Advances in Science and Technologies, Vol. 14, No 1 & 2, September / October 2020, pp 8 - 14

Basil (*Ocimum basilicum*) Cultivar Evaluation and Utilization in Southwest Mississippi

Robert Williams III and Patrick Igbokwe
Department of Agriculture, Alcorn State University, Alcorn State, Mississippi 39096, USA
(Submitted: May 15, 2020; Accepted: June 2, 2020)

Abstract

A field study was used to evaluate four basil *(Ocimum basilicum)* cultivars (Genovese, Lettuce, Spice and Sweet) planted on Memphis silt Loam soil in Southwest Mississippi, for survival, growth potential and quality. Additional indoor study was also used to determine the insecticidal potential of liquid extract from each basil cultivar against whiteflies (*Bemisia tabasi*) infestations on "snowy white" eggplants *(Solanum melongenal)* planted on ground-beds in the greenhouse at Alcorn State University. Data on survival and growth potentials suggest that most of each of the four basil cultivars will survive and grow to maturity as warm-season alternative crops in Southwest Mississippi if factors of production are not limiting. Quality evaluations indicate that the basil cultivars will differentially represent acceptable sources of nutrients essential in human nutrition. The plant extract insecticidal potential evaluations indicate that the extracts from sweet and Genovese cultivars will significantly reduce whitefly infestations on treated "snowy white" eggplant compared to untreated control.

Keywords: Basil cultivar, growth potential, nutrient compositions, snowy white eggplant, whitefly control.

1.0 Introduction

One of the primary goals of agricultural research at Alcorn State University is to discover new knowledge that could enable limited resource farmers in southwest Mississippi improve their income potential and quality of life through sustainable production and utilization of such alternative crops as herbs, vegetables, small fruits, and spices, and medicinal plants.

Herbs are the wonders of the culinary world. Most people can chop, dice, and sauté, but the real craft of cooking comes from enhancing flavors of ingredients and herbs. Additionally, herbs which have medicinal uses, are also companion plants, bee attractors, good scents and dye plants (Felty, 1983). Experimenting with different combinations of herbs can change ordinary cuts of meat, vegetables or deserts into different and unusual dishes (Miles, 1990). Essential oils from herbs are used extensively in the production of commercial food products such as candies, gums, pickles, beer and teas (Miles, 1990).

Basil *(Ocimum basilicum)* which is one of the alternative crops investigated for adaptation, yield potential, and some other agronomic characteristics at the Alcorn Experiment Station, is a culinary herb of the family Lamiaceae (Mint Family). It is a popular herb grown for fresh market and processing in many countries of the world, including United States. Both the fresh and dried leaves add a distinctive flavor to many foods, including Italian-style tomato sauce and dressing. It also has a pungent flavor that superbly complements all types of tomato dishes. Pesto, a green sauce served on pasta, is made from ground basil leaves, garlic, olive oil, nuts and cheese (Felty, 1983). Scientific studies in vitro established that compounds in basil oil have potent antioxidant, antiviral and antimicrobial properties, and potential for use in treating cancer (Chiang *et al*., 2005). It is also used for supplemental treatment of stress, asthma and diabetes mellitus in India (Duke, J. A., 2008). Basil known as sweet and garden basil is one of the endemic plants which is used as culinary herbs (Naghibi *et al*., 2005). In many parts of Asia, basil seeds are used to prepare traditional beverages and many ice desserts like "falooda" (Hosseini-Parvar *et al*., 2010), are used as diuretic, antipyretic, antispasmodic and stomachic (Alcicek *et al*., 2004); and are used as thickening and stabilizing agents because of their high polysaccharide contents (Rafe *et al*., 2012). Suitability of basil seed gums as ice

cream stabilizers in model systems has been reported (Bahram-Paravr and Razavi, 2012).

