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Effect of phosphorus management on growth, yield attributes and yields of basmati rice (*Oryza sativa* L.)

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Abstract

A field experiment was conducted Crop Research Centre of S.V.P. University of Agriculture and Technology, Meerut (U.P.) to Effect of phosphorus management on growth and yield attributes characters of basmati rice (*Oryza sativa* L.) during *kharif* season of 2022. The soil of the experimental field was well drained sandy loam in texture. The tested in completely Randomized Block Design (CRBD) with three replications. The rice variety Pusa basmati 1121. Results obtained from the study growth parameter revealed that plant height (cm), numbers of tillers (m^{-2}), leaf area index, dry matter accumulation (g m^{-2}), relative growth rate (g/g/day), Effective tillers m^{-2}, Panicle length (cm), Test weight (g), grain yield (q ha^{-1}) and straw yield (q ha^{-1}) in rice were significantly superior with the application of $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage as compared to T_1 of the treatments. However, the grain yield under T_{10} was 44.1% higher than T_3 ($N_{100}P_0K_{40}$). The application of $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage (T_{10}) incurred highest gross return (Rs-116584) and net returns 60588 ha^{-1} gross respectively. Besides, the highest B:C ratio (2.08) was also recorded with the application of $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage. Nano urea fertilizers significantly improved the plant growth performance and imparted sustainability to crop production with comprising the crop yield

Keywords: Nano urea, foliar spray, growth and yield

Introduction

Rice (*Oryza sativa* L.) is second most important cereal crop in world covering 164.19 million hectare with annual production of 513.02 million tonnes of grain with average productivity of 31.24 quintal per hectare (Anonymous, 2021) [1]. In India, rice is grown on around 43.86 million hectares area with record production of 127.93 million tonnes and productivity of about 23.90 quintal per hectare. Uttar Pradesh is the largest rice growing state after West Bengal in India, though its productivity is low. Rice is grown over an area of 5.95 mha with the production of 15.52 mt with average productivity of about 26.34 quintal per hectare in Uttar Pradesh.

Rice (*Oryzae sativa* L.) belongs to family Poaceae and genus "*Oryzae*". It contains 28.6% carbohydrate, 2.7% protein, 0.3% fat, and considerable proportion of Vitamin B6, Magnesium, Calcium, Iron (USDA, 2019). Biological value of rice protein is 80 which are higher than other cereal crop protein such as maize 50 and wheat 60. This compound is more concentrated in basmati than any other variety approximately 90 parts per billion. Rice production and productivity was significantly enhanced with the introduction and cultivation of semi-dwarf, fertilizer responsive and non-lodging high yielding verities in the late sixties leading to the "Green revolution". The yield level of high yielding varieties is plat eauing in recent years to meet the demand of increasing population and maintain the self sufficiency. This has to be done against the back drop of declining natural resources base such as land, water, labour and other inputs without adversely affecting the quality of environment.

Fertilizer has become increasingly crucial in improving food production and quality, particularly since the advent of high yielding and fertilizer responsive cultivars. Researchers have been working to improve rice production, but only a few cases of nano materials have been documented. Nano urea decreases the need for traditional urea by half or more while improving crop production, soil health and nutritional quality of output without compromising soil productivity. It is less expensive than conventional urea, which lowers farmers' input costs and boosts their profits. Rice plants require a lot of mineral nutrients, especially nitrogen to grow, develop and produce grains. Nitrogen is one of the important elements in plant owing to its major part in chlorophyll production, which is essential for the photosynthesis process. Whilst, nitrogen is part of different

enzymatic proteins that catalyze and regulate plant development processes. Foliar application of nano urea liquid at critical crop growth stages of a plant effectively fulfils its nitrogen requirement and leads to higher crop productivity and quality in comparison to conventional urea.

Methods and Materials

The present investigation entitled "Effect of phosphorus management on growth and yield attributes characters of basmati rice (*Oryza sativa* L.)" has been carried out during *kharif* season of 2022 at the Crop Research Centre (CRC, Chirori) of S.V.P. University of Agriculture & Technology, Meerut (U.P.) India. The soil of experimental field was sandy loam in texture. Soil samples from a depth of 0-15 cm were collected from each plot of the experimental field prior to transplanting and a composite sample was drawn for determining its physical and chemical properties of soil using the methods. The experimental soil was low in organic carbon, available nitrogen, phosphorus, potassium and zinc and medium. Field experiment was conducted in completely randomized block design (CRBD) with three replications and 10 treatments. (T_1) Control, (T_2) $N_{100}P_{60}K_{40}$(RDF), (T_3) $N_{100}P_0K_{40}$, (T_4) $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP, (T_5) $N_{100}P_{30}K_{40}$ + Root dipping with 2% Nano DAP, (T_6) $N_{100}P_{30}K_{40}$ + Foliar application of 2% DAP at MT & PI stage, (T_7) $N_{100}P_{30}K_{40}$ + Foliar application of 2% Nano DAP at MT & PI stage, (T_8) $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% DAP at MT & PI stage, (T_9) $N_{100}P_{30}K_{40}$ + Root dipping with 2% Nano DAP + Foliar application of 2% Nano DAP at MT & PI stage and (T_{10}) $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage were tested in Randomized Block Design (RBD) with three replications.

