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Effect of foliar application of NPK and micronutrients on growth, yield and quality parameters of summer sesame (*Sesamum indicum* L.)

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Abstract
A field experiment entitled "Effect of foliar application of NPK and micronutrients on summer sesame (*Sesamum indicum* L.)" was carried out during summer season of 2022 on clayey soil having pH 8.01 and EC 0.49 dSm^{-1} at Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh. The experiment was laid out in Randomized Block Design with three replications, comprised with 10 treatments of T_1 (100% RDF, *i.e.* 50:25:40 kg N-P_2O_5-K_2O ha^{-1}), T_2 (T_1 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS), T_3 (75% of RDF + 1.5% WSF at 30 and 45 DAS), T_4 (75% of RDF + 2.0% WSF at 30 and 45 DAS), T_5 (50% of RDF + 1.5% WSF at 30 and 45 DAS), T_6 (50% of RDF + 2.0% WSF at 30 and 45 DAS), T_7 (T_3 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS), T_8 (T_4 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS), T_9 (T_5 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS) and T_{10} (T_6 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS). The sesame variety (GJT-5) was tested in the experiment.
The initial phases of crop growth and plant population did not show a significant response to treatments, while, significantly higher values of growth parameters *viz*., plant height 60 DAS and at harvest, number of branches $plant^{-1}$, dry matter accumulation $plant^{-1}$, SPAD meter reading and yield attributes *viz*., number of capsule $plant^{-1}$, length of capsule, number of seeds $capsule^{-1}$, seed weight and yield *viz*., seed yield (1386 kg ha^{-1}) and stover yield (2124 kg ha^{-1}), quality parameters *viz*., protein content and oil yield, net return of (₹74425 ha^{-1}) were recorded higher with the application of T_8 (T_4 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS). Significantly, being at par with application of T_7 (T_3 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS) while the significantly lowest values of all those parameters were recorded with the application of T_5 (50% of RDF + 1.5% WSF at 30 and 45 DAS).

Keywords: Sesame, summer, randomised block design, water soluble fertilizer (WSF) and foliar spray

Introduction
Sesame (*Sesamum indicum* L.) is one of the world's oldest oil crop and has been cultivated in Asia since ancient times with the longest history of its cultivation in India. The cultivation of sesame in India is mentioned in Kautilya's Arthashastra. Out of 36 wild species of sesame, 19 are found in India and rest are confined to Africa. Most wild species of the genus *Sesamum* are native to sub Saharan Africa, but types including S*esamum indicum* also formerly found in India.
Sesame which is also known as *Til, Tilli, Gingelly, Gergelim, Simsim, Biniseed etc*. (Joshi, 1961) [12]. It is an important oilseed crop and the genus sesamum belongs to order Tubiflorae, family Pedaliaceae. Sesame seeds have been considered as "Queen of Oilseed" by virtue of its excellent quality of oil content, flavour, taste and traditionally categorised as a health food in Asian countries. Sesame is widely cultivated in tropical and subtropical parts of the world. India occupies an area of 1.722 million ha with production of 0.816 million tonnes with an average productivity of 474 kg ha^{-1} (Anon., 2021) [2]. Gujarat is the leading state in sesame production having an area about 2.588 lakh ha with production of 1.225 lakh tonnes and average productivity of 473.43 kg ha^{-1} (Anon., 2021) [2].
Sesame seed contains oil that varies from 46 to 52% which is of excellent quality and protein content in seed varies from 20 to 26%, making them a high source of both essential fatty acids and certain amino acids like methionine and tryptophan. About 73 percent of the sesame produced in the country is used for oil extraction, 14.5 percent for domestic uses including

preparation of sweet candies as condiments, culinary and confectionary purposes whereas 8.3 percent for hydrogenization and 4.2 percent is used for industrial purposes in manufacturing of paints, perfumed oils, pharmaceuticals and insecticides also used in manufacturing of soap, cosmetic and skin care products (Jat *et al.*, 2017) [10]. It is also popular as a cooking oil in south India and the sesame oil cake is used as feed for the milch animales as well as manure which contains 6.0 to 6.2% nitrogen, 2.0 to 2.2% phosphorus and 1.0 to 1.2% potash (Yadav *et al*., 2008) [26].

