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EFFECT OF NUTRIENT MANAGEMENT PRACTICES ON SULPHUR DYNAMICS UNDER CHICKPEA GROWN IN FARMERS FIELD OF INDAPUR TALUKA

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ABSTRACT

The present investigation entitled "Effect of nutrient management practices on sulphur dynamics under chickpea grown in farmers field of Indapur taluka" was carried out during *rabi* season of 2020-2021.The chickpea growing farmers field of various locations *viz*., Awasari, Vadapuri, Bedshinge, Survad and Bhandgaon of Indapur tahsil of Pune district were selected for recording various observations. The application of different nutrient management practices followed from last 4-6 years with irrigations and on residual moisture, with objective to assess the effect of different nutrient management practices on sulphur fractions and uptake nutrients by chickpea and relationship between soil properties with yield of chickpea.The total 40 surface (0-15cm) and sub-surface (15-30cm) soil samples were collected from five locations after harvest of chickpea from Indapur tahsil. The sulphur fractions and the total sulphur was observed from 303 to 437 mg kg^{-1} in soil. The organic sulphur ranged from 284.50 to 413.41 mg kg^{-1} in soil. Whereas, sulphate sulphur, water soluble sulphur, heat soluble sulphur and adsorbed sulphur ranged from 9.03 to 26.19, 10.80 to 27.18 and 9.00 to 23.53 and 7.90 to 13.67 mg kg^{-1}, respectively. The different forms of sulphur decreased with the increasing soil depth.

(Key words: Chickpea, Sulphur fraction, soil properties, organic carbon)

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important pulse crop of *rabi* season cultivated mainly in semi-arid and warm temperate regions of the world. It contains 18 to 24% protein which is almost three times more than that of cereals. Chickpea is the high protein yielding grain legume besides groundnut and soybean.Grain legumes are important crop plants for their protein rich seeds that used as a major source of dietary protein for human and livestock consumption. In addition, legumes can be efficiently used for improving soil fertility(Deotale *et al*.,2019). The crop has thecapacity to fix 140 kg N ha^{-1} in a growing season. Sulphur is also known to promote nodulation in legumes thereby promoting nitrogen fixation.

Legume crops are more Susceptible for sulphur deficiency. Sulphur has a number of oxidizing functions in soil and plant nutrition. Moreover, also associated with production of crops and of superior nutritional and market quality (Punse *et al*.,2018).Sulphur is an important secondary plant nutrients reflected the nutrients availability and soil fertility under the effect of different fertilizers management. Hence, it is essential to study the sulphur fractions under different management practices to chickpea grown in Vertisol.In soils, sulphur can be broadly grouped in to five forms *viz*., total S, organic S, available S, water soluble S and inorganic non-sulphate sulphur. Knowledge of different forms of sulphur and factors affecting their distribution throughout the root zone penetration, it is essential in improving the sulphur nutrition of the crops growing with diversified root system.

MATERIALS AND METHODS

The present investigation was undertaken to study the effect of nutrient management practices on sulphur dynamics under chickpea grown in farmers field of Indapur taluka. Total 40 soil samples were collected from farmers field on the basis of different nutrient management practices such as chemical fertilizers + residual moisture, INM + residual moisture,chemical fertilizers + irrigations, INM + irrigations. The soil samples were further used for studying sulphur fraction after harvest of chickpea.The 20 farmers will be selected on the basis of common soil type (Vertisol), variety, nutrient.management practices and irrigations scheduling to chickpea in Indapur taluka.

The samples were processed and analyzed in the laboratories of Soil Science and Agricultural Chemistry section, College of Agriculture, Nagpur during 2020-2021.The soil samples were analyzed for different forms of S

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- total S (Chapman and Pratt, 1961), organic S (Evans and Rost, 1945), sulphate S (Williams and Steinbergs, 1959)· water soluble S (Williams and Steinberg, 1959). Heat soluble S (Williams and Steinberg, 1959)·Adsorbed S was determined by substraction of extractable S.Sulphur in all extracts was determined turbidimetrically (Chesnin and Yien, 1951).

RESULTS AND DISCUSSION

Status of different forms of sulphur

Total sulphur mg kg^{-1}

From the data presented in Table 1-4, the total S content, indicates the reserve pool of this element in soil and its status in soils of Indapur tahsil was found in the range of 309-409 ,303 -416, 314-437 and 317-433 mg kg^{-1} with a mean value of 335, 359.80, 361.8,388.2 mg kg^{-1} under the application of chemical fertilizers + residual moisture, integrated nutrient management + residual moisture, chemical fertilizers + irrigations and integrated nutrient management + irrigations, respectively. Maximum around of total S (437 mg kg^{-1}) was obtained in surface soil collected under chemical fertilizers and irrigations and in sub-surface soil it recorded 428 mg kg^{-1}. Minimum value of total S at surface soil was 311 mg kg^{-1} and in sub–surface soil it was 309 mg kg^{-1} in soil collected under chemical fertilizers + residual moisture on farmers' fields. The results showed that total sulphur in soil was decreased with depth.

