Shobuj Bangladesh Publications House
International Journal of Natural and Social Sciences
ISSN: 2313-4461

Changes in indigenous microbial population in soils due to tobacco cultivation in some sourthern districts of Bangladesh

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ABSTRACT

A field experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural Universit, An experiment was conducted to assess the changes of indigenous microbial population viz. *cyanobacteria* and *Azotobacter* in soils due to tobacco cultivation of some sourthern districts viz. Kushtia, Meherpur and Jhenaidah of Bangladesh. The experiment was carried out at soil microbiology laboratory, Department of Soil Science, Bangladesh Agricultural University, Mymensingh and at the SRDI, Kushtia. Thirteen different types of soils were collected for the study from three districts where tobacco is cultivated. All the selected soils were alkaline in reaction. Indigenous cyanobacterial population in the selected soil varied from 12.4 x 10^4 g^{-1} soil to 25.3 x 10^4 g^{-1} soil and *Azotobacter* population ranged from 6.9 x 10^4 g^{-1} soil to 20.9 x 10^4 g^{-1} soil. Results showed that cyanobacteria and *Azotobacter* are different in their behavior in the soil. In kushtia soil, cyanobacterial population slightly increased in active growing stage than initial stage of planting but in post harvest soil it decreased markedly compared to active growing stage. But cyanobacterial population showed different behavior in Meherpur and Jhenaidah districts. In these two districts, highest cyanobacterial population was found at initial stage of planting but from active growing stage to after harvest it showed decreasing trend. *Azotobacter* population showed similar trend in the all selected soils under the study from three districts. In soils of the three districts viz. Kushtia, Meherpur and Jhenaidah, *Azotobacte*r population increased at active growing stage than that of initial soil and decreased sharply after harvest of tobacco plant.

Key words: Microbial population, soil, tobacco cultivation, Bangladesh.

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INTRODUCTION

Tobacco as a plant (*Nicotiana tabacum* or less widely used *Nicotianna rustica*) belongs to the Nightshade family indigenous to North and South America. Nightshade is any member of the genus *Solanum*. Geographical and agro-climatic conditions of Bangladesh are favorable for tobacco cultivation. Tobacco is one of the most important cash crops in our country which contribute to our economy through export. Bangladesh accounts for about 0.4% of the total volume of tobacco produced in the world. The *N. tabacum* varieties are used for cigarette, cigar, cheroot, bidi, hookah, chewing and snuff tobacco and the varieties of rustica are used only for hookah, chewing and snuff. The plant prefers sandy, well-aerated, well-drained soils and cooler climate. Hence it is grown in the winter season.

According to the official Agricultural Statistics (2010), three varieties of tobacco-Jati, Motihari and Virginia are grown in different districts of Bangladesh. Jati and Motihari are mostly grown in Rangpur and Bandarban, while Virginia is mostly grown in Kushtia, Rangpur, Jessore and Dhaka.

How to cite this article: MAI Juwel, T Sultana, MO Faruk, S Ahmed, MR Ahmed and L Yeasmin (2015). Changes in indigenous microbial population in soils due to tobacco cultivation in some sourthern districts of Bangladesh. International Journal of Natural and Social Sciences, 2(4): 90-99.

Besides, tobacco cultivation is extending to Jessore, Nilphamari, Lalmonirhat and even Manikganj and Tangail. In Bangladesh, tobacco is basically a rabi season crop with sowing being done during mid-October to mid-December. From the day the seeds are sown, it takes about 6-7 months to mature. It may be mentioned here that a number of rabi season food and cash crops are also sown during this period implying that tobacco competes with these other food crops.

Soil microorganisms play an important role in maintenance and improvement of soil fertility and productivity (Jenkinson and Powlson, 1976). Proper management of these will make it possible to increase the efficiency of use of soil and added nutrients. Several groups of microorganisms have the potential to enhance growth and improve the health of crops. The number and activity of these microbes (Tilak et al., 1995) exhibit variable responses to different agricultural management practices.

