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Impact of different levels of nitrogen, phosphorous and sulphur on Physico-chemical properties of soil on mustard crop

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Abstract
An experiment was conducted on "Effect of different level of Nitrogen, Phosphorus and Sulphur on physico-chemical properties of soil on mustard (*Brassica juncea* L.) *Var.* Varuna during *rabi* season 2019-2020 at the Research farm Department of Soil Science, Naini Agriculture Institute, SHUATS, PRAYAGRAJ, trial was laid out in randomized block design (RBD) with three replications on sandy loam soil (sand 70%, silt 16.50%, clay 13.50%) consisting of nine treatment. Treatment T_9 (N:P:S @ 100:60:40 kg/ha) was found to be the best in all treatment combinations. Data have been recorded in pre harvested crop in different days intervals at 30, 60, 90, and 120 days. Data have been recorded in post-harvest soil for pH, EC (dsm^{-1}), Organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available sulphur (ppm) were as 7.76, 0.6, 0.76%, 258.15, 22.75 and 22.75 respectively. Soil chemical properties like EC, available nitrogen, available phosphorus, available sulphur and % organic carbon found to be significant but soil pH found to be non-significant. Data have been recorded for soil physical properties like Bulk density (Mg m^{-3}), Particle density (Mg m^{-3}), % pore space and water holding capacity (%) were as 1.69, 2.78, 55.85% and 45% respectively and all were found to be significant.

Keywords: Soil, urea, SSP, gypsum, basal dose, significant

Introduction
Nitrogen is combined, to be the most important nutrient for the crop to metabolic activity and transformation of energy, chlorophyll and protein synthesis. Nitrogen also affects the uptake of other essential nutrients and it helps in the better for photosynthesis to reproductive parts which increases the seed: Stover ratio. Nitrogen use efficiency is greatly influenced by the rate, source, and method of fertilizer application. The rate of nitrogen depends upon the initial soil status, climate, topography, cropping system in practice, and crop. Crop under zero tillage is also more productive (695 kg/ha) with 80 kg N/ha. Increase in the nitrogen level up to 60 kg N/ha consistently and significantly increased the number of primary branches, number of seeds per siliquae and 1000 seed weight, however, increasing the nitrogen level up to 90 kg/ha increased the number of secondary branches per plant, number of siliquae per plant, and seed and straw yield with maximum cost benefit ratio of 3.03. Split application of total nitrogen in three equal doses one-each as basal, second after first irrigation and remaining one-third after second irrigation resulted in maximum increase in yield attributes as compared to application of total nitrogen in two split doses. Top dressing of N fertilizers should be done immediately after first irrigation. Delaying of first irrigation, results in yield reduction of mustard crop. The application of nitrogen with presowing irrigation was superior to that of nitrogen application with last preparatory tillage. (D.P Singh *et al.*, 2018) [5].

Phosphorus does not occur as abundantly in soil as N and K. Total concentration in surface soil varies between about 0.02 and 0.10 per cent Unfortunately, the quantity of total P in soils has little or no relationship to the availability of P to plants. Phosphorus is absorbed by plants largely as orthophosphate ions ($H_2PO_4^-$ and HPO_4^{2-}), which are present in the soil solution. Some low molecular weight, soluble organic P compound exist in soil solution and may be observed, but generally they are of minor importance. The average soil solution P concentration is about 0.05 ppm and varies widely among soils.

