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Effect of Nitrogen and Phosphorus Fertilization on the Yield and Nutrient Status of Rice Crop Grown on Artificial Siltation Soil From the Kelkit River*

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Abstract: The experiment was carried out on split plot design with four replications under greenhouse conditions. The pots containing 5 kg of soil which is collected from the 0-20 cm depth of artificial silation area made with silty water of Kelkit River were used for this study. Nitrogen at the rates of 0, 60, 120, 180 and 240 kg/ha as urea and phosphorus at the rates of 0, 50, 100 and 150 kg P_2O_5/ha as triple superphosphate were applied to the soil before sowing. Additionally potassium was applied at 40 kg K_2O/ha level as K_2SO_4 per pot for normal plant growth. The Ribe rice variety was sown in 15th June, 1995 and plants were harvested in 9th October, 1995. Straw dry matter and grain yields were recorded and macro-nutrient (N,P,K) and micro-nutrient (Fe,Cu,Zn,Mn) content of straw and grain were analysed.

Both nitrogen and phoshorus fertilization have increased the straw and grain yields of rice plant significantly. Maximum increase in straw yield, 29.84 g/pot, and grain yield, 13.99 g/pot, was obtained from 240 kg N/ha rate, on the other hand, 100 kg P_2O_5/ha had given the highest straw yield, 20.35 g/pot and grain yield, 9.35 g/pot, respectively. Macro-nutrient (N,P,K) and micro-nutrient (Fe,Cu,Zn,Mn) contents of straw and grain were significantly affected by N-fertilization, whereas only NPK content of straw and grain and only Mn content of grain were affected by P-fertilization. However, uptake of macro and micro-nutrients were significantly affected by N and P fertilizer rates.

Kelkit Çayından Siltasyon ile Tarıma Yeni Kazandırılan Topraklarda Azotlu ve Fosforlu Gübrelerin Çeltik Bitkisinin Gelişimi ve Bitki Besin Düzenine Etkisi

Özet: Sera koşullarında tesadüf parselleri deneme desenine göre dört tekerrürlü olarak yürütülen saksı denemesinde, siltasyon ile tarıma kazandırılan arazilerin 0-20 cm'lik kısımlarından örnekleme ile alınan topraklar 5'er kg toprak alabilen saksılara doldurulmuştur. Araştırmada bitki olarak 5.6.1995 tarihinde Ribe çeltik çeşidi ekilmiştir. 0, 60, 120, 180 ve 240 kg N/ha dozlarında azotlu gübre üre şeklinde, 0, 50, 100 ve 150 kg P_2O_5/ha dozlarında fosforlu gübre triple süperfosfat şeklinde ekimle birlikte uygulanmıştır. Ayrıca her saksıya normal bitki gelişimi için 40 kg K_2O/ha potasyumlu gübre K_2SO_4 şeklide ekimle birlikte uygulanmıştır. Yaklaşık 16 haftalık bir gelişmeden sonra bitkiler 9.10.1995 tarihinde hasat edilerek sap ve dane ağırlıkları belirlenmiş ve bazı makro (N,P,K) ve mikro (Fe,Cu,Zn,Mn) besin elementi kapsamları tespit edilmiştir.

Araştırma sonuçlarına göre, en yüksek sap ve dane verimi ortalama olarak 29.84 ve 13.99 gr/saksı ile 240 kg N/ha uygulamasından elde edilmiş, buna karşılık en yüksek sap ve dane verimleri ortalama olarak 20.35 ve 9.35 gr/saksı ile 100 kg P_2O_5/ha fosfor uygulamasından elde edilmiştir. Sap ve danelerin makro (N,P,K) ve mikro (Fe,Cu,Zn,Mn) besin elementi kapsamlarında azotlu gübrelemeye bağlı olarak önemli farklılıklar ortaya çıkmıştır. Fosforlu gübreleme ise yalnızca sap ve danelerin N,P,K kapsamı ile dane Mn kapsamı üzerine önemli bir etkide bulunmuştur. Sömürülen makro ve mikro besin elementi miktarları ise azotlu ve fosforlu gübrelemeye bağlı olarak önemli farklılıklar göstermiştir.

