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Muchakala Praveen
Student, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Arun Alfred David
Associate Professor, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Tarence Thomas
Professor, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Sneha Rout
Student, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Muchakala Praveen
Student, Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Response of NPK and sulphur on soil health parameters and yield attributes of mustard (*Brassica juncea* L.) *var*. Nirmal-111

Muchakala Praveen, Arun Alfred David, Tarence Thomas and Sneha Rout

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Abstract
Present paper investigation entitled "Response of NPK and Sulphur on Soil Health Parameters and Yield attributes of Mustard (*Brassica juncea* L.) *var*. Nirmal-111" was carried out at central research farm of Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during rabi season 2023-24. The texture of the soil in the experimental region was sandy loam. The design was set up using randomized block design, different levels of NPK (0:0:0, 60:30:20 & 120:60:40 kg ha^{-1}) and Sulphur (0, 25 & 50 kg ha^{-1}) respectively. The findings it is concluded from trail that the treatment T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] gave the best results and significant increase in terms of pore space, water holding capacity, EC, organic carbon, available nitrogen, available phosphorus, available potassium and available sulphur as well as plant growth and yield attributes. The maximum yield was recorded as 18.20 qha^{-1} in treatment T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] and minimum 8.20 qha^{-1} in T_1 [Absolute control] respectively which was higher than yield any other treatment combination. Among the various treatments, treatment T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] provided the highest net return of ₹34551.76 ha^{-1} followed by treatment T_8 [N:P:K @ 60:30:20 kg ha^{-1} + S @ 25 kg ha^{-1}] ₹32688.42 ha^{-1}. However, the control plot treatment showed lowest net returns of ₹5615 ha^{-1}. There was no discernible difference in the growth and production of mustard under control. The use of Sulphur, as well as their blend with complete NPK, significantly increases the characteristics of growth and total yield attributes of mustard. The trail was based on one season, so that the findings can be substantiate before recommendation.

Keywords: Soil, NPK, sulphur, mustard

1. Introduction
Soil is a mixture of organic matter, minerals, gases, water and living organisms that together support life Brady and Weil, (2016) [6]. Soil quality can be defined as the fitness of a specific kind of soil, to function within its capacity and within natural or managed ecosystem boundaries, to sustain plant productivity, maintain or enhance water and air quality, and support human health and habitation Arshad and Martin, (2002) [4]. Soil plays a critical role in mustard production by providing nutrients, water and physical support for growth Hotmode *et al., (*2001) [10]. Monitoring soil moisture levels is essential, with optimal levels between 50% and 75% of field capacity, managed through irrigation and water conservation Kumar *et al., (*2016) [12].
Mustard is India's second most significant edible oilseed crop, behind peanuts, accounting for roughly 30% of total oilseed production. It is shown that mustard oil has the least perilous saturated fatty acids when compared to other culinary oils. Additionally, it has sufficient levels of linoleic and linolenic, two necessary fatty acids that are absent from most other edible oils. The nation's top producer is the state of Rajasthan. Production of mustard seeds is predicted to rise from 35 lakh tons in 2020-2021 to 49.50 lakh tons in the rabi season of 2021-2022. With 39.722 lakh hectares, or more than 35.3 lakh ha, Rajasthan had the most acreage in 2020-2021. From 85.35 lakh hectares in 2021-2022 to 92.67 lakh hectares in 2022-2023, mustard data grew by 7.32 lakh hectares. Therefore, of the 8.20 lakh hectares of newly planted oilseeds, 7.32 lakh hectares were made up solely of rapeseed and mustard. A subtropical environment is needed to cultivate mustard Anonymous, (2021) [2]. Due to its ability to flourish in arid and chilly climates,

mustard is typically produced during the Rabi season. Temperatures between 10°C and 25°C are necessary for mustard crop growth. Areas with yearly rainfall between 625 and 1000 mm are used to cultivate mustard crops. Since this crop cannot withstand cold, it needs a bright sky and circumstances free from frost.

Nitrogen is considered as one of the significant macronutrients among all the mineral elements for all living tissues of the plant from metabolism to resource allocation, growth and development. Nitrogen is the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and the yield (Marschner, 2002) [14].

