

## Effects of Different Levels of Nitrogen and Phosphorus on Soil Physico-chemical Properties of Maize (*Zea mays* L.)

<sup>1</sup>Safiullah Hakimi, <sup>2</sup>Narendra Swaroop

<sup>1</sup> Research Scholar, Department of Soil Science, Samhigginbottom Institute of Agriculture, Technology and Science Deemed-to-be-University Allahabad, Uttar Pradesh, India.

<sup>2</sup> Associate Professor, Department of Soil Science, Samhigginbottom Institute of Agriculture, Technology and Science Deemed-to-be-University Allahabad, Uttar Pradesh, India.

### Abstract

Soil Physical and chemical properties, Soil amendment, nitrogen and phosphorus, pH, EC, Organic carbon, Pd and pore space – chemical properties of maize (*Zea mays* L.)” at the research farm of department of soil sciences, Sam Higginbottom Institute of Agriculture, Technology & Science, Allahabad, The experiment was laid out in randomized block design with three levels of Nitrogen (0 kg ha<sup>-1</sup>, 100 kg ha<sup>-1</sup>, 120 kg ha<sup>-1</sup>) and three levels of Phosphorous (0 kg ha<sup>-1</sup>, 80 kg ha<sup>-1</sup> and 100 kg ha<sup>-1</sup>). The treatments combinations were replicated three times and were allocated at random in each replication. The treatment combination T<sub>8</sub> [120 Kg N+ 100 kg P] gave the best result with the respect to Combined use of nitrogen and phosphorus resulted in significant increase on enrichment of soil available nitrogen, phosphorus, potassium, soil pH, Soil EC, soil OC, particle density, pore space and water capacity.

**Keywords:** Soil Physical and chemical properties, Soil amendment, nitrogen and phosphorus, pH, EC, Organic carbon, Pd and pore space

### Introduction

Maize is one of the world's leading crops cultivated over an area of 139 million hectares. with a production of about 600 million tones of grain. USA leads the largest area, followed by Brazil, China, Mexico and India. Maize is grown in almost all states of India occupying an area of 6 million hectares with the production and productivity of 9.7 mt and 1.7 t ha<sup>-1</sup> respectively (Kumar *et al.* 2007) [7].

Maize is one of the important cereal crops in the world agricultural economy both as food grains for human and fodder and feed for cattle and poultry. Maize grain contains about 72% starch, 10% protein, 4.8% oil, 5.8% fiber, 3.0% sugar and 1.7% ash (Choudhary, 1994) [4]. Along with this, it is rich in vitamin A, vitamin E, nicotinic acid, riboflavin and contains fairly high phosphorus than rice and sorghum. Its fodder and hay contain 7-10% protein, 15-36% fiber, 2.09 to 2.62% ether extract, 0.42-0.70% Calcium, 0.28-0.29% phosphorus, 0.45% Magnesium, 1.34% Potassium and 56% carbohydrate, therefore, it has very nutritive fodder and hay. Besides food grain, fodder and feed, it has prime importance in textile, starch and dye industries (Rai 2006) [11].

Maize is one of the most important cereal crops in the world it is a member of family gramineae (*poaceae*) sub family panicoideae. Maize is also known as 'Queen of cereals' and kind of fodder maize has been usually considered as poor man's crops and occupying the place in the rich communities due to its multifarious uses as industrial food and feed crops (Suke *et al.* 2011) [13].

One of these fertilizers is Phosphate bio-fertilizer (fertile 2). Its high capability as a solvent for phosphate, climatic adaptability, stability during the storage, easy consumption, cheap transport, and compatibility with other fertilizers and pesticides are mentioned as the features of this kind of fertilizer (Hashemi, 2008) [6]. Jat and Shaktawat showed that phosphate bio-fertilizer in comparison to triple super phosphate fertilizers considerably increased the yield. Phosphate solubilizing bacteria secrete phosphates and organic acids and thus make phosphate solution and increase the phosphate uptake by plants. (Peix *et al.* 2001) [10] reported that the use of phosphate solubilizing bacteria caused the increase solubility of insoluble phosphorus, increase of phosphorus uptake, and significant increase of yield in barley and peas. (Sylvia *et al.* 1993) [15] concluded that in treatments which used phosphate biological fertilizer, the concentration of phosphorus and copper increased in corn's shoots and seeds. (Goenadi, 1998) [5] reported that the use of bio-fertilizers and 50-75% chemical fertilizer led to a yield similar to the yield of the consumption of 100% chemical fertilizer.

