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Original Research Article

Transformation of N, P, K and S as Influenced by Micronutrient Application of Sunflower (*Helianthus annus* L.) in Inceptisol

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A B S T R A C T

The field experiment was conducted in College of Agriculture, Latur farm during the *kharif* season 2016-2017. The experiment under sunflower with various treatments T_1 –RDF, T_2-RDF+20 kg ha^{1} $ZnSO_4$,T_3 -RDF+20 kg ha^{1} EDTA $FeSO_4$ T_4 RDF+2 kg ha^{1} Borax.,T_5 -RDF+20 kg ha^{1} $ZnSO_4$+20 kg ha^{1} EDTA $FeSO_4$,T_6 -RDF+20 kg ha^{1} $ZnSO_4$+2 kg ha^{1} Borax, T_7 -RDF+20 kg ha^{1} EDTA $FeSO_4$+2 kg ha^{1} Borax, T_8 -RDF+20 kg ha^{1} $ZnSO_4$+20 kg ha^{1} EDTA $FeSO_4$+2 kg ha^{1} Borax. The experiment was laid in Randomized Block Design with three replications and eight treatments. Transformation of macronutrients at various growth stages of sunflower due to application of micronutrient was significantly affected with application of treatments. The availability of N, P, K, and S was maximum with application of treatment T_8 (RDF+20 kg ha^{1} $ZnSO_4$+20 kg ha^{1} EDTA $FeSO_4$+2 kg ha^{1} Borax) at all growth stages of sunflower over control. The availability of all the nutrients was initially higher and gradually decreased as crop grows up to harvest. The maximum availability was obtained at 30 DAS and thereafter as crop age advanced nutrient availability decreased.

Keywords

Macro-nutrients, Nutrient transformation, Sunflower

Introduction

Sunflower (*Helianthus annuus* L.) is an important oilseed crop in India popularly known as “Surajmukhi.” It belongs to the family compositeae. In India, sunflower is cultivated over an area of about 5.2 lakh hectares with a production of 3.35 lakh tones and a productivity of 643 kg per hectare (Anon., 2015-16).With burgeoning population, improved living standard and purchasing power of the people, the demand of vegetable oil in the country is increasing at the rate of about 4-6 percent. Therefore, there is urgent need to improve the productivity of oilseed crops to bridge up the current demand-supply gap. Nitrogen (N) play important role in chlorophyll production and other cell component i.e. protein, nucleic acid, amino acid etc. and required for large amount for protein synthesis. Deficiency of nitrogen impart stunted and yellowish green colour to leaves. Phosphorus (P) helps in photosynthesis, root nodulation, growth, yield and quality as well as flowering and fruiting. Deficiency of phosphorus causes chlorosis and necrosis of the leaves. Potassium (K) is useful for photosynthesis Due to potassium deficiency chlorophyll content decreases and leaves become chlorotic. Sulphur (S) is considered as most important essential element for oil content and protein synthesis. Sulphur is an integral constituent of sulphur containing amino acids (methionine and cystine) which are building units of protein. Adequate and balanced fertilizer is essential for obtaining better yield. Generally farmers do not apply micronutrients to sunflower crop hence the quality production is low therefore, for wide spread adoption and exploitation of high yield potential of the crop, it is necessary to work out the "Transformation of N, P, K and S as Influenced by Micronutrient Application of Sunflower (*Helianthus annus* L.) in Inceptisol."

Materials and Methods

The field experiment was conducted during *kharif* season 2016-2017 at College of Agriculture, Latur farm. Experiment was laid in Randomized Block Design with three replications and eight treatments. The experimental soil was clayey in texture, slightly alkaline reaction, low in content of available nitrogen, medium in available phosphorous, high in available potassium and medium in zinc, and boron, low in iron.

The experiment consist of 8 treatmentsT_1: RDF, T_2: RDF+20 kg ha^1 $ZnSO_4$, T_3: RDF+20 kg ha^1 EDTA $FeSO_4$, T_4: RDF+2 kg ha^1 Borax, T_5: RDF+20 kg ha^1 $ZnSO_4$+20 kg ha^1 EDTA $FeSO_4$, T_6: RDF+20 kg ha^1 $ZnSO_4$+2 kg ha^1 Borax, T_7: +20 kg ha^1 EDTA $FeSO_4$+2 kg ha^1 Borax,T_8: RDF+20 kg ha^1 $ZnSO_4$+20 kg ha^1 EDTA $FeSO_4$+2 kg ha^1 Borax. Recommended dose of fertilizer (90:45:45) was applied through urea, SSP and MOP and micronutrient through $ZnSO_4$, cheleted $FeSo_4$ and Borax was applied treatment wise at the time of sowing. Full dose of phosphorus, potassium and micronutrients along with 50 percent dose of nitrogen of each treatment was applied as basal dose and remaining 50 percent nitrogen dose of each treatment was applied 30 days after sowing. The soil samples were drawn at 35, 55, 75 and harvest stage of sunflower and analyzed for available N, P, K and S.

