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Effect of Seed Storage Period on Seed Quality and Seedling Growth of Basil *(Ocimum basilicum L.)*Varieties.

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Abstract

This study was conducted at Wondo genet Agricultural Research Center, to assess the effect of seed storage period on seed quality and seedling growth of basil varieties. A laboratory and lath house experiment consisting of two varieties (WG-sweet basil-II and WG-sweet basil-v) and six storage periods(time of harvest, 1(30days), 3(90days), 6(180days), 9(270 days) and 12(360 days) months) in CRD and RCBD with three replications. All parameters were taken after the seed germinated and seedlings were mature or two months after seeding. The results revealed that significant difference between the treatments and the basil variety WG-sweet basil-Vperformed better than the WG-sweet basil-II with respect of some growth parameters. The analysis of variance indicated that interaction effects of basil variety and storage time had a significant ($P<0.05$) effect on leaf number, dry biomass, branch number, vigor index and plant height of basil seedling. The highest leaf number was recorded from variety WG-sweet basil-v stored for 3 months and the lowest leaf number was recorded from variety WG-sweet basil-IIstored for 9 months. The tallest plant was recorded from variety WG-sweet basil-v stored for 3 months and the shortest plant was recorded from variety WG-sweet basil-Vwithout storing of seed. Significantly the maximum dry biomass was recorded at 6 months storage time from variety WG-sweet basil-II and the lowest dry biomass was recorded from the seedling of variety WG-sweet basil-Vat 12 months storage time. Basil dry biomass per plant for the variety WG-sweet basil-II ranged from 1.7 to 3.92 gm whereas for the variety WG-sweet basil-V ranged from 1.18 to 3.08 gm. The highest branch number were recorded from variety WG-sweet basil-V stored for 3 months and the lowest branch number were recorded from the seedling of variety WG-sweet basil-II stored for 9 months. Basil branch number per plant for the variety WG-sweet basil-II ranged from 3.5 to 10.8 whereas for the variety WG-sweet basil-V ranged from 6.4 to 12.4.The highest vigor index I was recorded at 6 and 9 months stored of variety WG-sweet basil-II and WG-sweet basil-Vrespectively.In general variety WG-sweet basil-II and WG-sweet basil-V had a better performance and seedling quality when the seed stored for 6 and 9-months storage time respectively.

Keywords: Storage, WG-sweet basil-IIand WG-sweet basil-V, Seed, Seedlings and Quality

Background and Justification

Basil (*Ocimum basilicum* L.) is one of the annual aromatics and medicinal herb plants from the lamiaceae family. Basil isnative to tropical parts of Asia, Africa, Central and South America and grown for its aromatic leaves, used as fresh or dried to boost up numerous culinary dishes (Rawat *et al.,* 2016**)**. The Ocimum genus (*Family Lamiaceae*) includes over 150 different species, 30 of which are native to the tropics and subtropics, with some species naturalized and/or cultivated in temperate areas (Labra et al., 2004; Vieira and Simon, 2006).The genus Ocimum is well represented in the warmer parts up to 1800 m altitude from sea level and Optimum temperature for germination is 20°C, with growing temperatures of 7 to 27°C (Department of Agriculture, Forestry and Fisheries. 2012). The plant is susceptible to frost and cold temperatures and therefore develops best in long-day, full-sun conditions (Department of Agriculture, Forestry and Fisheries., 2012). Basil can't tolerate drought stress as the plant tissue is very tender. Annual rainfall of 700 mm is the minimum for dryland cultivation (Department of Agriculture, Forestry and Fisheries., 2012). Basil requires well-drained, fertile soils with a high organic matter content. It grows well in soils with a pH ranging from 4,3 to 8,2 and an optimum pH of 6,4 (Department of Agriculture, Forestry and Fisheries., 2012).

Both herbal and essential oil of basil are important in international market being essential ingredient in many cooking traditions, cosmetics, perfumery, oral products, hygiene and cleaning products. Leaves 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 treatment of acne, snakebites and insect stings (Stanojkovic-sebic *et al*., 2017).

In Ethiopia, basil is named with different names from place to place and its cultivation is for home consumption and for income generation by small-scale growers. However, Alemu, (2017), cited byYimer (2010), also reported as basil was an export commodity in the country. Commercial producers have exported currently herbal products of basil to foreign market. Ethiopian agro-ecology is suitable for basil production and recently two varieties released after multi location evaluations. The two varieties propagated via seeds and proper seed conservation, handling and utilization techniques are important for sustainable production of the varieties.

