International Journal of Environment, Agriculture and Biotechnology (IJEAB) *Vol-3, Issue-5, Sept-Oct- 2018*
http://dx.doi.org/10.22161/ijeab/3.5.30 *ISSN: 2456-1878*

Effect of peak performance nutrients on soil chemical properties and nutrient uptake by rice (*oryza sativa* L.)

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Abstract: *The effects of peak performance nutrient (PPN) in combination with different fertilizer doses on soil properties and nutrient uptake by rice were investigated in a field experiment from seedling to maturity during the period of July to November 2014 in T. aman season. The experiment comprised of twelve treatments laid out in a randomized complete block design with three replications. The treatments were: T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD +PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK+PPN, T_7: 75 % P+100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}:75 % NPK+ PPN, T_{12}: 50% NPK+PPN. Experimental results reveal that the highest nutrient uptake (N and K) uptake by rice grain and straw was recorded in the treatment T_7. However, P uptake by rice grain and straw were higher in treatment T_3 that was statistically similar with treatment T_7. Initial and postharvest soil sample analysis indicated that most of the studied soil properties including soil pH and organic matter contents were increased in T_7. Therefore, the treatment combination PPN along with 75 % P+100 % NK (T_7) was found to be more suitable compared to other treatment combinations for improving soil quality as well as enhancing nutrient uptake by rice. Thus peak performance nutrient (PPN) showed a positive response both on improvement of soil health as well as nutrient uptake by the crop.*

Keywords— peak performance nutrients, rice, soil fertility, nutrient uptake.

I. INTRODUCTION

Rice is the main staple food and dominant crop in Bangladesh. It is grown on more than three fourths (81%) of the total cultivable land area and the per capita rice consumption is about 166 kg/year (BBS, 2010). The country is now producing about 25.0 million tons of rice to feed her 160 million people. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land, which contributes to about 73% of the country's total rice production. However, there is no reason to be complacent while the population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020. During this time total rice area will also shrink to 10.28 million hectares because of new settlements, industries and roads. To meet the current and future food requirements of increasing population and their rising dietary needs it is necessary to boost up crop yields adopting best management practices in agriculture (Gao *et al*., 2010). Therefore, yield boosting agronomic techniques such as application of certain plant growth regulators, foliar feeding need due attention.

Peak performance nutrient (PPN) can be a panacea to mitigate this problem because it is an eco-friendly mineral nutrient supplement serving as a liquid concentrate of natural assortment for agricultural crops. PPN contains a plenty of water-soluble nutrients in a balanced way, which is carefully extracted from the natural sources. It stimulates growth, yield, quality, nutrient concentration and taste of agricultural crops (rice, okra, tomato, eggplant, cabbage etc). The pH of PPN is around 9.0; it will progressively elevate the pH after each harvest. Therefore, utilization of PPN in acid soil might show significant effect to increase the soil pH and thereafter enhance the availability of plant nutrients. Sultana *et al*. (2001) revealed that foliar spray of nutrient solution partially minimized the salt-induced nutrient deficiency, increased photosynthesis, dry matter accumulation, number of fertile spikelet in the panicle and

http://dx.doi.org/10.22161/ijeab/3.5.30 ISSN: 2456-1878

grain yield. Since higher inorganic nutrient levels alone deteriorate soil health, an integration of nutrient solutions from botanical extracts and inorganic nutrients is the best solution for sustaining the soil health as well as enhancing the nutrient uptake by rice grain and straw. Considering the facts as stated above, the present investigation was undertaken to quantify the influence of PPN on soil properties and nutrient uptake by rice in acid soil.

II. MATERIALS AND METHODS

Experimental site

The experiment was performed in the research field of the Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. The site is located at 24.09 N latitude and 90.26 E longitude with an elevation of 8.4 meters from sea level (Anonymous, 1989). The experimental field belongs to the Salna series under the Madhupur Tract (AEZ - 28). The soils belong to the general soil type Shallow Red Brown Terrace Soil and maintain the soil order Inceptisol under USDA Soil Classification System (FAO, 1988).

Materials Used in the experiments

The recommended high yielding and short duration Aman variety, BRRI dhan49 was used as the test crop. Rice seeds were collected from variety Bangladesh Rice Research Institute (BRRI) Gazipur, Bangladesh. The variety is photosensitive and blast disease resistant with lower affinity to insect and other disease invasion. The seeds germinated in water for 3 days were broadcast uniformly on puddle seedling nursery on 28 June 2014. Twenty-five days old seedlings were transplanted in the experimental plots maintaining a distance of 25 cm from row to row and 20 cm from plant to plant. The plot size of each treatment was 4m × 3m = 12 m^2. Three seedlings were used in each hill. The selected peak performance nutrients (PPN) were collected from China through representative country dealers.

