RESPONSE OF TOMATO (*Lycopersicon esculentum* Mill.) CULTIVARS TO NITROGEN LEVELS

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Abstract

The influence of nitrogen levels on tomato cultivars was evaluated at New Developmental Farm (NDF), Khyber Pakhtunkhwa Agricultural University Peshawar in summer, 2011. The experiment was laid out in Randomized Complete Block (RCBD) with split plot arrangement. There were two factors i.e. nitrogen levels (0, 100, 150 and 200 kg ha⁻¹) which were allotted to main plots and tomato cultivars (Roma, Roma VF, Super classic, Bambino and Riogrand) assigned to sub plots. A total of twenty treatments were replicated thrice. Maximum days to flowering (44.53 days), days to fruiting (50.13 days) and fruit width (5.02 cm) was obtained when nitrogen was applied at 200 kg ha⁻¹. The tallest plants (63.09 cm), number of branches (6.73), maximum number of fruits (25.53), fruit length (5.97 cm) and yield (27.54 t ha⁻¹) was produced by the plots fertilized with 150 kg N ha⁻¹, while minimum days to flowering (37.93 days), days to fruiting (44.67), number of fruits (21.82), fruit width (4.45 cm) and yield (21.50 t ha⁻¹) were obtained from control plots. Maximum days to flowering (43.33 days) were taken by cultivar Bambino whereas, minimum (39.75 days) were taken by cultivar Riogrand. Similarly in case of cultivars, Bambino cultivar produced longer fruit (6.04 cm) while Roma VF produced smaller fruit (5.27 cm). Maximum fruit yield (29.65 t ha⁻¹) was produced by Riogrand whereas; poor yield (19.24 t ha⁻¹) was produced by Roma. Maximum number of fruit plant⁻¹ (27.61) was produced by Riogrand whereas; minimum (18.76) was produced by Roma VF. Among the various treatments studied in the experiment, it is suggested that Riogrand with the application of 150 kg N ha⁻¹ can be used in Peshawar valley for better growth and yield of tomato.

Keywords: Cultivars; Tomato; Nitrogen; Yield

Introduction

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family solanaceae, which is most well-liked and commonly grown vegetable in all over the world. Next to potato, tomato is the most widely produced and cultivated crop. It is a summer vegetable so can tolerate high temperature and drought and grown on various soil and a range of atmospheric conditions. About 500 B.C. tomato was grown by the Indians long ago before the arrival of Spaniards while it is native of west coast of South America [1]. The European imported tomato to subcontinent of the Indo-Pak in the second half of 19th century. Tomato is grown all over the world where as China, USA, Turkey, Italy, Egypt, India, Spain, Brazil, Iran and Mexico are the major producers [2]. Tomato is very popular all over the world which has gained the position of mostly consumed vegetable among the other vegetables [3]. In Pakistan, tomato was cultivated on 24,144 hectares area, which produced 275241 tons tomatoes during 2008-09. Area under cultivation of tomato in Khyber Pakhtunkhwa was 4230 hectares with a total production of about 51,062 tons per annum. In Peshawar, area under tomato cultivation was 944 acres produced 2.978 tons of tomato. The area has been increased by 54% during the last 17 years in Pakistan (MINFAL, 2008-2009).

Nutrient supply and environment mainly affect the productivity of the crop. Some of these nutrients are supplied by soil while, other are to be added from the external source in the form of organic and inorganic. Tomato crop requires heavy manure and sufficient amount of fertilizer for heavy yield. For improving plant growth and development, use of organic and inorganic manure is important which improve plant growth directly by providing nutrients [4]. Fruit yield of tomato has been influenced by different levels of nitrogen and phosphorous that's why it needs greater attention to apply these nutrients in proper amount [5-7]. Nitrogen is an essential constituent of proteins and chlorophyll and is present in many other compounds of great physiological importance such as nucleotides, phosphatides, alkaloids, enzymes, hormones, vitamins etc. It is thus, the very basic constituent of life. It promotes leaf, stem and vegetative growth. It improves quality, succulence of leafy vegetables and fodder crops and governs to a considerable degree, the utilization of potassium, phosphorus and other elements. Commercially production of tomato needs proper fertilizer and water management for high yield. On coarse-textured and low organic-matter soils nitrogen mainly limit

the growth of the crop due to leaching and denitrification [8].