Eggplant *(Slanum melongena L.)* used in this study is a warm-weather crop mostly cultivated in tropical and subtropical regions of the world (Schippers, 2000), has a very low caloric value and considered among healthiest vegetables for its high content of vitamins, minerals and bioactive compounds for human health (Docimo *et al*., 2016). The bioactive properties of eggplant are mostly associated with high content in phenolic compounds (Plazas *et al*., 2013), which are mostly phenolic acids particularly chlorogenic acid in the fruit flesh (Stommel *et al*., 2015), and anthocyanins in the first skin (Mennella *et al*., 2012). Both phenolic acids and anthocyanins have multiple properties beneficial for human health (Plazas *et al*., 2013). However, it is subject to attack by numerous insect pests including mites, whiteflies, aphids, leafhopper, thrips, spotted beetles, leafroller, stem borer among others (Medakker and Vijayaraghavar, 2007).

Herbs and Spices have been utilized as food additives all over the world, not only to enhance the organoleptic properties of food, but also to increase the shelf life by decreasing or eliminating the food borne pathogens (Lai and Roy, 2004). Studies have recommended the use of dietary herbs and spices for their beneficial effects on human health through antimutagenic, anti-inflammatory, antioxidative, and immune modulatory properties (Conn, 1995). A dietary guideline refers to the utility of herbs as excellent sources of antioxidants and as salt alternatives (Tapsell *et al*., 2006).

This study was designed to evaluate four basil cultivars planted in Memphis silt loam soil, in Southwest Mississippi for survival, growth potential and nutrient compositions. The effect of extract from each basil cultivar on "snowy white" eggplants infected by whiteflies was also determined.

2.0 Materials and Methods

2.1 Outdoor Study

Field experiment was used to determine the effect of agronomic practices on the survival, growth, yield potential and quality of four basil cultivars (Spicy, Lettuce, Sweet and Genovese). The study was conducted on Memphis silt loam (Typic Hapludalfs: Fine silty, mixed, thermic) soil at the Alcorn Experiment Station, in Southwest Mississippi. A Randomized Complete Block (RCB) experiment design, with 4 replications of each cultivar on rows, 6.1m long and 1.1m wide were used in this study. Soil test result indicated that the initial soil fertility levels were high for calcium (4,216 kg/ha) and magnesium (293 kg/ha), medium for phosphorous (89.6 kg/ha) and low for potassium (216.2 kg/ha) and sulfur (155 kg/ha). The soil acidity (pH) was 7.0 and the organic matter (OM) was 0.75%.

A tractor was used for disking (2 times) before row preparations. Fertilization with 1.5kg of 13N-13P-13K per row at preparations was based on soil test results. Transplanting at a within-row plant spacing (1.2cm) were with seedlings raised in Pro Mix Bx® growing medium, 6 weeks from seeding in seedling trays with drainage holes at the Alcorn State University glass-greenhouse. Weed control was by hoeing and hand-pulling between plants within each row, whereas garden tiller was used for the weed control between rows. Moisture applications were maintained by natural rainfall and overhead sprinkler system, except at transplanting when moisture was applied to each plant with watering can. No insecticide was applied during the study period.

Data were collected on plant survival, canopy height, canopy width and root fresh weights, percent shoot and root dry matter, plant nutrient compositions and volatile oil extractions. Plant canopy was a measure of the distance from soil surface to the highest canopy for each of the 5 test plants from each cultivar. Plant width was the average for a measure of the leaf spread in east to west, and north to south directions for each plant. Plant survival was the ratio of the number of plants at each harvest to the number initially transplanted.

Average of 4 separate edible shoot harvest (non-destructive) from randomly selected 5 plants per row were used for shoot fresh weight determinations during the growing season. The averages of one harvest (destructive) from the same randomly selected 5 plants per row were used for the root fresh weight determinations at the end of the growing season. The fresh shoots harvested at the end of the season were added to those harvested early in the

season and averages were reported for each cultivar. Weight determinations were performed with tabletop scale.

