Influence of Phosphorus and Sulphur application on Sesame yield in High P soils of Telangana, India

Abstract: The present study in pot experiments was conducted on "Influence of phosphorus and sulphur application on sesame yield in high P soils of Telangana, India". The experiment was conducted in two different levels of high phosphorus status soils with 67.29 kg P_2O_5 ha^{-1} in soil 1 (S_1) and 83.46 kg P_2O_5 ha^{-1} in soil 2 (S_2). The treatments were taken in factorial completely randomized design in combination of five levels of phosphorus (P_0-0, P_{25}- 5,P_{50}-10,P_{75}-15 and P_{100}-20 kg ha^{-1} of soil) four levels of sulphur (S_0-0,S_1-10,S_2-20 and S_3-30 kg ha^{-1} of soil). A significant increase in seed and stalk yield of sesame crop could be achieved by combined application of P_{75} (15 kg P_2O_5 ha^{-1}) + S_{20} (20 kg S ha^{-1}) in both high available phosphorus soils. Among the various treatments tested, maximum seed and stalk yield was obtained with combined application of P_{75} (15 kg P_2O_5 ha^{-1}) + S_{20} (20 kg S ha^{-1}) which was 11.89 g pot^{-1} higher over control in S_1 and P_{75} (15 kg P_2O_5 ha^{-1}) + S_{20} (20 kg S ha^{-1}) which was 11.92 g pot^{-1} higher over control in S_2.

Key words: Sesame, high P soil, phosphorus and sulphur

1. INTRODUCTION

"Sesame (*Sesame indicum* L.) belongs to family *Pedaliace* and it is fourth important edible oilseed crop next to the groundnut, rapeseed and mustard in India. About 78 per cent of the sesame produced in the country is used for oil extraction" [1]. "Sesame oil has 16-18% of carbohydrates and 42% essential linoleic acid. Its oil content generally varies from 46 to 52%, which is highly resistant to oxidative rancidity. As the protein content is around 25%, it is called as "Queen of oilseeds". Oilseeds are important constituent in human dietary system next to carbohydrates and proteins" [2]. "oil is characterized for its stability and quality. Because of its excellent quality characters, sesame oil is some also referred to as "poor man's substitute for ghee". Sesame cake is eaten mixed with sugar by poor people and added to bread to improve palatability and nutritive value. It is also a valuable nutritious feed for milch animals and is ingredient of poultry feed as it contains 6.0-6.2% N, 2.0-2.2% P and 1.0-1.2% K. India ranks second in area, third in production but ranks seventh in productivity in world" [3]. "In India, sesame is cultivated in 17.22 lakh ha of area with production 6.57 lakh tones and productivity 474 kg ha^{-1} during 2020-2021" [4]. In Telangana the area under sesame was 0.23 L ha^{-1} with production of 25,469 tonnes per acre and productivity 310 kg/acre during 2021-2022 [5]. The major sesame growing districts of Telangana are Jagtial, Karimnagar, Nirmal, Nizamabad, Khammam Kamma Reddy, Pedda palli and Adilabad.

In intensively cultivated areas due to indiscriminate application of phosphorus was leading to phosphorus accumulation in top layers of soil. In some studies it was revealed that at high phosphorus status soils the recommended dose of phosphorus can be reduced without reduction in the economic yield of crop. The P dose could be skipped in either of any crop or reduced to 50% under rice-wheat sequence if soil contains high available phosphorus [6]. Reduced P application by 25-50% from the current RDP in high P soils is reported to be a possible saving measure without sacrificing the yields in crops like rice, sunflower and in rice-rice and rice-sunflower-cropping sequences [7-10].

Sulphur plays a key role in the plant metabolism, indispensable for the synthesis of essential oils, chlorophyll formation, required for development of cells and it also increases cold resistance and drought hardiness of crops especially for oilseed crops. Use of high analysis sulphur free fertilizers, heavy sulphur removal by the crops under intensive cultivation and neglect of sulphur replenishment contributed to widespread sulphur deficiencies in arable soils. Sulphur has become one of the major limiting nutrients for oilseeds in recent years due to its widespread deficiency. In many crop sequences involving oilseeds, sulphur application was also reported to be quite profitable.

Synergistic effect of application of P and S at lower levels and antagonistic effect at higher rates of P and S application to cowpea crop [11]. The recent study conducted by Surendra Babu et al. [12] indicated that application of S in small doses is useful to increase the yields of rice in high P soils even when the soil is having sufficient available S. The nutrient requirement and interaction of different nutrients under high phosphorus conditions were not worked out so far in sesame track. To improve the productivity levels of sesame it is imperative to assess the phosphorus and sulphur requirement under high P fertility soils to obtain the potential yield by the farmers.

