Plant Archives Vol. 26, Supplement 1, 2026 pp. 1092-1095 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.146

STUDIES ON APPLICATION OF NANO DAP, BIOFERTILIZERS AND HUMIC ACID ON GROWTH AND YIELD OF BEETROOT (*BETA VULGARIS* L.)

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(Date of Receiving : 27-08-2025; Date of Acceptance : 16-11-2025)

ABSTRACT

The experiment entitled "Studies on application of nano DAP, biofertilizers and humic acid on growth and yield of beetroot (*Beta vulgaris* L.)" was carried out at New Orchard, Department of Horticulture, MARS, UAS, Raichur during *Rabi* (2023-2024). The experiment was laid out in randomized block design with nine treatments and is replicated thrice. According to the findings, it was observed that treatment T_9 i.e., 50% RDNP + 2mL kg^{-1} seed treatment & 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS)) recorded significantly higher plant height (46.64 cm), number of leaves per plant (14.31), leaf area (40.37 dm^2), LAI (3.53), root diameter (7.23 cm), root length (14.38 cm), root yield per plant (233.36 g), root yield per plot (17.92 kg), root yield per hectare (35.56 t) harvest index (84.23) and B:C ratio (3.17) when compared to control

Keywords **:** Beetroot, Nano DAP, Biofertilizers, Humic acid, Growth, Yield.

Introduction

Beetroot (*Beta vulgaris* L.), commonly known as garden beet or table beet, belongs to the family Chenopodiaceae having chromosome number 2n=18. Its origin lies in Western Europe and North Africa, where it was cultivated to feed humans and livestock. This biennial plant is cultivated as a cool-season annual. In India, it is mainly grown in the Northern and Southern regions. The beetroot plant consists of green tops and a swollen, fleshy and thick root that is used both as a vegetable and salads. During root development, concentric rings become visible in a central cross-section of the mature beetroot, which alternate between vascular and parenchyma tissue (Chhikara *et al*., 2019).

Beetroot helps to reduce blood pressure, prevents plaque formation and reduces bad cholesterol, keeps diabetes under check, treats anaemia, helps to relieve fatigue, improves sexual health and stamina, protects from cancer etc. Among the many constraints to increase productivity in beetroot, inorganic nutrition is the main limiting factor especially in alkaline soils. The continuous use of inorganic fertilizers is adversely affecting the sustainability of production besides causing environmental pollution.

The green revolution in 60's boosted agricultural production in India through high-yielding varieties, irrigation expansion, and chemical inputs. However, this intensity has led to soil degradation, nutrient deficiencies, increased pest resistance, and environmental pollution. To ensure long-term sustainability, there's a shift towards practices like crop rotation and organic farming, aiming to balance productivity with ecological health. Therefore, many farmers are looking for alternative methods to make agriculture more sustainable.

To maintain and sustain a higher level of soil fertility and boost crop productivity while mitigating

water pollution from inorganic nutrients. So, this study was undertaken to investigate the effectiveness of different combinations of nano DAP, biofertilizers and humic acid in enhancing crop growth, yield, and nutrient availability for both soil and plants.

Material and Methods

The present investigation on "Studies on application of nano DAP, biofertilizers and humic acid on growth, yield and quality of beetroot (*Beta vulgaris* L.)" was carried out at New Orchard, MARS, UAS, Raichur during 2023-24 using randomized complete block design with three replications. there were nine treatments viz., T_1-100% RDNP, T_2-50% RDNP + 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS), T_3-50% RDNP + 2mL kg-1 seed treatment & 2mL L-1 foliar spray of nano DAP (30 & 50 DAS), T_4-50% RDNP + 2mL L^{-1} foliar spray of nano DAP (30 &50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB), T_5-50% RDNP + 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS)+ humic acid 0.2% (30 & 50 DAS), T_6-50% RDNP + 2mL L^{-1} of nano DAP foliar spray (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS), T_7-50% RDNP + 2mL kg^{-1} seed treatment & 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB), T_8-50% RDNP + 2mL kg^{-1} seed treatment & 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS) + humic acid 0.2% (30 & 50 DAS) T_9-50% RDNP + 2mL kg^{-1} seed treatment & 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS). Here recommended K through conventional fertilizer is common for all the treatments.

The variety used in the study was Ruby King. Seeds were sown at the spacing of 30cm x 15cm and thinning was done to maintain spacing. Nitrogen, phosphorous and potassium were given through urea, SSP and MOP respectively. Fertilizers were applied according to the treatments. The data were recorded on five plants per treatment per plot in each replication on growth and yield parameters. Observations were recorded on plant height, number of leaves per plant, leaf area, leaf area index, chlorophyll content, root length, root diameter, root yield per plant, root yield per plot, root yield per hectare and harvest index. The data were statistically analysed using analysis of variance (ANOVA) for RBD following the standard procedure as described in "Statistical Procedure for Agricultural Research" by Gomez and Gomez (1984).