Basumatary and Das (2012) also reported that total S content indicates the reserve pool of this element in soil, it ranged from 229.45 to 625.50 mg kg^{-1} with mean value of 545.69 mg kg^{-1}. The soils of Soniput district had highest content of total S (463.39 mg kg^{-1}) might be attributed to the higher amount of organic carbon. Ghodke *et al*. (2016) reported that total S ranged from 139-717 mg kg^{-1} with the mean value of 518 mg kg^{-1} in soil of Pune district.

Organic sulphur (mg kg^{-1})

This fraction of sulphur in the present study accounted for about 91.73 to 94.64 per cent of total S on an average farming of major fractions of total sulphur. Organic S status of soils collected from chickpea growing soils of Indapur tahsil depicted in Table 1-4. The organic sulphur varied from 291.74-387.78, 284.50-391.56, 276.15-413.41 and 296.69-408.68 mg kg^{-1} with a mean value of 318.65, 339.27,344.78 and 368.39 mg kg^{-1} under the application of chemical fertilizers + residual moisture, integrated nutrient management + residual moisture, chemical fertilizers + irrigations and integrated nutrient management + irrigations, respectively. Maximum value of organic S 413.41 mg kg^{-1} in surface soil was observed in soil collected from the farmers field under chemical fertilizers + irrigations, whereas minimum value of 293.28 mg kg^{-1} was noted in integrated nutrient management + residual moisture condition. Patel and Patel (2011)found that the organic sulphur content in surface soil varied between 11.05 to 266.90 (mean 44.79 mg kg^{-1}) ,while in sub-surface soil, it ranged from 11.90 to 202.30 (mean 36.71 mg kg^{-1}).

Sulphate (Available S) mg kg^{-1}

This form of S (0.15% $CaCl_2$ extractable SO_4-S) is used as an index of S availability in many soils for plant growth and subsequently reductions in yield. The data with respect to available S in soil after harvest of chickpea crop are presented in Table 1-4. This form of S contributed about 5.36-8.27 per cent total sulphur. The available sulphur varied from 9.03-21.22, 18.07- 24.44, 9.38-23.59 and 16.21 - 26.19 with a mean value of 16.84, 20.42, 17.29 and 22.19, with the application of chemical fertilizers + residual moisture, integrated nutrient management + residual moisture, chemical fertilizers + irrigations and integrated nutrient management + irrigations, respectively. The highest available sulphur content of soil (26.19 mg kg^{-1})was obtained with the application of 81.2:23.7:23.7:00 NPKS kg ha^{-1} +VC 6 t ha^{-1} under irrigated condition. The value of available S of soil resulted under low to medium range in all locations of farmers' fields. The results indicate slightly increased in soil available S under the category IV (integrated nutrient management + irrigations). This result showed that sulphate sulphur in surface soils is high as compared to sub-surface soils,90 % samples of soil available S found medium in range under the present study.

Similar results were reported by Ghodke *et al.* (2016), who reported that, higher value of available sulphur (12.95 to 17.40 mg kg^{-1} and 10.14 to 12.90 mg kg^{-1}) was found in surface soil and found low (6.34 to 9.80 mg kg^{-1} and 12.30 mg kg^{-1}) in sub-surface soils of Kolhapur district. The available sulphur decreased with the depth in all the soil profiles under study might be due to greater plant and microbial activities and mineralization of organic matter in surface layer. Dutta *et al*. (2013) reported maximum content of total sulphur with 150% in NPK+S, which might be due to its higher rate of application through SSP.

Water soluble sulphur mg kg^{-1}

The water-soluble sulphur is readily available to plant. The data with respect to water soluble S in soil after harvest of chickpea crop are presented in Table 1-4.It is observed that the water-soluble sulphur in soil after harvest of chickpea varied from 10.80 - 24.03, 18.01 - 27.07,17.34 - 26.06,18.01 - 27.18 mg kg^{-1} with a mean value of 18.82, 21.66 ,19.96, 23.62 mg kg^{-1} under the application of chemical fertilizers + residual moisture, integrated nutrient management + residual moisture, chemical fertilizers + irrigations, integrated nutrient management + irrigations, respectively.