Lack of varieties for specific zones and low resistance against different diseases in varieties reduce the tomato yield per unit area. Limited amount of locally approved varieties and lack of local tomato based seed industry further helps in reduction of tomato yield. In order to increase the yield per unit area and period of production, better cultivars need to be developed. The easiest way to achieve this goal is to introduce exotic varieties, evaluate them under local climatic conditions, then release them to farmers or use them in genetic crosses and select promising lines from the segregating generation having the growth habits capacity, high yield, tolerance to heat stress, tolerance to disease with better fruit size.

Hence, keeping above points in view the present investigation was undertaken at Horticulture Research Farm, Khyber Pakhtunkhwa Agricultural University Peshawar with the following objectives:

1. To find the best cultivar of tomato for higher yield in Peshawar.
2. To find the optimum level of nitrogen for better production of tomato.

Materials and Methods

An experiment entitled “Response of tomato cultivars to nitrogen levels” was conducted at New Developmental Farm (NDF), Department of Horticulture, Khyber Pakhtunkhwa Agricultural University Peshawar in summer, 2011. The experiment was laid out in randomized complete block design with split plot arrangement. There were two factors i.e., Nitrogen levels (0, 100, 150 and 200 kg ha⁻¹) and tomato cultivars (Roma VF, Roma, Super Classic, Bambino and Riogrand). Nitrogen levels were kept in main plot while tomato cultivars were assigned to sub plot. A total of twenty treatments were replicated thrice. Soil samples were taken from different points randomly from the experimental field at 15-30 cm depth before other fertilizer application for chemical analysis. Different values obtained were nitrogen (0.166%), lime (11.4%), soil pH (7.55), EC dms⁻¹ (0.27) and texture was silty loam. Soil was ploughed up thoroughly and then was leveled through leveling machine. Well rotten farm yard manure was mixed with the soil. Recommended dose of phosphorus (80 kg ha⁻¹) and potassium (40 kg ha⁻¹) were incorporated into the soil at the time of transplanting of seedling. The source of potash was sulphate of potash (50%) while that of phosphorous was single super phosphate (18%). The source of nitrogen in the experiment was urea (46%), which was applied in three split doses i.e. first dose at

the time of transplantation and the remaining two after transplantation before flowering at ten days interval.

The seeds of tomato cultivars used in the experiment were taken from the market, which were sown in nursery bed on 19th February. The seed were watered after sowing. After that the water was applied according to the requirements. The seedling of obviously equal height and vigor was transplanted on 5th April 2011. Seedling was immediately irrigated. Ridges were made manually at proper height. A space of 60 cm was kept between ridges and 30 cm between plants. Plot size was kept as 1.8 m². Five cultivars of tomato (*Lycopersicon esculentum* Mill.) and four nitrogen levels were assigned to plots in accordance with the field layout. Subsequent irrigations were applied when required. All the standard cultural practices i.e. hoeing, weeding etc were performed regularly. The data were analyzed using MSTATC software and the significant means were separated by LSD at 0.05 probability level. [9].

Results and Discussion

Plant height (cm)

The tallest (63.09 cm) plants were produced by Bambino, while the shortest plants (51.87 cm) were produced by Super classic. Similarly in terms of nitrogen, the tallest (58.96 cm) plants were obtained from the plots fertilized with 150 kg ha⁻¹, while the shortest plants (52.81 cm) were produced by the control plots. While studying their interaction the tallest (65.40 cm) plants were obtained from the plots fertilized with 150 kg ha⁻¹ nitrogen by the cultivar Riogrand, while the shortest (44.70 cm) plants were produced by Super classic in control treatment (Table 1).

Plant height is a function of genetic as well as environmental conditions. Since nitrogen increase the vegetative growth of the plants [10], thus it increased with incremental increase in nitrogen. Plant height of tomato was significantly increased by different levels of nitrogen. Haque et al. [11] reported that 120 and 180 kg N ha⁻¹ produced the plants with similar plant height. The present results are in agreement with those of Ali et al. [12]; Mondal and Gaffer [13]; Gaffer and Razzaque [14], who reported that nitrogen significantly, increased plant height.

Number of branches Plant⁻¹

More number of branches (6.73) was obtained when 150 kg ha⁻¹ nitrogen was applied, while less number of branches (5.95) was obtained from control plots. In case of cultivars, Riogrand produced more branches (6.98) whereas, lesser number of branches were recorded (5.71) for cultivar Super classic. Thus, Riogrand has a genetic potential

for more number of branches as compare to the other varieties. Numbers of branches were significantly affected by nitrogen levels and cultivars (Table 1). Interaction between different tomato cultivars and nitrogen levels was non significant.

