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Effects of different levels of NPK on soil properties by wheat (*Triticum aestivum L.*)

[1] Ahmad Shahab Samimi, [2] Dr. Tarence Thomas

[1] Department of soil science, Allahabad school of agriculture Sam higgin bottom institute of agriculture, technology and sciences (deemed-to-be-university) allahabad-211007 (up.) India

[2] Department of soil science, Allahabad school of agriculture Sam higgin bottom institute of agriculture, technology and sciences (deemed-to-be-university) allahabad-211007 (up.) India

Abstract
A field experiment was carried out at the Sam Higginbottom Institute of agriculture, Technology and Science, Allahabad, within an individual agricultural holding, on lessive soil with medium and high richness in nitrogen, phosphorus and potassium respectively. During winter season in 27/11/2015 up to 26/03/2016 to investigate the effects of different levels Nitrogen, phosphorus and potassium on soil properties by wheat (*Triticum eastivum L*). The treatments such as: (T0: 0 -0 -0 NPK, T1: 30- 0-20 NPK, T2: 60 -0 -0 NPK, T3: 120 -0 -0 NPK, T4: 0 -15 -50 NPK, T5: 0 -30 -0 NPK, T6: 0 -60 -10 NPK, T7: 120 -60 -50 NPK, T8: 60 -30 -25 NPK) kg ha^{-1} were tested in randomized block design (RBD). Fertilizer application significantly changed soil properties. Application of 120- 60- 50 NPK kg ha^{-1} to T7 has showed the maximum results on soil properties (physical and chemical), like: moisture content, bulk density, particle density, pore space, water retaining capacity, pH, EC, nitrogen, phosphorus and potassium. The lowest values obtained from treatment T0: 0-0-0- NPK kg ha^{-1} in during of research.

Keywords: physical and chemical properties, NPK fertilizers, BD, PD, EC, OC, pH

Introduction
Soil nutrition absorbed by crops can be divided into mobile and immobile. Nitrogen (N) in form of nitrate and water are highly mobile and required in largest amounts by crops. Phosphorus (P) is the most immobile, and potassium (K) is also relatively immobile, both of which are macronutrients required by crops. The contents of N, P and K in agricultural soil are affected by plant growth and yield. Therefore, crop yield is limited by two important mobile resources, including nitrate and water, as well as two immobile resources, P and K. In recent years, there was about 60% of soil nutrition deficiency as a result of long-term agricultural production of existing cultivated land in China, could not meet with the needs of crop yield improvement. Fertilizer plays an important role in crop yield improvement, which increased crops grain yield Zhong, *et al*. (2014) [9].

A soil test is the analysis of a soil sample to determine nutrient content, composition and other characteristics. Tests are usually performed to measure fertility and indicate deficiencies that need to be remedied. The soil testing laboratories are provided with suitable technical literature on various aspects of soil testing, including testing methods and formulations of fertilizer recommendations. It helps farmers to decide the extent of fertilizer and farm yard manure to be applied at various stages of the growth cycle of the crop. Soil physical and chemical properties which largely determines the stock of both organic and inorganic form of carbon is bulk density (BD). The BD of Vertisols varies greatly because of their swelling and shrinking nature, which changes with moisture content. The soils have high BD when they are dry, and have low BD when they are in a swollen state. Bulk density has been reported to vary from 1.0 to 2.0 g/cm3, depending on the moisture content. Bulk density usually tends to increase with depth, due to compression caused by overburden weight. It has been observed that a volume change of nearly 60% occurs when a dry Vertisol is saturated with water (Rao *et al*. 1978) [4]. Various other physical properties of soils have been detailed by other authors (Ghosh and Raychaudhuri 1974) [2]. Therefore, the present study was to determined the effects of different levels of NPK on soil properties by wheat (*Triticum aestivum L*.).

Methods and materials
The materials and methods used for the study present title" Effects of different levels of Nitrogen, Phosphorous and Potassium on soil properties by wheat (*Triticum Aestivum L.*) comprised a field experiment which was carried out at soil science farm land, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Science, Allahabad. This experiment performanced in 27 November 2015- 26 March 2016 during winter season the details of various materials and methods followed

1. Experimental site: The area is situated in the south of Allahabad on right hand of rivers Yamuna at Rewa Road at a distance of about 6 km Allahabad city. It is positioned 25^0 57ʹ N Latitude 81^0 50ʹ E longitude and the altitude of 98 meters above the near sea level.

