Adaptability study of black cumin (*Nigella sativa* L.) varieties in the mid and high land areas of Kaffa zone, South West Ethiopia

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Abstract: The bases of the idea to conduct this field experiment are the uses of the spices and the suitable agro-ecology of Kafa zone. There was no any research activity conducted in the Kafa zone in relation to highland seed spices. It is important to evaluate the adaptability of improved black cumin varieties in the Kafa zone in order to diversify their production and to maximize the income of the farmers in the area. Based on this fact, a field experiment was conducted using three improved Black cumin (*Nigella sativa* L.) varieties; Dirishaye, Eden, and Deribera with the local check. The activity was conducted in the 2012 /13 cropping season at Alarigeta and Kaya Kela experimental sites of Bonga Agricultural Research Center. The objective of this study was to test the adaptability of improved Black cumin varieties to the representative areas Kafa zone. These varieties were evaluated for yield, plant height, pods per plant, emergence and flowering dates. The test varieties were used as experimental treatments and arranged in a randomized complete block design with five replications. The grain yield recorded in gram per plot was converted to kilogram per hectare. There were no significant differences ($p < 0.05$) in most parameters evaluated at Alarigata, unlike Kaya Kela site. The local check showed significantly higher grain yield (612.98 Kg ha^{-1}) than Eden, Dirishaye, and Deribera (473.06, 451.9, and 449.62 Kg ha^{-1}, respectively) at Kaya Kela. Based on the results obtained under this study variety Eden could be used for demonstration, popularization and pre-scaling up of the technology at Alarigata and the surrounding areas. On the other hand, this experiment showed the huge potential of the local variety at both experimental sites. Thus, such a potential suggests that the local check or the land race could be used for variety development program which would later be supported by agronomic and pathological studies (fertilizer rate, sowing date, and reaction to insect pests and diseases). This would give rise to the production of adaptive improved black cumin seed spices with specific quality traits at different agro-ecologies of the zone that fulfill the specific international market demands.

Keywords: Black Cumin Variety, Grain Yield, Plant Height, Pods per Plant, Emergence Date, Flowering Date

1. Introduction

Black Cumin (*Nigella sativa* L.) is a member of Apiaceae (Umbelliferae). This species is originated in Egypt and East Mediterranean, but is widely cultivated in Iran, Japan, China and Turkey (Shewaye, 2011). Black cumin grows on a wide range of soils. Sandy loam soil rich in microbial activity is the most suitable for its cultivation. 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 favorable for its production (Orgut, 2007).

Black Cumin has a long history of uses for food flavors,

perfumes and medicinal values. Oil has been used for bringing smell to some medicines, sterilizing of surgical operation fiber, production of some veterinary and agricultural medicines and plastic components (Aminpour and Karimi, 2004).

Black Cumin seeds have an aromatic odor and bitter taste. They are used as an essential ingredient in soup component, sausages, cheese, cakes and candies. The Ethiopian variety of cumin seed accumulate up to 50% thymol, a monocyclic phenolic compound. The presence of this compound makes cumin valuable source for health care Industry (Black et.al, 2005) and medicinal purposes (Ashraf and Orooj, 2006). In Ethiopia, it is commonly used in Amharic "*Berbere*" in which

it tends to reduce its hotness (Hedberg et al., 2003), for preparation of curries, bread, katikala (Jansen, 1981),"*Shamita*" (Mogessie and Tetemke, 1995), traditional Ethiopian stews, "*Wot*" and preservation of butter.

Black cumin is used principally to flavor food, either as whole grain, in powdered form or as an oleoresin extract. It is also used in gripe water and other herbal medicines. Within Ethiopia its main use is as a spice, which is typically ground and mixed with other spices. There is also some use in traditional medicine. The vast majority of Ethiopia's black cumin exports go to Arabic countries, which, together with other predominantly Muslim countries, accounted in 2008 for some 98% of national exports. Sudan overtook Saudi Arabia as the main export destination in 2007 and by 2008 it accounted for almost one half of all official exports. It is uncertain how reliable this market is and whether exports can be maintained at current levels. Value-adding to cumin in Ethiopia is low, with all exports being made in the form of whole grain (Orgut, 2007).

Taking into consideration of its use and the suitable agro-ecology of Kafa zone, there was no any research activity conducted in relation to highland spices. In order to diversify its production and increase the income of the farmers, it is important to evaluate the adaptability of improved black cumin varieties to the area. Therefore, this study was initiated with the objective of selecting the best adaptive black cumin varieties to the area.

2. Materials and Methods

2.1. Description of the Experimental Area

The experiment was conducted at Kaya Kela and Alarigata experimental sites of Bonga Agricultural research Center (BARC), which was located at,Kaffa zone, Southern Nations Nationalities and People's Region (SNNPR). It is found within the southwestern plateau of Ethiopia and 450km and 725km far from Addis Ababa and Hawassa respectively. The Kaya Kela site is located at 07°00'- 7°25'N Latitude and 35°55'-36°37'E Longitude at an elevation of 1753 meters above sea level. The area experiences one long rainy season, lasting from March /April to October. The mean annual rainfall ranges from 1710 mm to 1892mm.The mean minimum and maximum daily temperature ranges from 18.10C to 19.40C.

