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Agronomic, Yield and Fiber Quality Performance of Released Introduced Hybrid Cotton Varieties in Irrigated Agro Ecologies of Ethiopia

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Abstract: In Ethiopia, although research on cotton improvement started as early as the mid 60`s, not much progress have been made to develop high yielding and quality fiber cotton varieties for production. Hence, the purpose of this work was to study the agronomic, yield and fiber quality performance of hybrid cotton varieties (YD-206, YD-203 and YD-211) along two local check varieties (Deltapine 90 and Stam 59A) for local registration and wider use. The experiment was carried out in a non-replicated single plot size of 10m x 10m across seven locations viz. Werer Agricultural Research Center, Amibara, Melkasedi, Gewane, Arbaminch, Shellie and Woyto. The results of this study indicated that, the three introduced hybrid cotton varieties gave higher seed cotton yield than the two local check varieties at all locations. Accordingly, the hybrid cotton varieties showed seed cotton yield advantage of 35.59% (YD-211), 35.54% (YD-206) and 29.43% (YD-223) over the best performed local check variety (Deltapine 90). Similarly lint yield and fiber length performances of the hybrids were superior to that of the local check varieties. Furthermore, agronomic and crop protection practices have to be determined to maximize production and productivity of these hybrids to ensure the profitability of the user and widen its acceptance.

Keywords: YD-206, YD-203, YD-211, Seed Cotton, Lint, Fiber Length

1. Introduction

Cotton, a natural vegetable fiber, is one of the world`s oldest known fibers used for its spinable fibers (lint) in the genus *Gossypium L.* Although about 50 species of Gossypium genus were known there are four cultivated species viz. *G. arboretum* L., *G. herbaceum* L., *G. hirsutum* L., *and G. barbadense* L. species [5, 14, 16]. The first two species are known as old world cotton and are diploid, native to southern Asia and Africa. The last two species are called new world cotton and are allotetraploid. *G. hirsutum L*, is native to Mexico and parts of Central America and *G. barbadense L.* is native to South America [4]. The remaining 46 species are distributed throughout the tropics and subtropics of the world in wild forms and are important sources of useful traits such as special and superior fiber properties, cytoplasmic male sterility, resistance to biotic and abiotic stresses etc., which can be introgressed into the cultivated species for improvement [8].

In Ethiopia *G. hirsutum* L. species cotton is the most important fibre crop. It plays pivotal role by providing fibre, food, and feed and earns foreign exchange. The cotton plant provides raw material to all textile mills, ginning factories, cottage industries and oil mills. It is also used for edible oil production, which when quantified makes a huge contribution to the national oil production. The crop is also used as an important source of cash for the growers and it offers considerable employment opportunity on the farms, in ginneries, oil mills, knitting, textile and garment factories.

Overall, cotton has much more important utilization in the national economy of the country as well as in the culture of the Ethiopian people [6, 7, 13].

Except in Antarctica, cotton is grown on every continent [1, 15]. The world cotton production was 24.303 million metric tons row cotton in the 2020/21 year according to International Cotton Advisory Committee study [9]. India was the world's leading producer of cotton, producing an estimated 6.004 million metric tons. China was second with 5.910 million metric tons, followed by USA, with 3.181 million metric tons and, Brazil producing 2.356 million metric tons. At present, cotton (*G. hirsutum* L.) is produced under both rain-fed and irrigated conditions by private commercial farms and small holders in Ethiopia. Commercial cotton is produced in the lowland irrigated areas at elevations below 1300 meter above sea level. The major growing areas are the Upper, Middle and Lower Awash Rift Valley areas in the East and the Abaya, Arba Minch, Shellie, Weyto and Omorate areas in the South part of the country while the rain-fed cotton production centers are located in the medium altitude ranging from 1000 to 18000 meters above sea level mainly in Gambella, Beneshangul Gumuz, Amhara, Tigray, and Southern nations, nationalities, and people's regions. According to a study report of the Ministry of Agriculture, there is some 3,000,810 hectare of land suitable for cotton production [2]. Despite this immense potential, Ethiopia currently produces only about 61,000 metric tons of seed cotton from a total cultivated land amount of about 82,000 hectares which accounts for about 2.7% of the total potential area of the country [9].