In the present study water soluble sulphur in soil constituated about 4.85,6.26, 5.78 and 6.02 per cent of the total sulphur on the basis of mean under the category I, II, III and IV, respectively. Borkotoki *et al.* (2008) reported that water soluble sulphur accounted for only 3.50, 4.07, and 7.26 per cent of total S in Entisols, Inceptisols and Alfisols, respectively. The highest water-soluble sulphur (27.18 mg kg^{1}) fraction was obtained with the application of 81.2:23.7:23.7:00 NPKS kg ha^{-1} + vermicompost 6 t ha^{-1} over other applications of chemical fertilizers alone or in combinations.

Table1. Forms of sulphur after harvest of chickpea as influenced by chemical fertilizers on residual moisture

Locations	Soil depth (cm)	Fertilizers applied by farmers	Forms of sulphur					
Category I – Various doses of chemical fertilizers on (residual moisture)								
		Inorganics (NPKS (kg ha^{-1})	Total S (mg kg^{-1})	Organic S (mg kg^{-1})	Avail. S (mg kg^{-1})	Water soluble S (mg kg^{-1})	Heat Soluble S (mg kg^{-1})	Adsorbed S (mg kg^{-1})
Awasari	0-15	22.5:57.5:00:00	328	310.06	17.94	20.13	15.94	8.89
	15-30		315	298.28	16.72	18.90	15.70	9.83
Vadapuri	0-15	18.7:18.7:18.7:09	409	387.78	21.22	24.03	16.48	12.45
	15-30		403	382.88	20.12	21.34	16.02	10.56
Awasari	0-15	22.5:57.5:00:00	313	293.28	19.72	19.88	14.50	11.85
	15-30		311	291.74	19.26	19.00	14.28	10.43
Survad	0-15	35:35:00:00	311	301.73	9.27	14.34	9.0	9.24
	15-30		309	299.97	9.03	10.80	8.35	7.90
Vadapuri	0-15	12.5:32.5:32.5:00	336	317.78	18.22	20.79	14.28	10.80
	15-30		320	303.06	16.94	19.01	14.45	9.88
	Range		309-409	291.74-387.78	9.03-21.22	10.80-24.03	9.00-16.48	7.90-12.45
	Mean		335	318.65	16.84	18.82	13.90	10.18
	SD		36.17	34.11	4.06	3.53	2.72	1.28

Table 2. Forms of sulphur after harvest of chickpea as influenced by integrated nutrient management on residual moisture

Locations	Soil depth (cm)	Fertilizers applied by farmers	Forms of sulphur					
Category II – Integrated nutrient management on (residual moisture)								
		Inorganics (NPKS kg ha^{-1} (Organic kg ha^{-1})	Total S (mg kg^{-1})	Organic S (mg kg^{-1})	Avail. S (mg kg^{-1})	Water soluble S (mg kg^{-1})	Heat Soluble S (mg kg^{-1})	Adsorbed S (mg kg^{-1})
Vadapuri	0-15	35:35:00:00	346	326.14	19.86	20.51	15.59	10.58
	15-30	FYM 8 t ha^{-1}	321	300.74	19.26	20.22	15.12	10.22
Bhandgaon	0-15	30:30:00:00	408	389.17	18.83	20.75	14.20	9.46
	15-30	VC 5 t ha^{-1}	395	376.83	18.17	19.03	14.03	8.97
Survad	0-15	18.7:18.7:18.7:09	416	391.56	24.44	27.07	19.12	12.17
	15-30	FYM 6 t ha^{-1}	401	378.86	22.14	26.62	18.76	11.68
Bedshinge	0-15	23.7:23.7:23.7:00	316	297.38	18.62	18.25	16.86	9.82
	15-30	VC 4 t ha^{-1}	303	284.50	18.50	18.01	16.33	8.99
Awasari	0-15	12.5:32.5:32.5:00358	335.08	22.92	23.22	17.48	11.78	
	15-30	FYM 5 t ha^{-1}	334	312.53	21.47	23.00	17.13	11.82
Range			303-416	284.50-391.56	18.07-24.44	18.01-27.07	14.03-19.12	8.97-12.17
Mean			359.80	339.27	20.42	21.66	16.46	10.54
SD			39.90	39.17	2.06	3.06	1.66	1.17

Table 3. Forms of sulphur after harvest chickpea as influenced by chemical fertilizers under irrigated condition