Among the microorganisms cyanobacteria and *Azotobacter* may be taken into consideration in case of tobacco cultivation. Cyanobacteria are widespread photosynthetic microorganisms among which some are able to fix atmospheric nitrogen. Cayanobacteria have the capacity to fix atmospheric nitrogen in soils and improve the fertility of soils. Most of the soils of the country are deficient in organic matter, low nitrogen status and poor available phosphorus, potassium, sulphur, micro nutrients etc. Cyanobacteria are helpful overcome these types of problems (Kaushik 1997) *Azotobactor* is a heterotrophic free living nitrogen fixing bacteria present in alkaline and neutral soils. Apart from its ability to fix atmospheric nitrogen in soils, it can also synthesize growth promoting substances *viz.*, auxins, and gibberellins and also to some extent the vitamins. Many strains of *Azotobactor* also exhibit fungicidal properties against certain species of fungus. Response of *Azotobactor* has been seen in rice, maize, cotton, sugarcane, pearl millet, vegetable and some plantation crops. Cyanobacteria and *Azotobactor* are the component in different types of soils and they may have effect on soil properties. Thus with the aforesaid views in mind the present piece of work has been designed with the objective to assess the changes in indigenous microbial population viz. cyanobacteria and *Azotobacter* in soil due to tobacco cultivation.

MATERIALS AND METHODS

Soil samples collection

For the study, thirteen locations from the three major tobacco growing districts viz. Kushtia, Meherpur and Jhenaidah were selected. Soil samples were collected from the selected sites from surface to plough depth (0-15 cm). Care was taken to avoid exposing the samples to heat or drying during transportation. After collection, the samples were brought in the laboratory of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh. The collected soil samples were mixed thoroughly by hand on a thick paper sheet to make composite sample. Soil Samples were collected before planting, at active growing stage and after harvest of tobacco.

During this time pieces of bricks, stubbles and refuge materials were removed, air dried, sieved (10-mesh) and kept for analysis. The soil samples were then divided into three portions. First portion of each of the soil samples were used for physicochemical analyses. Second portion of the soil samples were used for population estimation of Cyanobacteria and the third portion of the soil samples were used for population estimation of Azotobacter.

Soil properties

Soil samples from the study areas were analyzed for physical and chemical properties. Samples were air dried and passed through a 2 mm sieve. After that the samples were analyzed for soil texture (Piper, 1950) and soil pH (Jackson 1962), according to the procedure described by respective authors mentioned against each characteristics.

Enumeration of indigenous cyanobacterial population

Enumeration of cyanobacteria was done according to the method as stated by Prammer and Schmidt (1967). Briefly 10 g of moist soil from each

sample was transferred to 250 ml Erlenmeyer flask containing 90 ml sterile distilled water. After shaking vigorously a series of 10 fold dilution up to 10-7 was prepared for each soil sample. A modified version of Chu 10D-N medium (Sinclair and Whitton, 1977) was used for the growth of cyanobacteria. For each set of dilution, 10 tubes containing growth media were inoculated with 1.0 ml portion of each soil dilution from 10-3 to 10-7. The tubes were incubated in racks under constant light of 100-watt bulbs fixed at 20 cm apart and 50 cm from the test tubes in the laboratory for 30 days at 30+2°C. The tubes were then observed occasionally for cyanobacterial growth as surface rings or pellicles on the surface of the culture fluid. After 30 days the tubes showing positive growth in each of the two successive lower dilution followed by negative growth in the next higher serial dilution were recorded. The readings were converted to most probable number (MPN) of cyanobacteria following the probability table for determination of abundance of organisms in soil as described by Prammer and Schmidt (1967).

Enumeration of *Azotobacter* population

Total count of Azotobacter in soil was done following the Most Probable Number (MPN) method revised by Alexander and Clark (1965). Briefly, three soil samples were taken at a time for population count of Azotobacter. For each dilution, a 1 ml aliquot was transferred to each test tube of the set of a 5 test tube containing the growth media. The tubes were then incubated at 28°C up to 10 days. Azotobacter, if present was found to grow as a skin or pellicle on the surface of the culture fluid. The number of tubes showing positive growth in each of the successive serial dilution was recorded. The readings was converted to most probable number (MPN) of Azotobacter g-1 of soil following the probability table (Table 3.3) as described by Cochran (1950). Finally the population of Azotobacter was counted by the following formula.

$$\text{Azotobacter counts g} - 1 \text{ of soil (oven dry basis):} \quad \frac{\text{MPN factor for 3 successive serial dilutions}}{\text{oven dry weight of 1g moist soil} \times \text{serial dilution (Middle)}}$$

RESULTS AND DISSCUSSION

The soil of Kushtia and Meherpur were calcareous dark grey floodplain soil, whereas the soil of Jhenaidah was calcareous brown floodplain soil.

Table 1
Physical Properties of the selected soils under study.

