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Elucidating The Effect Of Farmyard Manure And Zinc Along With Optimum Dose Of Inorganic Fertilizer On The Productivity Of Rice (*Oryza Sativa* L.)

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ABSTRACT

The continuous use of chemical fertilizers for a long period of time deteriorates the nutrient status of soil. Even if balanced doses are used it leaves a residual effect for the next crops grown in the same arable land. This change in soil becomes more problematic for a vulnerable crop. In this regard a field experiment was carried out during Kharif season of 2010 and 2011. To study the effect of Farmyard Manure and Zinc along with optimum dose of NPK on the productivity of rice variety Pant Dhan 4. The studies so far reveal that the application of essential plant nutrients particularly macro and micronutrient in optimum quantity and right proportion is the key to increased and sustained crop production. An application of NPK with FYM and Zn proved to be superior in recording the highest number of tiller, panicle length, leaf area index, test weight and grain yield. This study demonstrates that the combined application of inorganic fertilizers and organic manures along with Zn has the potential to reduce chemical fertilizer usage without decreasing the yield of rice variety pant Dhan 4. In addition, excessive use of chemical fertilizers in agriculture has led to a variety of environmental problems and in the future fertilizers will be a major source of heavy metals and radionuclides accumulating as inorganic pollutants in plants.

Keyword: Rice, NPK, FYM, number of the tiller.

INTRODUCTION

Rice is one of the major staple crops of the world. It is consumed by about half of the world's population. It is particularly consumed in Asiatic countries, where roughly 90% of the world's rice is also produced (Zeigler and Barclay 2008; Khush 2004). Though the rice production has been increasing since after the Green Revolution, yet food security is an issue due to ever growing population of the world. Hence it is estimated that rice production should be increased by 50% in this country by 2025 (Thiyagarajan and Selvaraju, 2001). In India that about 43% of the land is the area under rice cultivation and there is a little scope for bringing more area under cultivation due to rise in population. This concern brings into light a thought that

the soil of agricultural land should be protected and utilized sensibly by mankind for a sustainable development. Indeed the contribution of fertilizers for attaining increased agricultural production cannot be neglected as a majority of Indian soils are deficient in several macro and micro nutrients. The application of essential plant nutrients in optimum quantity and right proportion through correct methods and time of application has great importance for increased production (**Jaga and Patel 2012**). Notably the nutrients given through chemical fertilizers is gradually depleting the soil quality and posing to be environmentally unsustainable. Hence attention to organic fertilizers is increasing day by day as it is seen as an appropriate way to maintain soil health by providing soil organic matter and micronutrients (**Rabobank 2005**).

High agricultural yields depend strongly on fertilization with mineral nutrients. The macronutrients primarily deficient in soil and required by any crop are Nitrogen, Phosphorus and Potassium. Nitrogen is a very important mineral element that is required by plants in large quantity by the crops. It is an important component of highly crucial biomolecules such as amino acids, proteins and nucleic acids, chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins (**Taiz and Zeiger 2003; Azarpor et al. 2011**). Likewise phosphorus is an integral component of important compounds in plant cells. It is required in the formation of phosphate intermediates in processes such as respiration, photosynthesis, formation of phospholipids, constitution of DNA and RNA etc. It is essentially required in the formation of ATP and NADH, one a major energy storage form and other a reducing agent in metabolic reactions of plants respectively (**Taiz and Zeiger 2003; Gonias et al. 2005**). Potassium is known to play a role in ion homeostasis, salt tolerance mechanisms, antioxidant systems. It also controls the phenomenon of osmoregulation in guard cells thereby participating in the mechanism of opening and closing stomata (**Cakmak 2005; Chartzoulakis et al. 2006**).

Among the deficient micronutrients, zinc is becoming important in research investigations due its role and functions in a multitude of plant mechanisms. Zinc functions as an activator of several enzymes involved in metabolic activities (**Chaudhary et al. 2007**). The deficiency of zinc in soil is prevalent worldwide. If the current trend continues, Zinc deficiency in soils is projected to increase from the present level of 50% to an estimated 63% by 2025 bringing an alarming situation in agriculture (**Kaushik 2018**). Factually modern agriculture cannot be replaced completely in short span of time. Hence it is essential to opt for an integrated approach in which inorganic fertilizers should be used with bio-fertilizers or/and farmyard manure. Farmyard manure is easily available, cheap, proven source of nutrition to agriculture crops and has been used by the farmers traditionally. Besides supplying macro and micronutrients it also improves the physical, chemical and biological properties of soil (**Singh et al. 2017**). Farmyard manure release nutrients slowly and steadily over longer periods of time and also improves the soil fertility status by activating the soil microbial biomass (**Ayuso et al. 1996; Belay et al. 2001**). With this viewpoint the present study was conducted which aimed at improving nutritional status and fertility of soil by using nine treatments.

