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Effect of Farmyard Manure, *Azotobacter* and Cow Urine on Plant Nitrogen, Phosphorus & Pottassium Uptake at Tillering, Jointing and Harvest Stage of Wheat under Rice (*Oryza sativa* L.) - Wheat (*Triticum aestivum* L.) Cropping System

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ABSTRACT: Continuous use of inorganic fertilizers plays a vital role in deteriorating the soil health. Use of organic manure is the best remedy for maintaining soil quality as well as productivity and replacement of mineral fertilizers. In this context the present study entitled Effect of Organic Nutrient Sources on Soil Health and Productivity of Wheat under Rice-Wheat System was carried out during the *Rabi* seasons of 2017-18 at the Crop Research Centre, Chirodi farm of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, (Utter Pradesh), India. The experiment consisting seven treatments *viz.* T_1= Control (no organic manure), T_2 = 10 t ha^{-1} Farmyard manure, T_3 = 10 t ha^{-1} Farmyard manure + Cow urine + biofertilizer (*Azotobacter*), T_4 = 10 t ha^{-1} Vermicompost (V.C.), T_5 = 10 t ha^{-1} vermicompost (V.C.) + Cow urine + biofertilizer (*Azotobacter*), T_6 = 7.5 t ha^{-1} Farmyard manure + Cow urine + biofertilizer (*Azotobacter*), T_7 = 80 % of RDF of nitrogen through Vermicompost (V.C.) + 10 % through neem cake + biofertilizer (*Azotobacter*) was laid out with three replication in randomized block design (RBD). Result showed that T_7 (80 % of RDF of nitrogen through Vermicompost (V.C.) + 10 % through neem cake + (*Azotobacter*) had significantly higher plant N, P and K uptake at tillering, jointing, and at harvesting stage over the control plot (T_1). The present study thus indicates that a combination of 80 % of Recommended Dose of Fertilizer of nitrogen through vermicompost + biofertilizer (*Azotobacter*) + 10 % through neem cake holds promise for the cultivation of wheat. Also the using of *Azotobacter*, neem cake and FYM were the most positive effect on the measured characteristics.

Keywords: Vermicompost, *Azotobacter*, neem cake, phosphorus, and Wheat.

INTRODUCTION

Wheat is one of the cereal crop grown worldwide and one of the important staples of the world population nearly 2.6 billion. It is annual grass growing to between ½ to 1 ¼ meters in height. It is the major staple food crop, providing almost half of all calories in North Africa, West and Central Asia. India has achieved remarkable progress in wheat production during the last four decades and is the second-largest wheat-producing nation after china in the world. Globally, more people work in some way in agriculture than all other occupations combined. The wheat production has increased manifold at the time of independence to 109.52 million tonnes during 2020-21 from 6.60 million tonnes (Anonymous, 2021). Based on climate, crop duration, and soil type, India has been divided into five major wheat-growing zones, namely North Eastern Plains Zone, North Western Plains Zone, Peninsular zone Northern Hills zone, and Central Zone, thus accounting for 29.80 mha area under wheat cultivation which contributes 19.73 % of net sown area of India. The growing demand in tune with the increasing population is a major bottleneck and crop vulnerability in context to climate change conditions (Sendhil *et al.*, 2018). Cereals play role in satisfying the growing population's global food demand, in developing country where cereal production system is the only major source of nutrition and calorie intake. The cruise population is now facing a major crop production shortage, and there is a demand for high-quality, high-yielding crops to meet the higher population needs.