In Ethiopia, although research on cotton improvement started as early as the mid 60`s, not much progress have been made to develop high yielding and extra-long cotton varieties for production. The use of hybrid cotton is one of the methods to increase cotton yield and fiber qualities [3, 10-12, 17]. To this end, hybrid cotton cultivars was introduced from Israel with the final goal of increasing production, productivity and quality of cotton produce. Hence the main purpose of this work, was to study agronomic, yield and fiber quality performances of hybrid cotton against the local check varieties that would lead to selection of the best performers for local registration and or wider use of the hybrids.

2. Materials and Methods

2.1. Study Area

The experiment was carried out during the main season in Eastern and Southern Ethiopia at Afar and South Nation and Nationality People (SNNP) regions. The test sites in Afar region were at Werer Agricultural Research Center (Werer), Amibara, Melkasedi and Gewane and at SNNP region the sites were Arbaminch, Shellie and Woyto (Figure 1).

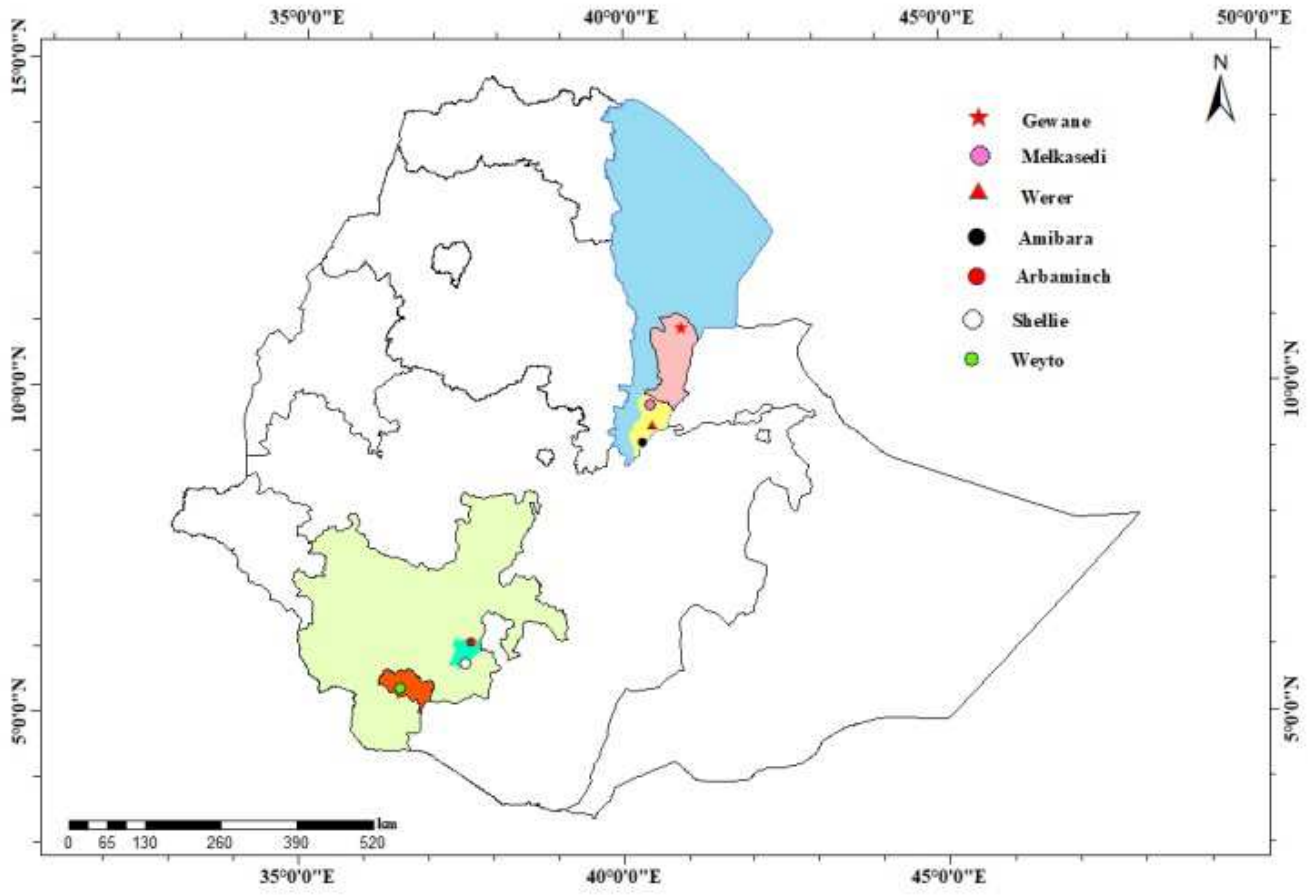

Figure 1. *Experimental sites of the study area.*

2.2. Plant Materials, Experimental Design and Data Analysis

The cotton varieties, Deltapine 90 and Stam 59A were used as a local check varieties against the new test entry introductions viz. YD-206, YD-203 and YD-211. Before sowing, trial site selection and land preparation activities were done at appropriate time. Three seeds per hole were hand sown at a spacing of 20 cm on the top of the ridges. Thinning was done fifteen days after emergence to allow a density of about 5.5 plants per m^2. A post-sowing application of irrigation water, using furrow irrigation system was applied every two weeks for 126 days. Weeds were controlled by hand weeding as often as required while pest were controlled fully using chemical insecticides and this was carried out uniformly across all plots. A shallow cultivation using inter-row cultivator was carried out only once at all sites prior to the plants reached the square formation stage.