MATERIALS AND METHODS

The investigation was done during Kharif season of 2010 and 2011 at Norman E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture & Technology, Pantnagar (U.S. Nagar), Uttarakhand, India. The study was performed on rice crop variety Pant Dhan 4 which was provided with different fertilizer combinations of N, P, K, Zn, FyM namely. Treatment combination constitute of T1(control), T2(N120), T3(N120 + P40), T4(P40 + K40), T5(N120 + K40) T6 (N120 + P40 + K40), T7 (N120 + P40 + K40 + Zn), T8(N120 + P40 + K40 + FYM), T9 (N120 + P40 + K40 + Zn + FYM) T10 (N180 + P80 + K + Zn + FYM), T11(N150 + P40 + K40), T12 (N180 + P80 + K40 + Zn), T13 (N180 + P80 + Zn), T14{N120 + P40 + K40 (DAP)} DAP= Diammonium Phosphate.

Half of the nitrogen (1/4 in 150 and 180 Kg N ha⁻¹ treatments) and total quantities of Phosphorous and Potash were applied just before transplanting on drained puddle surface and incorporated into top 15 cm. soil manually with the help of spade. The remaining quantity of nitrogen was top dressed in two equal installments in T1 to T9 at active tillering and 5-7 days before panicle initiation stage. In T10 to T12 nitrogen was top dressed at active tillering, 5-7 days before panicle initiation and at flowering stages. The FYM (5 t ha⁻¹ on dry weight basis) was applied and incorporated as per the treatment one month before transplanting. The foliar zinc was sprayed 10 to 20 days after transplanting both the year. Two days after transplanting Machete 50 EC (Butachlor at 1.5 Kg. ha⁻¹) was sprayed in the field and later one manual weeding was done to keep experiment weed free. Three plants were randomly selected from each replication for observations. Observations were recorded on per plot basis. The method of recording observations on various traits is given below.

Number of tillers of three randomly selected plants was counted from each replication at three stages 45, 60, 90, Days after sowing. The panicle length of each of the three randomly selected plants main panicle from each replication was measured in centimeters from the neck of stem to the tip of panicle. The leaf area index was recorded at 30 and 60 days after sowing. Three replications of each hill were taken. All the leaves of each hill were collected and the leaf area was calculated with the help of leaf area meter and the average of these was taken out. With the help of this calculation the per meter square leaf area was calculated. This leaf area was divided by one meter square for calculating leaf area index. The total leaf area is estimated as follows:

$$\text{Leaf Area Index (LAI)} = \text{Leaf Area} / \text{Land Area}$$

For 1000 grain weight One thousand well developed dried grains were randomly selected from each replication and weighed on a digital balance. The value was recorded in grams up to two decimal places. Grain yield (economic yield) from each replication was recorded and finally expressed as t/ha after harvesting.

RESULTS

Number of Tiller

Tillering is an important trait for grain production and is thereby an important aspect in rice yield the plant increase in number of tillers directly influences productivity.

The data presented in Table 1 showed that at 45 days after sowing maximum number of tillers was recorded for the NPK+Zn (5.92) and NPK + FYM (6.75) during 2010 and 2011 respectively whereas minimum number of tillers was recorded for both the year by the N (2.50) and (2.50) for 2010 and 2011 respectively. At 60 days after sowing N180 P80 K+Zn+FYM (16.67) and NPK+Zn+FYM (10.50) showed maximum number of tillers for 2010 and 2011 respectively whereas control (6.50) and N (5.83) showed minimum number of tillers for 2010 and 2011 respectively. At 90 days after sowing N180P80+ZnF (18.83) and NPK (DAP) (21.17) was found maximum number of tillers for 2010 and 2011 respectively whereas N (11.00) and control (7.58) showed minimum number of tillers for 2010 and 2011 respectively. Analysis of data on number of tillers showed that at 30 days after sowing number of tillers increase in range of 37.03% to 53.52% for 2011 and 2010 respectively and decreased 70% to 10% for 2011 and 2010 respectively in comparison to control. At 60 days after sowing tiller numbers increased 57.54% to 19.87% and decreased upto 44.27% for 2010 and 2011 respectively in comparison to control. At 90 days after sowing tiller numbers increased 30.09% to 64.17% and decrease upto 9.09% for 2010 and 2011 respectively in comparison to control. Tillering is an important trait for grain production and is thereby an important aspect in rice yield the plant increase in number of tillers directly influences productivity. The above result showed that in different growth stages NPK+FYM, NPK+Zn, N180 P80 +ZnF, NPK (DAP) are giving maximum number of tillers which reveals that integrated dose of NPK with Zn and FYM is important for better tillering.

