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Impact of Nano Nitrogen on Growth, Yield and Quality of Onion (*Allium cepa* L.) Var. Pusa Red

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Abstract
The study focused on the impact of Nano Nitrogen fertilization on growth and yield of onion (Allium cepa L.). It was conducted during the Rabi season of 2022-2023. The research farm, located at Department of Horticulture, R.B.S. College Bichpuri, Agra. The study evaluated nine treatments and found that Treatment T9 (RDN 10%+ 1250 ml NN/ha-1 at 25-30 days + 1250 ml NN / ha-1 50-55 days) consistently outperformed other treatments across various growth parameters, including plant height, number of green leaves, length and width of the longest leaf, pseudo-stem diameter, and fresh weight of tops and bulb. Post-harvest observations revealed that Treatment T9 resulted in the highest bulb yield per hectare, with significant improvements in bulb size, fresh weight, specific gravity, and dry matter content. The combined application of Nano Nitrogen Fertilizer demonstrated a positive impact on crop vigor, bulb size, and overall yield, aligning with previous research in onion cultivation. The study concluded that Treatment T9 was superior among all other treatments for onion growth and yield characteristics.
Keywords: *Nano Nitrogen fertilization, growth parameters.*

I. Introduction

Onion (*Allium cepa* L.) is a crucial vegetable crop, belonging to the family Alliaceae and the order Asparagales, with a chromosome number of 2n=16. It is widely grown in various countries, including India, which contributes significantly to the world's onion production and export. India is the second-largest producer and the fourth-largest exporter of onions globally. Major onion-producing states in India include Maharashtra, Karnataka, Gujarat, Orissa, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Rajasthan, and Bihar.(Britvich*et al*., 2017)

Onion is a cool-season crop that requires specific temperature and photoperiod conditions for both vegetative growth and bulb development. It is rich in minerals like phosphorus, calcium, and carbohydrates, and also contains protein, vitamin C, and other essential nutrients. India's onion production contributes significantly to meeting the country's vegetable consumption needs.

Nutrition is vital for the growth and development of onions, and the use of nano-based slow-release or controlled-release fertilizers has the potential to improve nutrient use efficiency, ultimately promoting productivity while ensuring environmental safety. Nano-fertilizers have shown promise in regulating nutrient release and enhancing nutrient absorption by crops. They have the potential to mitigate soil-related challenges and improve crop production.Lachica, J.F. (2012)

The proposed studies aim to evaluate the impact of Nano Nitrogenous fertilization on onion growth and yield, determine the best combination of Nano nitrogenous fertilization for yield and quality, and assess the economic viability of different treatments. These studies are essential in understanding how nano-based fertilizers can positively influence onion production, addressing the need for improved productivity and sustainability in onion cultivation.Omar, F.A. and A.E. Arafa (2012).

II. Materials and Methods

The "Impact on Nano Nitrogenous fertilization productivity and probability of onion (*Allium cepa L.*) Var. Pusa Red" field experiment was conducted at the Research Farm of the Department of Horticulture, R.B.S. College, Bichpuri, Agra during the Rabi season of 2022-2023. The experiment aimed to evaluate the effects of different fertilization methods on onion growth and yield.The research farm is situated at about 11 km to the west of Agra on Agra-Bharatpur Road at latitude of 27°02' N and longitude of 77°09' E with an elevation of 163.4 m above mean sea level. The experimental area is characterized by homogenous fertility and uniform textural makeup.The region experiences semi-arid, subtropical climate with extreme temperatures in both summer and winter. The mean annual precipitation is around 670 mm, primarily received during July, August, and September. The temperature can range from 2°C in winter to 46-48°C in summer.The experimental soil was found to be slightly alkaline (pH 7.9) and deficient in nitrogen and organic matter but moderate in phosphorus and fairly rich

