AGRICULTURAL RESEARCH FOUNDATION
FINAL REPORT
FUNDING CYCLE 2013 – 2015

TITLE: Using berry skin-building sprayables to increase blueberry firmness in order to prevent Spotted Wing Drosophila attack.

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SUMMARY:
The results from this study indicate that none of the five trialed compounds (Biomin® chelated Calcium, Phyta-Set QC™ liquid Calcium and Boron, Mainstay Calcium Silicate, ProGibb® Plus 2X gibberellic acid, and Parka™ SureSeal biofilm) had a significant effect compared to the untreated control on the number of eggs laid by spotted wing drosophila (SWD), *Drosophila suzukii*, in the blueberry cultivar 'Legacy' at the rates applied. Numerically fewer eggs were laid in berries treated with Mainstay, Phyta-Set QC™, and Parka™ compared to the control; however, these effects were only marginally significant. In all treatments, egg-laying in berries subjected to *D. suzukii* exceeded acceptable levels and repetition of the experiment had no practical value to decrease infestation for growers. Berry fruit characteristics were affected by Calcium treatments. Biomin® and Mainstay treatments significantly increased berry firmness, as measured by FirmTech 2 technology, of blue- or pink-colored berries, and pink berries treated with Phyta-Set QC™ and Parka™ were also firmer compared to controls. No differences in penetration force were observed in treated berries compared to controls, with the exception that Phyta-Set QC™-treated pink berries required significantly greater force to puncture berry skin. In all cases, penetration force values were below levels known to be susceptible to *D. suzukii* attack (Burrack et al. 2013). °Brix of treated blue-colored berries were statistically similar to control blue-colored berries. °Brix of pink berries treated with Biomin®, Phyta-Set QC™, and ProGibb® Plus 2X were lower than those of control pink berries. Acidity levels of treated berries were statistically similar to the untreated controls, with the exception that pink berries treated with Mainstay had lower pH than the control.

OBJECTIVES:
The primary objectives of the study were to determine whether commercially available Calcium-based foliar fertilizers, gibberellic acid, or the berry crack-prevention agent Parka™ (powered by SureSeal technology) would effectively increase firmness and puncture thresholds of conventionally managed blueberries, compared to untreated berries, when applied during the development of blueberry fruit.

PROCEDURES:
1. Trial layout:
For the trial, we used a randomized block design including five treatments and an untreated control, replicated four times in a single row of conventionally managed 'Legacy' blueberry bushes. A replicate consisted of three consecutive bushes in the row, treated identically, from

which the middle bush was used for berry sampling. In limited instances, four consecutive bushes were counted as a replicate because one of the bushes was very small. 'Legacy' is a soft-fruited variety with thin skin and was selected as a model cultivar for other late-season cultivars that are typically more prone to SWD attack due to pest seasonal phenology (Wiman et al. 2014). Including the untreated control, the treatments were:

1. Untreated control
2. Biomin® chelated Calcium (1.5% by volume)
3. Phyta-Set QC™ liquid Calcium and Boron (1.5% by volume)
4. Mainstay Calcium Silicate (1.1% by volume)
5. ProGibb® Plus 2X gibberellic acid (30 parts per million)
6. Parka™ SureSeal biofilm (0.5% by volume)

Pre-determined fruiting branches were flagged at the beginning of the experiment. Prior to grower pesticide applications, chemical-resistant Tyvek® sleeves were affixed to the flagged branches to control for confounding effects of pesticide residues that could affect *D. suzukii* oviposition behavior.

In 2013, blueberry bushes were sprayed 1 to 10 times, depending on treatment, at the recommended application rate using a portable backpack sprayer. The first application occurred on 23 April at 50% flowering and occurred weekly until 4 July, with the exception of the week of 20 May when applications were skipped due to cold and wet weather. Parka™ was applied on alternate weeks beginning at the end of bloom for a total of four sprays. ProGibb® Plus 2X was applied one time at first color on 15 June. The Calcium-based sprayable coating treatments were applied 9-10 times.

