Original Research Article||

The adaptability of black cumin (*Nigella sativa* L.) varieties in the mid land areas of Guji Zone, Southern Ethiopia

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Abstract

Black cumin (*Nigella sativa* L.) is one of the most important spices and cash crops in Ethiopia. However, in the midland areas of Guji zone access to improved black cumin variety is highly limited. Due to this and other bottle necks, the potential of the area to black cumin crop was not exploited. There was an urgent need to develop and promote technologies that suit for the area. As a result, the current experiment was conducted in the midland areas of Guji Zone at three farmers' field to evaluate the growth and yield performances of black cumin varieties and to select and recommend high yielding and diseases resistant varieties for for the study area. Six improved black cumin varieties Silingo, Eden, Gemechis, Derbera, Dershaye, and Sooressaa were used for selection trial. The treatments were arranged in randomized completed block design (RCBD) with three replications. Agronomic data were collected based on the recommended standards. The collected data were subjected to analysis of variance. Significant differences were observed ($p \leq 0.05$) among the tested black cumin varieties for days to 50% emergence, numbers of pod per plant and seed yield. However, non-significant difference was observed ($p > 0.05$) among the varieties for days to 50% flowering, days to 90% maturity, plant height, and number seeds per pod. The highest seed yield was recorded for Sooressaa (11.59 qt ha^{-1}) followed by Silingo (11.12 qt ha^{-1}), whereas Dershaye variety exhibited the lowest seed yield (7.22 qt ha-1). Accordingly, Sooressaa and Silingo black cumin varieties were selected by farmers due to their best performance, adaptability, and highest seed yield. Sooressaa and Silingo improved black cumin varieties were recommended for production for the midland areas of Guji Zonal administration of Oromia region, Southern Ethiopia.

Key words: Adaptability, black cumin, improved variety

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INTRODUCTION

Black Cumin (*Nigella sativa* L.) is a member of *Apiaceae* (*Umbelliferae*). S*ativa* species is originated in Egypt and East Mediterranean, but is widely cultivated in Iran, Japan, China and Turkey (Shewaye, 2011). Black cumin is one of the most important medicinal plants and with multipurpose uses (Badary, 1999). It is used as a whole or in crushed forms. Ethiopia is homeland to many spices, such as korarima (*Aframonum korarima*), long red pepper, black cumin, white cumin (bishops weed), coriander, fenugreek, turmeric, sage, cinnamon, and ginger (ITC, 2010). In Ethiopia, black cumin is one of the most important spice types which are mainly produced to flavor foods, preparation of oil for perfumes and medicinal purpose, source of income, crop diversification, and export purposes (Anshiso and Teshome 2018; Teshome and Anshiso 2019).

The demand of black cumin seed and its oil has also been increasing both in Ethiopian markets for consumption purpose. It is also the second important cash crop which is exported to international markets next to ginger (Teshome and

Anshiso, 2019). Currently, great deal of attention has been given to the seed and oil yields of black cumin. The consumption of black cumin in different forms is generally increasing (Takrun and Dameh, 1998).

Ethiopia is a country with different and favorable agroecological zones for production of various spices, vegetables and crops (Dessie *et al*. 2019a; Dessie *et al*. 2019b). Many spice varieties particularly of black cumin, white cumin, pepper, paprika, turmeric, fenugreek, garlic, coriander, ginger, cardamom, and basil are grown in Ethiopia for consumption and commercial purposes (Tesfa *et al*. 2017), making it one of the top spice producer and consumer countries (Vijayalaxmi and Sreepada 2014) and ranking first and seventh in Africa and global stages, respectively (FAOSTAT 2019). Black cumin is mainly cultivated in Amhara, Oromia, Tigray and Southern Nations, Nationalities and Peoples' Region (SNNPR) for own household consumption (Habtewold *et al*., 2007). Nigella sativa is widely cultivated in Amhara Region, Northern Gondar, and Oromia. It is highly cultivated at Kaffa and Keficho areas of the SNNPR (Assefa *et al*., 2015). It is also particularly growing at Western Arsi (Kofele and Dodola districts) and Arsi Zone in the Shirka, Tena and Silitana districts.

Black cumin is cultivated in areas with suitable agroecology (Yasar, 2005). According to Inga and Demissew (2000), *Nigella sativa* is found in an altitudinal range between 1500-2500 meters above sea levels and with a rainfall of 120-400 mm during its growing seasons for its optimal performance. *N. sativa* requires a temperature range of 5-25℃, where 12-14℃ is the optimum. Although it is known to be among low water demanding plants, typical of semi-arid areas, availability of water supply over the growing season is very crucial to the timeliness of flower emergence and seed setting. *N. sativa* grows best on well drained sandy loam to loamy soils with a pH range of 6.8 to 8.3. Acidic soils and extreme alkaline soil pH ranges reduce yield (Weiss, 2002). The sloppy soils of heavy rainfall areas and leveled and well drained soils of moderate rainfall areas are quite suitable for its cultivation. Soil pH of 7.0 to 7.5 is optimally favorable for its production (Weiss, 2002).