Nitrogen is a vitally important for plant nutrient. Nitrogen is essential constituent of protein and is present in many other compound of great physiological importance in plant metabolism. Nitrogen is called a basic constituent of life. Nitrogen also impart vigorous vegetative growth dark green colour to plant and it produce early growth of maize. Nitrogen governs the utilization of potassium, phosphorus and other elements in maize crop. Phosphorus has a great role in energy

storage and transfer and closely related to cell division and development of maize. Phosphorus is a constituent of nucleic acid, phytin and phosphor-lipid. Phosphorus compound acts as energy within plants. Phosphorus is essential for transformation of energy, in carbohydrate metabolism, in fat metabolism, in respiration of plant and early maturity of maize. Potassium play important role in formation of protein and chlorophyll and it provide much of osmotic “pull” that draw water into plant roots. Potassium produces strong stiff straw in maize and reduce lodging in maize. Potassium imparts increase vigor and disease resistance to plant. Phosphorus has a great role in energy storage and transfer and closely related to cell division and development of maize.

**Material and Methods**

**Soil Sampling**

The soil of experimental area falls in order of Inceptisol and in experimental plots is alluvial soil in nature. The soil samples randomly collect from five different sites in the experiment plot prior to tillage operation from a depth of 0-15 cm. The size of the soil sample reduce by conning and quartering the composites soil sample is air dry and pass through a 2 mm sieve by way of preparing the sample for physical and chemical analysis. The experimental details are given below under different heading:

**Design and treatment**

The experiment was carried out in 3×3 factorial randomized block design with three levels of Nitrogen, three levels of phosphorus. The treatments were replicated three times and were allocated at random in each replication.

**Experimental sites**

The experiment was conducted on the research farm of department of Soil Science, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad which situated six km away from Allahabad city on the right bank of yamuna river, the experimental site is located in the sub – tropical region with 25° N latitude 81.50° E longitude and 95 MSL altitude.

The fertilizers were applied in each plot according to treatment combinations. The nitrogen requirement meets with urea 46%. The nitrogen was applied with the three different levels *i.e.* 0 kg N ha<sup>-1</sup>, 100 kg N ha<sup>-1</sup> and 120kg N ha<sup>-1</sup>. The amount phosphorus was given in equal quantity to each plot which was calculated on the basis of general recommendation for maize as 0 kg, 80 kg, 100kg ha<sup>-1</sup> was supplied. On the basis of treatment combination the fertilizer used are described in table below.

**Table 1: Fertilizer applications**

S. NO.	Treatments	Dose ha <sup>-1</sup>	Symbol
1.	Levels of Nitrogen	0 kg ha <sup>-1</sup>	N <sub>0</sub>
		100 kg ha <sup>-1</sup>	N <sub>1</sub>
		120 kg ha <sup>-1</sup>	N <sub>2</sub>
2.	Levels of Phosphorous	0 kg ha <sup>-1</sup>	P <sub>0</sub>
		80 kg ha <sup>-1</sup>	P <sub>1</sub>
		100 kg ha <sup>-1</sup>	P <sub>2</sub>

**3.7 Soil sample analysis**

**Table 2: Soil physical parameters before sowing of Maize crop at 0-15 cm depth of soil.**

Ingredient	Result	Methods
Soil Texture (Sand, Silt & Clay %)	Sandy loamy	(Bouyoucos Hydrometer, 1927)
Particle density(g cm <sup>-3</sup> )	2.5	(Matheval <i>et al.</i> 1992)
Bulk density (g cm <sup>-3</sup> )	1.31	(Matheval <i>et al.</i> 1992)
Pore – space (%)	58.4	(Mutheaval <i>et al.</i> 1992)

**Table 3: Soil chemical parameters before sowing of Maize crop at 0-15 cm depth of soil.**

Ingredient	Result	Methods
Soil pH (1:2)	6.62	Digital pH meter
EC (dSm <sup>-1</sup> )	0.26	Digital Conductivity meter (Wilcox, 1950)
Organic carbon (%)	0.97	(Walkley and Black, 1947)
Available Nitrogen (kg ha <sup>-1</sup> )	225.3	(Subbiah and Asija,1956)
Available phosphorus (kg ha <sup>-1</sup> )	30.64	(Olsen <i>et al.</i> 1954)
Available Potassium (kg ha <sup>-1</sup> )	268.68	(Toth and Prince 1949)