Phosphorus plays a vital role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops. When Phosphorus was applied in conjunction with nitrogen and potash, there was significant increase in the yield of mustard. Excess supply of phosphorus results in increased root growth compared with shoot growth (Waghmode, 2010) [23].

Potassium develops tolerance to drought condition and enhances plant ability to resist attacks of pests and diseases. A large number of enzymes are either completely dependent on or stimulated by potassium (Suelter, 1970) [21]. It is also essential for most metabolic processes, including glycolysis, oxidative phosphorylation and adenine synthesis (Evans and Sorger, 1966) [9].

Sulphur requirement is highest in mustard owing to the presence of sulphur-rich glucosinolates. Sulphur is also important for oil content. Soils, which are deficient in sulphur, cannot on their own provide adequate sulphur to meet crop demand resulting in sulphur deficient crops and sub-optimal yields (Chattopadhyay *et al.,* 2012) [7].

2. Materials and Methods

2.1 Experimental Site and Location

The experiment was conducted at Research Farm of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The area is situated on the South of Prayagraj on the right side of the river Yamuna on the South of Prayagraj - Rewa National Highway 27, is nearly 6 Km away from the Prayagraj city. It is situated at $25^0$24'23" N latitude, $81^0$50'38" E longitude and at the altitude of 98 meter above the sea level.

2.2 Climate Condition

The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and cold winter. The maximum temperature of the location reaches up to 46 °C – 48 °C and seldom falls as low as 4^0C – 5 °C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. Prayagraj has a sub- tropical and semi- arid climate with rain mostly during July- September.

2.3 Experimentation

The experiment was laid out in Randomized Block Design with three replications. The treatments consisting of nine treatment combinations viz., T_1-[Absolute control], T_2-[N:P:K @ 0:0:0 kg ha^{-1} + S @ 25 kg ha^{-1}], T_3-[N:P:K @ 0:0:0 kg ha^{-1} + S @ 50 kg ha^{-1}], T_4-[N:P:K @ 60:30:20 kg ha^{-1} + S @ 0 kg ha^{-1}], T_5-[N:P:K @ 120:60:40 kg ha^{-1} + S @ 0 kg ha^{-1}], T_6-[N:P:K @ 60:30:20 kg ha^{-1} + S @ 25 kg ha^{-1}], T_7-[N:P:K @ 60:30:20 kg ha^{-1} + S @ 50 kg ha^{-1}], T_8-[N:P:K @ 120:60:40 kg ha^{-1} + S @ 25 kg ha^{-1}]and T_9-[N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] were applied. Characteristics of growth and yield were noted during the trial. The source of NPK and Sulphur is Urea, SSP, MOP, and Sulphur bentonite respectively.

3. Results and Discussions

3.1 Response of different levels of NPK and Sulphur on Physical properties and pH and EC of Post harvest Soil

The maximum soil bulk density at 0-15 cm soil depth was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 1.37g cm^{-3} and minimum soil bulk density was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 1.20g cm^{-3}. The maximum soil bulk density in soil at 15-30 cm soil depth was recorded in T_1 [@0% NPK + @ 0% Sulphur] which was recorded at 1.40g cm^{-3} and minimum soil bulk density was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] with 1.22 g cm^{-3}. Similar results have also been recorded by Yadav et al. (2019) [24], Soman *et al.* (2017) [20].

The maximum soil Particle density at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 2.62g cm^{-3} and minimum soil Particle density was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 2.42 g cm^{-3}. The maximum soil Particle density in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was recorded at 2.61g cm^{-3} and minimum soil Particle density was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] with 2.41 g cm^{-3}. Similar results have also been recorded by Yadav et al. (2019) [24] and Soman *et al.* (2017) [20].

The maximum soil Pore Space (%) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 48.26 (%) and minimum soil Pore Space (%) was recorded in T_1 [@ 0 kg ha^{-1} NPK +@ 0 kg ha^{-1} Sulphur] which was 42.74 (%). The maximum soil Pore Space (%) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was recorded at 46.26 (%) and minimum Pore Space (%) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] with 40.69 (%). Similar results have also been recorded by Yadav et al. (2019) [24] and Soman *et al.* (2017) [20].