2. MATERIALS AND METHODS

2.1 Study Area

Initially soils were screened for available phosphorus in and around Ranga Reddy district. Based on available phosphorus two soils were selected for conducting pot culture experiment with available phosphorus status S_1 (67.29 kg P_2O_5 ha^{-1}) and S_2 (83.46 kg P_2O_5 ha^{-1}) status. In the selected soils (S_1 and S_2) pot culture experiment was conducted in sesame crop (JCS 1020) during summer 2022-23 at Agricultural Research Institute, Rajendranagar and Hyderabad.

2.2 Analytical Procedures

Initially experimental soil samples were analyzed for textural analysis by Bouyoucos hydrometer method [13] before conducting the experiment. The pH of the soil in 1: 2.5 soil water suspensions and electrical conductivity of the soil in 1:2.5 soil water extract Jackson [14] and organic carbon rapid titration method [15] was done. Available nitrogen in the soil was determined by alkaline permanganate method [16], available phosphorus by Olsen's method [17], available potassium by neutral normal ammonium acetate method [18] and available sulphur was determined by turbidity method [19]. Both the experimental soils were sandy clay loam in texture, slightly alkaline with normal in reaction and low in organic carbon. The soils were low in available nitrogen, high in available potassium and medium in available sulphur.

2.3 Net House Study

Twenty phosphorus and sulphur treatment combinations were adopted in both the soils with four levels of replication. The different treatment combinations comprises of five levels of phosphorus (P_0-0, P_{25}- 5, P_{50}-10, P_{75}-15 and P_{100}-20 kg P_2O_5 ha^{-1} of soil) and four levels of sulphur (S_0-0, S_{10}-10, S_{20}-20 and S_{30}-30 kg S ha^{-1} of soil) were presented in table 1 & 2 and it was laid out in Factorial Completely Randomized Design. The recommended dose of fertilizer of sesame included 60-20-20 kg N, P_2O_5 & K_2O ha^{-1} and the recommended dose of nitrogen (60 kg ha^{-1}), potassium (20 kg ha^{-1}) were applied uniformly to all the treatments through urea and potassium chloride while phosphorus and sulphur were applied through diammonium hydrogen phosphate and potassium sulphate. Nitrogen was applied 50% basally while remaining was applied thirty days after application. Phosphorus, potassium and sulphur were applied as basally.

All the prophylactic plant protection measures were adopted as and when needed during the crop growth period.

Table 1: Treatment combinations in experimental soil 1 (67.29 kg P_2O_5 ha^{-1})

Treatment	N(Kg ha^{-1})	P_2O_5(Kg ha^{-1})	K_2O(Kg ha^{-1})	S(Kg ha^{-1})
$S_1P_0Su_0$	60	0	20	0
$S_1P_0Su_{10}$	60	0	20	10
$S_1P_0Su_{20}$	60	0	20	20
$S_1P_0Su_{30}$	60	0	20	30
$S_1P_{25}Su_0$	60	5	20	0
$S_1P_{25}Su_{10}$	60	5	20	10
$S_1P_{25}Su_{20}$	60	5	20	20
$S_1P_{25}Su_{30}$	60	5	20	30
$S_1P_{50}Su_0$	60	10	20	0
$S_1P_{50}Su_{10}$	60	10	20	10
$S_1P_{50}Su_{20}$	60	10	20	20
$S_1P_{50}Su_{30}$	60	10	20	30
$S_1P_{75}Su_0$	60	15	20	0
$S_1P_{75}Su_{10}$	60	15	20	10
$S_1P_{75}Su_{20}$	60	15	20	20
$S_1P_{75}Su_{30}$	60	15	20	30
$S_1P_{100}Su_0$	60	20	20	0
$S_1P_{100}Su_{10}$	60	20	20	10
$S_1P_{100}Su_{20}$	60	20	20	20
$S_1P_{100}Su_{30}$	60	20	20	30

Table 2: Treatment combinations in experimental soil 2 (83.46 kg P_2O_5 ha^{-1})

