RESPONSES OF EGGPLANT (SOLANUM MELONGENA L.) TO DIFFERENT RATES OF NITROGEN UNDER FIELD CONDITIONS

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ABSTRACT

The present study was carried out to evaluate the effect of nitrogen fertilizer on growth and yield of eggplant (Solanum melongena L.) under field conditions. Nitrogen was applied in four rates (0, 50, 100 and 150 Kg/ha). Average plant height, lateral stem number, leaf chlorophyll content, flower number, fruit weight and plant yield were determined , Increasing rates of Nitrogen significantly affected plant vegetative growth (plant height, lateral stem number, and leaf chlorophyll content).The highest lateral stem number and leaf chlorophyll content were obtained in plants receiving 150 Kg N ha^{-1}. Nitrogen fertilizer affected flower number and the days to first flowering. Nitrogen application decreased the days to first flowering and treated plants flowered early than control. It was observed that fertilization with 100 Kg N ha^{-1} resulted in the highest average fruit weight and fruit yield. Our results showed that nitrogen fertilization has strongly influenced vegetative and reproductive growth of eggplant plants grown under field conditions.

Keywords: Nitrogen, vegetative growth, fruit yield, eggplant

INTRODUCTION

Eggplant (Solanum melongena L.), also known as Aubergine, Brinjal or Guinea squash is one of the non-tuberous species of the night shade family Solananceae[12]. The varieties of Solanum melongena L. show a wide range of fruit shapes and colors, ranging from oval or egg-shaped to long club-shaped; and from white, yellow, green through degrees of purple pigmentation to almost black. It is an economically important crop in Asia, Africa and the sub-tropics (India, Central America) and it is also cultivated in some warm temperate regions of the Mediterranean and South America [23]. Eggplant fruits are known for being low in calories and having a mineral composition beneficial for human health. They are also a rich source of potassium, magnesium, calcium and iron [28]. The yield depends upon several production factors. Among these proper, balanced nutrition plays a significant role. Nitrogen is considered as one of the essential macronutrients required by the plants for their growth, development and yield [24]. Moreover, nitrogen is the main constituent of all amino acids in proteins and lipids that acting as structural compounds of the chloroplast [6].The productivity of eggplant is highly responsive to N fertilization. Pal et al. (2002) reported that eggplant fruit yield increased with increase in N up to187.5 kg N ha^{-1}. Sat and Saimbhi (2003) observed that increasing the nitrogen significantly delayed flowering of eggplant and increased the number of days taken to fruit setting of eggplant. Nitrogen fertilizer affected seed number, fruit pH, crude protein, total solid and ascorbic acid of eggplant; and nitrogen deficiencies reduced both physical and chemical properties [1]. Takebe et al. (1995) reported that increments in the leaf dry weight may be due to a combination of nitrogen with plant matter produced during photosynthesis such as glucose, ascorbic acid, amino acids and proteins. It was found that the increase of the N concentration in the nutrient solution stimulated dry mass accumulation, stem elongation and leaf expansion rate, but decreased the root: shoot dry weight ratio and root whole weight of eggplant [4]. Wange and Kale (2004) observed significant improvement in plant height, number of leaves and yield (74%) of eggplant over recommended rate of N fertilizer with the application of 75 kg ha^{-1}. Devi et al. (2002) found better fruit girth, fruit weight and fruit yield level of eggplant with the application of 120 kg per hectare. It is a well known that adequate nitrogen is required by eggplant for satisfactory growth, development and high yield. Thus, an adequate level of nitrogen is very vital to increase the production and yield of eggplant. The main aim of this experiment was to determine the influence of nitrogen fertilization on growth and yield of eggplant.

MATERIAL AND METHODS

Plant preparation: The experiment was conducted during the 2006 growing season at the experimental field of the Agricultural Faculty, University of Birjand (latitude 32◦53' N, longitude 59◦13′ E and 1470 m elevation), Iran. This site represents the range of dry conditions. Annual rainfall ranges between 91 and 120 mm and mean annual relative humidity is 37%. Soil samples (0-30 cm depth) were taken with auger after the site had been prepared for cultivation. The sample was analyzed for physical and chemical properties using standard laboratory procedures described by Mylavarapu and Kennelley (2002), and results are summarized in Table 1. Soil type was loam. The experimental field was cleared, ploughed, harrowed and divided into plots, with 10 m^2 areas. Phosphorus (P_2O_5) and potassium (K_2O_5) were applied 100 and 50 kg ha^{-1} before planting. Egg-shaped eggplant seeds were sown in a greenhouse in large trays with a 1:1 mixture of sand and peat (1:1 v/v). Irrigation was done based on plant requirements. Six-week-old eggplant plants were hand-transplanted into well-prepared beds in the field. The spacing between rows and plants were 0.5 m. Plots were irrigated during the growing season to maintain soil moisture at 65 percent of soil Water field Capacity. All practical managements included; mulching, weeding and other agronomic treatments were done mechanically.