Results and Discussion

Growth attributes

The effect of application of nano DAP, biofertilizers and humic acid had significant effect on growth parameters of beetroot presented in table 1 and 2.Treatment T_9 i.e. 50% RDNP + 2mL kg^{-1} seed treatment & 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS) recorded significantly higher plant height (28.35, 40.60 and 46.64 cm), number of leaves per plant (7.61, 14.56 and 15.34), leaf area (7.49, 15.21 and 21.07 dm^2), and LAI (1.66, 3.38 and 4.68), when compared to control. It was found on par with treatment T_6-50% RDNP + 2mL L^{-1} of nano DAP foliar spray (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS). The increase in plant height and number of leaves per plant and leaf area might be due to nitrogen and phosphorus being major nutrients involved in the synthesis of nucleic acids (DNA, RNA), amino acids, proteins and they play an important role in cell division and cell elongation in the meristematic tissue of the plants (AL-Kaby *et al*., 2021).The increase in plant height positively correlates with an increase in the number of leaves and leaf area in plants due to the interconnected nature of plant growth processes and nutrient availability.

Yield attributes

Effect of application of nano DAP, biofertilizers and humic acid had significant effect on growth parameters of beetroot presented in table 3. Significantly maximum root length (14.38 cm), root diameter (7.23 cm), root yield per plant (233.36 g), root yield per plot (17.92 kg), root yield per hectare (35.56 t)(Fig 1.), harvest index (84.23%) and B:C ratio (3.17) was observed in treatment T_9 i.e., 50% RDNP + 2mL kg^{-1} seed treatment & 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS) and was at on par with treatment T_6-50% RDNP + 2mL L^{-1} of nano DAP foliar spray (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS) and T7-50% RDNP + 2mL kg^{-1} seed treatment & 2mL L^{-1} foliar spray of nano DAP (30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB).

The increase in yield parameters may be due to nano fertilizers with their higher surface area-to-volume ratio, enhance nutrient absorption and utilization along with biofertilizers and humic acid

leading to better plant growth. The optimal nutrient absorption stimulates vegetative growth, enhances photosynthetic capacity, and optimizes resource allocation, all of which contribute to increased yield parameters in beetroot. Present findings are in line with the reports of Mishra *et al*. (2020) in tomato, Devi *et al*. (2016), Mounika *et al*. (2022) and Kumar *et al*. (2023) in beetroot.

Conclusion

Among the different treatments, T_9 (50% RDNP and 2 mL kg^{-1} seed treatment & 2 mL L^{-1} foliar spray of nano DAP 30 & 50 DAS) + biofertilizers (5 kg ha^{-1} each of *Azospirillum*, PSB, KMB) + humic acid 0.2% (30 & 50 DAS) was found to be an effective treatment in terms of both yield and quality of beetroot cultivation.

Table 1 : Effect of nano DAP, biofertilizers and humic acid on plant height and number of leaves per plant at different growth stages in beetroot

Treatments (T)	Plant height (cm)			Number of leaves $plant^{-1}$		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
T_1	19.86	24.34	34.83	5.45	8.21	12.19
T_2	20.85	28.34	37.18	5.47	9.26	13.71
T_3	20.96	33.96	37.90	6.10	9.88	13.83
T_4	25.30	36.70	40.88	7.23	11.38	14.78
T_5	24.70	35.21	39.11	5.61	10.11	13.87
T_6	25.60	39.40	44.34	7.36	13.25	15.27
T_7	27.40	38.9	42.62	7.56	12.95	15.18
T_8	24.90	36.59	39.80	6.45	10.36	14.46
T_9	28.35	40.60	46.64	7.61	14.56	15.34
Mean	**24.21**	**34.89**	**40.37**	**6.54**	**11.11**	**14.31**
S. Em. ±	**1.15**	**1.61**	**1.86**	**0.30**	**0.55**	**0.48**
C.D. at 5%	**3.47**	**4.82**	**5.58**	**0.91**	**1.65**	**1.45**

Table 2 : Effect of nano DAP, biofertilizers and humic acid on Leaf area (dm^2)and Leaf area index (LAI)at different growth stages in beetroot

