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CORRELATIONS BETWEEN SOME MORPHO-PHYSIOLOGICAL AND AGRONOMIC TRAITS OF COTTON (*GOSSYPIUM HIRSUTUM* L) VARIETIES GROWN IN TWO AGROECOLOGICAL AREAS OF MALI

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The study was conducted at the IER (Institut d'Economie Rurale) agricultural research stations of Finkolo (11°16′5″N 5°30′40″W) and N'Tarla (12°35'N 5°42'W) during the 2019-2020 cropping season. The objective was to analyze the correlations between some morpho-physiological and agronomic characteristics of cotton genotypes of different origin. Seven cotton genotypes constituting the plant material were distributed in a Randomised Complete Block Design (RCBD) with 6 replications in each site. The morpho-physiological traits observed were plant height, insertion of first sympodial branches, number of monopodial branches, days to 50% flowering and maturity. Concerning the agronomic traits, observations were made on the yield, the boll weight, the number of plants, bolls and sympodial branches. The results obtained show the good performance of the varieties BRS293 and X442-A for yield in both areas. Significant correlations (positive or negative) at P=0.01 and 0.05 were observed between yield and all the traits observed in both areas taken together and in Finkolo. On the other hand, at N'Tarla we observed significant positive correlations at P=0.01 between yield, average bolls weight and total number of plants per hectare, and significant negative correlations for the days to 50% flowering. These correlations may be useful in the cotton breeding program for the improvement of the yield.

Keywords: cotton ◆ correlation ◆ morpho-physiological traits ◆ agronomic traits ◆ varieties

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КОРРЕЛЯЦИИ МЕЖДУ НЕКОТОРЫМИ МОРФОФИЗИОЛОГИЧЕСКИМИ И АГРОНОМИЧЕСКИМИ ПРИЗНАКАМИ СОРТОВ ХЛОПЧАТНИКА (*GOSSYPIUM HIRSUTUM* L) ПРИ ВЫРАЩИВАНИИ В ДВУХ АГРОЭКОЛОГИЧЕСКИХ РАЙОНАХ МАЛИ

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Исследование проводилось на сельскохозяйственных исследовательских станциях Института сельской экономики в Финколо (11°16'5"СШ, 5°30'40"ЗД) и Н'Тарла (12°35' СШ, 5°42' ЗД) в сезон 2019-2020 гг. Цель работы состояла анализе корреляции между некоторыми морфофизиологическими и агрономическими характеристиками генотипов хлопчатника различного происхождения. Семь генотипов, составляющих растительный материал, были распределены с помощью рандомизированного полноблочного планирования (RCBD) с 6 повторениями на каждом участке. Наблюдаемыми морфофизиологическими признаками являлись высота растения, появление первых симподиальных ветвей, количество моноподиальных ветвей, количество дней до 50% цветения и зрелость. Из агрономических характеристик были изучены урожайность, масса коробочек, количество растений, коробочек и симподиальных ветвей. Результаты свидетельствуют о хороших показателях урожайности сортов BRS293 и X442-A в обоих районах. Наблюдались значимые корреляции (положительные или отрицательные) при P=0,01 и 0,05 между урожайностью и всеми признаками, наблюдаемыми в обоих районах вместе и в Финколо. С другой стороны, в Н'Тарла наблюдали значительную положительную корреляцию при P=0,01 между урожайностью, средней массой коробочек и общим количеством растений на гектар, а также значительную отрицательную корреляцию дней до 50% цветения. Эти корреляции могут быть полезны в программе разведения хлопчатника для повышения урожайности.