Experimental design and treatment exposure

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments were randomly allotted in each block. The experiment was comprised of twelve treatments including absolute control. The treatments were: T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD +PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK+PPN, T_7:75 % P+100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}:75 % NPK+ PPN, T_{12}: 50% NPK+PPN. The fertilizer treatments used in the experiment were based on soil analysis. In the 100% recommended fertilizer 220 kg ha^{-1} urea, 34 kg ha^{-1} triple super phosphate (TSP), 91.2 kg ha^{-1} MoP and 44 kg ha^{-1} gypsum was applied. The required amount of urea, TSP, MoP and gypsum as source of N, P, K and S respectively were calculated based on the following equation of Bangladesh Agricultural Research Council (FRG, 2012): $F_r = U_f - C_i / C_s \times (S_t - L_s)$

Where

F_r is the fertilizer nutrient required for given soil test values

U_f is the upper limit of the recommended fertilizer nutrient for the respective interpretation (STVI) class

Ci is the units of class intervals used for fertilizer nutrient recommendation

C_s is the units of class intervals used for STVI class

S_t is the soil test value within STVI class

L_s is the lower limit of the soil test value within STVI class

The full dose of TSP, MoP and gypsum were applied at the time of final land preparation. Urea was applied at three different splits at 20 days after transplanting (DAT), 40 DAT at maximum tillering stage and 60 DAT at panicle initiation stage. Peak performance nutrients (PPN) solution was applied both in nursery bed and main plot. Peak performance nutrients (PPN) solution was prepared by diluting 80 ml concentrated PPN in 18 L water per 1000 m^2 plot. Seeds were soaked with PPN solution before broadcasting to the nursery bed. PPN nutrient solution was applied to the main plots before transplanting of the rice seedlings and after seedling establishment at 10 days interval until 80 days of transplanting.

Intercultural operation

Preparation of land was done as per treatment. After the establishment of seedlings, various intercultural operations were accomplished for better growth and development of the rice plants. Proper intercultural operation facilities e.g. gap filling, weeding, irrigation and drainage, application of pesticides were provided whenever necessary.

Harvest

At maturity 6 subsamples (hills) in each were harvested for grain and straw nutrient analysis on 11 November 2014. After threshing Grain and straw samples were air dried and then put in an oven at about 65°C for 48 hours. Then ground in a grinding mill to pass through a 20-meshsieve. The ground plant materials (grain and straw) were stored in small paper bags and placed in desiccators.

Nutrient status evaluation of initial and residual soil Sample

For assessment of initial and residual soil properties, soil samples were collected from 0-15 cm depth before staring and after the experimentation respectively. During soil sampling, composites soil samples were collected from each plot following standard techniques as prescribed in FRG (2012). The collected samples were then air dried and ground to pass through a 2 mm sieve and stored in a clean

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plastic container for analysis. The physical and chemical properties of soil sample were analyzed by maintaining standard protocols. The textural class of the initial soil sample was assessing by using the methods of Bouyoucos, (1962). Bulk and particle density of the soil were analyzed by core sampler and pycnometer method respectively (Page *et al*., 1989). The pH of the soil sample was examined according to Jackson (1973). Organic carbon and organic matter was measured by using wet oxidation method (Walkey and Black, 1965). Ten ml of 1 N $K_2Cr_2O_7$ oxidized one gram of soil sample in presence of H_2SO_4 and the amount of organic carbon was calculated by the titrated value against ammonium ferrous sulphate (AFS) solution. Total N content in soil was determined by the Kjeldahl method (Black, 1965). Available phosphorus in the soil samples was extrated with the combination of HCl with ammonium fluoride extract solution (pH below 6.8) and color intensity developed by ascorbic acid was measured by atomic absorption spectrophotometer at 890nm wavelength (Bray and Kurtz, 1945). Exchangeable potassium of the soil sample was measured according to the ammonium acetate solution method (Jackson 1973). Available sulphur of the studied sample was calculated by the calcium dihydrogen phosphate solution extraction method (Thomas, 1982). The studied physical and chemical properties of initial soil sample were representing in the Table 1 & 2.

Table.1: Initial physical soil properties of the experimental site

Soil Characteristics	Analytical Value
Physical Properties	
Sand	17.8%
Silt	45.6%
Clay	36.6%
Textual class	Silty clay loam
Bulk density	1.4 g/cm^3
Particle density	2.6 g/cm^3

Table.2: Initial chemical soil properties of the experimental site

Chemical Properties	
Soil pH	6.2
Total N (%)	0.058
Organic C (%)	0.8
C : N ratio	13.79
Available P (ppm)	10.5
Exchangeable K (meq/100g)	0.14
Exchangeable Ca (meq/100g)	8.75
Exchangeable Mg (meq/100g)	2.46
Exchangeable Na (meq/100g)	0.65
Available Sulphur (ppm)	15
Available Boron (ppm)	0.20
Zinc (ppm)	1.1

Plant samples analysis

Plant samples collected from the field experiment were analyzed for N, P and K contents. Grind grain and straw sample were used for chemical traits analysis. Total nitrogen concentration of grain and straw sample was measured by the Kjeldahl method. For the determination of nitrogen, 0.1 g oven dried ground sample was digested with concentrated H_2SO_4 at 360^{o}C for 2 hrs in presence of catalyst mixture (K_2SO_4: $CuSO_4.5H_2O$: Se =100:10: 1) and titrated against H_2SO_4. Phosphorus and potassium concentration of the grain and straw sample was analyzed by the di-acid mixture (HNO_3: $HClO_4$ = 5: 1) digestion method.

