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Research Article

Determination of optimum planting time of different Sesame (*Sesamum indicium* L.) varieties for Chewaka district, Western Oromia, Ethiopia

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Abstract

Sowing date is the major problem in the production and productivity of sesame in western Oromia Ethiopia. The experiment was conducted to identify optimum sowing dates for sesame varieties to produce better seed yields. A field experiment consisting of the combination of three sesame varieties and three sowing times employed Randomized Complete Block in factorial arrangements with three replications. Analysis of variance indicated that plant height; branches number per plant and number of capsules per plant were significantly increased with sowing sesame at the onset of rainfall. All sesame varieties sown on the onset of rainfall gave the maximum seed yield in both years whereas three varieties had low yield at 10 days after the first and 20 days after the first. Among the three varieties, the Walin variety produced a maximum seed yield of 670 and 747 kg ha^{-1} on a farm in the first and second year respectively. The maximum yield (670 and 971 kg ha^{-1}) was obtained from Walin and Obsa sesame varieties in the first and second years of the farm respectively. Therefore, the result indicated that sowing sesame varieties at the onset of rainfall is recommended for Chewaka areas and similar agroecology.

Introduction

Sesame (*Sesamum indicum L.*) is an important annual oil seed crop grown especially in developing countries as a rich source of oil, protein, calcium, and phosphorus. Sesame is the most ancient oil seed known and grown by humans according to archaeological records among oil seed crops [1]. There are no definite findings on the origin of sesame, though Ethiopia is considered to be the center of cultivated sesame [2]. Despite its long history, sesame has recently attracted increasing interest as a source of good-quality oil that is resistant to oxidative rancidity due to the presence of endogenous antioxidants such as sesamol, and sesamolin [3].

Ethiopia has full potential for sesame production [4]. This is mainly linked to sesame's natural flexibility to adopt different soil types and harsh environments as well as Ethiopian diversified agroecology and the potential of arable land, water, labor force, and market opportunities. Ethiopia is one of the key players in the global market for sesame seed and remains a main source of foreign currency for agricultural commodities next to coffee [5]. Despite the country has high potential to increase production and rapid demand growth in the international market of Ethiopian sesame, the productivity of the crop is low as compared to its potential yield due to different production-related problems as indicated in studies by [4,6]. In Ethiopia, the production of sesame is both by small and large-scale farmers; and it is an important crop and export commodity [7]. Sesame, after coffee, is the second most significant agricultural product in terms of foreign exchange earnings, with about 449 million USD [8]. The total area, production, and productivity during 2020 were 375,119.95 hectares of land, 2,626,541.89 quintals, and 7.0 qt ha^{-1}, respectively [9]. Sesame ranks first in total area and production from oil crops during 2020; and

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Tigray, Oromia, Amhara, and Benshangul Gumuz regions are the major producers in Ethiopia. Due to its importance as a major export commodity, the area coverage and production have increased in the last consecutive years in Ethiopia. There is an enormous potential to expand sesame seed production in Ethiopia through the cultivation of additional new land. The government is enhancing investment in the oilseeds sector with an extended package of incentives. Through the transfer of technology and the provision of inputs, the increment of production and yield will be achieved strongly.

Generally in Ethiopia, and particularly in Oromia where sesame is grown, about 6.77qt/ha were obtained in 2019 [10]. Furthermore, western Oromia contributes more to sesame production and productivity. Thus to obtain a high yield the best time for the sowing period is found to be from the beginning of June to Mid-July when cultivated as rain-fed crop. Maturity depends on the weather condition and it usually varies from 90 - 105 days. The sowing date is one of the important factors for higher production as it determines the optimum time for the sowing of the crop [11]. An optimum time of sowing enhances the efficiency of sesame by exploiting growth factors in an effective way. Early sowing date of sesame recorded higher yield in comparison to late sown crop [12-14]. A delay in planting decreases sesame productivity [15].

Basically, the seed yield of sesame is very low due to poor management practices [16]. Yield decreases progressively with the delay in planting from the optimum time of sowing [17]. Research works are limited to sowing dates in sesame varieties in western Oromia and the same agroecologies. Even though, previously practiced sowing times are characterized by poor crop establishment and very low yields specifically in the Chewaka district, which is a high potential district for sesame production. Farmers in the district were conscious of the poor performance of sesame when planted at the blanket recommendation of sowing times and learned to plant earlier (usually early to mid-May), as a result attaining better yields. But, for different lately sowed sesame research activities, Bako Agricultural Research Center (BARC) has resulted in less performance than the early planted local sesame crops of the farmers. Therefore the objective of this study was undertaken to identify the optimum sowing date/s for sesame varieties to produce better seed yields.