Selected Locations	Sand (%)	Silt (%)	Clay (%)	Textural Class
Choduar, Kushtia	12	82	6	Silt
Chechua, Kushtia	16	78	6	Silt Loam
Nawdaazampur, Kushtia	18	76	6	Silt Loam
Kachubaria, Kushtia	10	84	6	Silt
Chuniapara, Kushtia	18	76	6	Silt Loam
Minapara, Meherpur	12	81	7	Silt
Olinagar, Meherpur	12	82	6	Silt
Vhomorda, Meherpur	14	80	6	Silt
Nowapara, Meherpur	22	72	6	Silt Loam
Amjhupi, Meherpur	14	80	6	Silt
Chandipur, Jhenaidah	18	76	6	Silt Loam
Nitanandapur, Jhenaidah	16	78	6	Silt Loam
Sohagpur, Jhenaidah	18	76	6	Silt Loam

Physico-chemical analyses of soil

The soils under study were either silt or silt loam. All the studied soils were alkaline in reaction (Table 1). The soil pH of the Kushtia soils ranged from 7.0 to 8.0 but that of Meherpur soils ranged from 6.6 to 7.6 and the Jhenaidah soils from 7.1 to 7.5. Total nitrogen content in Kushtia, Meherpur and Jhenaidah soils varied from 0.06 to 0.10, 0.07 to 0.09 and 0.09 to 0.10 % respectively. Organic matter contents were 1.22 to 2.11, 1.32 to 1.79 and 1.81 to 1.99 % in Kushtia, Meherpur and Jhenaidah respectively. The available phosphorous contents in Kushtia,Meherpur and Jhenaidah soils varied from 4.08 to 9.16, 8.57 to 25.25 and 8.45 to 17.25 ppm respectively. The available sulphur contents were 28.80 to 78.90,14.81 to 32.50 and 12.8 to 35.7 ppm respectively. Exchangeable K, Ca and Mg in all the studied soils were moderate.

Microbiological Study

Indigenous Cyanobacterial Population

Soil of Kushtia

in Kushtia district five locations (Choduar, Chechua, Nawdaazampur, Kachubaria and Chuniapara) were selected. Result showed that in Choduar soil, the maximum cyanobacterial population was found 23.5 x 10^4 g^{-1} soil at active growing stage and the minimum cyanobacterial population of 12.9 x 10^4 g^{-1} soil was obtained after harvest of tobacco plant (Figure 1). Cyanobacterial population slightly increased in active growing stage than that of initial stage of planting but in post harvest it decreased markedly compared to active growing stage. The cyanobacterial population in Chechua soils varied from 13.1 x 10^4 g^{-1} soil to 25.1 x 10^4 g^{-1} soil. The maximum number of cyanobacterial population was obtained 25.1 x 10^4 g^{-1} soil at active growing stage and the minimum number of cyanobacterial population was 13.1 x 10^4 g^{-1} soil after harvest of tobacco plant (Figure 1). Cyanobacterial population increased in active growing stage and decreased remarkably after harvest of the plant similar to that in Chechua soil.

Cyanobacterial population in Nawdaazampur soil showed similar pattern to those of Choduar and Chechua with respect to their number. The range of cyanobacterial population recorded in collected soil was 13.9 x 10^4 to 24.9 x 10^4 g^{-1} soil. The highest cyanobacterial population found was 24.9 x 10^4 g^{-1} soil at active growing stage and the lowest cyanobacterial population obtained 13.9 x 10^4 g^{-1} soil after harvest of tobacco plant. Cyanobacterial population decreased significantly after harvest of tobacco plant.

The highest number of cyanobacterial population of 25.3 x 10^4 g^{-1} soil was obtained at active growing stage and the lowest number of cyanobacterial population of 14.5 x 10^4 g^{-1} soil was obtained after harvest of tobacco plant in Kachubaria soil (Figure 1). The cyanobacterial population in collected soils ranged from 14.5 x 10^4 to 25.3 x 10^4 g^{-1} soil recorded after harvest and at active growing stage respectively. Cyanobacterial population decreased after harvest of tobacco plant than that at active growing stage.

In Chuniapara soil, the highest number of cyanobacterial population was found 23.8 x 10^4 g^{-1} soil at active growing stage and the lowest number of cyanobacterial population was obtained 12.7 x 10^4 g^{-1} soil after harvest of tobacco plant. The cyanobacterial population in collected soil varied from 12.7 x 10^4 to 23.8 x 10^4 g^{-1} soil (Figure 1). Cyanobacterial population slightly increased in active growing stage but after harvest it decreased.

Result on cyanobacterial population in soils of the selected locations of Kushtia district clearly showed that the population increased at active growing stage and decreased after harvest.