Panicle Length

The data for panicle length is presented in Table 2. It shows that the different fertilizer treatments and their combination with organic manure has a significant influence on Panicle length of Rice. The highest panicle length was observed for the NPK (DAP) (33.92cm) and N180 P80 +ZnF (27.25cm) in 2010 and 2011 respectively. In 2010, however, minimum increment in panicle length was recorded for the N180 P80 K+Zn+FYM (23.25cm). The increment in panicle length brought about by different treatments range from 23.09% to 18.35% for 2010 and 2011 respectively. However a decrement has also been recorded ranging from 12.18% to 2.29% for 2010 and 2011 respectively as compared to control. Results also shows that integrated dose of N, P, K with Zn gave highest panicle length but if the dose is increased from N120 to N180 then a decrease has been observed

Leaf area index

The data presented on Table 3, during 2010 and 2011 at 30 days after transplanting, maximum value of leaf area index was observed for N180 P80 K+Znf (2.629) and N180P80+Znf (2.37) respectively whereas least value of leaf area index was recorded for the NK(1.187) and N150PK (0.75) for 2010 and 2011 respectively. At 60 days after sowing N180 P80 K+Znf+FYM (4.908) and N180 P80 K+Znf (4.68) is showing best results for 2010 and 2011 respectively while treatment NK (2.208) and (1.27) shows minimum value for LAI during 2010 and 2011 respectively. The data presented on LAI at 30 days after sowing showed increment in range of 43.22% to 23.93% for 2010 and 2011 respectively and decreased upto 25.73% for both the year in comparison to control. At 60 days after sowing range of increment in LAI is 67.09% to 82.89% for 2011 and 2010 respectively and decreased upto 48.59% for both the year in comparison to control.

Test weight

Various parameters under study may have a correlation with each other (either positive or negative) eventually affecting the yield. Test weight is an important character which can again help to understand the effect of nutrient in productivity of rice. The data presented on Table 4, showed that during 2010 and 2011 maximum test weight was observed for NPK (27.56g) and N180 P80 +Znf (27.72g) respectively. However minimum test weight was recorded for N (21.00g) and N (22.24g) during 2010 and 2011 respectively. The values for test weight was found to increase in range of 15.16% to 19.76% for 2010 and 2011 respectively and decreased 11.33% to 0.26% for 2010 and 2011 respectively in comparison to control. Results showed that if Nitrogen, Phosphorus and Potassium were given separately they showed decreased test weight whereas if it was given together it was showed maximum test weight.

Grain yield

The data pertaining to grain yield of rice is presented in table 5 and reveals a significant effect of both inorganic fertilizers and their conjunction with organic manure during both the years of study. All the treatments produced higher grain yield over control treatment. The highest grain yield was observed in the treatment NPK+FYM (5.73tha⁻¹) during 2010 while in N180 P80 K+Znf, (6.22 tha⁻¹) during 2011. The lowest value was recorded for control treatment in the both years. The data presented on grain yield showed that the grain yield increased in range of 47.27% to 51.95% for 2010 and 2011 as compared to control. The result clearly indicates that the application of organic manures with fertilizers increased grain yield which was comparable to the 100% chemical fertilized treatment.

DISCUSSION

The findings of consecutive two years study (2010 & 2011) indicate a positive correlation between different growth parameters of Rice and various doses of mineral nutrition provided to the crop. Different minerals directly or indirectly participate in metabolism of plants. Without adequate minerals plants can't reach their full potential of yield and growth. In addition the nutrients also improve temperature tolerance and water use efficiency of plants (**Bagci et al. 2007**). Nitrogen is an important constituent of plant proteins and hence required throughout the crop growth period from vegetative period to maturity period (**Sahota 2006**). The present piece of work has utilized Farmyard manure (FYM) in treatment T9 and T10. It has been used in the study due to its several merits. Besides supplying macro and micronutrients, they improve different physical properties of soil like its structure, water holding capacity etc., FYM has low nutrient concentration with a complex organic form. The entire amount of nutrients present in manures is not available immediately and hence has long residual effect. About 30 per cent of nitrogen, 60 to 70 per cent of phosphorus and 70 per cent of potassium are available to the first crop (**Chandra . K. 2005**).