The treatments were arranged in a non-replicated single plot size of 10m x 10m = $100m^2$. Each plot consisted of eleven rows, each 10m long and spaced 0.9m apart. Prior to harvest time, data measurement on important agronomic parameters that include plant height, number of bolls per plant and boll weight was taken for each variety from centre rows of each and every plot. At harvest, a composite boll sample from ten marked plants early in the season was gathered for ginning out turn percent, lint yield and seed cotton yield determination and for fibre quality measurement purposes. Finally, all opened bolls in each plot for every variety were collected from all trial plots of each location for yield determination. Lastly, fibre quality parameters were analysed using high volume instrument (HVI).

3. Results and Discussions

3.1. Plant Height, Boll Number Per Plant and Boll Weight Performance

At all location except to Weyto all the three introduced hybrid cotton varieties were taller than the local check varieties (Table 1). The average plant height ranges from 93.3 cm to 240 cm, 111 cm to 239 cm and 104 cm to 236 cm for YD-206, YD-223 and YD-211 hybrid cotton varieties, respectively. The overall mean of plant height of hybrid cotton varieties at overall location were also numerically high and in general at Shellie location both introduced cotton varieties and local check varieties showed high tallness of over 2 m. Regarding boll number per plant hybrid cotton varieties showed higher number of boll number than local check varieties at all location (Table 2). With boll weight almost at all location the local check varieties were better than the introduced hybrid cotton varieties (Table 3).

Table 1. *Average plant height (cm) of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	113.8	141.6	113	167.3	240	128	93.3	142.43
2	YD-223	126.9	119	111	166.4	239	124	116.7	143.29
3	YD-211	107.8	125	106	169.5	236	124	104	138.90
4	Stam 59A	101.7	101.8	84	152.1	256	115	108.7	131.33
5	Deltapine 90	88.9	94.4	69	118.9	215	73	79	105.46
Mean		107.82	116.36	96.60	154.84	237.20	112.80	100.34	132.28

Table 2. *Average boll number per plant of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	23.4	22.5	22.4	35.8	34.4	39.8	32.8	30.16
2	YD-223	25.9	21.9	19.9	32.6	38.3	41.5	41.6	31.67
3	YD-211	27.4	22.5	23.5	38.5	39.8	43.3	40.6	33.66
4	Stam 59A	13.5	13.5	12.1	23.6	21.8	21.9	19.4	17.97
5	Deltapine 90	12.8	15.9	11.6	23.3	25.5	19.3	22.3	18.67
Mean		20.6	19.26	17.9	30.76	31.96	33.16	31.34	26.43