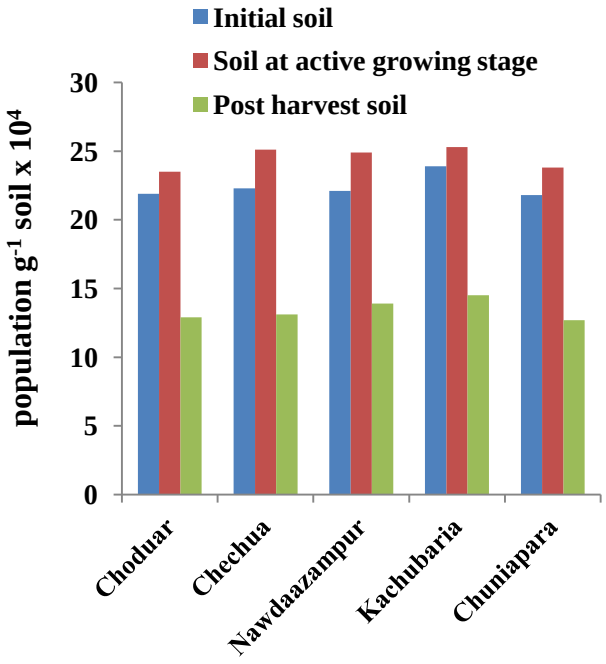

Figure 1
Indigenous Cyanobacterial population in selected location under study of Kushtia district at different growth stage of tobacco.

Soil of Meherpur

In Meherpur district five locations were selected for the study. The locations were Minapara, Olinagar, Vhomorda,Nowapara and Amjhupi. The cyanobacterial population in the collected soils varied from 17.1 x 10^4 to 24.5 x 10^4 g^{-1} soil in Minapara soil. The highest Cyanobacterial population was found 24.5 x 10^4 g^{-1} soil at initial stage of planting and the lowest Cyanobacterial population was obtained 17.1 x 10^4 g^{-1} soil after harvest of tobacco plant. Cyanobacterial population slightly decreased in active growing stage than that of initial stage of planting but in post harvest soil it decreased sharply compared to active growing stage (Figure 2).

In Olinagar soil, the maximum cyanobacterial population was found 23.8 x 10^4 g^{-1} soil at initial stage of planting and the minimum cyanobacterial population was obtained 16.9 x 10^4 g^{-1} soil after harvest of tobacco plant. The range of cyanobacterial population recorded in collected soil was 16.9 x 10^4 to 23.8 x 10^4 g^{-1} soil (Figure 2). Cyanobacterial population decreased both at active growing stage and after harvest of tobacco plant.

The cyanobacterial population in Vhomorda soil ranged from 15.2 x 10^4 g^{-1} soil to 21.8 x 10^4 g^{-1} soil. The maximum number of cyanobacterial population was obtained 21.8 x 10^4 g^{-1} soil and the minimum number of cyanobacterial population was obtained 15.2 x $10^4 g^{-1}$ soil after harvest of tobacco plant (Figure 2). Cyanobacterial population recorded in Vhomorda soil showed different behavior than that of Minapara and Olinagar soils. In Vhomorda soil, cyanobacterial population slightly increased at active growing stage and decreased steadily in post harvest soil. On the other hand, the population decreased in all stages in all the four selected locations of Meherpur district.

The highest number of cyanobacterial population was obtained 22.7 x 10^4 g^{-1} soil at initial stage of planting and the lowest number of cyanobacterial population was obtained 15.7 x 10^4 g^{-1} soil after harvest of tobacco plant in Nowapara soil (Figure 2). The cyanobacterial population in the collected soils ranged from 15.7 x 10^4 g^{-1} soil to 22.7 x 10^4 g^{-1} soil. Cyanobacterial population showed decreasing trend from initial planting stage to after harvest of tobacco plant.

In Amjhupi soil, the highest cyanobacterial population was found 25.3 x 10^4 g^{-1} soil at initial stage of planting and the lowest cyanobacterial population was obtained 17.3 x 10^4 g^{-1} soil after harvest of tobacco plant. The range of cyanobacterial population in collected soil varied from 17.3 x 10^4 to 25.3 x 10^4 g^{-1} soil (Figure 2). Highest cyanobacterial population found at initial stage of planting but active growing stage to after harvest it showed decreasing trend. The number of cyanobacterial population in Amjhupi soil showed similar trend as that Nowapara soil. In this soil the population decreased both at active growing stage and after harvest from that of initial stage.

