IMPROVING DISTRIBUTION UNIFORMITY OF SPRINKLERS UNDER WINDY CONDITIONS

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Wind often limits the uniformity of sprinklers in the Salinas Valley. Low uniformity wastes water and contributes to agricultural run-off and the leaching of nutrients. Though operating sprinklers at low wind speeds is the best solution, this option is not always feasible due to time conflicts with other field operations and because wind is unpredictable. Currently, most growers use impact sprinkler heads for solid-set and hand-move systems. Nelson Irrigation Corp. recently introduced a plastic, rotating sprinkler head, designed to improve uniformity under windy conditions. The Nelson R2000 Windfighter™ was developed to reduce splash-down near the riser and reach further than impact sprinkler heads during windy conditions. To test this claim, we conducted four on-farm trials to compare the distribution uniformity between the Nelson Windfighter and the Rainbird 20J sprinkler heads under low and high wind conditions.

Field Trial Design

Field trials were conducted in 4 commercial vegetable fields located near Chualar, Gonzalez, King City, and Soledad during September and October, 2002 (Table 1). New Rainbird J20 and Nelson R2000 Windfighter heads were compared in adjacent plots, replicated at 4 locations within each field site (Fig. 1). Sprinklers at all sites were operated as solid-set systems. Spacing between lateral lines and sprinkler heads varied depending on the growers' system (Table 1). Nozzle sizes were selected to match the grower's system, and ranged from 7/64 to 9/64 inch diameter openings. Sprinkler heads were installed in a 4 x 4 grid within each plot. Distribution uniformity (DU) was assessed in the center of each plot using 30 to 36, 8-inch diameter catch-cans arranged in a rectangular grid (Fig. 1). Volumes collected in catch-cans were measured after 2 or more hours of irrigation under low and high wind conditions. Distribution uniformity was expressed as the average of the lowest 25% (lowest quarter) of volumes collected divided by the average of all volumes collected from the grid of catch-cans:

$$DU_{lq} = \frac{average\ of\ lowest\ 25\%\ of\ catchcan\ volumes}{average\ of\ all\ catchcan\ volumes}$$

Average wind speed was recorded at 15-minute intervals using an anemometer and datalogger. Pressure of laterals lines was recorded in the plots closest and furthest from the pump. Distribution uniformity data was compared between sprinkler heads using analysis of variance (ANOVA) statistical procedures.

Results

Effect of wind speed on sprinkler distribution uniformity. Across all 4 locations, the average DU of the trials conducted at low wind speed (6.6 mph) was 0.72. The DU declined to 0.55 for tests conducted at high wind speeds (12.5 mph). An example of the change in the distribution uniformity for the third trial site under low and high wind conditions is presented in Figure 2. Note that the application rate in the center of the plots can be as little as half the rate measured near the lateral lines at the high wind speed. This large difference in application rate can contribute to non-uniform stands, run-off and excessive leaching.

Rotator vs. impact sprinkler heads. The Nelson head significantly improved distribution uniformity at low and high wind speeds at all trial sites (Table 2). DU improved as much as 20% under windy conditions (12-15 mph) using the Nelson head at the King City and Soledad trials (Sites 1 and 3). Figure 3 shows that the Nelson heads maintained a more even application than the Rainbird heads during windy conditions at site 3. Across all trials, average application rates were not statistically different between the 2 types of sprinkler heads (Table 2.)

In contrast to trials 1 and 3, the Nelson heads improved distribution uniformity only 8% or less at trials 2 and 4 (Table 2). The inconsistency of our results may be due to differences in the system designs among sites. We observed that the large distance between lateral lines and small nozzle size at the Gonzalez site limited the overlap pattern to less than 60% and may have had more effect on uniformity than the type of sprinkler head. In comparison, we noted that the overlap pattern at the Chualar site was greater than 100%, probably due to the high pressure and large nozzle size used, which could have had more effect on uniformity than the Nelson heads.

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Conclusions. The results of 4 replicated field trials demonstrated that the Nelson sprinkler head can improve distribution uniformity under low and high wind conditions. Perhaps the most important take home message from this study was that the choice of sprinkler heads is only one component that contributes to the uniformity of a sprinkler system. Nozzle size, pressure, and lateral and sprinkler head spacing, also have a major effect on distribution uniformity. Our results would suggest that sprinkler systems operated with an 80 to 100% overlap pattern might significantly benefit from the improved uniformity of the Nelson head.