Table 3. *Average boll weight (g) of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	4.1	3.4	3.8	3.4	4.3	4	4.1	3.87
2	YD-223	3.7	4.3	3.9	3.3	4.2	3.7	4.9	4.00
3	YD-211	3.7	4.4	4.6	3.7	3.8	3.7	3.9	3.97
4	Stam 59A	4	5.3	5.6	6.8	4.2	4.7	5.4	5.14
5	Deltapine 90	3.6	5.2	4.8	4.9	5.8	5.1	5	4.91
Mean		3.82	4.52	4.54	4.42	4.46	4.24	4.66	4.38

3.2. Seed Cotton Yield, Ginning Out-Turn and Lint Yield Performance

Seed cotton yield results of the hybrid cotton and local check cotton varieties at seven different irrigated sites is indicated at Table 4. Accordingly, all the three introduced hybrid cotton varieties gave higher seed cotton yield than the two local check varieties at all locations. The highest seed cotton yield was recorded at Werer followed by Amibara. While relatively the lowest seed cotton yield was obtained at Arbaminch. At Werer location, the introduced hybrid cotton varieties namely YD-211, YD-206 and YD-223 each gave a highest yield of 59.8 q/ha, 55.7 q/ha and 51.3 q/ha respectively. Similarly at Amibara location YD-206 gave highest seed cotton yield of 50.7 q/ha followed by YD-211 (44.5 q/ha) and YD-223 (43.8 q/ha). The best performed local check varieties (Deltapine 90) gave 40 q/ha and 40.3 q/ha at Werer and Amibara, respectively. At the other location a range of 29.9 q/ha to 39.4 q/ha, 29.3 q/ha to 42.1 q/ha and 31.3 q/ha to 39.0 q/ha seed cotton yield were recorded for YD-206, YD-223 and YD-211, respectively. Moreover, at overall location the three introduced hybrid cotton varieties showed a seed cotton yield advantage of 35.59% (YD-211), 35.54% (YD-206) and 29.43% (YD-223) over the best performed local check variety (Deltapine 90). With ginning out-turn, almost at all locations the local check varieties exceeded the three introduced hybrid varieties (Table 5). The lint yield performance of the three introduced hybrid cotton varieties were better than the local check varieties at all locations except at Shellie (Table 6). At Shellie only YD-223 exceeded the best performed local check variety (Stam 59A). The lint yield advantage of the three introduced hybrid varieties over the best performed local check variety (Stam 59A) at overall locations were 23.37%, 18.56% and 18.44% for YD-206, YD-211 and YD-223, respectively.

Table 4. *Seed cotton yield (q/ha) performance of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	55.7	50.7	38.1	35.5	39.4	29.9	40.9	41.46
2	YD-223	51.3	43.8	29.3	31.6	42.1	34.6	44.4	39.59
3	YD-211	59.8	44.5	36.8	38.4	39	31.3	40.5	41.47
4	Stam 59A	36.7	33.4	24.1	21	35.7	24.2	29.1	29.17
5	Deltapine 90	40	40.3	26.4	21	33.8	25.9	26.7	30.59
Mean		48.70	42.54	30.94	29.50	38.00	29.18	36.32	36.46

Table 5. *Ginning out turn (%) performance of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	35.8	36.3	36.9	34.2	39	37.7	40.5	37.20
2	YD-223	35.8	36.4	36	36.7	40.7	37.7	37.9	37.31
3	YD-211	34.6	36.2	34.9	35	37.7	35.8	35.9	35.73
4	Stam 59A	43.5	42.7	40.9	38.5	44.6	42	44.8	42.43
5	Deltapine 90	38	39.1	37.5	38.4	40.3	35.9	39.9	38.44
Mean		37.54	38.14	37.24	36.56	40.46	37.82	39.80	38.22