Results and Discussion

Nitrogen (kg ha^{-1})

Effect of micronutrients application on transformation of N (kg ha^{-1}) in soil at different growth stages of sunflower reported in table 1.Data indicated that available N was in range of (151.150 to 184.07 kg ha^{-1}) at 35 DAS due to application of RDF along with micronutrients. The maximum availability was found in range of (184.07, 179.50, 178.80 and 177.83) at 35, 55, 75 and harvest stage of sunflower respectively.

The maximum availability observed with $T_{8,}$ $T_{6,}$ T_7 and T_4 in all growth stages due to application of RDF + micronutrient combination over RDF+ alone micronutrient combination. During experimentation temperature increases hence the N content decreases as crop growth progress. The maximum availability was obtained at 30 DAS and thereafter as crop age advanced nitrogen availability decreased. This might be due to use of nitrogen by plant from the part of N in soil. The availability of nitrogen in soil was increased in Treatment due to application of RDF along with micronutrients which containing zinc than other treatments. This is due to zinc helps in increase in availability of nitrogen in soil effectively. The availability of nitrogen is more at 35 DAS and there after it decrease. The significant and positive response in nitrogen content was observed when micronutrient is combined with RDF, in that zinc combination shows more availability due to positive zinc nitrogen interaction. Similar findings were reported by Elayaraja (2014) who reported that application of Zinc sulphate at 30 kg/ha + RDF to groundnut increased nitrogen availability in soil. Sharma *et al.,* (2011) observed that application of NPK and Zn increased the availability of NPK and Zinc content in soil. This increase is due to positive response of zinc nitrogen interaction.

Phosphorous (kg ha^{-1})

Effect of micronutrients application on availability of P (kg ha^{-1}) in soil at different growth stages of sunflower tabulated in table 2.From data it is indicated that available P was in range of (13.67 to 19.13 kg ha^{-1}) at 35 DAS due to application of RDF along with micronutrients. The maximum availability was found in range of (19.13, 18.97, 18.60 and 17.23) at 35, 55, 75 and harvest stage of sunflower respectively.

The maximum availability of P was observed with treatment T_8 at each growth stages than treatment $T_{1.}$ The application of RDF + micronutrient combination increases availability than RDF + alone nutrient combination. The increase in availability of P among the treatments was due to rapid solublization of native and applied P as a result of carbonic acid produces due to higher microbial respiration, protection provided by humic, fulvic and humin substances resulting from the organic carbon recycling might explains reason for higher P availability. The inorganic P forms in soil are largely compounds associated with iron. There relative abundance and solubility in related with soil pH. Soil temperature also affects the solubility of P. The availability of P is more in warm soil than cold soil. Plant roots grow faster in warm soils therefore they explore more soil volume from which nutrients can be absorbed. The similar. results were also reported by Sharma *et al.,* (2011) observed that application of 100 % RDF and Zn increased the availability of phosphorus content of soil. Vyas *et al.,* (2003) observed that the application of micronutrients to soybean crop decreased periodical available P status of the soil up to harvest of crop, whereas, application of FYM either alone or along with micronutrients improved the available NPK status.

Potassium (kg ha^{-1})

Effect of micronutrients application on transformation of K (kg ha^{-1}) in soil at different growth stages of sunflower presented in table 3. From data it is indicated that available K was in range of (494.30 to 504.00 kg ha^{-1}) at 35 DAS due to application of RDF along with micronutrients. The maximum availability was found in range of (504.00, 942.17, 485.27 and 481.33 kg ha^{-1}) at 35, 55, 75 and harvest stage of sunflower respectively. While lowest availability of Potassium was found (491.30, 405.47, 396.17 and 391.93 kg ha^{-1}) at 35, 55, 75 and harvest stage of sunflower respectively.

Maximum K availability was found at 35 DAS and thereafter as crop growth advanced K availability decreased This might be due to use of potassium by plant from the part of K in soil. Application of RDF + micronutrients combination increase K availability as compared to RDF + alone micronutrients combination. This increase in K among treatment was attributed as soil pH has significant role in availability of K in soil. In soil H^+ and hydroxyl aluminum ion compete with K^+ ions for the exchange or adsorption sites and able to keep more K^+ ion in the solution phase and reduce their susceptibility to fixation. As the pH increases H^+ and hydroxyl aluminum ion are neutralized or removed marking it easier for the K^+ ions to move closer soil colloidal surfaces.

