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Effect of Different Levels of Inorganic Fertilizers on Growth and Yield of Beetroot under Poplar Based Agroforestry System

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Agroforestry play crucial role in satisfying the need for industrial round wood and reaching the national aim of bringing one-third of total country's land under forest/tree cover. The risk of losing money on crops due to poor monsoon conditions is mitigated, and farmers receive a steady stream of additional income as a result. Beet root is a highly productive, popular root vegetable grown mainly for its fleshy, enlarged roots prefers moderately cool condition. Furthermore, it could make a significant impact on the national initiative to double farmers' income growing agricultural crops under with spatial and temporal management. Present experiment was laid out to assess the effect of different levels of inorganic fertilizers on growth and yield of Beetroot under Poplar based Agroforestry in Randomized Block Design (RBD) with ten treatments and three replications viz. T_0 –(70:110:70 kg NPK / ha), T_1 –(100:110:70 kg NPK / ha), T_2– (130:110:70 kg NPK / ha), T_3–(160:110:70 kg NPK / ha), T_4 – (70:130:70 kg NPK / ha), T_5 –(70:150:70 kg NPK / ha), T_6–(70:180:70 kg NPK / ha), T_7– (70:110:80 kg NPK / ha), T_8– (70:110:90 kg NPK/ha), T_9–(70:110:100

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kg NPK / ha). Findings of experiment show that fertilizer Treatment has a significant influence on the growth and yield of Beetroot. The yield parameters of beetroot were significantly affected due to different inorganic nutrient management and comparatively higher tuber yield (307.67 q/ha) was recorded in Treatment T_6 (70:180:70kg NPK/ha).

Keywords: Poplar; beetroot; agroforestry; growth and yield attributes; nutrition levels.

1. INTRODUCTION

In recent years, agroforestry has emerged as a promising field with the potential to provide substantial value and new employment possibilities in rural India, while also improving our country's trade balance and aiding our efforts to achieve its climate and sustainability goals [3]. In recent years, plantations of fast-growing tree species have emerged as an emerging possibility as solutions to address the increasing demand for biomass as a source of renewable energy in global markets [4]. India has experienced remarkable economic growth over the past few decades, and as a result, the country's demand for wood and products made of wood has increased [13]. Because agroforestry reduce land competition for biomass and food production while also providing forest benefits like industrial raw material supply, agroforestry plantations, which include fast-growing tree species, could be an attractive option [9]. Agroforestry is defined as a land use system which integrates trees and shrubs on farmlands and rural landscapes to enhance productivity, profitability, diversity and ecosystem sustainability [11]. It is a dynamic, ecologically based, natural resource management system that, through integration of woody perennials on farms and in the agricultural landscape, diversifies and sustains production and builds social institutions. Poplar (*Populus deltoides*) belongs to the family Salicaceae. (19) These species merit wider recognition, systematic survey, collection and evaluation of desirable geographical races and development of suitable clones [12]. Exotic poplar species considering the importance of exotic poplar clones for their fast growth and ability to provide substantial production of wood on a short rotation, a major programme of introduction to select suitable species and their hybrids/clones/ cultivates for varying agro climatic conditions in India was initiated at the Forest Research Institute (FRI), Dehradun as early as 1950 [5,7]. Beetroot is also known as Table beet, Garden beet and Red beet, and its roots are eaten raw in salads or cooked as a vegetable [14]. Recently, beetroot has been gaining popularity as a “super food” due to its beneficial value for health. It can be consumed in a variety of states from raw to heavily process [15]. It is a rich source of protein, carbohydrates, calcium, and phosphorous; therefore, it is an ideal vegetable for health-conscious individuals [1]. It is also a rich source of potent antioxidants and nutrients, including magnesium, sodium, potassium and vitamin C, and betaine, which is important for cardiovascular health [8]. It is the taproot portion of a beet plant, usually known in North America as beets while the vegetable is referred to as beetroot in British English, and also known as the table beet, garden beet, red beet, dinner beet or golden beet [10]. However, the growth, development, and yield of beetroot depend greatly on soil conditions. Soils supplied with nitrogen (N), phosphorous (P), and potassium (K) through the addition of organic and inorganic fertilizers influence the growth and harvest of the beetroot crop [16]. Among the many constraints to increasing the productivity of beetroot, application of inorganic nutrients mainly N [17]. Optimum application of N fertilizers promotes growth and in turn increases both yield and quality [2]. It is one of several cultivated varieties of Beta vulgaris grown for their edible taproots and leaves. Beets are rich in folate (vitamin B_9) which helps cells grow and function [6,19]. Folate plays a key role in controlling damage to blood vessels, which can reduce the risk of heart disease and stroke [20]. Present study helps to know the suitability of cultivation and analyzing the growth and yield, quality of the beetroot under Poplar based agroforestry system with different inorganic nutrient management so that suitability of vegetable crops with tree component can be authenticated under poplar tree [18].

