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Soil fertility status and productivity of Rice as influenced by Neem Cake-Urea mixed application

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Abstract

A field experiment was conducted during kharif-2016 at ICAR-Krishi Vigyan Kendra (KVK), Mangaluru of Karnataka state to study the effect of neem cake urea mixed application on soil fertility status and productivity of rice under submerged condition. The soil of the experimental field was lateritic with acidic pH, medium in available nitrogen, high in phosphorus and low in potassium content. The experiment was laid out in randomized block design replicated thrice with seven treatments comprising of five neem cake and urea mixed application in various combinations along with one control and one treatment comprising application of recommended dose of nitrogen in form of urea. Soil samples were collected at harvest and analyzed for parameters of soil fertility. The results indicated that soil pH, Electrical Conductivity (EC), available nitrogen, available phosphorus and available potassium were not significantly influenced by treatment combinations of urea and neem cake. The grain yield (55.0 q/ha) and straw yield (4.35 tons/ha) was significantly higher in treatment T3 comprising of 100 % RDN applied in three splits with application of 100% recommended quantity of Neem cake. This was followed by treatment T4 (52.0 q/ha grain yield and 4.28 tons/ha straw yield) consisting of 75% RDN with 100% recommended quantity of Neem cake. The lowest grain yield (38.0 q/ha) and straw yield (3.46 tons/ha) was recorded in control (T1) where nitrogen and neem cake was not applied.

Keywords: Rice, soil fertility, Neem cake, Urea mixture, productivity, submerged condition.

Introduction

Rice (*Oryza sativa* L.) is the major staple food crop for most of Asian countries including India. Among the cereal crops, it serves as a principal source of nourishment for half of the world population occupying 11% of the world land (Tumrani *et al.* 2015) [23] Globally rice is grown in an area of 162 million ha with a production of 461 million tons and productivity is 4.09 tons/ha (Anonymous, 2015) [1]. In India, rice is grown in an area of 43.19 million ha with a production of 110.15 million tons. (Anonymous, 2017) [2]. Though rice production continues to play a vital role in the national food and livelihood security of the system, the productivity of rice is only 2.55 tons/ha (milled rice) which is less compared to global productivity of 3.28 tons/ha (Anonymous, 2018) [3]. Increasing the productivity of rice remains the main challenge considering that 90% of the cultivated area of rice belong to small and marginal farmers. The most feasible way by which this could be achieved is by adopting a more integrated approach involving water, nutrients and other agronomic factors for maximizing the rice grain yield (Gobi *et al.*, 2016) [10].

In rice, nitrogen is the key nutrient element required in large amounts and supply of nitrogen in the right rate and time throughout growing season is most important to increase the yield. (Arshdeep Singh *et al.*, 2016) [4]. Though the yield increase in rice due to nitrogen fertilization has been substantial (47%), the average agronomic efficiency of N is only 11.4 kg grain/kg N (Prasad, 2011) [16]. The nitrogen use efficiency is only 30-50% and is attributed to losses of nitrogen under flooded condition. (Johri and Yadav, 2006) [11] Slow-release fertilizers (SRF) are often used to increase nitrogen-use efficiency (Joshi *et al.*, 2014) [12] which are designed to release nitrogen over an extended period of time to match the needs of nitrogen in the crop and to reduce the losses of nitrogen to the environment (Ellison *et al.*, 2013) [8].

However, the farmers continue to rely on urea as main source of nitrogen and apply in split doses at various growth stages in rice (Bhalla and Deviprasad, 2008) [5]. Low cost alternative to slow release fertilizers include use of plant derived organic substances like neem cake, green leaf manure and Pongamia extract which exhibit nitrification inhibition property (Devkumar and Goswami, 1992) [7]. The neem cake obtained after oil extraction contains 5% nitrogen (Subbalakshmi *et al.*, 2012) [19]. Neem coated urea has been observed to improve nitrogen use efficiency and subsequently crop yield in rice (Pratap Reddy *et al.*, 2019) [17]. Nitrification inhibitors like neem cake when applied along with urea reduces losses of applied nitrogen thereby resulting in enhancing nitrogen use efficiency in crops (Khandey *et al.* 2017) [15]. The efficiency of nutrient use may be improved by combined use of organic neem cake with inorganic source of nitrogen fertilizer. The soil fertility fluctuates throughout the growing season each year due to alteration in the quantity and availability of mineral nutrients by addition of organic and inorganic sources. Hence evaluation of soil fertility status of the rice field is essential for maintaining optimum fertility in soil. Therefore an investigation was carried out to study the effect of neem cake urea mixed application on soil fertility status and yield of rice under submerged condition.