Number of branches gradually increased with the increase of nitrogen [15]. Our observations are in line with Dass and Mishra [16] who observed the highest number of branches (15.5) at 150 kg N ha⁻¹. Similarly, a linear increase in the number of branches plant⁻¹ in chillies with increase in nitrogen levels was also noticed by Khan and Suryanarayana [17].

Days to flowering

Maximum days to flowering (43.33) were observed in tomato cultivar Bambino whereas, minimum (39.75 days) observed in tomato cultivar Riogrand. Similarly, flowering was delayed (44.53 days) when nitrogen was used at the rate of 200 kg ha⁻¹, while early flowering (37.93 days) was recorded in controlled plots. Thus, application of the nitrogen delayed flowering (Table 1).

Flowering is perhaps the most sensitive character to the nitrogen fertilizer. Hence increase nitrogen levels increases the vigor of the plant, which ultimately increases the vegetative period and delayed flowering [11]. Similarly, Law and Egharevba [18] reported that maximum days to flowering were observed as fertilizer level increased. The results were also in line with those of Addae-Kahya and Norman [19] while studying the effect of nitrogen on tomato cultivars i.e. Cherry and Pearson.

Days to fruiting

In case of nitrogen, early fruiting (44.67 days) was recorded in control plots, while fruiting was delayed (50.13 days) when 200 kg ha⁻¹ nitrogen was used. Nitrogen increases the vegetative phase and delayed flowering which also delayed fruiting. Regarding cultivars, Riogard was early fruiting (45.75 days) while Bambino was late fruiting (49.42 days) cultivar (Table 1). Interaction between the two factors was regarded as non significant.

The difference in days to flowering among the tomato cultivars may be due to the different genetic makeup of the cultivars. The results are in line with those obtained by Addae-Kagay and Norman [19] while studying the effect of nitrogen of different tomato varieties. Nitrogen application, thus, delayed fruiting in tomato varieties. High nitrogen level, however, can stimulate excessive vegetative growth which can delay fruit setting and maturation [20].

Number of Fruits Plant⁻¹

Maximum number of fruit plant⁻¹ (27.61) was produced by Riogrand whereas; minimum

(18.76) was produced by Roma VF. In case of nitrogen levels, the highest number of fruit plant⁻¹ (25.53) was obtained with the application of 150 kg

Table-1: Plant height, leaves plant⁻¹, days to flowering and days to fruiting of tomato cultivars as affected by different N levels.

Treatments	Plant Height (cm)	Leaves plant ⁻¹	Days to flowering	Days to fruiting
N Levels				
0	52.81c	5.95b	37.93d	44.67c
100	56.24b	6.17ab	39.47c	45.73c
150	58.96a	6.73a	42.13b	47.87b
200	56.46ab	6.29ab	44.53a	50.13a
LSD value at P ≤ 0.05	2.59	0.59	0.88	1.07
Tomato cultivars				
Roma	53.13c	6.41b	40.42bc	46.92b
Roma VF	52.79c	6.03bc	40.58b	46.83b
Super Classic	51.87c	5.71c	41.00b	46.58b
Bambino	63.09a	6.29b	43.33a	49.42a
Riogrand	60.47b	6.98a	39.75c	45.75b
LSD value at P ≤ 0.05	2.32	0.44	0.83	1.20
N x Cultivars	Ns	Ns	Ns	Ns

N ha⁻¹, which was statistically different from other treatments. The lowest number of fruits plant⁻¹ (21.82) was produced by control treatment. There were statistically significant differences among tomato cultivars as well as nitrogen levels for number of fruit plant⁻¹ (Table 2). The interaction between the two factors, however, was non significant.

Number of fruits plant⁻¹ gradually increased with increasing levels of nitrogen up to 150 Kg N ha⁻¹ treatment [11]. Sharma [21] also found highest number of fruits plant⁻¹ with 120 kg N ha⁻¹. The difference in number of fruit plant⁻¹ of tomato varieties suggests that there is considerable genetic variability among the tested genotypes. It was observed that the application of N up to 150 kg ha⁻¹ increased number of fruits plant⁻¹ and further addition of N decreased the number of fruits plant⁻¹. The results are in close association with those of Haque et al. [11] and Banerjee et al., [22] who reported the highest number of fruits plant⁻¹ from the plots fertilized with 120 and 125 kg N ha⁻¹, respectively.

Fruit length (cm)

Longer fruits (5.97 cm) were obtained from the plots fertilized with 150 kg ha⁻¹ nitrogen whereas; smaller (5.07 cm) fruits were obtained when 200 kg ha⁻¹ nitrogen was applied. Similarly in case of cultivars, cultivar Bambino showed longer fruit length (6.04 cm) and Roma VF showed smaller fruit length (5.27 cm) (Table 2). Interaction between

tomato varieties and nitrogen levels was recorded as non significant.

