Yield Response of Three Waxy Corn Varieties to Various Nitrogen Rates

Suchada Boonlertnirun, Raweeewun Suvarnasara and Kitti Boonlertnirun*

ABSTRACT

Nitrogen fertilizer is generally considered as a yield-limiting factor in corn production. This study was conducted at the Rajamangala University of Technology Suvarnabhumi, during May to July 2008. The objective was to investigate suitable N fertilizer rates in growing waxy corn. A split-plot design was used, with three waxy corn varieties (main plot), namely Neaw Sawan (NSW), Big White 852 (BW852) and Thein Ban Khao (TBK), and five nitrogen rates (sub plot) of 0, 75, 150, 225 and 300 kg ha⁻¹. The results showed that NSW gave the highest yield, yield components and the maximum leaf area. The maximum leaf greenness value and dry weight were observed in BW852. TBK rarely responded to various nitrogen rates. The application of nitrogen at rates of 150 kg ha⁻¹ up to 250 kg ha⁻¹ significantly increased the leaf greenness of all varieties and increased the dry weight and leaf area of BW852 and TBK, whereas NSW showed the highest dry weight and leaf area when nitrogen was applied at the rate of 75 kg ha⁻¹. The plant height of all varieties was not affected by variation in the nitrogen rate. The yield of all varieties tended to increase after applying nitrogen at 150 kg ha⁻¹ up to 250 kg ha⁻¹; however the optimum nitrogen rate to increase the yield of BW852 and NSW was 150 and 225 kg ha⁻¹, respectively, whereas there was no effect on the yield of TBK.

Keywords: leaf greenness, nitrogen fertilizer, waxy corn

INTRODUCTION

Waxy corn is popularly grown as a cash crop in irrigated areas because it is usually consumed as green corn due to the short harvesting time, and can be grown throughout the year. The increase in the world’s population has contributed to market demand for waxy corn. Nitrogen fertilizer is generally considered as a yield-limiting factor in corn production. Corn takes up nitrogen at a higher rate than do the other crops (35 kg ha⁻¹ throughout the cropping season). Depending on the growth stage, nitrogen absorption from the soil increases with the actual rates depending upon the soil type and previous cropping history (Weir et al., 1996). The maximum absorption per day is 4.43 kg ha⁻¹ at the silking stage (30-45 days after emergence) (Piekielek and Fox, 1992). Nitrogen application in excess of crop requirements contributes to increased levels of NO₃⁻ in the soil profile, and a high concentration of postharvest soil NO₃⁻ increases the risk of leaching into ground water (Roth and Fox, 1990; Schepers et al., 1991). Reducing N application rates to 5% less than that...
of the required rate to achieve maximum corn yield reduces NO₃⁻ leaching by 40 to 45% (Sexton et al., 1996). Applying an economically optimal N rate minimizes NO₃⁻ accumulation in the soil resulting in lowering the potential of NO₃⁻ leaching into ground water (Schlegel and Havlin, 1995). The negative environmental impacts associating with corn production can be minimized through efficient N management and accurate N fertilizer recommendation (Fox et al., 1989). Oberle and Keeney (1990b) suggested that site-specific factors, such as soil organic mater (OM), crop rooting depth and drainage characteristics, should be considered to avoid applying N in excess of crop requirements. The objective of this study was to investigate suitable N fertilizer rates for growing waxy corn.

MATERIALS AND METHODS

The study was conducted in the Ayuttaya soil series using a split-plot design with four replications. The soil chemical properties were: pH = 6.98, %OM = 2.61 (high), available P = 49.04 mg/kg (very high) and exchangeable K = 271.69 mg/kg (very high). The main plot contained three waxy corn varieties, namely Neaw Sawan (NSW), Big White 852 (BW852) and Tien Ban Khoa (TBK) and the sub plots had five nitrogen rates: 0, 75, 150, 225 and 300 kg N ha⁻¹. Seeds of each waxy corn variety were planted in plots with a size of 3 × 4 m, comprising four rows, with plant spacing of 75 × 25 cm. At 14 days after emergence, only one healthy seedling per hole was selected to record growth and yield data. All recommended cultural practices, such as irrigation, weed control and plant protection, were uniformly undertaken, according to standard crop management. Nitrogen fertilizer was applied at 10, 20 and 30 d after emergence. Basal application was at the same rate for all treatments, except for the control. The details of each nitrogen fertilizer application are shown in Table 1. Leaf greenness was measured on one side of the midrib, midway between the leaf base and tip of two upper corn leaves at the V5, V7 and R1 growth stages using a chlorophyll meter (SPAD 502). Plant height and leaf area were recorded during the study, whereas plant dry weight, yield and yield components were recorded at harvesting time. All recorded data were subjected to analysis of variance (ANOVA) and the least significant difference (LSD) was used to compare treatment means.