The topography is characterized by slopping and rugged areas with very little plain land. Whereas, Alarigata experimental site is located at07°17' 316"N latitude and longitude of 36°22'243"E at an elevation of 2400 meters above sea level.

2.2. Land Preparation, Treatments and Design

Land was ploughed three times with oxen, which is similar to farmers' practice. The experimental field was divided into five blocks each having four plots. The width and length of individual plot was 1.8m and 4m, respectively, with each plot sub divided into six rows. The spacing between plots and blocks was maintained to be 1 and 2 m, respectively. The study was conducted using randomized complete block design with five replications. The varieties were assigned as treatments. The improved seeds were collected from national research center and the local seeds of black cumin were taken from farmers of the respective testing sites. The seeds were sown by drilling in rows as soon as the rains started. The spacing between each row was 30 cm.

2.3. Data Collection

*Y*ield and yield component data such us Grain yield, plant height, pods per plant, flowering and emergence dates data were collected.

The Grain yield were recorded in gram per plot and converted in to kilogram per hectare. The plant height data measure the height of the plant from the base "close to ground level" to the shoot tip of the main axis. Pods per plant also collected randomly selected five plants per plot and recorded by counting the number of pod per plant. Flowering date recorded first open flower 50% of the plants per plot by counting the number of days and Days to maturity also recorded when 95% of flowers per plot was matured.

2.4. Statistical Analysis

The analysis of variance was done using statistical analysis system, SAS 9.1 software (SAS, 2007). Wherever F values were found to be significant at a 5% level of probability, least significant difference (LSD) values were computed for making comparisons among the treatment means.

3. Results and Discussion

Table 1. Mean separation.

Mean Values										
Alarigata						KayaKela				
Varieties	DF	DM	PH	PP	GY	DF	DM	PH	PP	GY
Dirshaye	87[c]	163.2[cb]	51.28	6	997.5	78 [b]	133.8[b]	40.08[b]	6	451.9[b]
Eden	96[b]	166.4[ab]	52.2	5.04	1097.9	79.6[b]	136.6[b]	40.96[b]	5.96	473.06[b]
Deribera	85 [c]	160[c]	45.88	4.76	979.3	70.6[c]	132.4[b]	39.12[b]	6.88	449.62[b]
Local	114.4[a]	168.4[a]	48.36	4.24	957.8	91 [a]	146[a]	51.36[a]	6.78	612.98[a]
Mean	95.33	164.5	49.43	5.01	1008.1	79.8	137.2	42.88	6.41	496.89
CV	4.33	1.74	14.91	36.18	26.04	5.57	2.28	16.27	33.8	18.2
LSD	5.56	3.83	Ns	Ns	Ns	5.96	4.2	9.35	Ns	121.27

*= Significant at 5% probability level, CV= Coefficient of variation, LSD= Least significant difference, DF= Days to flowering, DM= Days to maturity, PH= Plant height, PP= Pods per plant, GY= Grain yield; Values with the same letter(s) are not significantly different

The results of analysis of variance indicated that there were no significant differences ($p < 0.05$) in most parameters compared at Alarigata site, unlike Kaya Kela site.

3.1. Days to Flowering

Significant variations were observed in days to 50% flowering in the tested varieties at both locations. The local check took the highest mean days to flower at both Alarigata and Kaya kela testing sites (114.4 and 91 days, respectively). Whereas, Dirishaye and Deribera took the shortest average days to flower (87 and 85 days, respectively) at Alarigata; and likewise, Deribera took the shortest mean days (70.6 days) to flower at Kaya kela.

3.2. Days to Maturity

The experimental varieties at both locations showed significant variations ($p < 0.05$) in days to maturity (Table 1). The longest average duration (168.4 days) was recorded by the local check to mature, while variety Deribera took the shortest duration (160 days) at Alarigata. Similarly, the local check at Kaya kela took the mean highest duration (146 days) to mature over the rest of the improved ones.

3.3. Plant Height

The mean values (Table 1) revealed that there were no statistically significant differences ($p < 0.05$) in plant height among the tested varieties at Alarigata. On the contrary, the local check showed the highest plant height (51.36 cm) over the improved varieties at Kaya kela.

3.4. Pods per Plant

The LSD result 2.43 at alpha 0.05 indicated that there was no significant difference among the tested varieties in pods per plant at both locations (Alarigata and Kaya kela).

3.5. Grain Yield

The LSD result 352.03 at alpha 0.05 indicated that there was no significant difference among the varieties in grain yield at Alarigata site. Whereas, the highest grain yield (612.98Kg ha^{-1}) was scored by the local check at Kaya kela. The released varieties (Dirishaye, Eden, and Deribera) did not show their grain yield potential at Kaya Kela site as compared with the Alarigata site. This might be associated with the occurrence of wilt disease on the experimental varieties at Kaya kela during the growth periods.

