatment (25 gpta). The higher nutsedge densities in these treatment indicates apparent limits to the addition of Chloropicrin for fungicidal activity without the addition of a supplemental herbicide for satisfactory weed control. None of the treatments completely eliminated preplant emergence of nutsedge through the plastic as a pest weed. By the end of the harvest season in March, nutsedge densities had increased to high levels in many of the shank and drip applied fumigant treatments.

Average strawberry yield of cv. Festival (lb fruit per 240 linear feet of plant row) among shank and drip applied fumigant treatments in experiment 1 at the Florida Strawberry Growers Research and Education Foundation Farm Dover, FL is illustrated in **Figure 2**. In this figure the actual shank treatments are not identified due to line plugging problem which occurred on the fumigation rig at the time of actual soil treatment biasing the 2 row distribution of fumigant gases and which contributed to the disparity in yield and pest control observed. In most years, shank treatments typically outperform drip treatment because of the differences in which gas and water move in fine to coarse textured sandy soils. All of the drip applied fumigants produced strawberry yields which were greater than that of the untreated control and that of the Deep Shank Telone II treatment alone. No significant differences were observed in strawberry yields among the drip treatments themselves (Figure 2) or among the shank treatments of a second

experiment conducted in another field.

Table 1. Soil Fumigant treatments evaluated at the Florida Strawberry Growers Research and Education Foundation (FSGREF) farm in Dover FL during the Fall 2015-16 production season. Each treatment plot, consisted of two 240 foot rows, with 4 replication per treatment.

1.	MBr + PIC 67/33 (350 lb/ta)	SHANK	+ TIF VaporSafe	1 tape	4 reps
2.	MBr + PIC 50/50 (320 lb/ta)	SHANK	+ TIF VaporSafe	1 tape	4 reps
3.	Telone C35 (30 gpta)	SHANK	+ LDPE	1 tape	4 reps
4.	Pic-Clor 60 (300 lb/ta)	SHANK	+ LDPE	1 tape	4 reps
5.	DMDS + PIC (40 gpta)	SHANK	+ TIF Vaporsafe	1 tape	4 reps
6.	DMDS + PIC (25 gpta)	SHANK	+ TIF Vaporsafe	1 tape	4 reps
7.	Dominus+PIC (400 lb/a)	DRIP	+ LDPE	1 tape	4 reps
8.	DMDS EC+PIC (40gpta)	DRIP	+ TIF Vaporsafe	1 tape	4 reps
9.	Kpam (62 gpta)	DRIP	+ LDPE	1 tape	4 reps
10.	Untreated + Deep Shank Telone II	SHANK	+ LDPE	1 tape	4 reps
11.	Untreated	--	+ LDPE	1 tape	4 reps
12.	Telone C35 +deep Shank Telone II (30gpta) + (12gpta)	SHANK SHANK	+ LDPE	1 tape	4 reps
13.	Telone C35 +deep Drip Telone EC (30gpta) + (12gpta)	SHANK DRIP	+ LDPE	1 tape	4 reps
14.	Telone C35 + deep Shank +deep Drip (30gpta)+(12gpta)+(12gpta)	SHANK DRIP	+ LDPE	1 tape	4 reps
15.	Dominus (25 gpta)	SHANK	+ LDPE	1 tape	4 reps
16.	Dominus+PIC 67/33 (325 lb/ta)	DRIP	+ LDPE	1 tape	4 reps

Figure 1. Degree Day Accumulations and number of days during the period October 11 through January 15 when average air temperature ranged in 5 degree increments between 40 and 100°F during the years 2008-2014 and compared with the same period of 2015-2016. A significantly warmer production season was observed last year compared to the preceding seven years.