Ключевые слова: хлопок ◆ корреляция ◆ морфофизиологические признаки ◆ агрономические признаки ◆ сорта

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INTRODUCTION

In Mali, cotton is the main export product. It is the second largest source of export revenue in this country after gold. The contribution of the cotton sector to the gross domestic product (GDP) is estimated at 15% (Compagnie Malienne pour le Développement du Textile, 2022). The cotton production area is restricted to the south-eastern part of the country, and has expanded to cover the southern part of the country (Bélières et al. 2008). It covers the entire Sikasso region, part of the Koulikoro region (the districts of Dioïla and Kangaba), Segou (the districts of Barouéli, Bla and San) and Kayes (the district of Kita). The cotton sector covers an area of 134,518 km^2, or 11% of the national territory, and includes 6,345 villages and hamlets with a population of approximately 3,400,000 inhabitants, or 28% of the national population (Maïga, 2019). Cotton provides producers with income to meet their cash needs and food security through cereal production. It supports the activities of the textile and seed processing industries, banks, transport operators, suppliers of spare parts, inputs and fuel.

At the end of the 2021/2022 season, Mali's cotton production amounted to 760,000 tons. The volume harvested for the 2021/2022 season makes Mali the leading cotton producer in Africa (Africanews & AFP, 2022). The Malian cotton growers' confederation explains Mali's climb to the top of the list of cotton-producing countries by the increase in cultivable area. This year, Malian producers plan to cultivate more than 800,000 hectares compared to 170,000 hectares in the previous season (Dembélé, 2022). If the total production of seed cotton is the national pride, it is however worrying to note that at the national level, the average yield per hectare, which was around 1300 kg in the mid-1980s (Ton, 2021), has fallen in recent years to 1003 kg/ha during the 2017/2018 campaign (MA, 2018). This drop in average yield per hectare is now a major concern for CMDT (Compagnie Malienne de Développement du Textile) and OHVN (Office de la Haute Valée du Niger), as cotton is the main crop that generates most of the producers' income.

Cotton yield is established throughout the cotton cycle through several components: the average bolls weight, the number of bolls per plant, the number of fruiting and vegetative branches, the insertion Node of the first Sympodial branches, number plant per hectare (plant density), etc. These components interact with each other, but the intensity of this interaction will depend on the growing conditions (pedoclimatic and agronomic factors) and the variety chosen. An improvement in the management of some of the components of cotton yield could be a powerful way to improve the crop's yield.

The objective of the study is to analyze the correlations between some agronomic (yield and its components) and morpho-physiological characteristics of seven (07) cotton varieties from different origin.

MATERIAL AND METHODS

The trials were established in a semi-controlled environment on two experimental stations during the 2019-2020 season. One on the N'Tarla station located in the Sahelo-Sudanese zone (12°35' North and 05°42' West). And the second on the experimental station of Finkolo located in the Sudano-Sahelian zone (11°22' North and 5°51" West).

The material is composed of seven (07) cotton varieties, including three Malian creations: NTA 88-6, NTA P31, NTA P35 and four introduced varieties: BRAS 293 (Brazil), FK 64 (Burkina Faso), X442-A (Cote d'Ivoir) and ZS1 (China).

The seven cotton varieties were arranged in a Randomised Complete Block Design (RCBD) with six replications at the two sites. Each of the varieties represents an object whose elementary plot is made up of 3 lines of 10 m long, the two lateral ones being the borders. The distances between the lines were 0.80 m and 0.30 m. The observations were made on the central line.

Observations were made on agronomic characteristics: seed cotton yield (SCY), bolls weight (BW), Number of bolls per plant (NB/PL), Number of sympodia (fruiting branches) per plant (NS/PL), number of plants per hectare (NP/ha). And on morpho-physiological characteristics, such as plant height (PLH), Insertion Node of the first Sympodia (fruiting branches) (INFS), Number of monopodia (vegetative branches) per plant (NM/PL), Days to 50% flowering (DF50%) and Days to 50% maturity (DM50%).

