

2021 REPORT ON GATTEN AND PARADE TRIAL ON APPLE POWDERY MILDEW IN WINCHESTER, VA

Apple cultivar: Idared planted in 1981 (40-yr-old trees) with experimental rows used in 2021 alternating with unsprayed tree rows. Hence, the trial rows had been nontreated (border) rows in 2020, which allowed high mildew inoculum pressure for 2021 trial. The trial was conducted in a randomized complete block design (RCBD) with four blocks (four single-tree replicates per treatment), all of them separated by non-treated border rows.

Equipment: All treatments were sprayed using a Durand Wayland Swanson air blast sprayer on a Dodge 1-ton truck based on the current growth stages. The sprayer tank had four 100 gal. compartments, where four different treatments could be made, and was calibrated to a 100 gal/acre output. The ground speed was 2.5 mph.

Maintenance sprays: mancozeb for apple scab and apple rusts control. Various insecticides for insect pest complex control. Standard herbicides and fertilizers.

Materials, treatments and spray dates: Gatten contains a.i. called flutianil (4.7%) and belongs to a new FRAC group U13. It is from a new chemical group of cyano-methylene thiazolidines. Parade contains a.i. pyraziflumid which belongs to a FRAC 7 group (SDHI class of chemicals).

Trt No.	Product / Formulation	PRODUCT / ACRE	Application growth stage
1	UNTREATED	-	-
2	Microthiol Disperss + Manzate	20 lbs/A + 3 lb/A	TC
	Gatten 5EC + NIS + Manzate	3.2 fl oz + 0.125% v/v + 3 lb/A	PK, PF, 1C
3	Microthiol Disperss + Manzate	20 lbs/A + 3 lb/A	TC
	Gatten 5EC + NIS + Manzate	6.4 fl oz + 0.125% v/v + 3 lb/A	PK, PF, 1C
4	Microthiol Disperss + Manzate	20 lbs/A + 3 lb/A	TC
	Gatten 2SC + NIS + Manzate	8 fl oz + 0.125% v/v + 3 lb/A	PK, PF, 1C
5	Microthiol Disperss + Manzate	20 lbs/A + 3 lb/A	TC
	Gatten 2SC + NIS + Manzate	16 fl oz + 0.125% v/v + 3 lb/A	PK, PF, 1C
6	Parade 20SC + Manzate	3.2 fl oz + 3 lb/A	TC, PK, PF, 1C
7	Standard Local Program:	Labeled Use Rates:	
	Nothing	-	HIG
	Rally + Manzate	6 oz/A + 3 lb/A	TC
	Rally + Manzate	6 oz/A + 3 lb/A	PK
	Merivon + Manzate	4 fl oz/A + 3 lb/A	PF
	Merivon + Manzate	4 fl oz/A + 3 lb/A	1C
8	Sulfur standard (Microthiol Disperss) + Manzate	20 lbs/A + 3 lb/A	HIG, TC, Pink, Bloom, PF, 1C

3/30 – ½” GREEN - Treatment 8.

4/5 – TIGHT CLUSTER - Gatten fungicide formulations were substituted with sulfur at TC in Treatments 2-5 because Gatten had not yet arrived due to delayed shipment. Treatments 6, 7 and 8.

4/8 – PINK BUD - Treatments 2-8 as per protocol.

