Advances in Bioscience and Bioengineering
2024, Vol. 12, No. 2, pp. 29-36
https://doi.org/10.11648/j.abb.20241202.11

Research Article

Effect of Seed Storage Duration and Methods on Growth and Yield of Basil Variety

Hailu Garkebo Mola[1, *], Betlhem Melese Kebele[2]

[1]Agronomy and Crop Physiology Program, Ethiopian Institute of Agricultural Research, Wondo Genet, Ethiopia
[2]Technology Multiplication and Seed Research, Ethiopian Institute of Agricultural Research, Wondo Genet, Ethiopia

Abstract

The experiment was conducted at Wondogenet Agricultural Research Center to determine the effect of seed storage period and methods on the growth and yield of basil. Basil seeds stored in three storage methods (Plastic jar, Polypropylene, and Cotton bags) for six storage periods (initial period, one, three, six, nine, and twelve months) were used to evaluate the impact of the treatments on the yield and performance in the field. The field experiment was arranged by using RCBD design with three replications. The data were taken at the 90% physiological maturity stage. The results showed a significant difference between the treatments. The results indicated that the interaction effects of basil seed storage time and methods had a significant ($P<0.05$) effect on Primary Branch Number, Plant Height, Umbrella length, Dry, and Fresh biomass. The umbrella number of the storage methods had an accelerating trend with raising storage duration to 3 months storage, after that it shows a declining trend with raising storage time. The two storage methods plastic jar and bag maintained the seed in good condition for 3 months further, storage of the seed leads to the shortest plant and umbrella length. The highest dry biomass was recorded at 3 months stored seed in a plastic bag which was not significantly different from 3 months stored seed in a plastic jar. Basil dry biomass for the jar stored seed ranged from 0.85 to 3.33, 0.91 to 3.42 ton/ha for plastic bag whereas for the cotton bag, it ranged from 0.6 to 2.26 ton/ha. In general, seeds stored for three months had shown better growth and yield.

Keywords

Storage, Method, Duration, Basil, Seed, Growth and Yield

1. Introduction

Basil (*Ocimum basilicum* L.) is among the annual aromatics and medicinal plants which belong to the *lamiaceae* family. It is native to tropical parts of Asia, Africa, Central and South America and cultivated for its aromatic leaves, used as fresh or dried to boost up numerous cooking dishes [17].

The basil plant includes over 150 different species, 30 of which are natural to the tropics and subtropics, with some species naturalized and/or cultivated in temperate zones [12, 21]. This genus is well recognized in the warmer areas up to 1800 m altitude and with cultivating temperatures of 7 to 27 ℃ [4]. Among all the species *Ocimum*, *Basilium* has been the most important aromatic and medicinal plant Since ancient civilizations. Due to its stimulant and carminative properties, this sweet basil is used in folk medicine [8].

*Corresponding author: garkebo@gmail.com (Hailu Garkebo Mola)

Received: 8 March 2024; **Accepted:** 3 April 2024; **Published:** 24 May 2024

Both herbal and essential oils of basil are important in the international market being essential ingredients in many cooking traditions, cosmetics, perfumery, oral products, hygiene, and cleaning products. Leaves are used in soups, stews, sauces, meat, fish, egg dishes, salads and vegetables, flavored vinegar, teas, and steeped in oil to produce flavored oils. Basil has a strong medicinal use as antimicrobial properties, very high in vitamins and minerals. Hot tea of basil plant leaves is good for treating nausea, dysentery, and flatulence. Externally, basil formulations can be used for different skin infections such as the treatment of acne, snakebites, and insect stings [20].

