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Effect of soil and foliar application of nitrogenous fertilizers on growth and budding of sweet orange

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Abstract

This field experiment was conducted to investigate the soil and foliar application of nitrogenous fertilizers on growth and budding of sweet orange. Different sources of nitrogenous fertilizes (urea, ammonium sulphate and ammonium nitrate)and application method (soil application and foliar application), were used to check the growth characters. The overall best performed was recorded in ammonium nitrate treatment for almost all parameters; rootstock length (35.62 cm), rootstock stem diameter (11.63 mm), number of leaves rootstock^{-1}(35.49), bud take success (97.03 %), scion length (39.96 cm), scion stem diameter (15.90mm) and number of leaves scion^{-1} (40.33).Whereas, Among different application methods, foliar application of fertilizer showed significant increase in rootstock length (30.50 cm), rootstock stem diameter (9.66 mm), number of leaves rootstock^{-1}(30.71), bud take success (92.38 %), scion length (33.74 cm), scion stem diameter (13.69 mm) and number of leaves scion^{-1} (35.11. it is concluded that ammonium nitrate and foliar application of fertilizer should be combined for successful budding of sweet orange on sour orange rootstock under the agro climatic conditions of Peshawar.

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Introduction

Citrus is one the most important and largest groups of fruits of tropical and subtropical regions. It belongs to family Rutaceae and believed to have originated in the part of South East Asia. It is a slow growing plant and is commercially propagated through budding/grafting on seedling rootstocks. The rootstocks have a great impact on fruit yield, fruit size and scion vigor and juice quality as well as tolerance to drought, cold and salt. Citrus rootstocks also have a considerable effect on leaf mineral content in the scion (Wutscher, 1989).

In Pakistan, However, little work has been done on production of citrus nursery plants. Significant efforts have been made to develop rootstocks, which beneficially modify the performance of scion varieties. As previously stated that sour orange is major and widely used rootstock in Khyber Pakhtunkhwa, because it is well adapted to our soil and climatic conditions. Usually it is propagated through seeds in open field nurseries (Metrav, 2009-10).

In Khyber Pakhtunkhwa there is only single rootstock has been used for citrus i.e., Sour orange (*Citrus aurantium, L.*) locally known as Narange. It is also known as bitter, bigarade, or Seville orange. It is believed natives of the South Sea Islands, especially Fiji, Samoa, and Guam, believed the tree to have been brought to their shores in prehistoric times. In Pakistan Citrus fruits are cultivated on an area of 198.4 thousands hectares with an average production of 2150 metric tons, while in Khyber Pakhtunkhwa 4.3 thousand hectares gave an average production of 35.1 metric tons (Metrav, 2009-10).

The commercial cultivars of sweet orange are Blood Red, Pineapple, Musambi, Succari, and Valencia late (Wilfred *et al.,* 2004). Citrus trees can be grown on a wide range of soils, including deep sandy loam, loam and clay loam.

The sour orange flourishes in subtropical, near-tropical climates, yet it can stand several degrees of frost for short periods. Generally it has considerable tolerance of adverse conditions. But the Bergamot orange is very sensitive to wind and extremes of drought or moisture. Unlike its sweet relative, the sour orange does well on low, rich soils with a high water Table and is adapted to a wide range of soil conditions. Sour orange trees volunteer readily from self-sown seeds. As generally grown for rootstock for sweet oranges, they are raised in nurseries for 1 or 2 years and then budded. In addition to its susceptibility viral diseases called tristeza, the tree is liable to other viruses' crinkly leaf, gummy bark, psorosis, and xyloporosis (Morton, 1990).

Fertilizer is a kingpin in enhancing crop production. It is also a key to securing the food need of a country. Balanced fertilization means application of essential plant nutrients, particularly the major nutrients, N, P and K in optimum quantity through correct method and time of application in right proportion.