2. Soil Analysis: Both the physical and chemical analysis were done before the start of experiment to ascertain the initial fertility gradient of the soil. Hence, the soil of the experiment field was analysed for physical and chemical parameters and procedure followed below.

2.1. Soil Sampling: Before conducting the experiment the soil samples were taken from various places randomly of the experimental plot with the help of auger from the surface 0 to

15 cm of depth. The collected sample all mixed, air dried and then poket soil sample for analysis of physical and chemical properties respectively.

2.2. Physical Analysis: The physical analysis was done for Bulk density, particle density, % pore space, water holding capacity, soil colour and % moisture. Bulk density was determined by method of Muthuaval *et al*, (1992). The particle density was estimated by method of Muthuaval *et al*, (1992). The pore space was estimated by method of Muthuaval *et al*, (1992)The water holding capacity was estimated by method of (Muthuaval et aI, 1992). The soil colour was determined by munsell colour chart and moisture was determined by permanent wilting point of soil – Veihmeyer and Hendrichsen (1949). Jaiswal, (2011) and swaroop.

Table 1: Physical analysis of soil properties before sowing

Name of Analysis	Quantity	Method
Moisture content (%)	14.31	(Veihmeyer and Hendrichsen 1949)
Bulk density (g/cm3)	1.33	Muthuaval *et al*, (1992)
Particle density (g/cm3)	2.40	Muthuaval *et al*, (1992)
Pore space (%)	35.51	Muthuaval et aI, (1992)
Water holding capacity (%)	23.49	Muthuaval *et al*, (1992)
Soil colour	Light yellow brown 6/4	Munsell (1971)

2.3. Chemical Analysis: The Chemical analysis was done for pH, Organic carbon, Electrical conductivity (EC), available nitrogen, phosphorus and potassium. pH was determined by Digital pH meter. The organic carbon was estimated by Walkley and Black method (1934). The Electrical Conductivity (EC) was estimated by electrical conductivity meter. The available nitrogen was estimated by kjeldahl method (Subaiah and Asija, 1956) the available phosphorus was determined by Olsen's Spectrophotometer method (Olsen, 1954) and available potassium was determined by Flame photometric(Toth and Prince,1949) respectively. Jaiswal, (2011).

Table 2: Chemical analysis of soil properties before sowing.

Name of analysis	Quantity	Method
pH (1:2)	6.68	Digital pH meter
EC dSm^{-1}	0.17	Digital EC meter (Wilcox, 1950)
Organic carbon %	0.24	Rapid titration (Walkley and Black,1947)
Available Nitrogen (kg ha^{-1})	221.44	Alkaline permanganate (Subbiah & Asija,1956)
Available Phosphorous (kg ha^{-1})	18.5	Colorimetric method (Olsen *et al*.1954)
Available Potassium (kg ha^{-1})	345.7	Flame photometric (Toth and Prince,1949)

The data recorded during the course of investigation were subjected to statistical analysis as per method of" Analysis of variance". The significant and non-significant of the treatment effect were judged with the help of 'F' variance ratio test and calculated with table value 'F' level of significance (Fisher, 1950).

Results and discussion:

Pre sowing and post-harvest soil analysis (physical analysis):

1. Moisture (%) in soil: Data has given at Table (1) reveals that the moisture content as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical shows significant on treatments. The moisture content of the experimental soil ranges from post harvest 11.17up to 18.04 **(%)** that reveals the soil in slight alkaline and slightly salinity in reaction. The moisture content was 14.31 **(%)** before sowing the crop. The % moisture content of soil shows increasing trend. The maximum % moisture content was recorded in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} that is 18.04 %, followed by T8 (N_{60} $P_{30}K_{25}$) kg ha^{-1} that is 17.6 the minimum % moisture recorded in treatment T0 ($N_0P_0K_0$) kg ha^{-1} that is 11.17 the reason is due to massive application of fertilizers which caused compaction of soil. Similar results were reported by Teruo Yamamoto., (1963) and Zhong, *et al.* (2014) [9].