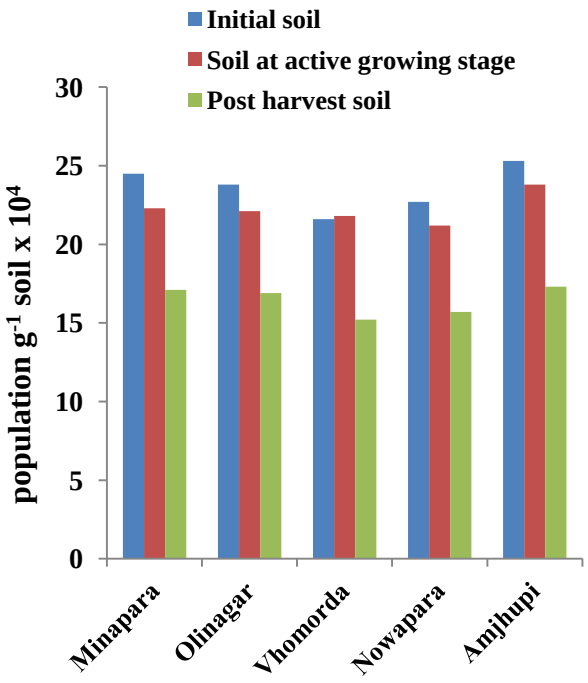

Figure 2
Indigenous Cyanobacterial population in selected location under study of Meherpur district at different growth stage of tobacco.

Soil of Jhenaidah

In Jhenaidah district three locations viz. Chandipur, Nitanandapur and Sohagpur were selected for the study. Soil Samples collected at different growth stage of tobacco were analyzed for indigenous cyanobacterial population and the results have been presented in figure 3.

In Chandipur soil, the maximum cyanobacterial population was found 13.6 x 10^4 g^{-1} soil at initial stage of planting and the minimum cyanobacterial population was obtained 8.2 x 10^4 g^{-1} soil after harvest of tobacco plant. The cyanobacterial population recorded in collected soil ranged from 8.2 x 10^4 to 13.6 x 10^4 g^{-1} soil (Figure 3). Cyanobacterial population slightly decreased at active growing stage than that of initial stage of planting but after harvest it again decreased compared to active growing stage.

Cyanobacterial population recorded in Nitanandapur soil ranged from 9.3 x 10^4 g^{-1} soil to 15.7 x 10^4 g^{-1} soil at initial stage of planting (Figure 3). The maximum number of cyanobacterial population was obtained 15.7 x 10^4 g^{-1} soil in initial soil and the minimum number of cyanobacterial population was obtained 9.3 x 10^4 g^{-1} soil after harvest of tobacco plant (Figure 3). Cyanobacterial population showed decreasing trend from initial soil to after harvest of tobacco plant.

In Sohagpur soil, the highest cyanobacterial population was found 15.2 x 10^4 g^{-1} soil at initial stage of planting and the lowest cyanobacterial population was obtained 9.1 x 10^4 g^{-1} soil after harvest of tobacco plant. The range of cyanobacterial population in this soil varied from 9.1x 10^4 to 15.2 x 10^4 (Figure 3). Highest cyanobacterial population was found at initial stage of planting but from active growing stage to after harvest it showed decreasing trend.

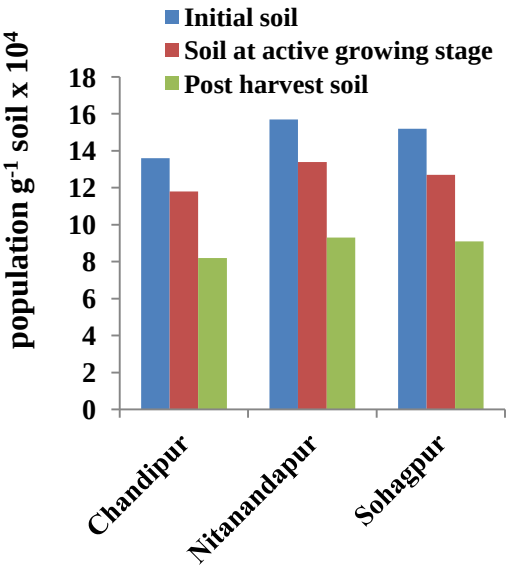

Figure 3
Indigenous Cyanobacterial population in selected location under study of Jhenaidah district at different growth stage of tobacco.