RESULTS

Results of statistical analysis of some agronomic and morpho-physiological traits recorded in the two agroecological areas (Finkolo and N'Tarla)

A highly significant difference was observed between varieties for seed cotton yield (SCY), mean bolls weight (BW), number of bolls per plant (NB/PL), number of fruiting or sympodial branches (NS/PL), number of plants per hectare (NP/ha), plant height, sympodial height (PLH), Insertion node of the first sympodial branches (INFS), number of vegetative branches (NM/PL), and Days to 50% flowering date (DF50%) (Table 1). A significant difference between genotypes for Days to 50% maturity date (DM50%). A significant difference was not found for the number of bolls per plant (NB/PL). Theë variety BRS 293 gave the best seed cotton yield per hectare (2405kg/ha) and the best mean bolls weight over the two zones. The highest number of BF was recorded by the variety FK 64, followed by the variety NTA 88-6 with 21.3 and 20.6 BF respectively. The varieties FK 64, BRS 293 and X 442-A gave the highest number of plants per hectare with more than 60,000 plants/ha. NTA 88-6 had the highest height (164cm) with lots of BV. BRS 293, NTA P31, X 442-A, ZS1 had the earliest maturity cycle with all 111 days from sowing to 50% maturity date. NTA P35 was the later-maturing variety (114 days).

Table 1. Average performance of varieties for some agronomic and morpho-physiological traits in the two agroecological areas (Finkolo and N'Tarla)

Variety	SCY (kg/ha)	BW (g)	NB/PL	NS/PL	NP/ha	PLH (cm)	INFS	NM/PL	DF50%	DM50%
BRS 293	2405^{a}	4,5^{a}	8,9	17,6^{d}	62708^{a}	135^{d}	6,2^{c}	2,2^{b}	52^{bc}	111^{b}
FK 64	2048^{abc}	4,1^{bc}	8,2	21,3^{a}	63438^{a}	155^{abc}	6,6^{ab}c	2,2^{b}	52^{bc}	112^{ab}
NTA 88-6	1979^{abc}	4,0^{bc}	9,7	20,6^{ab}	53125^{b}	164^{a}	6,8^{ab}	2,5^{a}	53^{b}	113^{ab}
NTA P31	1911^{bc}	4,0^{bc}	9,2	20,4^{abc}	52917^{b}	163^{ab}	6,5^{ab}c	2,2^{b}	51^{c}	111^{b}
NTA P35	1698^{c}	3,8^{c}	7,9	20,1^{abc}	59479^{ab}	157^{abc}	7,0^{a}	2,6^{a}	54^{a}	114^{a}
X 442-A	2318^{ab}	4,3^{ab}	9	18,6^{cd}	62188^{a}	151^{c}	6,3^{bc}	2,1^{b}	52^{bc}	111^{b}
ZS1	2194^{ab}	4,3^{ab}	10	19,2^{bcd}	53750^{b}	152^{bc}	6,4^{ab}c	2,1^{b}	51^{c}	111^{b}
Mean	***2079***	***4,2***	***9***	***19.7***	***58229***	***154***	***6,6***	***2,3***	***52***	***112***
Sign. Variety	**	**	**ns**	**	**	**	**	**	**	*
Sign. Site	**ns**	**	**	**	**	**	**	**ns**	**	**
CV%	***18,7***	***8,6***	***21,3***	***8.6***	***16***	***6,9***	***7,4***	***15,2***	***2,5***	***1,9***
SE	***388,4***	***0,4***	***1,9***	***1.7***	***9326,5***	***10,5***	***0,5***	***0,4***	***1,3***	***2,1***

SCY = Seed cotton yield, **INFS** = Insertion Node of the first Sympodial branches, **NM/PL** = Number of monopodia (vegetative branches) per plant, **NS/PL** = Number of sympodia (fruiting branches) per plant, **DF50% =** Days to 50% flowering**, DM50%** = Days to 50% Maturity, **NB/PL** = Number of bolls per plant, **BW** = Boll weight, **PLH** = Plant height, **NP/ha** = Number of plants per hectare**, SE** = Standard Error, **LSD**: least significant difference, **CV%**: Coefficient of variation expressed in percent. ***** Significant at the 0.05 probability level, ****** Significant at the 0.01 probability level, **ns** = not significant. **a, b, c, d, e, f**: the mean values followed by a common letter in the respective column do not differ by LSD 0.05.