Table.1 Effect of micronutrients application on transformation of N (kg ha^{-1}) in soil at different growth stages of sunflower

Treatments	Available Nitrogen			
	35 DAS	55 DAS	75 DAS	At harvest
T1	151.50	147.87	143.50	141.10
T2	169.40	168.50	168.17	167.87
T3	160.70	159.83	157.60	156.53
T4	164.10	163.27	161.97	161.20
T5	177.57	175.87	173.87	170.90
T6	181.33	177.83	175.17	174.50
T7	176.40	174.83	174.20	173.20
T8	184.07	179.50	178.80	177.83
S.E±	0.495	0.655	0.775	0.816
CD at 5%	1.502	1.986	2.350	2.475

Table.2 Effect of micronutrients application on transformation of P (kg ha^{-1}) in soil at different growth stages of sunflower

Treatments	Available Phosphorous			
	35 DAS	55 DAS	75 DAS	At harvest
T1	13.67	13.37	13.33	13.30
T2	14.70	14.46	14.22	13.90
T3	15.50	15.07	14.14	14.00
T4	16.60	16.13	15.12	14.90
T5	17.10	16.77	16.30	16.00
T6	18.83	18.37	18.23	17.07
T7	17.77	16.90	16.37	16.13
T8	19.13	18.97	18.60	17.23
S.E±	0.084	0.063	0.101	0.072
CD at 5%	0.254	0.190	0.306	0.218

Table.3 Effect of micronutrients application on transformation of K (kg ha^{-1}) in soil at different growth stages of sunflower

Treatments	Available Potassium			
	35 DAS	55 DAS	75 DAS	At harvest
T1	431.30	405.47	396.17	391.93
T2	452.83	449.40	444.50	437.87
T3	430.43	427.77	425.03	422.03
T4	442.27	435.47	431.50	427.90
T5	444.33	441.40	436.90	433.90
T6	490.33	486.37	471.13	473.83
T7	449.20	447.33	443.60	439.87
T8	498.00	492.17	485.27	481.33
S.E±	2.65	2.61	1.16	4.84
CD at 5%	8.06	7.91	3.53	13.59

Table.4 Effect of micronutrient application on transformation of S (mg kg ha^{-1}) in soil at different growth stages of sunflower

Treatments	Available Sulphur			
	35 DAS	55 DAS	75 DAS	At harvest
T1	15.01	14.24	13.67	13.76
T2	16.12	14.93	13.87	14.33
T3	15.70	14.27	13.65	13.94
T4	15.99	14.44	14.00	13.91
T5	15.43	15.37	14.47	14.54
T6	16.73	16.61	15.08	14.72
T7	16.57	15.77	15.17	14.67
T8	17.64	16.69	16.31	15.23
S.E±	0.473	0.248	0.143	0.238
CD at 5%	1.434	0.751	0.432	0.721

The similar result were also reported by Sharma *et al.,* (2011) observed that application of 100 % RDF and Zn increased the availability of potassium content of soil. Vyas *et al.,* (2003) observed that the application of micronutrients to soybean crop decreased the available K status of the soil after harvest of crop, whereas, application of FYM either alone or along with micronutrients improved the available NPK status.

Sulphur (mg kg ha^{-1})

Effect of micronutrients application on transformation of S (mg kg ha^{1}) in soil at different growth stages of sunflower presented in table 4. From data it is indicated that available S was in range of (15.01 to 17.64mg $kgha^{-1}$) at 35 DAS due to application of RDF along with micronutrients.

The maximum availability was found in range of (17.64, 16.69, 16.31 and 15.23 mg kg ha^{-1}) at 35, 55, 75 and harvest stage of sunflower respectively. While lowest availability of S was found (15.01, 14.24, 13.67 and 13.76 kg ha^{-1}) at 35, 55, 75 and harvest stage of sunflower respectively. The maximum availability of sulphur was observed by application of RDF along with micronutrient combination than alone micronutrient combination. This might be due to the essential nutrient sulphur can be provided in required amount for the crop in adequate amount through ferrous sulphate and zinc sulphate.

The sulphur in soil is being cycled continuously between inorganic and organic forms the nature of compound formed and their transformations are influenced by the biologically mediated process, which in terms are affected by environmental process.

Organic matter is the major source of soil sulphur oxidation to SO_4 is brought about by soil micro-organisms and process is called as mineralization.

Similar results were also observed by Soaud *et al.,* (2011) studied the effect of elemental sulphur, phosphorus, micronutrients on nutrient availability of calcareous soils and observed that soil properties changed with the application of micronutrients and the oxidation of S_0 resulted in direct chemical changes through the lowering of soil pH and an increased S concentration in all soils.

The nutrient availability was significantly affected with application of treatments. The availability of N, P, K and S was maximum with application of treatment T8 (RDF+20 kg ha1 ZnSO4+20 kg ha1 EDTA FeSO4+2 kg ha1 Borax) at all growth stages of sunflower over control. The transformation of all the nutrients was initially higher and gradually decreased as crop grows up to harvest. The maximum availability was obtained at 35 DAS and thereafter as crop age advanced nutrient availability decreased.

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