Original Research Article

Retroaction of summer sesame (*Sesamum indicum* L.) towardsfoliar application of NPK and micronutrients on content and uptake of nutrients in medium black calcareous soil of South Saurashtra region

ABSTRACT

A field trial was steered to ascertain the outcome of foliar application of NPK and micronutrients on nutrient content and uptake by sesame crop during the summer season of 2022on medium black calcareous soil of Instructional Farm,Junagadh Agricultural University, Junagadh. The experiment was conducted with three replications and 10 treatments by using Randomized Block Design, the GJT-5 variety of sesame was tested in this experiment. The treatment consists of 100 % RDF, *viz*. 50:25:40 N-P_2O_5-K_2O kg /ha (T1), T1 + Foliar spray of MMMG-IV @ 0.25 % at 30 and 45 DAS (T2), 75 % of RDF + 1.5 % Water Soluble Fertilizer at 30 and 45 DAS (T3), 75 % of RDF + 2.0 % Water Soluble Fertilizer at 30 and 45 DAS (T4), 50 % of RDF + 1.5 % Water Soluble Fertilizer at 30 and 45 DAS (T5), 50 % of RDF + 2.0 % Water Soluble Fertilizer at 30 and 45 DAS (T6), T3+ Foliar spray of multi micro mixture grade - IV @ 0.25 % at 30 and 45 DAS (T7), T4+ Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS (T8), T5 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS (T9) and T6+Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS (T10).The results of the experimentation revealed that the application of T4+ Foliar spray of MMMG- IV @ 0.25 % (T8) at 30 and 45 DAS) recorded the significantly higher content of N, P and K and micronutrients (Fe, Zn, Mn, Cu and B) in seed and stover of sesame and also enhanced the uptake of these nutrients by plant as well as the availability of Nitrogen, Phosphorous and Potassium in soil after harvest of the crop. Significantly, they were at par with the application of T3+ Foliar spray of MMMG- IV @ 0.25 % (T7) at 30 and 45 DAS). While, the significantly lowest values of nutrient content and uptake were recorded with 50 % of RDF + 1.5 % Water Soluble Fertilizer(T5) at 30 and 45 DAS.

Keywords -*Sesame, randomised block design, nutrient content, nutrient uptake and WSF (water soluble fertilizer).*

INTRODUCTION

Since the ancient times, the sesame plant (Sesamum indicum L.) has been grown as an important oilseed crop throughout Asia, with India having the longest history of sesame production. The Arthashastra of Kautilya makes mention of sesame farming in India. Sesame has 36 wild species, 19 of which are found in India and the rest only in Africa. The majority of Sesamum genus in the wild are native to sub-Saharan Africa, however Sesamum indicum was also previously discovered in India. One of the most significant and historic oilseed crops in the world, sesame (Sesamum indicum L.), has been farmed in Asia for thousands of years, with India having the longest history of sesame cultivation.

It is extensively cultivated in tropical and subtropical tracks in the world. In India, sesame occupies 1.722 million ha area and production of 0.816 million tonnes having an average productivity of 474 kg/ha. Gujarat is the foremost state in cultivation of sesame with an area, production and productivity about 2.588 lakh ha, 1.225 lakh tonnes and 473.43 kg/ha respectively, [1].

It is grown in less fertilized marginal and sub-marginal areas. Low grain yield is primarily caused by widespread flower shedding, nutritional deficits, hormonal abnormalities, and endogenous levels of growth regulators [2]. Midst the agronomic aspects recognized to enhance crop production, fertilizer stands first and is considered as one of the most productive inputs in agriculture. Of the major elements, nitrogen which is deficient in most of the Indian soils plays a considerably important role [3]. The application of nutrients through soil also be subjected to loss through leaching, fixation with clay and volatilization losses. In calcareous soil condition most of the nutrients are not readily available to the plants, specially N, P and micronutrients are deficient due to fixation in soil. These unavailability of nutrients causes poor absorption by plants which leads the deficiency and ultimately decreases the yield of crop plant.

Foliar nutrition is a useful technique for correcting nutrient shortages and getting around the soil's inefficiency in transferring nutrients to the plant. Foliar spray causes a rise in cellular activity, respiration, and chlorophyll production. Additionally, it stimulates a plant's response to increased soil water and nutrient uptake [4].