Results of statistical analysis of some agronomic and morpho-physiological traits in the agroecological areas of Finkolo and N'Tarla

The results of statistical analyses of some agronomic and morpho-physiological parameters measured in the agroecological aeras of Finkolo and N'Tarla are presented in Table 2. The significant difference (p = 0.05 and 0.01) was observed between the varieties for all the traits analyzed except for NB/PL and NM/PL in Finkolo site and in site of N'Tarla except for NB/PL, NP/ha and DM50%. The variety BRS 293 had the best seed cotton yield (SCY) in both sites with 2324 kg/ha in Finkolo and 2485 kg/ha in N'Tarla. The second highest yielding variety was X 442-A, with 2208 kg/ha at Finkolo and 2427 kg/ha at N'Tarla. The varieties BRS 293 and X 442-A had the highest Boll weight (BW) at Finkolo and N'Tarla respectively. The variety X 442-A has the highest NP/ha at Finkolo, but in N'Tarla site the varieties are statistically at the same level of NP/ha. Whether at Finkolo or N'Tarla, the variety BRS 293 has the lowest number of sympodia (fruiting branches) per plant (NS/PL) and the lowest plant height. There was no statistical difference between varieties for number of monopodia (vegetative branches) per plant (NM/PL) in Finkolo, but in N'Tarla NTA P35 recorded the highest NM/PL. The variety NTA P35 has the highest number of 50% flowering date (DF50%) and 50% maturity date (DM50%) in both zones.

Table 2. Average performance of varieties for some agronomic and morpho-physiological traits in the Finkolo and N'Tarla agroecological areas

Variety	SCY (kg/ha)		BW (g)		NB/PL		NS/PL		NP/ha		PLH (cm)		INFS		NM/PL		DF50%		DM50%	
	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar	Fink	N'Tar
BRS 293	2324^{a}	2485^{a}	4,9^{a}	4,2ab	6,7	11,1	22,7^{b}	12,6^{cd}	70833^{ab}	54583	157^{b}	113^{c}	5,9^{b}	6,5^{ab}	2,1	2,3^{ab}	54^{ab}	52^{ab}	117^{abcd}	104
FK 64	1968^{abc}	2129^{ab}	4,1^{b}	4,0ab	6,9	9,4	26,9^{a}	15,7^{a}	68958^{ab}	57917	185^{a}	126^{b}	6,3^{ab}	6,9^{a}	2,2	2,1^{b}	53^{ab}	51^{b}	118^{ab}	105
NTA 88-6	1674^{bc}	2283^{ab}	4,0^{b}	4,1ab	7,8	11,7	26,0^{ab}	15,3^{a}	54792^{c}	51458	186^{a}	143^{a}	6,7^{ab}	7,0^{a}	2,5	2,6^{a}	54^{ab}	52^{ab}	118^{ab}	107
NTA P31	2058^{abc}	1765^{b}	4,3^{ab}	3,8b	8,3	10,1	26,1^{ab}	14,7^{abc}	60000^{bc}	45833	191^{a}	135^{ab}	6,1^{ab}	7,0^{a}	2,1	2,3^{ab}	51^{b}	52^{ab}	116^{abc}	106
NTA P35	1532^{c}	1865^{b}	3,8^{b}	3,7b	6,3	9,5	25,6^{ab}	14,6^{abc}	65208^{abc}	53750	179^{a}	135^{ab}	6,8^{a}	7,1^{a}	2,7	2,6^{a}	56^{a}	53^{a}	119^{a}	108
X 442-A	2208^{ab}	2427^{a}	4,4^{b}	4,3a	6,9	11,1	23,1^{b}	14,0^{abcd}	72917^{a}	51458	173^{a}	128^{ab}	6,4^{ab}	6,3^{b}	2,3	1,9^{b}	53^{b}	52^{ab}	117^{abcd}	105
ZS1	2148^{ab}	2240^{ab}	4,4^{b}	4,1ab	8,2	11,8	23,7^{ab}	14,7^{abc}	61250^{abc}	46250	174^{a}	131^{ab}	6,1^{ab}	6,8^{ab}	2,1	2,1^{b}	52^{b}	51^{b}	116^{abc}	106
Mean.	***1987***	***2171***	***4,3***	***4,0***	***7,3***	***10,7***	***24,9***	***14,5***	***64851***	***51607***	***178***	***130***	***6,3***	***6,8***	***2,3***	***2,3***	***53***	***51***	***117***	***106***
Sign. Var	**	*	*	*	***ns***	***ns***	**	**	**	***ns***	**	**	*	*	***ns***	**	**	*	*	***ns***
CV%	***18,6***	***18,7***	***10,2***	***6,3***	***22,1***	***20,3***	***8,4***	***8,9***	***11,1***	***21,4***	***6,5***	***7,3***	***8,0***	***6,9***	***17,2***	***12,9***	***3,2***	***1,5***	***1,3***	***2,5***
SE	***369,4***	***406,5***	***0,4***	***0,3***	***1,6***	***2,2***	***2,1***	***1,3***	***7212,2***	***11043,1***	***11,5***	***9,5***	***0,5***	***0,5***	***0,4***	***0,3***	***1,7***	***0,8***	***1,5***	***2,6***