It is cultivated on marginal and sub-marginal lands with poor fertility management. An availability of nutrients is the most promising factor over other agronomical practices. The black calcareous soil of south Saurastra region having the deficiency of nitrogen, phosphorus and micronutrients particularly Fe and Zn and prone to fix the nutrient applied in soil, which obstruct the growth and yield of crop. The loss of nutrients can be reduced with foliar application of macro and micronutrients which supplements the soil application of nutrients. Moreover, foliar spray of nutrient is theoretically more nature friendly, quick and target oriented than the soil fertilization as the nutrients can be directly delivered to the plant tissues during critical period of crop growth. Foliar application is highly efficient in terms of absorption as nutrients are not subjected to various losses that occur with soil application. Nutrients applied through arial portion play a pivotal role in increasing the seed yield in pulses and oilseeds (Solanki *et al*., 2022) [23].

Supplementary application of NPK and micronutrients is quite advantageous than soil application due to faster absorption directly by leaf surface and improved translocation and assimilation of nutrients into economic parts of the plant. Thus, it encourages rapid growth and development by faster fulfilment of deficient nutrients, pest and disease resistance by keeping healthy plant, improve growth and yield parameters which ultimately boosts yield of the crop.

Materials and Methods

A field trial was conducted at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) during summer season of the year 2022. Geographically is located at 21.5^0 N latitude and 70.5^0 E longitude with an altitude of 60 m above the mean sea level**.** The soil of the experimental field was clayey in texture and slightly alkaline in reaction with pH (7.8) and EC (0.41 dsm^{-1}) and organic carbon (0.52%). The soil low in available nitrogen (237.2 kg ha^{-1}), medium in available phosphorus (28.5 kg ha^{-1}), Potash (252 kg ha^{-1}) and micronutrients Fe (5.5 ppm), Zn (0.55 ppm), Mn (5.1 ppm) Cu (0.51 ppm) and B (0.65 ppm), respectively. The experiment was laid out in Randomized Block Design having 10 treatments and replicated thrice, that are T_1 (100% RDF, *i.e*. 50:25:40 kg N-P_2O_5-K_2O ha^{-1}), T_2 (T_1 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS), T_3 (75% of RDF + 1.5% WSF at 30 and 45 DAS), T_4 (75% of RDF + 2.0% WSF at 30 and 45 DAS), T_5 (50% of RDF + 1.5% WSF at 30 and 45 DAS), T_6 (50% of RDF + 2.0% WSF at 30 and 45 DAS), T_7 (T_3 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS), T_8 (T_4 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS), T_9 (T_5 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS) and T_{10} (T_6 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS). The growth parameters of the plants were documented at regular intervals from 45, 60 DAS and at harvest and finally, the yield and quality parameters were documented after harvest. Plant samples (grain and stover) was collected from five randomly selected plants at specific interval and at maturity and subsequently dried, grinded and used for chemical analysis. The SPAD meter value was measured by using the chlorophyll meter (Minolta SPAD-502). Protein content was estimated by multiplying nitrogen content of seed with the factor of 5.46 (Jones, 1951) [11] and oil content was determined by non-destructive method using Nuclear Magnetic Resonance Spectrophotometer (Model Oxford 4000 NMR analyzer) as suggested by Tiwari *et al.* (1974) [24]. The experimental data were analysed in accordance with the analysis of variance techniques as suggested by Gomez and Gomez (1984) at 5% level of significance.

Results and Discussion

Effect on growth Parameters

Plant height

The data on plant height recorded at 45, 60 DAS and at harvest. The age of the crop often causes a gradual increase in plant height. The height of the plant enhanced rapidly over the first 60 days and then substantially at a slow rate between 60 DAS and harvest. At 45 DAS, found not significantly altered by different treatments, but at 60 DAS and at harvest, plant height was affected significantly. higher plant height (63.33 cm) at 60 DAS and (73.20 cm) at harvest was recorded under the treatment T_8 (T_4 + Foliar spray of multi micro mixture grade- IV @ 0.25% at 30 and 45 DAS), which was found at par with treatments. However, it was found at par with treatments T_7, T_2 and T_1 at 45 DAS. While T_7, T_2, T_1, T_4 and T_3 also found at par al Harvest. The lowest values were obtained in T_5 (50% of RDF + 1.5% WSF at 30 and 45 DAS) about (52.60 cm) and (60.33 cm) recorded at 60 DAS and at harvest, respectively.

Number of branches per plant

The data on number of branches per plant recorded at 45, 60 DAS and at harvest. Significantly higher number of branches per plant (2.20) at 45 DAS, (3.40) at 60 DAS and (4.00) at harvest was recorded under the treatment T_8 (T_4 + Foliar spray of multi micro mixture grade- IV @ 0.25% at 30 and 45 DAS), which was found at par with treatments T_7 and T_2 at 60 DAS while T_7, T_2 and T_1 at harvest. The lowest values were obtained in T_5 (50% of RDF + 1.5% WSF at 30 and 45 DAS) about (1.07) at 45 DAS, (1.80) at 60 DAS and (2.33) at harvest.