By considering the above facts within the view, an effort has been made during summer 2022 to increase the crop yield through foliar application of fertilizer along with a recommended dose of fertilizers.

MATERIALS AND METHODS

An experiment was conducted during summer of 2022 on medium black calcareous soil at Instructional Farm, Junagadh Agricultural University, Junagadh, Gujarat which is situated geographically at 21.50 North latitude and 70.50 East longitude with an altitude of 60 metre above the MSL (mean sea level). The soil was slightly alkaline in reaction with pH of 7.8, EC 0.41 ds/m, medium in organic carbon (0.52%) and clayey in texture. The soil low in available nitrogen (237.2 kg /ha), medium in available phosphorus (28.5 kg /ha), Potash (252 kg /ha) and micronutrients iron (5.5 ppm), zinc (0.55 ppm), manganese (5.1 ppm) copper (0.51 ppm) and Boron (0.65 ppm).

The experiment was laid out in RBD which consisting of 3 replications having 10 treatments viz., 100 % RDF, viz. 50:25:40 N-P_2O_5-K_2O kg /ha (T1), T1 + Foliar spray of MMMG-IV @ 0.25 % at 30 and 45 DAS (T2), 75 % of RDF + 1.5 % Water Soluble Fertilizer at 30 and 45 DAS (T3), 75 % of RDF + 2.0 % Water Soluble Fertilizer at 30 and 45 DAS (T4), 50 % of RDF + 1.5 % Water Soluble Fertilizer at 30 and 45 DAS (T5), 50 % of RDF + 2.0 % Water Soluble Fertilizer at 30 and 45 DAS (T6), T3 + Foliar spray of multi micro mixture grade - IV @ 0.25 % at 30 and 45 DAS (T7), T4 + Foliar spray of

MMMG- IV @ 0.25 % at 30 and 45 DAS (T8), T5 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS (T9) and T6 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS (T10). The recommended dose of fertilizer (50:25:40 N-P2O5-K2O kg/ha) was supplied through Urea, DAP and MOP respectively, and applied according to treatments. While rest of the nutrients were applied by means of foliar application of Water Soluble Fertilizer (19:19:19 N:P:K) and micronutrients through Multi micro. mixture grade –IV (MMMG- IV).

The sample for chemical analysis was drawn from 5 randomly selected plants at harvest, dried at 60oC, grinded and used for analysis. The analysis for concentration of N, P, and K was performed using the procedure as recommended by Jackson [5]. Micronutrients viz., Fe, Mn, Zn, Cu and B content in the seed and stover was estimated by using Triple acid extract-AAS method recommended by Lindsay and Norvell [6] and uptake of nutrients by the crop were calculated. The tentative data were analysed using analysis of variance techniques at 5% level of significance endorsed by Gomez and Gomez [7].

EXPERIMENTAL RESULTS

Effect on nutrient content of plant

NPK content in seed

An examination of data in Table 1 revealed that the NPK content in seed were significantly influenced by different treatments and the higher content of N (4.83%), P (0.52%) and K (0.64%) were recorded by applying treatment T8 (T4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 days after sowing), which remained at par with treatment T7 in phosphorus content, T7, T2 and T10 about N content and T7, T2, T10 and T9 about K content of seed. Whereas, significantly lowest N (3.72%), P (0.42%) and K (0.53%) content in seed were documented with the treatment T5.

Micronutrient content in seed

Scrutiny of data in Table 2 showed that the various treatments exerted their significant influence on micronutrient content in seed. Significantly the highest content of micronutrients in seed i.e. Fe (403.25 mg), Zn (64.22 mg), Mn (76.93 mg), Cu (58.61 mg) and B (40.89 mg) was registered under treatment T8 (T4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 days after sowing), which remained statistically at par with the treatments T7, T2 in Zn content, T7, T2, and T10 in case of Fe, Mn and Cu, while T7, T2, T10 and T9 in respect of B content in seed. Significantly the lowermost values of N, P and K content in stover were witnessed with treatment T5.

NPK content in stover

In context of NPK content in stover of sesame, the highest content of N, P and K about (1.77%), (0.27%) and (1.28%) respectively, were recorded by the application of T4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 days after sowing (T8), which was on par with treatment T7, T2, and T10 in context of N and P, while T7, T2, T10and T9 in terms of K content in stover. The lowest content of micronutrient content in seed were noted with treatment T5.

