



Evaluation of Sesame Yield and Yield Component under Different NPS Fertilizer Rates in Western Tigray, Ethiopia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Field experiments were conducted in three sites of Western Tigray, Ethiopia. The experiments aimed at identifying optimum the rate of the newly introduced NPS fertilizer impact with different levels on growth, yield attributes, yield and economics of sesame in vertisols of Western Tigray at the Humera station, Banat and Kebabo Kafta Humera and Tsegede Wereda's. The treatments consisted of six levels of NPS 0, 50, 100, 150, 200 and 250 kg ha⁻¹ and one blanket recommendation N and P was applied. The experiment was laid out in an RCBD with three replications. Yield of Sesame and yield related components showed significant difference ($p < 0.001$) compared to control. Results showed that number of branches plant⁻¹, length of pod bearing zone (cm), plant height (cm), number of capsules plant⁻¹, seeds capsule⁻¹ and seed yield was significant differences at ($P < 0.001$) Grain yield increases from 444.8 kg ha⁻¹ to 671.9 kg ha⁻¹ as NPS and 444.8 kg ha⁻¹ to 628 kg ha⁻¹ as NP increases from 0 (control) to 100 kg ha⁻¹ NPS and 41 kg

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N and 46 kg P₂O₅ ha⁻¹ respectively. But NPS was not significant with blanket recommendation of N and P (41 kg N and 46 kg P₂O₅ ha⁻¹), therefore no need to replace the NP by NPS fertilizer in the study area.

Keywords: Blanket recommendation; fertilizers; sesame; yield.

1. INTRODUCTION

Sources of plant nutrients for Ethiopian agriculture over the past five decades have been limited to Urea and Di ammonium Phosphate (DAP) fertilizers [1]. The two fertilizers contain only nitrogen and phosphorus that may not satisfy the nutrient requirements of crops including sesame [2]. In this regard however, [2] reported that Ethiopian soils lack most of the macro and micronutrients that are required to sustain optimal growth and development of crops. This is exacerbated especially by Ethiopian fertilizer rates that are below international and regional standards [1]. Consequently, the yield and productivity of the crop is low.

To avert the situation the Ministry of Agriculture of Ethiopia has been recently introduced a new compound fertilizer (NPS) containing nitrogen, phosphorous and sulphur with the ratio of 19% N, 38% P₂O₅ and 7% S [3]. This fertilizer has been currently substituted Di ammonium Phosphate (DAP) in Ethiopian crop production system as main source of phosphorous [3]. The situation is even more challenging for the researchers and smallholder farmers to understand the effects and identify the optimum rates of the newly introduced NPS fertilizer that contains sulphur for economical production of crops including sesame.

Most of the sesame producing farmers in the Western Tigray where advised to use the Blanket recommendation or National recommendation of P (64 kg P₂O₅ ha⁻¹) and N (41 N ha⁻¹), i.e. 50 kg of urea and 100 kg of DAP per hectare, but the newly introduced NPS fertilizer also currently applied with the same trend of the blanket rate agricultural office of the wereda.

In the study area there were not studied the optimum fertilizer rate of NPS, when they introduce to produce sesame under rain fed condition. As result improper fertilizes application may make final harvested yield low. Even though, new blended fertilizer NPS are currently being used by farmer in the study area, some of the farmers said that the blanket recommended fertilizer was high.

Moreover, these agronomic practices vary depending on the physical and chemical properties of the soil, the soil moisture status; varieties grown etc. Thus, there is a need to develop area specific recommendation of blended NPS fertilizer rate in order to achieve maximum and higher yield sesame ha⁻¹ production. Therefore, a field experiment aimed at assessing the effect of blended NPS fertilizer rate on yield and yield components of sesame in the Kaftahumera and Tsegedie district of Western Tigray Ethiopia.

2. MATERIALS AND METHODS

2.1 Description of the Experimental Site

The field experiment was conducted under rain fed conditions in three sites namely on station Banat and Kebabo, Kafta Humera and Tsegedie Wereda's, Western Tigray Ethiopia. Kafta Humera located at 13°10'N to 14°29'N, 36°31'E to 37°34'30"E with an average altitude of 609 masl. Tsegedie Wereda located at 13°4'25" to 14°6'55"N, 36°51'29" to 37°05'25"E with an average altitude of 1850 masl.