The different mineral nutrients provided through farmyard manure were conducive in providing better nutrition when used in combination with chemical fertilizers. Infact the combination proved to be at par with the treatments with higher chemical doses. Pant Dhan 4 has shown appreciable response towards N P K over tillering and other growth parameters. It is a medium maturing (130 days) semi dwarf and high yielding variety. It has field tolerance to bacterial leaf blight and yielding potential of 8 t/ha (**Pathak 1991**) Numbers of tillers (specialized grain bearing branch) is an important agronomical trait that affects the crop biomass as it has a direct influence on the production of any crop. Tillers were observed to grow more in number per square meter on application of different fertilizer combinations. The improvement might be due to the more availability of

nitrogen which is required in the manufacture of nucleic acids of new tillers during cell division. The results seek support from that of **(Miller 2007)** where chemical fertilizers and organic fertilizers enhanced the number of tillers when applied alone or in combination. Similar results were also found elsewhere that application of nitrogen, phosphorus and potassium fertilizer on improve growth, yield and tiller numbers. Maximum number of tillers recorded for the treatment with application of 150 kg/ha nitrogen fertilizer in comparison to control **(Mghase et al. 2011)**. Similar to growth parameters the yield parameters also showed improved results. Panicle length might have increased due to proper nutrition during the time of anthesis. In the plots where zinc doses have also been given there the levels of growth hormone auxin might have risen. Number of fertile tillers per hill, panicle number per square meter and panicle length significantly increased in all the treatments over control **(Siavoshi, 2011)**. Leaf area index (LAI) is an important physiological parameter in crop growth simulation as leaves are the primary photosynthetic organs. A larger assimilating area of crop generates an improved nutritional source, carbohydrates in particular **(Cakmak et al. 1998)**. It determines the interception of incoming photosynthetically active radiations (IPAR), and thereby affects crop biomass and its growth rate. As an example increase in Nitrogen concentration results increase in LAI by 62% and IPAR by about 20% **(Salvagiotti and Miralles 2008)**.

The treatments N180 P80 K+Znf and NPK+FYM has showm maximum LAI. The cause of this improvement may be attributed to the role of nitrogen in increasing division and elongation of cells. It is reported that increasing nitrogen levels upto 120 kg N/ha significantly increased plant height, leaf area, yield component and LAI were significantly increased when rice was fertilized with nitrogen levels kg/ha 0, 55, 110, 164 the leaf area index was recorded as 5.29, 5.61, 5.81, 6.42 respectively **(Li et al. 2012)**. With the addition of organic package fertilizer can increase the leaf area index by 1.725 each for each additional 150 kg ha⁻¹ of urea fertilizer. Without the application of organic fertilizer the index of leaf area increases by 0.93 for each additional 150 kg ha⁻¹ of urea fertilizer **(Pangaribuan et. al. 2018)**

Test weight is an important character which can help to understand the effect of nutrients in productivity of rice. It reflects the biomass and health of grain after the harvesting of crop. The enrichment of assimilates in the developing grain leads to enhancement of weight of the ripened grains. Improved Test weight shows an improved shoot biomass and partitioning of assimilates during grain filling stage on application of mineral nutrients. The study seek support from that of **(Naorem 2018)** where the highest test weight was 26.17 g per 1000 seeds in T7 and lowest was 22.63 g per 1000 seeds in T5. Grain yield is a multifactorial trait depending on components like panicle length, tillers, thousand grain weights etc. An expanded leaf area may also have affected yield in a positive way. Similar results were found which reveal the fact that, increasing levels of nitrogen from 80 to 160 and 240 kg ha⁻¹, wheat grain yield significantly increased 52%, 115% and 95% over control **(Abedi et. al. 2010)**. The grain yields of rice ranged from 3.28 to 5.58 t ha⁻¹ due to different treatments. All the treatments produced significantly higher grain yield over control. It was reported that the application of organic manure and chemical fertilizers increased the grain and straw yields of rice **(Sohel. et. al. 2016)**.