Introduction

Rice is an important cereal crop in the World in respect to food supply for human, it ranks second after wheat. It supplies more calories than wheat (1). Rice is grown in 148 million hectares and the production is 522 million tons in the World. In Turkey, rice is cultivated in 53.000 hectares and the annual production is 138.000 tons (2). This area and production is not sufficient. It seems not possible to incerase the area for rice cultivation in Turkey. However, some additional area is being brought under rice cultivation in Turkey. However, some additional area is being brought under rice cultivation in Turkey through artificial siltation. The second important thing is to increase the per hectare yields of rice in Turkey by applying modern agricultural techniques; using hybrid seeds, irrigation, weed control, use of insectisides and pesticides and fertilization pratices.

The Lands brought under rice cultivation in Turkey

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Table 1. Effect of N and P fertilization on dry matter yield of rice straw.

N	P_2O_5, kg/ha				
kg/ha	0	50	100	150	Av.
0	3.43 h	3.92 h	5.12 gh	4.61 gh	4.27 e
60	7.80 fh	11.40 ef	10.74 ef	11.14 ef	10.27 d
120	9.58 eg	18.33 cd	20.33 c	18.03 cd	16.57 c
180	13.60 de	28.12 b	29.39 b	29.61 b	25.18 b
240	11.94 ef	34.97 a	36.14 a	36.31 a	29.84 a
Av.	9.27 b	19.35 a	20.35 a	19.94a	

LSD (N-rates): 2.334** LSD (P-rates): 2.087**; LSD (NxP): 4.667**

Table 2. Effect of N and P fertilization on the grain yield of rice.

N	P_2O_5, kg/ha				
kg/ha	0	50	100	150	Av.
0	1.25 g	1.56 g	2.94 fg	2.15 g	1.97 e
60	4.21 eg	5.63 df	5.42 ef	5.33 ef	5.15 d
120	3.75 eg	8.50 cd	9.00 c	8.80 c	7.51 c
180	6.28 ce	12.06 b	12.37 b	12.79 b	10.87 b
240	4.04 eg	17.82 a	17.00 a	17.10 a	13.99 a
Av.	3.91 b	9.11 a	9.35 a	9.23 a	

LSD (N-rates): 1.390**; LSD (P-rates): 1.243**; LSD (NxP): 2.779**

through artificial siltation are generally poor in nutrients. Because siltation is done through the decantation method that is muddy water of the river is applied to Lands which are protected with soil bunds. Water is lost by leaching and evaporation by leaving the silt on the protected area. This treatment is repeated more than twice and is continued for many years to get a soil profile with different depths. When the silt is deposited up to 20 cm depth, it is possible to start rice cultivation on these lands. As mentioned above the soil obtained through siltation for cultivation are mostly poor in their fertility. Thus, nitrogen and phosphorus fertilizers play an important role on the yield of rice crop grown on such soils. Many workers have found positive effect of N and P fertilization on the yield of rice crop grown under Turkish conditions (3, 4). Rice crop responses very quickly to nitrogen fertilization (5). Similar results have been found by other workers (6, 7).

Generally, available P-content of soils is very poor in Turkey, hence it is necessary to apply P fertilizers in early growth period for root development. Especially P content of silation soils is very poor as compared to other soils of the study. The problem of fertilization has still not been solved in rice growing regions (4, 8). This is especially true for silation soils.

The siltation work is being carried out by the Directorate of Village Attairs of Ministry of Agriculture of Turkey. The work is carried out as Tokat-Niksar-Yarbaşı project and it comprises 700 hectares. The bunds are established at 250 meters distance and the silty water of Kelkit is applied to these protected areas for silt deposit (9). The main object of this research work is to find out the most suitable rates of nitrogen and phosphorus fertilizers for this area under greenhouse condition and then after to continue the research work under field conditions for farmer's recommendation.

Table 3. Effect of N and P fertilization on nutrient content of rice straw.

N kg/ha	N %	P %	K %	Fe ppm	Cu ppm	Zn ppm	Mn ppm
0	0.126 c	0.071 a	0.30 ab	180 a	14 b	17 a	114 a
60	0.166 b	0.043 c	0.33 ab	144 ab	8 d	6 c	62 b
120	0.145 bc	0.052 b	0.38 a	134 bc	10 cd	11 b	90 a
180	0.148 bc	0.040 c	0.26 b	98 c	13 bc	10 b	62 b
240	0.267 a	0.034 d	0.17 c	111 bc	21 a	14 a	48 b
LSD	0.094**	0.0029**	0.084**	42.47**	3.023**	2.356**	24.72**
P_2O_5, kg/ha							
0	0.208 a	0.050 a	0.36 a	140	16 a	17 a	84
50	0.171 b	0.041 b	0.28 b	127	13 b	11 b	79
100	0.151 b	0.042 b	0.24 b	141	13 b	10 b	71
150	0.152 b	0.051 a	0.27 b	125	12 b	9 b	67
LSD	0.084**	0.0020*	0.020**	N.S.	2.704**	2.107**	N.S.
LSD (NxP)	N.S.	0.0059**	0.168*	84.94**	6.05**	4.71*	49.45**