Results and Discussion

Growth parameter

The growth parameter was recorded treatment maximum plant height (113.5 cm), number of tillers (361 m^{-2}), leaf area index (4.65), dry matter accumulation (1308.2 g m^{-2}), crop growth rate (21.12 g/m^2) and relative growth rate (0.027g/g) was recorded treatment **(**T_{10})-N_{100} P_{30} K_{40} + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI Stage and the minimum data was recorded treatment **(**T_1)-control plant height (90.7 cm), number of tillers (226.3 m^{-2}), leaf area index (3.18), dry matter accumulation (919.8 g m^{-2}), crop growth rate (18.61 g/m^2) and relative growth rate (0.017g/g) was recorded. The Combined use of $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage resulted into significant increase in yield attributes characters over T_2 and T_3 at maturity stage. The effects of various treatments on number of tillers m^{-2} were found to be significant over T_2 and T_3, at all the stages of crop growth. The application of $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage increased the number of tillers m^{-2} significantly at all the stages of crop growth in comparison to T_2 and T_3. The significantly higher crop growth rate and relative growth rate taken to 50% flowering and maturity was recorded under application of $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage. Enhanced vegetative growth with higher nitrogen supply to the plant may be the primary reason for the rise in plant height with increased fertilizer treatment. Greater nitrogen availability to the plant at the active tillering stage may be the cause of the improved tillers due to the effect of nano urea application by Yomso and Menon 2021 [19].

Yield Parameter

The yield parameter was recorded effective tillers (358.3m^2), panicle length (28.9 cm) and test weight (22.37 g) T_{10}-$N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage**.** The treatment combination under treatment T_{10} also significantly increased the number of panicles/m^2 and test weight. The test weight and filled grains $panicle^{-1}$ in rice was found to be highest in plots which received $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage. Thus, better nutrition of plants associated with increased fertilization helped in maintaining significantly better vegetative growth leading to greater interception of solar radiation which helps in better photosynthates production and their translocation towards developing sink and thus ultimately contributed towards the significant increase in number of filled grains $panicle^{-1}$. Similar results were also reported by *Thakur* 2021 [14]. The maximum grain yield (50.9 q ha^{-1}) and straw yield (78.2 q ha^{-1}) was recorded significantly higher in the treatment T_{10}- $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage as compared to T_1 and T_2. The highest grain yield under treatment T_{10} was increased by 44.1% which was closely followed by treatment T_9, T_8 and T_7. The combination of RDF+Nano DAP Foliar spray balanced amount of essential nutrients into the soil and release the available nutrients for a longer period of time and thereby producing higher grains and straw yield *Biswas et al*. 2020 [3]. The variation in cost of cultivation of rice under different nutrient management practices. The highest B:C ratio (2.08) was in the crop grown with $N_{100}P_{30}K_{40}$ + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI stage (T_{10}) and lowest (1.12) under control (T_1).

Table 1: Effect of efficient phosphorus management on plant height (cm), Number of tillers (m^{-2}) at harvest, Dry matter accumulation (g m^{-2}) at harvest, Leaf area index, Crop growth rate (g/m^2/day) and Relative growth rate (g/g/day) of rice.

Treatments	Plant height (cm) at harvest	Number of tillers (m^{-2})	Dry matter accumulation (g m^{-2}) at harvest	Leaf area index	Crop growth rate (g/m^2/day)	Relative growth rate (g/g/day)
T_1-Control	90.7	226.3	919.8	3.18	18.61	0.017
T_2-N_{100} P_{60} K_{40} (RDF)	105.4	275.7	1121.8	4.12	19.88	0.019
T_3-N_{100} P_0 K_{40}	102.8	270.7	1034.9	3.96	19.15	0.019
T_4-N_{100} P_{30} K_{40} + Root dipping with 2% DAP	107.2	291.3	1143.0	4.26	19.97	0.022
T_5-N_{100} P_{30} K_{40} + Root dipping with 2% Nano DAP	109.1	305.0	1197.0	4.30	20.05	0.023
T_6-N_{100} P_{30} K_{40} + Foliar application of 2% DAP at MT & PI stage	110.0	327.3	1221.1	4.35	20.15	0.024
T_7-N_{100} P_{30} K_{40} + Foliar application of 2% Nano DAP at MT & PI stage	111.5	337.3	1244.2	4.39	20.24	0.024
T_8-N_{100} P_{30} K_{40} + Root dipping with 2% DAP + Foliar application of 2% DAP at MT & PI Stage	111.9	348.7	1265.6	4.43	20.47	0.025
T_9-N_{100} P_{30} K_{40} + Root dipping with 2% Nano DAP + Foliar application of 2% Nano DAP at MT & PI Stage	112.6	359.0	1293.4	4.57	20.94	0.027
T_{10}-N_{100} P_{30} K_{40} + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI Stage	113.5	361.7	1308.2	4.65	21.12	0.027
S.Em ±	3.2	9.4	47.3	0.12	0.08	0.001
C.D. (P=0.05)	9.6	28.1	141.8	0.37	0.22	0.002