Indigenous *Azotobacter* Population
Soil of Kushtia

The maximum *Azotobacte*r population was found 19.7 x 10^4 g^{-1} soil at active growing stage and the minimum *Azotobacte*r population was obtained 8.5 x 10^4 g^{-1} soil after harvest of tobacco plant in choduar soil. The *Azotobacte*r population in collected soil varied from 8.5 x 10^4 to 19.7 x 10^4 g^{-1} soil (Figure 4). *Azotobacte*r population increased in active growing stage than that of initial stage of planting but after harvest it decreased sharply compared to active growing stage (Figure 4).

The *Azotobacte*r population in the collected soils varied from 9.3 x 10^4 g^{-1} soil to 20.9 x 10^4 g^{-1} soil in Chechua soil. The maximum number of *Azotobacte*r population was obtained 20.9 x 10^4 g^{-1} soil at active growing stage and the minimum number of *Azotobacte*r population was obtained 9.3 x 10^4 g^{-1} soil after harvest of tobacco plant (Figure 4). *Azotobacte*r population increased at active growing stage but decreased markedly after harvest of tobacco plant.

In Nawdaazampur soil, the *Azotobacte*r population in collected soils varied from 9.8 x 10^4 to 19.8 x 10^4 g^{-1} soil. The highest *Azotobacte*r population was found 19.8 x 10^4 g^{-1} soil at active growing stage and the lowest *Azotobacte*r population was obtained 9.8 x 10^4 g^{-1} soil after harvest of tobacco plant from the field (Figure 4). *Azotobacte*r population recorded in Nawdaazampur soil showed similar behavior than that of Choduar and Chechua soils *Azotobacte*r population decreased after harvest of tobacco plant than that of active growing stage. The maximum number of *Azotobacte*r population was obtained 20.3 x 10^4 g^{-1} soil at active growing stage and the minimum number of *Azotobacte*r population was obtained 10.6 x 10^4 g^{-1} soil after harvest of tobacco plant was found in Kachubaria soil The *Azotobacte*r population recorded in the collected soils varied from 10.6 x 10^4 g^{-1} soils to 20.3 x 10^4 g^{-1} soil (Figure 4). In Kachubaria soil, *Azotobacte*r population slightly increased at active growing stage and decreased steadily in post harvest soil.

In Chuniapara soil, the highest *Azotobacte*r population was found 19.6 x 10^4 g^{-1} soil at active growing stage and the lowest *Azotobacte*r population was obtained 8.3 x 10^4 g^{-1} soil after harvest of tobacco plant. The range of *Azotobacte*r population in collected soil varied from 8.3 x 10^4 to 19.6 x 10^4 g^{-1} soil (Figure 4). *Azotobacte*r population increased in active growing stage but in post harvest soil it decreased sharply than that of active growing stage. *Azotobacte*r population in Kushtia soil showed similar trend in all collected soils. In soils of this district *Azotobacte*r population increased at active growing stage and decreased remarkably after harvest of tobacco plant from the field.

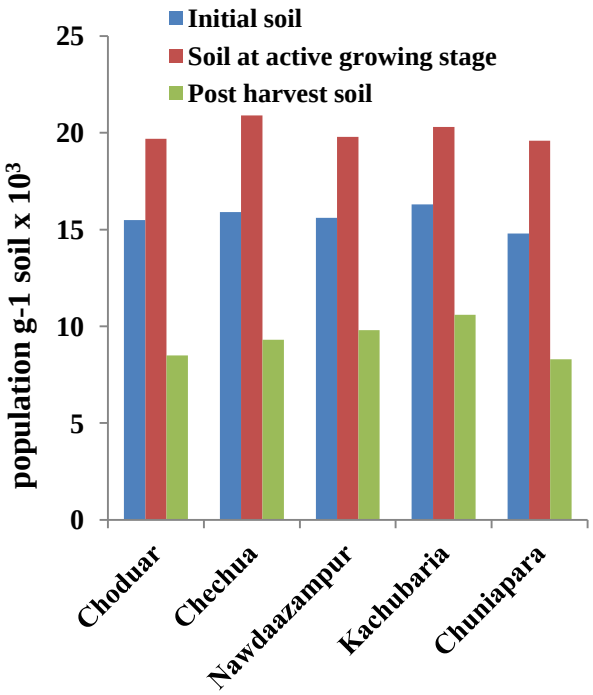

Figure 4
Indigenous *Azotobacte*r population in selected location under study of Kushtia district at different growth stage of tobacco.