Better soil, crop, and nutrient management strategies play a crucial role in achieving this. It would reduce the yield gap between achievable and actual yields and provide valuable feedback on yield sustainability. Organic nutrient sources are plant and animal wastes used as sources of plant nutrients and released after their decomposition. It is the concept of combined application of organic and biological nutrient sources to increasingly promote to improve nutrient use efficiency by matching soil nutrient availability with crop demand. It has been shown to increase crop yields by reducing nutrient losses to the environment and managing the nutrient supply, resulting in high resource-use efficiency, cost reductions, and improved nutrient availability. The quantity, quality of crop residue, FYM and biofertilizers (*Azotobacter*) also modify the soil micro-biome and soil enzymes (Nath *et al*., 2017). Organic nutrients are an effective agricultural model to improve environmental quality worldwide and ensure food security, especially in countries with sharply developing economies. Neem cake organic manure is the by-product obtained in neem kernels and fruit crushing. It is the de-oiled residue that can be used as protects the plant from insect and termites attacks and source potential source of organic manure. The average nutrient composition of neem cake is 5.2 % nitrogen, 1.0 % phosphorus and 1.4 % potassium (Ramanathan *et al.,* 2006). Biofertilizer is a living substance used to increase the accessibility of nutrients and stimulate plant growth through the synthesis of growth-promoting substances. Microbial biofertilizers are supplied as charcoal based inoculants and have been applied for wheat cultivation (Mahajan *et al.,* 2003; Ogut *et al*., 2005; Broschat and Moore, 2007; Kumar *et al.*, 2010; Ramanjaneyulu *et al*., 2010). Application of farmyard manure @ 10 and 20 t ha^{-1} increased the grain yield and the total nitrogen, phosphorus, and potassium uptake in wheat crop (Singh and Agrawal, 2005). In recent years, the deterioration in soil health associated with the global energy crisis, together with the escalation of chemical fertilizer prices, has led to a focus on supplementing chemical fertilizers with inexpensive nutrient sources such as organic and biological sources (Kumar and Dhar, 2010). Organic fertilizers are eco-friendly, inexpensive, and do not have bulky agricultural inputs. Most soils in our country have shallow organic matter content and poor nutrient supply; therefore, introducing appropriate strains of biofertilizers into such soils can help increase production due to increased microbial population and increased nitrogen fixation and phosphorus mobilization. Important of Rice (*Oryza sativa* L.) - Wheat (*Triticum aestivum* L.) cropping system is to meet local food needs and ensure food security. It is India's most prominent and popular dual cropping system under irrigated conditions. Traditionally a monsoon season crop, rice-wheat is still the dominant rice-based system and is India's first major crop rotation. With these facts in mind, the present study was designed to determine the effect of farmyard manure, *Azotobacter neem cake* and cow urine on plants' N, P and K uptake at different stages of wheat harvest rice-wheat cultivation system.

MATERIALS AND METHODS

To investigate the effect of different sources of nutrients on plant nitrogen, phosphorus, and potassium uptake by Wheat, the present experiment was conducted at Chirodi farm of SVPUA&T, Meerut during *rabi* season 2017-18. The area is at $29^o40'$N latitude and $77^o41'$E longitude with above mean sea level an elevation of 236 meters and is in the Upper Gangetic Plains region (4^{th} Agro-climatic Zone of Indian Planning Commission). The trial field has a flat topography with gentle slopes and good drainage. Before the preparatory cultivation of the test area, soil samples were taken from 10 spots and a depth of 0 to 15 cm before the sowing of the wheat crop in the experimental field.

Table 1: Physico-chemical properties of the experimental field.

Soil Parameters/characteristic	Value obtained	Methods adopted
A. Physical properties		
Textural class	Sandy loam	USDA triangular diagram (Brady and Well 1996)
B. Physical constants		
Bulk density (Mg/m^3)	1.40	Core sampler method (Piper,1966)
Porosity (%)	47.15	(Blake and Hartge 1986)
Particle density (g cc^{-1})	2.65	Picnometer method (Danienison and Sutherl 1986)
C. Chemical composition		
pH (1:2.5 Soil : water)	7.25	Electrode pH meter Suspension method (Page *et al*., 1982)
EC_e (dSm^{-1} at $25C^o$) (1:2.5 Soil: Water)	0.29	Solubridge, (Richard, 1954)
Organic Carbon (%)	0.41	Rapid titration method (Walkley and Black, 1934)
Available nitrogen (kg ha^{-1})	143.0	Alkaline potassium permanganate method (Subbiah and Asija, 1956)
Available phosphorus (kg ha^{1})	12.7	Olsen's method (Olsen's, 1954)
Available potassium (kg ha^{-1})	135.3	1 N NH_4OAC extraction method (Jackson, 1973)