The fertilizers constitute the most important scientific breakthrough in feeding the growing populations of Pakistan (Bowman, 2002). Nitrogen is the element that has the greatest effect on citrus production and a component of chlorophyll, which is associated with important tree functions such as growth, leaf production, flower initiation, fruit set, and fruit development and quality (Bowman, 2002).

The present study was conducted to find out the best sources of nitrogenous fertilizer and application method for better growth sour orange rootstock and budding.

Materials and methods

The experiment was conducted at Agricultural Research Institute Tarnab Peshawar during 2012 and Randomized Complete Block Design (RCBD) with split plot arrangement replicated three times. Sources of nitrogen (urea, ammonium sulphate, ammonium nitrate and control) were assigned to main plots while application method (soil application, foliar application) was kept in the twenty four sub-plots, the size of each was 2 m^2. Row to row and plant to plant distance was kept 70 -10 cm. All other cultural practices like weeding, hoeing, irrigation were carried uniformly during the course of the experiment.

Factor A (Main plot)

Sources of nitrogen

S_1 = Control

S_2 = Urea

S_3 = Ammonium sulphate

S_4 = Ammonium nitrate

Factor B (Sub plot)

Methods of fertilizer application

M_1 = Soil application

M_2 = Foliar application

The rate of nitrogen in soil application was 115 kg hac^{-1} or 46 kg acre^{-1}. So soil applied urea used was 50 g subplot^{-1}, ammonium sulphate used in soil application was 110 g subplot^{-1} and ammonium nitrate used in soil application was 68 g subplot^{-1}.

The rate of nitrogen in foliar application was 0.23 % or 2.3 g lit^{-1}. Urea used in foliar application was 5 g lit^{-1}, ammonium sulphate used in foliar application was 10.9 g lit^{-1} and ammonium nitrate used in foliar application was 6.7 g lit^{-1}.

The data was recorded for Phase 1 (Data for rootstock) i.e. Number of leaves rootstock^{-1}, Rootstock height (cm), Rootstock stem thickness (cm), and for Phase 2 (Data for scion) i.e. Bud-take success (%),Number of leaves scion^{-1}, Scion length (cm), Scion stem thickness (cm), Number of shoots scion^{-1}. This data was analyzed by varies techniques (Steel and Torrie, 1984). Whereas the significant means were separated by the least significant differences test at (0.05) probability level by using statistix 8.1 software.

Results and discussion

Number of leaves rootstock^{-1}

The data regarding growth behavior (table 1) showed significant differences to sources of nitrogen, foliar application, soil application. The highest number of leaves rootstock^{-1} (35.49) was recorded in plants treated with ammonium nitrate, followed by the plants (31.53) received ammonium sulphate. While the least number of leaves rootstock^{-1} (21.72) was observed in control plants. Similarly, more number of leaves rootstock^{-1} (30.71) was recorded in plants which received foliar application. While less number of leaves rootstock^{-1} (27.96) was recorded in plants with soil fertilizer application.

Table 1. Growth characters as influenced by nitrogen source and application method.

	Vegetative growth characters									
Sources of Nitrogen	Number of leaves rootstock^{-1}	Rootstock height (cm)	Rootstock stem diameter (mm)	Bud take success (%)	Number of leaves scion^{-1}	Scion height (cm)	Scion stem diameter (mm)	Plant survival (%)	Number of shoots scion^{-1}	Disease incidence (%)
Urea	28.59 c	29.53 c	8.94 c	90.52 c	31.50 c	32.13 c	12.83 b	92.62 b	4.14 c	7.49 b
Ammonium Sulphate	31.53 b	32.34 b	10.14 b	92.76 b	36.00 b	35.72 b	13.81 b	93.89 a	5.42 b	5.58 c
Ammonium Nitrate	35.49 a	35.62 a	11.63 a	97.03 a	40.33 a	39.96 a	15.90 a	93.83 a	6.65 a	3.60 d
Control	21.72 d	19.63 d	5.68 d	81.11 d	23.55 d	21.54 d	8.29 c	87.56 c	1.98 d	23.71 a
LSD at $P \leq 0.05$ %	0.64	1.11	0.56	0.52	1.81	0.65	1.62	0.91	0.34	0.74
Application Method										
Soil Application	27.96 b	28.06 b	8.54 b	88.32 b	30.58 b	30.93 b	11.72 b	90.36 b	3.78 b	10.33 a
Foliar Application	30.71 a	30.50 a	9.66 a	92.38 a	35.11 a	33.74 a	13.69 a	93.59 a	5.32 a	9.86 b