3.6. Quality Evaluation

The laboratory evaluation was made for the experimental varieties under this study. Moisture content, essential oil content, and oleoresin yield of the seeds of the tested black cumin varieties were taken as parameters. Based on the laboratory results (Table 2), the average moisture content, essential oil content both in dry and wet bases, and oleoresin yield of the tested varieties were equal or greater than the national average content (8, 0.6, and 26.3%, respectively). These laboratory results revealed that the tested varieties fulfill the international market demands.

Table 2. Laboratory results of Black cumin varieties tested at Alarigata and Kaya kela testing sites during 2012/13 crop season.

Variety	Moisture Content (%)				Oleoresin Yield (%)			
					Hexane Extract			
	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean
Dirishaye	9.09	8.14	8.57	8.6	25.2	24	25..20	24.79
Eden	9.17	8.85	9.65	9.22	28	28.8	28.4	28.4
Deribera	9.55	9.68	9.65	9.62	29	27.5	28.4	28.31
Local	9.34	9.87	10.5	9.89	26.6	28.4	27.88	27.64

Table 2. Laboratory results of Black cumin varieties tested at Alarigata and Kaya kela testing sites during 2012/13 crop season. (continue)

Variety	Essential oil Content (%)							
	WB				DB			
	Rep 1	Rep 2	Rep 3	Mean	Rep1	Rep 2	Rep 3	Mean
Dirishaye	0.52	0.61	0.6	0.58	0.57	0.66	0.66	0.63
Eden	0.43	0.42	0.42	0.42	0.48	0.46	0.46	0.47
Deribera	0.57	0.47	0.47	0.5	0.63	0.52	0.52	0.56
Local	0.53	0.57	0.57	0.56	0.59	0.64	0.64	0.62

Key: WB = wetness base; DB = dry base

4. Summary and Conclusions

The adaptability of improved black cumin varieties (Dirishaye, Eden, and Deribera) and the local checks of the respective locations was evaluated at Alarigata and Kaya kela testing sites of Bonga Agricultural Research Center during 2012/13 cropping season. The experiment was conducted based on the protocol required for black cumin varieties.

Days to 50% flowering, days to maturity, plant height, pods per plant and grain yield were taken as parameters of the evaluation. The results of the experiment indicated that the local check scored higher grain yield than the improved varieties at Kaya kela testing site. However, no statistically significant variations were recorded in grain yield among the tested varieties at Alarigata. Because of the occurrence of wilt disease on the experimental black cumin varieties at

Kaya Kela, the improved varieties yielded less than the national average (9-16 Q ha-1). The materials were also studied under laboratory for moisture content, essential oil content in dry and wet bases, and oleoresin yield. The results of the laboratory studies indicated that the tested materials scored much greater values than the national average. In general, the outcomes of the experiment in all parameters studied showed that the testing areas have huge potential for black cumin production. The performance of the local varieties at both locations also indicated that there is a need for further investigation.

Based on the results of the experiment, Eden could be used for demonstration, popularization and pre-scaling up of the technology at Alarigata and the surrounding areas and future research activities should focus on the further evaluation of the released black cumin varieties with respect to the local checks under various agro-ecologies. The due attention should be given towards the collection, characterization and evaluation of the landrace black cumin in order to help the variety development program. Agronomic and pathological aspects of the crop should also be area of concern under different agro-ecologies in the Kafa zone.

References

[1] Aminpour and Karimi (2004). Underutilized medicinal spices. Spice India. 17 (12): 5-7.

[2] Ashraf M, Orooj A (2006). Salt stress effects on growth,ion accumulation and seed oil concentration in an arid zone traditional medicinal plant ajowan (*Trachypermum ammi* [L.] Sprague). J. Arid Environ., 64(2):209-220.

[3] Black M, Bewley D, Halmer (2005). The Encyclopedia of seed science, technology and uses. wallinoford. CAB P 7.

[4] Hedberge I, Edwards S, SileshiNemomissa (eds) (2003). Flora of Ethiopia and Eriteria. Vol 4 (2), Apiaceae to Dipsaceae. The Natural Herbarium. Addis Ababa University, Addis Ababa and Uppsala. P. 21.

[5] Jansen PCM (1981). Spices, condiments and medicinal plants in Ethiopia. their taxonomy and agricultural significance. Addis Ababa: Center for Agricultural Publishing and Documentation pp. 111-120.

[6] Mogessie A, Tetemke M (1995). Some microbiological and nutritional properties of Borde and Shamita. Traditional Ethiopian fermented beverages. Ethiop. J. Health Dev. 9(1): 105-110.

[7] Orgut, Market Assessment Study, Ethiopian Nile Irrigation and Drainage Project, Main Report and Annexes, Ministry Of Water Resources, Addis Ababa, June 2007

[8] SAS (2007) Statistical Analysis Systems SAS/STAT user'sguide Version 9.1 Cary NC: SAS Institute Inc. USA

[9] Shewaye L (2011).Antifungal Substances from Essential Oils. M.Sc. Thesis. Addis Ababa University. p. 8