In Ethiopia, basil is called by different names in each ethnic group within the country and its production is for home uses and income generation by small-scale producers. However, [2, 22], also presented that it is an export commodity in the country. Commercial growers have exported currently herbal products of basil to foreign markets. Agroecology of Ethiopia is appropriate for basil production; recently, two varieties were released [5]. The two varieties propagated via seeds and proper seed conservation, handling, and utilization techniques are important for the sustainable production of the varieties. Good seed quality and seedling establishment are the bases of profitable, efficient, and sustainable crop production [7]. The seed quality is also affected by dormancy and controlled by several environmental factors such as light, temperature, and the duration of seed storage [13]. Sweet basil seeds possess a physiological dormancy that could be optimized for seed germination by pre-sowing treatment [10].

The actual storage life of a seed depends upon its viability and moisture content when primarily placed in storage. Good quality of seeds is a result of good production practices to storage conditions [14]. Improper storage conditions for a seed result in lower quality [3]. Storage duration and condition also may bring some physical and chemical changes in seeds [15]. Prolonged storage of seeds also causes a reduction of germination, an increase in germination time, and seedling vigour [11].

Despite various studies being reported in Ethiopia on Basil agronomic and breeding issues, best of our knowledge no data is scientifically available on the storage of basil in Ethiopia. The findings of this research study directly support basil growers to extend the storage of basil in the study location. Hence, the objective of this study was to determine the effects of seed storage periods and methods on growth, and seed yield of basil.

2. Material and Methods

2.1. Experimental Site Description

The experiment was conducted in 2020 on the Wondo Genet Agricultural Research Center field. Wondo Genet is located at 7^{o} 192 N latitude and 38^{o} 382 E longitude with an altitude of 1780 m *a.s.l*. The location obtained a mean annual rainfall of 1128 mm with minimum and maximum temperatures of 11.47 and 26.51 ℃, respectively. The soil texture of the experimental location was sandy loam with a pH of 6.4 [9]. The Variety WG-sweet basil-II was used as planting material for the experimental area.

2.2. Experimental Design and Treatments

Basil variety (WG-sweet basil-II) was used for the experiment. Seeds were sown at Wondogenet Agriculture Research Center field station. Agronomic practices were carried out uniformly whenever required. After maturity, the seed was harvested and dried under sunlight. After cleaning the seeds were stored in different storage methods (in Plastic jar, Polypropylene bags, and Cotton bags). The experiment was conducted for 12 months in the research center seed storage room. The experiment contained two factors. The first factor is the storage duration (initial day, three, six, nine, and twelve storage months), and the second factor is the three types of storage bags (plastic jar, polypropylene bag, and cotton bag). Each storage material was filled with 20 kgs of basil. All treatments were analyzed in triplicate and the total runs were 54.

The varieties of WG-II basil seed were subjected to different storage durations and storage methods at normal conditions. The experiment was conducted with a combination of six storage periods and three storage methods using RCBD design in three replications. There were 18 treatment combinations. The seedlings were prepared at different storage times on polyethylene tubes under nursery conditions. Throughout the seedling growing period watering and other agronomic practices were applied, including weeding, was done as needed. When the seedlings were matured enough, it was transplanted following their treatment plot on the field. Basil was planted at the inter and intra-row spacing of 60 cm and 30 cm respectively. Each experimental plot size was 1.8 m in length and 2.4 m in width, respectively.

2.3. Statistical Data Analysis

The data was subjected to statistical analysis. The analysis of variance was carried out using SAS software. The least significance difference (LSD) test at a 5 % level of significance was used to delineate the significance differences between treatment means.

3. Results and Discussions

3.1. Primary Branch and Umbrella Number of Sweet Basil

The variance analysis indicated significant ($P<0.05$) interaction effects of storage methods and duration on primary branch number per plant (Table 1). The greater primary branch number resulted from the seed stored for 6 months and the smaller was recorded from the basil plant after 9 months of storage for each

storage method. This shows that the effect of seed storage time on the seedling stage may extend to the yields of basil plants. Basil's primary branch number per plant for plastic jar ranged from 7.13 to 18.00 and for plastic bags from 8.13 to 18.00 whereas for cotton made bags ranged from 7.73 to 20.33. Even if there is no smooth trained of branch number on each storage method, as compared to before storage seed all stored seed have a decreasing trend of branch number. Similar to this finding [1] reported that after six months of storage of soya bean seeds seedling growth parameters were almost zero. Storing seeds beyond the optimum storage period may result in reduced seedling establishment and final seed production [18]. In general, according to the result of this study, out of the three storage methods, storing the basil seed in a cotton-made bag has more advantages than a plastic bag or jar.

