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Performance Evaluation of Improved Coffee (Coffea arabica L.) Varieties in the Mid Altitude Areas of Kafa Zone, South Ethiopia

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Abstract

With an assumption of identifying adaptable coffee varieties that could exhibit higher yield to maximize coffee productivity and production across the different environments of Keffa zone, an adaptation study was initiated at Bonga using thirteen coffee varieties which were released by Jimma Agricultural research center for south - western Ethiopia with local Check. The experiment was conducted based on the management practices required for coffee varieties. Plant height, Number of primary branch per plant, stem diameter, leaf diameter, clean coffee yield and incidence of coffee berry disease and leaf rust was taken as parameters of the evaluation. These varieties were released on basis of their high performance for yield, quality and resistance to major diseases and insect pests during their evaluation at variety and verification trials. The varieties which were used for the current study were transplanted in 2008 at Bonga research center in randomized block design to select and recommend better types which could exhibit relatively better performance at the area. The varieties were planted at a spacing of 2 m by 2 m between plants and rows, respectively and were evaluated for yield and yield component for three years. They were grown in existing shade with (Susbaniasusben). From the evaluation it was noted that the highest Clean Coffee Yield (1249.5, 1071.6, 1018.4 Kg ha^{-1}) was scored by the 74148, 74140 and 74158 varieties respectively. On the contrary Local check, Dessu, 75227, 74165 and 741 exhibited least mean grain yields ranges from 571-770 Kg of clean coffee per hectare (Table 1). With the current results selections 74148, 74140 and 74158 showed high results of clean coffee, only three years data recorded is less and it is required further evaluation years in order to know the yield consistency of each selections in the area.

1. Introduction

The genus coffee is a member of the family Rubiaceae. About 75% of the world's coffee comes from the tetraploid species coffee arabica. It is native of the wet highland forests of Ethiopia where it grows wild.

Globally, coffee is second in value only to petroleum in international trade and over 56 coffee growing countries heavily depend on the revenue from coffee export. In Ethiopia, coffee is produced organically as the bulk of the production comes from forest, semi-forest and home gardens where the use of inorganic fertilizers and chemicals is lacking. The plantation coffee accounts only for 3 – 5% of the production.

Ethiopia is the home of the most favored coffee species, arabica coffee (Coffea arabica L.). Economically, coffee is the leading export commodity crop of the nation and more than 60 per cent of the annual foreign exchange earnings of the country originate from this single crop. In addition, about 25 per cent of the population directly or indirectly depends on coffee industry through production, processing and marketing (Melaku and Samuel, 2000).

The best soils for coffee are deep, well-drained, fertile loams of lateritic or volcanic origin with reasonable humus content and slightly acidic (pH 5.3-6.0). Heavy loams and clays are unsuitable because they are poorly aerated; sandy soils are equally undesirable because they dry out rapidly (Onweme and Sinha, 1991).

Low yield is the major problem threatening the Ethiopian coffee industry. Such low yield is attributed to the lack of high yielding, disease resistant and good quality cultivars for different coffee growing ecologies of the country. Proper management practices are also important to use the genetic potential of cultivars efficiently and by that increase yield per unit area (Bayetta and et. al, 1997).

In SNNPR about 1.9 million hectares of land is covered with coffee. From these hectares of land farmers cultivate around 70% as a garden coffee (intercropping), 23% cultivated under semi-forest coffee, 5% is found in

some areas and categorized under forest coffee and the remaining 2% is part of cultivation by government and private investors. Around 200,000 ha of land of the region is potentially conducive for cultivation and extension of the crop. From this amount of land most of it is found in western part of the region (Kaffa, Sheka and Bench-Maji zones). Information from SNNPR showed that 5 qt, 8 qt, 3 qt and 2 qt production of clean coffee per hectare for garden, new plantation, semi-forest and forest coffee production system respectively. (Brochure of SNNPR- BORD, 2005)
Naturally Kaffa is a potential area for the mentioned crop. There are so many naturally grown coffee plantations. Different varieties have different response to a given environments. Jimma agricultural research center released several coffee varieties for the country in general and also for south-western Ethiopia in particular. It is critical to observe those varieties their adaptation and performance for Kafa areas. So this project was initiated based on the following objective.

