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Review on Effects of Genotypes and Harvesting age on Herbage and Oil Production of Sweet basil (*Ocimum basilicum* L.)

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Abstract: **Genotype and Harvesting age are found to be an important factor which affects the herbage and essential oil yield of sweet basil. Knowing harvesting age in aromatic crop production is essential for essential oil extraction to optimize the biomass production and to harvest the crop before any deterioration on biomass, oil content and quality occurs. It was found that the chemical composition of the essential oil in sweet basil is highly related to the age of the leaves, thus emphasizing the importance of the growth stage at which harvesting takes place. The relationship between age and essential oil content arises from the process of biosynthesis. Essential oil synthesis occurs only in very young cells; as the synthesis proceeds, the oil is released outside the cell. At the early period of leaf development, the release of oil is high and it remains at the same level during further period of leaf growth, when leaf weight increases significantly. Therefore, the amount of oil in the leaf, expressed in percent, decreases with plant growth; this also results from losses caused by oil evaporation. The cultivar, cropping period, plant ontogeny, and plant part have a determining effect on the yield and quality of the volatile oil of sweet basil. The extraction of essential oil at an appropriate age of plant makes it possible to obtain the highest herbage yield, essential oil yield and content of the desired components with special biological activity. Sweet basil genotypes have different herbage yield, essential oil yield and contents and differences in the essential oil yield and its components among the studied landraces of basil could be attributed to genetic diversity.**

***Keywords*: Chemical composition, Essential oil, Genotype, Harvesting age, Herbage.**

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1. INTRODUCTION

Sweet basil (*Ocimum basilicum* L.) is indigenous to India and other areas in tropical Asia, where it has been grown for 5000 years (Tucker and DeBaggio, 2000). The generic name, *Ocimum*, originates from the ancient Greek word okimon, which means smell. There are numerous suggestions for the origins of the word basil. One is that it stems from the Greek word basileus, meaning king, as it is believed to have grown close to the area where St Constantine and his mother St Helen discovered the Holy Cross (Jacqueline, 2001). According to Parkinson, basil's scent was 'fit for a king's house' (Grieve, 1931). There are about 150 to 160 species in this genus broadly dispersed over the warm regions of the globe (Evans, 2001; Kumar, 2009). They differ in growth habit, physiological appearance and chemical and aromatic composition. Among different cultivated species, *Ocimum basilicum* L. and *Ocimum canum* are cultivated extensively and commercially for essential oil production throughout the world (Nahak *et al.*, 2011).

Sweet basil is used in food, perfumery and pharmaceutical industries. Basically, oils are the most valuable commercial forms of basil and contribute flavor and aroma to a variety of products in the food and cosmetic industries (Putiev-sky and Galambosi, 1999). The high economical value of basil oil is due to the presence of phenyl propanoids, like eugenol, chavicol and their derivatives (Bowes and Zheljazkov, 2004). The presence of this essential oil enables the plant to provide good flavor to the *berbere*, *shiro*, or butter (G/Medhin, 2008). It is also known for its purifying and disinfecting properties (Agarwal *et al*., 2013). These authors also added that, basil can be used as an ointment for insect bites, and its oil is applied directly to the skin to treat acne among the plants known for medicinal value. The oil extracted from the leaves is reported to possess antibacterial and insecticidal properties, and is effective as a mosquito repellent. Jansen (1981) explained that both dried and fresh inflorescences and leaves of basil are used as flavoring agent in the preparation of all kinds of *wät*. Dried ground basil is also used to flavor butter and is sometimes sprinkled in tea or coffee to add flavor. Farrell (1998) also wrote that the herb complements meat, vegetables, cheese, and egg dishes. Etana (2007) and Mesfin *et al*. (2009) also noted the spice use of *O. basilicum.*

Yield and the essential oil composition of *Ocimum* species were influenced by interaction between the genotype and environment, method of distillation, kind of storage, crop age, spacing, diseases and insects, time of harvest and season (Randhawa and Gill, 1995; Gupta, 1996; Frąszczak *et al*., 2014; Smitha and Tripathy, 2016). Among the various factors, which affect the production of this plant, harvesting age is important. Yields of fresh material and essential oil, and composition were strongly dependent on developmental stage of the plant (ontogeny), and therefore harvesting age is one of the most important factors influencing basil oil (Randhawa and Gill, 1995). Therefore, the extraction of essential oil at an appropriate age of plant makes it possible to obtain the highest herbage yield, essential oil yield and content of the desired components with special biological activity. Therefore, the objective is to review the effects of genotypes and harvesting stages on sweet basil production.