The increase in plant height and number of branches per plant at harvest might be due to soil and foliar application of NPK and micronutrients. This could be attributed to the better nutritional conditions that prevailed during crop growth period which lead to the significant improvement in nutrient status of plant parts might have resulted in greater synthesis of amino acids, protein and growth promoting substances, synthesis of IAA, metabolism of auxins, biological activity, stimulating effect on photosynthetic pigments and enzyme activity (Michali *et al*., 2004) [17].

Dry matter accumulation per plant

Significantly higher dry matter production (5.05 g) at 45, (11.28 g) 60 DAS and (13.91 g) at harvest were recorded with application of 75% RDF + 2.0% WSF at 30 and 45 DAS +

Multi-micro mixture Grade-IV @ 0.25% at 30 and 45 DAS (T_8), which was statistically at par with the treatments T_7, T_2 and T_1 at 45 DAS and 60 DAS. While T_7, T_2, T_1, and T_4 in respect of at harvest.

The improvement in the dry matter production which could be ascribed to the increase in plant growth (*i.e.* plant height and number of branches) and cumulative effect of all these parameters on yield attributes. Which is a result of foliar application of nutrients and their greater absorption, assimilation and translocation of nutrients for increased photosynthesis. Therefore, better availability and uptake of nutrients could be assigned as the proper reason behind the significant increase in dry matter production. These results are in line with the findings of Jamdhade *et al.* (2017) [9], Bijarnia *et al.* (2019) [4], Batta (2020) [3], Jajoo (2022) [8] and Reddy *et al.* (2022) [2].

SPAD meter reading

Significantly higher SPAD meter reading (43.29) at 40 DAS and (48.95) at 55 DAS was observed with the treatment T_8 (T_4 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS, which was found at par with T_7, T_1, T_2, T_4 and T_{10} at 40 DAS. While, T_7, T_2 and T_1 at 55 DAS. Foliar application of water soluble fertilizers resulted that the crop growth was faster at early part of the crop age and gradually slows at later stage. The reason behind that could be greater and faster absorption of water soluble macro and micro nutrients by the crop. The total chlorophyll and the enzyme activities increased which resulted in higher photosynthesis, as iron serves as catalyst in the formation chlorophyll. These results are in close conformity with the findings of Vinod and Salakinkop (2017) [25], Kumar *et al.* (2018) [13], Batta (2020) [3] and Jajoo (2022) [8].

Table 1: Effect of foliar application of NPK and micronutrients on plant height and number of branches at different interval of time

Tr. No.	Treatments	Plant height (cm)			No of branches per plant		
		45 DAS	60 DAS	at harvest	45 DAS	60 DAS	at harvest
T_1	100% RDF (50:25:40 kg N-P_2O_5-K_2O ha^{-1})	42.53	57.20	66.67	1.60	2.80	3.40
T_2	T_1 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	43.13	59.40	68.00	1.73	2.87	3.60
T_3	75% of RDF + 1.5% WSF at 30 and 45 DAS	41.53	55.27	65.73	1.33	2.33	3.07
T_4	75% of RDF + 2.0% WSF at 30 and 45 DAS	42.20	55.40	66.20	1.40	2.53	3.20
T_5	50% of RDF + 1.5% WSF at 30 and 45 DAS	40.27	52.60	60.33	1.07	1.80	2.33
T_6	50% of RDF + 2.0% WSF at 30 and 45 DAS	40.73	53.87	61.73	1.07	1.87	2.33
T_7	T_3 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	43.87	61.00	71.53	1.80	3.13	3.67
T_8	T_4 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	46.60	63.33	73.20	2.20	3.40	4.00
T_9	T_5 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	40.80	54.13	63.73	1.20	2.20	2.57
T_{10}	T_6 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	41.07	54.07	64.67	1.20	2.33	2.87
	S.Em.±	1.731	2.19	2.54	0.11	0.19	0.23
	C. D. at 5%	NS	6.51	7.56	0.34	0.59	0.70

Table 2: Effect of foliar application of NPK and micronutrients on dry matter accumulation and SPAD meter reading of sesame

