J. Agrofor. Environ. 11 (1 & 2): 175-179, 2017 ISSN 1995-6983

Interaction of nutrients in some soils and their fluctuation in Sara soil during onion (*Allium cepa*) cultivation

M.A.K. Azad, M.K. Islam and M.S. Reza
Department of Crop Science and Technology, University of Rajshahi, Bangladesh, Email: azad.adrinwa@gmail.com

Abstract: Seven soil series viz. Amnura, Ekdala, Sara, Gopalpur, Ishordi, Gheor and Ganges alluvial under AEZ-11 at Paba Upazilla, Rajshahi were investigated to evaluate the interaction of nutrient elements and the changes of nutrient status of Sara soil during onion (*Allium cepa*) cultivation in the Rabi season from December 2012 to March 2013. The variety onion cultivated in the trail was Taherpuri following Randomize Complete Block Design (RCBD). The experimental soil samples from all soil series were analyzed and interactions among organic matter (OM), pH, Nitrogen (N), phosphorus (P) and Potassium (K) were also done. Results showed that total N was positively correlated with organic matter (r = 0.86), pH (r = 0.54) and phosphorus (r = 0.49), where as negatively correlated with potassium (r = - 0.22). Available phosphorus was positively correlated with OM (r = 0.57), pH (r = 0.21) and N (r = 0.70), and also positive with potassium (r = 0.15). Potassium exposed the negative correlation with organic matter (r = - 0.08), pH (r = - 0.32), nitrogen (r = - 0.32) and phosphorus (r = - 0.60). The soils of Sara series among them were selected to cultivate onion and the soils were analyzed before planting, during growing period and after harvesting of onion. It was found from the analysis that the concentration of nitrogen in the experimental field soil before planting was 0.05%, during growing period it was 0.08% and became 0.10% after harvesting. An increasing tendency of the content of N was observed during the growing season of onion and thereafter. In the case of phosphorus, there was a decreasing trend from pre-planting up to harvesting (before planting 29.1 ppm, during growing season 28.0 ppm and after harvest 20.9 ppm). Potassium also showed the same decreasing trends though the rate was not so much distinct. However, results indicated that P was uptaken in a large quantity by onion plant, so that P was identically lesser in the soil after harvesting of onion. Other nutrients were absorbed in a smaller quantity by onion plants.
Key words: Organic matter, nutrients, pH, interaction, onion, cultivation.

Introduction

Nutrient stresses in Bangladesh soils are increasing day by day. One of the major reasons for this stress is that the removal of nutrients from soil is much higher than the addition from different sources. As a consequence, a negative balance of nutrients is produced in soil. The net removal of nutrients from soil under intensive cultivation in Bangladesh as reported by Karim *et al.* (1990) ranges from 180 to 230 kg $ha^{-1}yr^{-1}$, may be cited here to emphasize the point.

The effects of fertility degradation on the other hand, are reflected in yield stagnation/declination as observed very recently. In order to minimize these problems, it is very pertinent to evaluate the fertility status of our soils at the farmers' level. Since land area under cultivation can not be increased, an increase in the crop yield per unit area through proper crop and soil management has no alternative (Ahamad, 2002). Evaluation of physical and chemical characteristics of soil is helpful for economic use of fertilizers and irrigation water which in turn may help in maximizing crop production.

Onion is grown in all parts of Bangladesh but its commercial production is mainly concentrated in the regions of Dhaka, Mymensingh, Commilla, Rangpur and Faridpur (Kamaluddin, 1966). The total area under onion is 35 thousand hectares and its production is about 144 thousand tons and the average yield per hectare comes about 4 tons which is very low as compared to that of other developed countries where the average yield is about 40 t/ha (Rashid, 1976). Reports indicate that the yield of onion depends on the method of production, including the application of manure and fertilizers. It is possible to increase the yield of onion by judicious management of fertilizers.

