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Performance of Arabica Coffee Grown in Two Locations in Egypt

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Abstract: The relationships between climatic parameters and agricultural production during the growth stages of Arabica coffee trees (*Coffea arabica* L.) was studied in private orchards during two consecutive seasons in two locations(Giza and Qalyubia Governorates) in Egypt. Coffee trees grown under fruit trees as shading conditions were used to evaluate vegetative growth, nutrition status, fruit yield of coffee plants grown under flood irrigated system. The obtained results indicated that coffee trees grown in orchard at Qalyubia had high values of both shoot diameter and number/plant with large leaf area. While, the highest shoot length and leaves number were obtained as coffee trees grown in the orchard of Giza. In addition, data show that shaded coffee trees grown in Giza orchard reflected an increase in different leaf micro and macro-nutrient contents except those of N, P and Cu contents. Also, yield/tree and quality parameters were dominated in Giza orchard than Qalyubia one according to its soil texture, high temperature and relative humidity. So, preliminary recommendation for coffee growers in these locations that Giza region is more suitable for planting Coffee under light texture soil than those of Qalyubia region.

Key words: Coffee (*Coffea arabica* L.) · Fruit quality · Locations · Nutritional status · Vegetative growth

INTRODUCTION

Coffee is a member of *Rubiaceae* and by far the most economically important fruit species. From the 25-100 species in genus *Coffea*, two main species are used in production: *Coffea arabica* L. called "Arabica" coffee and *C. canephorab* Pierre ex Froehner, called "Robusta" coffee [1]. *Coffea arabica* is self-pollination where best conditions for its growing are soils sandy to loamy, light textured; with slightly acid pH 5-6 [2]. Many factors affect coffee production and quality such as soil water status, climatic conditions, agricultural management systems for example shade, pruning, fertilization and genetic properties of cultivars [3]. The optimum annual temperature range for production of Arabica coffee is 18-23°C, where increasing temperature than 23°C accelerate fruit development and ripening that often leading to neither chilling requirements [4, 5]. Agronomic techniques can be used to face the challenge of climatic variability on coffee crop that can attenuate the impact of unfavorable temperatures such as growing under fruit trees management, planting at high densities and agronomical adaptation with focus on suitable area [3, 6]. Cultivation of Coffee needs some degree of shading, however, coffee can be grown in full sunlight [7] and often is in large plantations where the focus is on high yield. Sun-grown coffee will out-yield shade-grown if fertilized more heavily but loss of quality [8]. Measurements have shown that shaded trees evapo-transpiration of coffee by 25-50% (hence water use), while intercepting only 3-13% of incident rainfalls. Generally, the relationships between climatic parameters and agricultural production are quite complex, because environmental factors affect growth and development of plants under different forms during the growth stages of the coffee crop [9]. Shading coffee is regarded as more sustainable by some and promotes greater on-farm biodiversity [10]. According to the poor amount of local researches on coffee production. There are still many gaps in our knowledge on performance of coffee plants in Egypt. Therefore, the aim of this study was to evaluate the vegetative growth, nutritional status and yield of shaded Arabica coffee (*Coffea arabica* L.) grown in two locations (Giza and Qalyubia Governorates), resembling the effect of two environmental factors (soil type and climatic conditions).

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MATERIALS AND METHODS

This study was carried out in two successive seasons 2011 and 2012 on nineteen years old Arabica coffee (*Coffea arabica* L.) trees grown in private orchards at two locations (Giza and Qalyubia Governorates) in Egypt under flood irrigation system. The first orchard in sandy soil located at Abu Rawash, Giza Governorate. Trees were spaced 5 x 5 m. apart grown under fifteen years old mango trees as shading material. The second orchard in loamy soil located at Qalyubia Governorate. Trees were spaced 5 x 5 m. a part grown under twenty years orange trees. Table 1 illustrated the physical and chemical analyses of both experimental soil sites that conducted according to Evenhuis [11].

The total temperatures of both locations were recorded according to the Egyptian Meteorological station and conducted as recommended by Richardson *et al.* [12]. Selected trees were healthy, nearly uniform in growth vigor and received regularly the recommended horticultural practices.