2.2 Experimental Set-up

The field was prepared well before sowing by plough twice with tractor and well leveled for seed bed. Seeds of sesame were planted in rows 4*2.8 m long with spacing of 0.4 m between rows. The experiment consists of 7 rates of NPS. The rates of blended of NPS were 0, 50, 100, 150, 200 and 250 kg ha⁻¹ which included blanket recommended N and P fertilizers (41 kg N ha⁻¹, 46 kg P₂O₅ ha⁻¹). The amount of nitrogen was applied in split application form 1/3 at sowing and the remaining also applied 3 weeks after sowing. Top soil (0-15 cm) was collected from the experimental site, air dried and sieved through a 2 mm diameter mesh and laboratory analysis were made for texture, pH, organic matter, total N, available P and CEC following their respective standard procedures at Mekelle soil research center. All agronomic operations were done. The experiment was arranged in a completely randomized design (RCBD) replicated three times.

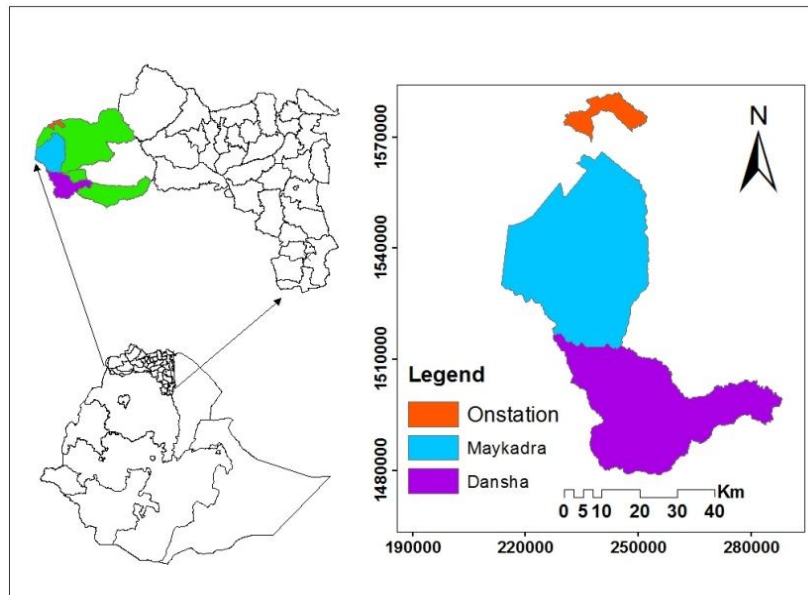


Fig. 1. Map of the study area

2.3 Data Collection

Data collected were number of branches, plant height, number of capsules per plant and number of seeds per capsule from five randomly selected plants per plot. Furthermore, grain yield and biological yield were obtained by harvesting an area of 4 m 2.8 from the middle of each plot.

2.4 Statistical Analysis

GenStat® 18th Edition (VSN International, Hemel Hempstead, UK) was used to perform analyses of variance (ANOVA). Differences between means of significant variables was Duncan's Multiple Range Test (DMRT) at the 5% significance level.

3. RESULTS AND DISCUSSION

3.1 Selected Physicochemical Properties of Soils of the Experimental Sites

The analytical results of the experimental soil indicated that the soil textural class at Humera station is clay with a particle size distribution of 60% clay, 37% silt and 3% sand. At Banat the soil textural class is clay with particle size distribution of 58% clay, 25% silt and 17% sand and similarly. While at Kebabo, the soil textural class is clay with particle size distribution of 59% clay, 26% silt and 15% sand (Table 1).

The soil reaction at Humera station is moderately alkaline whereas that of Banat and Kebabo substation is neutral according to the rating of Hazelton and Murphy [4] (Table 1). According to FAO [5] the pH in the experimental site is within the preferable range for most productive soils (5.5 to 7.5). Thus, the pH of the experimental soil is optimal for sesame production and didn't have soil productivity constraints associated with soil reaction. Organic matter content of the soil is 0.74%, 0.71% and 0.69% for Humera station, Banat and Kebabo substation, respectively. Compared to the soil organic matter rating of [6], the organic carbon content of soils is low in all the sites. Hence, amending the soils with organic fertilizers is important to enhancing crop yields as well as soil health.