2. Fruit measurements:

Normal-sized ripe fruit representing the sampled treatment bushes were randomly collected from flagged branches of each bush from both the inside and outside of the canopy. The unit weight, dimensions and firmness of the fruits were determined weekly for six weeks using the 25 mm plunger of a FirmTech 2 fruit firmness tester (BioWorks, Wamego, KS), as well as their resistance to mechanical damage using a blunted Number 2 insect pin attached to a Correx resistance gauge (Haag-Streit Ag, Köniz, Switzerland), as adapted from Burrack et al. (2013) to determine resistance to penetration. Measurements using the FirmTech 2 were performed on 24 fruits per treatment per sampling date (Table 1), and resistance to penetration was measured on 100 berries of each of three ripeness stages (ripe, pink, green) per sampling date. The content of soluble solids (°Brix) for a subset of each ripeness stage was determined using a hand-held refractometer.

3. Oviposition potential and analysis of berry characteristics:

Sets of fifteen 'Legacy' berries of varying ripeness stages treated with the same sprayable coating were subjected to five females and four males of a laboratory *D. suzukii* colony for 24-hour periods. Oviposition potential of *D. suzukii* was determined weekly for each treatment under controlled conditions (22°C, 60% relative humidity, and 16:8 Light: Dark regime for 24 hours). After 24 hours of caged exposure to *D. suzukii*, fruits were removed and the numbers of eggs laid by *D. suzukii* were counted under the microscope. Subsequently, the exposed fruits were tested for firmness with a FirmTech 2 machine, probed with a Correx resistance gauge as described above, then frozen for later analysis with a hand-held refractometer (Table 2).

4. Statistical analysis:
For fruit firmness, resistance to mechanical damage (*i.e.* penetration force), °Brix and pH, two-factor Analysis of Variance (ANOVA) was employed analyzing sprayable coating treatment effects on individual berries subjected to *D. suzukii* oviposition. Date was the random variable and Treatment was the fixed variable. For the number of eggs laid per cage, a random effects ANOVA was used, with each cage as a replicate. Number of eggs laid per cage was log-transformed prior to analysis. Significant effects were tested with Tukey's HSD means comparison at a threshold of $\alpha=0.05$.

SIGNIFICANT ACCOMPLISHMENTS:
Results from this study are being incorporated into a manuscript to be submitted to a peer-refereed journal by Dr. Jana Lee, USDA Horticultural Crops Research Unit, Corvallis, Oregon (Lee et al. *in preparation*). This work in progress will assess characteristics relating to fruit susceptibility to *D. suzukii*. Methodologies established by this work have been transferred to a recently published study investigating susceptibility of wine grapes to *D. suzukii* (Ioriatti et al. 2015). Data generated by this work are consistent with results found by other researchers regarding the stages of fruit susceptibility to *D. suzukii*.

BENEFITS & IMPACT:
Although the tested sprayable coatings did not show promise to deter *D. suzukii* oviposition in blueberries, these compounds did affect aspects of fruit quality in other ways. Strik noted beneficial effects of Calcium-containing sprays on post-harvest retention of fruit quality. Focused trials assessing the effects of Calcium treatments on post-harvest fruit storage have been ongoing as a result of this work.

ADDITIONAL FUNDING RECEIVED:
None.

FUTURE FUNDING:
None anticipated.

REFERENCES CITED:
Burrack, H.J., G.E. Fernandez, T. Spivey, and D.A. Kraus. 2013. Variation in selection and utilization of host crops in the field and laboratory by *Drosophila suzukii* Matsumara (Diptera: Drosophilidae), an invasive frugivore. Pest Manag. Sci. 69(10):1173-1180.

Ioriatti, C., V.M. Walton, D.T. Dalton, G. Anfora, A. Grassi, S. Maistri, and V. Mazzoni. 2015. *Drosophila suzukii* and its potential impact to wine grapes during harvest in two cool climate wine grape production regions. (Journal of Economic Entomology, in press.)

Lee, J.C., K. Swoboda, D.T. Dalton, H.J. Burrack, V.M. Walton, and D.J. Bruck. Fruit characteristics in relation to susceptibility to *Drosophila suzukii*. (*In preparation*.)