Materials and methods

A field experiment was conducted during kharif-2016 at ICAR-Krishi Vigyan Kendra, Mangaluru of Karnataka state to study the effect of neem cake urea mixed application on soil fertility status and productivity of rice. The soil of the experimental site was lateritic characterized by acidic pH (5.5) having Electrical conductivity of 0.14 dSm^{-1}. The soil of the experimental field before experimentation contained medium available nitrogen (380kg/ha), high available phosphorus (97.4kg/ha) and low available potassium was (96.13 kg/ha). The experiment was laid out in randomized block design replicated thrice with seven treatments comprising of five neem cake and urea mixed application in various combinations along with one treatment as control and one treatment comprising application of recommended dose of nitrogen in form of urea. The treatments were T1- Control ($N_0P_{30}K_{60}$+No Neem cake), T2-sole RDF($N_{60}P_{30}K_{60}$), T3-100%RDN($N_{60}P_{30}K_{60}$) + Neem cake(100%), T4-75% RDN ($N_{45}P_{30}K_{60}$)+Neem cake (100%), T5-50% RDN($N_{30}P_{30}K_{60}$)+Neem cake(100%), T6-50% RDN($N_{30}P_{30}K_{60}$)+ Neem cake(75%), T7-50% RDN($N_{30}P_{30}K_{60}$)+Neem cake(50%). The recommended dose of fertilizers was applied @ 60kg N/ha, 30 kgP_2O_5 and 60 kg K_2O. The source of nitrogen used was urea (46%N) applied in three split dose (33% each split) at planting, tillering and panicle initiation stage.

The Neem cake (@1.25 tons/ha (100%) and Farm yard manure (5.0 tons/ha) was applied at time of land preparation before planting. Phosphorus was applied in form of rock phosphate as basal dose and potassium was applied in three splits @ 33% each combined with nitrogen source urea. Characterization of surface soil for fertility status was studied by taking representative soil samples at random from treatment plots after harvest at a depth of 15.0 cm. The collected soil samples were dried under shade and were analyzed for pH, EC and available NPK. Standard procedures were adopted for analysis of the nutrients in the laboratory. The pH of the soil was determined by use of digital pH meter. The Electrical Conductivity is measured by Conductivity Bridge and expressed in millimhos per centimetre. The available Nitrogen (kg/ha) content in soil was determined by adopting alkaline potassium permanganate method (Subbaiah and Asija, 1956) [21]. The available phosphorus (kg/ha) was determined by using by Brays extractant and the available potassium (kg/ha) by determined by flame photometer (Jackson, 1973) [13]. During the period of crop growth a total rainfall of 2751.0 was received as against normal rainfall of 3245.00 mm. Bio-metric observations were recorded for yield at harvest and the treatment means were compared using least significant difference at 5% level of significance. (Gomez and Gomez, 1984) [9].

Results and Discussion

The results of effect of neem cake urea mixed application on soil fertility status and yield of rice under submerged condition is presented in Table-1.

Table 1: Effect of neem cake urea mixed application on soil fertility status and yield of rice.

	Treatments	**pH**	**EC Millimhos/cm**	**Available N Kg/ha**	**Available P_2O_5 Kg/ha**	**Available K_2O Kg/ha**	**Grain yield (q/ha)**	**Straw yield t/ha**
1	T1- Control ($N_0P_{30}K_{60}$+No Neem cake)	5.23	0.39	227.3	23.8	242.2	38.0	3.46
2	T2- Sole RDF $N_{60}P_{30}K_{60}$)+ No Neem cake	5.18	0.37	235.6	25.3	246.3	42.0	4.07
3	T3-100%RDN($N_{60}P_{30}K_{60}$)+ Neem cake (100%)	5.17	0.36	272.7	30.3	251.6	55.0	4.35
4	T4-75% RDN($N_{45}P_{30}K_{60}$) + Neem cake(100%)	5.19	0.38	268.8	28.3	248.3	52.0	4.28
5	T5-50% RDN($N_{30}P_{30}K_{60}$) + Neem cake(100%)	5.17	0.35	255.3	27.6	247.6	46.0	4.13
6	T6-50% RDN($N_{30}P_{30}K_{60}$) + Neem cake(75%)	5.16	0.32	251.7	26.4	247.3	45.0	4.12
7	T7- 50% RDN($N_{30}P_{30}K_{60}$) + Neem cake(50%)	5.18	0.38	248.6	23.7	247.2	43.0	4.10
	Sem $\pm$	0.05	0.14	28.64	1.95	3.69	1.31	0.04
	CD (5%)	NS	NS	NS	NS	NS	3.88	0.13

Soil pH

The soil pH influences the rate of nutrients release through its influence on decomposition, carbon exchange capacity and solubility of the materials. The results of the study indicated that the soil pH was not significant over the different treatment combinations of neem cake urea mixed application in rice. The highest pH was found in T1- Control ($N_0P_{30}K_{60}$+No Neem cake) which recorded 5.23. The pH recorded in all the treatment combinations indicated acidity of the soils and could be attributed to high degree of leaching of bases due to heavy rainfall received during the crop growth period (Kavitha and Sujatha, 2015) [14].