**Results and Discussion**

**Result of mechanical and chemical analysis of post harvest composite soil samples**

Perusal of table reveals the maximum bulk density 1.36 was recorded with (N<sub>0</sub> P<sub>0</sub>) treatment combination followed by 1.36 with (N<sub>0</sub> P<sub>80</sub>) treatment combination whereas the minimum 1.26 Particle density was recorded with control (N<sub>120</sub>P<sub>80</sub>) treatment. Among the nitrogen levels, the maximum bulk density was observed was 1.36 with nitrogen level (N<sub>0</sub>) where as minimum bulk density 1.28 was observed in the (N<sub>100</sub>)

level, while the phosphorus levels, the maximum 1.33 bulk density was observed with phosphorus level (P<sub>0</sub>) where as minimum bulk density 1.30 was observed in the (P<sub>100</sub>) level. The statistical analysis of bulk density data indicates that there was a non significant difference in bulk density interaction between nitrogen and phosphorus. Similar result have also been recorded by Bhattacharya *et al.*, (2004) [2].

the maximum Particle density 2.62 was recorded with (N<sub>0</sub> P<sub>0</sub>) treatment combination followed by 2.55 with (N<sub>0</sub> P<sub>80</sub>) treatment combination whereas the minimum 2.25 Particle density was recorded with control (N<sub>120</sub>P<sub>100</sub>) treatment.

Among the nitrogen levels, the maximum Particle density was observed was 2.53 with nitrogen level (N<sub>0</sub>) where as minimum Particle density 2.29 was observed in the (N<sub>120</sub>) level.

Among the phosphorus levels, the maximum 2.46 Particle density was observed was with phosphorus level (P<sub>100</sub>) where as minimum Particle density 2.33 was observed in the (P<sub>0</sub>) level.

The statistical analysis of Particle density data indicates that there was a significant difference in Particle density interaction between nitrogen and phosphorus simslar result also found by Zhong *et al.* (2014) [17].

the maximum pore space 59.98 was recorded with (N<sub>0</sub> P<sub>0</sub>) treatment combination followed by 57.26 with (N<sub>0</sub> P<sub>80</sub>) treatment combination whereas the minimum 49.94 pore space was recorded with control (N<sub>100</sub>P<sub>0</sub>) treatment.

Among the nitrogen levels, the maximum pore space was observed was 58.04 with nitrogen level (N<sub>0</sub>) where as minimum pore space 50.23 was observed in the (N<sub>100</sub>) level.

Among the phosphorus levels, the maximum 54.98 pore space was observed with phosphorus level (P<sub>100</sub>) where as minimum pore space 52.68 was observed in the (P<sub>100</sub>) level.

The statistical analysis of pore space data indicates that there was a significant difference in pore space interaction between nitrogen and phosphorus. Similar result have also been recorded by Bhattacharya *et al.* (2004) [2].

Perusal of table reveals the maximum pH 7.65 was recorded with (N<sub>0</sub> P<sub>0</sub>) treatment combination followed by 7.64 with (N<sub>0</sub> P<sub>80</sub>) treatment combination whereas the minimum 7.44 pH was recorded with control (N<sub>120</sub>P<sub>100</sub>) treatment. Among the nitrogen levels, the maximum pH was observed was 7.66 with nitrogen level (N<sub>0</sub>) where as minimum pH 7.52 was observed in the (N<sub>120</sub>) level, while the phosphorus levels, the maximum 7.62 pH was observed with phosphorus level (P<sub>0</sub>) where as minimum pH 7.42 was observed in the (P<sub>100</sub>) level. The statistical analysis of pH data indicates that there was a non significant difference in pH interaction between nitrogen and phosphorus. Similar result have also been recorded by Bhattacharya *et al.*, (2004) [2].