2. MATERIALS AND METHODS

Present experiment was laid out to assess the effect of different levels of inorganic fertilizers on growth and yield of Beetroot under Poplar based Agroforestry in Randomized Block Design (RBD) with thirteen treatments and three replications during Rabi season of 2022-23 in the crop research farm of Department of Silviculture and Agroforestry, College of Forestry-SHUATS, Prayagraj, India. The area is situated on the

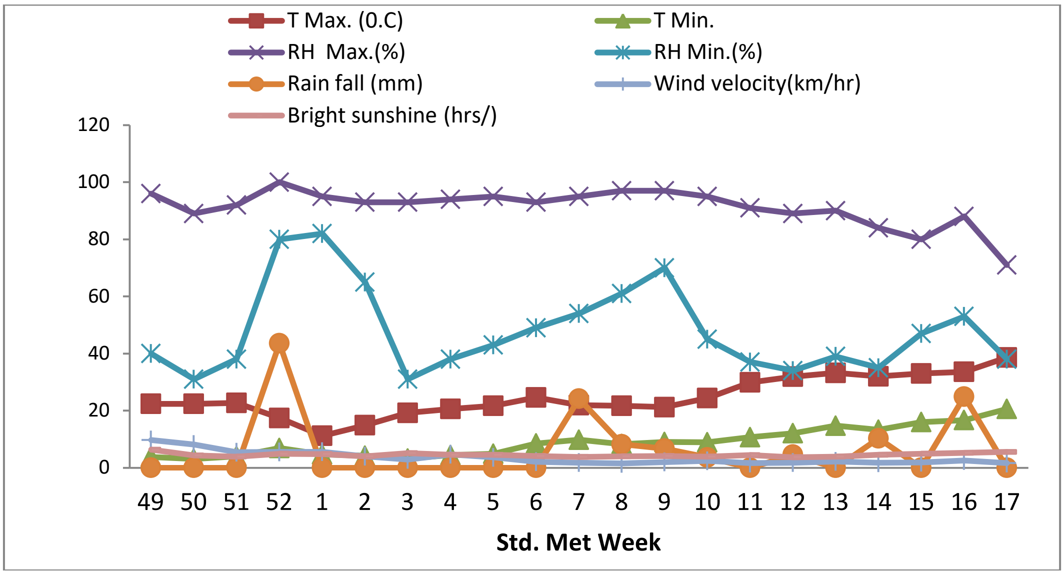

Fig. 1. Meteorological data recorded during experimental period (December 2022 to March 2023)

south of Prayagraj the right side of the river Yamuna on the South of Rewa road at a distance of about 6 km from Allahabad city. It is situated at 25024'23" N latitude, 81050'38" E longitude and at the altitude of 98 meter above the sea level (MSL).

2.1 Climate and Weather Condition

The meteorological data including the weekly average of maximum and minimum temperature, relative humidity, and rainfall recorded at the College of Forestry, SHUATS-Prayagraj. It is endowed with severe winters and mild summers, which remains covered with snow generally from November to March and sometime even upto mid of May. Winter rainfall received in this zone is very low (about 250 mm) and the temperature remains low throughout the growing periods of the crop. Mean weekly meteorological data recorded during the crop seasons (2022-23) have been given.

The climatic condition of Prayagraj is characterized by high rainfall, high relative humidity, moderate temperature, prolonged winter with high residual soil moisture. The temperature range of this area varies from minimum of 7-8^{0}C to maximum of 24-33.2^{0}C. The average rainfall of this zone ranges between 210 cm to 330 cm. The crop growing season of this zone are broadly classified as pre *kharif* (dry and warm) starting from March to May, *kharif* (wet and warm) starting from June to October and *rabi* (dry and cool) starting from November to February. The meteorological data pertaining to the study period are presented in Fig. 1.

2.2 Statistical Analysis

The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez and Gomez (1984). The significance of comparison was tested. The significant difference values were computed for 5 percent probability of error. Wherever the variance ratio (F value) was found significant, critical difference (CD) values were computed for the comparison among the treatment means.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

The data as pertaining to plant height was recorded at 30, 40, 50 and 60 DAS presented in Table 1 showed that the effect of different inorganic nutrients sources on plant height was found to be significant. At 30 DAS, significantly maximum plant height (6.27 cm) was recorded in treatment T_6, which was at par with treatment T_5 (6.24 cm), T_3 (6.22 cm) and T_2 (6.21 cm) and significantly superior over remaining treatments. The minimum plant height was recorded in T_0 (6.13 cm). At 40 DAS, significantly maximum plant height (12.08 cm) was recorded in treatment T_6 which was at par with treatment T_4 (12.06 cm), T_3 (12.04 cm) and T_8 (11.99 cm) and significantly superior over remaining treatments.