4/12 – EARLY BLOOM – no treatments applied

4/20 – FULL BLOOM – no treatments applied

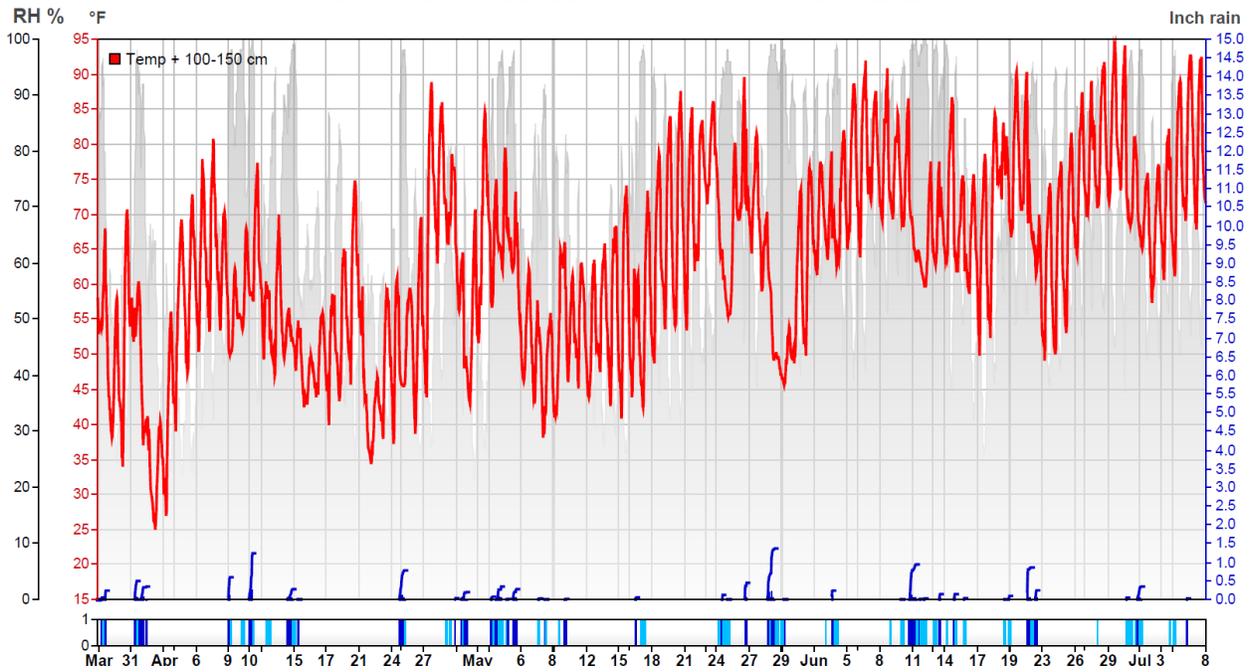
4/29 – PETAL FALL - Treatments 2-8.

5/13 – 1C (FIRST COVER) - Treatments 2-8.

The weather conditions from NEWA (Table 1) in April and through the whole season from RIMpro, graph 1), as well as infection periods in 2021 from RIMpro apple powdery mildew model (graphs A-C). Underlined dates are beginning of bloom (4/12) and full bloom (4/20).