2. EFFECTS OF HARVESTING AGE AND GENOTYPE ON HERBAGE AND ESSENTIAL OIL YIELDS OF SWEET BASIL

2.1. Effect of Harvesting age on Herbage and Essential Oil Yields of Sweet basil

The main objective of knowing harvesting age in aromatic crop production for essential oil is to optimize the biomass production and to harvest the crop before any deterioration on biomass, oil content and quality occurs. It is clearly indicated that in aromatic crops, the chemical composition of the essential oil is related to the age of the leaves, thus emphasizing the importance of the growth stage at which harvesting takes place (Motsa, 2006). Moreover, Fischer *et al*. (2011) observed that leaf age is one of the factors that influence the chemical composition of sweet basil. The authors reported that higher essential oil was produced at younger leaf ages than older leaves. The strongest activity of basil essential oil has been observed in younger leaves (Lupton *et al*., 2016). The commercial value of basil is influenced by its aroma. In addition, the composition of this plant's essential oil is related to the position of the leaves on the stem, because this position is tied to the plant's development, the plant's physiological age may be a factor that interferes in the composition of its oil (Fischer *et al*., 2011).

Moghaddam *et al*. (2015) reported that the essential oil yield and chemical compositions of *Ocimum basilicum* was dependant on different stages of growth. The authors also observed that essential oil yields were 1.80, 1.30, 1.20, 1.13, 1.03 and 0.80 (w/w %) at budding, vegetative, initial flowering, full bloom, immature and ripen fruit stages, respectively. Missanjo (2014) indicated essential oil yield decrease with increase in plant. This may be because of better growth conditions at early ages (Mansoori, 2014). Harvesting age of plant has an influence on quantity and quality of essential oil in most essential oil-bearing plants (Ramezani *et al*., 2009) including sweet basil. Moreover, optimum harvesting age depends on the target compound desired. The oil content and yield of aromatic plants are often altered during harvesting and post harvesting processes (Motsa, 2006). This alteration occurs due to spontaneous conversions occurring continuously, which changes the essential oil composition (Jose *et al*., 2006).

Generally, in sweet basil the relationship between age and essential oil content arises from the process of biosynthesis. Essential oil synthesis occurs only in very young cells; as the synthesis proceeds, the oil is released outside the cell. At the early period of leaf development, the release of oil is high and it remains at the same level during further period of leaf growth, when leaf weight increases significantly. Therefore, the amount of oil in the leaf, expressed in percent, decreases with plant growth; this also results from losses caused by oil evaporation. The cultivar, cropping period, plant ontogeny, and plant part have a determining effect on the yield and quality of the volatile oil of *Ocimum basilicum* (Liber *et al*., 2011; Verma *et al*., 2012). Ontogenetic variation is particularly important, since it largely determines the proper time for harvesting raw material as well as its chemical composition and activity (Nurzyńska-Wierdak *et al*., 2012; Zheljazkov *et al*., 2012). Plants and their essential oils are a potential source of antimicrobial substances. The activity of individual volatile oils in relation to particular microorganisms is associated with their composition (Koba *et al*., 2009; Runyoro *et al*., 2010), which is in turn determined by plant growth variation (Hussain *et al*., 2008).