Plant percent dry matter were the averages for oven-dried equal amounts of root and shoot samples. Sixty grams of each sample which were oven-dried at 70°F for 24 hours were used for dry weight determination, ground to pass 2mm sieve, and to determine their nutrient compositions. Proximate analysis (AOAC, 2004) of the root and shoot samples were therefore used to determine plant ash, crude protein, fat and fiber, and total digestible nutrient contents for each basil cultivar. Kjeldahl Analytical Procedure was used to determine plant nitrogen contents. All data were analyzed by the analysis of variance (ANOVA) and means were separated by the Least Significance Difference (LSD) test procedure (Steel *et al*., 2006). A t-test was used for root and shoot nutrient content comparisons.

2.2 Laboratory Experiment

Equal amounts(10gms) of fresh leaves from each basil cultivar were soaked in uniform volume (120 ml) of pure olive oil (distributed by Wal-Mart Stores, Inc. Bentonville, AR, USA) in petri-dishes in a growth chamber for 48 hours for leaf volatile oil extraction. This extraction process was repeated 3 times each with equal amounts of fresh leaf samples, soaked in the same pure olive oil. The extracts were stored in separate vials until ready for use.

For extract evaluation, one leaf from each of the four "Snowy White" eggplant cultivar per row was tagged for extract applications (treatments). The plants were planted on greenhouse groundrows, 6.1m long and 1.1m wide, at a within-row plant to plant spacing of 1.1m apart. Spray solutions prepared by mixing one tablespoon of each extract in 0.946 liter of water were sprayed on both upper and lower surfaces of the five tagged plant leaves per treatment to runoff once a week. The effectiveness of each extract spray was based on the number of whiteflies identified before the initial spray, and before the subsequent weekly sprays, compared to number of whiteflies on five tagged leaves on the fifth row similarly sprayed with pure water (control). Whiteflies on the surfaces were washed off after each count. Data on the numbers of whiteflies per leaf at each counting period, and the average per leaf for the three counting periods were also statistically analyzed and reported for each treatment and the control.

3.0 Results and Discussion

3.1 Outdoor Results and Discussion

The initial soil fertility levels were high for phosphorous (89.6 kg/ha); and calcium (4,216 kg/ha); and medium for potassium (216.2 kg/ha), magnesium (180.6 kg/ha) and sulfur (155.0 kg/ha). The soil acidity, organic matter and cation exchange capacity (CEC), were 7.3, 0.79, and 14.1 respectively. The basil cultivar survival and growth potentials is presented in Table1. Plant survival range was generally high (77 to 89%), except for spicy cultivar which had 59%. Plant canopy height was highest (0.95 m), for Sweet Basil cultivar, but lowest (0.39 m) for Spicy Basil. The canopy width was highest (0.89 m) for Sweet Basil cultivar, but lowest (0.52 m) for Spicy Basil cultivar. Both shoot fresh and dry weights per plant from different basil cultivars were not significantly different, however, their root fresh and dry weights were significantly different. The root fresh weight per plant was highest (0.042 kg) for Lettuce and Sweet Basil cultivars. The dry weight percent was highest (85.85) for Spicy Basil cultivar, but was not different from (79.54) reported for Genovese Basil cultivar.

Data from the growth and yield components suggest that the Memphis silt loan soil in southwest Mississippi will support the growth and development of the four basil cultivars evaluated in this study, if other factors of production are not limiting.

The basil cultivar root nutrient compositions is presented in Table 2. Basil root ash compositions was highest (7.20 %) for sweet basil cultivar, but was not different from 6.90 % reported for Genovese Basil cultivar. Root crude fiber was highest (44.40 %) for Sweet Basil cultivar and lowest (25.90 %) for Spicy Basil cultivar. Both crude protein and nitrogen were highest (6.2 and 1.00 %) for Genovese Basil and lowest (5.00 and 0.80 %) for Sweet Basil cultivar. Total digestible nutrient was highest (65.80 %) for Spicy Basil cultivar, and lowest (54.70 %) for Sweet Basil cultivar. Crude fat was highest (4.23 %) for Lettuce Basil cultivar, but lowest (2.44 %)

Table 1: Basil Cultivar Survival and Growth Potential [X]