Soil of Meherpur

Result presented in figure 5 showed that in Minapara soil the *Azotobacte*r population recorded in the collected soils varied from 11.3 x 10^4 to 16.9 x 10^4 g^{-1} soil. The maximum *Azotobacte*r population was found 16.9 x 10^4 g^{-1} soil at active growing stage and the minimum *Azotobacte*r population was

obtained 11.3 x 10^4 g^{-1} soil after harvest of tobacco plant (Figure 5). *Azotobacte*r r population slightly increased in active growing stage than that of initial soil but after harvest it decreased markedly compared to active growing stage.

In Olinagar soil, the highest number of *Azotobacte*r population was found 15.8 x 10^4 g^{-1} soil at active growing stage and the lowest number of *Azotobacte*r population was obtained 10.8 x 10^4 g^{-1} soil after harvest of tobacco plant. The *Azotobacte*r population in collected soil varied from 10.8 x 10^4 to 15.8 x 10^4 (Figure 5). *Azotobacte*r population steadily increased in active growing stage but in post harvest soil it decreased.

*Azotobacte*r population in Vhomorda soil showed similar pattern to those of Minapara and Olinagar with respect to their number. The *Azotobacte*r population recorded in Vhomorda soil varied from 9.5 x 10^4 g^{-1} soil to 15.6 x 10^4 g^{-1} soil. The maximum of *Azotobacte*r population was found 15.6 x 10^4 g^{-1} soil at active growing stage and the minimum of *Azotobacte*r population was obtained 9.5 x 10^4 g^{-1} soil in post harvest soil (Figure 5). *Azotobacte*r population slightly increased in active growing stage than that of initial soil but after harvest it decreased markedly compared to active growing stage.

The highest number of *Azotobacte*r population was obtained 15.3 x 10^4 g^{-1} soil at active growing stage and the lowest number of *Azotobacte*r population was found 10.6 x 10^4 g^{-1} soil after harvest of tobacco plant in Nowapara soil (Figure 5). The *Azotobacte*r population in the collected soils ranged from 10.6 x 10^4 g^{-1} soil to 15.3 x 10^4 g^{-1} soil. *Azotobacte*r population decreased after harvest of tobacco plant than that at active growing stage.

In Amjhupi soil, the maximum number *Azotobacte*r population was found 17.5 x 10^4 g^{-1} soil at active growing stage and the minimum number of *Azotobacte*r population was obtained 11.7 x 10^4 g^{-1} soil after harvest of tobacco plant. The *Azotobacte*r population in collected soil varied from 11.7 x 10^4 g^{-1} soil to 17.5 x 10^4 g^{-1} soil (Figure 5). *Azotobacte*r population slightly increased in active growing stage but in post harvest soil it decreased compared to active growing stage.

Result on *Azotobacte*r population in soils of the selected locations of Meherpur district clearly showed that *Azotobacte*r population increased at active growing stage and decreased after harvest of tobacco plant.

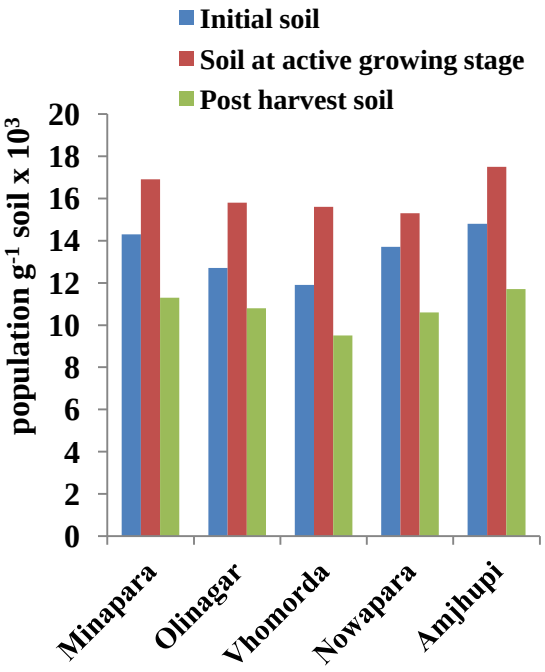

Figure 5
Indigenous *Azotobacte*r population in selected location under study of Meherpur district at different growth stage of tobacco.

Soil of Jhenaidah

Collected soils were analysed for *Azotobacte*r population. In Chandipur soil, the maximum number of *Azotobacte*r population was found 11.7 x 10^4 g^{-1} soil at active growing stage and the minimum number of *Azotobacte*r population was obtained 6.9 x 10^4 g^{-1} soil after harvest of tobacco plant. The *Azotobacte*r population recorded in collected soils ranged 6.9 x 10^4 to 11.7 x 10^4 g^{-1} soil (Figure 6). *Azotobacte*r population increased in active

growing stage than initial soil but in post harvest soil it decreased remarkably.