**, Significant 1% Level; *, Significant 5% Level; N.S. Non-Significant

Materials and Method

An experiment was carried out on split plot design with 4 replications under greenhouse conditions. The pots containing 5 kg of soil which is collected from the 0-20 cm depth of artificial siltation area made with silty water of Kelkit River were used for this study. Nitrogen at the rates of 0, 60, 120, 180 and 240 kg N/ha as urea were applied before sowing (15th June, 1995) and after sowing (15 th july, 1995) in two times. Phosphorus at the rates of 0, 50, 100 and 150 kg P_2O_5/ha as a triple superphosphate were applied before sowing. In addition, 40 kg K_2O/ha was applied as K_2SO_4 per pot for optimal plant growth before sowing. The Ribe rice variety (10 seed per pot) was sown in 15th June, 1995 and plants were harvested in 9th October, 1995. Straw dry matter and grain yields were recorded. The nitrogen (10), phosphorus (11), potassium (12), iron, cupper, zinc and manganes (13) contents of plant were analysed.

The soil used in the pot experiment was clay loam in texture with 45, 33 and 22 percent clay, silt and sand respectively. The soil is of 25.84% field capacity, 17.43% wilting point and 17.43% $CaCO_3$ content. The pH (1:2.5) was 8.56 and EC was 0.107 mmhos/cm. The cation exchange capacity and available K were 48.00 and 0.61 me/100 grams, respectively. The organic matter content, available P and Fe, Cu, Zn, Mn contents of soil (extractable in DTPA) were 0.75%, 8.50, 1.80, 1.27, 0.55 and 2.30 ppm, respectively (14). The total nitrogen content of soil is 0.038%.

Result and Discussion

Effect of N and P fertilization on dry matter yields of straw and grain

The effect of different rates of N,P fertilization on the dry matter yields of straw and grain is given on Table 1 and 2, respectively.

Table 4. Effect of N and P fertilization on nutrient-content of rice grain

N kg/ha	N %	P %	K %	Fe ppm	Cu ppm	Zn ppm	Mn ppm
0	0.83 d	0.263 a	0.39 a	35	12 b	29 b	42 a
60	0.94 c	0.281 a	0.38 a	41	17 a	33 a	37 ab
120	1.05 b	0.240 b	0.37 ab	28	14 b	34 a	39 a
180	1.08 b	0.212 b	0.34 bc	36	12 b	33 a	37 ab
240	1.17 a	0.183 b	0.32 c	37	11 b	34 a	31 b
LSD	0.084**	0.030**	0.030**	N.S.	3.442**	2.982*	5.711*
P_2O_5, kg/ha							
0	1.12 a	0.221	0.33 b	33	14	31	42 a
50	0.98 ab	0.222	0.37 a	36	12	32	34 b
100	0.97 b	0.230	0.36 a	33	12	33	35 b
150	0.98 ab	0.265	0.38 a	39	14	34	37 b
LSD	0.075**	N.S.	0.027**	N.S.	N.S.	N.S.	5.108*
LSD (NxP)	0.168**	0.059**	0.056**	16.71*	N.S.	N.S.	11.42*

**, Significant 1% Level; *, Significant 5% Level; N.S. Non-Significant

The increasing rates of nitrogen have significantly increased the straw dry matter yield of rice plant. A maximum straw dry matter yield of 29.84 g/pot was obtained with 240 kg N/ha rate (Table 1). Similarly, increasing rates of phosphorus have significantly increased the rice straw dry matter yield. The rice dry matter yields of 9.27, 19.35, 20.35 and 19.94 g/pot were obtained from 0, 50, 100 and 150 kg P_2O_5/ha rates, respectively. However, there is no difference found among the P-rates.

Nitrogen rates have significantly increased the rice grain. A maximum yield of 13.99 g/pot was obtained with 240 kg N/ha rate of nitrogen as compared to 1.97 g/pot of control treatment. Similarly a maximum grain of 9.35 g/pot was obtained with 100 kg P_2O_5/ha rate of P as compared to 3.91 g/pot of without P-treatment (Table 2). However, statistically there were no differences among the P treatments. This shows that 50 kg P_2O_5/ha rate is sufficient for rice cultivation in this study.