Basil Cultivars	Plant Survival (%)	Canopy Height (m)	Canopy Width (m)	Fresh Shoot (Kg)	Weight Root (Kg)	Dry Shoot (%)	Weight Root (%)
Spicy	59.0	0.39	0.52	0.49	0.018	20.34	85.85
Lettuce	89.0	0.63	0.69	0.76	0.042	20.89	85.45
Sweet	77.0	0.95	0.89	0.78	0.042	19.70	85.79
Genovese	85.0	0.65	0.67	0.57	0.029	18.76	79.54
LSD, 5%	14.8	0.17	0.15	NS	0.004	NS	2.07

[X]Values are averages from 5 randomly selected plants from each basil cultivar within each block, 6.1m long and 1.1m wide

Table 2: Basil Cultivar Root Nutrient Compositions (%) [X]

Basil Cultivars	Ash	Crude Fiber	Crude Protein	Crude Fat	Total Digestible Nutrients	Nitrogen
Spicy	5.50	25.90	5.60	2.44	65.80	0.90
Lettuce	5.50	43.70	5.60	4.23	55.10	0.90
Sweet	7.20	44.40	5.00	2.74	54.70	0.80
Genovese	6.90	41.40	6.20	4.17	56.50	1.00
LSD, 5%	0.38	0.38	0.15	0.05	0.75	0.07

[X]Values are averages for roots from 5 randomly selected plants within each block, 6.1m long and 1.1m wide.

Table 3: Basil Cultivar Shoot Nutrient Compositions (%) [X]

Basil Cultivars	Ash	Crude Fiber	Crude Protein	Crude Fat	Total Digestible Nutrients	Nitrogen
Spicy	13.90	12.70	8.10	4.31	71.10	1.30
Lettuce	12.10	23.00	14.20	4.58	67.50	1.80
Sweet	12.80	16.70	9.30	4.60	71.30	1.50
Genovese	12.10	13.90	15.00	4.52	73.00	2.40
LSD, 5%	0.22	0.15	0.21	NS	0.21	0.22

[X]Values are averages for shoots from 5 randomly selected plants within each block, 6.1m long and 1.1m wide

for Spicy Basil cultivar.

The basil cultivar shoot nutrient compositions is presented in Table 3. Basil shoot ash compositions was highest (13.90 %) for Spicy Basil cultivar. Total digestible nutrients were also highest (73.10 %) for the Spicy Basil cultivar. Crude fiber was highest (23.00 %) for the Lettuce Basil cultivar, and lowest (12.70 %) for Spicy Basil cultivar. Both highest values for crude protein (15.00 %) and nitrogen (2.40 %) were for the Genovese Basil cultivar. The respective lowest values (8.10 and 1.30 %) were for Spicy Basil cultivar. Crude fat compositions were not different. Since the different root and shoot highest nutrient compositions for the cultivars evaluated were not consistent, the nutrient of interest could determine the cultivar to be grown for home consumption.

The basil cultivar root and shoot nutrient compositions is presented in Figure 1. Basil shoot nutrient compositions were significant for crude protein (10.90 %) and nitrogen (1.75 %), and highly significant for ash (12.73 %) and total digestible nutrients (71.23 %) compared to their respective root compositions. Crude fiber contents were highly significant (38.85 %) for basil roots compared to 16.83 % reported for the shoot. Crude fat was not significantly higher (4.50 %) for basil shoot compared to 3.40 % reported for the root. The above-ground biomass which provided more beneficial nutrients required in human nutrition compared to the below-ground biomass, should be harvested more often to maximize benefits.