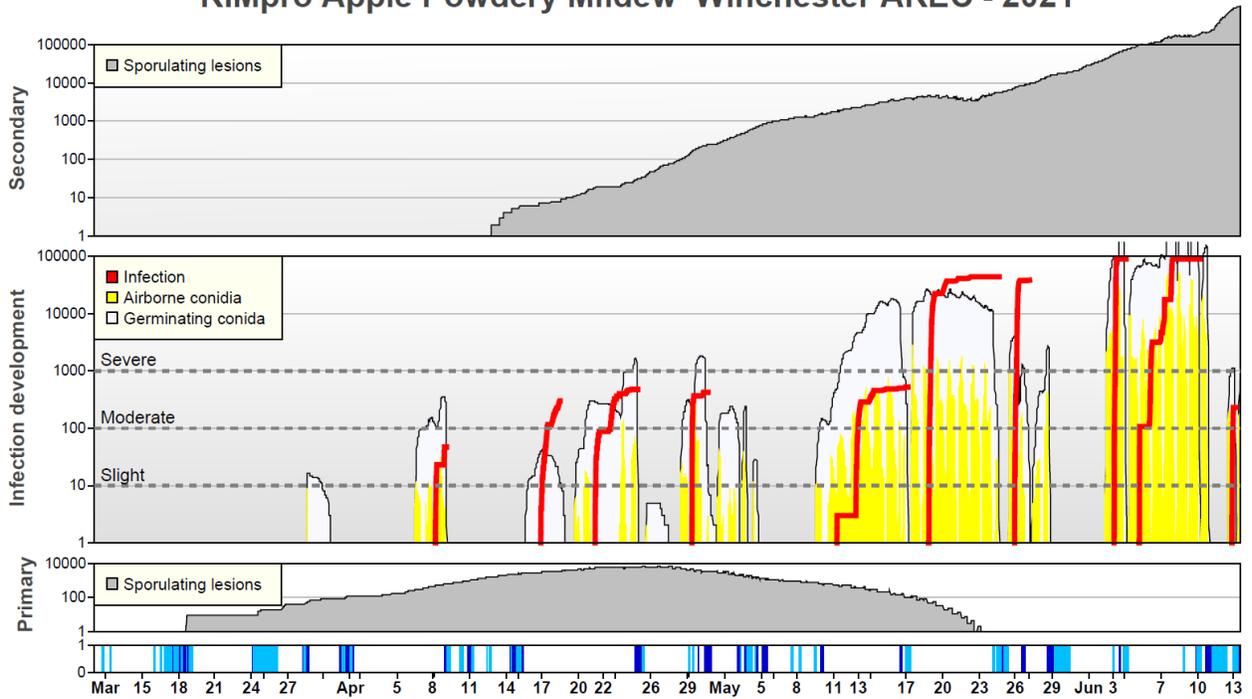
	AVG Air T	Max Air T	Min Air T	Total precipitation	Leaf wetness (h)	RH hours >90%	Avg Wind speed	Solar Radiation (Langleys)
4/1/2021	37.5	44.2	29.3	0.31	6	4	9	430
4/2/2021	32.8	40.4	24.9	0	0	0	8.8	545
4/3/2021	41.7	55.9	27	0	0	0	1.8	548
4/4/2021	57.4	69.2	39.1	0	0	0	5.2	563
4/5/2021	60.2	72.8	47.3	0	0	0	1.9	515
4/6/2021	63.8	77.9	50.3	0	0	0	2.2	468
4/7/2021	66.8	80.7	53.2	0	0	0	2.6	437
4/8/2021	62	70.4	53.5	0	1	0	4.2	518
4/9/2021	55	62.2	50	0.6	6	16	3.2	231
4/10/2021	59.4	68	53.6	0.18	12	14	2.8	320
4/11/2021	65.2	77.3	57.6	1.06	8	9	3.7	575
<u>4/12/2021</u>	<u>55.8</u>	<u>60.4</u>	<u>49.2</u>	<u>0</u>	<u>5</u>	<u>0</u>	<u>2.2</u>	<u>182</u>
4/13/2021	56.9	70	46.9	0	0	3	2.5	462
4/14/2021	52.9	56.5	49.4	0.27	15	15	0.9	109
4/15/2021	49.9	54.9	42.5	0.01	5	6	4.7	293
4/16/2021	46.5	50	42.9	0	0	0	6.5	204
4/17/2021	50.3	56	43.8	0	0	0	4.4	352
4/18/2021	51.2	58.5	39.9	0	0	0	1.8	350
4/19/2021	54.4	65.2	43.3	0	0	0	1.4	381
<u>4/20/2021</u>	<u>61.4</u>	<u>74.6</u>	<u>45.6</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>3.5</u>	<u>622</u>
4/21/2021	47.7	59.8	36.1	0	0	0	7.1	422
4/22/2021	40.8	46.8	34.5	0	0	0	7.4	550
4/23/2021	49.5	59.5	38	0	0	0	4	535
4/24/2021	49.7	61	37.3	0.57	7	4	1.6	303
4/25/2021	52.9	59.4	45.5	0.21	8	8	5.9	439
4/26/2021	53.9	69.7	38.6	0	0	0	4.1	648
4/27/2021	68.3	88.8	43.9	0	0	0	2.6	602
4/28/2021	75.1	86	62.9	0	0	0	3.6	482
4/29/2021	71.6	78.6	65.1	0.04	11	0	3.9	174
4/30/2021	57.1	64.9	47.8	0.2	4	0	10.1	522
Monthly Summary	54.9	88.8	24.9	3.45	88	79	4.1	12782

