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Effect of NPK and chemical application on nitrogen uptake and yield of rice under rainfed condition

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Abstract
Crop productivity and quality are dependent on better availability of essential crop nutrients. However, application of nutrients at best optimum is essential depending on genotype for improved yield and quality. Field experiment was carried out to assess the influence of various levels of chemical and NPK fertilizers (F1: RDF-NPK Zn @ 80-60-40-5 kg N-P_2O_5-K_20-Zn kg/ha), F2: F_1 + 70 kg $CaSO_4$ ha^{-1}, F3: F_2 + 1% KCl foliar spray at panicle initiation and F4: F_3 + Brown manuring with sesbania) on nitrogen uptake and yield components of drought tolerant rice variety under rainfed condition (Sahbhagi Dhan) at Instructional Farm, Acharya Narendra Deva University of Agriculture & Technology. Results revealed that application of (F4: F_3 + Brown manuring with sesbania) improved the nitrogen uptake, nitrogen use effciency and yield related traits *viz*. productive tillers $^{m-2}$, panicle length, 1000 grain weight, grain yield, as compared to other NPK levels. Among treatments F4 performed better than treatments. Results conclude that drought tolerant variety can yield better, by applying NPK combination with 70 kg $CaSO_4$ ha^{-1}, 1% KCl and sesbania with acceptable characteristics as compared to other treatments.

Keywords: Chemicals, NPK fertilization, $CaSO_4$ and KCl

Introduction
Rice is one of the most important cereal crops in the world. Rice ranks second among food grains, and half of the world's population depends on rice by getting the highest (26.2%) calories intake from it. Out of this almost 90% rice production and consumption takes place in Asian countries (Islam *et al*., 2010) [7]. In Asia, the largest rice producing countries include China, India, Indonesia, Bangladesh and Pakistan (FAO, 2011) [6]. India is the second largest producer in the world. India has the largest area of rice cultivation at global level (44 m ha). Determination of optimum levels of NPK fertilizers is essential for obtaining maximum economic returns. According to Ananthi *et al*. (2010) [2] best rate of fertilizer application is that which gives maximum economic returns at least cost. Among various essential plant nutrients, the macro nutrients NPK are crucial for determining the yield and quality. It has been noticed that farmers utilize imbalanced dose of N fertilizer which leads to higher insects/disease attack ultimately producing lower yield (Mannan *et al*., 2009; Alam *et al*., 2011) [8, 1]. Therefore, there is dire need to determine the best level of NPK fertilizers which may give maximum crop productivity with minimum losses.
Itrogen is required by plants in the processes of photosynthesis and photosynthesis, and is involved in the energy reactions in the form of ATP; a key component of chlorophyll, proteins and enzymes; and assists the plants in the synthesis and use of carbohydrates (Mengel and Kirkby, 2001; Sara *et al*., 2013) [9, 12]. Phosphorus plays a crucial role in the root proliferation, consistent grain filling, and higher grain yield and quality as well being a constituent of nucleotides such as in ADP and ATP energy bonds and also being involved in many processes such as photosynthesis, mitotic activities, tissue growth and development (Bhattacharyya and Jain, 2000) [3]. Plants cannot reach their maximum yield without adequate supply of phosphorus (Alam *et al*., 2009; Murtaza *et al*., 2014) [10]. Potassium is essential for the maintenance of electrical potential across cellular membranes and cellular turgor enhancing the cell expansion and enlargement, opening and closing of stomata, and pollen tube development. It is also involved in activation of many enzymes, translocation of nitrate and sucrose (Britto and Kronzucker, 2008) [4]. It is an important plant nutrient and is required in higher amount especially for rice. About 100 kg K is removed by rice plants for a yield of about 5 t ha-1. Intensive cropping systems and the use of modern rice varieties to obtain high yield causes a heavy decline of K in soil, especially in absence of K fertilization (Saha *et al*., 2009) [11].

Materials and Methods

A field experiment was conducted at Instructional farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya during *Kharif* season 2020-21 to study the effect of NPK and chemical application on nitrogen uptake and yield of rice under rainfed condition. Soil of the experimental field was normal in pH, clay and moderately drained. The initial soil status was low in available nitrogen (229 kg/ha) medium in available phosphorus (14.5 kg/ha) and medium in available potassium (168 kg/ha). Early duration rice variety Sahbhagi dhan was grown during the cause of investigation. Experiment was laid out in randomized block design with three replications. Treatments consisted of foliar spray of (F1: RDF-NPK Zn @ 80-60-40-5 kg N-P_2O_5-K_20-Zn kg/ha), F2: F_1 + 70 kg $CaSO_4$ ha^{-1}, F3: F_2 + 1% KCl foliar spray at panicle initiation and F4: F_3 + Brown manuring with sesbania). Potassium at the rate of 50 kg ha-1 in the form of muriate of potash was applied in four equal splits as a blank*et al*ong with the nitrogen fertilizer during basal, tillering, panicle initiation and flowering. Observations on nitrogen uptake at maturity, nitrogen use efficiency in straw and yield characters and yield were recorded.

