Arizona Iceberg Lettuce Research Council

Research Report

2013-2014

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Summary. This project addressed two disease problems of lettuce in Yuma, Arizona: Fusarium wilt and powdery mildew. Thirty-seven highly resistant F_4 plants with iceberg-like heads were selected from a naturally infected field test in Tacna for transplanting to a greenhouse and advancement to the F_5 and produce the first backcross to 'Autumn Gold' to combine high-level resistance with iceberg plant type, but none survived. The resistance will be advanced using remnant seed to produce the F_5 and backcross. Reactions of seven powdery mildew (PM) race differentials, 26 cultivars and several segregating populations from crosses of several putative PM resistance sources with PM-susceptible cultivars adapted to the spring season in Yuma ranged from highly resistant (no observable PM) to highly susceptible (all wrapper/outer leaves infected). Laboratory study of lettuce pathogenic race difference among PM isolates from Yuma, Gila, Dome, and Salinas continue, but field, greenhouse and laboratory data collected to date do not indicate different PM races in Yuma and Salinas.

Fusarium wilt (FW)

This soilborne fungal disease is especially serious in iceberg lettuce planted on the front end of the season in Yuma when air and soil temperatures are highly favorable to rapid infection and disease development. Infection can be apparent as early as thinning. Moderate-level resistance occurs in a few unadapted iceberg cultivars, but higher-level resistance occurs in several romaine lettuce cultivars.

Resistant F_4 families from the cross of the FW-susceptible iceberg cultivar Autumn Gold x FW-resistant romaine cultivar King Louie were planted in a replicated (3 reps) trial in a naturally infected, commercial lettuce field near Tacna, AZ. The test included the parents and the check lines (susceptible 'Patriot, race 1-resistant 'Costa Rica No. 4, 'Salinas'). The test was planted on 10 September. Disease reactions evaluated on 12 November using a 1 to 4 scale, where 1 = no apparent disease, 2 = slight–moderate stunting, 3 = severe stunting and wilting, and 4 = dead (Hubbard and Gerik, 1993).

Overall mean disease reaction for the test was 1.6. 'King Louie' expressed high-level resistance to FW as did Costa Rica No. 4. (Table 1). 'Salinas' expressed intermediate resistance. The FW-susceptible parent and 'Patriot' were, as expected, severely diseased. Mean disease reaction of the 95 F_4 families ranged from 1.0 (asymptomatic) to 4.0 (dead). Twelve families were comparable to the resistant parent for resistance expression (Figure 1).

Resistant plants were dug for transport to Salinas and transplanted into pots in a greenhouse for seed increase. None of the resistant selections survived, thus F_5 seed was not produced. The selected families will be planted in the greenhouse to produce the F_5 and the first backcross to 'Autumn Gold' in order to recombine FW resistance with iceberg type.

Table 1. Mean Fusarium wilt ratings of resistant 'King Louie', susceptible 'Autumn Gold', their F_4 generation and three other lettuce cultivars, Yuma, November 2013.

Entry	n	Mean
King Louie	3	1.2
Autumn Gold	3	3.7
F_4 King Louie x Autumn Gold	95	1.5
Costa Rica No. 4	3	1.0
Salinas	3	2.0
Patriot	6	4.0