CONCLUSION

The above study reveals the fact that maximum number of tiller, LAI, Panicle length; Test Weight and Grain yield was given by the treatments where all the three NPK are present with either FYM or Zinc or with both of them. T9 is the best treatment as it is having the entire nutrient and the dose of NPK was minimum. The treatments which are giving maximum production but they are showing insignificant difference with T9 Therefore optimum dose for maximum production is T9.

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Table 1: Effect of different nutrients on number of tillers of rice variety Pant Dhan 4 in kharif 2010 &2011.

S. No	Treatments	Number of tillers					
		45 DAS		60 DAS		90 DAS	
		2010	2011	2010	2011	2010	2011
T1	Control	2.75±0.20	4.25±1.38	6.50±0.41	8.42±0.82	12.00±0.68	7.58±0.58
T2	N	2.50±0.16	2.50±0.098	7.92±0.61	5.83±1.26	11.00±0.36	9.75±1.32
T3	NP	3.42±0.34	3.34±0.23	8.83±0.21	8.42±1.53	12.75±0.34	9.75±1.57
T4	PK	3.50±0.28	3.25±0.31	9.83±0.41	7.42±0.55	12.58±0.92	9.42±0.69
T5	NK	3.33±0.45	3.00±0.23	11.92±0.47	6.67±0.84	12.42±0.41	9.25±0.27
T6	NPK	4.50±0.61	4.42±0.76	13.92±0.61	8.59±1.61	14.67±0.36	14.75±0.49
T7	NPK+Zn	5.92±0.25	5.42±0.20	15.08±0.67	9.42±0.79	15.83±0.34	17.58±1.49
T8	NPK+FYMr	5.92±0.68	6.75±0.45	14.83±0.83	10.42±1.34	16.25±0.90	17.67±2.01
T9	NPK+ZnF+FYMr	4.67±0.68	6.00±0.40	16.00±0.72	10.50±0.28	16.42±1.07	19.25±0.97
T10	N ₁₈₀ P ₈₀ K+ZnF+F YMr	4.75±0.55	4.17±0.095	16.67±0.70	9.59±0.75	17.17±0.72	19.42±0.54
T11	N ₁₅₀ PK	5.33±0.84	5.34±0.10	16.33±0.65	9.08±0.74	16.92±0.15	18.50±1.17
T12	N ₁₈₀ P ₈₀ K+ZnF	5.00±0.10	5.58±0.95	15.42±0.75	8.92±2.63	16.17±0.096	18.17±0.86
T13	N ₁₈₀ P ₈₀ +ZnF	4.92±0.34	4.17±0.21	16.67±0.19	7.83±0.68	18.83±0.64	18.09±0.65
T14	NPK (DAP)	4.25±0.25	5.00±0.49	16.08±0.34	9.92±1.47	17.42±0.58	21.17±0.99
	S.Em.±	0.50	0.44	0.53	0.64	0.64	1.02
	CD at 5%	1.45	1.27	1.53	1.85	1.85	2.94

Table 2: Effect of different nutrients panicle length on rice variety Pant Dhan 4 in kharif 2010 and 2011.

S. No.	Treatments	Panicle length in cm	
		2010	2011
T ₁	Control	26.08±0.95	22.25±1.80
T ₂	N	25.75±1.03	23.42±1.14
T ₃	NP	27.67±0.75	22.75±1.70
T ₄	PK	29.42±1.34	22.92±1.69
T ₅	NK	28.67±0.99	21.75±1.02
T ₆	NPK	27.42±0.86	23.00±1.31
T ₇	NPK+Zn	31.25±0.41	25.50±1.07
T ₈	NPK+FYM	30.83±1.95	25.84±1.34
T ₉	NPK+Znf+FYM	33.08±2.14	26.34±0.93
T ₁₀	N ₁₈₀ P ₈₀ K+Znf+FYM	23.25±1.17	24.42±1.14
T ₁₁	N ₁₅₀ PK	31.75±2.25	25.59±0.39
T ₁₂	N ₁₈₀ P ₈₀ K+Znf	30.58±1.41	25.50±0.96
T ₁₃	N ₁₈₀ P ₈₀ +Znf	30.08±1.37	27.25±0.88
T ₁₄	NPK (DAP)	33.92±1.94	25.92±1.77
	S.Em.±	1.24	0.87
	CD at 5%	3.55	2.51

Table 3: Effect of different nutrients on LAI of rice variety Pant Dhan 4 in kharif 2010 and 2011.