High seed quality and seedling establishment are the cornerstones of profitable, efficient, and sustainable crop production (Finch-Savage, 1995). Seed dormancy is one of the factors for the quality of seed and dormancy can be defined as the failure of an intact viable seed to complete germination under favorable conditions and is controlled by several environmental factors such as light, temperature, and the duration of seed storage (Macchia et al., 2001).Seeds of sweet basil possess a physiological dormancy that could be optimized seed germination by pre-sowing treatment(Khalid *et al*., 2016).

The actual seed storage life will depend upon the viability and moisture content of the seed when initially placed in storage, the specific variety, and the conditions of the storage environment. The proper storage period, storage package, storage environment for the two variety of basil seeds did not identify. Since basil propagated via seeds and maintenance of the varieties have to be via seed conservation, knowledge of the influence of seed storage period for each variety is advantageous and the current work aimed to verify how long basil seeds be stored at normal condition. So, the main objectives of this activity are**,** to assess effects of seed storage periods on growth and yield of basil varieties and to identify the interaction effects of seed storage period and basil variety.

Materials and Methods

Description of Experimental Site

The experiment has been conducted during 2020in the laboratory and lath house of Wondo Genet Agricultural Research Center. Wondo genet is located at 7^{o} 192 N latitude and 38^{o} 382 E longitude with altitude of 1780 m a.s.l. The site receives mean annual rainfall of 1128 mm with minimum and maximum temperature of 11.47 and 26.51^{o}C, respectively. The soil textural area of the experimental area was sandy loam with the pH of 6.4 (Kassahun *et al*., 2014). TheWG-sweet basil-II and WG-sweet basil-V, varieties which were adaptable to the experimental area were used as planting material.

Treatments and Experimental procedure

Recently released two basil varieties were used for the experiment. Health seeds of each variety weresownon 10mx10m of land by the consideration of isolation distance of the crop with 60x30 spacing.Here no fertilizer and chemical pesticide applied during the experimentation. All agronomic practices of the experimental field were carried out uniformly whenever required.When the two basil varieties physiologically matured, the seed was harvested and dried with sunlight. After preparing the seed for storage, the seed were tested for its seed quality and seedling in the laboratory and light house condition for each storage duration.For each treatment20 seeds were used for germination test in the laboratory and 40 seedlings were used to evaluate the quality of the seedling.

The two varieties of basil seed were subjected to different storage period under normal condition uniformly. A combination of six-storage periods with two basil varieties were evaluated using RCBDdesign in three replications. The experiment includes 24treatments (combination of 0-month, 1 month, 3-month, 6-month, 9 month and 12-month storage periods with variety WG-sweet basil-II and WG-sweet basil-V). Healthy seeds from health mother plants were collected and used for seedlings preparation. The seedlings were prepared on polyethylene tube under nursery. wateringwas applied day and night throughout seedling growing time and other cultural practices, such as weeding, was done as needed.

Table 1 Details of Treatment Descriptions

Factor 1	Factor 2	Treatment's combination	Code
WG-sweet basil-V	Initial time	Initial time+ WG-sweet basil-V	T1
	1 months	1 months + WG-sweet basil-V	T2
	3 months	3 months + WG-sweet basil-V	T3
	6 months	6 months + WG-sweet basil-V	T4
	9 months	9 months + WG-sweet basil-V	T5
	12 months	12 months + WG-sweet basil-V	T6
WG-sweet basil-II	Initial time	Initial time+ WG-sweet basil-II	T7
	1 months	1 months + WG-sweet basil-II	T8
	3 months	3 months + WG-sweet basil-II	T9
	6 months	6 months + WG-sweet basil-II	T10
	9 months	9 months + WG-sweet basil-II	T11
	12 months	12 months + WG-sweet basil-II	T12

Statistical Data Analysis

The data recorded in this study was subjected to statistical analysis. The analysis of variance was carried out using SAS software. Significance differences between treatment means was delineated by least significance difference (LSD) test at 5 % level of significance.

