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Performance evaluation of black cumin (Nigella satival L.) varieties for yield and its components in Southwest Ethiopia

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Abstract

The experiment was carried out at two locations, namely, Alargeta and keyikela. The experiment was laid in RCBD design with three replications. Quantitative data were collected both on plot and plant bases, i.e., days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of capsules per plant, number of seeds per capsule, and seed yields were recorded. Analysis of variance shows significant differences among the varieties for most of the studied characters except for the number of primary branches per plant. Most of the traits showed significant difference for the environment by variety interaction, which implies a potential difference in the tested locations. Variety, Dershaye was observed as an early maturing type relatively. The maximum seed yield was harvested from Aden, followed by Gemmachis. Therefore, those two varieties, Aden and Gemmachis, were recommended for production in the study area and other similar agro ecologies.

1. INTRODUCTION

Black cumin (*Nigella sativa* L.) is a medicinal plant belonging to the Ranunculaceae family, originating from Southwest Asia and the Mediterranean region (Toncer and Kizil, 2004). It is an important spice crop used in human diets and for pharmaceutical purposes due to its rich composition of proteins, alkaloids (nigelledine), saponins (α-hederin), and essential oils (Ozel et al., 2009).

The gynoecium consists of multiple carpels containing numerous ovules, which develop into follicles after pollination and collectively form a capsule-like fruit. Black cumin seeds have been used since ancient times for promoting human health, as documented in both religious and scientific sources. In Islamic tradition, the importance of *Nigella sativa* is highlighted in a saying of the Prophet Muhammad, which states that the black seed is a remedy for many diseases (Ghaznavi, 1991).

The seeds are generally small (1–5 mg), dark gray to black in color, and have a corrugated surface, representing the economically important part of the plant (Ceylan, 1997). The fixed and essential oils of black cumin contain several bioactive compounds, including thymoquinone, thymol, tocopherol, trans-retinol, and selenium (Sultan et al., 2009). Ethiopian black cumin varieties may contain up to 50% thymol, a monocyclic phenolic compound with significant healthcare value (Jibat ,M ., et al., 2018).

In Ethiopia, black cumin is an important cash crop and is exported to international markets, ranking second after ginger (Teshome and Anshiso, 2019). It is widely cultivated due to its culinary and medicinal uses and its adaptability to diverse soil types. Most Ethiopian households use black cumin as a spice in food preparation. Despite its importance, productivity remains low in Africa (FAO and WFP, 2012).

In Ethiopia, black cumin is mainly grown under rain-fed conditions in highland areas ranging from 1500 to 2500 meters above sea level, particularly in the Amhara, Oromia, and Southern Nations, Nationalities, and Peoples' (SNNP) regions, often intercropped with cereals. The annual production is estimated at 18,000 metric tons, with an average productivity of 0.79 tons per hectare (Kifelew et al., 2017).

Previous studies in southwestern Ethiopia, such as those conducted by Ermias Assefa and colleagues, evaluated three improved varieties along with a local check and reported significant yield differences. However, recently released varieties were not included in those studies. Due to limited extension services and a shortage of improved varieties, black cumin production in southwestern Ethiopia remains low. Farmers in the study area primarily produce spice crops at a small scale for household consumption.

Therefore, evaluating improved black cumin varieties under different agro-ecological conditions is essential to enhance productivity. This study was conducted to identify well-adapted black cumin varieties for the study area and similar agro-ecologies.

2. Materials and Methods

2.1 Description of Experimental Sites

The experiment was conducted at Keykela (on-station) and Alargeta (substation) of the Bonga Agricultural Research Center (BARC), located in the Kaffa Zone of Southwestern Ethiopia.

Keykela is situated at 7°23' N latitude and 35°59' E longitude, at an altitude of 1760 m above sea level. The site receives an annual rainfall ranging from 1710 to 1892 mm, with mean daily temperatures between 18.1°C and 19.4°C.

Alargeta is located at 7°17' N latitude and 36°22' E longitude, at an elevation of 2250 m above sea level. Both locations experience an extended rainy season from March to October, although rainfall distribution varies between sites.

2.2 Experimental Design and Trial Management

The experiment was arranged in a randomized complete block design (RCBD) with three replications. Each plot measured 2 m × 1.8 m (3.6 m²). Row spacing, plot spacing, and block spacing were maintained at 0.3 m, 0.5 m, and 1 m, respectively.