Wiman, N.G., V.M. Walton, D.T. Dalton, G. Anfora, H.J. Burrack, J.C. Chiu, K.M. Daane, A. Grassi, C. Ioriatti, B. Miller, S. Tochen, and X. Wang. 2014. Integrating temperature-dependent life table data into a matrix projection model for *Drosophila suzukii* population estimation. PLOS One 9(9): e106909.

Table 1. Mean fruit firmness values of ripe uninfested blueberries from field collections

FirmTech 2 mean values of field-collected fruit	Date						
Product	10-Jul	15-Jul	23-Jul	31-Jul	6-Aug	14-Aug	**Grand Total**
UTC	209.7	217.2	216.8	234.0	201.7	197.4	**212.8**
Biomin® chelated Ca	208.0	234.3	223.5	233.0	180.5	195.3	**212.4**
Phyta-Set QC™ Ca B	228.4	247.6	234.4	250.6	212.5	199.3	**228.8**
Mainstay Ca Si	224.6	227.5	220.6	244.7	204.0	200.8	**220.4**
ProGibb® Plus 2X	202.9	218.6	222.1	240.7	208.7	189.3	**213.7**
Parka™ SureSeal	199.6	217.1	218.1	229.7	209.9	206.4	**213.5**
Grand Total	**212.2**	**227.0**	**222.6**	**238.8**	**202.9**	**198.1**	**216.9**

Table 2. Mean number (+SE) of eggs laid by *D. suzukii* and fruit characteristics of Legacy blueberries at different stages of ripeness treated with various protective coatings

		Firmness		**Penetration force**	
Treatment	**Eggs per cage**	**Blue**	**Pink**	**Blue**	**Pink**
UTC	65.6 ±9.0	245 +5.1 b	287 +7.0 c	22.8 ±5.2 a	29.3 ±0.78 b
Biomin®	72.7 ±16.6	265 +4.8 a	328 +5.1 ab	23.2 ±0.87 a	30.9 ±0.98 ab
Phyta-Set QC™	49.6 ±15.2	257 +6.0 ab	322 +5.3 b	24.1 ±0.65 a	33.1 ±1.2 a
Mainstay	31.8 ±5.9	269 +4.7 a	349 +8.1 a	25.0 ±0.54 a	32.1 ±0.70 ab
ProGibb® Plus 2X	80.3 ±15.9	243 +4.6 b	288 +4.0 c	22.5 ±0.83 a	28.5 ±0.82 b
Parka™	52.7 ±9.9	251 +4.2 ab	309 +3.7 b	22.6 ±0.61 a	30.9 ±0.79 ab
Statistics	$F_{5,50}$= 2.1, P = 0.087 log-transformed	$F_{5,370}$= 6.1, P < 0.001	$F_{5,409}$= 18.4, P < 0.001	$F_{5,371}$= 2.3, P = 0.041	$F_{5,409}$= 3.6, P = 0.004

	°Brix		**pH**	
Treatment	**Blue**	**Pink**	**Blue**	**Pink**
UTC	11.5 +0.17 ab	10.1 ±0.15 a	2.81 ±0.044 ab	2.66 ±0.035 b
Biomin®	10.9 +0.29 b	8.6 +0.17 c	2.98 ±0.047 a	2.67 ±0.032 ab
Phyta-Set QC™	10.7 +0.22 b	8.6 +0.12 c	2.85 ±0.041 ab	2.66 ±0.032 b
Mainstay	12.2 +0.21 a	9.6 +0.21 ab	2.75 ±0.038 b	2.60 ±0.026 c
ProGibb® Plus 2X	10.9 +0.23 b	8.70 +0.17 c	2.98 ±0.047 a	2.72 ±0.034 a
Parka™	11.3 +0.21 ab	9.0 +0.13 bc	2.94 ±0.057 a	2.67 ±0.028ab
Statistics	$F_{5,372}$= 6.0, P < 0.001	$F_{5,410}$= 15.4, P < 0.001	$F_{5,370}$=5.1, P < 0.001	$F_{5,408}$ = 8.6, P < 0.001