Weather Data location Winchester AREC - 2021



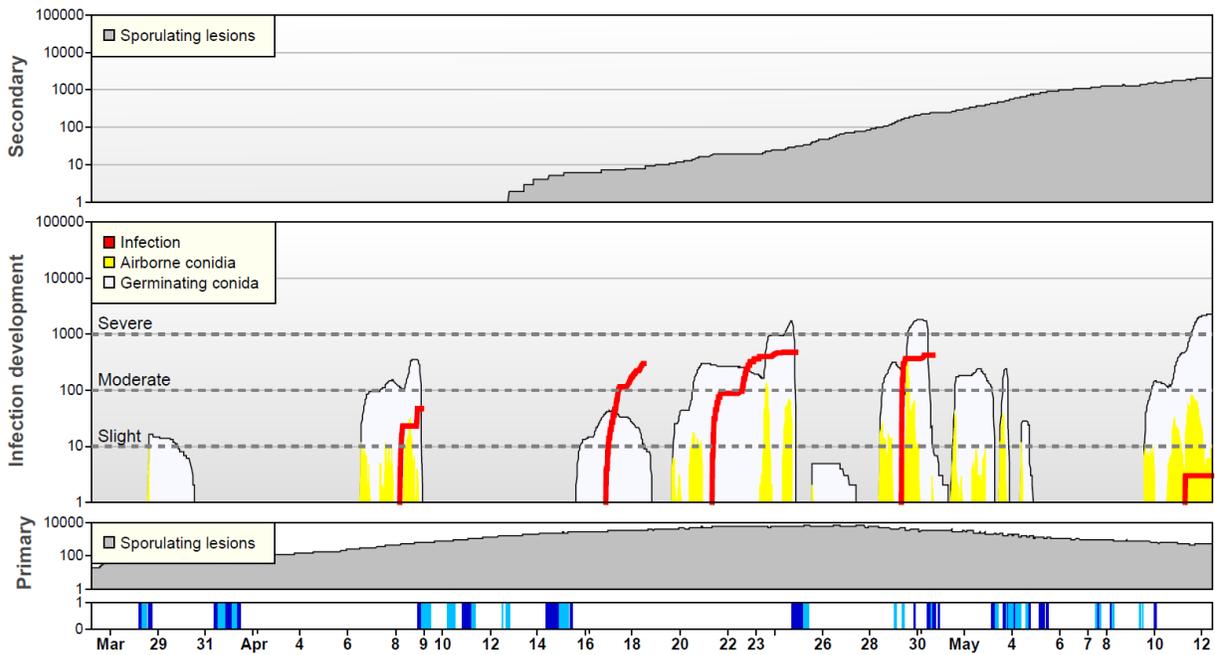
A) Sporulation of first powdery mildew lesions on 18 March from primary shoots (first graph at the bottom):

RIMpro Apple Powdery Mildew Winchester AREC - 2021



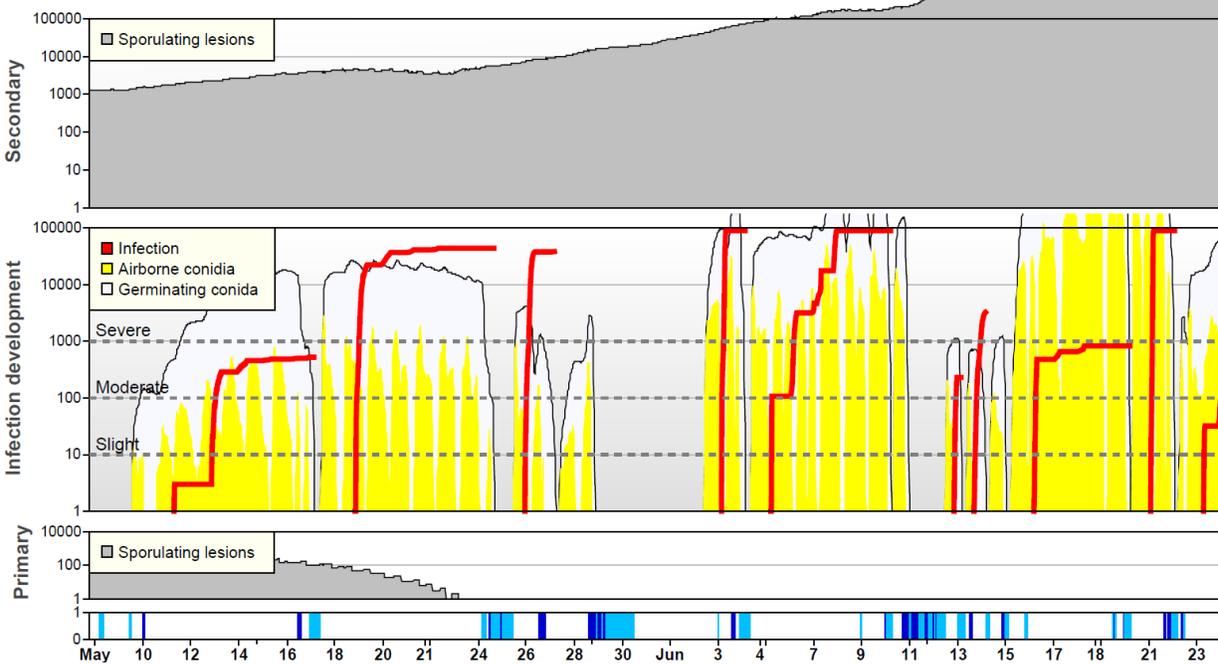
B) First secondary infection on 8 April (middle graph):

