ALTERNATIVE FUMIGANTS IN STRAWBERRY PRODUCTION AND THE USE OF REMOTE SENSING

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INTRODUCTION

The efficacy of alternative soil fumigation treatments on strawberry production was evaluated by collecting yield data from subplots with in a production field (5 subplots of 40 plants/treatment, market and cull yield collected) as well as entire production blocks ranging in size from 1-2.3 acres (trays/acre shipped). Data also was collected from these plots using ground based spectral and image analysis As well as aerial remote sensing. Digital images of production beds collected in the visible and near infrared spectrum were useful for determining leaf area and biomass of the plants grown with different soil fumigation treatments. Field trials evaluating the effect of alternative fumigation treatments to Methyl Bromide + Chloropicrin (MB + Pic) were established.

In 2002 yield was the greatest for the MB + Pic fumigation treatment and less for the T + Pic and nonfumigated control. Little difference in % Canopy Coverage (which is correlated to leaf area) was observed between the fumigation treatments, but both were significantly larger than the nonfumigated control. Spectral reflectance of the canopy taken shortly after harvest started was similar among treatments, however, two months later differences in reflectance among treatments were apparent. Some of these differences corresponded to changes in fruit production in the treatments. Analysis of aerial images and calculation of a normalized distribution vegetation index (NDVI) revealed that the T + Pic treatment block had a higher NDVI than the MB + Pic treatment block three weeks before harvest started (3/14/02). However, 3 ½ months later no differences were observed. A larger scale comparison between fumigation treatments was done by selecting specific production blocks 1-3 acres in size for collection of yield data (commercial trays/block) and analysis of NDVI data from aerial images.

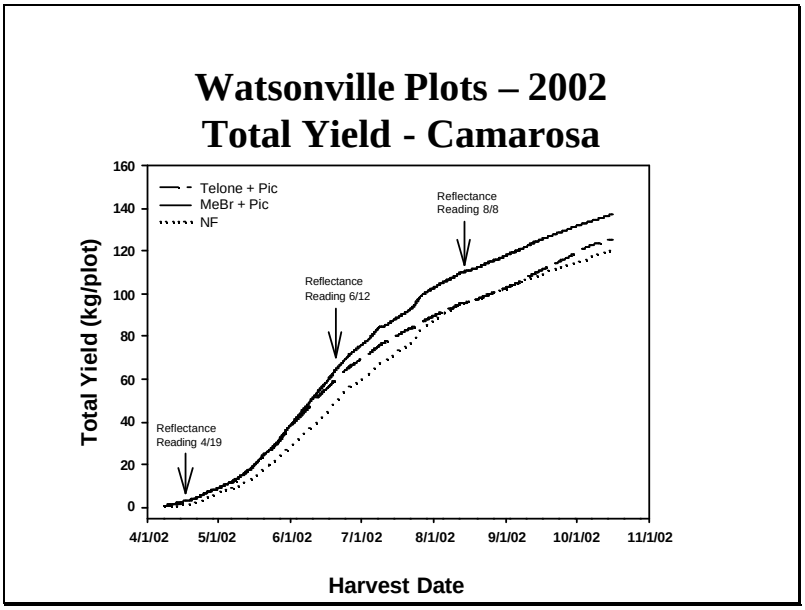
2002 Fumigation Trial

Trials were conducted in a commercial production field in Watsonville, CA with a previous history of MB + Pic broadcast fumigation and strawberry cultivation. A standard broadcast fumigation with MB + Pic (57:43 @ 350 lbs/A) was compared to T + Pic (42:58 @ 142 + 200 lbs/A). Due to buffer zone requirements no fumigants were applied at one edge of the field, allowing for data collection in a nonfumigated area. Market and cull yield was collected from 6 subplots of 40 plants twice/week in single blocks of the three treatment areas. Canopy coverage and reflectance data were collected in 24 other areas of the treatment blocks (6 for the nonfumigated treatment). The exact position of these subplots was

determined by GPS and placed on georeferenced aerial images for further analysis. Aerial images of the 46-acre field were collected with a 2-meter resolution. A 56% reflectance tarp was deployed on the day that images were collected to allow for calibration of images so comparisons could be made between different collection dates. Marketable yield (commercial trays/block) was collected for 3 larger blocks (1-3.2 acres each) in each fumigation treatment and image analysis of entire blocks was used to compare fumigation treatments.

Sub plot yield

Yield in the MB + Pic and Tel + Pic treatment were comparable (and greater than the nonfumigated control) until mid June, at which time productivity declined. There was a 9.2% reduction in yield for the Tel + Pic and 12.2% for the nonfumigated plots relative to the MB + Pic plots (both are significantly less than MB, P=0.001).