The present investigation with seven soil series viz. Amnura, Ekdala, Sara, Gopalpur, Ishordi, Gheor and Ganges alluvial under AEZ-11 at Paba Upazilla, Rajshahi was therefore, undertaken with a view to studying interactions among organic matter, pH, N, P, and K, and the changes of their availability at different growth stages of onion.

Materials and Methods

Location: Paba upazilla is situated in the southern part of Rajshahi district in Bangladesh. This upazilla is surrounded by Tanor and Mohonpur in the north, Durgapur and Puthia in the east, Rajshahi city in the south and Godagari upazilla in the west. This upazilla is situated between 24″ 17′ & 24″31′ North latitude and 88″ 28′ & 88″ 43′ East longitude. It is 8 km apart from Rajshahi city. The total area of this upazilla is about 5483 hectare. About 548 hectare of land is covered with habitat, water bodies and the rivers, about 4935 hectare land is under cultivation. High lands cover 80% and the rest are medium high land.

Climate: Paba upazilla belongs to the tropical monsoon climate like the other places of Bangladesh, and three seasons are predominant among the six seasons. The winter season starts from November and ends in February. This season is very dry and cool. The lower temperature exists in the month of January and the average temperature is 11.2 °C. Sometimes precipitation occurs in a very small amount, the average rainfall is about 7 mm in this season. March to May considered as summer. During this time the air becomes very hot and the humidity is very low. The humidity was lower in the months of March (63%) and April (56%), and higher in December (86%) and January (83%), medium humidity prevailed in November (79%) and February (78%). The rainy season persists from May to October, 92% precipitation occurs during this time (Bhumi and Mrittika sampod Babohar Nirdeshika 2012).

Soil series: The soil of Paba upazilla consists of seven soil series, such as Amnura, Ekdala, Sara, Gopalpur, Ishordi, Gheor and Ganges Alluvial. The land types of these series were mainly high to medium high and alkaline in nature. In Gheor series organic matter observed was medium but other soil series contained very low. Adequate content of

phosphorus was present in the soil, where as nitrogen and potassium were detected as very low to medium.

Preparation of soil samples: Soils were collected (0 - 15 cm depth) from at least three random spots of each treated plot of all series, including the field soils before planting, during growing season and after harvesting of onion under Sara series. After completion of collection of soils, the unwanted materials like stones, granules, plant parts, leaves etc, were removed and discarded from the soils. They were air dried, ground and passed through 10 mm mesh sieve. Composite samples were prepared by sieving the soils of each selected sites. The soil samples (500 g) were preserved in poly bags for laboratory analysis.

Analysis of Soil Samples:

Measurement of pH: Measurement of pH with Metrohm 691 pH meter. The pH of all soil samples were measure by a pH meter. The pH values of anymore of standard buffers were stored in the memory of the Metrohm 691 pH meter. The combined pH and referenced electrode were placed in the buffer solution with pH 6.87. The pH meter was switched on and then pressed pH cal. The display was briefly showed the temperature of the buffer solution. It should be between 25 °C and 30 °C.

Determination of Total Nitrogen: After preparing soil samples there followed some processes to determine total nitrogen. According to Black (1965) digestion, distillation, titration and calculation were performed for determining nitrogen. The formula was used to calculate nitrogen as: % N in the soil = $[\{(a \times M_{HCL} - b \times M_{NaOH}) \times 1.401\} \div c]$.

Where, a = mL HCl measured into the conical flask in the distill (usually 20.00 mL), b = mL NaOH used for titration of the content in the conical flask, M_{HCl} = molarity of the HCl measured into the conical flask, M_{NaOH} = molarity of the NaOH used for titration, c = g soil used for the analysis.

Determination of Phosphorus in Soils with pH_{H20}<7: According to Brady (1984) soil was extracted for determining Phosphorus. The formula was used to determine the concentration of Phosphorus as: mg P /kg soil = $\{(a \times 1250) \div (b \times c)\}$. Where, a = mg Phosphorus /1 measured by the spectrophotometer, b = mL filtrate transferred to the 50 mL volumetric flask (usually 5 mL), c = g soil used for the analysis (usually 3. 50 g).