in potash. It was determined to be a typical sandy loam soil with good water holding and heat absorbing capacity.The experiment consisted of nine treatments laid out in randomized block design with three replications. The treatments involved combinations of inorganic (N, P, and K) and Nano Nitrogen fertilization, and the experimental field was divided into twenty-seven plots.The research utilized a Randomized Block Design (RBD) with nine treatments and three replications. The variety used was Pusa Red, with a specific spacing, transplanting date, and irrigation methods.Inorganic fertilizers in the form of Urea, DAP, and MOP were applied as per the treatment. The fertilization involved incorporating nitrogen, phosphorus, and potassium in the soil before transplanting, with the remaining nitrogen doses applied in two splits after 30 and 60 days after transplanting (DAT).Uniform and healthy seedlings of Onion (*Allium cepa* L.) cv. Pusa Red were transplanted into the plots at specific spacing, and all necessary cultural operations and plant protection measures were adopted to maintain uniform plant population and ideal growth conditions.

The treatments comprised of 9 combinations of inorganic (N,Pand K), *Nano Nitrogenous* as detailed below.

T1=RDF (Recommended dose of fertilizer), T2=RDN 25%+500ml NN/ha at 25-30 days+500ml NN/ha 50-55 days, T3=RDN 25%+1000ml NN/ha at 25-30 days+1000ml NN/ha 50-55 days, T4=RDN 50%+500ml NN/ha at 25-30 days+500ml NN/ha 50-55 days, T5=RDN 50%+1000ml NN/ha at 25-30 days+1000ml NN/ha 50-55 days, T6=RDN 75%+500ml NN/ha at 25-30 days+500ml NN/ha 50-55 days, T7=RDN 75%+1000ml NN/ha at 25-30 days+1000ml NN/ha 50-55 days, T8=RDN 10%+1000ml NN/ha at 25-30 days+1000ml NN/ha 50-55 days, T9=RDN 10%+1250ml NN/ha at 25-30 days+1250ml NN/ha 50-55 days.

T_1	RDF(Recommended dose of fertilizers)
T_2	RDN25%+500mlNN/ha^{-1}at20-30days+500mlNN/ha50-55 Days
T_3	RDN25%+1000mlNN/ha^{-1}at25-30days+1000mlNN/ha50-55 Days
T_4	RDN50%+500ml NN/ha^{-1}at25-30days+500mlNN/ha^{-1}50-55 Days
T_5	RDN50%+1000mlNN/ha^{-1}at25-30days+1000mlNN/ha^{-1}50-55days
T_6	RDN75%+500ml NN/ha^{-1}at25-30days+500mlNN/ha^{-1}50-55 Days
T_7	RDN75%+1000mlNN/ha^{-1}at25-30days+1000mlNN/ha^{-1}50-55days
T_8	RDN10%+1000mlNN/ha^{-1}at25-30days+1000mlNN/ha^{-1}50-55days
T_9	RDN10%+1250mlNN/ha^{-1}at25-30days+1250mlNN/ha^{-1}50-55days

III. Result and Discussion

Growth Parameters:

a. Plant Height:

At 30 days after transplanting: Treatment T9 had the highest plant height (30.043 cm), significantly exceeding the heights of other treatments. At 60 days after transplanting: Treatment T8 exhibited the highest plant height (38.857 cm), significantly surpassing most treatments, except for T6 and T9.At 90 days after transplanting: Treatment T9 showed the highest plant height (47.657 cm), significantly out of performing treatments T1, T2, T3, T4, T5, T7, and T8.These results indicate variations in plant height over time and highlight the impact of specific treatments, particularly T9 and T8, on promoting plant growth at different stages following transplanting.(El-Kalla *et al*., 2016)

b. Number of Green Leaves Plant-1:

Number of green leaves per plant observations at different stages following transplanting:At 30 days after transplanting: Treatment T9 had the highest number of green leaves per plant (4.880), significantly surpassing other treatments, while T1 RDF had the lowest count (3.140).At 60 days after transplanting: Treatment