The maximum soil WHC (%) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha-1 + S @ 50 kg ha-1] which was 40.79 (%) and minimum soil WHC (%) was recorded in T_1 [N:P:K @ 0:0:0 kg ha-1 + S @ 0 kg ha-1] which was 35.60 (%). The maximum soil WHC (%) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha-1 + S @ 50 kg ha-1] which was recorded at 43.41 (%) and minimum WHC (%) was recorded in T_1 [N:P:K @ 0:0:0 kg ha-1 + S @ 0 kg ha-1] with 37.77 (%).Similar results have also been recorded by Yadav et al. (2019) [24] and Soman *et al.* (2017) [20].

The maximum soil pH (1:2) w/v at 0-15 cm soil depth was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 7.24 and minimum soil pH(1:2) w/v was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 6.76. The maximum soil pH (1:2) w/v in soil at 15-30 cm soil depth was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was recorded at 7.37 and minimum pH (1:2) was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] with 6.84. Similar results have also been recorded by Chauhan *et al.* (2020) [8] and Yadav et al. (2019) [24].

The maximum soil EC (dSm^{-1}) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha-1] which was 0.41 (dSm^{-1}) and minimum soil EC (dSm^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 0.36(dSm^{-1}). The maximum soil EC (dSm^{-1}) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} +

S @ 50 kg ha^{-1}] which was recorded at 0.36 (dSm^{-1}) and minimum EC (dSm^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha-1] with 0.27(dSm^{-1}). Similar results have also been recorded by Chauhan *et al.* (2020) [8] and Yadav et al. (2019) [24].

3.2 Response of different levels of NPK and Sulphur on Chemical properties of Post harvest Soil

The maximum soil Organic carbon (%) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 0.68 (%) and minimum soil Organic carbon (%) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 0.60 (%). The maximum soil EC (dSm^{-1}) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was recorded at 0.61 (%) and minimum Organic carbon (%) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] with 0.53 (%).Similar results have also been recorded by Yadav et al. (2019) [24] and Solanki et al. (2016) [19].

The maximum soil Available Nitrogen (kg ha^{-1}) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 289.15 (kg ha^{-1}) and minimum soil Available Nitrogen (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha-1 + S @ 0 kg ha-1] which was 219.86 (kg ha^{-1}). The maximum soil Available Nitrogen (kg ha^{-1}) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was recorded at 284.49 (kg ha^{-1}) and minimum Available Nitrogen (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] with 215.56 (kg ha^{-1}). Similar findings were also recorded by Ahmadi and David (2016) [3], Kumar *et. al* (2016) [12] and Singh *et. al* (2019) [16].

. The maximum soil Available Phosphorus (kg ha^{-1}) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 28.80 (kg ha^{-1}) and minimum soil Available Phosphorus (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 21.00 (kg ha^{-1}). The maximum soil Available Phosphorus (kg ha^{-1}) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was recorded at 27.18 (kg ha^{-1}) and minimum Available Phosphorus (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] with 19.55 (kg ha^{-1}). Similar results have also been recorded by Kumar *et.al* (2016) [12] and Singh *et. al* (2019) [16].

The maximum soil Available Potassium (kg ha^{-1}) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 150.52 (kg ha^{-1}) and minimum soil Available Potassium (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 141.67 (kg ha^{-1}). The maximum soil Available Potassium (kg ha^{-1}) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was recorded at 144.05 (kg ha^{-1}) and minimum Available Potassium (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0 kg ha^{-1} + S @ 0 kg ha^{-1}] with 134.92 (kg ha^{-1}). This might be due to adequate supply of N and P2O5 through chemical fertilizers by faster growth in term of increase in plant height. Such findings have been also reported by Kumar *et al.* (2016) [12] and Sharma et al. (2020) [22].

The maximum soil Available Sulphur (mg kg^{-1}) at 0-15 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was 18.03 (mg kg^{-1}) and minimum soil Available Sulphur (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] which was 6.53 (mg kg^{-1}). The maximum soil Available Sulphur (mg kg^{-1}) in soil at 15-30 cm soil depth was recorded in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] which was recorded at 16.66 (mg kg^{-1}) and minimum Available Sulphur (kg ha^{-1}) was recorded in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 0 kg ha^{-1}] with 6.16 (mg kg^{-1}). Similarly, Kumar *et. al* (2016) [12] and Solanki *et. al* (2016) [19] reported significant increase in Available Sulphur. Application of NPK and S had positive influence on available S in soil at harvest content over control.