Determination of Potassium: According to Black (1965) potassium was determined by using the formula as: C mol (+) K / kg soil = meq K / 100 g soil = $\{(a \times 25) \div g\}$. Where, a = cmol (+) Potassium per measured on the flame photometer, g = g soil used for the analysis.

Cultivation of onion: The experimental field was prepared by ploughing and cross ploughing with country plough, then leveled by laddering. Weeds, crop residues and stables were collected and removed from the field before final land preparation and fertilization. Urea, DAP, gypsum, boric acid and ZnO were applied to the experimental plots as basal at the rate of 150, 50, 20, 5 and 2 kg/h respectively. Total doses of fertilizers were applied at the time of sowing and growing period. The seedlings of onion (*Allium cepa*) were transplanted to the experimental field at the age of 15 days. Transplanting was done in the afternoon with a spacing of 15 cm × 20 cm in each unit plot for both the experiments. Irrigation water was applied for two times to the field, the first irrigation was done after 15 days of transplanting and the next was applied after fertilization for the normal growth of onion. To protect from the scorching of sunshine shade was provided to the transplanting seedlings. Different cultural operations were carried out in the field as when necessary during the growing period of this investigation. The crop was attacked with some local weeds. They were controlled by mechanically and using mulching.

Layout and statistical analysis of the experiment: The experiment was laid out in Randomized Complete Block Design. Each experimental field was divided into three blocks which represented three replications of the experiment. Each block was divided into 4 sub blocks and each block was again divided into 12 unit plots. The total number of unit plots of the experiments was 144. Data obtained were statistically analyzed to find out the significance of the differences among the treatments using Duncan's multiple range test (Duncan, 1995). The significant of differences among the treatment means were evaluated by least significant differences (LSD) ($p < 0.05$) (Gomez and Gomez, 1984) using MSTAT-C program.

Results and Discussion

Soil pH: The pH value of different soil series are shown in the Table 1 varied from 5.5 to 8.8. The pH of Sara (6 - 8.8) soil was the highest and was statistically similar to soils of Ganges Alluvial (pH 8.6 - 8.7), Gopalpur (pH 8.6), Ishordi (pH 6.2-8.5) and Gheor series (pH 6.1 - 8.5) (Table 1). It was found from the Table 2 that the pH values were significantly fluctuated in different growth stages of onion grown in Sara soil. The pH was 8.0 before planting of onion, while pH was decreased at 6.5 during the growing period, and after cultivation of onion it was 7.7. It is to be noted that the soil became acidic (pH 6.5) during the growing period of onion, the reason might be the increment of H^+ ions to soil solution releasing from onion roots. After harvesting, soil pH became alkaline (pH 7.7) as of pre planting of onion. The cause might be of stopping of H^+ ions from onion roots.

Organic matter: It was observed that the organic matter content in the selected soil series varied from (0.88% to 1.88%) (Table 1). The BARC (1997) has classified the organic matter status of soils of the country as very high (> 5.5%), high (3.4 - 5.5%), medium (1.7 - 3.4%), low (1.0 - 1.7%) and very low (<1.0%). It was appeared that the status of all properties gradually decreased with decreasing organic matter. The significant highest value of organic matter was found in soils of Gheor series (1.88%), then found in Ishordi (1.56%) and Ekdala (1.5%) series. Organic matter status of Amnura (0.945%), Sara (0.88%), Gopalpur (1.09%) and Ganges Alluvial (0.94%) soils were not different statistically.