The maximum EC 0.42 (dSm<sup>-1</sup>) was recorded with (N<sub>120</sub> P<sub>80</sub>) treatment combination followed by 0.40 with (N<sub>100</sub> P<sub>100</sub>) treatment combination whereas the minimum 0.34 EC by dSm<sup>-1</sup> was recorded with control (N<sub>120</sub>P<sub>100</sub>) treatment. Among the nitrogen levels, the maximum EC by dSm<sup>-1</sup> was observed was 0.39 with nitrogen level (N<sub>120</sub>) where as minimum EC by dSm<sup>-1</sup> 0.37 was observed in the (N<sub>100</sub>) level, while the phosphorus levels, the maximum 0.40 EC by dSm<sup>-1</sup> was observed with phosphorus level (P<sub>80</sub>) where as minimum EC by dSm<sup>-1</sup> 0.36 was observed in the (P<sub>100</sub>) level. The statistical analysis of EC by dSm<sup>-1</sup> data indicates that there was a significant difference in EC by dSm<sup>-1</sup> interaction between nitrogen and phosphorus. Similar result have also been recorded by Bhattacharya *et al.*, (2004) [2].

The maximum organic carbon 1.20 was recorded with (N<sub>120</sub> P<sub>80</sub>) treatment combination followed by 1.127 with (N<sub>0</sub> P<sub>80</sub>) treatment combination whereas the minimum 0.99 organic carbon was recorded with control (N<sub>120</sub> P<sub>100</sub>) treatment.

Among the nitrogen levels, the maximum organic carbon was observed was 1.10 with nitrogen level (N<sub>120</sub>) where as minimum organic carbon 0.75 was observed in the (N<sub>100</sub>) level

and the phosphorus levels, the maximum 1.07 organic carbon was observed with phosphorus level (P<sub>80</sub>) where as minimum organic carbon 0.88 was observed in the (P<sub>100</sub>) level.

The statistical analysis of organic carbon data indicates that there was significant difference in organic carbon interaction between nitrogen and phosphorus. Similar result have also been recorded by Bhattacharya *et al.*, (2004) [2]

In case of phosphorus the maximum available phosphorus 22.50 was recorded with (N<sub>120</sub> P<sub>100</sub>) treatment combination followed by 25.50 with (N<sub>120</sub> P<sub>80</sub>) treatment combination whereas the minimum 16.50 available phosphorus was recorded with control (N<sub>0</sub>P<sub>0</sub>) treatment. Among the nitrogen levels, the maximum available phosphorus was observed was 23.11 with nitrogen level (N<sub>120</sub>) where as minimum available phosphorus 17.50 was observed in the (N<sub>0</sub>) level and the phosphorus levels, the maximum available phosphorus 22.11 was observed with phosphorus level (P<sub>80</sub>) where as minimum available phosphorus 18.61 was observed in the (P<sub>0</sub>) level. The statistical analysis of available phosphorus data indicates that there was a significant difference in available phosphorus interaction between nitrogen and phosphorus. Similar result have also been recorded by Rai *et al.*, (2006) [11].

The maximum potassium 395.73 was recorded with (N<sub>120</sub> P<sub>80</sub>) treatment combination followed by 373.33 with (N<sub>120</sub> P<sub>100</sub>) treatment combination whereas the minimum 308.00 potassium was recorded with control (N<sub>0</sub>P<sub>0</sub>) treatment.

Among the nitrogen levels, the maximum potassium was observed was 372 with nitrogen level (N<sub>120</sub>) where as minimum potassium 330.40 was observed in the (N<sub>0</sub>) level, while the phosphorus levels, the maximum 375 potassium was observed with (P<sub>80</sub>) where as minimum potassium 334.13 was observed in the (P<sub>0</sub>) level.

The statistical analysis of available phosphorus data indicates that there was a significant difference in potassium interaction between nitrogen and phosphorus. Similar result have also been recorded by Szmigiel *et al.*, (2006) [16]

**Table 1:** Effect of different levels of Nitrogen and Phosphorus on available Soil, bulk density (g cm<sup>-3</sup>), Particle density (g cm<sup>-3</sup>) and pore space (%).