Measurement

Vegetative Growth: The average of shoot numbers/plant, shoot length & diameter (cm), number of leaves/shoot were recorded and leaf area (cm^2) was estimated using Planimeter according to Nauliyal *et al*. [13].

Leaf Analytical Data: Pre flowering stage, samples from the third or forth pair of turgid leaves were taken in the morning from tips of fruit-bearing branches, at mid-height of tree, on four quadrants; total of at least 40 leaves from 10 or more representative trees. Leaves washed, dried, grinded and digested to determine the macro- nutrients (N, P, K, Ca and Mg %) and micronutrient contents (B, Zn, Fe, Mn and Cu ppm) according to Rebbeca [14].

Yield Parameters: At harvest stage, yield was determined as kg/tree, dry beans as well as berries weight, berry/dried bean ratios calculated and Number of green beans/kg was recorded.

Statistical Analysis: Tested trees were arranged in a completely randomized design with four replicates according to Snedecor and Cochran [15]. The obtained data were statistically analyzed and Means were differentiated according to Duncan's multiple range test at 5% level of probability.

Table 1: Soil physical and chemical analysis

	Location	
Soil properties	Giza	Qalyubia
Physical properties:		
Sand %	88.8	14.8
Silt %	7.2	49.2
Clay %	4	36
Texture	Sandy	Loamy
Chemical properties:		
Organic matter %	0.34	2.04
pH	9.22	8.39
EC dS/m	0.06	0.32
CaCO3%	2.6	1.0
Available micro elements (ppm):		
Fe	5.6	7.2
Mn	2.1	3.4
Zn	0.9	1.3
Cu	1.2	1.7

RESULTS AND DISCUSSION

Soil analysis in Table 2 illustrated that soil of orchard in Qalyubia was characterized by its loamy texture with high organic matter % and micro-nutrients (Fe, Mn, Zn and Cu ppm) contents. But, the sandy soil of Giza orchard recorded remarkable increase in pH, EC and $CaCO_3$% than Qalyubia one.

Vegetative Growth: Data in Table 3 show the effect of environmental requirements on vegetative growth of Arabica Coffee, it is obvious that shaded coffee trees in Qalyubia orchard were significantly more superior than those shaded in Giza orchard in increasing average of shoot number/plant (15.9 & 16.1), shoot diameter (50 & 53 cm.) and leaf area (36.3 & 36.5 cm^2) in both seasons. Also, the shaded coffee trees in Giza location were significantly more superior in increasing shoot length (22.6 & 23 cm) and number of leaves (19.11 & 19.56) than coffee trees in Qalyubia location (16.23 &16.44). This hold true in the first and second seasons, respectively. On the other hand, statistical differences were lacking between both farms used under study concerning shoot diameter in the firs season. Similar behavior for plant growth was observed in developing of shaded coffee trees cultivated under relatively high temperature and relative humidity [6, 16]. Generally, the coffee trees grown under Qalyubia orchard conditions had a larger leaf area and average shoot number/plant. Also, the higher values of shoot length and leaf numbers were significantly obtained as coffee trees were grown in Giza orchard.

Table 2: Average temperatures and relative humidity of Giza and Qalyubia location

Giza								Qalyubia							
Temperature °C				Relative humidity %				Temperature °C				Relative humidity %			
Maximum		Minimum		Maximum		Minimum		Maximum		Minimum		Maximum		Minimum	
2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
33.6	33.4	10.9	11.3	80.9	87.5	24.5	25.2	30.9	31.1	10.6	12.4	88.6	87.6	23.5	21.1

According to Egyptian Meteorological Station.

Table 3: Effect of environmental requirements on vegetative growth of Arabica coffee (*Coffee arabica*) during 2011 and 2012 seasons

Characters	Shoot						Leaf			
	No./plant		Length (cm)		Diameter (cm)		Number		Area (cm^2)	
Locations	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza	12.3 b	12.3 b	30. 4 a	30.6 a	0.48 a	0.44 b	19. 11 a	19. 56 a	28. 1 b	28. 3 b
Qalyubia	15.9 a	16.1 a	22. 6 b	23.0 b	0.50 a	0.53 a	16. 23 b	16. 44 b	36. 3 a	36. 5 a

Means followed by the same letter (S) are not statistically different at 5% level.