There were no significant differences of organic matter content in Sara soil before or after cultivation of onion. The content of organic matter in experimental soils were almost same before or after planting (2.02% to 2.3%) (Table 2) the crop. Before cropping it was 2.20% and it remained unchange during growing season (2.20%), and after cultivation it was 2.3%. Organic matter was

increased due to the addition of organic residues (roots, plant debris etc.) from onion plants after harvesting.
Anon (2001) reported that the organic matter gradually decrease with the intensive crop cultivation. Maier *et al.* (1990) reported that crop residue increase the organic matter.

Table 1. Different properties of seven soil series at Paba upazilla, Rajshahi

Soil series	Land type	pH	Organic matter %	Total N (%)	P (ppm)	K (ppm)
Amnura	High Land	5.5-6.4 (0.2)	0.945 (very low) (0.01)	0.045 (very low) (0.01)	1.0 (0.2)	0.15 (0.01)
Ekdala	Medium High Land	5.6 (0.1)	*1.5 (low) (0.02)	0.07 (very low) (0.02)	1.0 (0.1)	0.10 (0.01)
Sara	High Land	*6.0-8.8 (0.3)	0.88 (very low) (0.01)	0.05 (very low) (0.01)	*12.7 (2.5)	0.32 (0.02)
Gopalpur	Medium High Land	*8.6 (0.4)	1.09 (low) (0.02)	0.05 (very low) (0.01)	**28.0 (4.3)	0.30 (0.02)
Ishordi	Medium High Land	*6.2-8.5 (0.3)	*1.56 (low) (0.02)	0.08 (Very low) (0.02)	8.8 (2.1)	0.33 (0.01)
Gheor	Medium High Land	*6.1-8.5 (0.2)	**1.88 (medium) (0.03)	0.11(very low) (0.03)	*13.43 (3.2)	*0.46 (0.03)
Ganges Alluvial	Medium-Low Land	*8.6-8.7 (0.3)	0.94 (very low) (0.02)	*0.35 (very low) (0.03)	7.1 (2.1)	0.33 (0.02)

**indicates the differences of test section at significant level of 1%, * indicates the differences of test section at significant level of 5%, Parentheses () indicate the standard deviation.

Table 2. Nutrients status of experimental plot in Sara series, Paba upazilla, Rajshahi

Nutrient contents / Nutrient status at different period	N (%)	P (ppm)	K (ppm)	pH	OM %
Before cropping	0.05 (0.01)	8.1 (2.3)	*0.38 (0.02)	*8.0 (2)	2.20 (0.3)
During crop growing	0.15 (0.02)	**29.1 (6.2)	0.14 (0.01)	6.5 (1.1)	2.2 (0.2)
After harvesting	0.10 (0.01)	**28.0 (5.3)	*0.36 (0.02)	*7.7 (1.3)	2.3 (0.3)
Average in total upazilla	0.02 (0.01)	11.05 (2.04)	0.28 (0.03)	6.85 (1.05)	1.2 (0.02)

**indicates the differences of test section at significant level of 1%, * indicates the differences of test section at significant level of 5%, Parentheses () indicate the standard deviation.