Table 1. *Interaction effect of storage duration and methods on Primary Branch Number of sweet basil.*

Storage methods	**Primary Branch Number** **Storage duration in months**						
	0	**1**	**3**	**6**	**9**	**12**	**Mean**
Plastic Jar	18.00^{bc}	11.73^{cd}	11.87^{cd}	12.13^{cd}	7.13^{d}	10.53^{d}	11.90
Plastic bag	18.00^{bc}	10.80^{d}	11.47^{cd}	12.53^{cd}	8.13^{d}	11.13^{cd}	12.01
Cotton bag	18.00^{bc}	11.53^{cd}	11.13^{cd}	20.33^{a}	7.73^{d}	9.53^{d}	13.04
LSD	7.035						
CV%	32.372						
SM*ST	*(0.047)						

Note; Means followed by the same letters within a column are not significantly different (P > 0.05) by lsd test, *= significant at 5 % probability level, SM; storage method, ST; storage time

The variance analysis indicated that significant (P<0.05) umbrella number differences were viewed due to varying storage duration between storage methods, but the interaction between storage duration and storage methods was not significantly different (Table 2). The umbrella number of the storage methods had an upward trend with a rising storage duration up to 3 months storage after that, it shows a decreasing trend with increasing storage time. Even if there is no significant difference, the overall mean of the data shows that the plastic jar had a greater umbrella number than the two storage methods.

Table 2. *Mean effect of storage duration and methods on umbrella number of sweet basil.*

Storage material	**Storage Time**	**Umbrella Number**
Plastic jar	0 months	12.50^{def}
	1 month	13.80^{bcde}
	3 months	16.03^{a}
	6 months	13.57^{cde}
	9 months	12.20^{ef}
	12 months	9.10^{g}
Plastic bag	0 months	12.50^{def}
	1 months	13.93^{bcd}
	3 months	15.30^{ab}
	6 months	13.9^{bcd}

Storage material	Storage Time	Umbrella Number
Cotton bag	9 months	12.63^{def}
	12 months	7.30^{h}
	0 months	12.50^{def}
	1 months	14.70^{abc}
	3 months	14.13^{bcd}
	6 months	13.20^{cdef}
	9 months	11.80^{f}
	12 months	8.57^{gh}
LSD	1.694	
CV	8.028	
P-value	***	

Note; Means followed by the same letters within column are not significantly different (P > 0.05) by lsd test, *= significant at 5 % probability level

3.2. Plant Height and Umbrella Length of Sweet Basil

The variance of analysis showed that highly significant (P<0.05) interaction effects of storage methods and storage duration on plant height and umbrella length of the basil plant. Even if there is no difference, the overall mean of basil plant height and umbrella length grown from the seed stored in a plastic bag shows the longest plant height as compared to the seed stored in a plastic jar and cotton bag. The longest plant height and umbrella length were recorded from 3 months of stored basil seed in a plastic bag which had no significant difference with 3 months of stored seed in a plastic jar storage method whereas the shortest plant height and umbrella length were recorded from 12 months of stored basil seed in a plastic bag which had no significant difference with 12 months stored seed of the two storage methods. similarly, The increasing duration of seed storage caused weight loss consistently in all the tested medicinal plants [19] also confirms that aging affects the seed quality during storage due to the oxidation processes. The value of plant height and umbrella length shows consistent increments up to 3 months of stored seed and decreases up to 12 months of stored seed in plastic jar and bag, but the plant height and umbrella length increment extended up to 6 months of seed stored in cotton bag. This result shows that the two storage methods plastic jar and bag stored the seed in good condition for 3 months after that, the seed bears the shortest plant and umbrella length consistently. Similarly, [6] the seedlings grown from M. foliolosa seed indicated rapid growth in the first month and a strong decline in relative growth rate in the next month. After a rapid relative growth rate values in the third month, Fastly decreased and remained constant (Table 3).