RIMpro Apple Powdery Mildew Winchester AREC - 2021



C) Infections until the end of the trial when disease rating was conducted (23 June to 1 July):

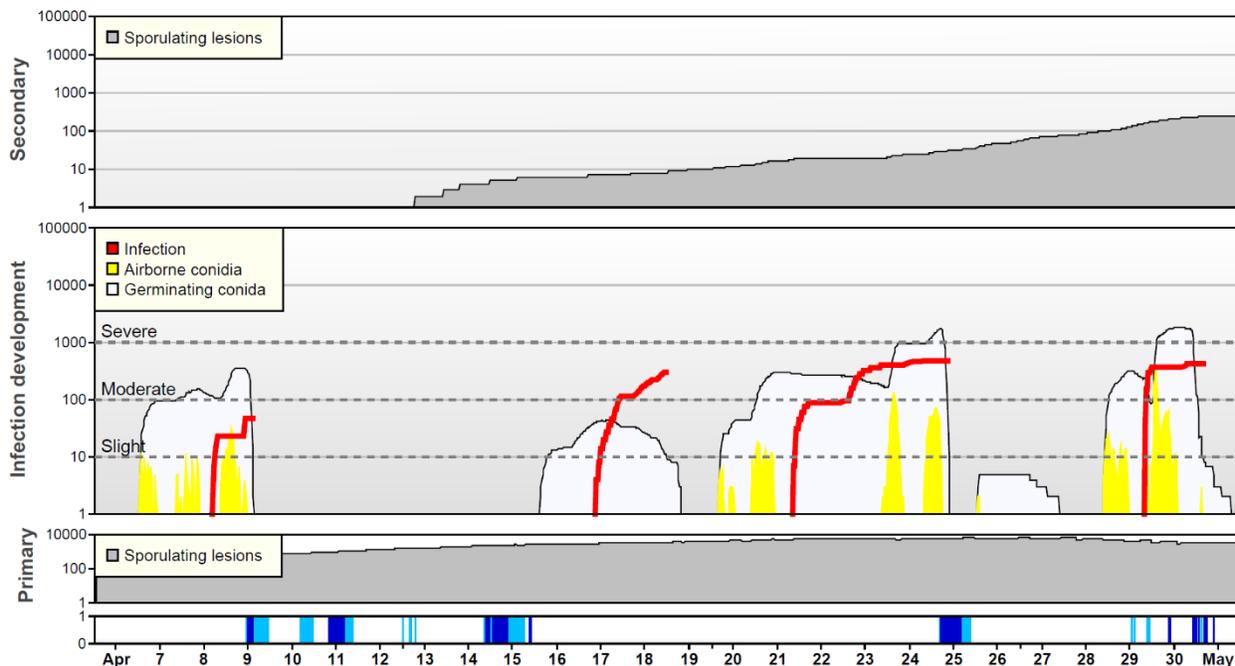
RIMpro Apple Powdery Mildew Winchester AREC - 2021



Year-specific weather conditions: Spring weather during the trial in Winchester was first highlighted by unusually warm air temperatures from 4th to 13th April (too early warming) and then unusually cool air temperatures from 14th to 26th April during bloom (Table 1). The cool weather extended flowering from lasting the usual average of 5 to 10 days to 21 days (very slow change of successive flower bud development stages). This cool period that unusually extended the flowering allowed two powdery mildew infections on 16th and 21st April (see graph under B above and a date specific graph D below). These infections were uncontrolled as no fungicide treatments were planned to be applied during bloom according to the protocol. The spray gap was 21 days between the protocol planned treatment applications on 4/8 (pink bud) and 4/29 (petal fall).