The solution P concentration required by most plant varies from 0.003 to 0.3 ppm and depends on the crop species and level of production. Application of phosphorus up to 60 kg/ha significantly enhanced dry matter/plant. Plant height, branches per plant and leaf chlorophyll content increased with up to 40 kg P/ha. The uptake of NPK and sulphur by both seed and Stover increased significantly with successive increase in nitrogen levels up to 120 kg N/ha, sulphur levels up to 60 kg S/ha, and P_2O_5 level up to 60 kg P_2O_5/ha. Seed yield and yield attributes increased
while oil content decreased with increasing level of nitrogen up to 120 kg/ha. Different levels of phosphorus increased seed yield, maximum being at 80 kg P/ha due to higher number of secondary branches/plant and consequently siliquae/plant. Oil content also increased with increase in levels of N, P_2O_5, and S. Activities of all nitrogen assimilating enzymes, namely; nitrate reductase, nitrite reductase, glutamine synthetase, and glutamate synthetase were found to be maximum at 100 kg N/ha. (Shashi vind Mishra *et al*., 2010) [8].
It is obvious that Sulphur plays an important and specific role in oilseed crops as it is required in the formation of S containing amino acids like methionine, cystine and cystenen, synthesis of proteins, chlorophyll and oil corteril oil content of oil seeds. Moreover, it is also associated with the synthesis of vitamins (biotin, thiamine), metabolism of carbohydrates, proteins & fats. Sulphur deficiency also results in poor flowering, fruiting, cupping and reddening of leaves, reddening of stem and petioles and stunt growth. Saalbach (1993) reported that Sulphur is a silent energy and can stealthily reduce the crop yield to an extent up to 10-30 per cent.Sulphur plays an important and specific role in oilseed crops as it is required in the formation of S containing amino acids like methionine, cystine and cysteme, synthesis of proteins, chlorophyll and oil content of oil seeds. Moreover, it is also associated with the synthesis of vitamins (biotin, thiamine), metabolism of carbohydrates, proteins & fats.Sulphur is a silent energy and can stealthily reduce the crop yield to an extent int 10-30 per cent for achieving a definite yield target of a crop, a definite quantity of nutrients must be applied to the crop and this requirement of nutrients can be calculated by taking into consideration the contribution of native soil available nutrients and applied fertilizer nutrients (Subba Rao and Srivastava, 2001).
The fertilizers have played a prominent role in increasing the oilseed production, balanced fertilization is thekey to achieve higher production and increase nutrient use-efficiency. Use of optimal doseof primary, secondary and micro nutrients ensure better and sustainable yield, while correcting some of the nutrients deficiencies. (Samar Pal Singh *et al.*, 2017) [12]. Fertilizer management is one of the important agronomic factors known to augment the crop yield. Data pertaining to fertilize use for different crops indicated that a notable bulk of fertilizer is used for good grain and cash used crops, whereas a negligible quantity is used for mustard crops. Balanced fertilization can be only option to mitigate this anomaly and it does not only mean the application of right quantity of fertilizers for crop growth, but also the right time, mode and sources of application,the nutrient management strategies involving the use of chemical fertilizers but also supplemented with organic manure and bio fertilizers. (Ravindra Sachan *et al.*, 2019) [10].

Material and Method

Experimental sites:

The experiment was conducted at research farm of Department of Soil Science, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj which is situated six km away from Prayagraj city on the right bank of Yamuna river, the experimental site is located in the sub – tropical region with 25^0 27'N latitude and $81^0$51'E longitude and at an altitude of 98 m above mean sea level.

Climatic condition in the experimental area

The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46 ^{0}C – 48 ^{0}C and seldom falls as low as 4 ^{0}C – 5 ^{0}C. The relative humidity ranges between 20 to 94 percent. The average rainfall in this area is around 1013.4 mm annually.

Soil sampling

The soil of experimental area falls in order of *Inceptisol*. The soil of the experimental field is alluvial in nature. The soil samples were randomly collected 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 was reduced by conning and quartering the composites soil sample and was air dried passed through a 2 mm sieve for preparing the sample for physical and chemical analysis.

Table 1: Physical and chemical analyses of composite soil samples

Particular	Method used
Bulk density (gcm^{-3})	Muthuvel *et al.*, (1992)
Particle density (gcm^{-3})	Muthuvel *et al.*, (1992)
Pore space (%)	Muthuvel *et al.*, (1992)
Water holding capacity (%)	Muthuvel *et al.*, (1992)
Soil pH (1:2) soil water suspension (w/v)	(Jackson 1958) [4]
Soil EC. (dSm^{-1}) at 25^{0}C of 1:2 soil water suspension	(Wilcox 1950) [17]
Organic carbon (%)	(Walkley and Black 1947) [16]
Available nitrogen (kgha^{-1})	(Subbiah and Asija 1956) [11]
Available phosphorus (kgha^{-1})	(Olsen 1954) [9]
Available Potassium (kgha^{-1})	(Toth and Prince, 1949) [15]
Available sulphur (kg ha^{-1}.)	(Chesnin and Yien 1960)