Rootstock height (cm)

The highest rootstock height (35.62 cm) was recorded in plants supplied with ammonium nitrate, followed by the plants (32.34 cm) received ammonium sulphate, whereas, the least rootstock height (19.63 cm) was observed in control treatment. Similarly, more rootstock height (30.50 cm) was recorded in plants which received foliar application. While less rootstock height (28.06 cm) was noted in plants supplied with soil application of fertilizer.

Rootstock stem diameter (mm)

The highest RSD (11.63 mm) was obtained in ammonium nitrate treatment, followed by the plants

(10.14 mm) applied with ammonium sulphate, while the least rootstock stem diameter (5.68 mm) was recorded in control plants. Among fertilizer application methods, the more rootstock stem diameter (9.66 mm) was noted in plants received foliar application. While least rootstock stem diameter (8.54 mm) was recorded in plants with soil application of fertilizer.

Bud-take success %

Significant differences were found bud-take success percentage to nitrogen sources. The maximum bud-take success (97.03 %) was noted in plants supplied with ammonium nitrate, followed by the plants (92.76 %) received the ammonium sulphate, while the least bud-take success (81.11 %) was observed in control plants. Similarly, among fertilizer application methods the more bud-take success (92.38 %) was obtained with foliar spray. While the least bud-take success in plants (88.32 %) was noted for soil application method.

Number of leaves scion^{-1}

The mean data revealed a significant variation in case of number of leaves scion^{-1}.The highest number of leaves scion^{-1} (40.33) was recorded in plants treated with ammonium nitrate, followed by the plants (36.00) received ammonium sulphate. The lowest number of leaves scion^{-1} (23.55) was obtained in control plants. Regarding fertilizer application methods, more number of leaves scion^{-1} (35.11) was noted in plants with foliar method. While less number of leaves scion^{-1} (30.58) was noted in plants with soil application of fertilizer.

Scion height (cm)

The mean data showed that the maximum scion height (39.96 cm) was recorded when the plants were treated with ammonium nitrate, followed by the plants (35.72 cm) received ammonium sulphate and the lowest scion height (21.54 cm) were recorded in control treatment. Regarding the application methods, more scion height (33.74 cm) was observed in plants received foliar application while less scion height (30.93 cm) in plants with soil application.

Scion stem diameter

Mean data revealed that nitrogen sources significantly affected the scion stem diameter. The highest scion stem diameter (15.90 mm and 13.81 mm) was observed in the plants treated with ammonium nitrate and ammonium sulphate respectively. The lowest scion stem diameter (8.29 mm) was observed in untreated plants. Between fertilizer application methods, more scion stem diameter (13.69 mm) was obtained with foliar application of fertilizer. While the least scion stem diameter (11.72 mm) was obtained with soil application of fertilizer.

Survival percentage

Regarding the nitrogen sources, the mean data showed a significant variation in the plant survival percentage. The maximum plant survival (93.83 %) was recorded in the plants when supplied with ammonium nitrate. Followed by the plants (93.89 %) received ammonium sulphate. The lowest plant survival (87.56 %) was obtained in untreated plants. Similarly, the more plant survival (93.59 %) was obtained in plants with foliar method, while less plant survival (90.36 %) was obtained in plants with soil application of fertilizer.

Number of shoots scion^{-1}

Significant variation in number of shoots scion^{-1} was recorded in response to different nitrogen sources. More number of shoots scion^{-1} (6.65) was recorded when the plants were treated with ammonium nitrate, followed by the plants (5.42) supplied with ammonium sulphate. While the lowest number of shoots scion^{-1} (1.98) was observed in control. Among application methods, the highest number of shoots scion^{-1} (5.32) was observed in plants received foliar application. While less number of shoots scion^{-1} (3.78) was recorded in plants with soil application.