The minimum plant height was recorded in T_0 (11.9 cm). At 50 DAS, significantly maximum plant height (20.96 cm) was recorded in treatment T_6, which was at par with treatment T_5 (20.30 cm), T_3 and T_8 (20.10 cm) and T_3 (20.80 cm) and significantly superior over remaining treatments. The minimum plant height was recorded in T_0 (16.76 cm). At 60 DAS, the significantly maximum plant height (27.35) cm was recorded in treatment T_6 which was at par with treatment T_4 (27.20 cm), T_3 (27.00 cm), T_5 (26.20 cm) and T_2 (26.10 cm) and was significantly superior other the remaining treatments. The minimum was recorded in T_0 (21.19 cm) with control treatment.

3.2 Leaves Per Plant

The data on number of leaves per plant recorded at 30, 40, 50 and 60 DAS are presented in Table 2 showed that the effect of different inorganic nutrient sources on number of leaves was found to be statistically significant. The maximum number of leaves per plant (7.73) was observed in treatment T_6 i.e. 70:180:70kg NPK/ha, which was significantly superior r over rest of the treatments. At 30 DAS, all the treatment was find the same value such like 2.40. At 40 DAS, maximum number of leaves per plant (5.67) was observed in treatment T_6 i.e. 70:180:70kg NPK/ha, which was at par with treatment $T_{4,}$ T_5 (5.42), and T_9 (5.42) significant superior over remaining treatments. The minimum number of leaves per plant was observed in control T_0 (4.73). At 50 DAS, maximum number of leaves per plant (7.80) were observed in treatment $T_{6,}$ which was at par with treatment $T_{5,\ (}$7.40), T_4 and T_8 (7.20) significant superior over remaining treatments. The minimum number of leaves per plant was observed in control T_0 (6.00). At 60 DAS, maximum number of leaves per plant (7.73) were observed in treatment T_6 which was at par with treatment T4 (7.67), T5, T9 (7.67) significant superior over remaining treatments. The minimum number of leaves per plant was observed in control T_0 (7.47). Probable reasons for enhanced more number of leaves, may be due to promoted effect of macro and micro nutrients on vegetative growth which ultimately lead to more photosynthetic activities. The beneficial effect of inorganic fertilizer was evident in response of the plant when remarkable increase in relative growth rate with the different treatment. Above finding are in agreement with Jagadeesh (2015) in beetroot.

3.3 Root Diameter

The data as pertaining to root diameter is presented in Table 3 showed that the effect of different inorganic nutrient sources on root diameter found to be statistically significant. The significantly maximum root diameter (6.27 cm) was recorded in treatment T_6, which was at par with T_9 (6.13 cm), T_5 (6.06) and T_4 (5.73 cm), showed significant superiority over all other remaining treatments. The lowest root diameter was recorded in T_0 (4.93).This might be due to the availability of the nutrients in readily available form and the C: N ratio was high over control.

Table 1. Average plant height (cm) of beetroot as influences by treatment of inorganic nutrient sources

Treatment		Plant height (cm)			
		30 DAS	40 DAS	50 DAS	At Harvest
T_o	70:110:70Kg NPK/ha	6.13	11.9	16.76	21.19
T_1	100:110:70kg NPK/ha	6.18	11.72	19.82	21.66
T_2	130:110:70kg NPK/ha	6.20	11.92	20.08	26.10
T_3	160:110:70 kg NPK/ha	6.21	12.04	20.10	27.00
T_4	70:130:70kg NPK/ha	6.22	12.06	20.10	27.18
T_5	70:150:70kg NPK/ha	6.24	12.06	20.30	26.20
T_6	70:180:70kg NPK/ha	6.27	12.08	20.96	27.35
T_7	70:110:80kg NPK/ha	6.15	11.88	19.82	21.66
T_8	70:110:90kg NPK/kg	6.17	11.99	20.10	24.08
T_9	70:110:100kg NPK/ha	6.19	12.04	20.10	26.10
'F' test		S	S	S	S
SE(m)±		0.91	1.59	1.61	1.98
CD at 5%		2.69	4.72	4.77	3.25