Materials and methods

Description of the experimental site

A field experiment was conducted at the Chewaka site Chewaka district. The site is located at 08˚57'05" N latitude and 036˚06'43''E longitude an altitude of 1294 meters above sea level (Figures 1,2).

Experimental design and management

A field experiment consisting of the combination of three sesame varieties (Obsa, Chalasa, and Walin) and three planting times (at the onset of rainfall, 10 days after the onset of rainfall, and 20 days after the onset of rainfall) was done at Chewaka site Chewaka district. The employed experimental design was a

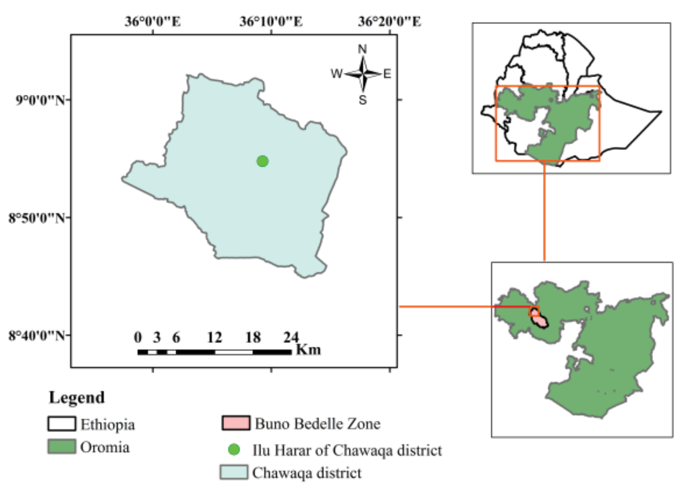

Figure 1: The geographical location of the Study Area.

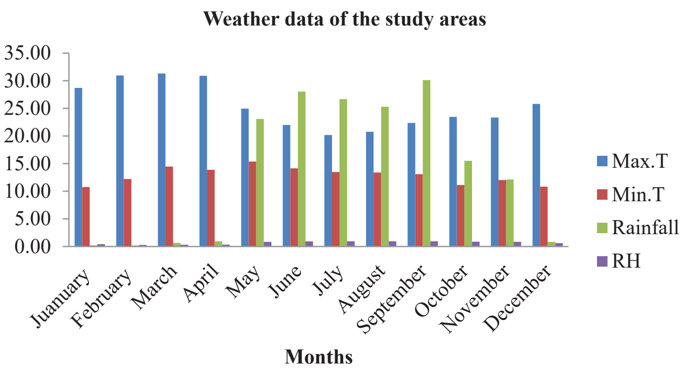

Figure 2: Mean rainfall, temperature, and relative humidity.

Randomized Complete Block (RCBD) in factorial arrangements with three replications.

The land was prepared by oxen-drawn plowing and hand tools, after that, it had been leveled and smoothed by human labor using hand tools. The seeds of the sesame varieties were drilled at a depth of about 2.5 cm at a row spacing of 40 cm to ensure adequate emergence. Fertilizer application was based on the recommendation of the area (64 and 38 kg ha^{-1} N and P_2O_5 fertilizers respectively). Hence, 100 kg ha^{-1} NPS (38% P_2O_5) and 50 kg ha^{-1} Urea (46% N) were used as sources of P and N nutrients. The whole NPS was applied at the different sowing times and the Urea was side dressed 30 to 40 days after emergence. Weeding and other crop management practices were carried out uniformly for each plot as per the recommendation for the crop. Harvesting was done at physiological maturity when 50% of the plants got yellow and when the bottom of the sesame capsule started to open. Drying was done by setting the bundles upright until all capsules opened. Threshing was done by shaking properly the inverted bundles until all seeds drop from the capsules.

Treatment combinations:

1. Variety Obsa planted at the onset of rainfall
2. Variety Obsa planted 10 days after onset of rainfall

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3. Variety Obsa planted 20 days after onset of rainfall
4. Variety Chalasa planted at the onset of rainfall
5. Variety Chalasa planted 10 days after onset of rainfall
6. Variety Chalasa planted 20 days after onset of rainfall
7. Variety Walin planted at the onset of rainfall
8. Variety Walin planted 10 days after onset of rainfall
9. Variety Walin planted 20 days after onset of rainfall

Data collection

Data collection and measurements: From the net plot area, five (5) plants were selected randomly and tagged to collect the growth and yield component traits of the sesame varieties.

Growth parameters: The number of branches per plant was counted from five randomly selected plants per net plot area at physiological maturity.

The plant height of the main stem was measured from the ground surface to the tip of the apex at physiological maturity.

Yield and yield-related traits: The number of capsules per plant was counted from five randomly selected and pre-tagged plants per net plot area at the physiological maturity of the crop.