Table 2: Treatment Combinations

S. No.	Symbol	Treatment combination (kg ha^{-1})
1	T_1	Control
2	T_2	$N_0P_0S_{20}$
3	T_3	$N_0P_0S_{40}$
4	T_4	$N_{50}P_{30}S_0$
5	T_5	$N_{50}P_{30}S_{20}$
6	T_6	$N_{50}P_{30}S_{40}$
7	T_7	$N_{100}P_{60}S_0$
8	T_8	$N_{100}P_{60}S_{20}$
9	T_9	$N_{100}P_{60}S_{40}$

Statistical Analysis

The data recorded during the course of investigation were subjected to statically analysis by randomized block design (RBD) for drawing conclusion. The significant and nonsignificant effect was judged with the help of "F" (variance ratio) table. The significant difference between the means was tested against the critical difference of 5% level. For testing the hypothesis, the following ANOVA table was used.

Result and Discussion

Table 3: Results of mechanical, physical and chemical analysis of soil before sowing

Particulars	Result values	Method
(A) Mechanical analysis		
Sand (%)	70.00	Bouyoucos Hydrometer (1963) [4]
Silt (%)	16.50	
Clay (%)	13.50	
Texture class	Sandy loam	
Physical analysis		
Bulk density(gcm^{-3})	1.63	Muthuvel *et al.*, (1992)
Particle density(gcm^{-3})	2.66	Muthuvel *et al.*, (1992)
Pore space (%)	57.22	Muthuvel *et al.*, (1992)
Chemical analysis		
Soil Ph	7.80	(Jackson 1958) [6]
Electrical conductivIty (dSm^{-1})	0.43	(Wilcox 1950) [17]
Organic Carbon (%)	0.72	(Walkley and Black 1947) [16]
Available Nitrogen (kg ha^{-1})	242	(Subbiah and Asija 1956) [11]
Available phosphorous(P_2O_5) (kg ha^{-1})	18.25	(Olsen *et al*.,1954) [9]
Available potassium (K_2O) (kg ha^{-1})	264.32	(Toth & Prince 1949) [15]
Available sulphur (ppm.)	22.34	(Chesnin&Yien1950)

Table 4: Physical properties of soil sample after harvesting of Mustard crop

Sample\Treatment	Bulk Density (Mg m-3)	Particle Density (Mg m-3)	Pore space (%)
T1	1.63	2.6	52.95
T2	1.65	2.62	53
T3	1.64	2.61	53.25
T4	1.65	2.64	52.85
T5	1.66	2.67	53.55
T6	1.66	2.71	54.5
T7	1.65	2.72	50
T8	1.68	2.75	52.9
T9	1.69	2.78	55.85
F-test	S	S	S
S. Em+	0.004	0.056	0.615
C.D	1.157	1.157	1.157

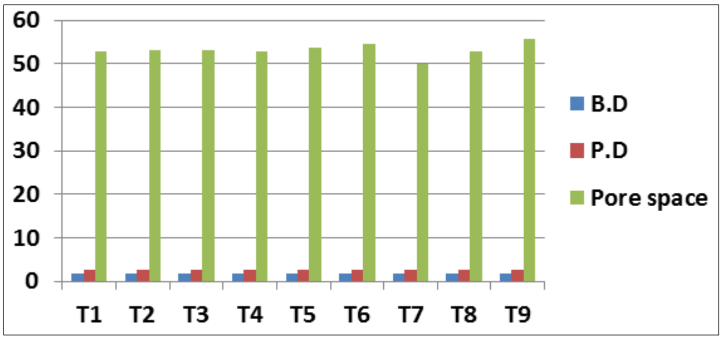

Fig 1: Show the BP, BD and pore space

Table 5: Chemical properties of soil sample after harvesting of Mustard crop

Sample\Treatments	Organic carbon (%)	Available Nitrogen (Kgha-1)	Available Phosphorus (Kgha-1)	Available Sulphur (Kgha-1)	pH	EC (dS m-1)
T1	0.32	224.85	14.1	17.05	7.38	0.61
T2	0.63	245.4	17.8	17.15	7.45	0.58
T3	0.64	250.25	18.25	17.33	7.5	0.55
T4	0.6	232.1	19.17	18.76	7.3	0.54
T5	0.73	253.45	20.2	19.79	7.33	0.54
T6	0.75	253.25	22.1	20.34	7.55	0.61
T7	0.58	229.95	19.55	19.51	7.23	0.41
T8	0.65	250.2	21.15	19.8	7.34	0.45
T9	0.76	258.15	22.75	22.75	7.74	0.61
F-test	NS	S	S	S	NS	S
S. Em+	0.28	1.11	0.71	0.39	0.325	0.054
C.D. (P= 0.05)	0.485	2.371	1.17	0.765	0.61	0.116