Fresh herb yield of basil was increased significantly with increase in crop age or delay in harvesting at first harvest due to better growth of plants in terms of plant height, spread and number of branches per plant due to longer growth period. Oil content in the fresh herb of basil plant increased significantly up to 60 DAT, beyond that significant decrease in oil content was recorded (Singh *et al*., 2010). At this stage, plants had a greater number of matured leaves and less proportion of bulky stem containing very less amount of essential oil and further delay in harvesting, plants approached to seed formation and shedding of lower leaves. Chang *et al*. (2009) also found that there was a significant difference between youngest and most matured leaves with essential oil content and composition of basil. The authors also added that, young leaves had a higher content of essential oil per unit area compared to old leaves, which indicated that the essential oil content was decreased as leaf age increased. This indicated that harvesting age is one of the most important factors influencing essential oil yield.

2.2. Effect of Genotype on Herbage and Essential Oil Yields of Sweet basil

Basil (*Ocimum basilicum* L.) genotypes have different herbage yield, essential oil yield and contents which were reported by different authors. According to Blank *et al*. (2010), dry weight of leaves and essential oil yield presented high variability. Suera *et al*. (2015) reported oil yield to be dependent on the fresh herbage yield, and significantly vary amongst *Ocimum* species. The authors stated essential oil yield variation among the species to be due to their genetic composition differences. According to Agarwal *et al*. (2013), the comparative study of *Ocimum* species was examined to assess the variability of qualitative and quantitative morphological characters present among the sixteen different genotypes of *Ocimum* species. The authors found that there was highly significant variations amongst the various characters existed in different genotypes of *Ocimum* species. Similar results were reported in some earlier studies involving different *Ocimum* species for different morphological traits such as plant height, fresh herb yield, and oil content and number of branches (Sarvin *et al.*, 1992; Gupta, 1996; Verma *et al*., 1998). Basil essential oil content, ranging from 0.07% to 1.37% was reported by Wetzeil *et al*. (2002). However, screening of large number of basil accessions in the United States demonstrated that the essential oil content varied from 0.04% to 0.7% (Simonet *al*., 1990)

Verma *et al*. (2011) analyzed the composition of the essential oil from two cultivars of *O. basilicum* and found that its quality differed significantly according to the cultivar's cropping season, plant ontogeny and plant part. The main component in one of the cultivars was methyl chavicol (84.3 - 94.3%), while the other contained methyl chavicol (62.5 - 77.6%) and linalool (14.4 - 34.1%) as the main components. Yield and essential oil composition are remarkably variable between purple and green genotypes (Marotti *et al*, 1996; Sajjadi, 2006) which also differ in biomass yield (Hochmuth and Leon, 1999). According to Ghawas and Ahmad (2002), ten locally selected *Ocimum* accessions showing differences in morphological characters were evaluated for their yield potential and chemical profile. Significant differences in fresh herb and essential oil yield, and oil recovery percentages were obtained among them. The authors further explained that the yield and essential oil content variability between species resulted due to varying genetic factors, ecological factors, geographic origins, different chemotypes and differences in the nutritional status of plants.

Ghasemi (2014) reported that the essential oil components of two Iranian landraces of basil varied with genotype and chemotypes. The author also indicated that methyl chavicol or estragol and linalool for the purple landrace and methyl chavicol, geranial and neral for the purple landrace are the main constituents of the essential oils. Zheljazkov *et al*. (2007) conducted an experiment to assess yield, oil content, and composition of 38 genotypes of sweet basil (*Ocimum basilicum* L.) and significant variation was observed among tested basil genotypes with respect to oil content and composition. In contrast to the previous report Patel *et al*. (2016) reported existence of variability among 15 genotypes of *Ocimum* species with regard to morphological traits and essential oil yields. Kassahun *et al*. (2014) also reported significant morphological and chemical characters differences among spearmint genotypes. Significant variations are observed in the content and composition of the essential oils obtained from different *Ocimum species,* based on their distinct morphological characters (Saran *et al*., 2017). Essential oil content, fresh herb yield, essential oil yield, methyl chavicol content and methyl chavicol yield were found to vary among the investigated *O. basilicum* accessions (Padalia *et al*., 2017). Generally, differences in the essential oil yield and its components among the studied landraces of basil could be attributed to genetic diversity.