Treatments (T)	Leaf area (dm^2)			Leaf area index (LAI)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
T_1	3.40	7.89	12.89	0.75	1.75	2.86
T_2	3.56	9.28	13.07	0.79	2.06	2.90
T_3	3.68	9.56	13.28	1.00	2.13	2.95
T_4	5.69	12.74	15.97	1.26	2.83	3.55
T_5	4.53	11.05	15.13	0.83	2.45	3.36
T_6	5.90	14.58	19.11	1.31	3.24	4.24
T_7	7.22	13.26	17.57	1.60	2.95	3.90
T_8	4.87	12.06	15.21	1.08	2.68	3.38
T_9	7.49	15.21	21.07	1.66	3.38	4.68
Mean	**24.21**	**34.89**	**40.37**	**1.14**	**2.60**	**3.53**
S. Em. ±	**1.15**	**1.61**	**1.86**	**0.07**	**0.12**	**0.17**
C.D. at 5%	**3.47**	**4.82**	**5.58**	**0.22**	**0.36**	**0.51**

Table 3 : Effect of nano DAP, biofertilizers and humic acid on root length and diameter and root yield per plant, root yield per plot, harvesting index and B:C ratio in beetroot

Treatments (T)	Root length (cm)	Root diameter (cm)	Root yield $plant^{-1}$ (g)	Root yield $plot^{-1}$ (kg)	Harvest index (%)	B:C ratio
T_1	9.82	5.19	149.34	12.34	63.70	2.32
T_2	10.95	5.53	164.62	13.08	66.31	2.49
T_3	11.26	5.74	169.82	13.23	67.21	2.52
T_4	13.26	6.43	210.01	14.99	78.97	2.73
T_5	12.50	6.14	186.89	14.49	73.76	2.67
T_6	14.27	7.07	230.98	17.30	80.18	3.06
T_7	13.66	6.61	215.62	16.42	79.75	3.00

T_8	12.85	6.19	198.01	15.58	76.35	2.87
T_9	14.38	7.23	233.36	17.92	84.23	3.17
Mean	**12.55**	**6.24**	**195.41**	**15.04**	**74.49**	**-**
S. Em. ±	**0.48**	**0.28**	**9.25**	**0.66**	**3.44**	**-**
C.D. at 5%	**1.45**	**0.86**	**27.73**	**1.97**	**10.31**	**-**

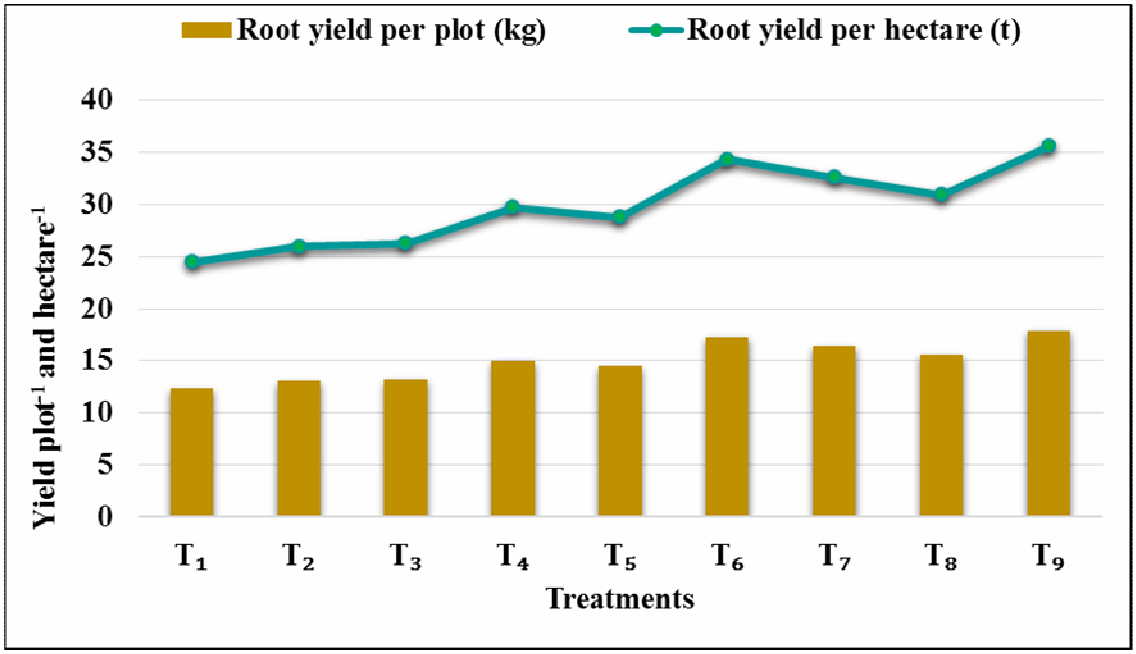

Fig. 1 : Effect of nano DAP, biofertilizers and humic acid on root yield per plot and hectare in beetroot

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