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Comparison between direct sowing and transplanting methods of carrot (*Daucus carota* L.) using Biofertilizer with different doses at Namsai District of Arunachal Pradesh

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Abstract
The present investigation entitled "Comparison between direct sowing and transplanting methods of carrot (*Daucus carota* L.) using biofertilizer with different doses at Namsai District of Arunachal Pradesh" was carried out at the experimental field of the Arunachal University of Studies, Namsai during rabi season, 2022-23. The experiment was laid out in Randomized
Block Design (RBD) with four replication and six treatments. As treatment are T0 (control), T1 (0.06g Azotobacter), T2 (1g Azotobacter), T3 (3g Azotobacter), T4 (5g Azotobacter), T5 (7g Azotobacter). The main objective of this field is to the study the effect of biofertilizer on growth and yield of carrot and to study the yield of direct sown and transplanted carrot. The results showed that in direct sowing method the treatment of T3 (3g Azotobacter) recorded significantly higher germination (92.16%), root length (19.20 cm), average root weight (81.25 g), root yield per plot (1.94 kg) and yield (86.22 q/ha) as compare to transplanting. In transplanting method treatment T3 (3g Azotobacter) recorded significantly higher germination (70.24%), root length (17.53 cm), average root weight (56.00 g), root yield per plot (1.16 kg), yield (51.55 q/ha).

Keywords: biofertilizer, azotobacter, carrot, yield

Introduction
Carrot (*Daucus carota* L) is one of the root vegetable crops which is grown worldwide for its therapeutic and nutritional properties (Fanlégué *et al.*, 2017) [3]. It belongs to Apiaceae or umbelliferae family and is a cool season biennial, cultivated as an annual crop in the tropic's region (De Lannoy, 2001) [2]. In India, leading states of carrot producer are Haryana (386390 tonnes) followed by West Bengal (235390 tonnes), Punjab (224740 tonnes), and Utter Pradesh (178970 tonnes) etc. Carrot is an ancient cool season root vegetable, it has thick root, fleshy, annual, or biennial herb that is 30-120 cm tall and has upright or branching stem. The root starts developing after 12 to 16 days of sowing and reached its optimum length, shape, and size. In cultivation of carrot, temperature range of 15.5-21.1 ℃ is ideal for better colour and development of roots. Carrots provide a significant source of alpha and beta carotene and the building blocks of vitamin A. (Speizer *et al.*, 1999) [8]. It is also a significant source of vitamins, minerals, polyacetylenes, carotenoids, and flavonoids, all of which have a variety of nutritional and physiological advantages (Silva Dias, 2014) [7]. Furthermore, carrot can provide paramount of vitamin A better than other vegetables due to the high bioavailability of carrot carotenoids (van *et al.*, 2000) [11]. It can be used as salad, cooked vegetable and in juices (Sharma *et al.*, 2020) [9]. Besides being food, different parts of the crop can be utilized for different medicinal purposes like curing kidney diseases (Anjum and Amjad, 2002) [1].
Biofertilizer can be defined as a substance which contains living micro-organisms, when applied to seeds, plant surface or soil, colonize the rhizosphere of the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Biofertilizer add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. The microorganisms in biofertilizer restore the soil natural nutrient cycle and build soil organic matter. Using biofertilizer, healthy plants can be grown, while enhancing the sustainability and the health of the soil. Biofertilizer can be expected to reduce the use synthetic fertilizer and pesticides, but they are not yet able to replace their use.

Since they play Several roles, a preferred scientific term for such beneficial bacteria is "plant growth promoting rhizobacteria" (PGPR). Nitrogen fixing bacteria and phosphate solubilizers are main biofertilizer for horticulture crops. These micro-organisms are either free living in soil or symbiotic with plants and contribute directly or indirectly towards nitrogen and phosphorus nutrition of the plants. They also produce hormones, vitamins and other growth factors required for the growth and development of plants. (Singh, 2014) [10].