D) Powdery mildew infections during bloom on 16 and 21 April (middle graph):

RIMpro Apple Powdery Mildew Winchester AREC - 2021



Methods: The severity of primary infections and incidence of secondary infections of powdery mildew on terminal shoots were rated from 23rd June to 1st July (Fig. 1). The percent severity of the disease on terminal shoots was determined on 10 randomly selected terminal shoots per tree and by using the following scale index rating scale from least to worst infected: 20% of leaves infected (5), 40% of leaves infected (4), 60% of leaves infected (3) and 100% of leaves infected (1). The percent incidence of powdery mildew by secondary infections was calculated from the number of leaves with white mildew colonies versus the number of leaves without lesions on 10 randomly selected terminal shoots per tree, counting all leaves from shoot base to the tip. Disease severity on terminal shoots were subjected to ANOVA and then LSD test ($\alpha=0.05$) for a completely randomized design (CRD) because the effect of blocking was not significant and this factor was removed (Block, $Pr > F$, $p = 0.6550$; $\alpha = 0.05$). We used PROC MIXED in SAS Studio software (SAS Institute Inc., Cary, NC). Disease incidence on terminal shoots were subjected to ANOVA and then LSD test ($\alpha=0.05$) for a randomized complete

block design (RCBD) as the effect of blocking was significant ($Pr > F, p = 0.0454; \alpha = 0.05$). Powdery mildew has not established on apple fruit.

