Yield and Microbial Quality of Head Lettuce as Affected by Field Moisture at Harvest

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Abstract

The effect of moisture conditions on microbial quality (as total aerobic bacteria) and yield of head lettuce was investigated. Head lettuce cv. Honcho II grown at the Yuma Agricultural Center was evaluated for microbial population at harvest and postharvest quality either following different irrigation termination schedules or after a rainfall event. The last irrigation was scheduled 24, 16 and 6 days prior to harvest resulting in soil’s water content of 15.9%, 17.0% and 17.2%, respectively, at harvest. Lettuce receiving the last irrigation 6 days before harvest had 10% more weight, higher total aerobic bacteria and shorter shelf life than plants irrigated 24 days before harvest. The plants with the last irrigation scheduled 16 days before harvest showed similar weight at harvest, lower total aerobic count and longer shelf life than plants with irrigation termination scheduled 6 days prior to harvest. The effect of field’s moisture prior to harvest on quality was further evaluated with lettuce harvested 1 and 7 days after a rainfall event. A day after rain the microbial population in both outer leaves and head leaves increased. The microbial population in head leaves continued increasing during the week after rain. The results from this study suggest that managing moisture conditions at harvest is important to enhance quality of lettuce. Although the potential decrease in weight produced with an early irrigation termination is a great concern of growers, it was shown in this study that excessively late pre-harvest irrigation of lettuce is not necessary to obtain maximum weight at harvest.

Introduction

Understanding the dynamic of the microbial population of lettuce is extremely important for growers to deliver safe food to consumers. Water used for irrigation in Yuma County for example, is not treated and is likely that it contains high amounts of microbial counts. Although not all microbes are harmful, excessive levels of them can become damaging. Assurance of non-contaminated head lettuce is crucial for the growth of the industry. Cases of illness outbreaks associated with consumption of fresh commodities have resulted in catastrophic damages to the industry.

It is thought that the longer the term between last irrigation and harvest the lower the microbial population in the harvested product. However, early irrigation termination potentially causes weight loss and affects grower profits. Moreover, the impact of rainfall on microbial quality of lettuce has not been reported in our area.

The objectives of this study were: a) to evaluate different schedules of last irrigation on microbial population of fresh head lettuce; b) to determine the effect of timing of irrigation termination on yield and visual quality of fresh head lettuce; c) to determine the impact of rainfall a few days before harvest on microbial quality of head lettuce.

Material and Methods

Lettuce plants were grown at the Yuma Agricultural Center conducting agronomical practices as currently applied in commercial settings. For the irrigation termination trial the treatments were: 1) Last irrigation scheduled 24 days...
prior to harvest; 2) Last irrigation scheduled 16 days prior to harvest; 3) Last irrigation scheduled 6 days prior to harvest. Harvest was conducted on the same day for all treatments.

Microbial analysis was performed on the day of harvest. For the irrigation termination evaluation six heads per replicate were taken. Samples (7g) of head leaves were diluted in 70mL of water according to the film manufacturer’s recommendation, and submitted to gentle agitation for 90 seconds using a stomacher.

Aliquots were taken from the solution and diluted to $10^{-1}$ to $10^{-7}$. Aliquots of the diluted solutions were placed onto 3M-Petrifilm™ and incubated at 32°C for 48 hours. The inoculation of the samples was conducted in duplicate. For the irrigation termination, trial samples were sent to analysis to Bio Research Laboratories, Inc. (Redmond, WA 98052). The bacterial analysis for the rainfall study was conducted at the Vegetable Quality Lab of the Yuma Agricultural Center.

The lettuce were stored at 34-38°F. Quality was evaluated on days 0, 5 and 10. Visual quality was conducted using a 9-point hedonic scale where 9 was the best quality and 6 is the minimum level for consumer acceptability. Maximum shelf life of the product was considered when 50% of the lettuce had a visual quality below 6, using the same scale described before for visual quality. Color (L*, a*, b*) was measured using a Minolta™ chromameter. Water loss during postharvest storage was monitored by measuring weight changes. We report here only quality results after 5 days of storage.

The irrigation termination experiment was arranged in a completely randomized design and each treatment consisted of 3 replicates. Sampling of lettuce before and after rainfall was conducted at random in ½ acre field, using 5 plants per each of four replicates. Data were subjected to analysis of variance (ANOVA) at $p \leq 0.05$ to determine statistical significance. Mean comparisons were conducted using Fisher’s Protected LSD Method at $p \leq 0.05$.

**Results and Discussion**

Lettuce subjected to the latest irrigation termination showed higher microbial population than that of lettuce harvested 16 days prior to harvest (Figure 1). Irrigation termination 16 days prior to harvest produced the same yield than that with termination irrigation set 6 days prior to harvest. The lettuce subjected to irrigation termination 24 days before harvest showed a reduction of approximately 10% in weight in comparison with lettuce that had irrigation termination 6 and 16 days prior to harvest (Figure 2).
Figure 1. Effect of time of last irrigation of the microbial population of head lettuce. A rainfall event occurred 19 days before harvest. Mean separation using LSD test ($P=0.05$). Bars indicate SE.

Figure 2. Effect of time of last irrigation on weight of whole lettuce. Rainfall occurred 19 days prior to harvest. Mean separation using LSD test ($P=0.05$) Bars indicate SE.
The reduction of weight with the earliest irrigation termination was expected. However, it was interesting that no difference in weight was observed between the two late irrigation termination treatments. It is possible that low temperatures during the last two weeks prior to harvest influenced these results. The water uptake rate of lettuce slows down by harvest time, which could partially explain the results. It was also evident that the higher the water content of the lettuce at harvest the more prone external heads leaves are to turn brown. After five days of storage the lettuce subjected to the earliest irrigation termination showed a better overall visual quality than that of lettuce that had last irrigation 6 days before harvest. Similar results, showing the earliest irrigation termination as the treatment with the highest quality and longer shelf life, was observed with factors such as water loss and color (data not shown).

![Figure 3](image.png)

*Figure 3. Effect of the time of last irrigation on the quality of head lettuce after 5 days of storage at 34-38 °F. Mean separation using LSD test (P=0.05). Bars indicate SE.*

The effect of rainfall on microbial population was also evaluated. The results showed that microbial population in lettuce heads increased after a rain in both outer leaves of the plant and head leaves. The increase however, was more dramatic in head leaves, showing a 7 times increase a week after rainfall. The outer leaves showed a decline after 7 days, but increased again when irrigation was applied to the field. The head leaves also declined and increased back again one week after irrigation (Figure 4). These results showed that rainfall has a stronger impact on microbial population of head leaves that on that of older leaves. It is possible that moisture from rain creates an ideal microclimate that allows surviving microorganisms to proliferate. In outer leaves, a decline is rapidly observed probably because these leaves are quickly dried out and are more exposed to UV light, two factors that diminish microbial population.
Figure 4. Microbial population found in heads and outer leaves of Head Lettuce harvested during March, 2003, after rainfall and the last irrigation event. The interaction between time and leaves location was significant according to LSD test ($P=0.05$). Bars indicate SE.

The results from this study showed that regulation of moisture at harvest through appropriate scheduling of last irrigation could be a practical way to reduce microbial population of head lettuce, while yet keeping the same yield. Moreover, rain prior to harvest increased microbial population, suggesting that a disinfectant treatment may be needed when harvest is conducted immediately after a rainfall event.

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