Total N content of the soil is 0.12, 0.04 and 0.03% Humera station, Banat and Kebabo substation, respectively. According to the classification of [6] the soil analysis result indicated that total N is a limiting factor for optimum crop growth. Therefore, the soils need amendment. The Available soil phosphorous (Olsen P) at all sites was low according to [6].

According to the rating of Hazelton and Murphy [4], the soils at the experimental sites have very high and high CEC values (Table 1). The higher CEC probably facilitates the capacity of the soils in the three sites to retain nutrients against leaching.

Table 1. Initial surface (0-15 cm) physical and chemical property of the experimental field

Soil parameters	Experimental sites		
	Humera	Banat	Kebabo
Sand (%)	18	17	15
Silt (%)	30	25	26
Clay (%)	52	58	59
Textural Class	C	C	C
pH(1:2.5 H ₂ O)	7.4	6.91	6.99
Organic Matter (%)	0.74	0.71	0.69
Total Nitrogen (%)	0.03	0.03	0.02
Available Phosphorous(mg kg ⁻¹)	3.5	4	4.5
Cation Exchange Capacity (cmol (+) kg ⁻¹)	40	39	42

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3.2 Growth and Yield Parameters of Sesame

Rates of fertilizer (NPS) blends significantly ($P < 0.001$) affected almost all the growth and yield attributes of sesame and seed yield over the control. Furthermore, the NPS with blanket recommendation (NP) had no significant effect on parameter. Branches plant⁻¹, length of pod bearing zone (cm), maximum plant height (cm), capsules plant⁻¹, seeds capsule⁻¹ and seed yield (670.2 kg ha⁻¹ and 671.9 kg. ha⁻¹) were recorded in NPS at 50kg ha⁻¹, followed by NPS at 100kg ha⁻¹, whereas minimum growth and yield parameters were noted in No fertilizer (Control). Similarly in the findings application of NP rates show significant effect ($P \leq 0.001$) on number of branches per plant, length of pod bearing zone (cm), number of capsule per plants, number of seeds per capsule and grain yield (Table 2), but NP and NPS did not affect each other [7]. Reported that the interaction between nitrogen phosphorus showed maximum growth and yield attributes of sesame over a control plot.

The results are generally in agreement with the findings of different researchers who reported positive response of NPS fertilizer rates at different areas on potato [8,9,10,11].

3.3 Grain Yield/Seed Yield

Grain yield was significantly affected by NPS fertilizer rate ($P < 0.001$). But the NPS fertilizer interaction location had no significant effect on that parameter. Furthermore, the NPS with blanket recommendation (NP) had no significant effect on grain yield. Grain yield increases from 444.8 kg/ha to 671.2 kg/ha and 670.9 as NPS increases from 0 to 50 kg and 100 kg/ha NPS. Thus, sesame plants grown at the rate of 100 kg NPS ha⁻¹ produced as much yield (additional increment of 34%) as the grain yield produced from the control.

Similarly grain yield increases from 444.8 kg/ha to 628.2 kg/ha as NP increases from 0 to 41 kg N and 46 P₂O₅. This finding is in line with the ideas of [12] that indicates maximum yield of seed hectare⁻¹ was obtained from the application of NP whereas the minimum seed yield was obtained from control or without NP.

The highest yield was obtained at a rate of NPS fertilizer 50 kg (670.2), 100 (671.9) kg ha⁻¹ and blanket recommendation NP (628.2) kg ha⁻¹ were in statistical parity and the lowest yield (444.8) kg ha⁻¹ was recorded at nil application rate of the fertilizer [13]. Reported that grain yield and yield parameters of sesame were significantly enhanced by the application NP [14]. [15] Found maximum growth and yield parameters in the application of NP [16]. Positive influence of NPS fertilizer and other sulphur-containing fertilizers have been also recorded on various vegetable crops [17] and [18].