Electricity Conductivity (EC)

The measure of electricity conductivity shows the total amount of soluble salts present in the soil. The electrical conductivity at harvest was not significantly influenced by mixed application of urea and neem cake. However, the low EC (0.32 millimhos/cm) was recorded in treatment T6 comprising of 50% RDN ($N_{30}P_{30}K_{60}$) with 75% Neem cake application followed by treatment T5 comprising of 50% RDN ($N_{30}P_{30}K_{60}$) and Neem cake (100%) which recorded 0.35 millimhos/cm. The low EC indicate that the soluble salts were leached out of soil due to high rainfall leading to low accumulation of soluble salts in these soils. (Roy and Landey, 1962) [18]

Available Nitrogen (N)

The available nitrogen (kg/ha) was not significantly influenced by various treatment combinations of urea and neem cake application in rice. The highest available nitrogen was recorded in treatment T3 (272 kg/ha) comprising of 100%RDN ($N_{60}P_{30}K_{60}$) with Neem cake (100%) and the lowest was observed in treatment T1- Control ($N_0P_{30}K_{60}$+No Neem cake) which recorded 232 kg/ha. The medium availability of Nitrogen status in the soils was observed among the different treatments and could be attributed to limited quantity of mineralized nitrogen retained by soil losses of nitrogen through denitrification and leaching (Usha and Jose, 1983) [24]

Available Phosphorus (P_2O_5)

Phosphorus is an essential constituent of protoplasm. It does not move readily through the soil and is not leached by rain or irrigation. Most of the phosphorus is tied up chemically in compound of limited solubility (Brady, 1984) [6]. The results indicated that the available phosphorus was not significantly influenced any of the treatments of urea and neem cake. However non significantly higher available phosphorus was recorded in Treatment T-3 comprising of 100% RDN with 100% neem cake application (30.3 kg/ha) followed by treatment comprising 75% RDN with 100% neem cake application (28.3 kg/ha)

Available Potassium (K_2O)

The available potassium (K) was not significantly influenced by neem cake urea application in rice. The highest available K was observed in treatment T3 (251.6 kg/ha) comprising of 100% RDN with application of 100% of neem cake. The lowest was observed in treatment T1-Control (242.2 kg/ha) where neem cake and urea was not applied.

Grain and straw yield

The results indicated that the treatment T3 comprising of application of 100% RDN($N_{60}P_{30}K_{60}$) in three splits (planting, tillering and panicle initiation stage) combined with application of 100% Neem cake recorded significantly higher yield in (55q/ha) compared to treatment T1-control (38.0 q/ha) and treatment T2- Sole RDF ($N_{60}P_{30}K_{60}$)+ No Neem cake (42.0 q/ha) but was on par with treatment T4 (52q/ha) comprising of 75% RDN ($N_{45}P_{30}K_{60}$) with 100% Neem cake. The treatment T5, T6 and T7 recorded significantly higher yield (46q/ha, 45 q/ha and 43 q/ha respectively) than T1-control but were significantly lower than treatments T3 and T4. Higher yield in rice by application of 100% NCU (Neem Coated Urea) and 80% NCU was also reported by Suganya *et al.* (2007) [22] and Khandey *et al.* (2017) [15]

In case of straw yield, the treatment T3 comprising of 100% RDN (three splits) with 100 % Neem cake application recorded significantly higher straw yield (4.35 tons/ha) followed by treatment T4 (4.28 tons/ha) consisting of 75% RDN ($N_{45}P_{30}K_{60}$) with 100% Neem cake application which were on par with each other but were significantly higher than treatment T1 control(3.46 tons/ha) and treatment T2 (4.07 tons/ha) comprising of application of 100% RDN without neem cake application. The increase in straw yield could be attributed to increased vegetative growth which could be attributed to increased nitrogen use efficiency and continuous supply of nitrogen. (Sarangi *et al.* 2016) [20]. Two processes probably contributed to increased nitrogen availability one is inhibition of denitrifying bacteria by neem cake and the other is slow release of nitrogen caused by the binding of urea particles to surface of neem cake (Wakimoto, 2004) [25].

Conclusion

It can be concluded that the fertility parameters namely pH, electrical conductivity, available nitrogen (kg/ha), available phosphorus (kg/ha), and available potassium (kg/ha), were not significantly influenced by neem cake urea application in rice. However, the grain yield and straw yield was significantly higher in treatment T3 comprising 100%RDN ($N_{60}P_{30}K_{60}$) in three splits with 100% Neem cake application followed by treatment T4 comprising 75% RDN ($N_{45}P_{30}K_{60}$) with 100% Neem cake application The lowest grain yield and straw yield was recorded in control where nitrogen was not applied.

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