Results and Discussion

Moisture content and Germination percentage

The interaction effect of the storage duration and basil seed variety had a significant (P<0.01) effect on moisture content of basil seed (Table 2). Almost similar moisture content was recorded at the beginning of storage duration for the two-basil variety which had the lowest moisture content as compared to the rest of storage duration. The results of this experimental datashowed that moisture content increasedwith an increasing storage time of seed of basil.This result is in agreement with the findings of Naznin, (2005) and M.R. Ali1 *et al*, (2017) who reported that air tight tin can showed an increase in moisture content and sharp decline seed viability within a year of storage.This may be occurred the seed attract the moisture from the environment and fluctuate through time.In general, the variety WG-sweet basil-II had slightly higher ability to attract moisture from the environment as compared to the variety WG-sweet basil-V.

Table 2: Interaction effects of basil varieties and storage duration on basil seed moisture content

		Moisture content (%)					
		Storage duration in months					
Variety	0	1	3	6	9	12	Mean
WG-sweet basil-II	8.24f	19.92cde	32.44ab	22.28cd	27.43abc	22.93bc	22.21
WG-sweet basil-V	8.51f	12.74def	4.49f	11.16ef	35.00a	19.84cde	15.29
LSD	**9.86**						
CV%	**31.06**						
VR*ST	***						

Means with the same letter are not significantly different at 5% probability level. VR=varietyST=storage duration.

The analysis of variance indicated that significant (P<0.05) germination percentage differences observed due to varyingstorage duration between basil variety, but the interaction between storage time and basil variety had no significantly different. The germination percentage of the two basil varieties had un increasing trained with increasing storage duration and then somewhat constantafter six months storage time. According to the overall mean of the data the variety WG-sweet basil-ll had greater germinating capacity than the variety WG-sweet basil-v, similarly variations in seed germination were species dependent (Khalid *et al*., 2016), A. B. Siddique and D. Wright., (2003).

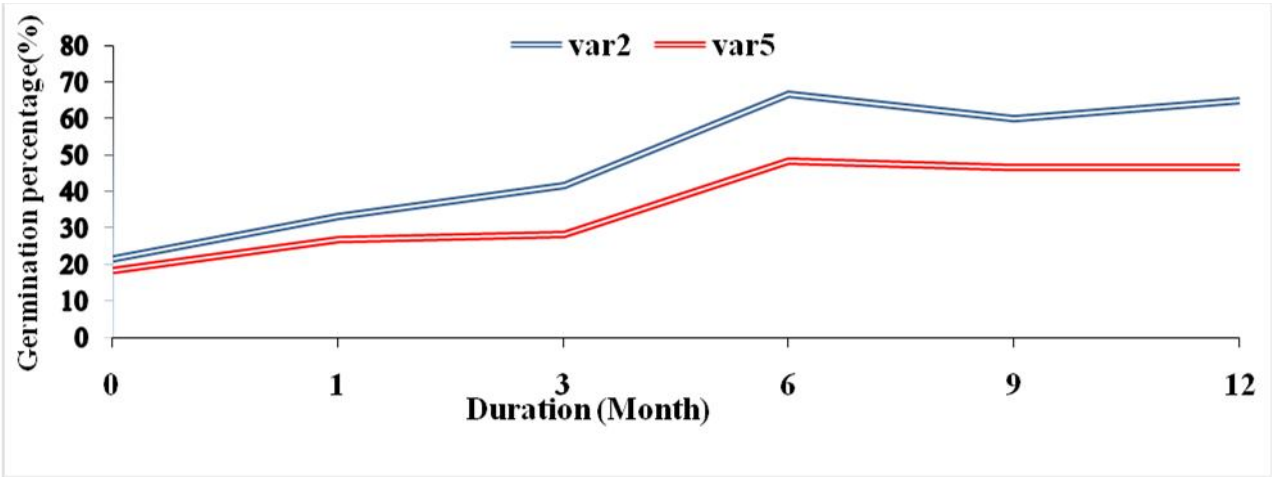

Figure 1: Effect of basil varieties and storage duration on basil seed germination.