T9 showed a significant increase in the number of green leaves per plant (5.510), outperforming most treatments, with T7 and T8 being exceptions, and T1 RDF having the lowest count (4.443).At 90 days after transplanting: Treatment T9 recorded the maximum number of green leaves per plant (8.097), statistically comparable to T7 and T8, while T1 RDF had the minimum count (5.393).These results demonstrate the impact of different Nano Nitrogenous fertilization treatments on the number of green leaves per plant at various stages post-transplanting, highlighting the effectiveness of Treatment T9 in promoting leaf growth in onions.

c. Length of Longest Leaf:

Length of longest leaf observations at different stages following transplanting:At 30 days after transplanting: Treatment T9 exhibited the longest leaf length (28.043 cm), significantly higher than other treatments, with T8 showing superiority as well. Treatment T8 was on par with T7 in this aspect.At 60 days after transplanting: Treatment T9 had the longest leaf length (39.630 cm) at 60 days, significantly exceeding the lengths observed in treatments T1, T2, T3, T4, T5, T6, T7, and T8.

At 90 days after transplanting: Treatment T9 yielded the longest leaf length (54.767 cm) at 90 days, significantly surpassing treatments T1, T2, T3, T4, T5, and T6, while treatments T7 and T8 were statistically comparable to T9 in this parameter.These findings indicate the impact of various Nano Nitrogenous fertilization treatments on the length of the longest leaf at different stages post-transplanting, highlighting the effectiveness of Treatment T9 in promoting leaf growth in onions.

d. Width of the Longest Leaf:

Width of the longest leaf observations at different stages following transplanting:At 30 days after transplanting: Treatment T9 had the widest longest leaf width (0.550 cm) at 30 days, with T1 RDF showing the narrowest width (0.453 cm).At 60 days after transplanting: Treatment T9 exhibited the widest longest leaf width (0.897 cm) at 60 days, significantly surpassing treatments T7 and T8, while T1 RDF had the narrowest width (0.680 cm).At 90 days after transplanting: Treatment T9 recorded the widest longest leaf width (1.533 cm) at 90 days, significantly exceeding the widths observed in treatments T8 and T7, with T1 RDF having the narrowest width (1.257 cm).These results demonstrate the influence of different Nano Nitrogenous fertilization treatments on the width of the longest leaf at various stages post-transplanting, highlighting the effectiveness of Treatment T9 in promoting leaf width in onions.

e. Diameter of Pseudo-Stem:

Diameter of pseudo-stem observations at different stages following transplanting:At 30 days after transplanting: Treatment T9 had the widest pseudo-stem diameter (0.3550 cm) at 30 days, significantly exceeding the diameters of treatments T2, T3, T4, T5, T6, T7, and T8, with T1 RDF displaying the narrowest diameter. At 60 days after transplanting: Treatment T9 showed the largest pseudo-stem diameter (0.963 cm) at 60 days, significantly surpassing treatments T8, T7, T6, T5, and T4, while T1 RDF had the smallest diameter. At 90 days after transplanting: Treatment T9 exhibited the widest pseudo-stem diameter (1.250 cm) at 90 days, significantly exceeding the diameters of treatments T2, T3, T4, T5, T6, T7, and T8, with T1 RDF showing the narrowest diameter. These results indicate the impact of different Nano Nitrogenous fertilization treatments on the diameter of the pseudo-stem at various stages post-transplanting, highlighting the effectiveness of Treatment T9 in promoting pseudo-stem growth in onions.

f. Fresh Weight of Tops:

Fresh weight of tops per plant observations at different stages:At 60 days after transplanting: Treatment T9 had the highest fresh weight of tops (46.630 gm) at 60 days, statistically comparable with itself. T1 RDF had the lowest fresh weight of tops (29.04 gm) at this stage.At harvest: Treatment T9 recorded the highest fresh weight of tops (23.140 gm) at harvest, significantly comparable to treatment T8, while T1 RDF had the lowest fresh weight of tops (17.983 gm) at harvest. These results indicate the influence of different Nano Nitrogenous fertilization treatments on the fresh weight of tops at 60 days post-transplanting and at harvest, highlighting the effectiveness of Treatment T9 in promoting top growth in onions.