Statistical analysis

Data were analyzed statistically with the help of computer package STATISTIX 10. The mean differences of the treatments were observed by least significant difference (LSD) test at 5% level of probability for the interpretation of results (Gomez and Gomez, 1984).

III. RESULTS AND DISCUSSION

Nutrient uptake by grain and straw as influenced by Peak Performance Nutrient (PPN) and different fertilizer combinations

Nitrogen uptake by grain and straw

Nitrogen uptake by grain and straw varied significantly due to the effect of different fertilizer doses with Peak Performance Nutrient (PPN) treatments (figure 1 and 2). Results displayed in figure- 1 indicated that the N uptake by grain varied from 36.84 to 98.36 kg ha^{-1}. The highest N uptake (98.36 kg ha^{-1}) by grain was recorded in the treatment T_7 (75 % P + 100 % NK + PPN) which was statistically superior to all other treatments. The lowest N uptake (36.84 kg ha^{-1}) by grain was obtained in the treatment T_1 (control) that was statistically different from all other treatments. In straw, the N uptake ranged from 12.23 to 26.20 kg ha^{-1}(Fig1). The highest N uptake (26.20 kg ha^{-1}) by straw was observed in the treatment T_7 (75 % P + 100 % NK + PPN) which was statistically identical with treatment T_3 (100 % NPK + PPN) with the value 0f 25.70 kg ha^{-1}. The lowest N uptake (12.23 kg ha^{-1}) by straw was recorded in the treatment T_1 (control) treatment that was statistically inferior to all other treatments (figure 2). It has been reported that foliar application of nutrients in rice increases the nutrient content in rice grain (Rabin *et al*., 2016) which might enhance the higher nutrient uptake due to PPN application.

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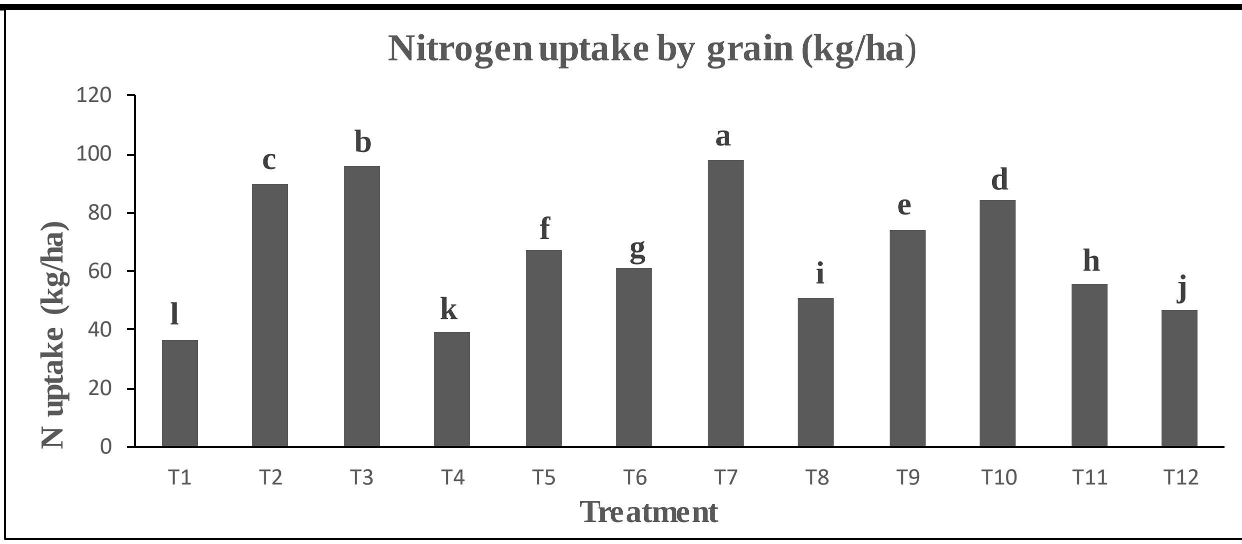

Fig.1: Effects of Peak Performance Nutrient (PPN) and different fertilizer treatments on N uptake by grain

Legends,

T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD + PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK + PPN, T_7: 75 % P + 100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}: 75 % NPK + PPN, T_{12}: 50% NPK + PPN.