Disease incidence %

Significant variation was recorded in disease incidence percentage in response to different nitrogen sources. The highest disease incidence (23.71 %) was recorded in plants supplied with no nitrogen, followed by the plants (7.49 %) treated with urea. While the lowest disease incidence (3.60 %) was recorded in plants treated with ammonium nitrate. Between fertilizer application methods, the more disease incidence (10.33 %) was obtained in plants supplied with soil application of fertilizer. While less disease incidence (9.86 %) was obtained in plants with foliar application method.

Discussion

Total leaf N and chlorophyll increased with repeated foliar applications of ammonium nitrate and ammonium sulphate solutions. Ammonium nitrate is readily soluble in water and so can be taken by the plant directly through their root system or through leaves when applied in foliar spray. The present findings were in correspondence to Yepes (1993), who stated that the number of leaves was significantly affected by foliar application of ammonium nitrate. Shahbazi (2005) showed that there was a significant difference in the number of leaves among nitrogen levels (0, 50, 100 and 110 Nha^{-1}), and that the highest leaf number was obtained with 110 kg N ha^{-1}. The increase in plant height is due to more uptake of N from the soil. These findings are in line with the study of Saha and Ray (2005) who found that the plant height was highest in plants treated with ammonium nitrate. They also found that foliar application was efficient method than soil application of fertilizer. The foliar spray significantly enhanced the growth and stem diameter of plant. Same results were obtained by Siddiqui *et al.* (2008) who reported that foliar application of N significantly increased growth characteristics. Ammonium and nitrate are the two forms in which plants can directly utilize nitrogen from the soil.

The reduction and unavailability of nutrients makes the plant weak. This overall weakness reduces the sap content in the plant body and the sap content directly affects the bud-take success percentage (Fredzan, 1991). Their survival also falls in threat if plants do not get required nutrition for long time. The increase in plant height might be due to more uptake of nitrogen from the soil. Saha and Ray (2005) who compared foliar application with soil application of fertilizer and find foliar application as more efficient method and significantly increased the plant height of sour orange. Bose and Tripathi (1996) reported that ammonium nitrate and ammonium sulphate foliar spray increased the stem diameter in sweet orange but the same results were not achieved with urea with same intensity as urea mostly volatize to the atmosphere. Plants which might not get proper nutrients required for their normal growth, become weak and highly susceptible to diseases.

The survival percentage of plants in control is low as compared to plants which were getting nutrition (Basavarajeshwari, 2008). Alexandria *et al.* (2005) found ammonium nitrate as best nitrogen source for obtaining high plant survival percentage in sour orange. Nitrogen helps in transport of potassium inside plant body which increases the number of shoots $scion^{-1}$ and ultimately the growth of citrus plants. This was reported by El-Bassiony *et al.* (2010).

Nitrogen provides plants with building blocks required for growth, resistance and recovery from disease injury. Plants suffering from a lack of nitrogen are weak, grow slower and aged faster. Such plants become more susceptible to pathogens that are specialized in infecting weak and slow growing plants (Sabah, 1994).

Conclusion

The maximum growth characters i.e. rootstock length (cm), rootstock stem diameter (cm), number of leaves rootstock $^{-1}$, bud take success (%), scion length (cm), scion stem diameter (cm) , number of leaves $scion^{-1}$, plant survival (%) and number of shoots $scion^{-1}$, were recorded in assigned treatment with ammonium nitrate. While the minimum growth behavior were recorded in control treatment. In response to application method, more rootstock length (cm), rootstock stem diameter (cm), number of leaves $rootstock^{-1}$, bud take success (%), scion length (cm), scion stem diameter (cm) and number of leaves $scion^{-1}$ were recorded with foliar spray, compared with soil application method.

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