1.1 Objective

- To evaluate the released coffee cultivars for their adaptability and yield response.
- To maintain the cultivars for future research works.

2. MATERIALS AND METHODS

2.1. Description of the study area

The study was conducted in Kayakella Kebele, Gimbo woreda which was located at Kaffa zone, Southern Nations Nationalities and People's Region (SNNPR). It is found within the southwestern plateau of Ethiopia and 450km and 725km far from Addis Ababa and Hawassa respectively. The area lies within 07°00'- 7°25'N Latitude and 35°55'-36°37'E Longitude. The altitude of the study area is 1750 m.a.s.l. The topography is characterized by slopping and rugged areas with very little plain land. The area experiences one long rainy season, lasting from March /April to October. The mean annual rainfall ranges from 1710 mm to 1892mm. Over 85% of the total annual rainfall occurs in 8 months rain season**,** with mean monthly values in the range of 125-250mm occurs in 8 months long rain season. The mean temperature ranges from 18.1^{0}**C** to 19.4^{0}C .

2.2 Land Preparation, Treatments, Design, Data Collection and Analysis

The 13 previously CBD resistant varieties were obtained from Jimma agricultural research center and local seeds of coffee were collected from local coffee collections around Bonga research center. All nursery preparations and subsequent management practices were applied according to the established procedure or recommendation. Seeds were sown in polythene bags (20cm x 16cm) filled with forest soil and managed for 8 months. Site selection and preparation were carried out prior to field transplanting. Accordingly, 40 cm X 40 cm 40cm (depth X width X length) planting hole size were dug. Seedlings from the released varieties and one local check were field planted in June 2008 using randomized complete block design with three replications, 11 trees per plot and 2mx2m spacing between plants and raw. All field management practices were properly applied according to the recommendation. Susbaniasusben shade tree was also planted right after field transplanting of the coffee seedlings based on the recommended spacing to protect the coffee trees from direct sun light. Data were recorded for the following characteristics and analyzed using the statistical package SAS 9.0 software. Mean separation was also performed using LSD at the probability level of 0.05. Clean coffee yield (recorded in fresh cherry from 11 bushes and converted to clean coffee bean yield per hectare), Plant height (meter),Numberof primary branch per plant, stem diameter(cm), leaf diameter(cm), and incidence of coffee berry disease and leaf rust were recorded.

3. Results and Discussion

The results of analysis of variance for all the parameters recorded were indicated in table1 and discussed bellow.

Table1. Arabica coffee genotypes evaluated for yield and yield components at Bonga

Variety	Clean Coffee Yield Kg/ha	Plant Height	Steam Diameter	Leaf Diameter	Number of Primary Branch
741	770.7^{bcd}	2.87	3.9	11^{a}	45.8
744	927.9^{abcd}	2.81	4.45	9.9^{ab}	46.65
7487	863.2^{bcd}	2.84	3.7	8.7^{b}	45.85
74110	885.3^{abcd}	2.4	3.4	8.1^{b}	53.7
74112	828.9^{bcd}	2.51	4.05	8.7^{b}	50.35
74140	1071.6^{ab}	2.79	3.45	8.3^{b}	45
74148	1249.5^{a}	2.83	3.47	8.5^{b}	50
74158	1018.4^{abc}	2.84	3.5	9.2^{ab}	50.3
74165	725.9^{bcd}	2.62	3.6	9.5^{ab}	50.15
754	818.3^{bcd}	2.6	3.8	9.6^{ab}	45
75227	708.5^{bcd}	2.66	4	9.9^{ab}	48.5
Dessu	693.5^{cd}	2.43	4	8.8^{b}	53.15
Mioftu	868.2^{bcd}	2.63	3.85	9.9^{ab}	48
Local	571.0^{d}	2.48	4.3	9.3^{ab}	50.5
Mean	857.2	2.66457	3.818929	9.242857	48.7821
CV	26.2714	9.87073	13.72895	10.23133	10.7204
LSD	376.65	Ns	Ns	2.0283	Ns

***=Significant at 5% probability level, CV= Coefficient of variation, LSD= Least significant difference; Ns= none significant difference, Values with the same letter(s) are not significantly difference**

3.1 Clean Coffee Yield

Significant differences ($p< 0.05$) among the varieties were observed for clean coffee yield ha^{-1}. The highest mean yield **was recorded for 74148** followed by 74140 and 74158, with values 1249.5, 1071.6 and 1018.4 respectively. However, these values are statistically at par with values recorded for 744 (927.9 kg/ha) and 74110 (885.3 kg/ha). The lowest mean yield on the other hand, was obtained from local check with value of 571 kg/ha. However, this value was statistically not different from values recorded for most of the released varieties except the first three top yielders.