Treatment	N(Kg ha^{-1})	P_2O_5(Kg ha^{-1})	K_2O(Kg ha^{-1})	S(Kg ha^{-1})
$S_2P_0Su_0$	60	0	20	0
$S_2P_0Su_{10}$	60	0	20	10
$S_2P_0Su_{20}$	60	0	20	20
$S_2P_0Su_{30}$	60	0	20	30
$S_2P_{25}Su_0$	60	5	20	0
$S_2P_{25}Su_{10}$	60	5	20	10
$S_2P_{25}Su_{20}$	60	5	20	20
$S_2P_{25}Su_{30}$	60	5	20	30
$S_2P_{50}Su_0$	60	10	20	0
$S_2P_{50}Su_{10}$	60	10	20	10
$S_2P_{50}Su_{20}$	60	10	20	20
$S_2P_{50}Su_{30}$	60	10	20	30
$S_2P_{75}Su_0$	60	15	20	0
$S_2P_{75}Su_{10}$	60	15	20	10

$S_2P_{75}Su_{20}$	60	15	20	20
$S_2P_{75}Su_{30}$	60	15	20	30
$S_2P_{100}Su_0$	60	20	20	0
$S_2P_{100}Su_{10}$	60	20	20	10
$S_2P_{100}Su_{20}$	60	20	20	20
$S_2P_{100}Su_{30}$	60	20	20	30

3. RESULTS AND DISCUSSION

Effect of different doses of P and S levels on seed and stalk yield of sesame was presented in table 3 and 4. Application of different levels of phosphorus fertilizer to sesame crop in high P soils significantly influenced the sesame seed yield. It was found that increasing the phosphorus application from P_0 to P_{75} (15 kg P_2O_5 ha^{-1}) enhanced the sesame seed yield by 13.82% significantly from 10.01 to 11.39 g pot^{-1}. Subsequent enhancement of phosphorus application from P_{75} (15 kg P_2O_5 ha^{-1}) to P_{100} (20 kg P_2O_5 ha^{-1}) to sesame crop recorded statistically on par seed yield of sesame seed in these high P soils. Application of increased dose of sulphur from 0 to 30 kg ha^{-1} enhanced the sesame seed yield by 10.07% significantly from 10.23 to 11.26 g pot^{-1}. Subsequent enhancement of S application from S_{20} to S_{30} kg ha^{-1} to sesame crop did not affect the yield of sesame seed and they were statistically on par (11.26 and 11.35 g pot^{-1}) in these high P soils. The interaction effect of P X S on sesame seed yield was found to be significant. Maximum seed yield of 12.02 g pot^{-1} was recorded due to combination of P_{100} (20 kg P_2O_5 ha^{-1}) + S_{30} (30 kg S ha^{-1}) treatment. Similar on par yields are also observed when $P_{100}S_{20}$ and P_{75} with either S_{30} or S_{20}. Sesame seed yield was not significantly affected by two high P soils. The interaction effect of high P soils and doses of phosphorus application was found to be non-significant on seed yield of sesame. The interaction effect of high P soils and sulphur doses applied to crop on sesame seed yield was found to be statistically significant. The interaction effect of P, S and two high P soils on sesame seed yield was found to be statistically significant. However, in S_1 (67.29 kg P_2O_5 ha^{-1}) significant increase in seed yield was recorded with P_{75} while in S_2 (83.46 kg P_2O_5 ha^{-1}) it was recorded with P_{50} compared to control. These differences in seed yield were found to be statistically significant.

Stalk yield of sesame is significantly influenced by application of different levels of phosphorus fertilizer to sesame crop in high P soils. The overall yield of sesame stalk at different levels of phosphorus application was in range of 19.07 to 21.62 g pot^{-1} with mean of 20.78 g pot-

^{1}. It was found that increasing the phosphorus application from P_0 to P_{75} (15 kg P_2O_5 ha^{-1}) enhanced the stalk yield significantly from 19.07 to 21.51 g pot^{-1}. Subsequent enhancement of phosphorus application from P_{75} (15 kg P_2O_5 ha^{-1}) to P_{100} (20 kg P_2O_5 ha^{-1}) to sesame crop did not affect the stalk yield of sesame significantly in these high P soils. Application of increased dose of sulphur from S_0 to S_{20} kg ha^{-1} enhanced the sesame stalk yield by 8.19% significantly from 19.63 to 21.24 g pot^{-1}. Subsequent enhancement of sulphur application from S_{20} to S_{30} kg ha^{-1} to sesame crop did not affect the yield of sesame stalk and they were statistically on par (21.24 and 21.48 g pot^{-1}) in these high P soils. There was non-significant result in the interaction effect of P X S on sesame stalk yield. Two high P soils had no significant effect on stalk yield of sesame. The interaction effect of phosphorus doses and high P soils was found to be statistically non-significant on stalk yield of sesame. The interaction effect of high P soils and sulphur doses applied to crop on sesame stalk yield was found to be statistically significant. The interaction effect of P, S and different high P soils on stalk yield of sesame was found to be statistically significant. However, in S_1 (67.29 kg P_2O_5 ha^{-1}) significant increase in stalk yield was recorded with P_{75} while in S_2 (83.46 kg P_2O_5 ha^{-1}) it was recorded with P_{50} compared to control. These differences in seed yield were found to be statistically significant.