Table 4: Effect of environmental requirements on leaf nutrient contents of Arabica coffee during 2011 and 2012 seasons.

Characters	Macro nutrients (%)									
	N		P		K		Ca		Mg	
Locations	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza	2.80a	2.96a	0.19a	0.21a	2.10a	2.21a	1.20a	1.07a	0.32a	0.39a
Qalyubia	2.70b	3.85b	0.18a	0.19a	2.40b	2.60b	1.17a	1.05a	0.30b	0.37b
	Micro nutrients (ppm)									
	B		Zn		Fe		Mn		Cu	
Giza	87.2a	84.4a	23.5a	25.2a	139a	146a	80.9a	84.5a	16.9a	17.2a
Qalyubia	60.0b	68.2b	18.6b	20.1b	118b	122b	3.7b	77.4b	16.4a	17.6a

Means followed by the same letter (S) are not statistically different at 5% level.

Table 5: Effect of environmental requirements on yield parameters of Arabica Coffee (*Coffea arabica* L.) during 2011 and 2012 seasons.

Characters	Yield parameters (average)					
	Yield (kg/tree)		Berry/dried bean wt.		No. green beans / kg	
Locations	1st season	2nd season	1st season	2nd season	1st season	2nd season
Giza	13.62a	13.44a	5.66:1a	5.58:1a	681a	674a
Qalyubia	9.12b	8.96b	4.53:1b	4.47:1b	453b	450b

Means followed by the same letter (S) are not statistically different at 5% level.

Leaf Minerals Content: Table 4 shows the effect of environmental factors on macro and micro-leaf nutrient contents of Arabica coffee during two seasons. Chemical analyses showed differences in macro and micronutrient concentrations in leaves among the two studied orchards. It is clear that shaded coffee trees grown in Qalyubia Governorate were characterized by increasing in leaf P (0.18 & 0.19%), Ca (1.17 & 1.05%) and Cu (16.4 &17.6 ppm) contents to be significantly equal with those of the shaded coffee trees grown in Giza location in the 1st and 2nd seasons, respectively. Where, no significant difference was noticed between two locations used under study concerning leaf P, Ca and Cu contents in both seasons. In addition, leaf N, K, Mg, B, Zn, Fe and Mn contents were significantly higher in shaded coffee trees grown in Giza orchard as compared with those of shaded coffee trees under Qalyubia Governorate conditions. For almost macronutrients, mainly levels of nitrogen, potassium and

magnesium were decreased with cultivation of coffee trees under Qalyubia location conditions. The same trend was also obtained with B, Zn, Fe and Mn as micronutrient contents. Previous reports show that high temperature and vapor pressure largely promote photosynthetic rate accompanied by increasing in leaf mineral contents [2, 9, 17]. Generally, cultivation of coffee trees in light texture soil and shaded under fruit trees at Giza Governorate orchard induced an increase in different leaf nutrient contents under study as compared with those of Qalyubia location.

Yield Parameters: Data presented in Table 5 indicated that coffee bean yield was increased enormously in Giza orchard by 1.5 fold than those cultivated in Qalyubia location. The effect on yield in kg/tree was more evident for trees grown in Giza location, which yielded an average of 13.62 & 13.14 kg/tree in the 1st and 2nd seasons, respectively. Meanwhile, trees grown under Qalyubia Governorate conditions yielded an average of 9.12 & 8.96 kg/tree. Where, number of green beans/kg (681 & 674) and the ratios of berry/dried bean weight (5.66: 1& 5.58:1), were better in coffee trees grown in Giza location as compared with Qalyubia location in the1st and 2nd seasons, respectively. Suitable environment resembled by relatively high temperature and relative humidity are very important for coffee plants that reflects relatively high photosynthetic rates and probably requires large amounts of carbohydrates to sustain high crop yields with preferable quality [3, 10, 18, 19].

CONCLUSION

In conclusion, the results concerning effect of environmental requirements on vegetative growth, leaf nutrient contents and yield parameters of Arabica Coffee reflected preliminary recommendation for coffee growers in these regions that Giza climate is more suitable for planting Coffee in light textured soil than those of Qalyubia region.