Locations	Soil depth (cm)	Fertilizers applied by farmers	Forms of sulphur					
Category III – Chemical fertilizers (irrigations after sowing)								
		Inorganics (NPKS kg ha^{-1})	Total S (mg kg^{-1})	Organic S (mg kg^{-1})	Avail. S (mg kg^{-1})	Water soluble S (mg kg^{-1})	Heat Soluble S (mg kg^{-1})	Adsorbed S (mg kg^{-1})
Awasari	0-15	50:50:00:32.5	437	413.41	23.59	26.06	21.60	13.52
	15-30		428	405.20	22.80	23.31	21.01	12.56
Awasari	0-15	60:60:00:00	314	287.40	18.60	18.98	17.14	9.45
	15-30		293	276.15	15.85	18.03	16.81	9.41
Awasari	0-15	12.5:32.5:32.5:00	324	304.25	19.75	20.50	17.52	10.39
	15-30		314	294.98	19.02	18.23	17.10	10.43
Awasari	0-15	47.5:47.5:47.5:00	396	386.37	9.63	17.66	9.28	8.45
	15-30		391	385.42	9.38	17.34	9.13	8.40
Awasari	0-15	25:65:65:00	365	347.70	17.30	20.47	15.66	10.56
	15-30		356	339.97	16.03	19.05	15.30	9.34
	Range		314-437	276.15-413.41	9.38-23.59	17.34-26.06	9.13-21.60	8.40-13.52
	Mean		361.80	344.78	17.29	19.96	16.05	10.25
	SD		47.78	48.88	4.51	2.63	3.93	1.58

Table 4. Forms of sulphur after harvest of chickpea as influenced by integrated nutrient management under irrigated condition

Locations	Soil depth (cm)	Fertilizers applied by farmers	Forms of sulphur					
Category IV – Integrated nutrient management (irrigations after sowing)								
		Inorganics (NPKS kg ha^{-1}) (Organic kg ha^{-1})	Total S (mg kg^{-1})	Organic S (mg kg^{-1})	Avail. S (mg kg^{-1})	Water soluble S (mg kg^{-1})	Heat Soluble S (mg kg^{-1})	Adsorbed S (mg kg^{-1})
Awasari	0-15	22.5:57.5:00:00FYM 4 t ha^{-1}	394	370.31	23.84	25.41	22.31	13.67
	15-30		362	363.69	22.31	23.15	22.10	12.49
Awasari	0-15	25:65:65:00FYM 5 t ha^{-1}	420	401.35	18.65	18.56	15.32	9.03
	15-30		406	389.79	16.21	18.01	15.06	8.11
Awasari	0-15	22.5:57.5:00:00FYM 3 t ha^{-1}	345	322.03	22.97	24.79	20.23	12.77
	15-30		317	296.69	20.31	24.06	19.95	11.32
Awasari	0-15	81.2:23.7:23.7:00VC 6 t ha^{-1}	396	369.81	26.19	27.18	21.49	13.21
	15-30		387	363.65	23.35	25.46	21.30	12.58
Awasari	0-15	25:25:00:16.2FYM 5 t ha^{-1}	433	408.68	24.32	24.87	23.53	12.55
	15-30		422	397.97	24.03	24.78	23.46	11.85
	Range		317-433	296.69-408.68	16.21-26.19	18.01-27.18	15.06-23.53	8.11-13.67
	Mean		388.2	368.39	22.19	23.62	20.47	11.75
	SD		34.92	33.73	2.82	2.84	2.86	1.71

Heat soluble sulphur mg kg^{-1}

This form of S constituted about 3.55, 4.61, 4.10 and 5.15 per cent of the total S under the category I, II, III and IV, respectively. It is an indicator of the mineralizable S present in the soil. The heat soluble sulphur (mg kg^{-1}) in soil differed among the various categories. The findings indicated that heat soluble sulphur after harvest of chickpea in soil varied from 9.00–16.48,14.03–19.12, 9.13–21.60, 15.06–23.53 mg kg^{-1} with a mean value of 13.90, 16.46 ,16.05, 20.47 mg kg^{-1}due to application of chemical fertilizers + residual moisture, integrated nutrient management + residual moisture, chemical fertilizers+ irrigations, integrated nutrient management + irrigations, respectively (Table 1-4).

Adsorbed sulphur mg kg^{-1}

It was accounted for the 2.83 to 2.94 per cent of the total S under present study and it ranged from 7.90-12.45, 8.97– 12.17, 8.40 -13.52, 8.11-13.67 mg kg^{-1} with a mean value of 10.18, 10.54,10.25, 11.75 mg kg^{-1} with the application of chemical fertilizers + residual moisture, integrated nutrient management + residual moisture, chemical fertilizers + irrigations,integrated nutrient management + irrigations, respectively (Table 1-4).This may be attributed due to non-displacement of adsorbed SO_4-S under medium rainfall which restricts the leaching loss of SO_4-S ions in lower layers.

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