Yield and quality parameters:

Fresh weight of Bulb: Fresh weight of bulb observations at different stages:At 90 days after transplanting: Treatment T9 showed the highest fresh weight of bulbs (57.777 gm) at 90 days, significantly exceeding treatments T2, T3, T4, T5, T6, T7, and T8, while T1 RDF had the lowest fresh weight of bulbs (39.253 gm).At harvest: Treatment T9 recorded the highest fresh weight of bulbs (81.787 gm) at harvest, outperforming all other treatments. Treatment T7 was statistically comparable to T8, while T1 RDF had the lowest fresh weight of bulbs (64.783 gm) at harvest.These findings demonstrate the impact of different Nano Nitrogenous fertilization

treatments on the fresh weight of bulbs at 90 days post-transplanting and at harvest, highlighting the efficacy of Treatment T9 in enhancing bulb growth in onions.

Diameter of Bulb:

Diameter of bulb observations at different stages:At 60 days after planting: Treatment T9 exhibited the maximum diameter of bulb (7.150 cm) at 60 days, significantly larger than treatments T2, T3, T4, T5, T6, T7, and T8. T1 RDF had the smallest diameter of bulb (4.37 cm) at this stage.At harvest: Treatment T9 recorded the highest diameter of bulb (7.443 cm) at harvest, significantly surpassing treatments T2, T3, T4, T5, T6, T7, and T8. T1 RDF had the smallest diameter of bulb (4.980 cm) at harvest.These results demonstrate the impact of different Nano Nitrogenous fertilization treatments on the diameter of bulbs at 60 days after planting and at harvest, highlighting the effectiveness of Treatment T9 in enhancing bulb size in onions.

Fresh Weight of Bulb per Plot:

Fresh weight of bulb per net plot observations: The maximum fresh weight of bulb per net plot (6.28 kg/plot) was achieved with Treatment T7 (RDN 75%+ 1000 ml NN/ha-1 at 25-30 days + 1000 ml NN / ha-1 50-55 days), followed by T8 and T9, which were statistically similar to each other.The minimum fresh weight of bulb per net plot (3.43 kg/plot) was observed with T1 RDF (Recommended dose of fertilizers).These results illustrate the impact of different Nano Nitrogenous fertilization treatments on the fresh weight of bulbs per net plot, highlighting the effectiveness of Treatment T7 in enhancing bulb weight in onions.

Specific Gravity of Bulbs:

The specific gravity of bulb was significantly influenced by various treatments of Nano Nitrogenous fertilization significantly maximum specific gravity of bulb (1.722) was recorded in the treatment T8 (RDN 10%+ 1000 ml NN/ha-1 at 25-30 days + 1000 ml NN / ha-1 50-55 days). Treatment was statistically at par with the treatment T6 in this parameter while the minimum specific gravity of bulb (0.916) was recorded in treatment T1 RDF (Recommended dose of fertilizers).

Dry Matter Content of Bulb:

Maximum dry matter content of bulb (11.20) was produced by treatment T9 (RDN 10%+ 1250 ml NN/ha-1 at 25-30 days + 1250 ml NN / ha-1 50-55 days) which were higher in comparison to all other treatments, while the lowest dry matter content of onion bulb was obtained with T1 (RDF).

Total Bulb Yield q ha-1:

Treatment T9 resulted in the highest bulb yield per hectare (323.06 qha^{-1}), significantly surpassingother treatments, while T1 RDF had the lowest yield (186.963 qha^{-1}).The results consistently show Treatment T9 as highly effective across various parameters, indicating its significant impact on plant growth, yield, and quality characteristics. (Pandey *et al*., 2019)

The combined application of Nano Nitrogen Fertilizer led to increased plant height, number of green leaves per plant, length of the longest leaf, and bulb size, thereby positively impacting crop vigor and yield. Treatment T9 (RDN 10%+ 1250 ml NN/ha-1 at 25-30 days + 1250 ml NN / ha-1 50-55 days) consistently showed promising results across various parameters, such as plant height, number of green leaves, leaf length, leaf width, bulb diameter, neck thickness, and fresh weight of tops per plant. The application of Nano Nitrogenous fertilization had a significant influence on the average bulb weight, specific gravity of onion bulb, and overall bulb yield per plot and per hectare. (Haggag*et al*., 2017).