Each plot consisted of six rows; however, only the four central rows were used for data collection, while the outer rows served as borders. A seed rate of 15 kg ha^{-1} was applied. All agronomic practices were carried out in accordance with national recommendations.The black cumin varieties evaluated in this study were obtained from the Ambo Agricultural Research Center.

2.3 Data Collection

The following parameters were recorded on a plot or plant basis:

Days to 50% flowering (DF): Number of days from sowing to the stage when 50% of plants in a plot had flowered.

Days to maturity (DM): Number of days from sowing until 95% of the capsules in a plot turned light green.

Plant height (PH, cm): Measured at physiological maturity from five randomly selected plants per plot.

Number of primary branches per plant (PBPP): Average number of primary branches from five randomly selected plants.

Number of capsules per plant: Average number of capsules counted from five sampled plants.

Number of seeds per capsule: Determined by counting seeds from five randomly selected capsules and computing the average.

Seed yield (SYLD, kg ha^{-1}): Plants from each plot were harvested, dried, and threshed. The seeds were weighed, and plot yield was converted to kilograms per hectare.

2.4 Data Analysis

All collected data were analyzed using SAS software (version 9.3). Prior to analysis, assumptions of analysis of variance (ANOVA), including normality and homogeneity of variance, were verified.Homogeneity of error variances across locations was tested using Hartley's F-max test. The ratio of the largest to the smallest error mean square was 2.61, which is below the critical threshold of three, indicating homogeneity of variances. Therefore, combined analysis across locations was performed following the procedure described by Gomez and Gomez (1984).

Mean comparisons among treatments were conducted using the least significant difference (LSD) test at the 5% level of significance.

3. RESULT AND DISCUSSION

Analysis of variance (ANOVA) revealed significant differences ($P < 0.05$ and $P < 0.01$) among the black cumin varieties for most of the studied parameters, except for the number of primary branches per plant, which showed a non-significant difference (Table 1). This indicates the presence of detectable variability among the tested black cumin varieties for most traits. Additionally, most traits showed significant environment × variety interactions, suggesting differential performance of varieties across locations.

Table 1
Mean square values of traits combined over locations

SV	DF	DTF	DTM	PH	NPBPP	NCPP	NSPC	SYLD
ENV	1	2916**	3823.36**	294.7**	9.2^{ns}	11.73**	870.25^{ns}	467.42*
REP	2	3.25^{ns}	6^{ns}	5.60^{ns}	1.63^{ns}	2.06^{ns}	14.08^{ns}	63.64*
VAR	5	37.46**	320.58**	51.52**	0.29^{ns}	5.84**	24.52**	119.96**
ENV*VAR	5	72.8**	64.11**	51.52**	0.41^{ns}	4.9**	37.10**	199.96*
ERROR	35	3530	84.16	29.37	23.05	83.81	1477.31	397.02

Where, S. variance=source of variance, DF=degree of freedom, DTF=days to 50% flowering, DTM=days to 95% physiological maturity, PH=plant height, NPBPP=number of primary branches per plant, number of capsules per plant, number of seeds per plant, SYLD=seed yield per.

The combined mean performance of black cumin varieties for yield and yield components is presented in Table 2. Days to 50% flowering showed highly significant variation ($P < 0.001$) among the tested varieties. The longest time to flowering was recorded for DERSHAYE (73.83 days) and ADEN (73.66 days), followed by Sooressa (72.5 days). In contrast, the shortest time was observed in the local variety (67 days), indicating that DERSHAYE and ADEN are late-flowering types, whereas the local variety is early flowering.

Similarly, days to 95% physiological maturity showed highly significant variation ($P < 0.01$). Variety ADEN (151.66 days) required the longest time to maturity, followed by Silingo (148.83 days) and the local variety (148.16 days), while DERSHAYE (142.16 days) matured earliest.

Plant height also differed significantly among varieties ($P < 0.01$). The tallest plants were observed in ADEN (58.7 cm), followed by the local variety (55.66 cm), whereas the shortest plants were recorded in Sooressa (50.53 cm). This suggests that ADEN is a vigorous type, while Sooressa is relatively dwarf and potentially more resistant to lodging.