Treatments: Treatments were applied in four levels of nitrogen (0, 50, 100 and 150 Kg N/ha). The source used for nitrogen was urea, divided into three equal parts and applied at 3 stages included 10, 30 and 50 days after

Table 1. Soil characteristics of the experimental site

Parameter	
N (%)	0.05
P(mg kg^{-1})	14
K(mg kg^{-1})	270
$pH_{(H2O)}$	7.1
Clay (%)	19
Silt (%)	41
Sand (%)	40

transplanting (DAP) as top dressing.

Measurements: Ten plants in each replication were taken to assess plant height, leaf number and lateral stem length at three growing stages including vegetative, flowering and reproductive. Leaf chlorophyll content was measured by a portable chlorophyll meter, SPAD-502 (Minolta Corporation, Ramsey, NJ). Leaf samples were oven dried at 75° C for 72 h to the constant leaf dry weight for each plant was weighed using digital balance and recorded in grams [6]. The days to first flowering were estimated for each plot and number of flowers per plant was evaluated based on the method by Remison (1997). Mature fruits were harvested at 10-14 day intervals to assess the average fruit weight (g) and fruit yield per plant (g/plant).

Experimental design and statistical analysis: The experiment was arranged in a completely randomized block design (CRBD) with four treatments and three replications, each replication with ten plants. Data were analysed using MSTAT-C and means were compared by Duncan's multiple range test (DMRT) at 5% level of confidence.

RESULTS AND DISCUSSION

Data (Tables 2-4) showed that nitrogen fertilization significantly affected eggplant growth and fruit yield.

Vegetative Growth: Nitrogen application increased plant height at vegetative, flowering and reproductive stages (Table 2). The level of 50 kg N ha^{-1} produced the tallest plants and the shortest plants formed in the control (at vegetative and flowering stages). However, no significant differences were found between three treatments: 50, 100 and 150 kg N ha^{-1}(at all stage). The obtained results were in agreement with Bar et al. (2001), Prabhu et al. (2003) and Wange and Kale (2004) and Ge et al. (2008). Also the effect of nitrogen on the lateral stems number of eggplant was significant at flowering stage (Table 2). The highest number of lateral stems (14.33) was obtained at 50 kg N ha^{-1}, but there was no significant difference between three treatments: 50, 100 and 150 kg N ha^{-1}. Similar results were observed in the study done by Bar et al. (2001). The height of plant can be considered as one of the indices of plant vigour ordinarily and it depends upon vigour and growth of the plant. Soil nutrients are also very important for the height of plants [17].

The effect of nitrogen fertilization level on leaf number was significant at flowering and reproductive stages (Table 3). The highest leaf number were obtained as a result of the higher rates of N (100 and 150 kg N ha^{-1}) with 41.33 and 57.33 leaves at flowering and reproductive stages, respectively, while the lowest values were observed at the control plants showing the average value of 32.0 leaves (at flowering stage) and 44.33 leaves (at reproductive stage); however, no significant differences were found between treatments at the vegetative stage (Data not shown). The results were in agreement with the observations of Wange and Kale (2004). Increases in inorganic fertilizer additions tended to increase number of leaves per plant compared with the unfertilized control. This variation might be due to the availability of nutrients especially nitrogen and could be due to the improvement of soil water holding capacity as mentioned earlier by Roe and Cornforth (2000). Leaf chlorophyll content was affected by nitrogen fertilizer at reproductive stage (Table 3). Results indicated the lowest leaf chlorophyll content by control plants, however, no significant difference was found between three treatments: 50, 100 and 150 kg N ha^{-1}. Similar results have been reported in investigations conducted by Bowen and Frey (2002) and Ge et al. (2008). A promotion effect of inorganic fertilizers on chlorophyll content might be attributed to the fact that N is a constituent of chlorophyll molecule. By increasing the nitrogen fertilizer rate the leaf dry matter content increased at reproductive stage (Table 3). The highest leaf dry matter content was obtained at 100 kg N ha^{-1} application (18.67%), while the least leaf dry matter content was obtained in the control (16.33%). Similarly, Balliu et al. (2008) and Magdatena (2003) reported that leaf dry matter content increased as N rate increased.