The NxP interaction was also found for straw and grain yields. The highest straw yield, 36.31 g/pot, was obtained at 240 kg N/ha and 150 kg P_2O_5/ha, on the other hand, the highest grain yield, 17.82 g/pot, was obtained at 240 kg N/ha and 50 kg P_2O_5/ha. The nitrogen rates of 150-240 kg/ha have also found sufficient for the maximum rice yield by other workers (15, 16, 17, 18, 19). In addition, the maximum yield was obtained at 50-100 kg P_2O_5/ha rates in other studies (16, 19, 20, 21).

Effect of N and P fertilization on the nutrient content of rice straw

The results regarding the effect of different rates of N and P fertilization on the nutrient content of rice straw are given on Table 3.

The detailed results of NxP interactions for macro and micro nutrient contents couldn't be showed in this paper because of the restriction of page.

The N-content in straw by N treatments increased from 0.13% (control) to 0.27% (240 kg N/ha). The P-content decreased from 0.07% (control) to 0.03% (240

Table 5. Effect of N and P fertilization on uptake some nutrients in rice straw.

N	N	P	K	Fe	Cu	Zn	Mn
kg/ha		mg/pot			µg/pot		
0	5.31 e	2.79 c	12 c	799 b	57 d	139 bc	456 b
60	16.94 d	4.12 bc	33 b	1423 b	79 d	62 c	651 b
120	22.25 c	8.51 a	56 a	2038 ab	177 c	167 bc	1400 a
180	36.62 b	8.28 a	62 a	2450 ab	307 b	347 ab	1576 a
240	75.57 a	6.57 b	50 a	3686 a	552 a	425 a	1531 a
LSD	5.990**	1.456**	15.81**	1798**	79.30**	217.7**	432.0**
P_2O_5, kg/ha							
0	20.35 b	3.61 b	29 b	1223 b	137 b	186	611 b
50	36.41 a	5.71 a	46 a	2326 a	278 a	228	1407 a
100	34.75 a	7.45 a	48 a	2400 a	231 a	206	1407 a
150	33.84 a	7.45 a	46 a	2367 a	292 a	292	1309 a
LSD	5.357**	1.302**	14.14**	1608*	70.93**	N.S.	386.4**
LSD (NxP)	N.S.	2.911**	31.61**	3596**	158.6**	327.4*	864.0**

**, Significant 1% Level; *, Significant 5% Level; N.S. Non-Significant

kg N/ha). K-content in straw increased slighthly up to 120 kg N/ha treatment and then significantly decreased with increasing N- treatments. Fe-content in straw was significantly decreased with N-treatments. Cu-content in straw first decreased and then increased. Zn and Mn-contents in straw significantly decreased with N-treatments (table 3). N-treatments have increased the dry matter yield of straw, hence this increase has a dilution effect on micro-nutrients content in rice straw. Similar results have been found by many workers who worked on the fertilization of rice plant (22, 23, 24, 25).

Different treatments of P have significantly affected N,P,K,Cu and Zn contents in straw. Generally the contents of all these nutrients in straw significantly decreased with increasing rates of phosphorus (26, 27, 28).

Effect of N and P fertilization on the nutrient-content of rice grain

The effect of different rates of N and P fertilization on the nutrient-content of rice grain is given on Table 4.

As it is seen on Table 4, increasing rates of N-treatments have significantly affected the nutrient-content in rice grain. N-content in grain increased from 0.83% (control) to 1.17%, P-content decreased from 0.26 to 0.18%, K-content decreased from 0.39 to 0.32%, Fe-content except 120 kg N/ha treatment increased slightly from 35 to 37 ppm, Zn-content increased from 29 to 34 ppm (the differences between treatments were not important) and Mn content in grain decreased from 42 to 31 ppm at control and 240 kg N/ha treatments, respectively. Similar results have been found by many workers (24, 25).

P-treatments decreased the N-content from 1.12 to 0.98%, increased the P-content from 0.22 to 0.26%, increased K-content from 0.33 to 0.38% and decreased Mn-content from 42 to 37 ppm at control and 150 kg P_2O_5/ha rate, respectively. Other workers have also found the similar results (24, 28).

Table 6. Effect of N and P fertilization on the uptake of some nutrients in rice grain.