Treatments		Dry matter accumulation			SPAD meter reading	
		45 DAS	60 DAS	At harvest	40 DAS	55 DAS
T_1	100% RDF (50:25:40 kg N-P_2O_5-K_2O ha^{-1})	4.46	10.20	12.58	41.69	44.37
T_2	T_1 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	4.65	10.48	12.76	40.99	45.52
T_3	75% of RDF + 1.5% WSF at 30 and 45 DAS	3.94	9.47	11.94	38.79	43.02
T_4	75% of RDF + 2.0% WSF at 30 and 45 DAS	3.99	9.78	12.40	40.16	43.78
T_5	50% of RDF + 1.5% WSF at 30 and 45 DAS	2.95	7.66	8.73	36.67	40.19
T_6	50% of RDF + 2.0% WSF at 30 and 45 DAS	3.07	8.06	9.39	37.83	40.88
T_7	T_3 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	4.75	10.61	13.08	42.68	46.35
T_8	T_4 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	5.05	11.28	13.91	43.29	48.95
T_9	T_5 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	3.51	8.70	10.73	38.18	41.39
T_{10}	T_6 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	3.67	8.99	11.16	39.56	42.73
	S.Em.±	0.31	0.41	0.55	1.38	1.59
	C. D. at 5%	0.92	1.245	1.66	4.10	4.72

Effect on yield attributes and yield

Effect on yield attributes

Application of 75% RDF + 2.0% WSF at 30 and 45 DAS + Multi-micro mixture Grade-IV @ 0.25% at 30 and 45 DAS (T_8) recorded significantly improved yield attributes such as a number of capsule per plant at harvest and length of capsule at harvest, number of seeds per capsule at harvest and seed weight per plant. Which remained statistically at par with the treatment T_7 and T_2 in case of seed weight per plant and T_7, T_2 and T_1 in respect of number of capsule per plant at harvest and length of capsule at harvest, while treatments T_7, T_2, T_1 and T_4 (75% of RDF + 2.0% WSF at 30 and 45 DAS) in respect of number of seeds per capsule at harvest.

The superiority of foliar nutrition might be due to coincidence of foliar application with peak nutrition requirement of the crop as a supplementation to soil application. The higher number of capsules per plant was due to the fulfillment of the demand of the crop by higher assimilation and translocation of photosynthates from source to sink exert an important regulative function on the complex process of plant growth and development, which ultimately depicted in increased yield attributes (Vinod and Salakinkop, 2017) [25]. Similar findings were reported by Patel and Raj (2017) [18], Seervi *et al.* (2018) [21], Shwetha *et al.* (2018) [22], Batta (2020) [3], Haritha *et al.* (2022) [7], jajoo (2022) [8] and Solanki (2022) [23].

Effect on yield

Different treatments significantly influenced on the seed and stover yield of sesame. Significantly higher and lower seed and stover yield were recorded with the application of 75%

RDF + 2.0% WSF at 30 and 45 DAS + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS (T_8) and T_5 (50% of RDF + 1.5% WSF at 30 and 45 DAS) respectively. Seed and stover yield were found statistically equivalent to treatment T_7 and T_2 in respect of seed yield and T_7, T_2 and T_1 (100% RDF *i.e.* 50-25-40 kg N-P_2O_5-K_2O ha^{-1}) in respect of stover yield.

Significantly the lower yield was registered under the treatment (T_5) might be due to severe competition for nutrient by resources, which made the crop plant incompetent to take up nutrients, consequently growth and yield attributes was effected adversely and ultimately poor yield. The superiority of foliar nutrition might be due to coincidence of foliar application with peak nutrition requirement of the crop as a supplementation to soil application. The quantity of nutrients absorbed by roots at peak period of nutrient requirement may not be sufficient to meet the needs at seed development stage. Supplementing nutrients through foliage might have resulted in better nutrient balance in the plants leading to increased yield components (Shwetha *et al*., 2018) [22].

Table 3: Effect of foliar application of NPK and micronutrients on yield attributes and yield of summer sesame

Tr. No.	Treatments	Yield attributes and yield							
		No. of capsule plant^{-1}	Length of capsule	Number of seeds capsule^{-1}	Seed weight (g plant^{-1})	Test Weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest Index (%)
T_1	100% RDF (50:25:40 kg N-P_2O_5-K_2O ha^{-1})	39.00	2.53	46.64	3.86	3.22	1198	1953	38.13
T_2	T_1 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	43.13	2.64	48.05	4.14	3.27	1292	1999	39.40
T_3	75% of RDF + 1.5% WSF at 30 and 45 DAS	35.33	2.47	43.04	3.23	3.20	1007	1649	37.82
T_4	75% of RDF + 2.0% WSF at 30 and 45 DAS	42.20	2.50	45.43	3.34	3.20	1045	1763	37.20
T_5	50% of RDF + 1.5% WSF at 30 and 45 DAS	29.23	2.27	37.61	2.42	3.03	758	1124	40.31
T_6	50% of RDF + 2.0% WSF at 30 and 45 DAS	31.13	2.33	37.67	2.59	3.09	815	1210	40.25
T_7	T_3 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	42.83	2.75	49.33	4.25	3.28	1331	2065	39.25
T_8	T_4 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	43.70	2.89	50.37	4.44	3.29	1386	2124	39.53
T_9	T_5 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	32.30	2.39	39.87	2.98	3.05	919	1284	41.63
T_{10}	T_6 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	35.00	2.41	41.54	3.03	3.12	941	1310	41.73
	S.Em.±	2.067	0.12	2.54	0.16	0.127	54.55	101.3	NS
	C. D. at 5%	6.143	0.36	7.56	0.49	NS	162.07	301.2	4.91