Number of leaves per plant and Seedling plant height

The analysis of variance indicated significant ($P<0.05$) interaction effects of basil variety and storage duration on leaf number of basil seedling. Even if the value of leaf number didn't show consistent trend with an increasing storage duration of basil seed, the highest leaf number was recorded from 3 months stored of variety WG-sweet basil-v and the lowest leaf number was recorded by storing variety WG-sweet basil-ll for 9 months. This result was in agreement with (Fernando *etal*,2014) who reported that the relative growth rate in number of leaves, seedlings from fresh seeds initially produced slightly more leaves compared to seedlings from stored seeds. According to the overall mean of basil leaf number of a seedling, variety WG-sweet basil-v had a greater number of leaves as compared to variety WG-sweet basil-ll.

Table 3: Interaction effects of varieties and storage duration on Seedling plant height and Number of leaves of basil per plant.

	Number Leaves						
	Storage duration in months						
Variety	**0**	**1**	**3**	**6**	**9**	**12**	**Mean**
WG-sweet basil-II	23.00cd	49.33ab	24.67cd	29.67c	13.00d	31.00c	28.45
WG-sweet basil-V	32.67c	31.33c	56.33a	26.00cd	37.33cb	23.00cd	34.44
LSD (p0.05)				14.97			
CV%				28.12			
VR*ST				***			

Means with the same letter are not significantly different at 5% probability level. VR=variety ST=storage duration

Table 4: Interaction effects of basil varieties and storage duration on basil seed moisture content

		Moisture content (%)					
		Storage duration in months					
Variety	**0**	**1**	**3**	**6**	**9**	**12**	Mean
WG-sweet basil-II	14.30e	14.23e	15.33e	34.67a	15.33e	22.17cd	19.34
WG-sweet basil-V	13.50e	20.83d	37.17a	25.20bc	29.00b	20.33d	24.34
LSD (p0.05)	4.14						
CV(%)	11.18						
VR*ST	***						

The analysis of variance indicated significant (P<0.05) interaction effects of basil variety and storage duration on plant height of basil seedling. According to the overall mean of basil plant height of a seedling, variety WG-sweet basil-V had the longest plant height as compared to variety WG-sweet basil-II. The longestplant height was recorded at 3 months stored of variety WG-sweet basil-V and the shortestheight was recorded from thevariety of WG-sweet basil-V before storing the basil seed. Similarto leaf number the value of plant height didn't show consistent trend with an increasing storage duration of basil seedling.However, the seedling height of the stored seed was longer than the seedling height grown from initial seed, in the contrary(Fernando *et al*, 2014) reported that the seedlings grown from *M. foliolosa*seed showed a fast growth in the first month and a strong reduction in relative growth rate in the following month. After high relative growth rate values in the third month, height decreased and remained constant.

Dry biomass and Primary branch number per plant

The results revealed that dry biomass per plantwas significantly affected ($p < 0.05$) by the interactions of storage duration and variety of basil.The highest dry biomasswas recorded at6 months stored of variety WG-sweet basil-II and the lowest dry biomasswas recorded from the seedling of variety WG-sweet basil-v after 12 months storage time, this result in agreement with (Ramlah*et al*, 2020) who reported that the dry weight was higher at the seedlings derived from the seeds that previously stored at 4 months, followed by 36 and 72-months storages.Higher seedlings dry weight indicated that tissues and organs formations were optimally promoted through active respiration and biosynthesis from the carbohydrate mobilization (Sánchez-Linares *et al*., 2012).There was variable trend of dry biomass due to the increasing duration of storage for each variety. Basil dry biomass per plant for the variety WG-sweet basil-II ranged from 1.7 to 3.92gmwhereas for the variety WG-sweet basil-V ranged from 1.18 to 3.08 gm (Table 5). In general, the average dry biomass per plant indicated that the variety WG-sweet basil-II had somewhat a greater weight than the variety WG-sweet basil-V.

Table 5: Interaction effects of varieties and storage duration on dry biomass of basil.

	Dry Biomass per plant (gm)						
	Storage duration in months						
Variety	0	1	3	6	9	12	Mean
WG-sweet basil-II	2.14f	2.80d	1.38h	3.92a	1.7g	3.73b	2.61
WG-sweet basil-V	2.11f	2.57e	1.4h	1.29i	3.08c	1.18j	1.92
LSD (p0.05)	0.0488						
CV (%)	1.27						
VR*ST	***						

Means with the same letter are not significantly different at 5% probability level. VR=variety ST=storage duration

Table 6. Interaction effects of varieties and storage duration on branch number of basil per plant