The samples were mixed homogenously, and the composite sample were powdered, air-dried and allowed to pass through a 2 mm sieve. It was analyzed for different Physico-chemical properties. The experiment was consisting seven treatments *viz*. T_1 = Control (no organic manure), T_2 = 10 t ha^{-1} Farmyard manure, T_3 = 10 t ha^{-1} Farmyard manure + Cow urine + biofertilizer (*Azotobacter*), T_4 = 10 t ha^{-1} Vermicompost, T_5 = 10 t ha^{-1} Vermicompost + Cow urine + biofertilizer (*Azotobacter*), T_6 = 7.5 t ha^{-1} Farmyard manure + Cow urine + biofertilizer (*Azotobacter*), T_7 = 80 % of RDF of nitrogen through vermicompost + 10 % through neem cake + biofertilizer (*Azotobacter*) was laid out in randomized block design having plot size of 4 × 3 meters with three replication. The required quantities of basal dose of NPK (120:60:40) kg ha^{-1} were applied in the different treatments by Farmyard manure, Vermicompost, neem seed, and cow urine. Wheat seed PBW-590 was sown in the last week of December with a row to row distance of 22.5 cm and a seed rate of 120 kg ha^{-1}. Seed treatment with *Azotobacter* (250 gm for 10-15 kg seed) before one day of sowing and FYM, Vermicompost, and neem seed cake applied 15 days before sowing and foliar spray at tillering and jointing stage @ 5-liter cow urine with water 100 liters ha^{-1}. Plant samples were collected from tagged plants at various growth periods and ten randomly selected plants at tillering jointing and harvest stage. The samples were first dried in the shade separately and then in a hot air oven at 65°C till the constant weight was obtained. Plant N, P and K content at different of stages crop were estimate by the different Method. After estimating the nitrogen, phosphorus, potassium content, and dry matter yield at tillering, jointing, and harvest stage (grain and straw), the uptake of these nutrients was calculated in kg ha^{-1}**.**

Uptake of nutrients (kg ha^{-1}) = Crop yield dry matter (q ha^{-1}) × Nutrient (%) in dry-matter

Statistical analysis. Data generated during experimentation were statistically analyzed outlined by Cochran and Cox (1967).

RESULTS AND DISCUSSION

A. Nitrogen uptake

Adopting a plan for applying farmyard manure, *Azotobacter* and Vermicompost (organic sources) to agricultural soils and cow urine spray on the crop in the production strategy requires information about the effect of organic agriculture sources on wheat crops. Nitrogen uptake by Wheat differed significantly from the data present in the Table 2. It showed at the tillering stage that the maximum nitrogen uptake (17.6 kg ha^{-1}) was found under the application of 80 % of RDF of nitrogen through Vermicompost + 10 % through neem cake + *Azotobacter* (T_7), which was significantly higher than remaining treatments. The minimum nitrogen uptakes (8.8 kg ha^{-1}) acquired under control (T_1) and considerably lower than halting treatments. These results corroborate the findings of Singh and Kumar, (2014). Similar to at jointing stage, the maximum nitrogen uptake (60.4 kg ha^{-1}) was obtained in T_7 and at *par* with T_5, $T_{6,}$ and T_3 and higher than the remaining treatments. The N uptake was recorded more at the jointing stage than at the tillering stage in each treatment. This increased the biological efficiency of crops and created a more oversized source/sink in the plant system. The maximum nitrogen uptake in grains and straw was found under T_7, which was statistically *at par* with T_5, $T_{3,}$ and T_6 and significantly higher over rest at the treatments. In the case of the total uptake of nitrogen recorded in T_7 and at par with T_5 and T_6, the lowest was found under control. The application of Farmyard manure @ 5 and 10 tha^{-1} significantly increased N's uptake in wheat crop over control (Singh *et al.*, 2001). A similar finding by Singh & Agarwal (2004) reported that the application of 10 t ha^{-1} Farmyard manure in rice-wheat cropping systems resulted in significantly higher nitrogen, phosphorus, and potassium uptake than the control similar concluded by Matsi *et al*., (2003); Butler and Muir, (2006). In the present study, positive correlations between grain yield and total nitrogen, phosphorus and potassium accumulation at maturity were found, confirming the direct association between nutrient uptake by plants and grain yield. The production of photosynthesis and its transfer to the sink largely depends on the soil's sufficient supply of mineral nutrients. Most photosynthetic pathways depend on enzymes and coenzymes synthesized and catalyzed by nutrients.