Table 3. *Interaction effect of storage duration and methods on Plant Height and Umbrella Length of sweet basil.*

Storage methods	Plant Height (cm) Storage duration in months						
	0	1	3	6	9	12	Mean
Plastic Jar	30.80^{ef}	36.00^{ed}	55.93a	45.00^{bc}	35.80^{ed}	25.20^{fgh}	38.12
Plastic bag	30.80^{ef}	36.53^{ed}	58.00a	46.73^{b}	35.40^{ed}	22.80^{h}	38.38
Cotton bag	30.80^{ef}	36.40^{ed}	40.27^{cd}	44.60^{bc}	30.60^{efg}	24.67^{hg}	34.56
LSD	6.1168						
CV%	9.930						

Storage methods	Plant Height (cm) Storage duration in months						
	0	**1**	**3**	**6**	**9**	**12**	**Mean**
SM*ST	***						
	Umbrella Length(cm)						
Plastic Jar	10.30^{de}	13.50^{bc}	15.97^{a}	14.37^{ab}	9.70^{de}	6.13^{g}	11.66
Plastic bag	10.30^{de}	13.40^{bc}	16.07^{a}	14.20^{ab}	10.00^{de}	4.50^{g}	11.41
Cotton bag	10.30^{de}	12.80^{bc}	12.67^{bc}	13.37^{bc}	8.70^{ef}	6.60^{fg}	10.74
LSD	2.129						
CV%	11.300						
SM*ST	*						

Note; Means followed by the same letters within a column are not significantly different (P > 0.05) by lsd test, *= significant at 5 % probability level, SM; storage method, ST; storage time

3.3. Effect of Storage Durations and Methods on Dry and Fresh Biomass of Basil

The analysis revealed that dry biomass was significantly affected ($p < 0.05$) by the interactions of storage duration and methods of basil. The highest weight of dry biomass resulted from 3 months of basil seed stored in a plastic bag which was not significantly different from 3 months of stored seed in a plastic jar. The minimum dry biomass weight was recorded from 9 months of seed stored in a cotton bag, this result is in agreement with [16] who reported that the dry weight was higher at the seedlings derived from the seeds that were previously stored at 4 months, followed by 36 and 72-months storage. There was an increasing trend of dry biomass up to 3 months stored seed after that the value of biomass shows a decreasing trend for plastic jar and bag storage methods, but the dry biomass produced from cotton storage method shows that decreasing trend along with increasing storage time. The weight of fresh biomass of 12 months stored seed shows somewhat an increment as compared with 9 months stored seed. This result may indicate the moisture content may affect the weight of the biomass, that's why inconsistent fresh biomass trends with increasing storage time. The over mean of fresh and dry biomass indicated that the two storage methods plastic bag and jar had an advantage over the cotton bag stored seed to produce more biomass. Basil dry biomass for the jar stored seed ranged from 0.85 to 3.33, 0.91 to 3.42 ton/ha for plastic bag whereas for the cotton bag ranged from 0.6 to 2.26 ton/ha (Table 5).