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Table 1. Summary of sprinkler systems used in the distribution uniformity tests.

Trial	TestDate	Location	Nozzle Size (in)	Head Pressure (psi)	Tail Pressure (psi)	Bed Width (in.)	Lateral line Spacing (ft.)	Sprinkler Head Spacing (ft.)	Head Pattern	Avg. Riser Height (in)
1	9/19/02	Soledad	1/8	58	--	40	36.7	30.0	alternate	15
2	9/24/02	Gonzalez	1/8	55	50	80	48.0	35.0	alternate	16
3	10/10/02	King City	7/64	58	52	80	33.3	30.0	alternate	12
4	10/18/02	Chualar	9/64	57	54	80	43.3	30.0	rectangle	12

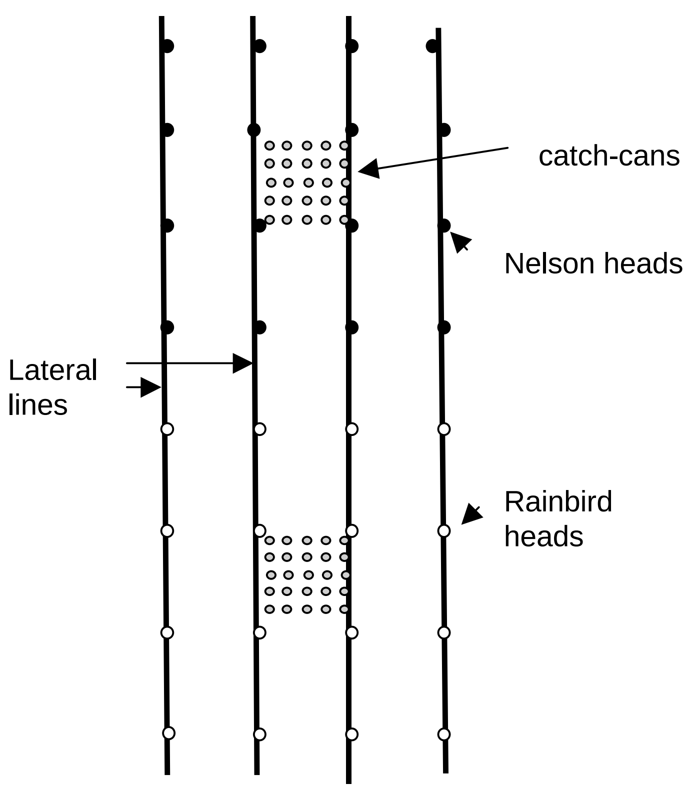

Figure 1. Field trial design for side-by-side comparison of Rainbird and Nelson sprinkler heads.

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Table 2. Distribution uniformity of Nelson and Rainbird sprinklers heads tested under low and high wind conditions at 4 locations in the Salinas Valley.

Site	Sprinkler Type	N[1]	Wind Speed (mph)	Distribution Uniformity (lowest quarter)	Application Rate (in/hr)	% Increase in DU
			low wind test			
1	Nelson	4	9.5	0.69 A[2]	0.24 A	10
1	rainbird	4	9.7	0.63 A	0.26 A	--
			high wind test			
1	Nelson	4	14.9	0.59 A	0.24 A	21
1	rainbird	4	14.9	0.49 B	0.26 A	--
			overall			
1	Nelson	8	12.2	0.66 A	0.25 A	22
1	rainbird	8	12.3	0.54 B	0.25 A	--
			low wind test			
2	Nelson	4	9.1	0.53 A	0.16 A	10
2	rainbird	4	9.2	0.48 B	0.15 A	--
			high wind test			
2	Nelson	4	13.2	0.42 A	0.17 A	7
2	rainbird	4	13.2	0.39 A	0.16 A	--
			overall			
2	Nelson	8	11.1	0.47 A	0.17 A	8
2	rainbird	8	11.2	0.44 B	0.16 A	--
			low wind test			
3	Nelson	4	4.1	0.90 A	0.22 A	3
3	rainbird	4	4.1	0.88 B	0.23 A	--
			high wind test			
3	Nelson	4	10.1	0.69 A	0.21 A	22
3	rainbird	4	10.3	0.57 B	0.22 A	--
			overall			
3	Nelson	8	7.1	0.80 A	0.21 A	10
3	rainbird	8	7.2	0.72 B	0.22 A	--
			low wind test			
4	Nelson	3	3.5	0.86 A	0.30 A	5
4	rainbird	4	3.5	0.82 A	0.31 A	--
			high wind test			
4	Nelson	4	11.6	0.66 A	0.28 A	7
4	rainbird	4	11.6	0.62 A	0.30 A	--
			overall			
4	Nelson	7	7.6	0.74 A	0.29 A	4
4	rainbird	8	7.6	0.72 B	0.30 A	--

