AZILRC Grant Program – Final Report
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Reducing Nitrogen Use in Lettuce

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Objectives

1. Determine whether uptake of fertilizer in lettuce is improved through use of a point injection system type applicator as compared to a knife blade applicator.

2. Determine how crop yield is affected through use of a point injection system type applicator as compared to a knife blade applicator.

3. Determine if applied nitrogen rates can be reduced through use of a point injection system type applicator.

Methods

A two bed, two rank frame equipped with knife blade and point injection type fertilizer applicators was fabricated for conducting experiments (Fig. 1). The point injection systems were oriented so that their wheels operated on the sides of the bed walls. In this configuration, the unit's injected fertilizer to the side a below the plants. Each applicator was calibrated to apply 30 gallons/A of liquid. Trials were conducted in the fall of 2011, fall of 2012 and spring of 2013 on furrow irrigated iceberg lettuce at the Yuma Agricultural Center. Experimental design was a randomized complete block design with 2 factors (applicator type and nitrogen rate) and 4 replications. Nitrogen was applied in a split application at a standard rate of 200 lbs/A (control) and nitrogen deficient rates of 150 (75% of standard), 100 (50% of standard), 50 (25% of standard) and 0 lbs/A (check) in the form of UAN32. Experimental unit plot size was 50 feet long by 4 beds wide. Fertilizer uptake in lettuce plants was assessed by measuring leaf midrib nitrate levels (NO_3-N) at four times during the growing period – prior to the first sidedress (~ eight leaf stage of growth), two weeks after the first sidedress, two weeks after the second sidedress and at maturity. Whole plant samples were also taken at maturity and analyzed for total nitrogen content. Crop yield was determined by harvesting, trimming and weighing individual heads from 10 ft of row from the middle two beds of each 4 bed plot. A marketable head was considered to be a head that weighed 1.5 lbs or more. Data collected from the three experiments were combined for analysis.

Results

Prior to the first side dress, midrib nitrate N levels were roughly 3,000 ppm and uniform across all treatments (data not shown). Fertilizer applicator type was found to have a significant effect on midrib nitrate levels (Fig. 2). At the 25% rate of applied N, use of the point injection system resulted in midrib nitrate levels that were significantly higher after the first sidedress (29%), after

the second sidedress (23%) and at maturity (29%) as compared to the knife blade applicator. At the 50% rate of applied N, use of the point injection system resulted in midrate nitrate levels that were 23% higher after the first sidedress. The results also show that when the point injection system was used to apply 25% or more of the standard rate of N, midrib nitrate levels at all sample dates were equivalent to or higher than those found when the knife blade applicator was used to apply 50, 75 or 100% of the standard rate of N. Differences between fertilizer applicator types were not found when applied N rate exceeded 75% of the standard rate. Very similar results were found for total plant N at maturity (Fig. 3). At the 25 and 50% rates of applied N, total N in above ground plant material for the point injection system were 41 and 20% higher respectively as compared to the knife blade applicator. Also, when the point injection was used to apply 25% or more of the standard rate of N, total plant N values were equivalent to or higher than those at any rate with the knife blade applicator.

Fertilizer applicator type also had a significant effect on yield parameters. At the 25 and 50% rate of applied N, use of the point injection system resulted in significantly higher head weight (>8%), total yield (>10%) and marketable yield (>19%) as compared to the knife blade applicator. The data also show that when the point injection system was used to apply 50% of the standard rate of N, yield parameters were equivalent to, or higher than when 75% or the full rate of N was applied with either applicator type. At applied N rates exceeding 75%, there were no differences between applicator types.

Interpretation of these results indicates that only 75% of the standard rate of N was required to raise the crops, due presumably to excessive residual N in the soil and/or small, low weight heads. It is appropriate then that results at the 75% and lower rates of applied N be used to compare differences in fertilizer applicator type. If one compares the point injection system at the 50% rate with the knife blade system at the 75% rate, the point injection system had midrib nitrate levels, total plant N and crop yield parameters that were equivalent to or higher than the knife blade applicator. Consequently, these results suggests that fertilizer application rates can be reduced by at least 25% (50 lb/A) without negatively affecting fertilizer uptake levels or crop yield.