Table 4. *Interaction effect of storage duration and methods on Fresh and Dry biomass of sweet basil.*

Storage methods	Fresh Biomass (ton/ha) Storage duration in months						
	0	**1**	**3**	**6**	**9**	**12**	**Mean**
Plastic Jar	9.17^{cde}	16.61^{a}	12.75^{abc}	8.49^{edf}	3.37^{g}	4.91^{fg}	9.22
Plastic bag	9.17^{cde}	15.35^{ab}	13.72^{ab}	9.33^{cde}	3.46^{g}	5.57^{efg}	9.43
Cotton bag	9.17^{cde}	15.22^{ab}	5.05^{fg}	9.21^{cde}	2.37^{g}	3.85^{g}	7.48
LSD	3.950						
CV%	26.904						
VR*ST	*						

Storage methods	Fresh Biomass (ton/ha) Storage duration in months						
	0	**1**	**3**	**6**	**9**	**12**	**Mean**
	Dry biomass (ton/ha)						
Plastic Jar	1.72^{cde}	2.13^{bcd}	3.33^{a}	1.40^{defgh}	1.01^{efgh}	0.85^{fgh}	1.74
Plastic bag	1.72^{cde}	2.68^{ab}	3.42^{a}	1.61^{cdef}	1.06^{efgh}	0.91^{efgh}	1.90
Cotton bag	1.72^{cde}	2.25^{bc}	1.54^{cdefg}	1.52^{cdefg}	0.60^{h}	0.71^{gh}	1.39
LSD	0.847						
CV%	29.885						
SM*ST	*						

Note; Means followed by the same letters within column are not significantly different (P > 0.05) by lsd test, *= significant at 5 % probability level, SM; storage method, ST; storage time

Table 5. *Mean effect of storage periods and methods on Fresh and Dry Leaf weight of sweet basil.*

Storage material	Storage Time	Fresh Leaf weight (ton/ha)	Dry Leaf weight (ton/ha)
Plastic jar	0 months	3.78^{bcd}	0.59^{abc}
	1 month	5.79^{a}	0.81^{a}
	3 months	3.78^{bcd}	0.71^{ab}
	6 months	1.73^{efg}	0.26^{d}
	9 months	1.37^{fg}	0.37^{cd}
	12 months	3.40^{cde}	0.58^{abc}
Plastic bag	0 months	3.78^{bcd}	0.59^{abc}
	1 months	4.64^{abc}	0.68^{ab}
	3 months	3.1^{cdef}	0.56^{abcd}
	6 months	2.06^{defg}	0.33^{cd}
	9 months	1.36^{fg}	0.43^{bcd}
	12 months	3.67^{bcd}	0.53^{abcd}
Cotton bag	0 months	5.27^{ab}	0.59^{abc}
	1 months	5.76^{a}	0.80^{a}
	3 months	1.47^{fg}	0.33^{cd}
	6 months	2.21^{defg}	0.30^{cd}
	9 months	1.08^{g}	0.29^{cd}
	12 months	2.47^{defg}	0.42^{bcd}
LSD		1.750	0.301
CV		33.458	34.752
P-value		***	***

Note; Means followed by the same letters within column are not significantly different (P > 0.05) by lsd test, *= significant at 5 % probability level

The variance of analysis indicated that significant ($P<0.05$) fresh and dry leaf weight variations were observed due to varying storage duration between storage methods, but the interaction between storage duration and storage methods was not significantly different. The maximum fresh and dry biomass produced from 1 month plastic jar stored seed, but the dry biomass result had no significant difference with 12 months stored plastic jar (0.58 ton/ha) and plastic bag (0.53 ton/ha) seed (Table 5). Even if there is no significant difference, the overall mean of the data shows that the plastic jar had a higher dry biomass than the two storage methods.

4. Summary and Conclusion

An experiment was conducted during the 2022 growing seasons to see the effect of storage duration and methods on the growth and yield of sweet basil in Wondogenet Agricultural Research Center. The dried basil seed was used to evaluate the seed potential to 12 months storage duration and storage methods for its growth and yield. Three storage methods (plastic jar, plastic bag, and cotton bag) with six storage times (0, 1, 3, 6, 9, and 12 months) were replicated three times with a complete block design.