N	N	P	K	Fe	Cu	Zn	Mn
kg/ha		mg/pot			µg/pot		
0	15.41 e	4.90 d	8 e	71 d	51 b	59 e	77 e
60	48.68 d	14.61 c	20 d	212 c	136 a	170 d	199 d
120	77.92 c	17.66 bc	28 c	203 c	102 ab	252 c	288 c
180	115.61 b	22.61 b	37 b	383 b	134 a	363 b	372 b
240	153.24 a	24.45 a	48 a	524 a	143 a	498 a	494 a
LSD	15.83**	3.122*	6.067**	105.1**	65.57*	73.72**	70.02**
P_2O_5, kg/ha							
0	41.49 b	8.05 b	12 b	136 b	60 b	137 b	145 b
50	95.57 a	17.40 a	32 a	315 a	113 ab	297 a	342 a
100	97.13 a	19.42 a	33 a	307 a	161 a	321 a	324 a
150	94.50 a	22.50 a	35 a	358 a	119 ab	319 a	333 a
LSD	14.16**	2.793**	5.426*	94.02**	58.65*	65.94**	62.63**
LSD (NxP)	31.67**	6.245**	12.13*	210.2**	N.S.	147.4**	140.0**

**, Significant 1% Level; *, Significant 5% Level; N.S. Non-Significant

Effect of N and P fertilization on the nutrient uptake of rice straw

The effect of different rates of N and P fertilization applied to rice plant on the uptake of some macro and micro-nutrients in rice straw is given on Table 5.

Different rates of nitrogen applied to rice plant have significantly increased the uptake of nutrients in rice straw. It increased from 5.31 at control to 75.57 mg/pot at the highest rate of N. The P-uptake in straw varied from 2.79 (control) to 8.51 mg/pot (120 kg N/ha), K-uptake varied from 12.0 (control) to 6.20 mg/pot at 180 kg N/ha rate. Uptake of Fe, Cu, Zn and Mn in straw linearly increased with increasing N-treatments. The results are parallel to the findings of other workers (22, 24, 29, 30). The application of P up to 100 kg P_2O_5/ha rate has significantly increased the N, P and K-uptake in straw, similarly the uptakes of Fe, Cu, Zn and Mn were also increased with increasing rates of P-fertilization (table 5). The similar findings were also found from other studies (22, 26).

Effect of N and P fertilization on the nutrient uptake of rice grain

The effect of N and P fertilizer rates on the uptakes of some macro and micro-nutrients in rice grain is given on Table 6.

Different rates of N and P applied to rice plant under greenhouse conditions have significantly increased the uptake of macro and micro-nutrients in rice grain. A maximum inrcease of 153.24, 24.45, 48.0 mg/pot for N, P and K-uptake and 524, 143, 498 and 494 µg/pot for Fe, Cu, Zn and Mn-uptake were obtained at the highest rate of N when compared to their control data. The results are parallel to the findings of other workers (22, 25, 31).

Similarly, P-rates increased N, P and K-uptakes from

41.40 (control) to 97.13 (100 kg P_2O_5/ha); from 8.05 (control) to 22.50 (150 kg P_2O_5/ha) and from 12.0 (control) to 35.0 mg/pot (150 kg P_2O_5/ha), respectively. Maximum Fe, Cu and Zn and Mn-uptakes in grain were obtained at 150 kg P_2O_5/ha, 10 kg P_2O_5/ha and 50 kg P_2O_5/ha rates of P-application, respectively (Table 6). Other workers have also found the similar findings (22, 32).

As a results, nitrogen and phosphorus fertilization increased the dry matter yield and micronutrient uptake by rice plant in the artificial siltation soils made with silty water of Kelkit River. This treatment will economically increase the rice production especially in artificial siltation areas poor in nutrients. In this study, maximum increase in straw yield, 29.84 g/pot, and grain yield, 13.99 g/pot, was obtained from 240 kg N/ha rate, on the other hand, the highest straw and grain yields, 20.35 and 9.35 g/pot, were obtained at 100 kg P_2O_5/ha rate. This shows that nitrogenous fertilizer up to 240 kg N/ha and phosphorus fertilizer up to 100 kg P_2O_5/ha may be safely applied to rice plant in these soils. However, statistically there were no differences among the P treatments and 50 kg P_2O_5/ha rate is sufficient for rice cultivation in this study. It was also found that macro and micro nutrient contents and uptakes of straw and grain were significantly affected by N and P-fertilization. This working is the first step of our studies and we will carry out detailed studies under field conditions in these areas.

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