	Primary branch Number per plant						
	Storage duration in months						
Variety	**0**	**1**	**3**	**6**	**9**	**12**	Mean
WG-sweet basil-II	6.20e	10.20bc	6.80e	10.80b	3.50f	9.40c	7.82
WG-sweet basil-V	10.00bc	8.40d	12.40a	8.00d	8.40d	6.40e	8.93
LSD (p0.05)	0.98						
CV (%)	6.89						
VR*ST	***						

Means with the same letter are not significantly different at 5% probability level. VR=variety ST=storage duration

The analysis of variance indicated significant (P<0.05) interaction effects of basil variety and storage duration on primary branch number per plant. The highest primary branch number were recorded at3 months stored of variety WG-sweet basil-v and the lowest branch number were recorded from the seedling of variety WG-sweet basil-II after 9 months storage time. Basil primary branch number per plant for the variety WG-sweet basil-II ranged from 3.5 to 10.8whereas for the variety WG-sweet basil-v ranged from 6.4 to 12.4. In general, the average primary branch number per plant indicated that the variety WG-sweet basil-v had more primary branch number than the variety WG-sweet basil-II.

Vigor Index of basil seedling

The analysis of variance indicated significant (P<0.05) interaction effects of basil variety and storage duration on vigor index I of basil seedling. The highest vigor index I was recorded at6- and 9-months stored seeds of variety WG-sweet basil-II and WG-sweet basil-V respectively. On the other hand, the lowest vigor index I was recorded from the seedling of variety WG-sweet basil-V before storing the seed.

Table 7: Interaction effects of varieties and storage duration on Vigor Index of the seedling.

Variety	Vigor Index I						
	Storage duration in months						
	0	1	3	6	9	12	Mean
WG-sweet basil-II	1558.70ef	1209.80fg	1027.30g	4784.00b	1763.30e	3834.80cd	2362.98
WG-sweet basil-V	877.50g	1645.80ef	3382.20d	4107.60c	5307.00a	3883.70c	3200.63
LSD (p0.05)	496.58						
CV(%)	10.54						
VR*ST	***						

Means with the same letter are not significantly different at 5% probability level. VR=variety ST=storage duration.

The value of vigor index at variety WG-sweet basil-v show increasing trend with an increasing storage duration of basil seed up to 9 months, this result was contradicted with (Ravindra *et al.*, 2021)who reported that the vigor index of stored pea seed reduced with increase in storage period. But on the variety WG-sweet basil-II it shows inconsistent trained. In general, the average vigor index I indicated that the variety WG-sweet basil-v had a greater vigor index than the variety WG-sweet basil-II.

Summary and Conclusion

The laboratory and lath house experiment to see the effect of storage durationon basil seed variety was conducted during 2021 growing seasons inWondo Genet agricultural research center seed laboratory and lath house condition. The harvested and well dried two basil seed variety were made to evaluate their seed potential to 12 months storage time for its germination and seedling performance. Treatments applied were a control plot (testing each variety before storing the seed), two basil variety (WG-sweet basil-v and WG-sweet basil-II) with five storage time (1, 3,6,9 and 12months) were used incomplete block design and randomized complete block design for the laboratory and lath house experiment respectively with three replications.

Most of the seed and seedling quality parameters, Moisture content, Germination percentage Seedling plant height, Number of leaves per plant, Dry biomass per plant, Branch number per plant and Vigor Index of basil seedling were significantly affected due to basil variety and storage duration. Basil seed germination was significantly influence by storage time and basil variety. Whereas the interaction effects of basil variety by time of their storage showed significant influence on Moisture content, Seedling plant height, Number of leaves per plant, Dry biomass, Branch number per plant and Vigor Index of basil seedling. The parameters like germination, Seedling plant height, Dry biomass, Branch number per plant and Vigor Index of basil seedling had the highest value for WG-sweet basil-ll after 6 months stored seed whereas the variety WG-sweet basil-vshows an increasing trend up to 9 months storage for its vigorosity.

In conclusion the variety WG-sweet basil-ll and WG-sweet basil-v had a good seed and seedling quality up to 6- and 9-months storage time respectively. Even if the two variety shows the maximum value after 6 and 9 months of storage, on some parameters the value indicated that almost similar after the listed months of storage. This result needs further investigation on the two-basil variety by increasing the storage duration.

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Conflict of Interest

The author(s) declares no conflict of interest.

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