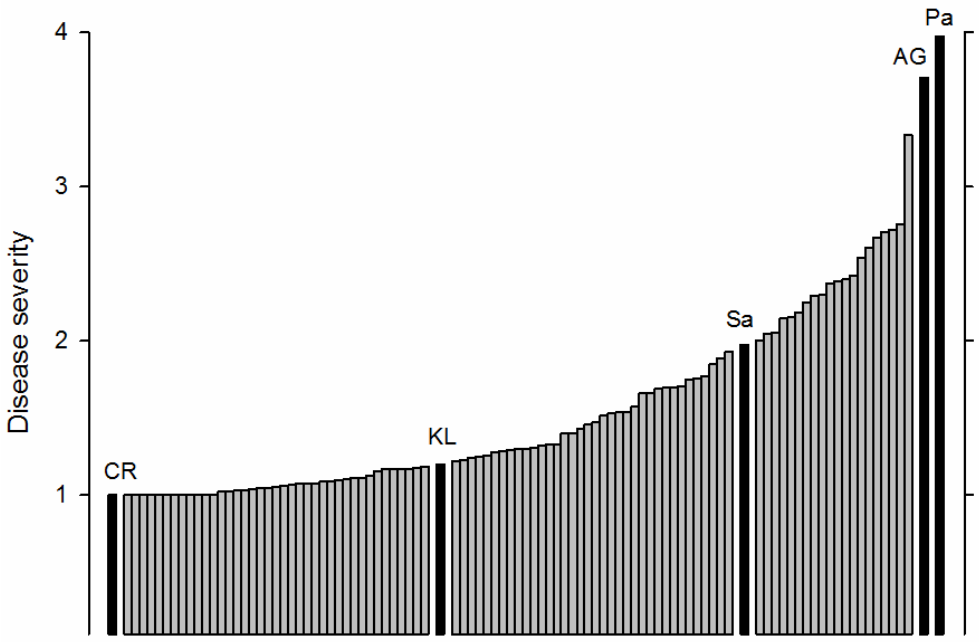

Figure. 1. Distribution of F_4 family means of Fusarium wilt symptom severity ratings and five reference cultivars: 'Costa Rica No. 4 (CR), King Louie (KL), Salinas (Sa), Autumn Gold (AG), and Patriot (Pa).

Powdery mildew (PM)

This airborne, fungal disease infects lettuce harvested in the end of the season in Yuma when air temperatures are favorable. PM infections prior to market maturity can result in stunted heads or loss of product quality. Infected outer leaves including cap leaves of iceberg types and can result in postharvest decay if they are not trimmed off at harvest, but PM is more likely to result in additional labor time to trim heads and lost product.

Differences in the reactions of wild lettuce accessions PI 490999 and PI 509525 to PM indicated the possibility of different pathogenic/physiological races of PM in Arizona and California. PI 509525 was susceptible in a greenhouse at Salinas, but both were observed to be resistant in a field test at Yuma in 2010. Presence of different races of PM complicates breeding for resistance to this disease. Field and laboratory tests were done to confirm the possibility of different PM races in Yuma and Salinas.

Field test. Lettuce PM race differentials (provided by Ales Lebeda, Palacky University, Czech Republic) and 26 cultivars were planted at the University of Arizona, Yuma Agriculture Center (YARC) in mid-November and evaluated for PM reaction in early to mid-March. Reactions to PM were visually assessed using a 0 to 4 scale, where 0 = no PM present on plant, 2 = PM on lower wrapper leaves or lower leaves only, 3 = PM on lower wrapper leaves, or lower leaves and on upper wrapper leaves, or middle leaves and on cap leaf or upper leaves, and 4 = extensive PM on the entire plant.

PI 490999 was completely free of observable PM in 2014 with a mean value of 0.0 (Table 2). PI 509525 was susceptible, with a mean disease rating of 0.8 that was significantly higher than the mean of PI 490999. These data indicate no difference between the PM populations at YARC and Salinas, i.e., they are the same pathological race.

Mean reactions of the seven PM race differentials ranged from 0.1 on line 09-H58-998 and 4.0 on LSE/57/15, which is the universal susceptible PM race differential. Reactions of the other 24 lettuce cultivars and accessions ranged from 0.0 to 4.0 (Table 2); their ranking is similar to that reported by Simko et al. (2014).

The most resistant entries were the two wild lettuce accessions PI 255665 (*Lactuca serriola*) and PI 490999 (*Lactuca saligna*), and the leaf lettuce cultivar Clarion (Table 2). The only lines completely free of PM were PI 255665 (*Lactuca serriola*) and PI 490999 (*Lactuca saligna*), but transfer of PM resistance from these weedy species of lettuce to iceberg lettuce will take a considerable amount of time. Though 'Clarion' had a low level of mildew, it would be good source of resistance for iceberg lettuce and is closely related to iceberg lettuce.

Laboratory assays. Nine PM isolates were collected in the Yuma region in March 2014 and transported to Salinas for axenic culture on the universal susceptible lettuce, *L. serriola* accession LSE/57/15, but two isolates did not survive (Table 3). This and all subsequent transfers transfers were done in a biosafety hood to prevent cross-contamination. Inoculated plants were maintained in a temperature controlled growth room, where each plant was kept in a separate, enclosed, transparent plastic enclosure. Isolates 1, 2, 6 and 9 were subsequently lost. Once established on the universal susceptible, the isolates were individually transferred to the other race differentials (Table 4). Isolates 5 and 7 have been maintained to date (November 2014), but isolate 8 may not survive much longer. These three isolates represent samples from Dome Valley, Gila and YARC. Results from their transfers to the differentials are incomplete (Table 4).

Race typing remains an on-going project. Initial tests were done using whole plants, but due to difficulty in handling whole plants in axenic culture, the leaf disc technique is currently in use. Leaf discs are excised using a 15 mm diameter stainless steel punch from PM-free plants and placed on moistened capillary mats in covered, square Petri-type dishes (9 cm x 9 cm x 1.5 cm deep; Figure 2).