Application of different doses of phosphorus to these high P soils resulted response to sesame seed yield (Table. 3). Application of P_{75} increased the sesame seed yield significantly by 13.82% over control. Further increase in dose of phosphorus from P_{75} to P_{100} to sesame crop did not influence the yield of sesame seed significantly in these high P soils. Application of phosphorus fertilizer based on conventional soil test based P recommendation (25% reduction of RDP and 50 % reduction of RDP) to high P soils recorded on par yields with P_{100} in S_1 (67.29 kg P_2O_5 ha^{-1}) and S_2 (83.46 kg P_2O_5 ha^{-1}) (Table.3). It is noticed that the enhancement in seed yield of sesame was only 0.74% due to application of P_{100} (20 kg P_2O_5 ha^{-1}) over P_{75} (15 kg P_2O_5 ha^{-1}) in S_1 (67.29 kg P_2O_5 ha^{-1}) and the enhancement in seed yield of sesame was only 1.57% due to application of P_{100} (20 kg P_2O_5 ha^{-1}) over P_{50} (10 kg P_2O_5 ha^{-1}) in S_2 (83.46 kg P_2O_5 ha^{-1}) to this high P soils. Based on the above results we can conclude that enhanced biomass accumulation and its efficient translocation from source to sink might have boosted growth parameters and yield contributing characters which in turn paved way to seed yield increase at elevated fertilizer levels Harshitha et al. [20]. A similar result was also in conformity with the results of [21-23]. "Reduced P application by 25-50% from the current RDP in high P soils is reported to be a possible P saving measure without scarifying the yields in crops for e.g., in rice, sunflower, rice-rice, rice-sunflower" [7-10]. Thus, the present results clearly establish once again that the phosphorus application can be saved in high P soils including the phosphorus-loving crop like sesame. These observations clearly indicate that it is possible to reduce current RDP by 25% to 50% in high P soils without scarifying the yield.

Application of S_{20} (20 kg S ha^{-1}) increased the seed yield of sesame by 10.08% over control. Further increase in dose of sulphur from S_{20} to S_{30} to sesame crop didn't influenced the seed yield of sesame in these high P soils. It might be due the bioactivity of sulphur played important role in improving yield attributes like capsule per plant, length of capsule and there by seed yield per plant ultimately increase in seed yield Parmar et al. [24]. Padasalagi et al. [25] stated that application of sulphur might helped in floral primordial initiation that resulted in higher number of capsules per plant helped in improved seed setting. Yadav et al. [26] reported that the significant increase in capsules per plant and test weight after applying sulphur might be attributed to an overall increase in crop vigour and growth as a result of the previously described balanced nutritional environment. A sufficient supply of sulphur also helps in the growth of floral precursors, or reproductive portions, which leads to the formation of capsules and seeds in plants.

"The combination of $P_{75}S_{20}$ to sesame crop results in highest seed yield in high P soils. The significant increase in seed yield per plant with increase in levels of phosphorus and sulphur and their interaction effect may be because of higher nutrient availability and their uptake with each increment level of phosphorus and sulphur, which results in favorable condition for more seeds formation" [27, 28]. Mishra et al. [29] stated that "the probable reason may be that the increasing P and S levels resulted in greater accumulation of carbohydrate, protein and their translocation to the productive organs, which in turn, improved all growth and yield attributing characters, resulting in more seed yield". Two high P soils having different native available phosphorus status did not show any significant effect on the seed yield of sesame (Table. 3).

Stalk yield of sesame also significantly influenced by application of different doses of phosphorus in high P soils (Table. 4). Application of P_{75} increased the sesame stalk yield significantly by 12.75% over control. Further increase in dose of phosphorus from P_{75} to P_{100} to sesame crop did not influence the stalk yield of sesame crop significantly in these high P soils.