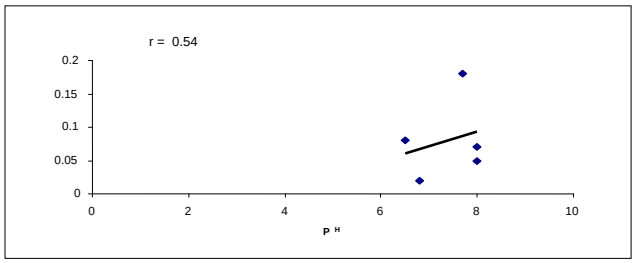

Fig. 1. Relationship between nitrogen and pH

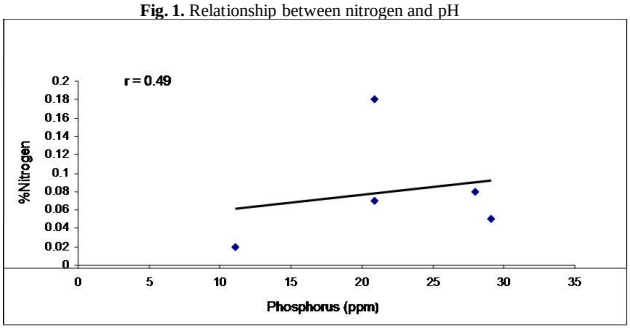

Fig. 2. Relationship between nitrogen and phosphorus

Total nitrogen: Total nitrogen content was very low in all soil series which varied from 0.05% to 0.35 % among all experimental soils. The highest nitrogen content was found in Ganges Alluvial soil (0.35%) which was significantly higher than all other soils (P= 0.05) (Table 1). The lowest nitrogen was found in Amnura series. Regarding cultivation of onion the content of N were not different significantly before or after cultivation in sara soil. The content of N was 0.05 % before cropping and it was 0.15% during cultivation, and after harvesting N was 0.10% (Table 2). Total nitrogen was positively correlated with organic matter (r = 0.86), pH (r = 0.54) and phosphorus (r = 0.49) with exposing highly significance where as nitrogen showed negatively correlation with potassium (r = - 0.22) (Figs 1, 2, 3 and 4).

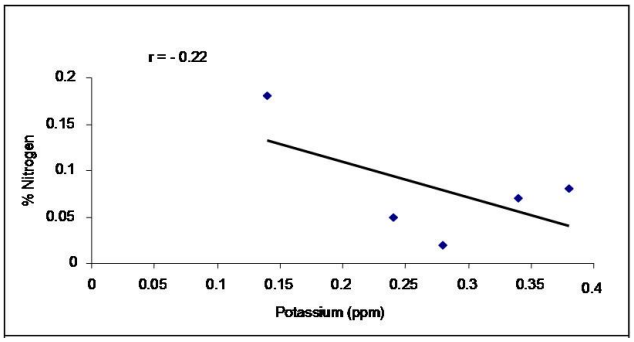

Fig. 3. Relationship between nitrogen and potassium

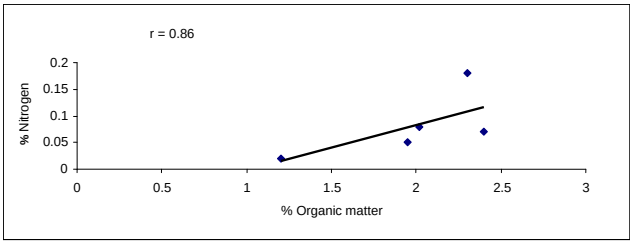

Fig. 4. Relationship between nitrogen and organic matter

Ahmed (1989) reported almost similar results where nitrogen is positively correlated with organic matter (r = 0.55), phosphorus (r = 0.19), calcium (r = 0.12) and potassium (r = 0.11). Kumer and Sharma *et al.* (1991) reported that there were positive correlation of nitrogen with organic matter (r = 0.79), phosphorus (r = 0.57),

potassium (r = 21) and zinc (r = 0.15) along with highly significance.

Available Phosphorus: Available phosphorus of the selected soil series are shown in Table 1 which were varied from 1.0 to 28.0 ppm. Significantly highest (P= 1%) content of phosphorus was obtained in Gopalpur soil series (28.0 ppm), then significantly higher at 5% level in Gheor (13.43 ppm) and Sara (12.7 ppm). The lowest values were found in Amnura (1.0 ppm) and Ekdala series (1.0 ppm). The content of phosphorus was significantly different (P= 5%) from its original state to harvesting stage. In the cultivated soil the concentration of phosphorus was 8.1 ppm before cultivation and it was significantly increased to 29.0 ppm during cultivation. After harvesting of onion, the status of phosphorus was 28.0 ppm.