Levels of Nitrogen (N)	Bulk density (g cm <sup>-3</sup> )			Mean (N)	Particle density(g cm <sup>-3</sup> )			Mean (N)	Pore space (%)			Mean (N)
	Levels of Phosphorous (P)				Levels of Phosphorous (P)				Levels of Phosphorous (P)			
	0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>		0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>		0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>	
0 kg ha <sup>-1</sup>	1.36	1.36	1.35	1.36	2.25	2.27	2.37	2.29	49.94	50.22	50.54	50.23
100 kg ha <sup>-1</sup>	1.33	1.31	1.30	1.31	2.33	2.45	2.39	2.39	51.21	54.02	54.43	53.22
120 kg ha <sup>-1</sup>	1.29	1.28	1.26	1.28	2.42	2.55	2.62	2.53	56.89	57.26	59.98	58.04
Mean (P)	1.33	1.32	1.30		2.33	2.42	2.46		52.68	53.83	54.98	
	F-test	S. E m. (±)	C.D. at 5%		F-test	S. E m. (±)	C.D. at 5%		F-test	S. Em. (±)	C.D. at 5%	
Due Nitrogen (N)	S	0.02287	0.04848		S	0.041	0.086		S	0.66518	1.41019	
Due to Phosphorus (P)	NS	0.02287	0.04848		NS	0.041	0.086		S	0.66518	1.41019	

Inter (N x P)	NS	0.03960	0.08396		S	0.070	0.149		S	1.15213	2.44252	
---------------	----	---------	---------	--	---	-------	-------	--	---	---------	---------	--

**Table 2:** Effect of different levels of Nitrogen and Phosphorus on available Soil, pH (1:2), Electro Conductivity (EC) dSm<sup>-1</sup> and organic carbon (%).

Levels of Nitrogen (N)	pH			Mean (N)	EC(dSm <sup>-1</sup> )			Mean (N)	OC(%)			Mean (N)
	Levels of Phosphorous (P)				Levels of Phosphorous (P)				Levels of Phosphorous (P)			
	0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>		0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>		0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>	
0 kg ha <sup>-1</sup>	7.65	7.64	7.47	7.66	0.38	0.38	0.38	0.38	1.09	1.12	0.89	1.03
100 kg ha <sup>-1</sup>	7.56	7.57	7.36	7.50	0.35	0.40	0.37	0.37	0.61	0.89	0.75	0.75
120 kg ha <sup>-1</sup>	7.63	7.48	7.44	7.52	0.40	0.42	0.34	0.39	1.12	1.20	0.99	1.10
Mean (P)	7.62	7.63	7.42		0.38	0.40	0.36		0.94	1.07	0.88	
	F-test	S. Em. (±)	C.D. at 5%		F-test	S. Em. (±)	C.D. at 5%		F-test	S. Em. (±)	C.D. at 5%	
Due Nitrogen (N)	NS	0.38456	0.81527		NS	0.00624	0.01322		S	0.02287	0.04848	
Due to Phosphorus (P)	NS	0.38456	0.81527		S	0.00624	0.01322		S	0.02287	0.04848	
Inter (N x P)	NS	0.66608	1.41208		S	0.01080	0.02290		S	0.03960	0.08396	

**Table 3:** Effect of different levels of nitrogen and phosphorus on soil available nitrogen (kg ha<sup>-1</sup>), phosphorus (kg ha<sup>-1</sup>) and potassium (kg ha<sup>-1</sup>).

Levels of Nitrogen (N)	Nitrogen (kg ha <sup>-1</sup> )			Mean (N)	Phosphorus(kg ha <sup>-1</sup> )			Mean (N)	Potassium (kg ha <sup>-1</sup> )			Mean (N)
	Levels of Phosphorous (P)				Levels of Phosphorous (P)				Levels of Phosphorous (P)			
	0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>		0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>		0 kg ha <sup>-1</sup>	80 kg ha <sup>-1</sup>	100 kg ha <sup>-1</sup>	
0 kg ha <sup>-1</sup>	173.94	212.71	194.90	193.85	16.50	18.00	18.00	17.50	308.00	358.40	324.80	330.40
100 kg ha <sup>-1</sup>	231.57	217.96	219.00	222.84	18.00	22.83	23.17	21.33	347.20	373.33	336.00	352.18
120 kg ha <sup>-1</sup>	220.05	234.72	228.43	227.73	21.33	25.50	22.50	23.11	347.20	395.73	373.33	372.09
Mean (P)	208.52	221.80	214.11		18.61	22.11	21.22		334.13	375.82	344.71	
	F-test	S. E m. (±)	C.D. at 5%		F-test	S. E m. (±)	C.D. at 5%		F-test	S. Em. (±)	C.D. at 5%	
Due Nitrogen (N)	S	2.18405	4.63018		S	0.26607	0.56408		S	2.02759	4.29849	
Due to Phosphorus (P)	S	2.18405	4.63018		S	0.26607	0.56408		S	2.02759	4.29849	
Inter (N x P)	S	3.78288	8.01971		S	0.46085	0.97701		S	3.51188	7.44520	