The increment in stalk yield due to P_{100} was only 0.51% with that of P_{75}. Application of phosphorus fertilizer based on conventional soil test based P recommendation (25% reduction of RDP and 50 % reduction of RDP) to high P soils recorded on par stalk yields with P_{100} in S_1 (67.29 kg P_2O_5 ha^{-1}) and S_2 (83.46 kg P_2O_5 ha^{-1}) (Table. 4). It is noticed that the enhancement in stalk yield of sesame was only 0.53% due to application of P_{100} (20 kg P_2O_5 ha^{-1}) over P_{75} (15 kg P_2O_5 ha^{-1}) in S_1 (67.29 kg P_2O_5 ha^{-1}) and the enhancement in stalk yield of sesame was only 1.80% due to application of P_{100} (20 kg P_2O_5 ha^{-1}) over P_{50} (10 kg P_2O_5 ha^{-1}) in S_2 (83.46 kg P_2O_5 ha^{-1}) to this high P soils. These observations clearly indicate that it is possible to reduce current RDP by 25 to 50% in high P soils. Madhavi et al. [8] and Dhage et al. [30] claim that the application of RDP to a variety of crops with low to medium intrinsic phosphorus status has led to a 15–20% increase in production. Additionally, it was shown that the stalk yields obtained with 100% RDP were on par with those obtained with 75% RDP in high P.

Application of different doses of sulphur fertilizer influenced the stalk yield of sesame crop significantly. It is noticed that the application of S_{20} (20 kg S ha^{-1}) recorded higher stalk yield by 8.19% over control. Further increased dose of sulphur from S_{20} to S_{30} didn't showed any significant effect on stalk yield of sesame in these high P soils. As for the impact of sulphur fertilization on sesame stalk yield, our results are also in accordance with Kalyani et al. [31] stated that "increased stalk yield with increasing levels of sulphur application might be due to higher plant growth and biomass production, possibly as a result of higher uptake of nutrients". The above findings clearly indicate that sulphur might have played a crucial role in enhancing the stalk yield by its role in physiologically improved dry matter accumulation further led to hiking the stalk yield [32]. The interaction effect of P X S on sesame stalk yield was found to be non-significant. Two high P soils having different native available phosphorus status did not show any significant effect on the stalk yield of sesame (Table. 4).

4. CONCLUSION

Combination of $P_{75}S_{20}$ is sufficient to obtain higher yield in S_1 (67.29 kg P_2O_5 ha^{-1}). While combined application of $P_{50}S_{20}$ is sufficient to obtain higher yield in S_2 (83.46 kg P_2O_5 ha^{-1}). The extent of saving of recommended dose of phosphorus fertilizer is 75-100% and 50-100% in soil 1 (67.29 kg P_2O_5 ha^{-1}) and soil 2 (83.46 kg P_2O_5 ha^{-1}) respectively.

Table 3. Effect of different levels of P and S on seed yield (g pot^{-1}) of sesame crop in high P soils

3 Factor Tables

	Soil 1(67.29 kg P_2O_5 ha^{-1})					Soil 2(83.46 kg P_2O_5 ha^{-1})					
P levels	S_0 (Control)	S_{10} (10 kg S ha^{-1})	S_{20} (20 kg S ha^{-1})	S_{30} (30 kg S ha^{-1})	Mean	S_0 (Control)	S_{10} (10 kg S ha^{-1})	S_{20} (20 kg S ha^{-1})	S_{30} (30 kg S ha^{-1})	Mean	Grand Mean
P_0 (Control)	9.37	9.95	10.21	10.27	9.95	9.50	10.12	10.26	10.37	10.06	10.01
P_{25} (5 kg P_2O_5 ha^{-1})	10.15	10.57	10.70	10.80	10.55	10.01	10.75	10.82	10.95	10.63	10.59
P_{50} (10 kg P_2O_5 ha^{-1})	10.55	10.81	10.93	11.16	10.86	10.38	10.94	11.92	11.98	11.31	11.08
P_{75} (15 kg P_2O_5 ha^{-1})	10.62	10.95	11.89	11.94	11.35	10.59	11.14	11.96	12.00	11.42	11.39
P_{100} (20 kg P_2O_5 ha^{-1})	10.64	11.13	11.96	12.00	11.43	10.62	11.30	11.99	12.05	11.49	11.46
Mean	10.26	10.68	11.14	11.23	10.83	10.22	10.85	11.39	11.47	10.98	10.91