Table 6. *Lint yield (q/ha) performance of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	19.9	18.4	14	12.1	15.4	11.3	16.6	15.39
2	YD-223	18.4	16	10.5	11.6	17.1	13	16.8	14.77
3	YD-211	20.7	16.1	12.9	13.4	14.7	11.2	14.5	14.79
4	Stam 59A	15.9	14.3	9.9	8.1	15.9	10.2	13	12.47
5	Deltapine 90	15.2	15.8	9.9	8.1	13.6	9.3	10.6	11.79
Mean		18.02	16.12	11.44	10.66	15.34	11.00	14.30	13.84

3.3. Fiber Quality Performance

The fiber quality testing result showed that all the candidate hybrids have superior fiber quality at all locations (Tables 7 and 8). At almost all locations, the candidate hybrid cottons scored higher fiber length of greater than 33mm. However, at Shellie and Arbaminch the fiber length values of all candidate hybrids were lower compared to other locations. At all six locations, the candidate hybrid cotton varieties scored fibre length values of 31.8 mm to 37 mm (YD-206), 30.3 mm to 36.2 mm (YD-223) and 31.8 mm to 37.8 mm (YD-211). The advantage of the introduced hybrid cottons for fiber length over the best check (Stam 59A) at all

locations ranged from 15.02% to 17.19%. The micronaire values of all hybrids were relatively lower than the two checks but it is within optimum range in most locations except at Gewane and Arbaminch where the values were lower than 3.5.

Table 7. *Fiber length (mm) of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	34.7	36.2	37	34.3	31.8	32.8	36.6	34.77
2	YD-223	35.6	35.3	36.2	33.2	30.3	33.1	35.2	34.13
3	YD-211	35.6	34.2	37.8	35.5	31.8	32.3	35.9	34.73
4	Stam 59A	30.5	31	30.8	28	27.7	29.5	30.2	29.67
5	Deltapine 90	29.7	29.1	29.8	27.6	27.1	28.5	30.1	28.84
Mean		33.22	33.16	34.32	31.72	29.74	31.24	33.60	32.43

Table 8. *Micronaire reading of introduced hybrid cotton and local check cotton varieties.*

S. No	Varieties	Locations							Overall Location
		Werer	Amibara	Melkasedi	Gewane	Shellie	Arbaminch	Weyto	
1	YD-206	3.9	4.1	4.2	2.7	3.4	2.9	4	3.60
2	YD-223	3.9	3.9	3.9	3	3.6	2.8	3.5	3.51
3	YD-211	3.7	3.4	3.4	3.1	3.2	2.9	3.4	3.30
4	Stam 59A	4.6	4.9	4.8	3.2	3.8	3.6	4.9	4.26
5	Deltapine 90	4.7	4.8	4.5	4.2	4.3	3.7	4.9	4.44
Mean		4.16	4.22	4.16	3.24	3.66	3.18	4.14	3.82

3.4. Earliness and Stress Tolerance

No significant difference in days to emergence, initial squaring, initial flowering, initial boll opening, and days to 65% boll opening was observed between hybrids and local check varieties at each locations. However, during field evaluation, hybrids showed tolerance to shortage of irrigation water. This indicates the present recommended irrigation amount and frequency applied to the hybrids may not appropriate for their proper growth and development. Hence, further study has to be conducted to determine the optimum irrigation amount and interval to the hybrids.

During field visit it was also observed that the hybrids were resistant to insect pest's attacks. They seem healthy while the two checks attacked by different insect pests. Therefore, the resistance level of hybrids needs to be determined by conducting further study on its reaction to different insect pests. The determined threshold level of the hybrids may decrease the number of spray and thereby decrease cost of production which in turn increases profitability to the growers.

4. Conclusions and Recommendations

All the introduced hybrid cottons (YD-206, YD-223 and YD-211) showed superior performance for economically the most important traits including seed cotton yield, lint yield and fiber quality at all locations. The hybrids were verified at each location using the recommended agronomic and crop protection practices for existing commercial upland cotton varieties. However, the hybrids by its nature are fast growing, vigorous and branchy types. So that the existing practices such as plant spacing, irrigation water amount and frequency, application of fertilizer and pest control methods may not appropriate for its proper growth and development. Hence, optimum agronomic and crop protection practices have to be determined to maximize its production and productivity so as to ensure the profitability to the user and widen its acceptance.

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