Micronutrient content in stover

Scrutiny of data in Table 2 revealed that different treatments imparted their significant impact on micronutrient content in stover. The higher content of micronutrient in stover *i.e.* Fe (348.5 mg), Zn (42.81 mg), Mn (66.38 mg), Cu (39.07 mg) and B (31.46 mg*)* were recorded with the application of treatment T4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS (T8). The result is in similarity with the treatments T7, and T2 in terms of Zn, while T7, T2 and T10 in terms of Fe, Mn, Cu and B content in stover of sesame. Whereas, significantly the lower content of micronutrients in stover were recorded under treatment T5.

Effect on nutrient uptake by plant

NPK uptake by seed

A glimpse of data (Table 1) revealed that application treatment T4+ Foliar spray of MMMG-IV @ 0.25 % at 30 and 45 days after sowing (T8) recorded significantly greater uptake of N, P and K by seed *i.e.*(67.07 kg/ha), (7.14 kg/ha) and (8.91 kg/ha) respectively, it was recorded statistically at par to treatment of T7in context of Phosphorus uptake and T7and T2 in terms of Nitrogen and Potash uptake. Whereas, significantly the lowest NPK uptake by seed was recorded under treatment T5.

Micronutrient uptake by seed

An assessment of data indicated that the micronutrient uptake by seed of sesame was influenced significantly by different treatments and significantly higher values of uptake of Micronutrient by seed *i.e.* Fe (559.1 g/ha), Zn (88.93 g/ha), Mn (106.49 g/ha), Cu (81.22 g/ha) and B (56.82 g/ha*)* were recorded with the treatment T4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 days after sowing (T8). This treatment was in similarity to the treatments T7in context of Zn and B uptake, while T7 and T2 in respect of Fe, Mn and Cu uptake by seed of sesame. Significantly the lowermost number was recorded about micronutrient uptake under the treatment T5.

NPK uptake by stover

An examination of data in Table 1 showed that different treatments exerted their significant influence on Nitrogen, Phosphorus and Potassium uptake by stover. Significantly higher N (37.75 kg/ha), P (5.72 kg/ha) and K (27.29 kg/ha) uptake by stover of sesame was observed under the treatment T4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 days after sowing (T8), which was statistically at par with the treatments T7in context of N uptake, whereas T7 and T2 in respect of Phosphorus and Potassium uptake by stover. Significantly the lowest Nitrogen, Phosphorus and Potassium uptake by stover was documented with the treatment T5.

Micronutrient uptake by stover

An investigation of data (Table 1) indicated that the micronutrient uptake by stover of sesame was influenced significantly by different treatments and significantly higher values of uptake of Micronutrient by stover*i.e.* Fe (742.4 g/ha), Zn (90.87 g/ha), Mn (141.49 g/ha), Cu (82.99 g/ha) and B (66.99 g/ha)were recorded underthe treatment T_8 (T_4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS). The result is in similarity with the treatments T_7 in context of Zn uptake, T_7 and T_2 in respect of Fe, Cu and B uptake, while T_7, $T_2$and T_1 in termsof Mn uptake by stover of sesame. Significantly the lowestfigureabout micronutrient uptake was documented under the treatment T_5.

Effect on Post-harvestnutrient status of soil

An assessment of data (Table 3) revealed that different treatment imparted their significant effect on the available soil macronutrients after harvest of the crop. Significantly increased the accumulation of available N (272.73 kg/ha), P (34.37 kg/ha) and K (272.20 kg/ha) in soil after harvest of crop were noted under the application of T4 + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS (T8), which was remained statistically parallel with T7, T2, T10, T9 and T1in respect of available nitrogen and with treatments T7, T2 and T10 in respect of available phosphorous and potassium in soil. Significantly lower available soil N, P and K was recorded under treatment T5. However, available micronutrients status of soil remained unaffected due to various treatments.

DISCUSSION

The growth and maintenance of greater chlorophyll and photosynthetic area in terms of higher leaf area and leaf area index occurred from the foliar feeding of important nutrients, mainly N, which led to higher photosynthesis. Additionally, foliar K feeding promotes a higher transfer of photosynthates from the leaves to the growing seeds, improving seed output. These two elements worked together to improve the transfer of photosynthates to growing seeds, which led to the production of healthy, mature seeds. Similar to this, applying micronutrients through foliar application promotes the activation of various enzymes and increases basic metabolic rate in plants, which facilitated the synthesis of nucleic acids and hormones and increased seed yield due to greater availability of nutrients and photosynthates [8].