Patil *et al*. (1983) reported that posphorus uptake relatively high during onion (cv. Cream gold) cultivation which is similar to our results. An observation was revealed that the phosphorus concentration of soils gradually increased with the increase of organic matter, nitrogen, potassium and zinc. Pande and Mundra *et al*., (1971) found that the phosphorus concentration of soils gradually increased with the increase of organic matter, potassium and zinc. Available phosphorus was positively correlated with soil pH (r = 0.21), organic matter (r = 0.57), nitrogen (r = 0.70) and potassium (r = 0.15) (Figures 5, 6, 7 and 8). The results of Rahman *et al*., (1986) showed the same trends. They noticed that phosphorus showed positively correlation with organic matter (r = 0.35), nitrogen (r = 0.54), calcium (r = 0.07), zinc (r = 0.47) and negatively correlated with sulphur (r = - 0.09) and potassium (r = - 0.02).

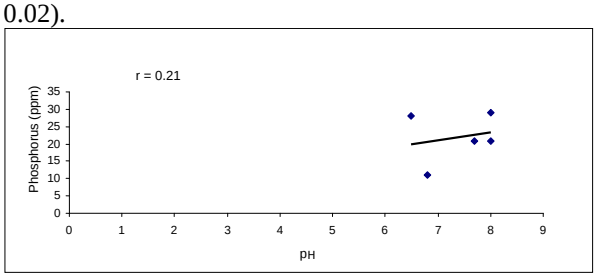

Fig. 5. Relationship between phosphorus and pH

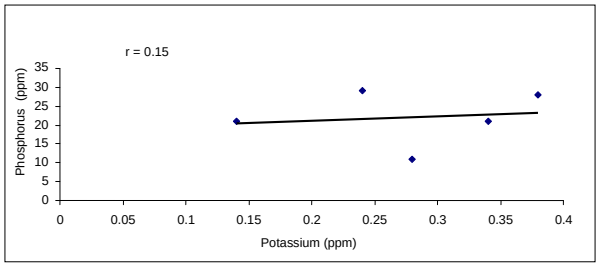

Fig. 6. Relationship between phosphorus and potassium

Exchangeable potassium: It was observed that the exchangeable potassium content of the soil varied widely among the series ranging from CEC 0.1 meq /100 g soil to CEC 0.46 meq /100 g soil. Significantly highest (P= 5%) concentration of potassium was found in Gheor soil (0.46 meq /100 g soil) followed by Ishordi and Ganges Alluvial (0.33 meq /100 g) soil. The status of Amnura (0.15 meq /100 g soil) and Ekdala (0.1 meq /100 g soil) were almost closer and followed by Gopalpur (0.30 meq /100 g soil) soil. On the other hand, status of Sara (0.32 meq /100 g soil) and Gopalpur (0.30 meq /100 g soil) series were almost equal and lower than Amnura and Ecdala (Table 1). Exchangeable potassium in the experimental soil before planting and after harvesting of onion were significantly different (P= 5%) from its growing stage. The content of potassium was 0.38 meq /100 g soil before cropping and 0.14 meq/100 g soil during growing time and after harvest potassium was 0.36 meq /100 g soil (Table 2).