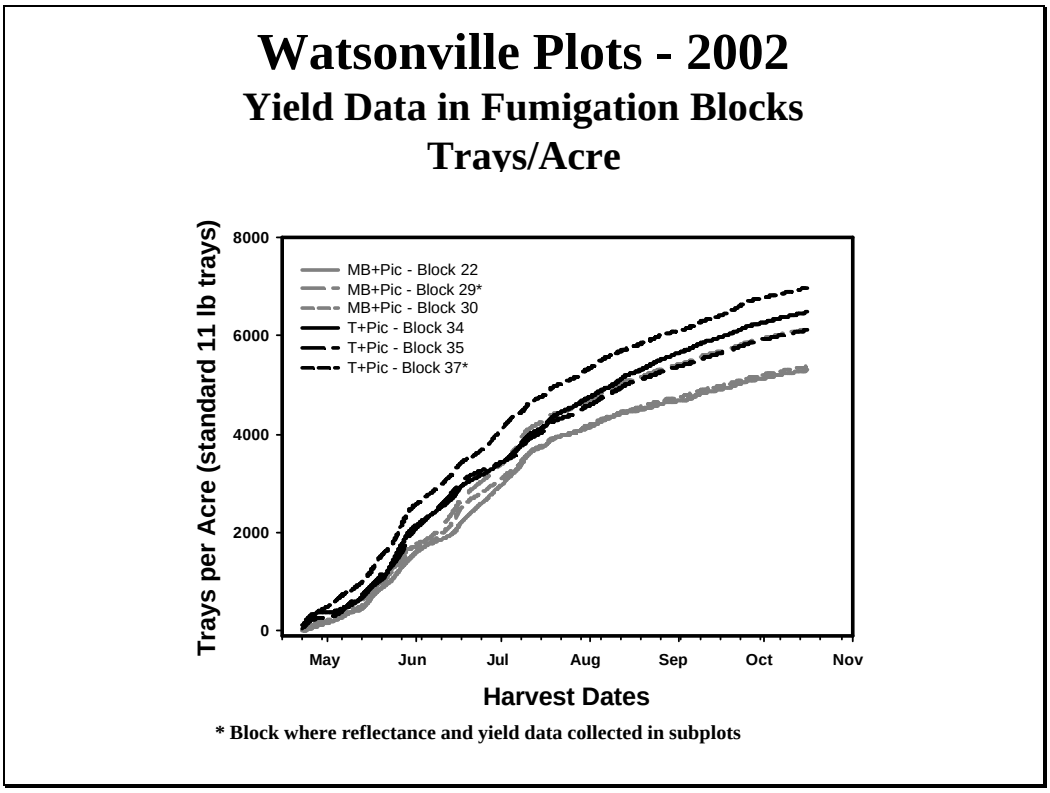


Detailed canopy reflectance data was collected from these subplots at the time points indicated in the graph. Interestingly, the data for the 6/12/02 collection date (about the same time point where the yield in the Tel + Pic treatment started to decline) indicates noticeable differences in reflectance of specific wavelengths of light (in particular, the near infrared). It should be noted that the plant sizes during this time period were almost equal (in fact, plants in the Tel + Pic treatment were statistically larger than the MB + Pic treatment), suggesting that changes in reflectance data were due to plant vigor and may be indicators of future plant productivity. This is currently being examined in greater detail (both by more comprehensive analysis of the data as well as plans for more detailed data collection this coming season).

Surprisingly, when looking at the marketable yield for the entire block where the subplots were located (in trays/acre), plants grown in the Tel + Pic treatment had

a greater yield than the MB + Pic treated soil (block 29 and 37, below). Possible reasons for this will be discussed below.

Yield in Production Blocks



The results of these trials evaluating yield in large treatment blocks indicates no statistical difference (P=0.07) between the Telone + chloropicrin and methyl bromide + chloropicrin treatment (it should be noted that this production site has been fumigated with MB + Pic every other year for approximately 30 years). This is in contrast to the results observed in the small-scale subplots (MB + Pic had a 13% greater yield than Tel + Pic). With aerial image data from only two dates it is difficult to evaluate if this difference in yield was due to chance placement of the subplots in areas of the Telone + chloropicrin block with lower vigor, but this is one possible explanation for the discrepancies in results. Additional airborne imagery is needed for clarification and improved capabilities of using this data for supporting management decisions.

Analysis of aerial images

Production blocks (3 per treatment) ranging from 1 to 2.45 acres were selected in areas of the field that had been fumigated with two different treatments; the standard methyl bromide + chloropicrin and Telone + chloropicrin. Aerial images were collected prior to harvest (3/14/02) and during full fruit production (7/1/02). The boundaries of the plots were determined by GPS and accurate acreage figures for each block determined so the data could be converted to trays/acre. The

NDVI calculated for the entire production field revealed a range in values through out the field. When looking at the NDVI calculated for only the six blocks in which yield data was collected, significant differences in NDVI were observed for the image from the first flight (3/14/02), but not the second (7/1/02). While it is not possible to draw firm conclusions about the relationship between the vegetation index from the remotely sensed images and fruit yield in the different production blocks, there are some interesting trends in the data. The yield data is the cumulative market yield that is taken out of the field in twice-weekly pickings, so the slope of this line is reflective of the amount of the harvest (the higher the slope, the greater the rate of yield during that time period). In examining the slope of the yield lines for 4 week moving averages it is apparent that early season yields are greater in the Telone + Pic blocks than the MB + Pic treatments. Since there is a 5-6 week lag from the time that a flower is formed to when it is a harvestable fruit at this time of year, the NDVI values from the 3/14/02 image acquisition are reflective of the plant shortly before it produces the flowers that matured into the harvestable fruit at the beginning of the season. The higher NDVI values in the Telone + Pic treatments correspond to higher yield observed in these treatments early season (there were no significant difference in plant size on these treatments on 3/14/02). In contrast, there were no differences in the yield between fumigation treatments from mid June through mid July; during this time period there were no differences between treatments in the vegetation index. More frequent collection of aerial images is needed to more carefully examine this relationship.

2003 Fumigation Trial

Trials included the same fumigation treatments as 2002 in addition to broadcast fumigation by chloropicrin and chloropicrin followed by Vapam or K-pam. Plant size and canopy reflectance data was collected at periodic intervals throughout the season while yield from subplots and larger production blocks were collected as before. Aerial imagery (0.5 meter spatial resolution) was collected every 4-6 weeks of the harvest season with a 12% and 56% reflectance calibration tarp deployed to enable comparison of imagery collected on different dates. The results of these trials will be discussed in the context of the efficacy of alternative fumigants as well as the utility of remote sensing for monitoring crop vigor and productivity.