2. Bulk density (g cm^{-3}): Data has given at Table (1) reveals that the bulk density as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical analysis shows non-significant different among the treatments. The bulk density of the experimental soil ranges from post-harvest 1.05 up to 1.09 (g cm^{-3}) that reveals the soil in slight alkaline and slightly salinity in reaction. The bulk density was 1.33 (g cm^{-3}) before sowing the crop. The bulk density of soil shows increasing trend. The maximum bulk density was recorded in treatments T7 (N_{120} P_{60} K_{50}) kg ha^{-1} that is 1.09 g cm^{-3} followed by T1 (N_{30} P_0 K_{20}), T5 (N_0 P_{30} K_0), T6 ($N_0P_{60}K_{10}$) and T8 ($N_{60}P_{30}K_{25}$) kg ha^{-1} that are 1.08 g cm^{-3}, the reason for the maximum recorded bulk density in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} is due to the massive applications inorganic fertilizers, organic materials and residues of plants on the surface of soil. Similar results were recorded by Bhattacharyya, *et al*., (2007) [1] and Zhong1, *et al*., (2014) [9].

3. Particle Density (g cm^{-3}): Data has given at Table (1) reveals that the particle density as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical analysis shows significant different among the treatments. The particle density of the experimental soil ranges from post-harvest 2.41 up to 2.92 (g cm^{-3}) that reveals the soil in slight alkalinity and slight salinity in reaction and become good soil for growing crop and achieving yield. The particle density was 2.40 (g cm^{-3}) before sowing the crop. The particle density of soil shows increasing trend. The maximum particle density was recorded in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} that is 2.92 (g cm^{-3}). The reason for the maximum recorded particle density in treatment T7(N_{120} P_{60} K_{50}) kg ha^{-1} is due to the massive materials of organic inorganic and debris of different parts of plants; such as roots, stems leaves and so on, on the surface of earth and then converted to soil. Similar result was reported by Zhong1, *et al.* (2014) [9].

4. pore space percentage (%): Data has given at Table (1) reveals that the pore space as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical analysis shows significant different among the treatment. The pore space of the experimental soil ranges from post-harvest 32.55 to 42.11 (%) that reveals the soil in slight alkalinity in reaction and become good soil for growing crop and achieving yield. The pore space was 35.51 (%) before sowing the crop. The pore space of soil shows increasing trend. The maximum pore space was recorded in treatment T7 (N_{120} P_{60} K_{25}) kg ha^{-1} that is 42.11% followed by T8 ($N_{60}P_{30}K_{25}$) kg ha^{-1} that is 38.8 (%) and the minimum was recorded T0 (control) that is 32.55 (%). The reason for the maximum recorded pore space in treatment T1 (N_{120} P_{60} K_{50}) kg ha^{-1} is due to the massive application inorganic fertilizer and existing of different parts of plants; such as roots, stems, leaves and so on, on the surface of the soil. Similar result was recorded by Zhong, *et al*. (2014) [9].

5. water retaining capacity (%): Data has given at Table (1) reveals that the water retaining capacity as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical analysis shows significant different among the treatment. The water retaining capacity of the experimental soil ranges from post-harvest 22.55 to 28.11 (%) that reveals the soil slight alkaline and sandy loam in reaction. The water retaining capacity was recorded 23.49 (%) before sowing the crop. The water retaining capacity of soil shows increasing trend. The maximum water retaining capacity was recorded in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} that is 28.11 followed by T8 ($N_{60}P_{30}K_{25}$) kg ha^{-1} that is 27.8 (%) and the minimum was recorded on T0 (control) that is 22.55 (%). The reason for the maximum recorded water retaining capacity in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} is due to the massive application of inorganic fertilizer and debris of different parts of plants; such as roots, stems leaves and so on, after many years converted to organic carbon and improving properties of soil especially water retaining capacity. Similar result was recorded by Zhong1, *et al*. (2014) [9].