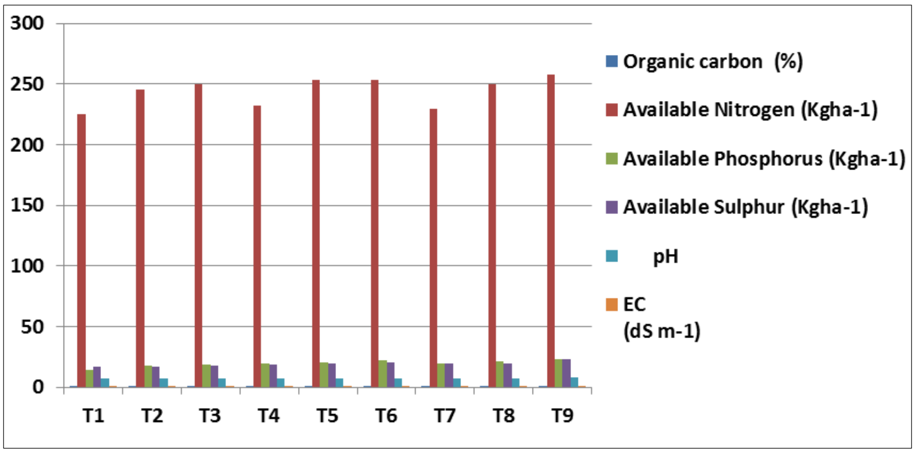

Fig 2: The organic carbon nitrogen phosphorus and sulphur

Summary and Conclusion

Maximum bulk density of soil (1.69g/cm^3) was recorded with T_9[@100% NPS] followed by (1.68g/cm^3) T_8[@100% NP+50% sulphur]. Maximum particle density of soil (2.78g/cm^3) was recorded with T_9[@100%NPS] followed by (2.75g/cm^3) T_8[@100%NP+50% sulphur]. Soil pH after harvesting (7.74) was recorded with T_9**[**@ 100%NPS] followed by(7.55) T_6[@ 50%NP+100% sulphur]. Electrical conductivity (Ds m^{-1}) of soil after harvesting (0.61) was recorded with T_9**[**@ 100% NPS] followed by (0.61) T_6[@ 50%NP+100% sulphur]. Organic carbon (%) in soil after harvesting (0.76) with T_9**[**@ 100% NPS.] followed by (0.75) T_6[50%NP+100% sulphur]. Available nitrogen (258.15kg ha^{-1}) in soil after harvesting T_9**[**@ 100%NPS] followed by (253.25) T_6[@50% NP+100% sulphur]. Available phosphorus (22.75kg ha^{-1}) in soil after harvesting T_9**[**@ 100%NPS] followed by (22.10kg ha^{-1}) T_6[@ 50% NP+100% sulphur].Available Sulphur (ppm) in soil after harvesting (22.75) T_9**[**@ 100% NPS] followed by (20.34) T_6[@50% NP+100% sulphur].Maximum water holding capacity and % pore space was 45% and 55.85% in soil in T_9[@ 100% NPS] followed by 45% and 54.50% in T_6[@50% NP+100% sulphur].

It was concluded from trial that the Impact of different levels of Nitrogen Phosphorus and Sulphur on Physico-Chemical Properties of soil on Mustard (*Brassica juncea* L.)*Var. VARUNA* T_9-@ 100%NPS was found to be the best in the physical and chemical properties of soil such as bulk density (1.69 gcm^{-3}), particle density (2.78 gcm^{-3}), pore Space (55.85%), pH (7.74). EC (0.61 dsm^{-1}), organic carbon (0.76%), nitrogen (258.15 Kg ha^{-1}), phosphorus (22.75 Kg ha^{-1}), and sulphur (22.75ppm), were found to be at par than any other treatment combinations.

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