Results and Discussion

Data clearly indicated that treatment F4 (RDF fertilizer combination with 70 $kgha^{-1}$ $CaSO_4$, 1% KCL and brown manuring with sesbania) shows more nitrogen uptake ($kgha^{-1}$) at maturity stage and nitrogen use efficiency (%) in straw (5.02 $kgha^{-1}$ and 55.37%) which indicates that utilization of nitrogen is much more higher in comparisons to others treatments (table-2). Yield and yield attributing parameters (table-3) *viz.* No. of $tillers^{-m2}$ (322.5), No. of $panicles^{-m2}$ (289.2), Panicle length (30.2cm), Test weight (28.63 gm) in treatment F4, respectively, were recorded significantly superior with other treatments. Furthermore, as per yield concern F4 treatment produced (12.7%) more yield as compare to F1 treatment (-14.57%) and rest of the treatments produced F2 (-13.07), F3 (-10.19) respectively against F4 treatment.

It seems that majority of Indica varieties are adapted to relatively low levels of nitrogen in the region of 25 kg N/ha. There are two stages in the growth of rice crop when nitrogen is most needed; early vegetative and panicle initiation stages. Fertilizing the crop during early vegetative growth promotes tillering leading to higher yield.

Application at panicle initiation or early booting stage will help the plant produce more and heavier grains per panicle. Calcium supply can increase both N use efficiency and hence plant growth as well as Na+ exclusion by plant roots exposed to NaCl stress. In addition, root medium supplied with external Ca2+ facilitates to maintain plant K+ concentration and healthy crop stand. Thus adequate Ca 2+ is required in the medium to maintain the selectivity and integrity of cell membrane of plants. The above study was also conveyed by Fageria *et al.*, (2003) [5] that in cereals including rice, N accumulation is associated with dry matter production and yield of shoot and grain.

Table 1: Effect of different nutrient doses on nitrogen uptake ($kgha^{-1}$) at maturity and nitrogen use efficiency (%) in straw

Treatments	Nitrogen uptake at maturity	Nitrogen use efficiency (%)
F_1	4.20	44.4
F_2	4.27	48.23
F_3	4.68	51.56
F_4	5.02	55.37
SEm±	0.03	2.50
CD at 5%	0.05	7.88

***Note:** F_1 (RDF-NPKZn @ 80-60-40-5 kg N-P_2O_5-K_20-Zn kg/ha), F_2 (F_1 + 70 kg $CaSO_4$ ha^{-1}), F_3 (F_2+ 1% KCl foliar spray at panicle initiation), F_4 (F_3 +Brown manuring with sesbania)

Table 2: Effect of different nutrient doses on number of $tillers^{-m2}$, number of $panicles^{-m2}$, panicle length (cm), total grains $panicle^{-1}$, number of fertile grain, number of sterile grain, total $biomass^{-m2}$ (gm), test weight (gm) of Shahbhagi dhan

Treatments	No. of $tillers^{-m2}$	No. of $panicles^{-m2}$	Panicle length	Total number of grains $panicle^{-1}$	No. of fertile grain	No. of sterile grain	Total $biomass^{-m2}$	Test weight	Yield (q/ha)
F_1	310.8	242.6	26.16	155.3	110.50	44.80	382.7	22.77	22.64
F_2	315.2	245.2	27.24	173.5	116.33	57.17	415.8	23.27	22.94
F_3	319.6	275.2	28.12	181.5	122.45	59.05	425.4	25.09	23.54
F_4	322.5	289.2	30.2	210.9	155.60	55.30	455.3	28.63	25.94
SEm±	2.27	2.65	0.78	2.07	2.10	2.09	1.78	0.37	1.62
CD at 5%	7.93	8.99	2.63	6.98	6.82	7.05	6.09	2.10	5.49

***Note:** F_1 (RDF-NPKZn @ 80-60-40-5 kg N-P_2O_5-K_20-Zn kg/ha), F_2 (F_1 + 70 kg $CaSO_4$ ha^{-1}), F_3 (F_2 + 1% KCl foliar spray at panicle initiation), F_4 (F_3 + Brown manuring with sesbania)

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