Ethiopia has suitable environmental condition for the production of black cumin. Even though, the production and area coverage of black cumin have been increasing, its productivity is still very low in most areas. The national average productivity of black cumin was 0.79 t/ha (Kifelew *et al*., 2017). The main factors influencing the production and productivity of black cumin were lack of improved variety, absence of recommended fertilizer rate, postharvest handling problems, lack of improved agricultural practices and extension system, as well as marketing problems (Yosef, 2008). Habtewold *et al*. (2017) also reported that limited production technologies developed for spices so far have yet not multiplied and popularized to farmers. In general, farmers give little attention for spices crops while giving prior attention to food crops (Tesfa *et al*., 2017).

Besides, the value-addition to black cumin is low in Ethiopia, with all exports being made in the form of whole grain. Furthermore, taking into account of its use and the suitable midlands of agroecology Guji zone, there is no research activity conducted to evaluate the adaptability of black cumin varieties. In order to diversify its production, availability and increase the income of the farmers, it is important to evaluate the adaptability of improved black cumin varieties to the midland areas of Guji zone. Therefore, the study was aimed to evaluate the growth and yield performances of released black cumin varieties and to select better yielders for midlands areas of Guji zone.

MATERIALS AND METHODS

Description of the experimental site

The experiment was conducted at three locations (Kiltu Sorsa, Gobicha, and Dole) during 2019/20 cropping season to evaluate the growth and yield performances of black cumin varieties and to select and recommend high yielding and diseases resistant/tolerant cultivars for midlands of Guji zone. Adola district is located at about 470 km south from Addis Abeba. Adola district is characterized by three agroclimatic zones, namely high land (>2300 masl), mid land (1500 to 2300

masl) and low land (≤1500masl). The mean annual rain falls and temperature ranges of the district are about 900 mm and 12-34°C, respectively. Based on this condition two cropping seasons are commonly practiced i.e., Arfasa (main cropping season) which occurs between March and April where maize, haricot bean, sweet and Irish potatoes are grown. The second cropping season is called Gana (short cropping season), which is practiced as double cropping using small size cereal crops like tef, potato and barley after harvesting the crops of the main season. This study was also conducted during short cropping season (July to January) in midland areas of Guji zone.

Treatments and experimental design

The treatments consisted of 6 released black cumin varieties (Silingo, Dershaye, Eden, Darbera, Sooressaa and Gemechis), which were obtained MARC = Melkasa; KARC = Kulumsa; SARC = Sinana Agricultural Research Centers. The varieties were evaluated during the 2019/20 cropping seasons at all districts considered for this tiral.

Plot size of 2 m x 2.1 m with 0.3 m spacing between rows were used. The spacing between plots and adjacent blocks were 0.4 m and 0.80 m, respectively. Seed rate of 15 kg ha^{-1} and fertilizer rates 100 kg ha^{-1} of Urea (during planting and top dressing), as well as 100 kg ha^{-1} of blended NPS were applied and all agronomic practices such as land preparation and weeding were done uniformly for all treatments. The experiment was set up in a randomized complete block design (RCBD) under factorial arrangements (GxE) with three replications.

Table 1. The improved black cumin varieties released from national and regional research centers in Ethiopia

Released variety	Releasing Research Center	Year of release	Altitude ranges (masl)
Dershaye	MARC	2009	1800-2500
Eden	MARC	2009	1800-2500
Darbera	SARC	2006	1650-2400
Sooressaa	SARC	2016	1650-2400
Silingo	Tepi & KARC	2017	1800-2500
Gemechis	SARC	2016	1650-2400

Source: MoANR 2017 and from the Research Center; MARC = Melkasa; KARC = Kulumsa; SARC = Sinana Agricultural Research Centers; masl = meters above sea level.

Data to be collected

Phenology and growth (days to 50% emergence, days to 50% flowering, days to 90% maturity, plant height (cm), number of branches per plant) were among the performance indices used to evaluate the six released varieties. Yield and yield components that included number of pods per plant, number of seeds per pod, 1000 seed weight (g) and seed yield (kg ha^{-1}) were also used to evaluate the performances of the released varieties for selection of better performers for the study area (midland areas of the Guji Zonal administration in the Oromia regional state, southern Ethiopia.

Data analysis

Field data were analyzed by using Gen-Stat release 18th Edition software following the standard procedures outlined by Gomez and Gomez (1984). Comparisons among the treatment means were done using Fisher's protected least significant difference (LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

Phenology and growth

Phenology and growth variables of the six black cumin varieties planted at Kiltu Sorsa, Gobicha, and Dole on-farm were trials showed statistically significant differences ($p<0.05$) among varieties, locations and their interaction for days to 50% emergence and 90% physiological maturity (Table 2). Varieties and locations had significant

differences observed ($p<0.05$) for number of pods per plant. However, days to 50% flowering was was not influenced ($p >0.05$) by the varieties, locations and their interactions.