Increased availability of N, P, K, and micronutrients during combined foliar treatment may be the cause of the rise in N, P, and K content in seed and stover. The increased nutrient intake was caused by an increased supply of nutrients and a well-developed root system, which increased water and nutrient absorption. This may possibly be related to the increased availability of minerals in the treated soil and the role that micronutrients play in the activation of several enzymes that aid in nutrient uptake.

It depends on the concentration of nutrient ions in the plant system and is connected to the metabolic processes of the plant. The increase in micronutrients concentration in plant due to the foliar application of micronutrients which lead to the quick absorption and avoid nutrient loses. Combined soil and foliar application of NPK and micronutrients resulted in increased concentration of macro and micronutrients in sesame crop. The findings are in agreement with Manasa et al., [9].

This might be explained by their complementary effects, which increase availability in the root environment and facilitate extraction and transit to the plant system. Increased uptake of nitrogen, phosphorus, potassium, iron, zinc, manganese, copper, and boron follow better yield and nutrient absorption. These results of present investigation are in close agreements with the findings of [10-12] in case of soil application of NPK fertilizers and [13-15] in case of foliar application.

The amount of nutrients that remain in the soil after a crop is harvested mostly depends on both the input of nutrients from various sources and crop uptake. Higher levels of N, P2O5, and K2O in soil may be the result of foliar spraying these nutrients, which reduced soil uptake. The conclusions of [9, 14–16] are highly supported by the findings of the current investigation.

CONCLUSION

Based on one year's experimentation, it can be concluded that sesame crop fertilized with 75 % recommended dose of fertilizers (37.5: 18.75: 30- N: P_2O_5: K_2O kg /ha) + 2.0 % Water Soluble

Fertilizer at 30 and 45 days after sowing + Foliar spray of MMMG- IV @ 0.25 % at 30 and 45 DAS led to remarkable improvements in nutrient content and uptake due to efficiently absorption by plant from soil and through foliar application which strengthen the plant system and ultimately improves the performance of the crop.

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Table 1: Effect of foliar application of NPK and micronutrients on content and uptake of Macronutrients (N, P and K) by the crop

Treatments	N				P				K			
	Content (%)		Uptake (kg/ha)		Content (%)		Uptake (kg/ha)		Content (%)		Uptake (kg/ha)	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
T_1	4.24	1.48	50.92	28.85	0.45	0.22	5.42	4.32	0.58	1.08	6.98	20.99
T_2	4.64	1.61	59.86	32.21	0.47	0.25	6.14	4.94	0.62	1.18	8.07	23.67
T_3	4.01	1.35	40.24	22.35	0.44	0.21	4.41	3.45	0.57	0.98	5.74	16.15
T_4	4.13	1.43	43.24	25.22	0.45	0.22	4.69	3.83	0.57	1.03	6.03	18.16
T_5	3.72	1.19	28.21	13.43	0.42	0.16	3.19	1.79	0.53	0.87	4.01	9.65
T_6	3.82	1.24	31.20	15.07	0.43	0.17	3.52	2.08	0.54	0.90	4.46	10.81
T_7	4.73	1.70	63.09	35.13	0.50	0.25	6.60	5.19	0.63	1.22	8.43	25.20
T_8	4.83	1.77	67.07	37.75	0.52	0.27	7.14	5.72	0.64	1.28	8.91	27.29
T_9	4.33	1.53	39.94	19.53	0.46	0.22	4.19	2.86	0.61	1.12	5.57	14.28
T_{10}	4.47	1.59	41.90	20.79	0.46	0.24	4.37	3.11	0.61	1.14	5.77	14.90
SEm ±	**0.13**	**0.06**	**2.82**	**1.76**	**0.01**	**0.01**	**0.25**	**0.35**	**0.02**	**0.06**	**0.45**	**1.50**
CD at 5%	**0.38**	**0.18**	**8.38**	**5.24**	**0.04**	**0.03**	**0.74**	**1.04**	**0.06**	**0.19**	**1.34**	**4.47**

Table 2: Effect of foliar application of NPK and micronutrients on content and uptake of micronutrients (Fe, Zn. Mn. Cu and B) by the crop