Highly significant differences ($P < 0.01$) were observed among varieties for the number of capsules per plant. The highest values were recorded in Sooressa (7.21), ADEN (7.14), and Silingo (6.74), followed by DERSHAYE (6.26), whereas Gemmachis (4.82) had the lowest value.

The number of seeds per capsule also showed highly significant variation ($P < 0.01$). The highest values were recorded in ADEN (62.13) and Silingo (61.20), followed by DERSHAYE (60.36), Sooressa (59.60), and Gemmachis (58.53). The lowest value was observed in the local variety (56.46). This finding is consistent with Taqi (2013), who reported significant variation among black cumin varieties for this trait.

Seed yield showed highly significant differences ($P < 0.01$) among the tested varieties. The highest yield was obtained from ADEN (709.26 kg/ha), followed by Gemmachis (639.81 kg/ha), Silingo (617.59 kg/ha), and the local variety (610.19 kg/ha), whereas the lowest yield was recorded in Sooressa (593.52 kg/ha). This result agrees with the findings of Assefa and Girma (2016), who reported significant yield variation among black cumin varieties.

Table 2
The mean performance of black cumin varieties in adaption trial combined over locations

Varieties	DTF	DTM	PH	NPBPP	NCPP	NSPC	SYLD
Sooressa	72.5^{ab}	145.16^{d}	50.53^{e}	3.4	7.21^{a}	59.6^{ab}	593.52^{c}
Gemmachis	71.5^{b}	146.5^{c}	51.8^{de}	3.06	4.82^{c}	58.53^{ab}	639.81^{b}
DERSHAYE	73.83^{a}	142.16^{e}	53.16^{cd}	3.36	6.26^{ab}	60.36^{ab}	634.26^{bc}
ADEN	73.66^{a}	151.66^{a}	58.7^{a}	3.2	7.14^{a}	62.13^{a}	709.26^{a}
Silingo	71.5^{b}	148.83^{b}	54.76^{c}	3.7	6.74^{a}	61.2^{a}	617.59^{bc}
Local	67^{c}	148.16^{b}	55.66^{b}	3.5	5.31^{bc}	56.46^{b}	610.19^{bc}
Mean	71.66	147.08	54.10	3.37	6.25	59.71	634.10
CV	2.22	2.1	3.57	16.76	12.85	5.87	3.59
LSD	1.91	0.95	2.31	Ns	0.96	4.2	41.44

DF=degree of freedom, DTF=days to 50% flowering, DTM=days to 95% physiological maturity, PH=plant height, NPBPP=number of primary branches per plant, number of capsules per plant, number of seeds per plant, SYLD=seed yield kg/ha.

4. Conclusion and Recommendation

The present study demonstrated clear varietal differences in the adaptation and performance of black cumin under the agro-ecological conditions of southwest Ethiopia. Among the tested varieties, DERSHAYE exhibited relatively early maturity, indicating its potential suitability for environments where a shorter growing period is advantageous or where terminal moisture stress may occur. Early maturity is an important agronomic trait in such regions, as it allows crops to escape late-season drought and better fit into existing cropping systems.

In terms of productivity, the highest seed yield was recorded from the variety ADEN (709.26 kg ha^{-1}), followed by Gemmachis (639.81 kg ha^{-1}). These yield advantages suggest that both varieties possess superior adaptation and yield stability under the tested conditions. The performance of ADEN, in particular, highlights its strong potential as a high-yielding variety, while Gemmachis also demonstrated consistent and competitive productivity. Such performance differences underscore the importance of varietal selection in improving black cumin production in the region.

Based on these findings, it is recommended that ADEN and Gemmachis be promoted for further demonstration and scaling in Gimbo and Adio districts, as well as in other areas with comparable agro-ecological conditions. Future research should focus on multi-location and multi-season evaluations to validate their stability and adaptability, alongside assessments of agronomic practices that could further enhance yield performance. Strengthening seed dissemination systems and farmer-based demonstrations will be essential to facilitate wider adoption and maximize the crop's contribution to local agricultural productivity.

Declarations

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Autor contribution

All authors contributed equally to all aspects of this research. They have reviewed and approved the final manuscript, accept responsibility for its content, and confirm that it is original and not under consideration elsewhere.

Data availability

The collected data and analyzed in this study can be obtained from the corresponding author upon reasonable request.