The study's results indicate that the use of Nano Nitrogenous fertilization, particularly treatment T9, had a positive impact on the growth and yield of onion crops. These findings align with previous research in the field of onion cultivation.Overall, the study suggests that the use of Nano Nitrogen Fertilizer in combination with recommended doses of NPK fertilizers holds promise for enhancing onion productivity and quality, providing a more economically viable and environmentally benign approach for onion cultivation during the Rabi season.(Sharma *et al*., 2022).

IV. Conclusion

On the basis of present investigation, following conclusions were drawn: On the basis of experiment conducted, the treatment T9 (RDN 10%+ 1250 ml NN/ha-1 at 25-30 days + 1250 ml NN / ha-1 50-55 days) was found superior among all other treatments for growth and yield characters of onion. So, second best treatment T8 (RDN 10%+ 1000 ml NN/ ha-1 at 25-30 days + 1000 ml NN / ha-1 50-55 days) can be recommended as a cost effective method for higher yield of onion bulb production in western (U.P).

Table:1. Effect of Nano Nitrogenous fertilization on vegetative growth of onion.

Treatment	Plant height (cm)		Number of green leaves per plant		Length of longest leaf (cm)		Width of longest leaf (cm)		Diameter of pseudo-stem (cm)		Fresh weight of tops (gm)	
	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	At harvest
T1	32.820	38.037	4.443	4.743	27.370	37.037	0.680	1.257	0.787	1.250	29.043	17.983
T2	34.370	42.037	4.700	5.393	30.783	41.740	0.777	1.307	0.813	1.397	39.303	18.807
T3	36.190	42.893	4.673	5.960	33.110	46.430	0.820	1.427	0.840	1.440	40.223	19.400
T4	34.747	39.220	4.773	5.917	30.480	38.837	0.800	1.293	0.830	1.437	39.733	19.037
T5	34.730	40.377	4.663	6.063	30.547	41.117	0.830	1.390	0.810	1.420	40.257	19.843
T6	42.340	45.213	5.183	6.177	36.287	52.517	0.807	1.483	0.907	1.527	43.890	21.067
T7	43.190	47.367	5.170	6.953	38.480	54.063	0.857	1.510	0.930	1.577	45.880	21.383
T8	38.857	43.473	6.913	7.723	39.510	54.220	0.873	1.520	0.957	1.593	46.217	22.257
T9	38.433	47.657	7.510	8.097	39.630	54.767	0.897	1.533	0.963	1.617	46.630	23.140
S.Em±	0.654	0.312	0.380	0.091	0.190	0.330	0.012	0.026	0.010	0.023	0.279	0.325
C.D.(P=0.05)	1.978	0.943	0.126	0.274	0.576	0.996	0.038	0.078	0.030	0.071	0.843	0.981

Table:2. Effect of Nano Nitrogen fertilizer on yield and quality of onion bulb.

Treatment	Fresh weight of bulb at harvest (gm)	Diameter at harvest (cm)	Fresh weight of bulb (Kg/plot)	Specific gravity of bulb	Dry matter content of bulb (gm)	Total bulb yield (q/ha)
T1	64.783	4.980	3.43	0.916	9.68	186.963
T2	74.747	5.527	3.59	1.118	9.78	224.800
T3	75.820	5.717	4.30	1.335	10.45	230.587
T4	74.443	5.417	4.43	1.163	10.67	195.963
T5	75.443	5.750	3.76	1.049	10.12	199.890
T6	76.407	6.147	3.91	1.428	10.47	196.023
T7	79.250	6.720	5.96	1.735	10.92	202.970
T8	81.213	7.387	5.76	1.826	11.05	304.623
T9	81.787	7.443	6.28	1.734	11.20	323.060
S.Em±	0.282	0.085	0.26	0.027	4.11	1.107
C.D.(P=0.05)	0.854	0.256	0.78	0.080	NS	3.348

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