With the exception of 'Argeles', all the differentials have been tested against the Salinas isolate either in the laboratory or in the greenhouse (Table 4). LVIR/50 09-H58-0958 is the only differential resistant to the Salinas isolate.

Field, greenhouse and laboratory data have not to date revealed any differences among the three Yuma area isolates and Salinas PM isolates. The laboratory assays on leaf discs will continue in order to obtain reactions on all lettuce PM race differentials. If necessary the YARC isolate will be re-sampled in spring 2015.

Literature Cited

Simko, I., G. Rauscher, R.G. Sideman, J.D. McCreight, and R.J. Hayes. 2014. Evaluation and QTL mapping of resistance to powdery mildew in lettuce. Plant Pathol. 63:344–353.

Figure 2. Typical lettuce leaf disc assay for powdery mildew reaction, 8 days post-inoculation.

Table 2. Mean reactions of lettuce PM race differentials and 26 lettuce cultivars and accessions to natural infection at YARC to PM, March 2014.

Group	Entry	n	Mean[z]
Race Differentials	LSE/57/15	4	4.0 a
	PI 273617	4	3.5 abcd
	Sabine	4	3.9 ab
	Colorado	4	1.5 ghi
	UCDM2	4	3.0 de
	Capitan	4	3.6 abcd
Cultivars and Accessions	09-H58-998	3	0.1 k
	UC96US23	4	4.0 a
	Glacier	4	4.0 a
	Green Lake	4	3.9 ab
	Tiber	8	3.9 a
	Salinas	4	3.8 abc
	Salinas 88	4	3.8 abc
	Wolverine	4	3.8 abc
	PI 281877	4	3.8 abc
	Vanguard 75	4	3.7 abc
	Yuma	4	3.6 abcd
	PI 273596	4	3.3 bcd
	Margarita	4	3.2 cde
	Winterhaven	4	3.0 de
	Clemente	4	3.0 de
	Merlot	4	2.6 ef
	PI 274359	4	2.1 fg
	Imperial 50	4	2.0 fg
	Darkland EL	4	1.7 gh
	Salad Bowl	4	1.5 ghi
	Parris Island Cos	4	1.5 ghij
	Iceberg	4	1.3 hij
	PI 509525	4	0.9 ij
	Two Star	4	0.8 j
	Clarion	4	0.1 k
	PI 490999	4	0.0 k
	PI 255665	4	0.0 k

[z]Means followed by different letters are significantly different, $P_{0.05}$.

Table 3. Lettuce powdery mildew isolates collected in the Yuma region, March 2014, success of their initial transfer (March) and current status (November), where "+" indicates growth of the pathogen, and "-" indicates no pathogen growth.

Location	Isolate no.	Initial transfer	Current status
Dome Valley	1	+	-
Dome Valley	2	+	-
Wellton	3	-	-
Wellton	4	-	-
Dome Valley	5	+	+
Dome Valley	6	+	+
Gila	7	+	+
Yuma Ag. Center	8	+	+?
Yuma Ag. Center	9	+	-

Table 4. Summary of lettuce–PM reactions on a set of 13 PM race differentials and four additional lettuce lines, where "+" indicates compatible reaction manifested by growth of the pathogen, and "-" indicates incompatible reaction, i.e., no pathogen growth.

		Powdery mildew isolate			
Entry	Species	5 (Dome)	7 (Gila)	8 (YARC)[z]	Salinas[y]
Differential 2011					
LSE/57/15	*serriola*	+	+	+	+
PI 273617	*serriola*	+	+	+	+
Sabine	*sativa*	+	+	+	+
Colorado	*sativa*	+	+	+	+
UCDM2	*sativa*	+	+	+	+
Capitan	*sativa*		+	+	+
09-H58-1013[x]	*saligna*		+		+
LVIR/50 09-H58-0958[x]	*virosa*				-
09-H58-0998	*virosa*		+	+	+
Supplemental differentials					
Argeles	*sativa*	+	+		
Cobham Green[x]	*sativa*		+		+
09-H58-1010[x]	*saligna*				+
Hilde x L. serriola[x]			+		+
Additional lines					
Winterhaven	*sativa*	+	+	+	+
PI 491093	*serriola*	+	+	+	+
Salinas	*sativa*	+	+	+	+
Autumn Gold	*sativa*		+	+	+

[z]Combined field and axenic culture (isolate 8) data.
[y]Combined greenhouse and axenic culture data.
[x]Not included in the YARC field test.