In general, all the evaluated varieties revealed variable performance with regard to clean coffee yields per ha. Only three varieties, namely, **74148,** 74140 and 74158 have showed significant yield variation with average performance of about 1018.4 to 1249.5 kg/ha. The remaining 10 varieties did not exhibit better performance than the local check. Thus, this indicated that **74148,** 74140 and 74158 have better adaptive potential to the environment where this experiment is executed than the remaining ones. This could probably be the varieties were collected from similar environment during the mother tree selection program made at the beginning of breeding for CBD resistance in the early 1972.

3.2 Plant Height

The mean values revealed that there were no statistically significant differences ($p < 0.05$) in plant height among the tested varieties. The genotypes exhibited the mean plant Height ranged from 2.43-2.87meter per plant. However, variety 741 and 74110 showed the highest (**2.87cm**) and the lowest (2.4cm) values for this characteristic, respectively.

3.3 Steam Diameter

The mean values showed that there were no statistically significant differences ($p < 0.05$) in Steam Diameter among the tested varieties. The genotypes exhibited the mean steam diameter ranges from 2.43-2.87 cent meter per plant. However, variety 744 and 74110 showed the highest (**4.45cm**) and the lowest (3.4cm) values for this characteristic, respectively.

3.4 Leaf Diameter

The LSD result 2.0283 at alpha 0.05 indicated that there was significant difference among the varieties in leaf diameter**.** The highest leaf diameter ranges from 9.3-11cm was scored by 741, 744, 75227, Mioftu, 754 and local varieties. While, the rest of testing material scored 8.1-8.8 cm average mean value of leaf diameter per plant.

3.5 Number of Primary Branch

The experimental varieties showed there were no significant variations ($p < 0.05$) in Number of Primary Branch . The highest average number of primary branch (53.15) was recorded by variety Dessu. 74110,74165, 74158, 74148,74112 and Local check exhibited average number of primary branch that ranged from 50 to 53.15 (Table1) while variety 741, Mioftu, 75227, 74140,754 and 7487 took the average number of primary branch that ranged from 45 to 48.5 per plant.

4. Summary and Recommendation

With an assumption of identifying adaptable coffee varieties that could exhibit higher yield to maximize coffee productivity and production across the different environments of Kaffa zone, an adaptation study was initiated at Bong using thirteen coffee varieties which were released by Jimma Agricultural research center for south - western Ethiopia with local Check. The experiment was conducted based on the management practices required for coffee varieties. Plant height, Number of primary branch per plant, steam diameter, leaf diameter, clean coffee yield and incidence of coffee berry disease and leaf rust were recorded was taken as parameters of the evaluation. These varieties were released on basis of their high performance for **CBD during the initial release.** From the present evaluation it was noted that the highest Clean Coffee Yield (1249.5, 1071.6, 1018.4 Kg ha^{-1}) was scored by coffee genotypes 74148, 74140 and 74158 varieties respectively. On the contrary Local check, Dessu, 75227, 74165 and 741 exhibited least mean grain yields ranges from 571-770 Kg of clean coffee per hectare. The yield range of these varieties at Jimma was from 13 to 18 quintals during their evaluation at release.

Based on the results of the experiment, it appeared that the performance of the varieties differs mainly for yield indicating that the importance of conducting preliminary evaluation trials to identify the best adaptable genotypes for certain environmental conditions rather than distributing seeds/seedlings from the same material to wider coffee growing agro ecologies. Since this experiment is conducted at one location, it is not pertinent to recommend for all similar environments at Bonga. Therefore, it is vital to repeat the experiment at different locations to draw conclusive recommendation. However, as the specific site where this activity is carried out, variety 74148, 74140 and 74158 could be recommended for wider use than the remaining varieties.
Future research activities should focus on the further evaluation of the released coffee varieties for a long and at different coffee growing agro ecologies of Bonga.

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