1. Number of replications.
2. Means followed by different letters are statistically different ($P < 0.05$ level).

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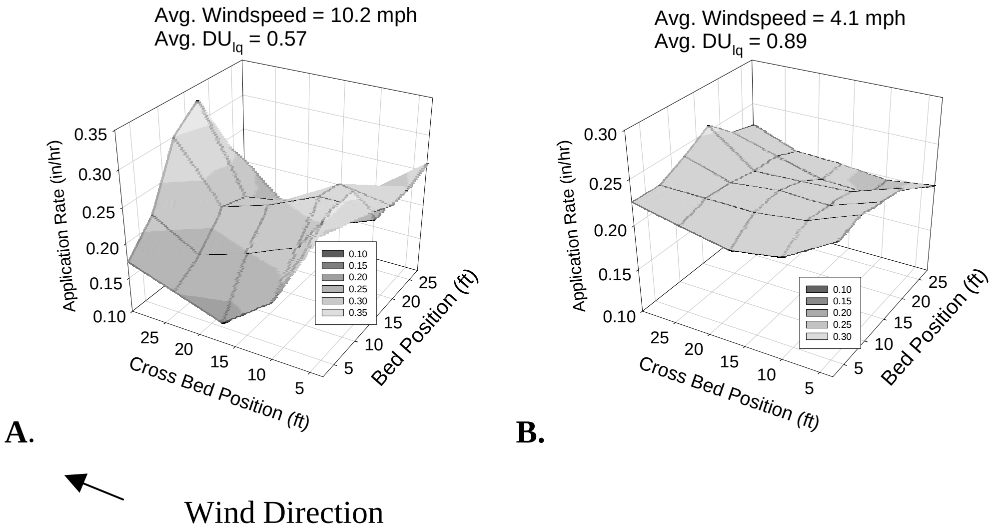

Figure 2. Sprinkler distribution uniformity under high (A) and low (B) wind conditions at site 3. Graphs represent the average of 8 replications.

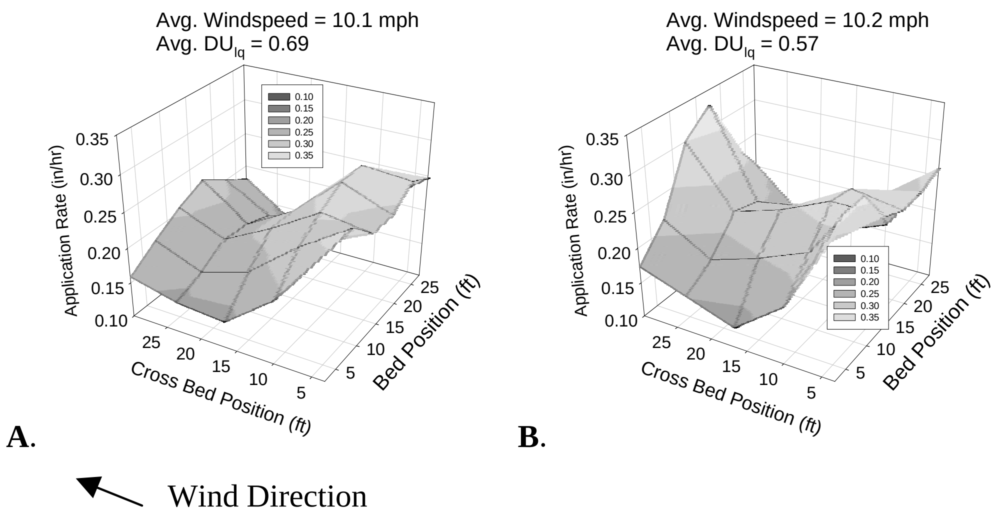

Figure 3. Distribution uniformity of Nelson Windfighter (A) and Rainbird 20J (B) sprinkler heads under high wind conditions at site 3. Graphs represent the average of 4 replications.