B. Phosphorus uptake

The phosphorus uptake by Wheat also increased significantly with the application of organic nutrient sources (Table 3) because uptake is a mathematical parameter calculated from yield and phosphorus content as both yield and phosphorus content increased significantly over control (no organic manure). Hence, uptake of phosphorus also increased significantly. The maximum P uptake at the tillering and jointing stage was found under treatment T_7. The minimum P uptake was found under control; similarly, Chaturvedi (2006) reported that P uptake by Wheat increased with increasing N level. The maximum (16.7 kg ha^{-1}) and minimum (4.6 kg ha^{-1}) P uptake in straw was recorded in T_7 and $T_{1,}$ respectively. Uptake of P by wheat straw was higher with the application of 60 % of RDF of nitrogen through Vermicompost + 20 % through neem cake + 20% through biofertilizer *(Azotobacter*) was significantly higher than all other treatments. The minimum P uptake in straw was found in control followed by $T_{2,}$ and T_4 was significantly lower than the remaining treatments. This result agrees with Kumawat (2003), who saw a significant increase in grain and straw N, P, and K concentration and their uptake and protein content in grain in barley due to organic fertilizer application. The total phosphorus uptake by wheat ranged from 8.7 to 25.8 kg ha^{-1}. The maximum total phosphorus uptake (25.8 kg ha^{-1}) was recorded in T_7, significantly higher than all the reaming treatments. The minimum phosphorus uptake (8.7 kg ha^{-1}) was registered under control (Table 3). Sefidkoohi and Sepanlou (2013) reported similar results, who noted that vermicompost (V.C.) application is increase the phosphorous uptake by shoot and kernel wheat. There were no differences among treatments in nutrient translocation efficiency in the grains. These results indicated the enhanced phosphorus translocation in applying 80 % of RDF of nitrogen through Vermicompost + 10 % through neem cake + *Azotobacter* compared with the control.

C. Potassium uptake

Potassium uptake by Wheat was affected significantly due to various treatments. The data on potassium uptake in Table 4 reveals potassium uptake (20.4 kg ha^{-1}) was more obtained in T_7 and considerably higher than all the treatments at the tillering stage. Similar at jointing stage, maximum potassium uptake was found under (T_7) 80% RDF of nitrogen by Vermicompost + 10% by neem cake + *Azotobacter* with significantly higher and same minimum K uptake was recorded in T_1 (Table 4). The increased nutrient uptake resulted from extra nutrient feeding and a good-developed root system, resulting in nutrient uptake, better water use. These results agree with the results of Datta *et al.* (2003). Uptake of potassium by wheat straw under different treatments was more than the uptake of potassium by wheat grain. This is explained due to higher dry matter accumulation and plant K content. Potassium removal by grain was low than straw. At harvest, maximum K assimilation in grain and straw was found in T_7. K uptake also followed a similar trend as shown in the case of N and P with maximum under T_7 and minimum under control. It was mainly because K uptake is governed by nutrient content and their respective yield, the combined action of both led to more uptake of K in straw compared to grain. These organic fertilizer treatments recorded higher uptake of these nutrients. They help build soil fertility by rapidly building up micro flora and micro fauna, which may have obliged significantly, supply the native nutrient pool from the soil. The variations in nitrogen, phosphorus, and potassium uptake from different organic sources could be attributed to their inherent ability to supply these nutrients during the plant's growth phase, which in turn affects nutrient uptake by the Harvest as reported by Gehlot (2001).

Table 2: Effect of organic nutrient sources on plant nitrogen uptake (kg ha^{-1}) at tillering, jointing and harvest stage of wheat.