Conclusions

Results of the study suggest fertilizer placement has significant effect on nutrient uptake and crop yield in lettuce production. At deficient levels of applied nitrogen, nutrient uptake was improved when fertilizer was placed in the root zone using the point injection system as compared to at its edge with the knife blade applicator. Improved nutrient uptake translated into higher head weights, total yield and marketable yield. The study also showed that applied nitrogen rates may be able to be reduced by at least 50 lbs/A through use of fertilizer applicators that place fertilizer in the root zone without negatively affecting crop yield. Trials at the field scale level are needed to confirm this result.

Outreach

This knowledge gained from this research has been disseminated by giving a field day demonstration at the 2012 Southwest Ag Summit and by making oral presentations at the 2012 Southwest Ag Summit and at the 2013 Pre-Season Vegetable Workshop.

Fig. 1. Knife blade (left column) and point injection (right column) fertilizer applicators.

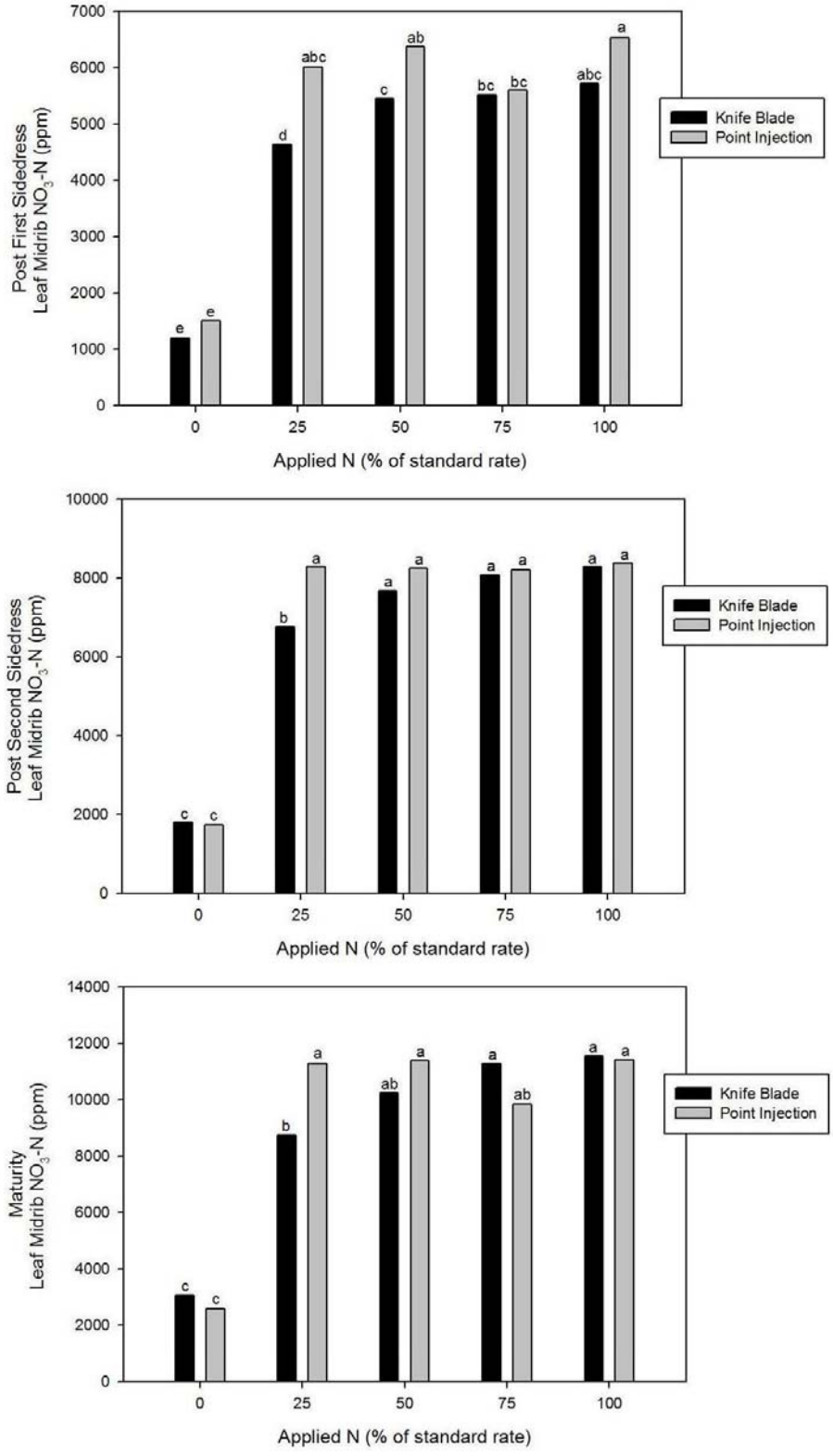

Fig. 2. Effect of fertilizer applicator type at various application rates of N on lettuce midrib nitrate-N content. Standard rate of applied N was 200 lb/A (split application).

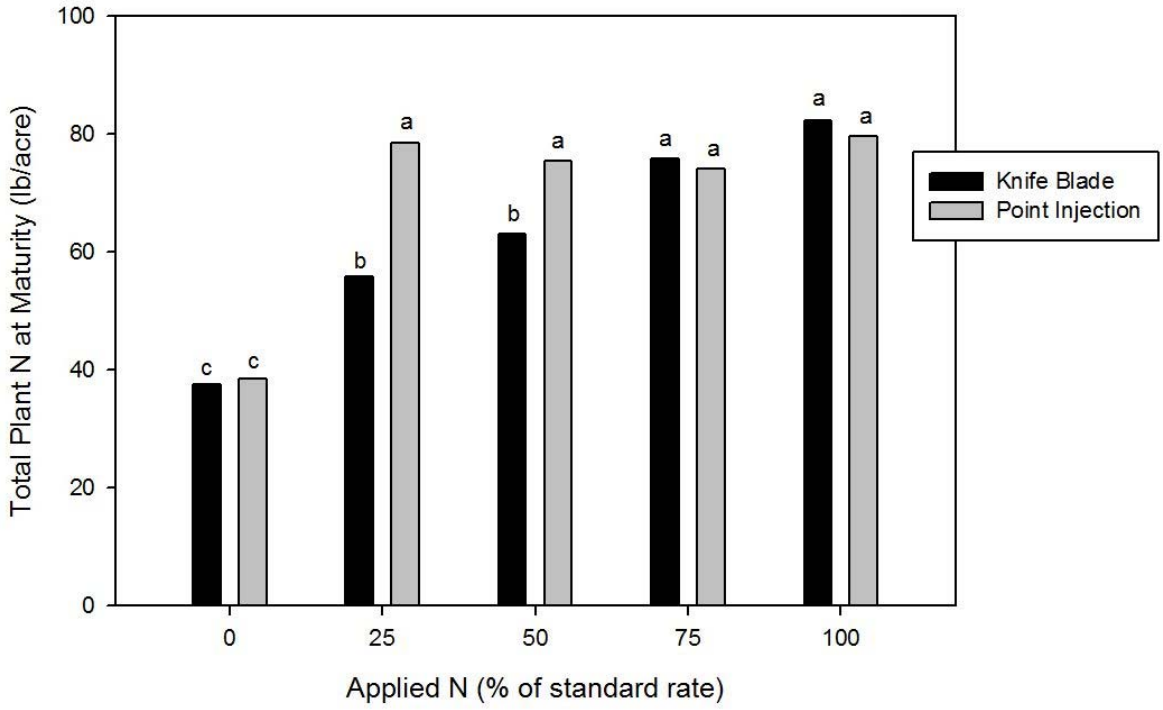

Fig. 3. Effect of fertilizer applicator type at various application rates of N on total lettuce plant N at maturity. Standard rate of applied N was 200 lb/A (split application).