REFERENCES

1. Davies, A.P., R. Govaerts, D.M. Bridson and P. Stoffelen, 2006. Air, annotated taxonomic conspectus of genus *Coffea* (Rubiaceae). Bot. J. Linn. Soc., 152: 465-512.
2. DaMatta, F.M., C.P. Ronchi, M. Maestri and R.S. Barros, 2007. Ecophysiology of coffee growth and production: a review. Braz. J. Plant Physiol., 19: 485-510.
3. Mayoli, R.N. and K.M. Gitau, 2012. The effects of shade trees on physiology of Arabica Coffee. Afr. J. Hort. Sci., 6: 35-42.
4. Beer, J., R. Muschler, D. Kass and E. Somarriba, 1998. Shade management in coffee and cacao plantions. Agrofor. Syst., 38: 139-164.
5. Van Kanten, R. and P. Vaast, 2006. Transpiration of arabica coffee and associated shade tree species in suboptimal, low-altitude conditions of Costa Rica. Agrofor. Syst., 67: 187-202.
6. Chaves, A.R.M., A. Ten-Caten, H.A. Pinheiro, A. Ribeiro and F.M. DaMatta 2008. Seasonal changes in photoprotective mechanisms of leaves from shaded and unshaded field grown coffee (*Coffea arabica* L.) trees. Trees, 22: 351-61.
7. DaMatta, F.M. and J.D.C. Ramalho, 2006. Impacts of drought and temperature stress on coffee physiology and production: a review. Braz. J. Pl. Physiol., 18: 55-81.
8. Cai, Z.Q., Y.J. Chen, Y.H. Guo and K.F. Cao, 2005 Responses of two field-grown coffee species to drought and rehydration. Photosynthetica, 43: 187-193.
9. Camargo, M.B.P., 2010. The impact of climatic variability and climate change on Arabic coffee crop in Brazil. Bragantia, 69: 12.
10. Maestri, M., R.S. Barros and A.B. Rena, 2001. Coffee. In: F.T. Last, (Ed.), Tree Crop Ecosystem, pp: 339-360. Elsevier Publishers, Amsterdam.
11. Evenhuis, B., 1978. Simplified Methods for Foliar Analysis. Koninklijk Voor de Jropen, Amesterdum, pp: 1-170.
12. Richardson, E.A., S.D. Seeley and D.R. Walker, 1974. A model for estimating the completion of rest for 'Redhaven and 'Elberta' peach trees. HortSci., 9: 331-332.
13. Nauliyal, M.C., P.K. Singh, R.N. Shukla, S. Parkash and M. Kummar, 1990. Correcting leaf area measurement by conventional methods: a new approach for apple (*Malus domestica* Borkh). Horticulture Science, 65: 15-18.
14. Rebbeca, B., 2004. Soil Survey Laboratory Methods Manual. Soil Survey. Investigation Report. 42 Natural Resources Conservation Services.
15. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 5th Ed., Iowa State Univ. Press, Ames, Iowa, USA, pp: 593. 67: 187-202.
16. Barros, R.S., M. Maestri and A.B. Rena, 1999. Physiology of growth and production of the coffee tree - a review. J. Coffee Res., 27: 1-54.

17. Cavatte, P.C., S.C.V. Martins, R. Wolfgramm and F.M. DaMatta, 2008. Physiological Response of Two Coffee (*Coffea canephora)* Genotypes to Soil Water Deficit. In: Sanchez JM (Ed), Droughts: Causes, Effects and Predictions. Nova Science Publishers, New York, in press.
18. Campanha, M.M., R.H.S. Santos, G.B.D. Freitas, H.E.P. Martinez, S.L.R. Garcia, F.L. Finger, 2004. Growth and yield of coffee plants in agro-forestry and monoculture systems in Minas Gerais, Brazil. Agrofor. Syst., 63: 75-82.
19. Catalina Jaramillo-Botero, Ricardo Henrique Silva Santos, Herminia Emilia Prieto, Paulo Roberto Cecon and Merci Pereira Fardin, 2010. Production and vegetative growth of coffee trees under fertilization and shade levels Sci. Agric. (Piracicaba, Braz.), 67(6): 639-645.