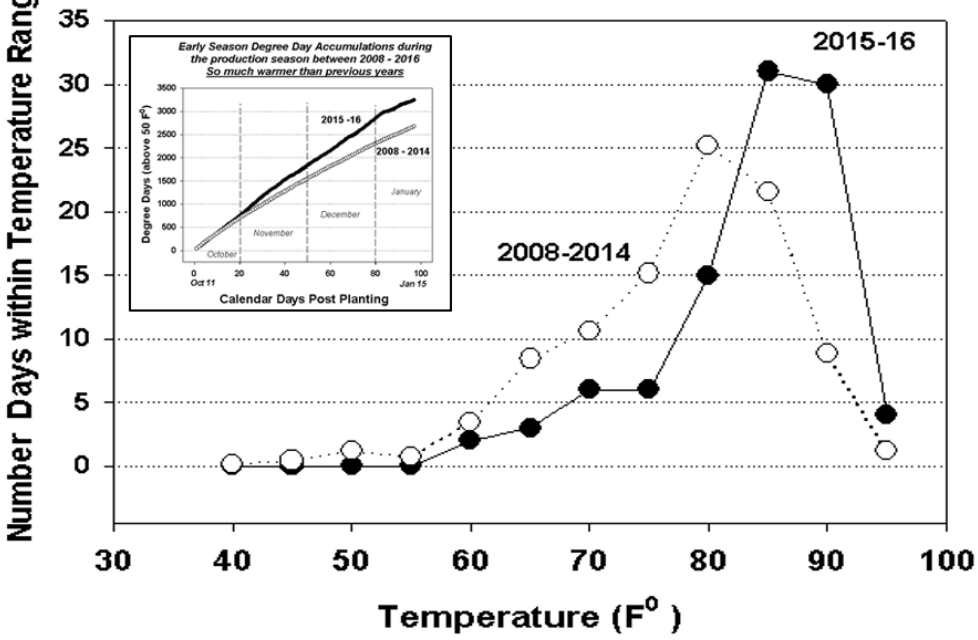
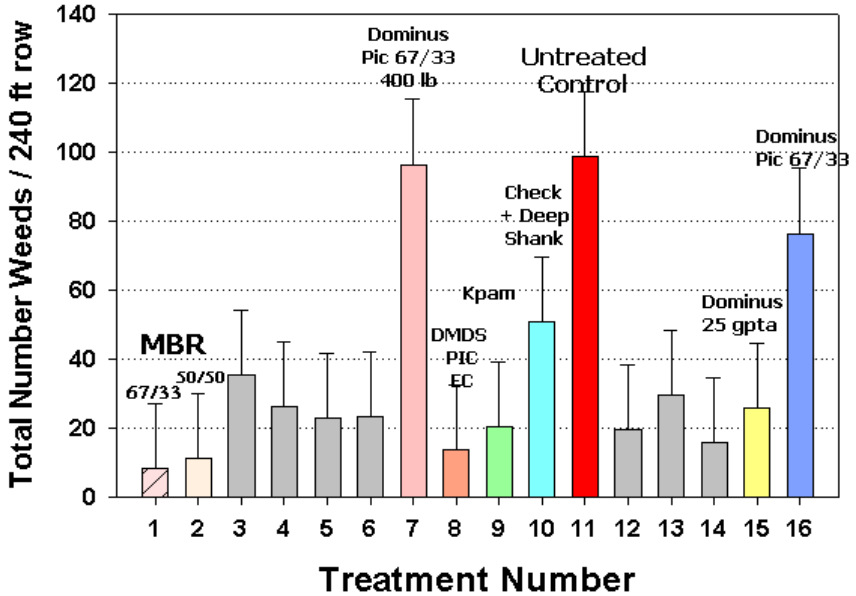
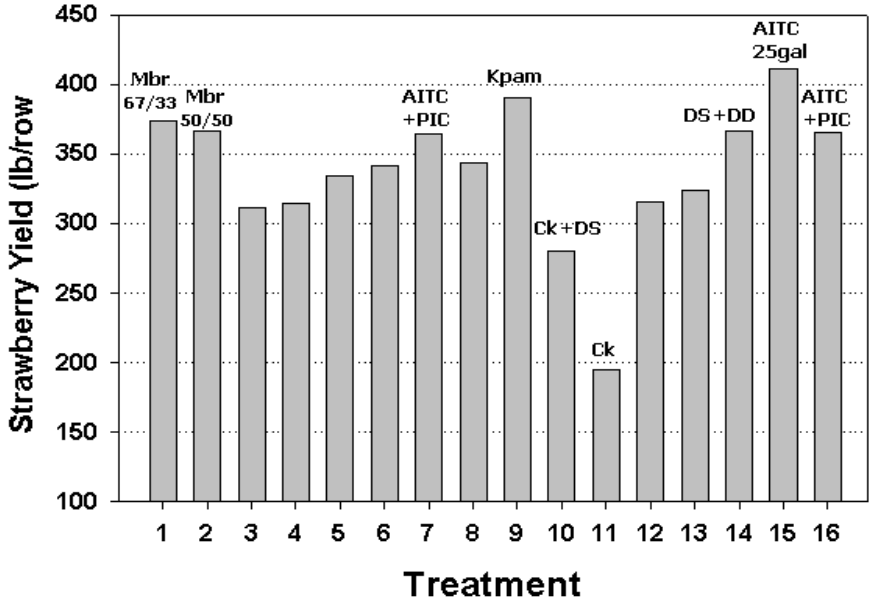


Figure 1. Average number of total weeds (primarily nutsedge) per 240 linear feet of plant row at seasons end (February 28, 2016) at the Florida Strawberry Growers Research and Education Foundation Farm Dover, FL.



Shank treatments not identified due to line plugging problem on fumigation rig at the time of soil treatment biasing 2 row distribution

Figure 2. Average strawberry yield cv. Festival (lb fruit per 240 linear feet of plant row) at seasons end (February 28, 2016) among shank and drip applied fumigant treatments in experiment 2 at the Florida Strawberry Growers Research and Education Foundation Farm Dover, FL.



Shank treatments not identified due to line plugging problem on fumigation rig at the time of soil treatment biasing 2 row distribution

Figure 3. Average strawberry yield cv. Festival (lb fruit per 240 linear feet of plant row) at seasons end (February 28, 2016) among shank applied fumigant treatments in experiment 2 at the Florida Strawberry Growers Research and Education Foundation Farm Dover, FL.