Phosphorus uptake by grain and straw

The phosphorus uptake by grain and straw of aman rice (BRRI dhan49) was significantly influenced by different fertilizer combinations along with Peak Performance Nutrient (PPN) solution (figure 3 and 4). Phosphorus uptake by rice grain varied from 4.638 to 12.44 kg ha^{-1} (figure 3). The maximum P uptake (12.440 kg ha^{-1}) by grain was recorded in the treatment T_3 (100 % NPK + PPN) and it was statistically identical with treatment T_7 (75 % P + 100 % NK + PPN) with a value 12.290 kg ha^{-1}. On the other hand, the minimum P uptake (4.638 kg ha^{-1}) by grain was observed in the treatment T_1 (control) but it was statistically similar with the treatment T_4 (0 % RD +PPN only) having the value of 4.863 kg ha^{-1}. In case of rice straw, the P uptake ranged from 3.633 to 8.430 kg ha^{-1} (Fig 4). The highest P uptake by straw (8.430kg ha^{-1}) was documented in the treatment T_3 (100 % NPK + PPN) and it was statistically identical with

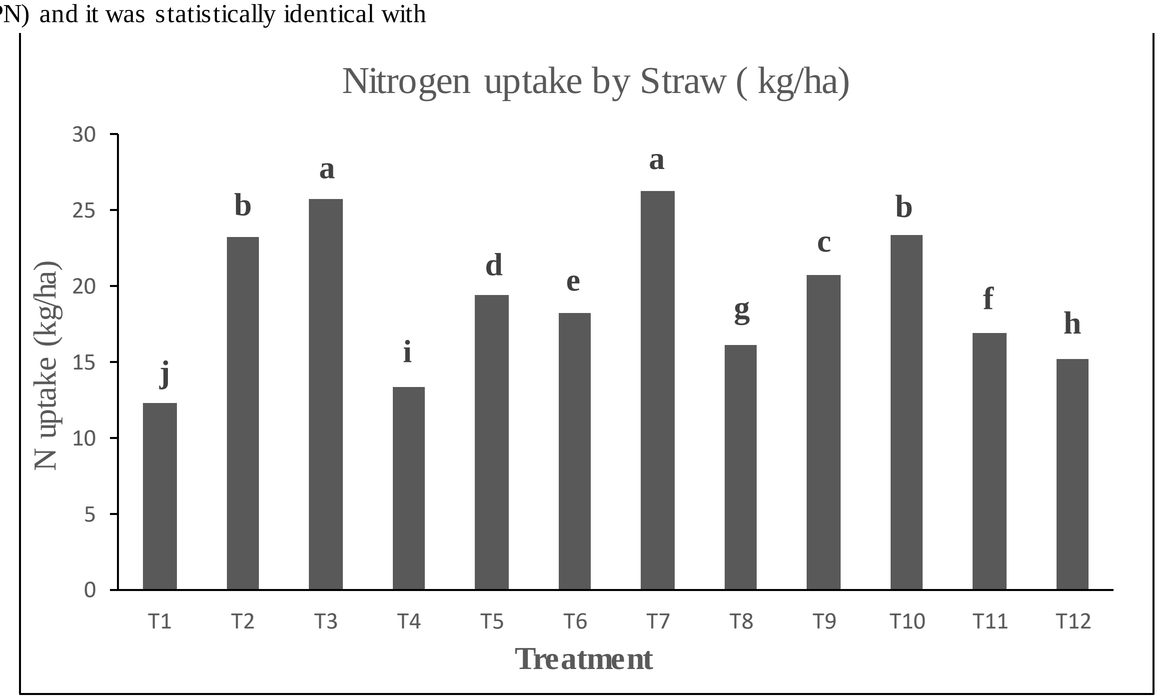

Fig.2: Effects of Peak Performance Nutrient (PPN) and different fertilizer treatments on N uptake by straw

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Legends,

T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD + PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK + PPN, T_7: 75 % P + 100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}: 75 % NPK + PPN, T_{12}: 50% NPK + PPN.

Treatment T_7 (75 % P + 100 % NK + PPN) with a value 8.350 kg ha^{-1}. The lowest P uptake (3.633 kg ha^{-1}) was found in the T_1(control) treatment, which was statistically similar to the treatmentT_4 (0 % RD +PPN only) with the P uptake of 3.666 kg ha^{-1} (figure 4). Experimental results indicated that P uptake by grain and straw respond differently by different treatment combinations. Due to the application of PPN in soil, the pH value in acid soil increased which ultimately might enhance more P uptake by the plants.