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3. SUMMARY AND CONCLUSION

Harvesting age of plant has an influence on quantity and quality of essential oil in most essential oil-bearing plants. Knowing harvesting age in aromatic crop production is essential for essential oil extraction to optimize the biomass production and to harvest the crop before any deterioration on biomass, oil content and quality occurs. It was found that the chemical composition of the essential oil in sweet basil is highly related to the age of the leaves, thus emphasizing the importance of the growth stage at which harvesting takes place. Moreover, leaf age is one of the factors that influence the chemical composition of sweet basil. As a result, higher essential oil was produced at younger leaf ages than older leaves. The strongest activity of basil essential oil has been observed in younger leaves. In addition, the composition of this plant's essential oil is related to the position of the leaves on the stem, because this position is tied to the plant's development, the plant's physiological age may be a factor that interferes in the composition of its oil

Generally, in sweet basil the relationship between age and essential oil content arises from the process of biosynthesis. Essential oil synthesis occurs only in very young cells; as the synthesis proceeds, the oil is released outside the cell. At the early period of leaf development, the release of oil is high and it remains at the same level during further period of leaf growth, when leaf weight increases significantly. Therefore, the amount of oil in the leaf, expressed in percent, decreases with plant growth; this also results from losses caused by oil evaporation. The cultivar, cropping period, plant ontogeny, and plant part have a determining effect on the yield and quality of the volatile oil of *Ocimum basilicum*. The extraction of essential oil at an appropriate age of plant makes it possible to obtain the highest herbage yield, essential oil yield and content of the desired components with special biological activity. Sweet basil genotypes have different herbage yield, essential oil yield and contents and differences in the essential oil yield and its components among the studied landraces of basil could be attributed to genetic diversity.

REFERENCES

[1] Agarwal, C., Sharma, N.L. and Gaurav, S.S. (2013). An analysis of basil (*Ocimum sp.*) to study the morphological variability.*Indian J Fundam Appl Life Sci*, *3*(3):521-525.

[2] Blank, A.F., de Souza, E.M., de Paula, J.W. and Alves, P.B. (2010).Phenotypic and genotypic behavior of basil populations.*Horticultura Brasileira*, 28(3):305-310.

[3] Bowes, K.M. and Zheljazkov, V.D. (2004). Factors affecting yields and essential oil quality of *Ocimum sanctum* L. and *Ocimum basilicum* L. cultivars. *Journal of the American Society for Horticultural Science*, 129(6): 789-794.

[4] Etana, T. (2007). Use and conservation of traditional medicinal plants by indigenous people in Gimbi woreda, western Wellega. *Ethiopia (Doctoral dissertation, AAU)*.

[5] Farrell, K.T. (1998). *Spices, condiments and seasonings*.Springer Science & Business Media.

[6] Fischer, R., Nitzan, N., Chaimovitsh, D., Rubin, B. and Dudai, N. (2011). Variation in essential oil composition within individual leaves of sweet basil (*Ocimum basilicum* L.) is more affected by leaf position than by leaf age. *Journal of agricultural and food chemistry*, 59(9):4913-4922.

[7] Frąszczak, B., Golcz, A., Zawirska-Wojtasiak, R. and Janowska, B. (2014). Growth rate of sweet basil and lemon balm plants grown under fluorescent lamps and led modules. *Acta Sci. Pol. Hortorum Cultus*, 13(2):3-13.

[8] G/Medhin, A. (2008). Local use of spices, condiments and non-edible oil crops in some selected woredas in Tigray, Northern Ethiopia.MSc Thesis, Addis Ababa University, Ethiopia.

[9] Ghasemi, P.A. (2014). Diversity in chemical composition and yield of essential oil from two Iranian landraces of sweet basil. *Genetika*, 46(2):419-426.

[10] Ghawas, M.M. and Ahmad, A.W. (2002). Preliminary study on yield performance and chemical composition of 10 locally selected Ocimum accessions. *Journal of Tropical Agriculture and Food Science*, *30*:25-30.