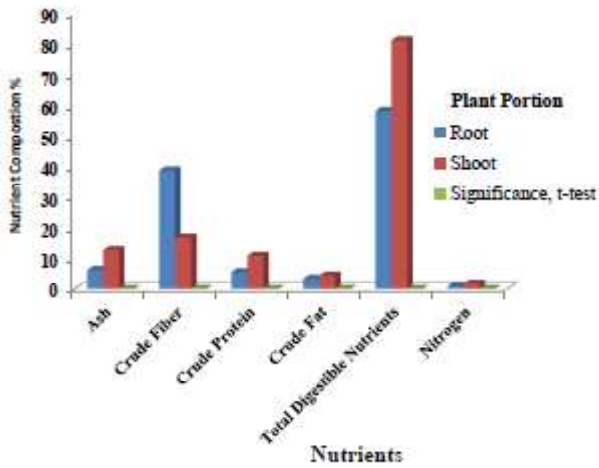

Figure 1: Basil Cultivar Root and Shoot Nutrient Compositions (%).

3.2 Laboratory Results and Discussion

The effect of basil aqueous extracts on whitefly control potential is presented in Figure 2. Whitefly infestations were lowest (7.75, 6.00, and 3.00) during the first, second, and third count periods, respectively for Sweet Basil cultivar, but were not different from 11.5, 8.00, and 4.00, respectively, reported for Genovese Basil cultivar. The average count for the three counting periods was lowest (5.58) for the Sweet Basil cultivar which was not different from 7.83, 10.33, and 10.67, reported for Genovese, Spicy, and Lettuce Basil cultivars, respectively. Both Sweet and Genovese Basil cultivar extracts may be preferred for whitefly control in greenhouse-grown snowy white eggplant compared to both Lettuce and Spicy cultivars, and the untreated control. They could enhance whitefly control on other greenhouse vegetables and ornamentals.

4.0 Conclusion

Data suggest that over 50 % of each basil cultivar seedlings transplanted into field plots will grow to maturity as warm season alternative crops in Southwest Mississippi if factors of production are not limiting. Sweet Basil cultivar will provide more plant, above- and below-ground biomass compared to Lettuce, Genovese, and Spicy cultivars. These Basil cultivars will differentially provide nutrients essential in human growth and developments. The extracts from these basil cultivars will differentially and significantly reduce whitefly infestations on greenhouse groundrow-grown "snowy white"

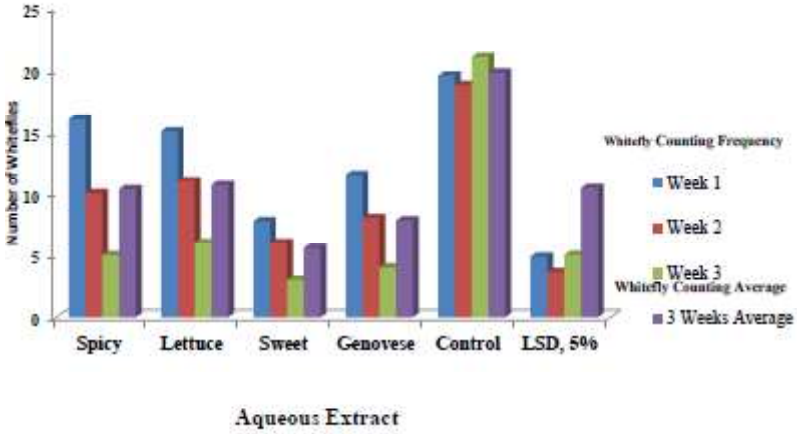

Figure 2: Basil Cultivar Aqueous Extract Control of Whiteflies

eggplant compared to the infestations on the untreated plants. Proper Basil cultivation in Southwest Mississippi will enhance income potential of growers from the sales of its highly priced marketable yields (root and shoot), benefit from its composition of nutrients essential in human nutrition and the insecticide properties of its extracts.

Acknowledgements

The authors are grateful to Mississippi State Legislature for funding research efforts at the Alcorn Experiment Station. Sincere appreciations are extended to Alcorn State University Administration for supporting agricultural research at the University. The assistance from Alcorn Experiment Station staff is also highly appreciated.