SCY = Seed cotton yield, **INFS** = Insertion Node of the first Sympodial branches, **NM/PL** = Number of monopodia (vegetative branches) per plant, **NS/PL** = Number of sympodia (fruiting branches) per plant, **DF50% =** Days to 50% flowering**, DM50%** = Days to 50% Maturity, **NB/PL** = Number of bolls per plant, **BW** = Boll weight, **PLH** = Plant height, **NP/ha** = Number of plants per hectare**. Fink =** Finkolo, **N'Tar =** N'Tarla, **SE** = Standard Error, **LSD**: least significant difference, **CV%**: Coefficient of variation expressed

Results of correlation analyses between agronomic and morpho-physiological traits for the two agroecological areas (Finkolo and N'Tarla)

The results in Table 3 show a significant correlation at the p = 0.05 and 0.01 level between SCY and all other parameters studied except plant height. This correlation is positive for the parameters BW, NB/PL and NP/ha and for all the others it is negative. A highly significant negative correlation between SCY and number sympodial branches, flowering and maturity cycles could be explained by the early rainfall interruption during the season, which favors short-cycle varieties such as BRS 293 and X 442-A. A significant positive correlation at the p = 0.01 level is recorded between BW and NP/ha and a significant negative correlation at the p = 0.01 level with NB/PL and INFS. There was a highly significant negative correlation between NB/PL and NP/ha, PLH, DF50% and DM50%. The results of the analysis show a significant positive correlation between NS/PL and NP/ha, PLH, DF50% and DM50% and significant negative with INFS. Highly significant positive correlations between PLH, INFS, DF50% and DM50% were found. The INFS had a significant positive correlation at p = 0.01 with NM/PL and negative with DM50%. The NM/PL was significant positive at p = 0.05 with DF50% just as DM50% is significant positive at p = 0.01 with DF50%.

Table 3. Correlation matrix between some agronomic and morpho-physiological traits in the two agroecological areas (Finkolo and N'Tarla)