Reproductive Growth: The days to first flowering ranged

Table 2. Effect of nitrogen fertilizer on vegetative characteristics of eggplant

Treatment	Plant height (cm)			Lateral stem number.
	Vegetative stage	At flowering	Reproductive stage	Vegetative stage
0(control)	7.000b	11.33b	30.67b	11.33b
50kgN ha^{-1}	10.00a	14.33a	37.67a	14.33a
100kgN ha^{-1}	8.667ab	12.67ab	40.33a	12.67ab
150kgN ha^{-1}	9.333 a	13.67ab	36.33a	13.67ab

Within each column, same letters indicate no significant differences between the values at the P =5% level

Table 3. Effect of nitrogen fertilization on the vegetative characteristics of eggplant

Treatment	Leaf Number		Leaf chlorophyll content	Leaf dry matter content (%)
	Flowering	Reproductive.	Reproductive.	Reproductive
0(control)	32.00b	44.33b	54.00b	16.33c
50kgN ha^{-1}	37.33a	55.33a	63.33a	17.33b
100kgN ha^{-1}	41.33 a	54.00a	63.00a	18.67a
150kgN ha^{-1}	37.67a	57.33a	67.33a	17.67b

Table 4. Effect of nitrogen fertilization on the reproductive characteristics of eggplant

Treatments	Days to 1st flowering	Flower number at lateral stem	Fruit weight(g)	Yield Plant/ (g)
0 (control)	50.33a	4.33c	301.7b	2615b
50kgN ha^{-1}	43.67bc	6.00ab	348.3ab	3470ab
100kgN ha^{-1}	43.33c	6.33a	375.0a	3713a
150kgN ha^{-1}	46.67b	5.00bc	298.3b	3591ab

from 43.33 days to 50.33 days in average (Table 4). Thus nitrogen treatments decreased the days to first flowering and treated plants flowered earlier than control plants. Nitrogen deficiency retarded the vegetative as well as reproductive growth, which resulted in more days to flowering and fruit setting. Similarly, more nitrogen led to maximum days to flowering and fruit setting, as in case of. It means nitrogen enhanced vegetative growth and reduced reproductive growth [11] therefore, a fertilizer dose of 100 kg N per hectare proved better for minimum days to flowering, which leads to early fruit setting which were in agreement with findings of Sat and Saimbhi (2003) and Law and Egharevba (2009). Flower number at lateral stem was significantly affected by nitrogen fertilizer (Table 4). The highest flower number at lateral stem was observed in 100 Kg nitrogen having 6.33 flowers in average, while the least number of flowers was recorded at control having 4.33 flowers. This result agrees with the finding by Bobadi and Damme (2003) and XU et al. (2001). Increase of soil fertility delayed at the beginning of flowering and fruit set of eggplant. This trial revealed that statistical significances differences existed among the treatments for average fruit weight (Table 4). Data showed the highest fruit weight (375 g) was observed from 100 Kg N ha^{-1} treatment, while the lowest (298.3 g) related to 150 Kg N ha^{-1}. These results are consistent with those reported by Ali and Kelly (1992), Devi et al. (2002) and Aujla et al. (2007) who also reported that increasing the rate of nitrogen fertilizers increased the average fruit weight and fruit volume. Nitrogen fertilization significantly increased yield per plant compared to control (Table 4). The highest yield in plant was obtained as (3713 g) with application of 100 kg ha^{-1}. The lowest yield was obtained as (2615 g) in the zero nitrogen application, i.e. the control that were in agreement with Rosati et al. (2002), Akanbi et al. (2007) and Aujla et al. (2007) reported that increments in the nitrogen rate of the fertilizers increased the yield and number of fruits. Increasing the N levels of the fertilizers to 50 kg N ha^{-1} significantly increased the yield of eggplant while yield decreased at the highest rate of nitrogen. This decrease in yield might be due to excess levels in the plant. The marked effect of nitrogen on yield might be due to the cumulative stimulating effect of nitrogen on the vegetative growth characters which form the base for flowering and fruiting.

CONCLUSIONS

The improvement occurred in the plant growth and development could be attributed to effects of nutrients on carbohydrate influx or plant growth regulators synthesis in growing plant.Although higher nitrogen level increased vegetative growth of eggplant, however, reproductive growth was enhanced with the lowest level of nitrogen (50 kg N ha^{-1}). On the other hand, there were no significant differences between N levels on almost all cases of variables; however, they were improved with lower nitrogen levels. Under our experiment conditions, this plant showed a good response to the lowest N level, but we cannot recommend this level to all soils or climatic conditions, which justify site specific and need, based nutrient management. Nitrogen promotes growth and increases biomass production, and nitrogen fertilization has been used to increase growth and yield of eggplant.

In excess, nitrogen may have adverse effects on the vitality of plants. Extra nitrogen fertilizers cause changes in the shoot/root ratio and reduce mycorrhizal induction in soil . The reduced activity of roots can create a nutrient imbalance. These factors may consequently increase the susceptibility of plant to stresses such as drought and pathogens. Thus, our study shows that application of low amounts of N (50 kg/ha) is recommended for eggplant production and could be a concern for growers.

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