The variation with respect to days to emergence, and maturity were ranged from 25.11 to 31.22, and 114.7 to 124 days, respectively. The overall location mean indicated that the longest days to 50% emergence was recorded from Gemechis (31.22 days) followed by Derbera (29.56 days) varieties. However, early emergence was recorded for Eden (25.11 days) followed by Silingo (27 days) genotypes. In other cases, Sooressaa variety was late maturing (124 days) whereas Gemechis matured early (114.7 days). The overall location means revealed that the highest number of capsules per plant was exhibited from Sooressaa (14.54) followed by Gemechis (13.51).

The lowest number of capsules per plant was recorded from Dershaye variety (9.57) (Table 2). Nimet *et al*. (2015) who reported that plant height, the number of branches, the number of pod and 1000-seed weight of populations varied by locations. The results of the current research also agreed with those reported by Ozguven and Sekeroglu (2007) and Tuncturk *et al*. (2012).

Table 2. The overall locations (Dole, Gobicha and Kiltu sorsa) mean values of phenology and Growth traits of Black cumin varieties in 2019/20 cropping season

Variety	Phenology, and Growth traits mean				
	Days to 50% Emergence	Days to 50% Flowering	Days to 90% physiological maturity	Plant height (cm)	Capsule per plant
Silingo	27^{d}	64.44^{a}	117.7^{d}	51.67^{a}	12.33^{abc}
Eden	25.11^{e}	65.69^{a}	119.7^{b}	51.56^{a}	10.32^{bc}
Sooressaa	29.22^{b}	67.33^{a}	124.0^{a}	49.71^{a}	14.54^{a}
Dershaye	28.67^{c}	67.33^{a}	118.0^{c}	48.04^{a}	9.57^{c}
Derbera	29.56^{b}	70.44^{a}	116.7^{e}	45.07^{a}	10.01^{bc}
Gemechis	31.22^{a}	69.56^{a}	114.7^{f}	43.5^{a}	13.51^{ab}
Significance level					
Replication	0.02^{ns}	22.89^{ns}	0	168.14^{ns}	6.07^{ns}
Variety	41.04***	44.79^{ns}	96.0***	102.41^{ns}	37.88**
Location	12.07***	30.72^{ns}	0.5***	252.06**	63.23**
Variety x Location	3.14***	44.21^{ns}	353.3***	44.39^{ns}	10.37^{ns}
Error	0.32	28.41	0	62.64	11.2
CV (%)	1.96	7.89	0	16.36	28.56

*, **,***= significant at $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively, ns = $p > 0.05$ for non-significant comparisons; means sharing the same letter in each column for each factor have no-significant difference ($p<0.05$); CV (%) = coefficient of variation

Yield and yield components

The overall seed yield was significantly influenced by locations ($p<0.05$) among varieties (Table 3). The interaction effects of varieties by locations on number of pods per plant and seed per pod were not significant. There were significant differences ($p<0.05$) in the number of seed per pod among the tested varieties.

The overall location means revealed that the highest seed yield was obtained from Sooressaa variety (11.59 qt ha^{-1}) followed by Silingo variety (11.12qt ha^{-1}), whereas the lowest seed yield corresponded to Dershaye variety (7.22 qt ha^{-1}) followed by Eden and Derbera varieties (7.29 and 7.72qt ha^{-1}) was recorded. The result from the current work is in line with that of Tarakanovas and Rusgas (2006). Yield can inexpensively quantify the genetic, physiological and environmental controls that results in yield

differences among cultivars, seasons and locations. Nimet *et al*. (2015) also reported that the seed yields of black cumin populations varied by locations.

Table 3. The yield and yield components of black cumin varieties (from 2019/20 cropping seasons)

Variety	Yield and yield component traits	
	No. seed per pod (Numbers)	Seed yield(qt/ha)
Silingo	89.00[a]	11.12[a]
Eden	83.06[a]	7.29[c]
Sooressaa	96.28[a]	11.59[a]
Dershaye	90.33[a]	7.22[c]
Derbera	86.22[a]	7.72[c]
Gemechis	94.15[a]	9.57[b]
Significance level		
Replication	98.34[ns]	1.08[ns]
Variety	216.16[ns]	34.56***
Location	452.31**	53.06***
Variety* Location	90.15[ns]	2.36[ns]
Error	120.28	1.92
Cv (%)	12.21	15.26

*, **,***= significant at $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively, ns = non-significant ($p > 0.05$); means sharing the same letter in each column for each factor have no-significant differences ($p<0.05$); CV (%) = coefficient of variation

CONCLUSIONS AND RECOMMENDATIONS

Evaluation of adaptation and performances of black cumin varieties is an effective tool in facilitating selection of the improved cultivars for the midlands of Guji zone. Higher seed yields were recorded for Sooressaa (11.59 qt ha^{-1}) and Silingo (11.12 qt ha^{-1}) black cumin varieties and make them selected and recommended for the midland areas of Guji zone.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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