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Effects of Nitrogen Fertilizer and Irrigation on Growth Performance of Maize (*Zea mays* L.) in the Mid Country of Sri Lanka

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ABSTRACT. *Nitrogen nutrition as well as adequate amount of water are essential for the growth and yield of all plants including maize (Zea mays L.). The yield response of maize (variety Ruwan) and its physiological basis to nitrogen supply under rainfed and irrigated conditions were evaluated in two agro-ecological zones and seasons in Sri Lanka. The crop was grown in the University experimental stations, Peradeniya (mid country wet zone) in maha, 1998/99 season and Dodangolle (mid country intermediate zone) in yala, 1999 season at three nitrogen levels namely, 0, 112.5 and 225 kg urea ha^{-1} under rainfed and irrigated conditions in a split plot design. The rate of photosynthesis, yield and yield components were studied. The results of the experiment revealed that the interaction between nitrogen fertilizer levels and irrigation significantly affected the grain yield of maize in both experimental sites. At high nitrogen level (225 kg urea ha^{-1}), irrigation enhanced crop yield by 70% and 21% compared to the rainfed treatment in Dodangolle and Peradeniya sites, respectively. The maize grain yield of Peradeniya site was more than double when compared to that of Dodangolle site. Maize plant can be successfully grown by applying high nitrogen fertilizer in maha season of mid country wet zone under rainfed condition but irrigation further improved the yield performance. In yala season of mid country intermediate zone the application of high nitrogen level would give successful maize growth only under irrigation.*

The highest ear weight/m^2, number of grains/m^2 and number of ears/m^2 were obtained from the treatments with application of 225 kg urea ha^{-1} under irrigation. The rate of photosynthesis also improved under these conditions. High fertilizer dosage and irrigation were essential for high grain formation.

INTRODUCTION

Sri Lanka, as a tropical country, is suitable for C4 type photosynthetic plants such as maize. Maize is grown in Sri Lanka mainly as a rainfed crop during *maha* season in the dry zone and the production is very low. However, it can also be grown during *yala* season, but under supplementary irrigation. Hence, identifying different areas and seasons on which maize grows well and give high yields is essential to improve the maize production in Sri Lanka.

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The two physical factors most responsible for limiting maize production in developing countries are soil moisture and soil fertility. Soil moisture status may influence the amount of soil nitrogen utilized by maize. High nitrogen fertility can further increase the severity of water deficit by increasing total plant leaf area and the rate of soil water depletion (Ne Smith and Ritchie, 1992; Abrecht and Carberry, 1993). Therefore, study on nitrogen management entails an understanding of nitrogen-soil water interactive effect on maize growth and development.

It would be reasonable to postulate the high nitrogen rates may increase maize grain yield and yield components when grown under irrigation. Hence, the objectives of the present study were to quantify the yield response of maize to different nitrogen levels under rainfed and irrigated condition and to elucidate the physiological basis of the above response using two selected areas and seasons in Sri Lanka.

MATERIALS AND METHODS

Experiments were conducted at the University experimental stations, Peradeniya during the longer rainy season *maha*, 1998/99 and Dodangolla during the shorter rainy season *yala*, 1999 season. The two selected sites Peradeniya and Dodangolle are situated in the mid country wet zone and mid country intermediate zone of Sri Lanka, respectively (Panabokke, 1996). Maize (*Zea mays* L.), variety *Ruwan*, which is a 120 day crop was used for the study.

Three levels of nitrogen treatments N0, N1 and N2 were imposed by supplying 0, 112.5 and 225 kg urea ha^{-1} (the recommendation of Department of Agriculture is 150 kg urea ha^{-1}). These treatments were tested under both irrigated (I1) and rainfed (I0) conditions. A split plot design with irrigation treatment as the main factor and the nitrogen treatment as split plot factor were used with three replicates. The planting density used was 55,000 plants ha^{-1}. Rate of leaf photosynthesis (using a portable photosynthesis system), yield and yield component parameters were measured.

RESULTS AND DISCUSSION

Leaf photosynthesis

The interaction of nitrogen fertilizer and irrigation significantly affected the rate of photosynthesis during grain filling stage in Dodangolle site. However, it was not significant at the Peradeniya site. The rate of photosynthesis significantly increased by nitrogen fertilizer application as well as irrigation in both sites of experiments. Plants treated with 225 kg urea ha^{-1} under irrigated condition (I1N2) showed the highest photosynthesis rate throughout the season in both sites and the untreated control (I0N0) showed the lowest. Therefore, when maize plants were subjected to nitrogen deficiency and water deficit condition photosynthesis was affected and this is reflected in the grain yield.

Grain yield and yield components

The increasing levels of nitrogen under irrigation significantly enhanced ear weight/m^2, grain number/m^2 and yield/m^2 in both sites when compared to rainfed condition. Length of ear was significantly increased by nitrogen application as well as by irrigation. Number of ears/m^2 was significantly increased by the interaction effect of levels of nitrogen and irrigation in Dodangolle site but not in Peradeniya site. The highest number of ears/m^2 was recorded in I1N2 treatment.

In the present study number of ears/m^2, ear weight/m^2 and number of grains/m^2 showed a significant positive correlation with yield at both sites. Length of ear showed a positive correlation with number of grains/m^2. This reveals that ensuring initiation and retention of number of longer ears with greater weight through increasing nitrogen fertilizer application with irrigation is the physiological basis of maximizing yield in maize.

Nitrogen deficiency and water deficits made the maize plants to attain low photosynthesis rate in both sites, which would lead to low carbon assimilation and low number of grain set. The reduced grain number in nitrogen stressed plants (Uhart and Andrade, 1995) and water deficits plants (Ne Smith and Ritchie, 1992; Abrecht and Carberry, 1993) have been previously reported.

Significant yield gains were achieved by the interactive effect of nitrogen and irrigation in both sites. The maximum yield of 10573 kg/ha and 5164 kg/ha in Peradeniya and Dodangolle sites, respectively, were obtained from the high nitrogen level with irrigation treatment (I1N2). The I0N2 treatment gave 8753 kg/ha and 3043 kg/ha in Peradeniya and Dodangolle sites, respectively.

The results revealed that high nitrogen fertilizer level under irrigation greatly increased maize grain yield in *yala* season of mid country intermediate zone (Dodangolle) but the yield in *maha* season of mid country wet zone (Peradeniya) can be further increased by irrigation during late growing season when plants started to receive low level of rainfall.

Therefore, it can be concluded that the maize grain yields are responsive to the interactive effect of nitrogen fertilizer application and irrigation. Efforts to improve maize grain yield should concentrate on increasing rate of photosynthesis, which initiates high number of large ears/plant and number of grains/ear, by increased nitrogen application (225 kg urea ha^{-1}) with irrigation at both the Peradeniya and Dodangolle sites.

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