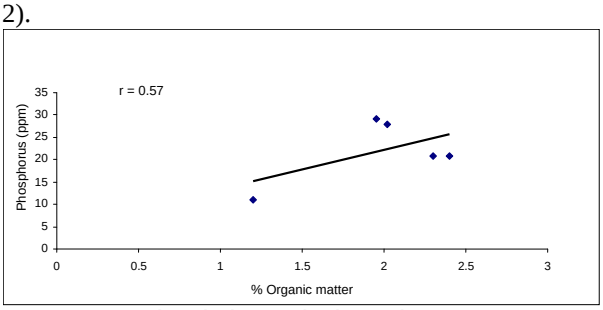

Fig. 7. Relationship between phosphorus and organic matter

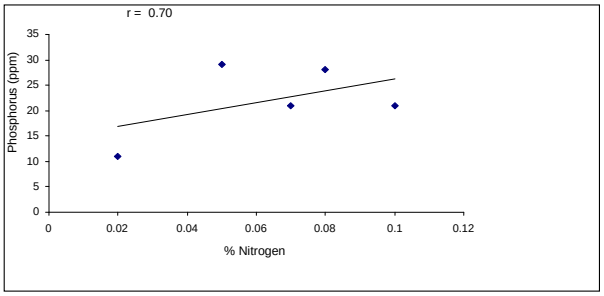

Fig. 8. Relationship between phosphorus and nitrogen

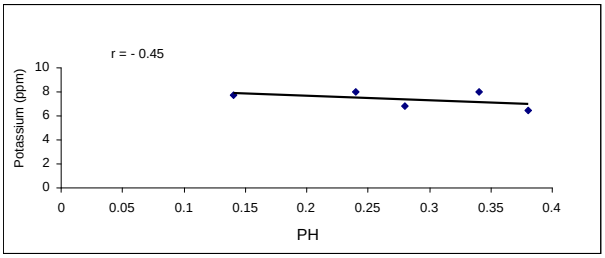

Fig. 9. Relationship between potassium and pH

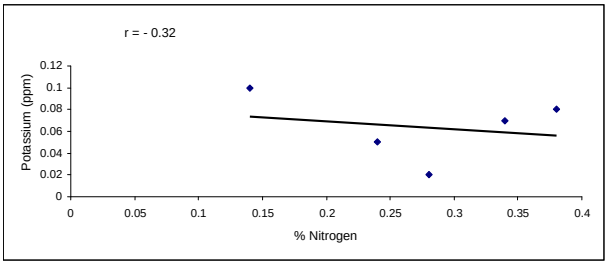

Fig. 10. Relationship between potassium and nitrogen

Potassium content of soil showed negative correlation with pH (r = - 0.32), nitrogen (r = - 0.32), phosphorus (r = - 0.60) and organic matter (r = - 0.08) (Figures 9, 10, 11 and 12). Our results were similar with the findings of Sharma (1992). He found negative correlations of potassium with nitrogen (r = - 0.32), phosphorus (r = - 0.60) and organic matter (r = - 0.08), alternatively positive correlation was found with sulphur (r = 0.13), calcium (r = 0.25) and zinc (r = 0.08).

The pH value of experimental land was 8.0 where as all soil series varied from 5.5 to 8.8. The soils of Amnura and Ekdala series were slightly acidic to highly alkaline. Sara, Ishordi & Gheor series were slightly acidic to alkaline, and

Gopalpur, Ganges Alluvial series were highly alkaline. After the cultivation of onion the pH was 7.7 in the experimental land (Sara soil), which was 8.0 before cultivation.