Table 4: Effect of foliar application of NPK and micronutrients on quality parameters and economics of summer sesame

Treatments		Quality parameters			Economics	
		Protein content (%)	Oil content (%)	Oil yield (kg ha^{-1})	Net return (₹/ha)	B: C Ratio
T_1	100% RDF (50:25:40 kg N-P_2O_5-K_2O ha^{-1})	23.14	46.57	558.02	61568	2.82
T_2	T_1 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	25.33	46.90	605.49	67984	2.95
T_3	75% of RDF + 1.5% WSF at 30 and 45 DAS	21.91	45.62	461.38	45206	2.29
T_4	75% of RDF + 2.0% WSF at 30 and 45 DAS	22.52	46.07	482.42	47832	2.35
T_5	50% of RDF + 1.5% WSF at 30 and 45 DAS	20.33	44.08	334.91	26215	1.77
T_6	50% of RDF + 2.0% WSF at 30 and 45 DAS	20.84	44.55	364.33	30373	1.88
T_7	T_3 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	25.84	47.32	630.67	70768	3.01
T_8	T_4 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	26.40	48.46	671.19	74425	3.09
T_9	T_5 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	23.65	45.02	412.08	38720	2.13
T_{10}	T_6 + FS of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS	24.41	45.58	427.47	39647	2.14
	S.Em.±	0.70	1.15	26.71	-	-
	C. D. at 5%	2.10	NS	79.38	-	-

Effect on quality parameters

Quality parameters such as protein content and oil yield significantly influence by different treatments. protein content and oil yield were registered higher under the treatment T_8 (T_4 + Foliar spray of multi micro mixture grade -IV @ 0.25% at 30 and 45 DAS), however statistically equivalent to T_7 and T_2 in respect of oil yield and T_7, T_2 and T_{10} in respect protein content. While all treatments had equal effects on test weight and oil content.

The protein percent higher may be due to more availability of nutrients particularly nitrogen, it is an integral part of protein and phosphorus is structural element of certain co-enzymes involved in protein synthesis. It was also due to improved nitrogen fixation by plants as a result of zinc and boron supply as evidenced by increase in the nitrogen content of seeds. This might be due to the K and B promoting the production of photosynthates and their transport to storage organs and to enhance their conversion into protein and oil (Mengl and Kirkby, 1987) [16]. These findings are in agreement with Ali and Ahmed (2012) [1], Kumara *et al*. (2014) [14], Lakhran *et al*. (2015) [15], Prakash *et al*. (2013) [19], Jajoo (2022) [8] and Solanki (2022) [23].

Economics

Maximum net returns of ₹74425 ha^{-1} and B:C ratio 3.09 was secured with the treatment T_8 (T_4 + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS), which was closely followed by T_7 and T_2. The lowest net return of

₹26215 ha^{-1} and B:C ratio 1.77 was accrued under the treatment T_5 (50% of RDF + 1.5% WSF at 30 and 45 DAS). The higher net realization and B: C ratio in T_8 might be due to higher seed and stover yield in this treatment as a result of better utilization and higher nutrient availability throughout the crop growth period. The results of the present investigation strongly support the findings of Chetana and Math (2018) [5], Batta (2020) [3] and Jajoo (2022) [8].

Conclusion

Based on one year's experimentation, it seems quite logical to conclude that for getting higher seed yield and net realization from summer sesame, crop should be fertilized with 75% RDF (37.5: 18.75: 30 kg N: P_2O_5: K_2O ha^{-1}) + 2.0% WSF (19:19:19 N-P_2O_5-K_2O) at 30 and 45 DAS + Foliar spray of multi micro mixture grade - IV @ 0.25% at 30 and 45 DAS under medium black calcareous soil of South Saurashtra Agro-climatic Zone.

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