Soil analysis of pre sowing and post-harvest crop (chemical analysis)

1. pH (1:2): Data has given at Table (2) reveals that the soil ph as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical analysis shows significant different among the treatments. The pH of the experimental soil ranges from 7.36 to 7:85 that reveals the soil in slight alkaline in reaction. The pH was 6.68 before sowing the crop. The pH of soil shows increasing trend. The maximum pH were recorded in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} that is 7.85 reason for the maximum recorded pH in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} was due to the application of alkaline fertilizers. Similar results were reported Sarkar and Billah. (2014) [5] and Zhong1, *et al.* (2014) [9].

2. Soil Electro Conductivity (EC) dSm^{-1}: Data has given at (2) reveals that the EC as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical analysis shows significant different among the treatment. The EC of the experimental soil ranges from post harvest 0.24 to 0.30 dSm^{-1} that reveals the soil as slightly alkaline and slightly salinity in reaction. The EC was 0.17dSm^{-1} before sowing the crop. The EC of soil shows increasing trend to salinity. The maximum EC were recorded in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} that is 0.30 dSm^{-1} followed by T8 ($N_{60}P_{30}K_{25}$) that is 0.29 dSm^{-1} and minimum was recorded T0 (control) that is 0.24 dSm^{-1}. The reason for the maximum recorded EC in treatment T7 (N_{120} P_{60} K_{50}) kg ha^{-1} was due to the massive application of inorganic fertilizer (alkaline fertilizer). The above findings showed the EC dSm^{-1} in pre harvest non significant and in the post harvest significant so, increasing EC was due to using of inorganic fertilizer. Similar results were reported Sarkar and Billah, (2014) [5].

3. Organic Carbon % in soil: Data has given at Table (2) reveal that The Organic carbon 0.24 % before sowing data shows significant and the plot treated with the treatment combination T7 (N_{120} P_{60} K_{50}) kg ha^{-1} recorded maximum percentage of organic carbon in soil that is 0.49 % at comparison T8 (N_{60} P_{30} K_{25}) kg ha^{-1} percentage of organic carbon in soil that is 0.42 % and minimum percentage of organic carbon in soil were observed in treatment combination T7 (N_0P_0 K_0) kg ha^{-1} that is 0.25 %. The above finding showed that the optimum dose of nitrogen, phosphorus and potassium and their interaction increased percentage organic carbon in pre and post-harvest significant which may attribute to bringing the inorganic fertilizer and existing of plants residue, therefore helps to improve the percentage of organic carbon of soil. Similar results were reported Sarkar and Billah, (2014) [5].

4. Available nitrogen (kg ha^{-1}) in soil: Data has given at Table (2) the Nitrogen was recorded 221.44 (kg ha^{-1}) before sowing, data shows that the plot treated with the treatment combinations T7 (N_{120} P_{60} K_{50}) kg ha^{-1} recorded maximum available nitrogen in soil that is 234.72 (kg ha^{-1}) in comparison of T3 (N_{120} P_0 K_0) kg ha^{-1} available nitrogen in soil that is 231.57 (kg ha^{-1}) and minimum available nitrogen in soil were observed in treatment combination T0 (control) that is 216.91 (kg ha^{-1}). The above finding showed that the optimum dose of nitrogen, phosphorus and potassium and their impacts increased available nitrogen in significantly which may attribute to bringing the inorganic fertilizer and existing of plants residue, therefore helps to improve the available nitrogen of soil. Similar result was recorded by Shrivastava and Kanungo, (2014) [6].

5. Available Phosphorus (kg ha^{-1}) in soil: Data has given at Table (2) the phosphorus is18.5 (kg ha^{-1}) before sowing, data shows that the plot treated with the treatment combination T7 (N_{120} P_{60} K_{50}) kg ha^{-1} recorded maximum available phosphorus in soil that is 25.50 (kg ha^{-1}) in comparison of T6 (N_0 P_{60} K_{10}) kg ha^{-1} and T8 ($N_{60}P_{30}K_{25}$) kg ha^{-1}available phosphorus in soil that are 22.50 and 20.5 (kg ha^{-1}) and minimum available phosphorus in soil were observed in treatment combination T0 (control) that is 17.50 (kg ha^{-1}). The above finding showed that the optimum dose of nitrogen, phosphorus and potassium and their interaction increased available phosphorus in significantly which may attribute to bringing the inorganic fertilizer, therefore helps in improving the available phosphorus of soil. Similar result was recorded by Shrivastava and Kanungo, (2014) [6].