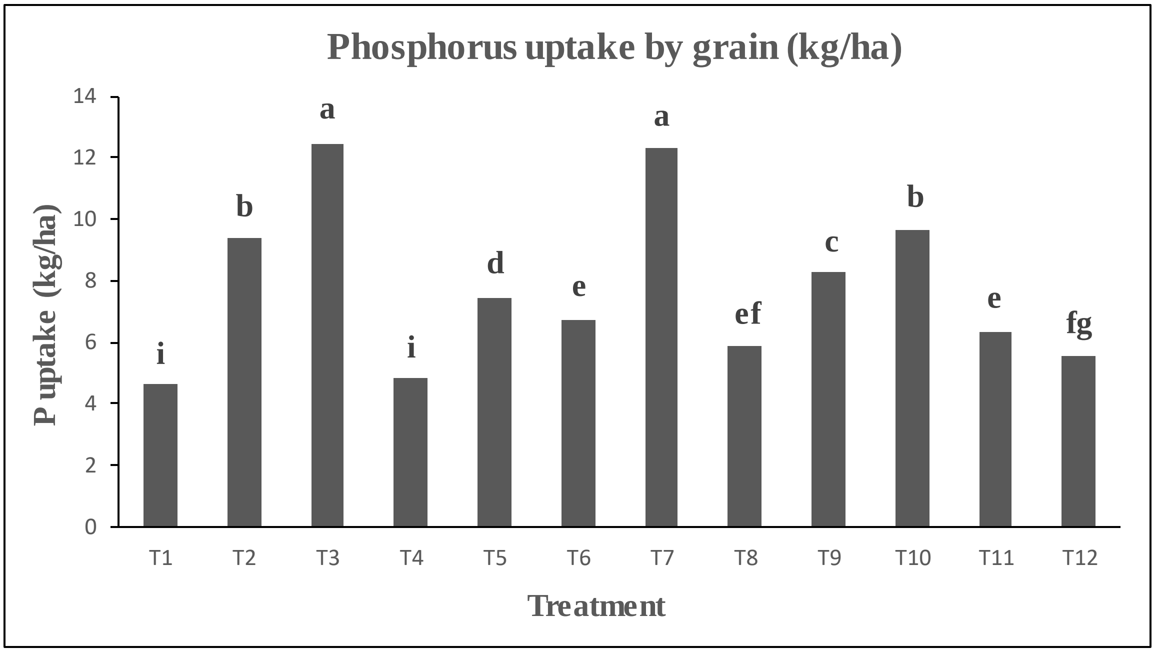

Fig.3: Effects of Peak Performance Nutrient (PPN) and different Fertilizer treatments on P uptake by grain

Legends,

T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD + PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK + PPN, T_7: 75 % P + 100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}: 75 % NPK + PPN, T_{12}: 50% NPK + PPN.

Potassium Uptake by grain and straw

Potassium uptake by BRRI dhan49 in both grain and straw was significantly influenced by various treatments of different fertilizer doses with Peak Performance Nutrient (PPN) treatments in this experiment (figure 5 and 6)). From the figure 5, it appears that the K uptake by grain varied from 14.540 to 32.443 kg ha^{-1}. The highest K uptake (32.443 kg ha^{-1}) by grain was noted in the treatment T_7 (75 % P + 100 % NK + PPN) that was superior from all other treatments. The lowest uptake value of K (14.540 kg ha^{-1}) by grain was obtained in the treatment T_1 (control) (figure 5). In straw, uptake values of K ranged from 24.327 to 52.380 kg ha^{-1}(figure 6). The highest K uptake value of 52.380 kg $ha^{-1}$was observed in the treatment T_7 (75 % P + 100 % NK + PPN) that was statistically superior from all other treatments. The lowest K uptake (24.327 kg ha^{-1}) by straw was obtained in the treatment T_1 (control).