Table 1: Response of different levels of NPK and Sulphur on Physical properties and pH and EC of Post harvest Soil

Treatments combination		Bulk density (Mg m^{-3})		Particle density (Mg m^{-3})		% Pore space		WHC (%)		pH (1:2)		EC (dS m^{-1})	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 Cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 Cm	15-30 cm
T_1	Absolute control	1.37	1.40	2.42	2.41	42.74	40.69	35.60	37.77	7.24	7.37	0.36	0.27
T_2	[N:P:K @ 0 kg ha^{-1} + S @ 25 kg ha^{-1}]	1.33	1.36	2.45	2.44	44.57	42.57	37.47	49.44	7.11	7.24	0.35	0.29
T_3	[N:P:K @ 0 kg ha^{-1} + S @ 50 kg ha^{-1}]	1.26	1.30	2.51	2.50	45.74	43.74	38.46	40.46	6.98	7.11	0.39	0.32
T_4	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 0 kg ha^{-1}]	1.32	1.35	2.44	2.44	43.45	41.45	36.35	38.35	6.89	7.02	0.38	0.33
T_5	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 0 kg ha^{-1}]	1.26	1.29	2.49	2.48	45.11	43.11	37.96	39.96	6.87	7.00	0.40	0.32
T_6	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 25 kg ha^{-1}]	1.22	1.25	2.54	2.54	46.84	44.84	39.73	41.73	6.83	6.96	0.40	0.34
T_7	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 50 kg ha^{-1}]	1.28	1.31	2.49	2.49	43.91	41.91	37.28	39.28	6.85	6.98	0.38	0.34
T_8	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 25 kg ha^{-1}]	1.23	1.27	2.55	2.54	46.23	44.23	39.40	42.40	6.81	6.94	0.42	0.35
T_9	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}]	1.20	1.22	2.62	2.61	48.26	46.26	40.79	43.41	6.76	6.84	0.41	0.36
F- test		NS	NS	NS	NS	S	S	S	S	S	S	S	S
S. Ed. (±)		0.588	0.577	1.608	0.678	1.708	0.660	0.617	0.660	0.617	0.016	0.014	0.312
C. D. (P = 0.05)		1.235	1.225	3.298	1.435	3.607	1.402	1.306	1.406	1.306	0.028	0.028	0.654

Table 2: Response of different levels of NPK and Sulphur on Chemical properties of Post harvest Soil

Treatments combination		Organic Carbon (%)		Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})		Available S (mg ha^{-1})	
		0-15 cm	15-30 cm	0-15 cm	15-30 Cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 Cm
T_1	Absolute control	0.60	0.53	219.86	215.56	21.00	19.55	141.67	134.92	6.53	6.16
T_2	[N:P:K @ 0 kg ha^{-1} + S @ 25 kg ha^{-1}]	0.61	0.54	232.60	228.30	22.93	21.48	144.50	137.76	10.76	10.16
T_3	[N:P:K @ 0 kg ha^{-1} + S @ 50 kg ha^{-1}]	0.63	0.56	239.82	235.48	25.15	23.70	148.35	141.61	11.93	10.76
T_4	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 0 kg ha^{-1}]	0.64	0.56	234.85	230.55	22.04	20.59	142.50	135.75	12.66	11.36
T_5	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 0 kg ha^{-1}]	0.64	0.57	252.56	248.26	23.96	22.51	145.63	138.89	13.03	12.66
T_6	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 25 kg ha^{-1}]	0.66	0.58	264.73	260.43	26.13	24.68	149.40	142.66	14.53	13.16

T_7	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 50 kg ha^{-1}]	0.66	0.58	260.96	256.60	23.90	22.45	143.31	136.57	16.53	14.16
T_8	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 25 kg ha^{-1}]	0.67	0.59	276.66	272.36	27.02	25.57	146.52	140.12	17.73	15.36
T_9	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}]	0.68	0.61	289.15	284.49	28.80	27.18	150.52	144.05	18.03	16.66
F- test		S	S	S	S	S	S	S	S	S	S
S. Ed. (±)		0.31	0.210	0.208	6.416	5.970	1.691	1.539	0.776	0.680	0.848
C. D. (P = 0.05)		0.65	0.550	0.546	13.469	12.537	3.440	3.123	1.761	1.538	2.749