RESULTS AND DISCUSSION

Leaf greenness

Leaf greenness was significantly related to growth stages and varieties. BW852 leaves showed remarkably more greenness than those of NSW at all recorded growth stages (V5, V7 and R1), whereas the leaf greenness value of TBK was the lowest. The growth stage of waxy corn slightly affected leaf greenness, with its values increasing

<table>
<thead>
<tr>
<th>Nitrogen rate (kg ha⁻¹)</th>
<th>Basal application (g plot⁻¹)</th>
<th>1ˢᵗ Top dressing (g plot⁻¹)</th>
<th>2ⁿᵈ Top dressing (g plot⁻¹)</th>
<th>3ⁿᵈ Top dressing (g plot⁻¹)</th>
<th>Total nitrogen (g plot⁻¹)</th>
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<tbody>
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<td>784</td>
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DAE = days after emergence.
as the corn plants grew. The leaf greenness value at the R1 growth stage was higher than at the V7 and V5 growth stages. This finding was supported by the work of Piekielek and Fox (1992), who found that leaf greenness values depended on genotype, growth stage, leaf position and environmental stress. The variations in the SPAD readings were highest in the early stages of plant growth (Argenta et al., 2004). Various nitrogen fertilizer rates had an impact on leaf greenness at all growth stages. The application of nitrogen at 150 kg ha\(^{-1}\) contributed to darker green corn leaves, while the leaf greenness value observed in the control (0 kg N ha\(^{-1}\)) was the lowest (Figure 1).

### Growth

#### Plant height

The plant height of the three waxy corn varieties was not influenced significantly by the nitrogen rate. This result was supported by the study of Boonlertnirun et al. (2008), which revealed that various nitrogen rates and the timing

Figure 1  Effect of various nitrogen rates on leaf greenness at (a) V5, (b) V7 and (c) R1 growth stages of three waxy corn varieties.
of application did not affect the plant height of waxy corn compared with BW852. On the other hand, different varieties of waxy corn strongly affected plant height. Different barley varieties treated with various nitrogen fertilizer rates (90, 180 and 270 kg N ha\(^{-1}\)) showed highly significant differences in plant height (Al-Otaiby, 2003). NSW produced the maximum height of 191.180 cm, whereas the plant height of BW852 was 160.94 cm. The shortest plants were TBK, being only 105.16 cm (Figure 2a).

**Plant dry weight**

Application of different nitrogen rates had an effect on the plant dry weight of all waxy corn varieties. Application at the rates of 75 to 225 kg ha\(^{-1}\) tended to increase plant dry weight in NSW and BW852, but produced a poor response in TBK.

![Figure 2](image_url) Effect of various nitrogen rates on plant height(PH), plant dry weight(DW) and leaf area (LA) of three waxy corn varieties.
The response to nitrogen was quite varied among varieties. The dry weight of NSW showed the best response at a rate of 75 kg N. ha\(^{-1}\), but BW852 and TBK responded well to N applied at the rate of 225 and 150 kg N. ha\(^{-1}\), respectively. Considering interaction effects, BW852 treated with nitrogen at rates of 150 to 225 kg ha\(^{-1}\) gave the maximum plant dry weight. High nitrogen levels increased the vegetative growth of plants, thus increasing the photosynthetic capacity and resulting in higher dry matter accumulation (Allen and Morgan, 1972; Gulser, 2005). Straw dry matter of wheat at different growth stages was reported to increase significantly with increasing levels of N application (Balasubramanian and Singh, 1982).

**Leaf area**

Different nitrogen rates had marked effects on leaf area. The application of nitrogen fertilizer at rates of 75 to 150 kg ha\(^{-1}\) tended to produce the largest leaf area; however the rate varied among varieties. Similar results have been reported, where the main effect of N fertilizer was to increase the rate of leaf expansion, leading to increased interception of daily solar radiation by the canopy (Squire et al., 1987). The application of 60 kg N ha\(^{-1}\) at planting, followed by 120 kg N ha\(^{-1}\) at 6 wk after sowing (WAS) was associated with high leaf area index (Esechie et al., 1995). The maximum leaf areas were obtained from the NSW variety, with a value of 4,253 cm\(^2\) plant\(^{-1}\) while BW852 and TBK had values of 3,822 and 1,640 cm\(^2\) plant\(^{-1}\), respectively (Figure 2c).

**Yield**

Total yield was significantly affected by nitrogen rate and plant variety. The responses to different nitrogen rates among varieties were varied. BW852 and TBK tended to have the same response, but differed from NSW. NSW responded to nitrogen fertilizer to a greater extent than BW852 and TBK. The maximum yields of BW852 and TBK were gained when applying nitrogen at the rate of 150 kg ha\(^{-1}\), whereas an application of 300 kg ha\(^{-1}\) gave the highest yield in NSW. Similar results were reported by Amany et al. (2006), who found that the grain yield of maize was affected significantly by increasing the application rate of slow-release N fertilizer. Increasing the N level produced an increase in the grain yield and kernel weight of corn hybrid 8644-27 (Oiken et al., 1998). The effect of interactions between the nitrogen rate and variety on total yield indicated that NSW treated with nitrogen at the rate of 300 kg ha\(^{-1}\) produced the maximum yield, while the lowest yield was observed in TBK, with no N application (Figure 3).

**CONCLUSION**

This study involved three waxy corn varieties and five nitrogen application rates. Each variety responded differently to changes in the nitrogen rate. NSW showed greater positive responses to increased nitrogen than the other varieties, with the optimum rate being 300 kg ha\(^{-1}\). BW852 showed the best N response at 150 kg ha\(^{-1}\), whereas TBK was rarely influenced by increasing nitrogen rates. Application rates of

![Figure 3](image-url)
nitrogen ranging from 150 to 250 kg ha\(^{-1}\) were appropriate for increasing waxy corn yield; however, it was important to consider variety effects.

**ACKNOWLEDGEMENT**

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**LITERATURE CITED**