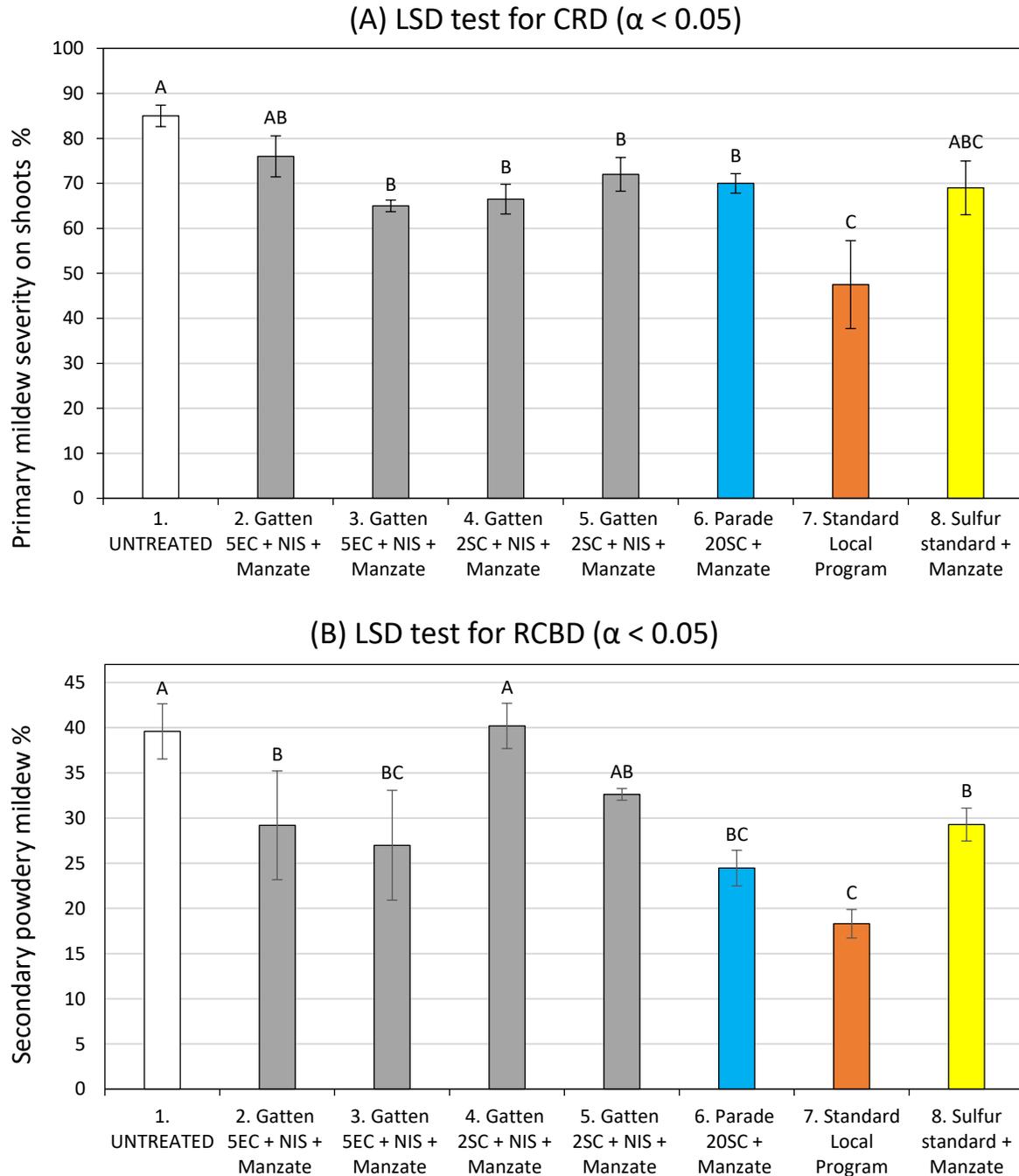


Figure 1. Apple powdery mildew management on ‘Idared’ with two Gatten formulations and Parade: (A) Effect on primary infections developing on terminal shoots after pathogen overwintering in buds, (B) Effect on secondary infections on leaves of terminal shoots. Mean bars followed by different letters within each graph (A) or (B) are significantly different from one another (LSD, $p \leq 0.05$). Error bars represent standard error of the mean (SEM). Each mean consists of 4 tree replicates.

Results and interpretation. Overall, there was a very weak but statistically significant effect of all fungicide spray treatments on primary powdery mildew (**Fig. 1A**). The disease severity in treatments ranged from 47.5% to 76% in comparison to 85% in the untreated control. This was probably because: (1) the materials we used have poor eradicated or post-infection effect on the overwintering mycelium in buds which was developing on the growing shoots from these buds and/or (2) the lack of fungicides applied during bloom i.e. between 8 and 29 April which was a 21 days gap without fungicide coverage. The usual average for a growth stage change from one to another ranges between 5 to 10 days. This delay of 21 days during flowering was caused by the unusually lower temperatures from 14-26 April. During that time there were two major powdery mildew infections on 16 and 21 April during bloom (graph D above). The same lack of fungicide spray application during bloom in all treatments, i.e. from 8 to 29 April, is likely the key reason why we do not see a much better effect of tested treatments in control of the secondary infections on shoot leaves (**Fig. 1B**). Finally, the last key factor that contributed to poor control of both primary and secondary infections is the lack of continued fungicide applications in all treatments after First Cover (1C) i.e. at second cover (2C) and third cover (3C) (beyond 13 May). In some years, like 2021, these applications would be necessary until the leaves completely age i.e. become ontogenically resistant due to thick cuticle formation on epidermis, which is right after the shoots finish their growth by terminal bud set.

Since the two Gatten fungicide formulations (EC, SC) had not yet arrived at the Tight Cluster (TC) growth stage application (5 April) due to Covid-19 shutdown shipment delays, we substituted them in treatments 2 to 5 with the applications of sulfur i.e. Microthiol Disperss at 20 lbs/A at this stage. Thus, we believe that the treatments 6 and 7 had a slight advantage due to application of Parade and Rally at TC (a growth stage earlier) in providing a numerically and/or statistically better effect in comparison to the treatments 2, 3, 4 and 5 (Figure 2 A, B). Also, due to systemic activity providing post-infection effect and longer residual due to tissue absorption, we would expect Rally and Parade to perform better, while the treatments 2 to 5 only had sulfur as a contact fungicide at TC, which would likely have shorter residual and minimal to no post-infection activity. Gatten in treatments 2 to 5 was first started at Pink Bud (PK) growth stage.

Under these weather conditions and the trial's specific factors at play, the systemic DMI fungicide Rally, which is known to have post-infection activity, had the best effect when controlling both primary and secondary powdery mildew infections (Fig. 1 A, B). However, due to lack of coverage during bloom of 21 days, even this grower standard allowed 48% primary infection severity and 18.3% secondary infection incidence. The second-best treatments in control of secondary powdery mildew infections were 2 and 3 (Gatten 5EC) and 6 (Parade), allowing only 27%, 29% and 25 % secondary infections.

Report compiled by Dr. Srdjan G. Acimovic, Assistant Professor Virginia Tech, from: 6/23/2021 – 7/21/2021. Detailed weather data records for Highland NY during 2021 can be accessed at <http://newa.cornell.edu/index.php?page=all-weather-data>. This report will be made available to Virginia apple growers in July 2021 online at Tree Fruit Pathology Lab's website at Virginia Tech's Alson H. Smith Jr. AREC in Winchester VA.