Table 2. The average number of beetroot leaves per plant as influences by treatment of inorganic nutrient sources

Treatment		Number of leaves per plant			
		30 DAS	**40 DAS**	**50 DAS**	**60 DAS**
T_o	70:110:70Kg NPK/ha	2.40	4.73	6.00	7.47
T_1	100:110:70kg NPK/ha	2.40	5.13	6.20	7.53
T_2	130:110:70kg NPK/ha	2.40	5.27	6.20	7.60
T_3	160:110:70 kg NPK/ha	2.40	5.40	7.00	7.60
T_4	70:130:70kg NPK/ha	2.40	5.47	7.20	7.67
T_5	70:150:70kg NPK/ha	2.40	5.47	7.40	7.67
T_6	70:180:70kg NPK/ha	2.40	5.67	7.80	7.73
T_7	70:110:80kg NPK/ha	2.40	5.20	6.20	7.53
T_8	70:110:90kg NPK/kg	2.40	5.40	7.20	7.60
T_9	70:110:100kg NPK/ha	2.40	5.47	7.40	7.67
‘F’ test		S	S	S	S
SE(m)±		0.26	0.45	0.69	0.76
CD at 5%		0.76	1.33	2.04	2.21

Table 3. The average root diameters of beetroot as influences by treatment of inorganic nutrient sources

Treatment		Root diameter in (cm)
To	70:110:70Kg NPK/ha	4.93
T1	100:110:70kg NPK/ha	5.33
T2	130:110:70kg NPK/ha	5.54
T3	160:110:70 kg NPK/ha	5.60
T4	70:130:70kg NPK/ha	5.73
T5	70:150:70kg NPK/ha	6.06
T6	70:180:70kg NPK/ha	6.27
T7	70:110:80kg NPK/ha	5.20
T8	70:110:90kg NPK/kg	5.23
T9	70:110:100kg NPK/ha	6.13
‘F’ test		S
SE(m)±		0.62
CD at 5%		1.843

Table 4. The yield of beetroot as influences by treatment of inorganic nutrient sources

Treatments		Root yield per ha (q/ha)
T_o	70:110:70Kg NPK/ha	219.00
T_1	100:110:70kg NPK/ha	246.83
T_2	130:110:70kg NPK/ha	253.58
T_3	160:110:70 kg NPK/ha	277.17
T_4	70:130:70kg NPK/ha	281.42
T_5	70:150:70kg NPK/ha	296.92
T_6	70:180:70kg NPK/ha	307.67
T_7	70:110:80kg NPK/ha	249.67
T_8	70:110:90kg NPK/kg	244.58
T_9	70:110:100kg NPK/ha	261.58
‘F’ test		S
SE(m)±		2.702
CD at 5%		8.09

3.4 Root Tuber Yield (q/ha)

The data as regards to root yield ha^{-1} (q), is presented in Table 4 showed that the effect of different organic nutrient sources on root yield $hectare^{-1}$was found to be statistically significant. The highest root tuber yield ha^{-1} was recorded in (307.67 q/ha) with the application of treatment $T_{6,}$ which was significantly superior over all other treatments. The lowest root yield per ha was recorded by T_0 (219.00 q/ha). Probable reason for increased marketable root yield $plot^{-1}$ and root yield $hectare^{-1}$ is due to accumulation of humus substances could have mobilized the reserve food materials to the sink through increased activity of hydrolyzing and oxidizing enzymes. The higher root yield might be due to increase in plant height, number of leaves which attributes increase in root length and diameter of root, fresh weight of root. This might be due to the availability of the nutrients in readily available form and the C: N ratio was high over control.

4. CONCLUSION

The findings of present study concludes that different levels of inorganic nutrient sources viz., N, P and K to beetroot under poplar based agroforestry significantly influences growth parameters *viz*., plant height, leaves per plant, leaf length and leaf breath and yield attributing characters i.e. root diameter, root length, root weight and root yield per hectare were also significantly increased with alleviated dose of inorganic nutrient sources of NPK as soil treatment. Therefore, the integrated application of organic and inorganic N sources is suggested for the optimum production and quality of beetroot. The combination of 70:180:70kg NPK/ha (T_6) found superior over other treatments for increasing growth, yield and economic in beetroot over all other treatments followed by T_5 (70: 150: 70kg NPK/ha). Comparatively higher tuber yield (307.67 q/ha) was recorded in Treatment T_6 (70:180:70kg NPK/ha). Hence it is being recommended to farmers to grow beetroot under poplar based agroforestry system for better economic returns. These observations are based on the results of experiment conducted for one season only however, an extensive trial may be conducted to confirm these results.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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