S. No	Treatments	Leaf Area Index			
		30 DAT		60 DAT	
		2010	2011	2010	2011
T1	Control	1.493±0.22	1.43±0.14	3.281±0.44	1.54±0.060
T2	N	1.393±0.25	1.40±0.26	2.468±0.031	1.49±0.11
T3	NP	1.894±0.21	1.73±0.32	3.134±0.096	2.31±0.0037
T4	PK	1.699±0.21	1.99±0.24	2.637±0.046	1.66±0.045
T5	NK	1.187±0.51	1.74±0.15	2.208±0.13	1.27±0.090
T6	NPK	1.380±0.59	2.34±0.49	2.915±0.10	3.02±0.10
T7	NPK+Zn	1.208±0.24	1.51±0.24	4.655±0.52	4.35±0.13
T8	NPK+FYMr	2.498±0.54	1.88±0.54	3.481±0.36	3.85±0.36
T9	NPK+ZnF+FYMr	1.807±0.34	1.67±0.30	3.633±0.16	3.79±0.16
T10	N ₁₈₀ P ₈₀ K+ZnF+FYMr	2.134±0.73	1.66±0.22	4.908±0.077	1.89±0.67

T11	N ₁₅₀ PK	1.411±0.41	0.75±0.043	4.670±0.33	4.34±0.33
T12	N ₁₈₀ P ₈₀ K+ZnF	2.629±0.53	1.92±0.12	4.862±0.19	4.68±0.19
T13	N ₁₈₀ P ₈₀ +ZnF	2.347±0.12	2.37±0.10	3.560±0.17	3.73±0.17
T14	NPK (DAP)	1.973±0.049	2.05±0.074	3.582±0.083	3.60±0.083
	S.Em.±	0.088	.1325	0.249	.1521
	CD at 5%	0.252	.3792	0.712	.4352

Table 4: Effect of different nutrients on test weight of rice variety Pant Dhan 4 in kharif2010 and 2011.

S. No.	Treatments	Test weight in gm.	
		2010	2011
T1	Control	23.38±0.31	22.30±0.59
T2	N	21.00±1.06	22.24±0.73
T3	NP	23.00±0.61	23.69±0.57
T4	PK	25.00±0.54	23.40±0.37
T5	NK	24.13±1.66	23.44±0.62
T6	NPK	27.56±0.54	23.39±1.16
T7	NPK+Zn	25.38±0.55	24.16±0.49
T8	NPK+FYM	26.38±0.55	24.72±0.63
T9	NPK+Znf+FYM	25.63±0.55	26.16±0.59
T10	N ₁₈₀ P ₈₀ K+Znf+FYM	26.50±0.54	26.00±0.64
T11	N ₁₅₀ PK	26.13±0.82	25.96±0.65
T12	N ₁₈₀ P ₈₀ K+Znf	26.63±0.77	27.10±0.59
T13	N ₁₈₀ P ₈₀ +Znf	27.38±0.51	27.72±0.43
T14	NPK (DAP)	25.50±0.93	26.81±0.37
	S.Em.±	0.83	0.62
	CD at 5%	2.38	1.79

Table 5: Effect of different nutrients on grain yield in kg of rice variety Pant Dhan 4 in kharif 2010 and 2011.

S. No.	Treatments	Grain yield in tha^{-1}	
		2010	2011
T1	Control	3.02±0.14	2.99±0.20
T2	N	3.02±0.16	3.54±0.24
T3	NP	3.78±0.14	4.84±0.11
T4	PK	3.65±0.17	3.68±0.095
T5	NK	3.68±0.18	3.68±0.097
T6	NPK	4.41±0.12	5.17±0.047
T7	NPK+Zn	5.03±0.094	5.21±0.21
T8	NPK+FYM	5.73±0.23	6.19±0.13
T9	NPK+Znf+FYM	4.86±0.44	6.20±0.12
T10	N ₁₈₀ P ₈₀ K+Znf+FYM	4.17±0.22	4.93±0.17
T11	N ₁₅₀ PK	5.17±0.29	5.46±0.16
T12	N ₁₈₀ P ₈₀ K+Znf	5.26±0.52	6.22±0.74
T13	N ₁₈₀ P ₈₀ +Znf	4.90±0.047	5.83±0.12
T14	NPK (DAP)	5.07±0.0957	5.56±0.26
	S.Em.±	0.24	0.16
	CD at 5%	0.69	0.47