Fruit length is a character highly influenced by nitrogen levels. Sainju et al. [20] reported that nitrogen deficiency in tomato can result in stunted growth and decrease fruit number and size. Winsor and Massey, [23] found that the highest nitrogen treatment (275 ppm) reduced the proportion of high grade tomato fruit. Also, low nitrogen concentration increased the high grade fruits and the fruit size. These results confirmed the previous findings of Nathulal and Pundrik, [24] and Dod et al., [25] who reported significant increase in fruit length with increased nitrogen levels reaching maximum at 100 kg and at 125 kg N ha⁻¹, respectively. Singh and Srivasta [26] also reported that application of 120 kg N ha⁻¹ significantly increased length of chilli fruits (6.10 cm) over control treatment (4.68 cm).

Fruit width (cm)

The thickest fruits (5.02 cm) were obtained from the plots when 200 kg ha⁻¹ nitrogen was used. Less fruits width (4.45 cm) was obtained from control plots. Similarly in case of cultivars, Super classic showed more width (5.07 cm) and Roma showed smaller fruit width (4.39 cm). Tomato cultivars as well as nitrogen levels disclosed significant variability for fruit width as evident from the analysis of variance (Table 2). Interaction between the factors was considered as non significant.

The results indicated that the application of nitrogen provided thicker fruits which ultimately resulted in greater yield. Fruit width blows directly the final yield in tomato. Imas, [27] and Zekri and Obreza, [28] reported that low concentrations of N will result in smaller fruit since the rate of photosynthetic activity of the plant will drop sharply therefore, growth was reduced and smaller fruits was produced. Our results are in concurrence with that of Subramanian et al. [29], who reported that fruit quality (length, girth and weight) increased with increasing nitrogen application rate.

Yield (t ha⁻¹)

Maximum yield (29.65 t ha⁻¹) was produced by Riogrand whereas; minimum (19.24 t ha⁻¹) was produced by Roma vf. In case of nitrogen levels, maximum yield (27.54 t ha⁻¹) was obtained from the plots fertilized with 150 kg N ha⁻¹ while, minimum (21.50 t ha⁻¹) was obtained from control plot. There were statistically significant differences among tomato cultivars as well as nitrogen levels for fruit weight (Table 2). The interaction between the two factors, however, was non significant.

Overall yield and its components were normally more responsive to application of N [30]. However, tomato is highly responsive to N, but an

excessive rate of N application is seldom adversely affects tomato quality [31]. Olasantan [32] also found that fruit yield of the tomato plant was reduced at higher N application rates. Sainju et al. [33] concluded that marketable yields were maximized at N rates of 180 kg N ha⁻¹. The difference in fruit yield of tomato varieties suggests that there is considerable genetic variability among the tested genotypes. Our results are in close association with those of Haque et al. [11] and Banerjee et al. [22] who reported the highest fruit yield from the plots fertilized with 120 and 125 kg N ha⁻¹, respectively. Pandey et al. [7], however, obtained increase in fruit yield up to level of 80 kg N ha⁻¹. The difference in results of different scientist may due the different response of the varieties to the nitrogen. Other reasons could be the difference in nitrogen availability, cropping pattern and soil structure among the experimental plots.

Table-2: Number of fruits plant⁻¹, fruit length (cm), fruit width (cm) and yield (tons ha⁻¹) of tomato cultivars as affected by different N levels.

Treatments	Number of fruits plant ⁻¹	Fruit length (cm)	Fruit width (cm)	Yield (tons ha ⁻¹)
N Levels				
0	21.82d	5.43bc	4.45b	21.50d
100	23.18c	5.73ab	4.79a	24.12c
150	25.53a	5.97a	4.91a	27.54a
200	24.01b	5.07c	5.02a	25.61b
LSD value at P ≤ 0.05	0.62	0.38	0.28	0.95
Tomato cultivars				
Roma	22.38d	5.33b	4.39b	23.19c
Roma VF	18.76e	5.27b	4.44b	19.24d
Super Classic	23.34c	5.66ab	5.07a	24.12c
Bambino	26.09b	6.04a	5.03a	27.28b
Riogrand	27.61a	5.45b	5.06a	29.65a
LSD value at P ≤ 0.05	0.85	0.45	0.31	1.23
N x Cultivars	Ns	Ns	Ns	Ns

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