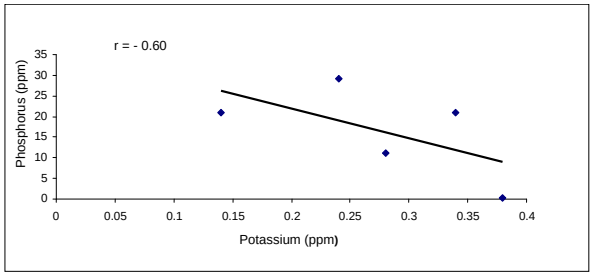

Fig.11. Relationship between potassium and phosphorus

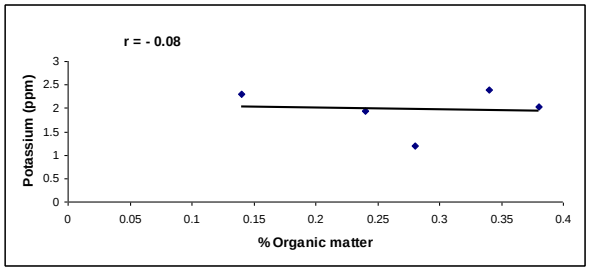

Fig. 12. Relationship between potassium and organic matter

The organic matter of the experimental soil was 2.20% and it varied from 0.88 to 1.88% in all soil series, and after the cultivation of onion it was increased to 0.10%. Therefore, it can be summarised that organic matter became higher in the experimental land after cultivation of onion. The percentage of nitrogen in the experimental soil was 0.05% which was similar with Gopalpur series, while the other series varied from 0.04 to 0.35%. The phosphorus of seven soil series varied from 1.0 to 28.0 ppm where as the experimental soil had 8.1 ppm that was almost similar with Gopalpur series. It can be said that phosphorus was very low in our experimental land before planting of onion. After cultivation phosphorus was increased to 19.9 ppm. Potassium was varied from 0.1 to 0.46 ppm in all soil series while experimental soil was 0.38 ppm, which was similar with Ishordi and Ganges Alluvial soil. After the cultivation of onion potassium was decreased to 0.02 ppm. However, results of this study indicated that the properties of soil like OM, pH, N, P and K influenced remarkably on the cultivation of onion.

References

Ahamad, E. 2002. A study on physico-chemical properties of steep land of Hill soil, Terrace soil and Floodplain soil. M.S. Thesis, Dept. of Soil Science, BAU, Mymensingh, Bangladesh.

Ahmed, M.K. 1989. Effect of nitrogen and sulphur fertilizers and plant growth regulators on growth and yield of onion cv. Faridpur Bhatti. An M.Sc. (Ag) Thesis, Dept. of Horticulture, Bangladesah Agril . University, Mymesningh.

Anonymous, 2001. Effect of organic matter on the growth and yield of kharif onion lines. Research Report of Spices Research Centre, Bangladesh Agril. Res. Inst., 48-49.

BARC, 1997. Fertilizer Recommendation Guide. Soils Publications Number 41. 182-192.

Black, C.A. 1965. Methods of Soil Analysis. Part I and Part II. American Soc. Agron. Inc. Pub. Madison, Winconson, USA.

Brady, N.C. 1984. The Nature and Properties of Soils., Mc Millian, New York. 2 1-39.

Duncan, D.B. 1955. Multiple Ranges and Multiple F-Test. Biometrics , 11, 1-42. Edition, John Wiley and Sons, New York, 680 p.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research. 2nd https://doi.org/10.2307/3001478

Kamaluddin, A.S.M. 1966. "Shabjir Cash" Qamrunnahar, 2124, Mohammadpur Housing State, Dhaka-1207, p. 338.

Karim, Z., Hussain, S.G. and Ahmed, M. 1990. Salinity problems and crop investigation in the coastal region of Bangladesh. Soil Pub. No. 33, BARCC, Dhaka-1215, Bangladesh.

Kumar, J.C. and Sharma J.R. 1991. Studies on nitrogen requirement of kharif onion. Haryana J. Hort. Sci., 20(1-2): 95-97.

Maier, N.A., Dahlenburg, A.P. and Twigden, T.K. 1990. Effect of nitrogen on the yield and quality of irrigated onion cv. Cream Gold grown on siliceous sands. Aust. J. Hort. 30(6): 845-851.

Pande, R.C. and Mundra, R.S. 1971. Note on response of onion *(Allium cepa)* to varying levels of N, P and K. Indian J. Agril. ScL, 4(2):107-108.

Patil, P.Y., Mahopkar, V.K. and Patil, V.K. 1983. Effects of nitrogen, phosphorus and potash on growth and yield onion. J. Maharashtra Agric. Univ., 8 (1): 41-43.

Rahman, M.M. 1986. Detennination of physical properties of some soils on old Brahmaputra and Old Meghna Estaurine Floodplain of Bangladesh. SRDI, Dhaka. 12-54.

Rashid, M.M. 1976. Bangladesher Shabji (in Bengali). Bangla Academy, Dhaka. p. 457.

Sharma, R.P. 1992. Effect of planting, nitrogen and potash on bulb yield of rainy season onion. Indian J. Agron., 37(4): 868-869.