Most of the growth and yield parameters, Primary branch, umbrella number, Plant Height, Umbrella Length, Dry and Fresh biomass, and Fresh and Dry Leaf weight of sweet basil were significantly affected due to storage duration and storage methods. The interaction effects of storage time with storage methods showed a significant influence on Primary Branch Number, Plant Height, Umbrella Length, Dry, and Fresh biomass of sweet basil. The parameters like umbrella number, plant height, umbrella length, and dry biomass of basil plant had the highest value for sweet basil up to 3 months stored seed in plastic jar and bag.

In conclusion, the sweet basil ll had good growth up to 3 months of storage where as good yield at 1-month storage time. Even if the two varieties show the maximum value at 3 and 1 months of storage. However, some growth parameters show a good result from plastic jar stored seed. In general, the storage methods plastic jar and bag were a recommended storage for basil seed than cotton bag. This result needs further investigation on the two-basil variety of storage duration and storage methods.

Acknowledgments

We would like to acknowledge the technology multiplication and seed research directorate for the allocation of the budget for this study, technology multiplication, and seed research process of Wondo Genet Agricultural Research Center for providing all the necessary facilities and support during the entire experimentation. Our acknowledgement also to miss Workitu Tura of technical assistance for her tireless effort and collect all necessary data from all experimental fields during the study.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] A. Kandil, A., E. Sharief, A., and S. Sheteiwy, M. Effect of Seed Storage Periods, Conditions and Materials on Germination of Some Soybean Seed Cultivars American Journal of Experimental Agriculture. 2013, 3(4) 1020-1043. https://doi.org/10.9734/AJEA/2013/3590

[2] Alemu A, Garedew W, Gebre A. Essential oil yield and yield components of basil (Ocimum basilicum L.) as afected by genotype and intrarow spacing at Jimma, SW Ethiopia. Acta Agrobot. 2018; 71(3): 1743. https://doi.org/10.5586/aa.1743

[3] Bhandari, G., Ghimire, T. B., Kaduwal, S., Shrestha, J., & Acharya, R. Effects of storage structures and moisture contents on seed quality attributes of quality protein maize. *Journal of Maize Research and Development*, 2017, *3*(1), 77-85. https://doi.org/10.3126/jmrd.v3i1.18924

[4] Department of Agriculture, Forestry and Fisheries. Basil production., 2012, www.daff.gov.za/publications

[5] Desta F. Benefit and use of sweet basil (Ocimum Basilicum l.) in Ethiopia. A review. Journal of nutrition and food processing. 2021, 4(5). https://doi.org/10.31579/2637-8914/057

[6] Fernando A. Silveira O, Daniel N., Bernardo D. Ranieri, Celice A. Silva, L. Araújo1 & Wilson G. Effect of seed storage on germination, seedling growth and survival of Mimosafoliolosa (Fabaceae): implications for seed banks and restoration ecology. Tropical Ecology. 2014, 55(3): 385-392, © International Society for Tropical Ecology www.tropecol.com ISSN 0564-3295.

[7] Finch-Savage, W. E. Influence of seed quality on crop establishment, growth and yield, 1995, p. 470. In: A. S. Basra (ed.). Seed quality: Basic mechanisms and agricultural implications. Food Products Press, Binghamton, NY. https://doi.org/10.4236/ajps.2014.514231

[8] Gowda, M. P., Dorajeerao, A. V. D., Madhavi, M., Suneetha, D. R. S. A study on genetic variability for yield and its attributes in sacred basil (Ocimum tenuiflorum L.). Journal of Crop and Weed. 2019, 15(3): 01-06, https://dx.doi.org/10.22271/09746315.2019.v15.i3.1227

[9] Kassahun B., M., Tilahun S., Zigene Z., D., Teferi, Z., Mihret Mekonnen, M., and Melka B. Morpho-agronomic Characteristics, Essential Oil Content and Essential Oil Yield of Oregano (*Origanum vulgare L.*) in Ethiopia. *Scholarly Journal of Agricultural Science*. 2014, 4(12): 565-571.