	SCY	**BW**	**NB/PL**	**NS/PL**	**NP/ha**	**PLH**	**INFS**	**NM/PL**	**DF50%**	**DM50%**
SCY	**1**									
BW	**0,446****	**1**								
NB/PL	**0,350****	**-0,331****	**1**							
NS/PL	**-0,287****	0,179	0,589	**1**						
NP/ha	**0,265***	**0,413****	**- 0,740****	**0,440****	**1**					
PLH	**- 0,242***	0,160	**- 0,575****	**0,919****	**0,445****	**1**				
INFS	**- 0,225***	**-0,329****	0,130	**-0,267***	**-0,234***	**0,292****	**1**			
NM/PL	**- 0,274***	-0,175	- 0,121	0,025	-0,016	0,064	**0,643****	**1**		
DF50%	**- 0,436****	-0,060	**- 0,498****	**0,539****	**0,285****	**0,453****	-0,064	**0,232***	**1**	
DM50%	**- 0,300****	0,206	**- 0,687****	**0,890****	**0,540****	**0,835****	**-0,300****	0,070	**0,639****	**1**

SCY = Seed cotton yield, **BW =** Boll weight, **NB/PL** = Number of bolls per plant, **NS/PL** = Number of sympodia per plant, **NP/ha =** Number of plants per hectare, **PLH** = Plant height, **INFS** = Insertion node of the 1st sympodial branches, **NM/PL** = Number of monopodia per plant, **DF50% =** Days to 50% flowering**, DM50% =** Days to 50% Maturity**, *** Significant at the 0.05 probability level, ****** Significant at the 0.01 probability level.

Results of the analysis of correlations between agronomic and morpho-physiological traits in the Finkolo and N'Tarla sites

The correlation matrix between agronomic and morpho-physiological traits in the Finkolo and N'Tarla sites is shown in Table 4 (On the left and below the site of Finkolo; On the right and above the site of N'Tarla).

The study revealed a significant positive correlation at p = 0.01 and 0.05 between SCY and BW, NB/PL and NP/ha at Finkolo site. A negative correlation at p = 0.01 between SCY and the other studied traits.

At N'Tarla site a significant positive correlation at p = 0.01 between SCY and BW and NP/ha was obtained, however the correlation between SCY and DF50% was also highly significant but negative. The correlation between SCY and the rest of the studied traits was not significant and negative except for NB/PL. The correlation was also highly significant and negative between NB/PL and NP/ha at two sites. The correlation between NS/PL, NP/ha and PLH was highly significant and positive at Finkolo, however, it was not significant at N'Tarla for both traits. The INFS had a significant positive correlation at p = 0.01 with NM/PL the same observation is made between DFLO and DMAT in both locations.

Table 4. Correlation matrix between agronomic and morpho-physiological traits in the Finkolo and N'Tarla sites

Finkolo Site	Variables	N'Tarla Site									
		SCY	**BW**	**NB/PL**	**NS/PL**	**NP/ha**	**PLH**	**INFS**	**NM/PL**	**DF50%**	**DM50%**
	SCY		**0,688****	0,169	-0,096	**0,546****	-0,003	-0,095	-0,067	**-0,493****	-0,289
	BW	**0,480****		-0,138	-0,158	**0,433****	0,038	-0,269	-0,202	**-0,402****	-0,159
	NB/PL	**0,470****	-0,276		0,124	**-0,663****	-0,158	-0,020	0,010	-0,083	-0,217
	NS/PL	**-0,339****	-0,273	0,070		-0,039	0,263	**-0,553****	0,008	-0,046	0,173
	NP/ha	**0,363***	0,276	**-0,498****	**0,435****		0,129	0,042	-0,013	-0,174	0,020
	PLH	-0,249	-0,293	0,162	**0,796****	**-0,310***		0,201	0,193	-0,104	0,136
	INFS	**-0,580****	-0,239	**-0,426****	0,219	-0,070	0,086		**0,516****	-0,082	0,278
	NM/PL	**-0,486****	-0,170	**-0,404****	0,176	-0,001	0,141	**0,840****		0,259	0,240
	DF50%	**-0,406****	-0,258	-0,304	0,032	0,006	-0,124	**0,363***	**0,333***		**0,420****
	DM50%	**-0,347***	-0,206	**-0,376***	0,231	0,193	0,177	0,184	0,252	**0,421****	

SCY = Seed cotton yield, **BW =** Boll weight, **NB/PL** = Number of bolls per plant, **NS/PL** = Number of sympodia per plant, **NP/ha =** Number of plants per hectare, **PLH** = Plant height, **INFS** = Insertion node of the 1st sympodial branches, **NM/PL** = Number of monopodia per plant, **DF50% =** Days to 50% flowering**, DM50% =** Days to 50% Maturity**, *** Significant at the 0.05 probability level, ****** Significant at the 0.01 probability level.