References

Alcicek, A, M. Bozkurt, and M. Cabuk. 2004. The effect of mixture of herbal essential oils, an organic acid or a probiotic on broiler performance. S. Afr. J. Anim. Sci., **34:** 217-222

ADAC. 2004. Official method of analysis of Association of Official Analytical Chemists. 15th ed., Washington, USA

Bahram-Parvar, M. and S.M.A Razavi. 2012. Rheological interactions of selected hydrocolloids-sugar-milk-emulsifier systems. Int. J. Food Sci. Technol. **47:** 854-860

Chiang, L. C., Ng L. T., Cheng P.W. Chiang W., Lin, C. C. 2005. Additional activities of extracts and selected pure constituents of Ocimum basilicum. Clin. Exp. Pharmacol. Physiol. **32 (10):** 811-816.

Conn. 1995. The world of phytochemicals. D. L. Gustine, H.E. Flores (Eds), phytochemicals and Health, American society of Plant Physiologists, Rockville, MD, Pp 1-14

Docimo, T., Francese, G., Ruggiero, A., Batteli, G., DePolma, M., Bassolino, L.et al., 2016. Phenylpropanoids accumulation in eggplant fruit: chariterization of biosynthetic genes and regulation by a MVB transcription factor. Front. Plant Sci. **6:** 1233.

Duke, James A. "Basil as the Holy Hindu Highness". doi: 10.1089/oct.2008.14101. Retrieved 10 May, 2008

Felty, Sheryl, 1983. Grow 15 Herbs for the Kitchen. Garden Way Publishing, Bulletin A-61. Powral, Vermont, USA.

Hosseini-Parvar, S.H., L. Matia-Merino, K.K.T. Goh, S. M. A. Razavi and S.A. Mortazavi. 2010. Steady shear flow behavior of gum extracted from basil seed: effect of concentration and temperature. J. Food Eng. **101:** 236-243

Lai and Roy. 2004. Antimicrobial and Chemopreventive Properties of herbs and spices, Curr. Med. Chem. **11:** 1451-1460

Medakker, A. and Vijayaraghavan, V. 2007." Successful Commercialization of insect-resistant eggplant by a public-private partnership: reaching and benefitting resource-poor farmers" in Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices, ed. Krattiger et al., (Oxford: MIHR and Davis PIPRA).

Mennella, G., Sealzo, R. Fibiani, M., D'Alessandro, A., Francese, G., Toppino, L., et al., 2012. Chemical and bioactive quality traits during fruit ripening in eggplant and allied species. J. Agric. Food Chem. 60:1

Miles, K. 1990. Essential Oils. Frontier C. Herbs Publishers, Norway, Iowa, USA.

Naghibi, F. M., Mosaddegh, S. M. Motemed and A. Ghorbani. 2005. Labiatae family in folk medicine in Iran J. Pharm. Res. 2:63-79

Plazas, M., Andiyar I., Vilanova, S., Hurtado, M., Gramazio, P., Herraiz, F. T. et al., 2013. Breeding for chlorogenic acid content in eggplant: interest and prospects. Not. Bot. Hort. Agrobot. **41:** 26-35

Rafe, A., S. M. A. Razavi, and S. Khan. 2012. Rheological and structural Properties of b-lactoglobulin and basil seed gum mixture: Effects of heating rate. Food Res. Int. **49:** 32-38.

Schnippers, R. R. 2000. African Indigenous Vegetables: An Overview of the cultivated species. Natural Resources institute/ACP-EU Technical Center for Agricultural and rural Cooperation, Chatham, UK.

Stommel, J. R., Whitaker, B.D., Haynes, K. G. and Prohens, J. 2015. Genotype X environment interactions in eggplant for fruit phenolic content. Euphytica **205:** 823-836.

Steel, G. D. and Torrie, J. H. and Dickey. 2006. Principles and Procedures of Statistics: A Biometrical Approach. 3rd edition. CRAM 101 Publisher, Sim Valley, CA, USA.

Tap Sell, L. C., I. Hemphill, L. Cobiac, C.S. Patch, D.R. Sullivan, M. Fenech, S. Roodenrys, J.B. Keogh, P.M. Clifton, P.G. Williams, V.A. Fazio, K.E. Inge. 2006. Health benefits of herbs and species: The past, present, and future. Med. J. Aust. **185:** 4-24.