[10] Khalid M. Elhindi., Yaser Hassan Dewir., Abdul-Wasea Asrar., Eslam Abdel-Salam., Ahmed Sharaf El-Din., and Mohamed Ali. Improvement of Seed Germination in Three Medicinal Plant Species by Plant Growth Regulators. Hortscience: A Publication of the American Society for Hortcultural Science, 51(7), 887-891. https://doi.org/10.21273/hortsci.51.7.887

[11] Khatril, N., Pokhrel, D., Pandey, B., Pant, K., & Bista, M. Effect of different storage materials on the seed temperature, seed moisture content and germination of wheat under farmer's field condition of kailali district, Nepal. Journal of agricultural science & technology. 2019, 11, 352-355. https://doi.org/10.15547/ast.2019.04.060

[12] Labra, M.; Miele, M.; Ledda, B., Grassi, F.; Mazzei, M. Sala, F. A Morphological characterization: the essential oil composition and DNA genotyping of Ocimum basilicum L. cultivars. Plant Science. 2004, v. 167, p. 725–773, https://doi.org/10.1016/j.plantsci.2004.04.026

[13] Macchia, M., L. G. Angelini, and L. Ceccarini. Methods to overcome seed dormancy in Echinacea angustifolia DC. Sci. Hort. 2001, 89: 317–324. https://doi.org/10.1016/S0304-4238(00)00268-5

[14] Mew, T. W. and Misra, J. K. A manual of rice seed health testing. International Rice Research Institute. 1994, Los Banos, Laguna, Philippines. Manila, Philippines.

[15] Rahouma M. Effect of storage periods and packaging types on germination, seedling characters and biochemical changes of barley grains, Alexandria sci. exch. J. 2021, 42, 133-138. https://doi.org/10.21608/asejaiqjsae.2021.152593

[16] Ramlah A., Koes, F., & Komalasari, O. (2020). Efects of seed storage duration and matriconditioning materials on germination and seedling characteristics of maize. AGRIVITA Journal of Agricultural Science, 42(3), 425–434. https://doi.org/10.17503/agrivita.v42i3.2034

[17] Rawat R., Negi K. S., Mehta P. S., Tiwari Y, Verma S. K. and Bisht I. S. Study of Six Varieties of Sweet Basil (*Ocimum basilicum* L.) and their Morphological Variations, *Journal of Non-Timber Forest Products | Volume: 23 | Issue: 1 | Page No. 17-22 | 2016, https://doi.org/10.54207/bsmps2000-2016-7T1Z9Z*

[18] Sisman *C. B.*, Quality losses in temporary sunflower stores and influences of storage conditions on quality losses during storage. Journal of Central European Agriculture. 2005, 6: 143-150. https://hrcak.srce.hr/16847

[19] Suriyong, S. Studies About Mechanisms of Oil Seed Deterioration Under Different Storage Conditions in Oil Seed Rape (Brassica napus L.) Cuvillier verlag Gottingen. 2007, Göttingen: Cuvillier Verlag, 2. https://cuvillier.de/de/shop/publications/1749

[20] Stanojkovic-Sabic A., Dinic Z., Ilicic R., Pivic R., Josic D. Effect of indigenous pseudomonas chlororaphis strains on morphological and main chemical growth parameters of basil. 2017, 54(2): 42-47. https://doi.org/10.5937/ratpov54-12629

[21] Vieira, R. F.; Simon, J. E., Chemical characterization of basil (Ocimum spp.) based on volatile oils. Flavour and Fragance. 2006, v. 21, p. 214-221. https://doi.org/10.1002/ffj.1513

[22] Yimer M., (2010). Market profile on spice in Ethiopia, Addis Aba, Ethiopia. https://www.nabc.nl/uploads/content/files/Factsheet%20ABSF%20spices.pdf accesed in June 18/2016