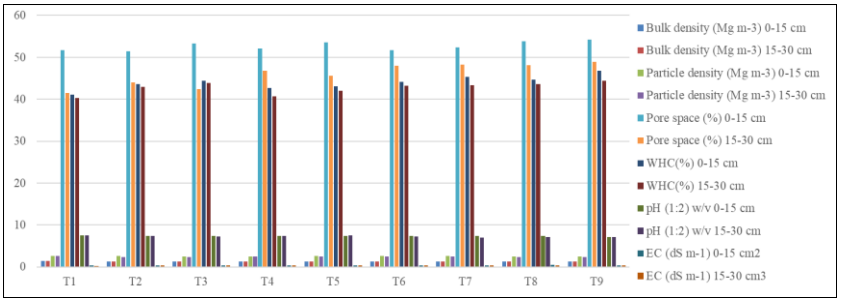

Fig 1: Response of different levels of NPK and Sulphur on Physical properties, pH and EC of Post harvest Soil

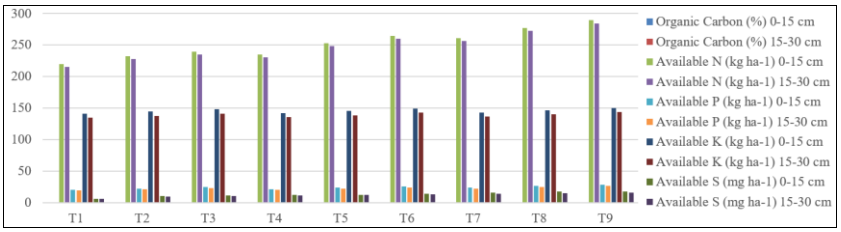

Fig 2: Response of different levels of NPK and Sulphur on Chemical properties of Post harvest Soil

3.4 Growth and Yield Parameters of Mustard

The results showed that application of T_9 [N:P:K @ 120:60:40 kg ha-1 + S @ 50 kg ha-1] attained the maximum plant height was 169.69 cm at 120 DAS was also found to be significant, which followed by T_8 [N:P:K @ 120:60:40 kg ha-1 + S @ 25 kg ha-1], followed by T_7 [N:P:K @ 60:30:20 kg ha^{-1} + S @ 50 kg ha-1] and the minimum plant height 104.44 cm was found in T_1 [N:P:K @ 0:0:0 kg ha-1 + S @ 0 kg ha-1]. The application of NPK and Sulphur recorded statistically at par values of plant height at various stages of observation. Similar results have also been recorded by Sharma et al. (2020) [22], Lakhan *et al*. (2020) [13], Singh *et al*., (2019) [16] and Soman *et al*., (2017) [20]. Also, Yadav *et al*. (2013) [25] reported that the integrated nutrient management gave significant impact on all growth parameters including plant height. The increase in fresh and dry weight of plant was closely associated with plant height.

The maximum number of leaves per plant at 90 DAS was also found to be significantly in T_9 [N:P:K @ 120:60:40 kg ha-1 + S @ 50 kg ha-1] which was 18.27 followed by T_8 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 25 kg ha-1], followed by T_7 [N:P:K @ 60:30:20 kg ha^{-1} + S @ 50 kg ha^{-1}] and the minimum number of leaves per plant 11.33 was found in T_1 [N:P:K @ 0:0:0 kg ha-1 + S @ 0 kg ha-1]. Similar results have also been recorded by Sharma et al. (2020) [22], Lakhan *et al*. (2020) [13] and Tripathi *et al*., (2011) [22].

The maximum number of siliqua plant^{-1} 198.60 plant^{-1} of mustard was found in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}], followed by T_8 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 25 kg ha^{-1}], followed by T_7 [N:P:K @ 60:30:20 kg ha^{-1} + S @ 50 kg ha^{-1}] and the minimum Number of Siliqua plant^{-1} (97.00 plant^{-1}) was found in T_1 [N:P:K @ 0:0:0 kg ha^{-1} + S @ 25 kg ha^{-1}]. These findings are substantiated with the results reported by Ajnar and Namdeo (2021) [1], Lakhan *et al*. (2020) [13] and Sharma et al. (2020) [22].