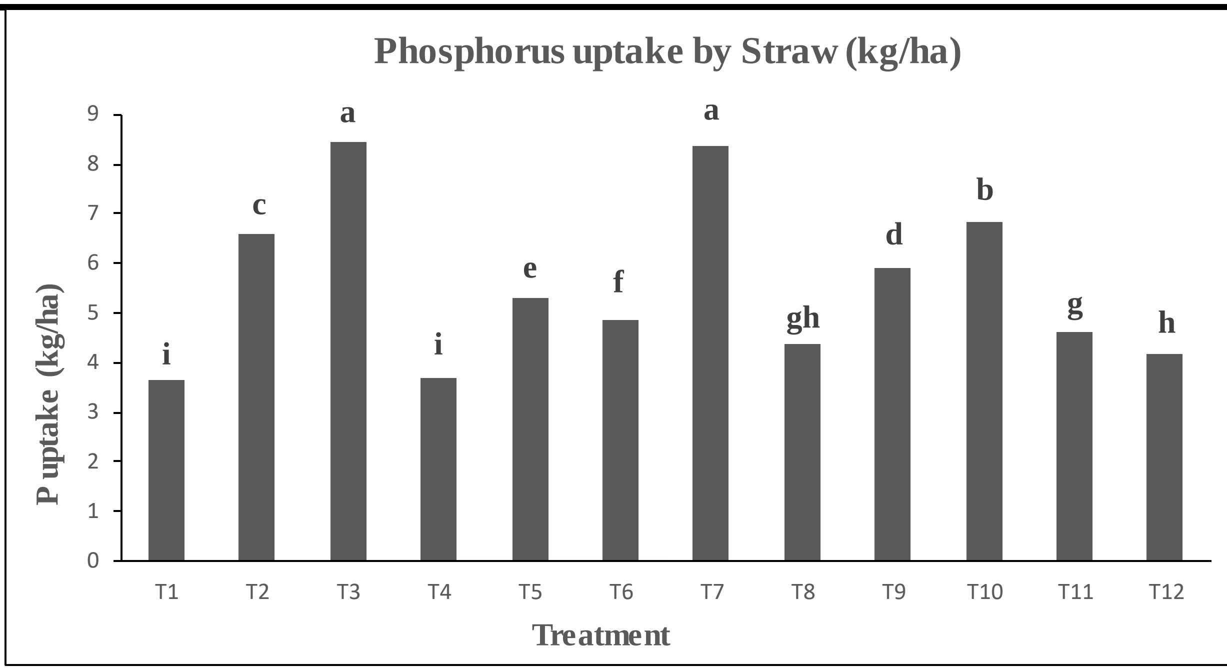

Fig.4: Effects of Peak Performance Nutrient (PPN) and different Fertilizer treatments on P uptake by straw

Legends,

T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD + PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK + PPN, T_7: 75 % P + 100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}: 75 % NPK + PPN, T_{12}: 50% NPK + PPN.

These results revealed that the K uptake by rice straw was much higher than that of K uptake by rice grain. It indicates that treatment T_7 (75 % P + 100 % NK + PPN) had pronounced effect on K uptake in both grain and straw. The results were in agreement with the findings of Sachdev *et al*. (1991).

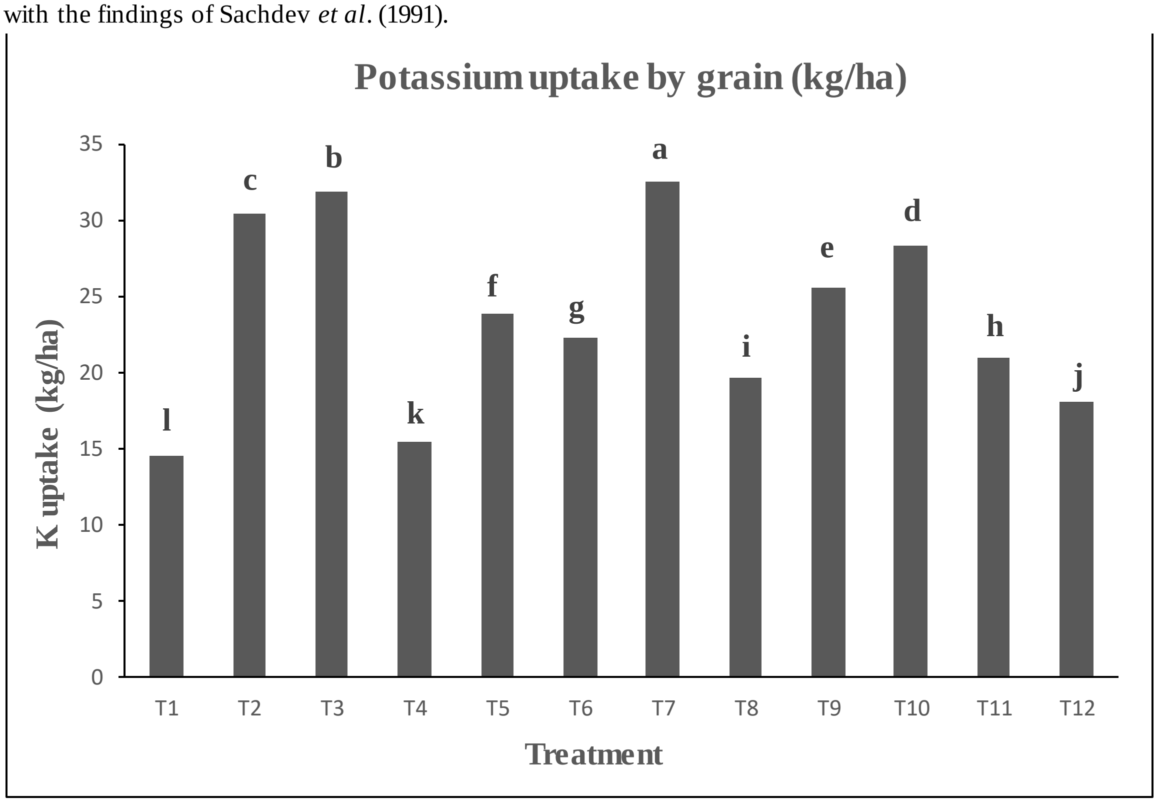

Fig.5: Effects of Peak Performance Nutrient (PPN) and different Fertilizer treatments on K uptake by grain

Legends,

T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD + PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK + PPN, T_7: 75 % P + 100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}: 75 % NPK + PPN, T_{12}: 50% NPK + PPN.