From the three locations the maximum sesame grain yields (727.9 kg/ha for Humera station, 584 kg/ha for Banat and 530 kg/ha for Kebabo) were obtained at the rate of 100 kg/ha NPS fertilizer. This also is in agreement with the results reported by [19] on tef. In the locations (Humera station, Banat and Kebabo station) there were significant difference at ($P < 0.001$) on yield and yield traits of sesame. But the significant difference might be the influence by the environment whether condition in 2018 because of the occurrence of high rain fall affected which could have counted for the lower yield in Banat and Kebabo. Because of the change in the environmental condition that forces the crop to reduce vegetative growth and commence reproductive phase as reported by [20]. Reported by [21] crops to be enhanced by favorable growth condition as obtained in most cases at early part of the season when rains are fully established.

Table 2. Mean yield and related traits of sesame obtained from the sown across the three sites during 2018-2019

Factor	NB	PH(cm)	LPBZ(cm)	NCPP	NSPC	GY(Kg ha ⁻¹)
Humera station	3.29a	161.6a	76.86a	46.65a	67.95a	725.9a
Banat	1.64b	137.7b	62.31b	34.61b	57.12b	584b
Kebabo	3.24a	121.8c	52.2c	39.31b	53.26c	530.6c
LSD	0.33	4.56	2.68	4.73	2.72	50.75
F. prob	<.001	<.001	<.001	<.001	<.001	<.001
control (0)	2.17 ^c	125.6 ^b	56.74 ^b	32.61 ^c	54.71 ^b	444.8 ^b
41 N and 46 p ₂ O ₅	2.53 ^{ab}	145.3 ^a	64.87 ^a	39.6 ^{ab}	61.63 ^a	628.2 ^a
50	2.88 ^{ab}	141.4 ^a	67.22 ^a	44.64 ^a	61.33 ^a	670.2 ^a
100	2.99 ^a	141.8 ^a	67.18 ^a	40.46 ^{ab}	59.8 ^{ab}	671.9 ^a
150	2.88 ^{ab}	144.9 ^a	64.6 ^a	42.26 ^a	56.14 ^{ab}	633.5 ^a
200	2.72 ^{ab}	141.8 ^a	62.98 ^a	38.88 ^{ab}	58.81 ^{ab}	611.3 ^a
250	2.87 ^{ab}	141.5 ^a	62.94 ^a	42.89 ^a	60.66 ^{ab}	634.8 ^a
Grand mean	2.75	140.35	63.79	40.19	59.44	613.50
CV	28.4	7.5	9.7	27.1	10.6	19.1
F. prob	0.018	<.001	<.001	<.001	<.001	0.031
LSD 5%	0.52	6.97	4.2	7.23	4.16	77.53

NB=number of branch, PH= plant height, LPBZ=length of pod bearing zone, NCPP= number of capsules per plant, NSPC= number seeds per capsule, GY= grain yield

Table 3. Analysis of variance (Mean square) for combined location *treatment *year Summary of F probabilities from the analysis of variance for yield and related traits of sesame

Source of variation	DF	F probability values					
		NB	PH(cm)	LPBZ(cm)	NCPP	NSPC	GY(Kg ha ⁻¹)
Block	2	0.0086	359.2	13.43	120.2	173.59	29931
NPS fertilizer rate (kg ha ⁻¹)	6	0.8939 ^(0.018)	807.3 ^(<0.001)	228.26 ^(<0.001)	272.9 ^(<0.001)	67.08 ^(<0.001)	108473 ^(<0.001)
Location	5	33.65 ^(<0.001)	16799.2 ^(<0.001)	6457.31 ^(<0.001)	1547.3 ^(<0.001)	2435.88 ^(<0.001)	427813 ^(<0.001)
NPS fertilizer rate *Location	30	0.8769 ^(0.164)	111.9 ^(0.445)	34.23 ^(0.555)	128.9 ^(0.385)	146.84 ^(0.137)	11420 ^(0.614)
Grand mean		2.75	140.35	63.79	40.19	59.44	613.50
CV%		28.4	7.5	9.7	27.1	10.6	19.1

DF= degrees of freedom

4. CONCLUSION

According to this study NPS fertilizer effects on sesame yield and yield components showed that the blended fertilizers would be promising to grow sesame but compared to blanket recommendation NP it has no difference. Thus indicated that sesame productivity in the study sites was increased due to NPS fertilizer over the control but it was at par with the blanket recommendation NP, therefore no need to replace the NP fertilizer in the study area.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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