Treatments	Nitrogen uptake (kg ha^{-1})				
	Tillering	Jointing	At harvest		Total
			Grain	Straw	
$T_{1=}$ (Control)	8.8	33.2	34.3	10.9	45.1
T_2 =(10 t ha^{-1} FYM)	13.0	46.2	54.9	18.8	73.6
T_3 =(10 t ha^{-1} FYM + cow urine + biofertilizer)	14.9	55.5	61.8	21.7	83.4
T_4 =(10 t ha^{-1} Vermicompost)	13.2	52.1	57.5	19.5	76.9
T_5 =(10 t ha^{-1} Vermicompost + cow urine + biofertilizer)	15.7	57.5	64	23.8	87.6
T_6 =(7.5 t ha^{-1} FYM + cow urine + biofertilizer)	14.5	55.8	59.9	20.8	80.6
T_7 =(60 % of RDF of nitrogen through vermicompost + 20 % through neem cake + 20% through biofertilizer)	17.6	60.4	67.2	26.2	93.3
SEm±	**0.5**	**1.7**	**2.3**	**0.8**	**3.2**
CD (P=0.05)	**1.3**	**5.0**	**6.9**	**2.4**	**9.3**

Table 3: Effect of organic nutrient sources on plant phosphorus uptake (kg ha^{-1}) at tillering, jointing and harvest stage of wheat.

Treatments	Phosphorus uptake (kg ha^{-1})				
	Tillering	Jointing	At harvest		Total
			Grain	Straw	
T_1 = (Control)	3.0	8.0	5	3.7	8.7
T_2 = (10 t ha^{-1} FYM)	3.7	12.3	7.9	8	15.9
T_3 = (10 t ha^{-1} FYM + cow urine + biofertilizer)	5.0	14.5	11.2	10.5	21.7
T_4 = (10 t ha^{-1} Vermicompost)	4.6	13.4	9.6	9.4	19.1
T_5 = (10 t ha^{-1} Vermicompost + cow urine + biofertilizer)	5.4	15.1	12.5	11.3	23.7
T_6 = (7.5 t ha^{-1} FYM + cow urine + biofertilizer)	4.8	14.0	10.7	10.4	21.1
T_7 = (60 % of RDF of nitrogen through vermicompost + 20 % through neem cake + 20% through biofertilizer)	6.0	16.9	12.4	13.4	25.8
SEm±	**0.2**	**0.4**	**0.4**	**0.4**	**0.8**
CD (P=0.05)	**0.5**	**1.3**	**1.2**	**1.2**	**2.4**

Table 4: Effect of organic nutrient sources on plant potassium uptake (kg ha^{-1}) at tillering, jointing and harvest stage of wheat.

Treatments	Potassium uptake (kg ha^{-1})				
	Tillering	Jointing	At harvest		Total
			Grain	Straw	
T_1 = (Control)	11.6	42.7	7.0	46.8	53.8
T_2 = (10 t ha^{-1} FYM)	15.2	59.3	11.7	73.4	85.2
T_3 = (10 t ha^{-1} FYM + cow urine + biofertilizer)	16.9	63.6	14.2	90.2	104.4
T_4 = (10 t ha^{-1} Vermicompost)	15.7	61.5	11.4	78.3	89.8
T_5 = (10 t ha^{-1} Vermicompost + cow urine + biofertilizer)	18.0	64.8	15.9	90.5	106.4
T_6 = (7.5 t ha^{-1} FYM + cow urine + biofertilizer)	16.5	60.5	14.8	83.5	98.3
T_7 = (60 % of RDF of nitrogen through vermicompost + 20 % through neem cake + 20% through biofertilizer)	20.4	67.5	16.7	94.3	110.9
SEm±	**0.5**	**2.0**	**0.5**	**3.3**	**3.8**
CD (P=0.05)	**1.6**	**5.9**	**1.5**	**9.6**	**11.2**

CONCLUSION

The continuous introduction of the rice-wheat cultivation system without organic nutrient sources proved detrimental to soil health and quality. It resulted in a significant decrease in nitrogen, phosphorus and potassium from their original values in the soil. Organic manure application resulted in the most significant increase in the uptake of major nutrients. The current study showed that the application of 80% RDF of nitrogen from Vermicompost + 10% from neem cake + *Azotobacter* (T_7) resulted in significantly higher N, P, and K uptake of the plants in the tillering, jointing, and harvesting stage over the control plot (no manure application). The present study thus indicates that a combination of 80% of RDF nitrogen from vermicompost + 10% from neem cake + *Azotobacter* is promising for the cultivation of Wheat.

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