2 Factor Tables

	S_0	S_{10}	S_{20}	S_{30}	Mean
P_0	9.44	10.03	10.24	10.32	10.01
P_{25}	10.08	10.66	10.76	10.87	10.59
P_{50}	10.47	10.87	11.42	11.57	11.08
P_{75}	10.61	11.05	11.93	11.97	11.39
P_{100}	10.62	11.22	11.98	12.02	11.46
Mean	10.24	10.77	11.26	11.35	10.91
	P	**S**	**P X S**		
SEm(±)	0.107	0.095	0.156		
CD (P=0.05)	0.24	0.21	0.35		

	Soil 1	Soil 2	Mean
P_0	9.95	10.06	10.01
P_{25}	10.55	10.63	10.59
P_{50}	10.86	11.31	11.08
P_{75}	11.35	11.42	11.39
P_{100}	11.43	11.49	11.46
Mean	10.83	10.98	10.91
	P	**Soil**	**P X Soil**
SEm(±)	0.107	-	-
CD (P=0.05)	0.24	NS	NS

	Soil 1	Soil 2	Mean
S_0	10.26	10.22	10.24
S_{10}	10.68	10.85	10.77
S_{20}	11.14	11.39	11.26
S_{30}	11.23	11.47	11.35
Mean	10.83	10.98	10.91
	S	**Soil**	**S X Soil**
SEm(±)	0.095	-	0.090
CD (P=0.05)	0.21	NS	0.20
Soil X P X S:SEd(±): 0.214			**CD (P=0.05):** 0.48

Table 4. Effect of different levels of P and S on stalk yield (g pot^{-1}) of sesame crop in high P soils

3 Factor Tables

	Soil 1(67.29 kg P_2O_5 ha^{-1})					Soil 2(83.46 kg P_2O_5 ha^{-1})					
P levels	S_0 (Control)	S_{10} (10 kg S ha^{-1})	S_{20} (20 kg S ha^{-1})	S_{30} (30 kg S ha^{-1})	Mean	S_0 (Control)	S_{10} (10 kg S ha^{-1})	S_{20} (20 kg S ha^{-1})	S_{30} (30 kg S ha^{-1})	Mean	Grand Mean
P_0 (Control)	16.99	19.01	19.19	20.41	18.90	17.26	19.37	19.91	20.45	19.25	19.07
P_{25} (5 kg P_2O_5 ha^{-1})	19.89	20.13	20.77	20.82	20.40	20.00	20.61	21.10	21.52	20.81	20.60
P_{50} (10 kg P_2O_5 ha^{-1})	19.94	20.63	21.41	21.51	20.87	20.31	21.04	21.89	21.91	21.29	21.08
P_{75} (15 kg P_2O_5 ha^{-1})	20.28	21.54	21.98	22.02	21.45	20.50	21.62	22.04	22.09	21.56	21.51
P_{100} (20 kg P_2O_5 ha^{-1})	20.45	21.77	22.01	22.04	21.57	20.68	21.82	22.08	22.11	21.67	21.62
Mean	19.51	20.62	21.07	21.36	20.64	19.75	20.89	21.40	21.61	20.91	20.78

2 Factor Tables

	S_0	S_{10}	S_{20}	S_{30}	Mean
P_0	17.13	19.19	19.55	20.43	19.07
P_{25}	19.94	20.37	20.94	21.17	20.60
P_{50}	20.12	20.84	21.65	21.71	21.08
P_{75}	20.39	21.58	22.01	22.05	21.51
P_{100}	20.57	21.79	22.04	22.07	21.62
Mean	19.63	20.75	21.24	21.49	20.78
	P	**S**	**P X S**		
SEm(±)	0.134	0.112	-		
CD (P=0.05)	0.30	0.25	NS		

	Soil 1	Soil 2	Mean
P_0	18.90	19.25	19.07
P_{25}	20.40	20.81	20.60
P_{50}	20.87	21.29	21.08
P_{75}	21.45	21.56	21.51
P_{100}	21.57	21.67	21.62
Mean	20.64	20.91	20.78
	P	**Soil**	**P X Soil**
SEm(±)	0.134	-	-
CD (P=0.05)	0.30	NS	NS

	Soil 1	Soil 2	Mean
S_0	19.51	19.75	19.63
S_{10}	20.62	20.89	20.75
S_{20}	21.07	21.40	21.24
S_{30}	21.36	21.61	21.49
Mean	20.64	20.91	20.78
	S	**Soil**	**S X Soil**
SEm(±)	0.112	-	0.089
CD (P=0.05)	0.25	NS	0.20
Soil X P X S:SEm(±): 0.143			**CD (P=0.05):** 0.32

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