[11] Grieve, M.A. (1931). *A Modern Herbal, Vol.* 2. Dover, New York.

[12] Gupta, S.C. (1996). Variation in herbage yield, oil yield and major component of various *Ocimum species*/varieties (chemotypes) harvested at different stages of maturity. *Journal of Essential Oil Research*, 8(3):275-279.

[13] Hochmuth, R.C. and Leon, L.L. (1999). Evaluation of six basil cultivars grown in a vertical hydroponic production system inside a greenhouse.*Univ. of Florida, FLO, NFREC-SV Research Report*, pp.99-06.

[14] Hussain, A.I., Anwar, F., Sherazi, S.T.H. and Przybylski, R. (2008). Chemical composition, antioxidant and antimicrobial activities of basil (*Ocimum basilicum*) essential oils depends on seasonal variations. *Food chemistry*,108(3):986-995.

[15] Jacqueline, A.S. (2001). Father Kino's herbs: growing and using them today. Tierra Del Sol Institute Press, Tucson, Arizona.

[16] Jansen P. C. (1981). Spices, condiments and medicinal plants (*Ocimum basilicum*) in Ethiopia, their taxonomy and agricultural significance; Laboratory of Plant Taxonomy and Plant Geography, Agricultural University, Wageningen,Netherlands. http://uses.plantnetproject.org/en/Jansen,_Spices_and_medicinal_plants_in_Ethiopia,_1981(accessed, 18/02/2018)

[17] Jose, L.S., Carvalho, F., Blank, A.F., Alves, P.B., Ehlert, P.A., Melo, A.S., Cavalcanti, S.C., Arrigoni-Blank, M.F. and Silva-Mann, R. (2006). Influence of the harvesting time, temperature and drying period on basil (*Ocimum basilicum* L.) essential oil. *Brazilian Journal of Pharmacognosy* 16 (1): 24-30.

[18] Koba, K., Poutouli, P.W., Raynaud, C., Chaumont, J.P. and Sanda, K. (2009). Chemical composition and antimicrobial properties of different basil essential oils chemotypes from Togo. *Bangladesh J. Pharmacol*, 4(1):1-8.

[19] Liber, Z., Carović-Stanko, K., Politeo, O., Strikić, F., Kolak, I., Milos, M. and Satovic, Z. (2011). Chemical characterization and genetic relationships among *Ocimum basilicum* L. cultivars. *Chemistry & biodiversity*, 8(11):1978-1989.

[20] Lupton, D., Khan, M.M. and Abdullah, R. (2016). 3 Basil. *Leafy Medicinal Herbs: Botany, Chemistry, Postharvest Technology and Uses*, p.27.

[21] Mansoori, I. (2014). The Effect of Plant Density and Harvesting Time on Growth and Essential Oil of Peppermint (*Mentha Piperita* L.). *Journal of Medical and Bioengineering*, *3*(2):

[22] Mesfin, F., Demissew, S. and Teklehaymanot, T. (2009). An ethnobotanical study of medicinal plants in Wonago Woreda, SNNPR, Ethiopia.*Journal of Ethnobiology and Ethnomedicine*, *5*(1), p.28.

[23] Missanjo, E. 92014). Essential Oil Yield of Corymbia citriodora as Influenced by Harvesting Age, Seasonal Variation and Provenance at Citrifine Plantations in Northern Malawi. J Biodivers Manage Forestry 3(*5)*:2.

[24] Moghaddam, M., Pirbalouti, A.G., Mehdizadeh, L. and Pirmoradi, M.R. (2015). Changes in composition and essential oil yield of *Ocimum ciliatum* at different phenological stages. *European Food Research and Technology*, 240(1): 199-204.

[25] Motsa, N.M. (2006). Essential oil yield and composition of rose-scented geranium (*Pelargonium* sp.) as influenced by harvesting frequency and plant shoot age. M.Sc. Thesis, University of Pretoria, Gauteng, South Africa.

[26] Nurzyńska-Wierdak, R. (2013). Does mineral fertilization modify essential oil content and chemical composition in medicinal plants. *Acta Sci Pol Hortorum Cultus*, 12(5):3-16.