The seed yield of each plot was weighed in grams and converted to an area basis to determine the yield per hectare in kg ha^{-1}.

Statistical data analysis

Data were subjected to analysis of variance (ANOVA) using SAS software (9.3). All significant pairs of treatment means were compared using Duncan's multiple tests at 5% and 1% levels of significance.

Results and discussions

Main effects of sowing date and varieties on growth performance of sesame

Analysis variances indicated that there was a significance different among varieties in terms of plant height and number of capsules per plant whereas non-significance differences were detected in the number of primary branches per plant. Sowing dates significantly influence plant height, number of capsules per plant, and number of primary branches per plant (Table 1). In this detail, plant height, branch number per plant, and number of capsules per plant were significantly increased with planting sesame at the onset of rainfall at Chewaka in both years. The result is in agreement with [18] who reported that early sowing sesame varieties gave the tallest and increased number of primary branches per plant and delayed sowing gave the shortest plant height and decreased number of primary branches per plant.

Plant height: Sowing dates and varieties had a significant influence on plant height. Among the three sesame varieties the tallest plants were recorded from the Walin variety which was (96.7 and 122.6 (cm)) while the shortest plant was recorded from the Obsa variety (83.7 and 103.2 (cm)) in the first and second year respectively. The tallest plant for all varieties was recorded at the onset of rainfall (Table 1). In this experiment, the attained results show that the suitable environmental growth factors harmonized with the growth stages of sesame planted at the onset of rainfall promoting the growth. The tallest plant was recorded when sown sesame varieties were at the onset of rainfall in both years compared to 10 and 20 days after the onset of rainfall at Chewaka (Table 1). The tallest plant height (136.4 cm) and shortest plant height (63.2 cm) were recorded in the second year and first year on the farm respectively. This might be attributed to sufficient moisture in the soil during the vegetative periods at the onset of rainfall sown sesame varieties in both years. Accordingly, the enhancements in sesame yield components at the onset of rainfall sowing time may be due to that the plants had optimum vegetative growth, adequate photosynthetic activity and more assimilates than 20 days after the onset of rainfall sowing time. In contrast to this result delaying the sowing date resulted in greater plant height due to rising temperature favoring vegetative growth of sesame compared to earlier sowing [19].

Capsule per plant: Sowing date and varieties were significantly influenced by capsule per plant. Among the three sesame varieties, the highest number of capsules per plant was recorded from the Walin variety which is 20.3 and 46.7 whereas the smallest number of capsules per plant was Obsa variety (10.9 and 39.6) in the first and second year respectively at one farm. The number of capsules per plant recorded in the second year was significantly paramount with Chalasa Variety. In line with these results [20] revealed that the number of capsules per plant was influenced by varieties. Likewise, the highest number of capsules per plant was recorded when sown sesame varieties at the onset of rainfall in both years compared to 10 and 20 days after the onset of rainfall at Chewaka (Table 1).

Number of primary branch: Analysis of variance shows that there was no significant difference in varieties in terms of the number of primary branches per plant (Table 1). This result was disapproved by [21] who reported that the number of branches per plant was significantly influenced by crop varieties. However, the sowing date had a significant influence on the number of primary branches per plant. The result had been obtained in agreement with [21] who reported the number of branches plant per plant significant due to the effect of the date of sowing.

Interaction effect of sowing date and varieties on sesame seed yield

Seed yield of sesames: Analysis of variance indicated that sowing sesame at the onset of rainfall was an effective practice for enhancing all yield, yield attributes (Table 2). The interaction effect of sowing date and variety exerted a significant influence on the seed yield of sesame varieties in the investigation (Table 2). Three sesame varieties sown on the onset of rainfall gave

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Table 1: The main effect of Sowing date and Varieties on the Growth performance of Sesame at Chewaka.

	1st year			2nd year					
	On-farm			On-farm			On station		
Variety	PH	NCPP	NPB	PH	NCPP	NPB	PH	NCPP	NPB
Chalasa	88.7^{b}	13.5^{b}	1.08	113.5^{b}	52.5^{a}	3.82	115.3^{b}	45.7	3.71
Obsa	83.7^{b}	10.9^{b}	1.36	103.2^{bc}	39.6^{b}	3.52	101.8^{c}	45.1	3.98
Walin	96.7^{a}	20.3^{a}	1.23	122.6^{a}	46.7^{a}	3.35	120.8^{a}	48.9	3.71
LSD (0.05)	5.18	4.8	ns	9.08	6.84	ns	5.2	ns	ns
Sowing Date									
Onset	124.5^{a}	23.5^{a}	1.92^{a}	136.4^{a}	42.4^{b}	3.82^{a}	124.2^{a}	53.2^{a}	4.07^{a}
S10	82.4^{b}	15.0^{b}	0.97^{b}	139.5^{a}	58.3^{a}	3.78^{a}	112.9^{b}	45.2^{b}	3.93^{a}
S20	62.3^{c}	6.2^{c}	0.78^{b}	123.5^{b}	38.1^{b}	3.09^{b}	100.8^{c}	41.3^{b}	3.40^{b}
LSD(0.05)	5.18	4.8	0.32	9.08	6.84	0.34	5.2	4.06	0.46
CV (%)	5.8	23.3	16.5	6.8	14.8	9.4	4.6	8.7	12.1