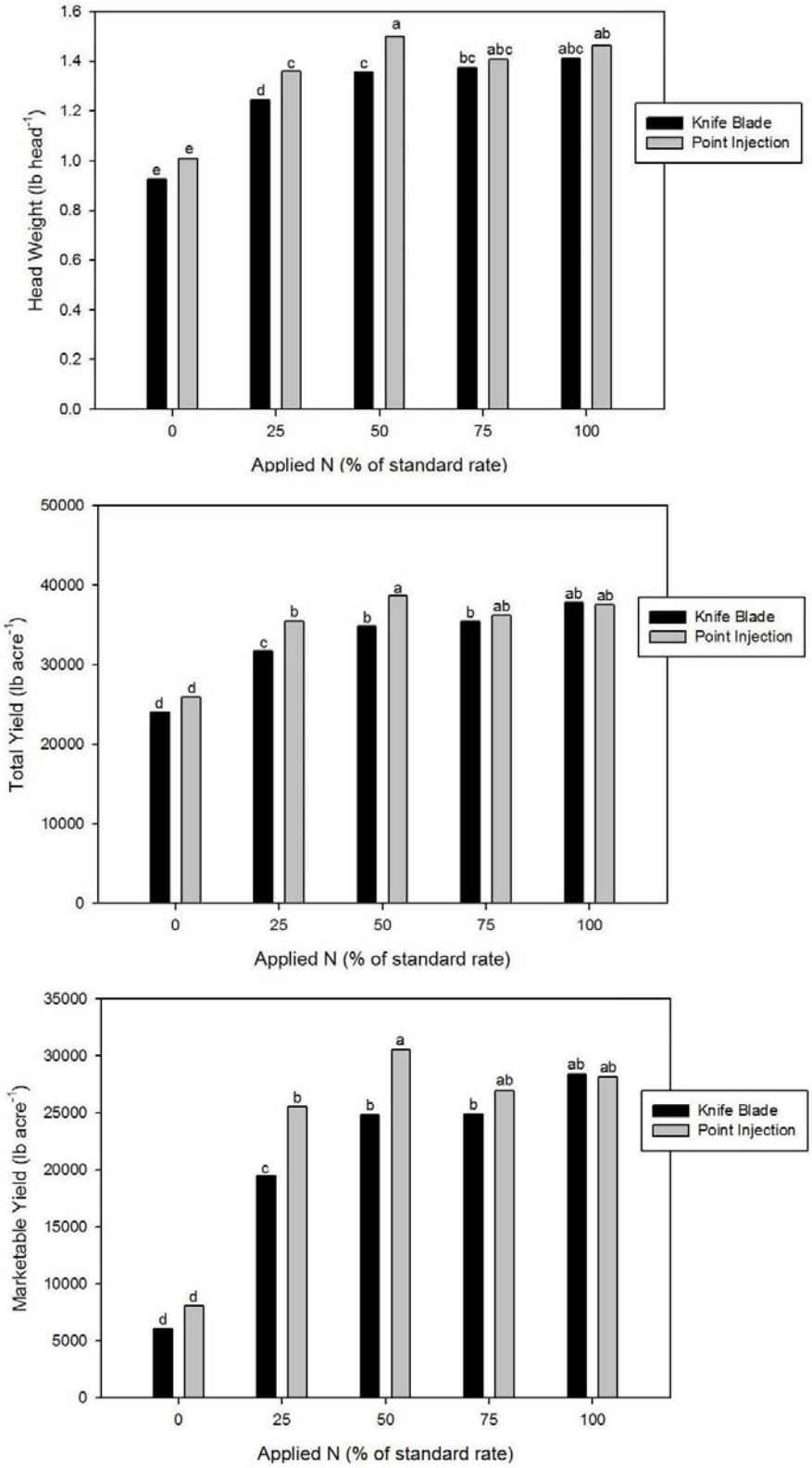

Fig. 4. Effect of fertilizer applicator type at various application rates of N on lettuce yield. Standard rate of applied N was 200 lb/A (split application).