Tr. No.	Fe				Zn				Mn				Cu				B			
	Content		Uptake		Content		Uptake		Content		Uptake		Content		Uptake		Content		Uptake	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
T_1	319.4	300.7	381.3	590.0	49.93	34.11	59.62	65.95	63.55	58.53	76.02	114.71	47.19	32.13	56.93	62.56	35.62	26.89	42.81	52.62
T_2	375.6	331.3	484.5	663.9	58.65	39.09	76.01	77.90	72.62	62.53	93.80	125.54	55.49	36.99	71.86	73.73	38.03	29.25	49.07	58.48
T_3	308.3	295.4	311.5	486.8	48.02	32.61	47.91	53.58	60.86	57.47	61.48	95.04	45.69	29.42	46.37	48.79	34.22	25.86	34.28	42.59
T_4	311.7	297.4	327.5	525.4	49.65	33.11	51.76	58.46	62.36	58.23	65.40	102.93	46.19	31.02	48.50	54.88	34.59	26.54	36.32	46.96
T_5	304.6	286.9	231.6	322.8	45.03	30.49	33.99	34.48	58.73	53.97	44.36	60.94	41.93	27.30	31.78	30.52	31.99	22.96	24.11	26.05
T_6	307.6	291.5	253.3	353.9	47.29	32.08	38.39	38.74	60.53	55.85	49.10	67.90	43.39	28.43	35.46	34.47	33.54	23.85	27.32	28.84
T_7	390.3	340.9	520.1	705.9	61.18	40.72	81.39	84.06	75.02	65.01	99.98	134.58	57.53	38.36	76.69	79.39	39.60	30.46	52.69	62.82
T_8	403.2	348.5	559.1	742.4	64.22	42.81	88.93	90.87	76.93	66.38	106.5	141.49	58.61	39.07	81.22	82.99	40.89	31.46	56.82	66.99
T_9	343.9	309.8	316.2	401.1	54.31	35.98	49.90	46.11	67.07	59.60	61.86	77.02	51.09	34.44	47.28	44.26	36.89	28.38	34.03	36.48
T_{10}	359.9	320.5	337.0	422.5	56.03	37.35	52.92	49.10	70.01	60.81	65.61	79.29	53.05	35.37	49.71	46.21	37.76	29.05	35.41	37.94
SEm ±	**16.8**	**11.06**	**25.32**	**46.9**	**2.61**	**1.78**	**3.51**	**3.87**	**3.20**	**2.09**	**4.81**	**9.03**	**2.34**	**1.55**	**4.58**	**4.34**	**1.54**	**0.91**	**2.58**	**3.52**
CD at 5%	**50.0**	**32.88**	**75.24**	**139.3**	**7.76**	**5.31**	**10.45**	**11.51**	**9.53**	**6.22**	**14.29**	**26.84**	**6.96**	**4.62**	**13.62**	**12.89**	**7.35**	**2.72**	**7.66**	**10.47**

Table 3: Effect of foliar application of NPK and micronutrients on post-harvest nutrient status of soil

Treatments	Post-harvest soil Available nutrients							
	Macronutrients (kg/ha)			Micronutrients (mg/kg)				
	N	P	K	Fe	Zn	Mn	Cu	B
T_1	237.81	28.73	244.71	5.60	0.54	5.78	0.94	0.42
T_2	260.92	31.97	259.58	6.00	0.58	5.95	0.98	0.49
T_3	226.11	26.33	236.15	5.44	0.53	5.77	0.93	0.40
T_4	230.39	27.53	240.66	5.55	0.54	5.80	0.94	0.41
T_5	213.25	24.28	229.39	5.24	0.48	5.53	0.88	0.39
T_6	217.64	25.31	232.09	5.42	0.50	5.61	0.90	0.40
T_7	266.98	33.86	266.34	6.09	0.58	6.08	0.98	0.51
T_8	272.73	34.37	272.20	6.21	0.59	6.15	0.99	0.52
T_9	246.49	29.41	249.67	5.71	0.55	5.83	0.95	0.45
T_{10}	252.24	30.95	252.82	5.89	0.58	5.93	0.98	0.48
SEm ±	**13.16**	**1.15**	**7.18**	**0.25**	**0.03**	**0.25**	**0.04**	**0.03**
CD at 5%	**39.11**	**3.43**	**21.33**	**NS**	**NS**	**NS**	**NS**	**NS**