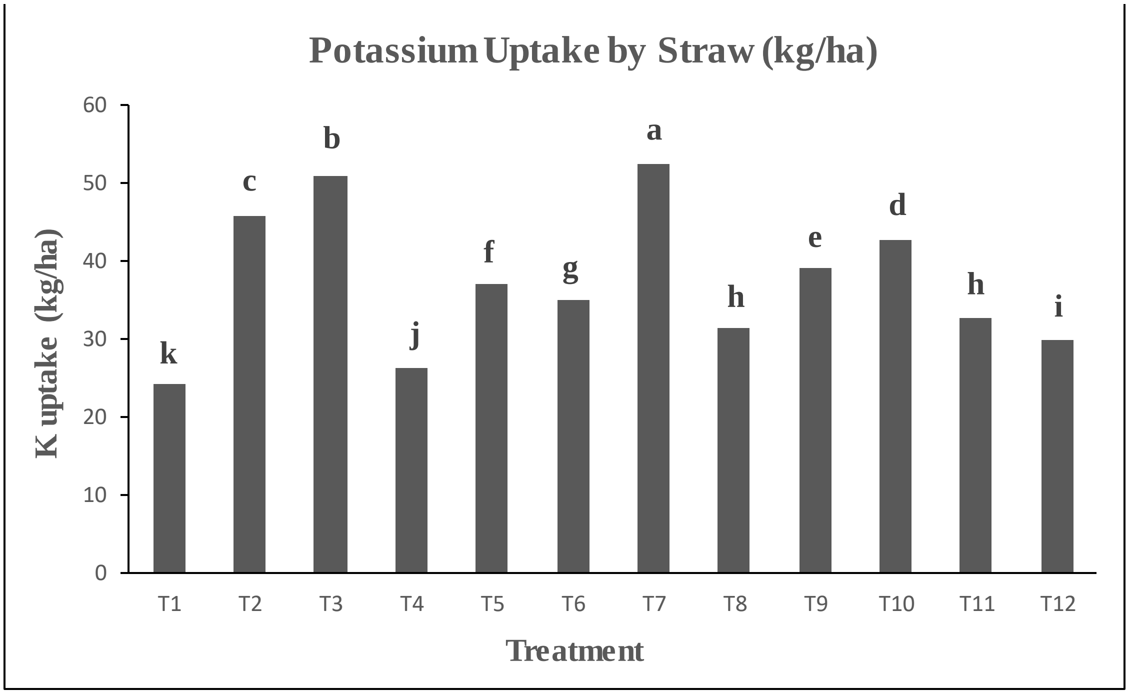

Fig.6: Effects of Peak Performance Nutrient (PPN) and different Fertilizer treatments on K uptake by straw

Legends,

T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD + PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK + PPN, T_7: 75 % P + 100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}: 75 % NPK + PPN, T_{12}: 50% NPK + PPN.

Effect of Peak Performance Nutrient (PPN) and chemical fertilizers on the nutrient status of Postharvest soil

Soil pH

There was a significant effect of different fertilizer doses with Peak Performance Nutrient (PPN) treatments on the pH of soil after harvest of aman rice (BRRI dhan49) (Table-3). Among the different treatments, highest pH (6.5) was found in T_7 (75 % P+100 % NK + PPN), which was statistically identical with the treatment T_3 (100 % NPK + PPN) with a value of 6.47 and superior from all other treatments. The lowest pH (6.04) was found in T_1 (control) treatment. Soil pH value was increased in the treatments that received the PPN solution. This result is very likely as the pH value of the PPN solution was high (more than 8.0). Therefore, PPN solution might be very effective to raise the pH of the acidic soil.

Organic carbon in soil

A significant variation ($p<0.05$) was recorded in the organic carbon content of the postharvest soil samples where the Peak Performance Nutrient (PPN) along with different fertilizer doses were incorporated in soil (Table- 3). Among the different fertilizer doses with Peak Performance Nutrient (PPN), T_7 (75 % P+100 % NK + PPN) treatment showed the highest organic carbon content (1.12 %) after the harvest of rice which was statistically similar with the treatmentT_3 (100 % NPK + PPN) with a value of 1.1 %. On the other hand, the lowest organic carbon content (0.852%) was observed in treatmentT_1 (control). Similar results were obtained by kamal *et al*., (2002) who explained that soil organic carbon increased when organic fertilizers were supplied instead of NPK fertilizers.