The *Azotobacte*r population recorded in collected soils varied from 7.8 x 10^4 g^{-1} soil to 14.3 x 10^4 g^{-1} soil in Nitanandapur soil. The maximum number of *Azotobacte*r population was obtained 14.3 x 10^4 g^{-1} soil at active growing stage and the minimum number of *Azotobacte*r population was found 7.8 x 10^4 g^{-1} soil after harvest of tobacco plant (Figure 6). *Azotobacte*r population increased at active growing stage but decreased significantly in post harvest soil.

In Sohagpur soil, the highest number of *Azotobacte*r population was found 13.5 x 10^4 g^{-1} soil at active growing stage and the lowest number of *Azotobacter* population was obtained 8.7 x 10^4 g^{-1} soil after harvest of tobacco plant. The range of *Azotobacte*r population in collected soils varied from 8.7 x 10^4 to 13.5 x 10^4 g^{-1} soil (Figure 6). *Azotobacter* population slightly increased in active growing stage than initial soil but after harvest it decreased sharply compared to active growing stage which showed similar behavior as all other collected soils of Jhenaidah.

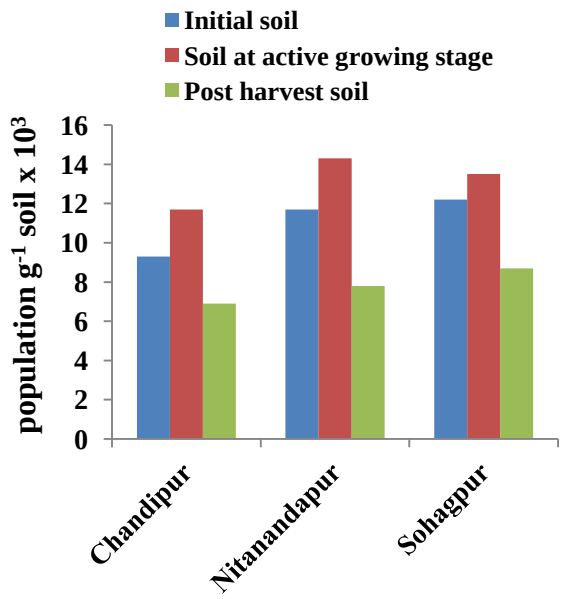

Figure 6
Indigenous *Azotobacte*r population in selected location under study of Jhenaidah district at different growth stage of tobacco.

The indigenous cyanobacterial population in the selected soils of Kushtia district varied from location to location. The maximum number of cyanobacterial population was 25.3 x 10^4 g^{-1} soil observed in Kachubaria soil at active growing stage and the minimum number of cyanobacterial population was 12.4 x 10^4 g^{-1} soil in Chuniapara soil after harvest. On the other hand, the population of cyanobacteria in Meherpur soils varied from 15.2 x 10^4 g^{-1} soil in post harvest soil of Vhomorda to 25.3 x 10^4 g^{-1} soil in initial soil of Amjhupi. But Jhenaidah soils had cyanobacterial population ranging from 8.2 x 10^4 g^{-1} soil observed in post harvest soil of Chandipur to 15.7 x 10^4 g^{-1} soil in initial soil of Nitanandapur. In kushtia soil, cyanobacterial population slightly increased in active growing stage but after harvest it decreased sharply than that of active growing stage. In contrast, cyanobacterial population showed different behavior in Meherpur and Jhenaidah districts. In these two districts, highest cyanobacterial population was found at initial stage of planting but from active growing stage to after harvest it showed decreasing trend (Figure 1 to 3).

Azotobacter population showed similar trend in the all selected soils under the study from three districts. In soils of all the three districts viz. Kushtia, Meherpur and Jhenaidah, the *Azotobacter* population slightly increased in active growing stage than initial those recorded in soil but in post harvest soil it decreased markedly compared to those observed in active growing stage (Figure 4 to 6).

From the result it seems clear that indigenous cyanobacterial population behaved differently in different soils of tobacco field but after harvest the number decreased. But in case of *Azotobacter* the trend is different. *Azotobacter* population decreased in all the thirteen selected soils both at active growing stage and after harvest of tobacco plant. To draw definite conclusions changes in oil characteristics need to be determined.

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