FUMIGANT AND STRAWBERRY VARIETY EVALUATIONS IN *MACROPHOMINA* AND *FUSARIUM* FIELDS

Steve Koike, University of California Cooperative Extension-Monterey County
Tom Gordon and Husein Ajwa, University of California, Davis,
Oleg Daugovish*, University of California Cooperative Extension, Ventura County and Mark Bolda, University of California Cooperative Extension, Santa Cruz County, Dan Legard, California Strawberry Commission

Recent plant diagnostic analyses confirmed that collapsing strawberry plants from various parts of California were associated with two soilborne fungi: *Macrophomina phaseolina* and *Fusarium oxysporum*. Outbreaks of both problems have been observed in patches of plants in a number of coastal and inland strawberry production areas. Symptoms consist of wilting of foliage, plant stunting, and drying and death of older leaves, though the central youngest leaves often remain green and alive. Plants eventually collapse and die. When plant crowns are cut open, internal vascular and cortex tissues are dark brown to orange brown. In locations where the disease has occurred for more than one season, the patches can be quite large and appear to have spread from the initial problem area. Such patterns are consistent with the spread of a soilborne pathogen. It is noteworthy that in these cases we have never isolated other important, well known pathogens such as *Colletotrichum, Phytophthora*, or *Verticillium*.

During 2008-2009 production season we have evaluated several fumigant treatments, fungicide programs (Table 1) and strawberry varieties in fields with the history of *Macrophomina* and *Fusarium* at five locations in coastal California. The locations were: Ventura (13 treatments and 6 varieties), Camarillo (1,3-D+Chloropicrin fumigation and 7 varieties), Oxnard (13 treatments), Santa Maria1 (13 treatments) and Santa Maria2 (non-fumigated, 8 varieties). All studies were deigned as randomized complete blocks with 4 replications during typical production season: October-June at Ventura, Camarillo and Oxnard and October-August at Santa Maria locations.

In all trials plant decline was observed but pathogens isolated from plants differed. *Fusarium* was isolated in Ventura, Camarillo and Oxnard throughout the season while Macrophomina was isolated from declining plants at the two Santa Maria locations and during late season decline (May, 2009) at Ventura.

At all locations fungicide treatments did not differ from untreated checks when mortality or disease evaluations were performed. At Ventura, plant survival in all fumigant treatments was excellent during most of the season and similar to that of MB/Pic 300lb/acre, except for MB/Pic 200 lbs/acre and Pic 300 lbs/acre (Table 2). Plant losses (Table 2) and diseases ratings were greatest for Camarosa,

followed by Albion, while Ventana and Palomar appeared more tolerant to plant decline. With heavy fruit loads at the end of the season (May-June), plant decline accelerated in all treatments which coincided with isolations of both *Macrophomina* and *Fusarium* from dying plants. Overall, higher rates of fumigants for which two rates were tested (Table 1) tended to prevent plant mortality greater than lower rates of these fumigants resulting in 5-7% more surviving plants at the end of the season.
Above-ground dry biomass samples of surviving plants in June showed differential variety response to fumigation. For example, biomass of Palomar in untreated check was reduced more than 50% compared to fumigated treatments, in spite of low disease ratings and low mortality of Palomar in untreated check. Biomass of surviving San Andreas and Ventana plants, on the other hand, was similar among all treatments, including untreated check.

At Oxnard, mortality reached 100% in non-fumigated check in mid May, but all fumigated treatments protected strawberry equally well (<5 % mortality) until May-June evaluations when about 10-15% plant loss was observed.
At Camarillo, again, Camarosa had the highest rate of mortality, followed by BG959, 1975 and Albion, reaching 20-40 % by mid-June in spite of previous fall fumigation with 1.3-D +Chloropicrin at 200 lbs/acre.

At Santa Maria locations the trends were similar to that of Ventura. In the non-fumigated trial (Santa Maria2) Camarosa and Albion had the greatest rates of decline due to *Macrophomina* and Ventana appeared most tolerant. In the fumigation trial (Santa Maria1) all treatments prevented decline and disease development equally until July, while untreated checks suffered significant plant losses.

Current results suggest differential tolerance of common strawberry varieties to decline caused by *Fusarium* and *Macrophomina* and ability of fumigants to protect plants from disease development early in the season. However, both pathogens were isolated in rapidly declining plants with heavy fruit loads at the end of the season, suggesting that fall-applied fumigants can not provide complete season-long protection in fields infested with Fusarium and Macrophomina.

Table 1. Fumigant and Fungicide Treatments at Camarillo, Oxnard, Ventura and Santa Maria1, California.

Fumigant[a] / Fungicide[b]	Rate[c]
1. Untreated	
2. MB/Pic (50/50)	300 lb/A
3. MB/Pic (50/50)	200 lb/A
4. Pic 60 (1.3-D/Pic, 60/35)	200 lb/A
5. Pic EC	200 lb/A
6. Pic EC	300 lb/A
7. 1,3-D + Pic (InLine 32/62)	200 lb/A
8. 1,3-D + Pic (InLine 32/62)	400 lb/A
9. IM + Pic (Midas (EC 33/67)	200 lb/A
10. IM + Pic (Midas (EC 33/67)	300 lb/A
11. Topsin M Fungicide – Early season application	Full label rate
12. Topsin M Fungicide – Late season application	Full label rate
13. Topsin M Fungicide – Multiple bi-weekly applications	Full label rate

[a] MB=methyl bromide, Pic = chloropicrin; InLine = 32% Pic plus 62% 1,3-dichloropropene; Midas = 67% Pic plus 33% iodomethane (IM). Emulsifiable concentrate (EC) formulations of these fumigants were drip-applied.
[b] Topsin M Fungicide was applied through the drip irrigation systems twice a month at different timings: begin treatments early in the season (treatment 11), begin treatments late in the season (treatment 12), begin treatments only when symptoms are observed or if the crop enters March without any symptom development (treatment 13).
[c] Rate per treated area.

Table 2. Plant decline over time (mortality) in fall-planted strawberry at Ventura, California.

Variety	Treatment [a]											
	MBPic High			MB Pic Low			Pic High			Untreated Check		
	Number of live plants per 160ft²											
	10.23.08	03.10.09	06.04.09	10.23.08	03.10.09	06.04.09	10.23.08	03.10.09	06.04.09	10.23.08	03.10.09	06.04.09
San Andreas	130a[b]	128a	94b	130a	126a	78c	130a	120ab	92bc	130a	122a	89b
Camarosa	130a	122a	101ab	130a	111b	85bc	130a	119b	101ab	130a	90d	12d
Ventana	130a	126a	102ab	130a	127a	91ab	130a	126a	104ab	130a	124a	111a
Palomar	130a	127a	115a	130a	122a	105a	130a	124a	113a	130a	117b	104a
Monterey	130a	124a	100b	130a	120a	86bc	130a	116b	85c	130a	113b	49c
Albion	130a	129a	105ab	130a	125a	76c	130a	120ab	96bc	130a	103c	56c

[a] MB Pic High= methyl bromide/choloropicrin 50/50 at 300lbs/acre and Low =200 lb/acre; Pic High=chloropicrin at 300 lb/acre.

[b] Means within each column that contain the same letter are not significantly different at P=0.05.