6. Available Potassium (kg ha^{-1}) in soil: Data has given at Table (2) reveals that the available potassium (kg ha^{-1}) as influenced by various treatment combinations from pre to post harvest, soil analysis when subjected to statistical analysis shows significant different among the treatment. The potassium is 345.7 (kg ha^{-1}) before sowing, data shows that the plot treated with the treatment combination T7 ($N1_{20}$ P_{60} K_{50}) kg ha^{-1} recorded maximum available potassium in soil that is 393.00 (kg ha^{-1}) in comparison T4 (N_0 P_{15} K_{50}) kg ha^{-1} and T8 ($N_{60}P_{30}K_{25}$) kg ha^{-1}available potassium in soil that are 375.33 and 373.33 (kg ha^{-1}) and minimum available potassium in soil where observed in treatment combination T0 (control) that is 308.00 (kg ha^{-1}). Similar result was recorded by Shrivastava and Kanungo, (2014) [6].

Conclusion

The conducted research shows that there is changes both physical and chemical properties in soil. The value obtained reveal that the application of Nitrogen 120 kg ha^{-1}, Phosphorus 60 kg ha^{-1} and Potassium 50 kg ha^{-1} in treatment number T7 (N_{120} P_{60} K_{50}) kg ha^{-1} has the highest results while T0 (N_0 P_0 K_0) kg ha^{-1} has lowest values.

Table 1: Effects of different levels of NPK on soil physical properties by wheat (*Triticum aestiveum L.*)

T- combinations	% moisture	Bulk density g cm^{-3}	particle density g cm^{-3}	% pore space	% WRC
T0= 0 -0 -0 NPK	11.17	1.05	2.41	32.55	22.55
T1= 30- 0-20 NPK	13.7	1.08	2.5	35.42	25.42
T2= 60 -0 -0 NPK	16.31	1.07	2.67	33.78	23.78
T3= 120 -0 -0 NPK	16.03	1.07	2.63	37.11	24.44
T4= 0 -15 -50 NPK	16.7	1.07	2.74	34.11	24.11
T5= 0 -30 -0 NPK	13.54	1.08	2.59	36.71	25.37
T6= 0 -60 -10 NPK	14.6	1.08	2.52	37.33	26.33
T7= 120 -60 -50 NPK	18.04	1.09	2.92	42.11	28.11
T8= 60 -30 -25 NPK	17.6	1.08	2.8	38.8	27.8
F-test	**S**	**NS**	**S**	**S**	**S**
S Ed (+)	**8.34**	**0.026**	**0.278**	**1.232**	**1.403**
C.D. at 0.05%	**3.934**	**0.056**	**0.589**	**2.734**	**2.911**

Table 2: Effects of different levels of NPK on soil chemical properties by wheat (*Triticum aestiveum L.*)

T- combinations	pH	EC (dSm^{-1})	% OC	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
T0= 0 -0 -0 NPK	7.65	0.24	0.25	216.91	17.5	308
T1= 30- 0-20 NPK	7.48	0.28	0.32	224.24	18	358.4
T2= 60 -0 -0 NPK	7.47	0.25	0.30	228.43	18	324.8
T3= 120 -0 -0 NPK	7.56	0.26	0.26	231.57	18.5	347.2
T4= 0 -15 -50 NPK	7.57	0.28	0.32	217.96	19	375.33
T5= 0 -30 -0 NPK	7.36	0.27	0.31	219	18	336
T6= 0 -60 -10 NPK	7.64	0.28	0.34	220.05	22.5	347.2
T7= 120 -60 -50 NPK	7.85	0.30	0.49	234.72	25.5	393
T8= 60 -30 -25 NPK	7.44	0.29	0.42	228.43	20.5	373.33
F-test	**S**	**S**	**S**	**S**	**S**	**S**
S Ed (+)	**0.048**	**0.014**	**0.030**	**24.359**	**1.871**	**7.956**
C.D. at 0.05%	**0.102**	**0.03**	**0.063**	**11.491**	**3.966**	**16.866**

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