Conflict of interest; The authors declare no competing interests.

References

1. Assefa, G. and Girma, S., 2016. Evaluation and Selection of Black Cumin (Nigella sativa L) Varieties at Mid Highland of West Hararghe Zone, Eastern Ethiopia. Evaluation, 6(23).https://www.researchgate.net/profile/GezahegnAssefa/publication/346561519_Evaluation_and_S

2. Ceylan, A., 1997. Medical plants II (Essential oil plant) .Univ.Ege. Fac .Agri. Izmir, Turkey, Pub No.481.https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Ceylan%2C+A.%2C+1997.+Med
3. Food and Agricultural Organization (FAO), World Food Program (WFP) (2012) Crop and food security assessment mission to Ethiopia. Special Report of Food and Agriculture Organization and World Food Program https://www.fao.org/4/ak346e/ak346e00.htm
4. Ghaznavi KM, 1991. Tibbe-e-Nabvi aur Jadid Science, Al-Faisal Nasheeran WA Tajeera-e- Kutab. Urdu Bazar Lahore, Pakistan. 1:228-236.https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Ghaznavi+KM%2C+1991.+Tibbe-e-Nabvi+aur+Jadid+Science%2C+Al-Faisal+Nasheeran+WA+Tajeera-e-
5. Gomez, K.A. and Gomez, A.A., 1984. *Statistical procedures for agricultural research*. John wiley&sons.https://books.google.com/books?hl=en&lr=&id=PVN7_XRhpdUC&oi=fnd&pg=PA1&dq=Gomez,+K.A.+and+Gomez,+A.A.,+1984.+
6. Jibat, M., Getachew, W., Kifelew, H. and Getu, A., 2018. Survey and Identification of Major Diseases of Black Cumin (Nigella sativa L.) in Ethiopia. *Results of Plant Protection Research*.https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.academia.edu/59763052/Survey_and_Identification_of_MajorWeeds_of_Seeds_Spice_in_Ethio
7. Kifelew, H., Getachew, W., Luleseged, T., Mitiku, H., Bekele, D. and Fikere, D., 2017. Seed spicesproductionguideline.https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Kifelew%2C+H.%2C+Getachew%2C+W.%2C+Luleseged%2C+T.%2C+Mitiku%2C+H.%2C+Bekele%2C+D.+and+Fikere%2C+D.%2C+2017.+Seed+spices+production+guideline.
8. Ozel, A., U. Demirel, I. Guler and K. Erden. 2009. Effect of different row spacing and seeding rate on black cumin (Nigella sativa L.) yields and some agricultural characters. Harran Uni. J. of Agriculture Faculty. 13(1): 17-25. (In Turkish).https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Ozel%2C+A.%2C+U.+Demirel%2C+I.+Guler+and+K.+Erden.+2009.+Effect+of+different+row+spacing+and+seeding+rate+on+black+cumin+
9. Sultan, MT., MS. Butt, FM. Anjum, A. Jamil, S. Akhtar and M. Nasir. 2009. Nutritional profile of indigenous cultivar of black cumin seeds and antioxidant potential of its fixed and essential oil.
Pakistan J. Botany. 41: 32-40.https://www.pakbs.org/pjbot/PDFs/41(3)/PJB41(3)1321.pdf
10. Taqi, H., 2013. Samsun koşullarında bazı çörek otu (Nigella sativa L.) populasyonlarında önemli tarımsal ve kalite özelliklerinin belirlenmesi. Ondokuz MayısÜniversitesi Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı Yüksek Lisans Tezi, Samsun.
https://acikerisim.omu.edu.tr/entities/publication/e14b9f65-6f5c-477f-a583-99a63014a953
11. Teshome, W. and Anshiso, D., 2019. Assessment of production and utilization of black cumin (Nigella sativa) at the Oromia Regional State, Ethiopia. *Asian Journal of Agricultural Extension, Economics & Sociology*, *31*(3), pp.1-12. https://ageconsearch.umn.edu/record/357609/
12. Toncer, O. and S. Kizil. 2004. Effect of seed rate on agronomic and technologic characters of Nigella sativa L. International J. of Agriculture & Biology. 3: 529-532.https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Toncer%2C+O.+and+S.+Kizil.+2004.+Effect+of+seed+rate+on+agronomic+and+technologic