PH: Plant Height; NCPP: Number of Capsules Per; NPB: Number of Primary Plants; S0: Sowing at the onset of rainfall; S10: 10 days after onset of rainfall; S20: 20 days after onset of rainfall.

Table 2: Interaction effect of sowing date and varieties on seed yield of Sesame at Chewaka.

	1st year			2nd year					
	On-farm			On-farm			On station		
	Sowing date								
Variety	S0	S10	S20	S0	S10	S20	S0	S10	S20
Chalasa	322.5^{c}	195.3^{d}	80.6^{fg}	754.2^{b}	245.3^{cd}	394.5^{cd}	409.4^{b}	82.8^{de}	142.2^{cd}
Obsa	372.8^{b}	148.3^{de}	44.0^{g}	971.9^{a}	188.3^{d}	361.7^{cd}	444.5^{b}	45.3^{e}	124.0^{cd}
Walin	670.0^{a}	386.4^{b}	116.7^{ef}	747.7^{b}	290.6^{cd}	456.3^{c}	573.4^{a}	96.9^{cd}	165.6^{c}
LSD(0.05)	47.7			202.2			67.2		
CV (%)	10.5			23.8			16.8		

S0: Sowing at onset of rain fall, S10: 10 days after onset of rain fall, S20: 20 days after onset of rain fall.

the maximum seed yield in both years whereas three varieties had low yield at 10 and 20 days after the first onset of rainfall. The maximum yield at onset rainfall sowing time might be attributed to favorable temperature at the grain development stage which in turn increased the photosynthetic rate and assimilates the supply for seed and seed growth rate in timely sown crops. Maximum seed yield of sesame at onset rainfall sown condition as compared to other sowing dates of sesame was also reported by several workers [22,14]. Among the three varieties, the Walin variety produced a maximum seed yield of 670 and 747 kg ha^{-1} on a farm in the first and second year respectively. The maximum yield (670 and 971 kg ha^{-1}) was obtained from Walin and Obsa sesame varieties in the first and second years of the farm respectively. The result indicated that as the sowing date was late the seed yields of three varieties were decreased. In the second year the yield of three varieties sown 20 days after onset of rainfall gave better yield compared to 10 days after onset of rainfall. This result might be moisture unavailability observed while sesame seeds were sown 10 days after the onset of rainfall which affected the germination of the seed. Among three varieties Walin gave better seed yield at 10 and 20 DAS sowing. These results indicated that sown sesame varieties at the onset of rainfall had longer growth periods as a result more seed yield was produced as compared to late sown sesames. These findings are in line with those of [23]. Also, [13] reported that earlier sowing dates resulted in significantly higher seed yield by about 56%. The onset of rainfall sowing date as an optimum date for higher yield and its attributes compared to late sowing date in three sesame varieties were confirmed for western Oromia, especially at the targeted district. Similar results were reported by [20,15].

Conclusion and recommendation

The experiment was conducted to identify optimum sowing dates for sesame varieties to produce better seed yields. The analysis of variance indicated that the sowing date significantly influenced the growth parameters of sesame varieties. Optimum yield and growth parameters were obtained when sesame was sown at the onset of rainfall and then 10 and 20 days after the first onset of rainfall. Even though sowing sesame at the first onset of rainfall is the best time, it depends on the amount of rain intensity and soil types to germinate seeds better. The variability of rainfall in amount and intensity was the challenge across the year. Moreover, it is more important to focus on measuring soil moisture and temperature to identify better times of sowing for research related to sowing dates in the future. Based on the result obtain from two-year yield data; it could be concluded that under similar conditions, sown sesame

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varieties at the onset of rainfall is the optimum sowing time at Chewaka. Therefore, the three varieties are recommended for better production and productivity of sesame at the onset of rainfall in the District and the same Agroecology.

Data availability

The raw data are available from the corresponding author upon request.

Authors' contributions

Tadese Birhanu initiated the research proposal, and Alemayehu Debasa established the approved proposal and started fieldwork. Chala Debela has conducted the research, executed data collection, entry, and analysis, and wrote the manuscript. Teshome Gutu and Feyera Tekele, have followed the activities and methodologies.

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