Table 2: Effect of efficient phosphorus management on Effective tillers m^{-2}, Panicle length (cm), Test weight (g), Grain Yield (q/ha), Straw Yield (q/ha) and Harvest Index (%) of rice

Treatments	Effective tillers m^{-2}	Panicle length (cm)	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
T_1-Control	222.3	18.3	20.37	21.5	43.2	
T_2-N_{100} P_{60} K_{40} (RDF)	269.3	21.7	21.07	37.8	56.4	30.4
T_3-N_{100} P_0 K_{40}	266.7	19.4	20.90	35.3	51.6	40.0
T_4-N_{100} P_{30} K_{40} + Root dipping with 2% DAP	287.3	22.7	21.41	40.7	60.3	39.8
T_5-N_{100} P_{30} K_{40} + Root dipping with 2% Nano DAP	300.3	23.8	21.47	42.4	63.4	40.5
T_6-N_{100} P_{30} K_{40} + Foliar application of 2% DAP at MT & PI stage	322.7	24.9	21.50	44.1	65.8	41.0
T_7-N_{100} P_{30} K_{40} + Foliar application of 2% Nano DAP at MT & PI stage	331.3	25.7	21.56	46.6	68.9	40.8
T_8-N_{100} P_{30} K_{40} + Root dipping with 2% DAP + Foliar application of 2% DAP at MT & PI Stage	343.3	26.3	21.69	47.4	72.1	41.7
T_9-N_{100} P_{30} K_{40} + Root dipping with 2% Nano DAP + Foliar application of 2% Nano DAP at MT & PI Stage	353.7	27.0	21.83	48.8	74.6	41.5
T_{10}-N_{100} P_{30} K_{40} + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI Stage	358.3	28.9	22.37	50.9	78.2	41.9
S.Em ±	9.3	2.1	0.6	1.8	2.4	42.5
C.D. (P=0.05)	27.8	6.4	NS	5.2	7.3	1.2

Table 3: Effect of efficient phosphorus management on economic analysis of rice cultivation

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
T_1-Control	45198	50770	5572	1.12
T_2-N_{100} P_{60} K_{40} (RDF)	49031	86328	37297	1.76
T_3-N_{100} P_0 K_{40}	50282	80458	30176	1.60
T_4-N_{100} P_{30} K_{40} + Root dipping with 2% DAP	52396	92887	40491	1.77
T_5-N_{100} P_{30} K_{40} + Root dipping with 2% Nano DAP	52854	96854	44000	1.83
T_6-N_{100} P_{30} K_{40} + Foliar application of 2% DAP at MT & PI stage	52536	100716	48180	1.91
T_7-N_{100} P_{30} K_{40} + Foliar application of 2% Nano DAP at MT & PI stage	55974	106331	50357	1.90
T_8-N_{100} P_{30} K_{40} + Root dipping with 2% DAP + Foliar application of 2% DAP at MT & PI Stage	52558	108459	55901	2.06
T_9-N_{100} P_{30} K_{40} + Root dipping with 2% Nano DAP + Foliar application of 2% Nano DAP at MT & PI Stage	56454	111718	55264	1.98
T_{10}-N_{100} P_{30} K_{40} + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT & PI Stage	55996	116584	60588	2.08
S.Em ±	1633	2939	1416	0.06
C.D. (P=0.05)	4890	8801	4239	0.17

Conclusion

On the basis of experimental findings, it can be concluded that application of 100 kg N + 30 kg P_2O_5 + 40 kg K_2O + Root dipping with 2% DAP + Foliar application of 2% Nano DAP at MT and PI stages improves the growth, yield and yield attributes of basmati rice and proves to be best for economic basmati rice production. Besides, it also improves phosphorus use efficiency and available nutrient status in soil. The next best option is T_9 (N_{100} P_{30} K_{40} + Root dipping with 2% Nano DAP + Foliar application of 2% Nano DAP at MT & PI Stage). Further, one year more research is also needed to validate the recommendations under western U.P. conditions.

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