The maximum yield 22.00 q ha^{-1} of mustard was found in T_9 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] followed by T_8 [N:P:K @ 120:60:40 kg ha^{-1} + S @ 25 kg ha^{-1}], followed by T_7 [N:P:K @ 60:30:20 kg ha-1 + S @ 50 kg ha-1] and the minimum Yield (q ha^{-1}) (11.60 q ha^{-1}) was found in T_1 [N:P:K @ 0 kg ha-1 + S @ 25 kg ha-1]. Similar findings were reported by Ajnar and Namdeo (2021) [1], Lakhan *et al*. (2020) [13] and Sharma et al. (2020) [22].

Table 3: Response of different levels of NPK and Sulphur on Growth and Yield attributes of Mustard

	Treatment combination	Plant height (cm)	Number of leaves plant^{-1}	No. of Siliqua plant^{-1}	Yield (qha^{-1})
T_1	Absolute control	104.44	13.63	97.00	8.20
T_2	[N:P:K @ 0 kg ha^{-1} + S @ 25 kg ha^{-1}]	117.44	14.26	110.60	11.18
T_3	[N:P:K @ 0 kg ha^{-1} + S @ 50 kg ha^{-1}]	119.00	15.21	131.00	12.60
T_4	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 0 kg ha^{-1}]	139.44	15.77	144.00	12.84
T_5	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 0 kg ha^{-1}]	151.33	15.90	154.50	14.20
T_6	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 25 kg ha^{-1}]	156.80	16.21	163.40	15.40
T_7	[N:P:K @ 60:30:20 kg ha^{-1} + S @ 50 kg ha^{-1}]	162.25	16.88	175.60	16.40
T_8	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 25 kg ha^{-1}]	166.23	17.21	187.15	17.50
T_9	[N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}]	169.69	18.27	198.60	18.20
	C.D. at 5%	14.929	2.199	59.007	3.45
	S.Em. (±)	7.109	3.028	28.362	1.64
	F-Test	S	S	S	S

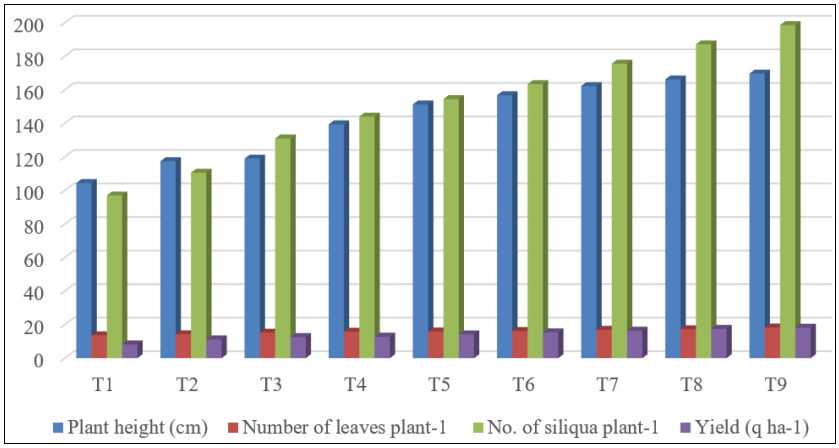

Fig 3: Response of different levels of NPK and Sulphur on Growth and Yield attributes of Mustard

4. Conclusion

It is concluded from trail that treatment T_9 - [N:P:K @ 120:60:40 kg ha^{-1} + S @ 50 kg ha^{-1}] was best in all soil health parameters. T_9 also provide significantly highest growth as well as yield attributes and positive effect on net return up to Rs. 34551.76 ha^{-1} with C: B ratio of 1:1.90 of Mustard therefore, it is suggested that T_9 found most suitable for sustainable soil health parameters, Mustard to obtain higher yield and economic of the farmers, the trail was based on one season, so that the findings can be substantiate before recommendation.

5. References

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