[27] Nurzyńska-Wierdak, R., Bogucka-Kocka, A., Kowalski, R. and Borowski, B. (2012). Changes in the chemical composition of the essential oil of sweet basil (*Ocimum basilicum* L.) depending on the plant growth stage. *chemija*, 23(3):216-222.

[28] Padalia, R.C., Verma, R.S., Upadhyay, R.K., Chauhan, A. and Singh, V.R. (2017). Productivity and essential oil quality assessment of promising accessions of *Ocimum basilicum* L. from north India. *Industrial crops and products*, 97:79-86.

[29] Patel, R.P., Singh, R., Rao, B.R., Singh, R.R., Srivastava, A. and Lal, R.K. (2016). Differential response of genotype× environment on phenology, essential oil yield and quality of natural aroma chemicals of five Ocimum species. *Industrial Crops and Products*, 87:210-217.

[30] Randhawa, G.S. and Gill, B.S. (1995). Transplanting dates, harvesting stage, and yields of French basil (Ocimum basilicum L.). *Journal of herbs, spices and medicinal plants*, 3(1):45-56.

[31] Runyoro, D., Ngassapa, O., Vagionas, K., Aligiannis, N., Graikou, K. and Chinou, I. (2010). Chemical composition and antimicrobial activity of the essential oils of four Ocimum species growing in Tanzania. *Food chemistry*, 119(1): 311-316.

[32] Saran, P.L., Tripathy, V., Meena, R.P., Kumar, J. and Vasara, R.P. (201. Chemotypic characterization and development of morphological markers in *Ocimum basilicum* L. germplasm. *Scientia horticulturae*, 215:164-171.

[33] Simon, J.E., Quinn, J. and & Murray, R.G. (1990). Basil: A source of essential oils,. p. 484–489. Iin: J. Janick and J.E. Simon (Ed.), *Advances in new crops*. Portlandedited by J. Janick and J.E. Simon.: Portland: Timber Press.

[34] Singh, S., Singh, M., Singh, A.K., Kalra, A., Yadav, A. and Patra, D.D. (2010). Enhancing productivity of Indian basil (*Ocimum basilicum* L.) through harvest management under rainfed conditions of subtropical north Indian plains.*Industrial crops and products*, 32(3):601-606.

[35] Smitha, G.R. and Tripathy, V. (2016). Seasonal variation in the essential oils extracted from leaves and inflorescence of different Ocimum species grown in Western plains of India. *Industrial Crops and Products*, 94:52-64.

[36] Tucker, A.O. and DeBaggio, T. (2000). *big book of herbs*. Interweave Press.

[37] Verma, P.K., Gupta, S.N., Khabiruddin, M. and Sharma, G.D. (1998). Genetic variability parameters for herb and oil yield in different *Ocimum species*. *Indian Perfumer*, 42(1):36-38.

[38] Verma, R.S., Padalia, R.C. and Chauhan, A. (2012). Variation in the volatile terpenoids of two industrially important basil (*Ocimum basilicum* L.) cultivars during plant ontogeny in two different cropping seasons from India. *Journal of the Science of Food and Agriculture*, 92(3):626-631.

[39] Zheljazkov, V.D., Astatkie, T. and Hristov, A.N. (2012). Lavender and hyssop productivity, oil content, and bioactivity as a function of harvest time and drying. *Industrial Crops and Products*, 36(1):222-228

[40] Zheljazkov, V.D., Callahan, A. and Cantrell, C.L. (2007). Yield and oil composition of 38 basil (*Ocimum basilicum* L.) accessions grown in Mississippi. *Journal of Agricultural and Food Chemistry*, 56(1):241-245.

[41] Zheljazkov, V.D., Cantrell, C.L., Ebelhar, M.W., Rowe, D.E. and Coker, C. (2008). Productivity, oil content, and oil composition of sweet basil as a function of nitrogen and sulfur fertilization. *HortScience*, 43(5):1415-1422.