Total nitrogen content in soil

Significant ($p<0.05$) variation was recorded in the nitrogen content of the postharvest soil samples as influenced by different treatment combinations (Table- 3). The highest total nitrogen (0.158%) was found in T_7 (75 % P+100 % NK

http://dx.doi.org/10.22161/ijeab/3.5.30 ISSN: 2456-1878

+ PPN), which was statistically superior from all other treatments. The lowest (0.085%) was found in treatment T_1 (control). This result might be attributed due to no use of fertilizers and nutrient solution in the control treated plots.

Table.3: Chemical properties of post-harvest soil as influenced by Peak Performance Nutrient (PPN)

Treatments	Nutrient content in soil				pH	% OC
	% N	P (ppm)	K meq/100g soil	S (ppm)		
T_1	0.085j	13.347e	0.132k	10.733i	6.040j	0.852i
T_2	0.142c	15.577cd	0.253b	17.567b	6.100i	1.060b
T_3	0.154b	18.453a	0.272a	19.800a	6.473a	1.100a
T_4	0.093i	15.007d	0.153j	12.067h	6.186h	0.882h
T_5	0.112f	15.973bc	0.228d	16.200cd	6.300de	0.980e
T_6	0.103h	16.250bc	0.220e	15.527de	6.266f	0.960e
T_7	0.158a	18.000a	0.276a	20.350a	6.500a	1.120a
T_8	0.118e	15.693bcd	0.207f	14.733f	6.286ef	0.920fg
T_9	0.123d	15.653bcd	0.234c	16.633c	6.373c	1.005d
T_{10}	0.138c	16.567b	0.200g	17.400b	6.426b	1.030c
T_{11}	0.108g	16.010bc	0.185h	15.087ef	6.320d	0.932f
T_{12}	0.096i	15.493cd	0.168i	13.867g	6.220g	0.910g
% CV	1.94	3.49	1.45	2.62	0.30	1.26
$LSD_{0.05}$	.003	0.94	.005	0.70	0.03	0.02

In a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

Legends,

CV= Co-efficient of Variation

T_1: Control (no fertilizer and no PPN), T_2: 100 % recommended dose of NPK, T_3: 100 % NPK + PPN, T_4:0 % RD + PPN only, T_5: 75 % N + 100 % PK+PPN, T_6: 50 % N + 100 % PK + PPN, T_7: 75 % P + 100 % NK + PPN, T_8: 50 %P + 100 % NK + PPN, T_9: 75 % K+ 100 % NP + PPN, T_{10}: 50 % K + 100 % NP + PPN, T_{11}: 75 % NPK + PPN, T_{12}: 50% NPK + PPN.

Available phosphorous in soil

Phosphorous content of postharvest soil showed significant ($p<0.05$) variation in the available phosphorus content of the postharvest soil samples (Table-3). Combined effect of different fertilizer doses and Peak Performance Nutrient (PPN) recorded significant variation in available phosphorous content of postharvest soil. Among the different treatments, the highest available phosphorous (18.453 ppm) was found inT_3 (100 % NPK + PPN) treatment which was statistically similar with the treatmentT_7 (75 % P+100 % NK + PPN) with a value of 18.0 ppm. The lowest (13.347 ppm) was found in T_1(control) treatment. Guan, (1989) reported that the application of organic fertilizers increased the availability of phosphorous in soil. As the PPN increased the pH of the acidic soil, therefore it increases the availability of phosphorus in soil.

Exchangeable Potassium content in soil

Significant ($p<0.05$) variation was recorded in exchangeable K content in soil after harvest of the rice in the (Table-3). The highest K (0.276 meq/100g soil) found in treatmentT_7 (75 % P+100 % NK + PPN) treatment, which was statistically similar with the treatmentT_3 (100 % NPK + PPN) with a value of 0.272 (meq/100g soil). On the other hand, the lowest K (0.132 meq/100g soil) was found in T_1 (control).

Available Sulphur in soil

Available sulphur content in the postharvest soil samples was affected significantly ($p<0.05$) variation due to the application of different fertilizer doses and Peak Performance Nutrient (PPN), which is shown in the Table-3. The highest sulphur (20.35 ppm) was found in treatment T_7 (75 % P+100 % NK + PPN) treatment that was statistically similar with the treatmentT_3 (100 % NPK + PPN) with a value of 19.8 ppm. The lowest available sulphur (10.733 ppm) was found in the control treatment.

Experimental results revealed that nutrient solution had significant influence on the available sulphur content of the postharvest soil samples.

IV. CONCLUSIONS

Based on the findings of the present study on the response of Peak Performance Nutrient (PPN) and different fertilizer doses on post-harvest soil properties and nutrient uptake by aman rice, it might be concluded that the treatment T_7 (75 % P + 100 % NK +PPN) showed better performance in acid soil. Moreover, the findings reveal that combined application of Peak Performance Nutrient (PPN) and chemical fertilizer could reduce the application of 25% P from the recommended dose.

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