**Conclusion**

It may be concluded the application of 120 kg ha<sup>-1</sup> Nitrogen, 100 kg ha<sup>-1</sup> Phosphorus supplied through inorganic fertilizers gave the best results it term of growth and yield of maize and soil phsico-chemical properties. Since the result is based on one year experiment further trail is needed to substantiate the results.

**References**

1. Ali EA. Grain yield and nitrogen efficiency of pearl millet as affected by plant density, nitrogen rate and splitting in sandy soil. *American Emrasian J Agric and Environ Sci.* 2010, 327-335.
2. Bhattacharya R, Vedprakash Kundu S, Srivastava AK, Gupta HS. Effect of long term Manuring on soil organic Carbon, Bulk density and water retention characteristics under soyean-wheat cropping sequence in north-western Himalays. *Journal of the Indian society of soil science.* 2004, 238-242.
3. Choudhary AC, Meena NL, Jat RL. Effect of nitrogen and moisture conservation practices on growth and yield of rainfed pearl millet (*Pennisetum americanum* L.). *Ann Agrl Res.* 2002, 223-225.
4. Chowdhury MK, Rosario EL. Comparison of nitrogen, phosphorus and potassium utilization efficiency in maize/mungbeaninter cropping. *Journal of Agricultural Science.* 1994, 193-199.
5. Goenadi DH. Fertilization efficiency of oil palm through biofertilizer application. In: *Proceedings of International Oil Palm Conference*, Nusa Dua, Bali. 1998, 370-376.
6. Hashemi A. Irrigated and rain-fed wheat farming using fertile 2 phosphate bio-fertilizer, summer, 2008.
7. Kumar MAA, Gali SK, Hebsur NS. effect of different levels of NPK on growth and yield parameters of sweet corn. *Karnataka Journal of Agricultural Sciences.* 2007; 20:(1):41- 43. 4 ref.

8. Mahesh K. Effect of nitrogen levels on growth and yield of winter maize genotypes. *Journal of Environment and Ecology*. 2010; 386-388.
9. Nanwal RK. Intercropping studies in rainfed pearl millet under different planting systems and fertility levels. Ph.D. Thesis Division of Agronomy, IARI, New Delhi, 1991.
10. Peix A, Rivas AA, Mateos PF. Growth promotion of chickpea and barley by a phosphate solubilizing strain of mediterranean under growth chamber conditions. *Soil biology and biochemistry*. 2001; 33(1):110-103.
11. Rai M. effect of integrated nutrient management local and hybrid varieties of maize (*Zea mays* L.) yield, *Hand Book of Agriculture*, 2006, 872-886.
12. Shivay YS, Singh RP, Pandey CS. Response of nitrogen in maize (*Zea mays*)-based intercropping system. *Indian Journal of Agronomy* 1999; 44(2):261-266.
13. Suke SN, Deotale RD, Hiradeve P, Deogirker M, Sorte SN. effect of nutrients and biofertilizer of chemical and biochemical parameter of Maize (*Zea mays* L.) *J Soil and crop*. 2011; 21(1):107-112.
14. Surendra M, Singh M, Kumar R. Effect of nitrogen, phosphorus and zinc fertilization on yield and quality of kharif fodder, *Agricultural Reviews*, 2015; 36(3):218-226.
15. Sylvia DM, Hammond LC, Bennett JM, Haas JH, Linda SB. Field response of maize to a VAM fungus and water management. *Agronomy Journal*. 1993; 85:193-198.
16. Szmigiel A, Kolodziejczyk M, Oleksy A. The effect of organic and mineral fertilization on grain yield of maize [*Zea mays* (L.)]. *Fragment Agronomica*. 2006; 29(3):70-79.
17. Zhong H, Wang O, Zhao X, Dul O, Zhao Y, Wangl X *et al*. Effect of different Nitrogen Applications on Soil Physical, Chemical properties and Yield in Maize (*Zea mays* L.), *Agricultural Sciences*. 2014; 5:1440-1447.