Materials and Method

The comparison between direct sowing and transplanting methods on the growth and yield parameter of carrot (*Daucus carota* L.) was carried out at the Agriculture Research Field, Arunachal University of studies, Namsai, Arunachal Pradesh. The experiment was laid out in Randomized Block Design (RBD) with four replications and six treatments. Both direct sowing and transplanting method was done on November 2022. A biofertilizer dose of Treatments are T0 (control), T1 (0.06g Azotobacter), T2 (1g Azotobacter), T3 (3g Azotobacter), T4 (5g Azotobacter), T5 (7g Azotobacter) was applied. All other cultural practices were kept normal and uniform for all the treatments. Data were recorded on yield and growth components such as seed germination, root length, average root weight, average yield per plot, total yield. Data collected were analysed statistically using Fisher's analysis of variance technique and Least Significant Difference (LSD) test at 5% probability level was applied to compare the differences among treatment means.

Result and Discussion

From the table no.1 and table no. 2, The results show among the treatments, T3 (3g of Azotobacter) showed higher value on growth and yield parameter in both direct and transplanting method of sowing. The treatment of T3 (3g Azotobacter) recorded significantly higher germination (92.16%), root length (19.20 cm), average root weight (81.25 g), root yield per plot (1.94 kg) and yield (86.22 q/ha) as compare to transplanting. In transplanting method treatment T3 (3g Azotobacter) recorded significantly higher germination (70.24%), root length (17.53 cm), average root weight (56.00 g), root yield per plot (1.16 kg), yield (51.55 q/ha). This could be due to biofertilizer (Azotobacter) since it provides plants to nutrients through the addition of microorganisms in the soil that have a positive role in supporting plant nutrition and stimulating root growth and it modifies the pH in the soil, which facilitates the plants absorption of nutrient Howeidi *et al*., (2023) [4].

Table 1: Effect of biofertilizer on direct sowing methods in yield and growth parameter of carrot (*Daucus carota* L.).

Treatments	Germination %	Root length (cm)	Average root weight (g)	Average yield per plot (kg)	Total yield (q/ha)
T0 (control)	80.15	15.73	45.75	0.83	36.88
T1(0.6g Azotobacter)	84.00	16.23	54.00	1.31	58.22
T2 (1g Azotobacter)	84.55	16.86	66.25	1.31	58.22
T3 (3g Azotobacter)	92.16	19.20	81.25	1.94	86.22
T4 (5g Azotobacter)	82.45	17.39	52.75	1.33	59.11
T5 (7g Azotobacter)	81.54	17.71	59.50	1.21	52.77
S.E (d)±	0.48	0.77	3.48	0.04	8.56
C.D (5%)	1.04	1.66	7.48	0.09	18.23

Table 2: Effect of biofertilizer on transplanting methods in yield and growth parameter of carrot (*Daucus carota* L.).

Treatments	Germination %	Root length (cm)	Average root weight (g)	Average Yield (kg) per plot	Total yield (q/ha)
T0 (control)	50.16	12.25	43.50	0.66	29.33
T1(0.6g Azotobacter)	60.15	14.05	51.50	1.05	46.66
T2 (1g Azotobacter)	61.18	16.26	55.73	1.12	49.77
T3 (3g Azotobacter)	70.24	17.53	56.00	1.16	51.55
T4 (5g Azotobacter)	51.60	13.70	50.34	0.75	33.33
T5 (7g Azotobacter)	62.26	13.42	50.04	1.07	47.55
S.E (d)±	0.12	0.06	1.47	0.11	7.12
C.D (5%)	0.25	0.14	3.16	0.23	15.89

From the above table's growth, and yield parameter; germination percentage, root length, average root weight, average yield per plot and yield is higher in direct sowing method as compare to transplanting method due to biofertilizer effect. As direct sowing significantly influenced the root marketability parameters; root uniformity, marketable yield, and total marketable root yield percentage, it is paramount in commercial carrot production. Similarly, results were reported by Obidiebube *et al*., (2023) [6].

Conclusion

It can be concluded that from the finding of the present study that comparison between direct sowing and transplanted method in carrot at Namsai district of Arunachal Pradesh, the direct sowing method recorded highest growth and yield attributes as compared to transplanting method. Based upon the observation, it can be recommended that cultivation of carrot in direct sowing method could be viable the climatic and soil condition of Namsai district, Arunachal Pradesh in terms of growth and yield.

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