DISCUSSION

The improvement of cotton yield requires the improvement of some agronomic and morpho-physiological characteristics or traits of the plant. The main objective of this study was to identify correlations between yield and some agronomic and morpho-physiological characteristics of seven cotton varieties that have been or are being extended in Mali.

For the evaluation of the average performance of the varieties for some agronomic and morpho-physiological traits in the two agroecological areas (Finkolo and N'Tarla), the results show that over the whole of the two experimental areas, the variety BRS 293 showed a very good level of seed cotton yield (2,400 kg/ha) and boll weight (4.5g). These results are similar to those obtained by Bourgou, Sanfo (2012) in Burkina Faso and Sissoko et al. (2020) in Mali. All these authors confirm in their studies the good performance of the variety BRS 293, for the two parameters mentioned above, in different agroecological areas. It is also the earliest variety with 111 days between sowing and the days 50% maturity. This confirms the results of Yattara, Kassambara (2019) in the trials in

research stations and in the farmers' fields. The variety X 442-A also proved to be a good performer in terms of seed cotton yield (2318kg/ha), boll weight (4.3g) and good earliness (111 days) in both agroecological areas. Yattara, Kassambara (2019) reported the good performance of variety X442-A in preliminary trials of new cotton varieties in controlled environments. Sylla et al. (2021) reported in Côte d'Ivoire a lower yield (1984 kg/ha) and a higher number of days from sowing to 50% maturity (122 days) of the variety X 442-A. And we note that in the Finkolo site, located in the south of Mali, a humid zone compared to the N'Tarla site, the seed cotton yield of X 442-A is below the yield obtained in N'Tarla site, a Sahelo-Sudanese zone, and the variety is a little late in Finkolo (177 days) compared to N'Tarla (104 days). This variety would seem to be much better adapted to areas with low rainfall than to humid areas. Correlations between the seed cotton yield of the varieties and some agronomic and morpho-physiological traits were identified. A significant positive correlation at $p = 0.01$ and 0.05 was obtained between seed cotton yield and the traits: boll weight, number of bolls per plant and number of plants per hectare. The results obtained by Surriya (1996), Azhar et al. (1999), Larik et al. (1999), Sultan et al. (1999), Satange et al. (2000), Hussain et al. (2000) and Salahuddin et al. (2010) are in agreement with the results presented in our study. This significant association between yield and these traits can be exploited in the breeding program leading to the improvement of cotton varieties. A highly significant negative correlation was observed between seed cotton yield and the number of sympodial branches. This result would certainly be explained by the effects of drought and pest attacks, which must have caused the abscission (shedding) of fruiting organs (squares and bolls) especially for the late and tall varieties. As found with the results in our study which revealed that sympodial branches have a highly significant positive correlation with the number of plants per hectare, plant height, days 50% flowering and maturity. On the other hand, Satange et al. (2000) and Shaheen et al. (2021) who also worked with cotton found that sympodial branches were highly significantly correlated with seed cotton yield. Seed cotton yield was also negatively and moderately correlated at $p = 0.05$ with plant height, insertion node of the 1st sympodial branches, number of monopodial branches. However, a significant positive association of seed cotton yield was observed by Chattha et al. (2013) for plant height, Shaheen et al. (2021) for insertion node of the 1st sympodial branches and Erande et al. (2014) and Shaheen et al. (2021) for number of monopods. A significant negative correlation at $p = 0.01$ of yield with days 50% flowering and maturity was observed in our study. This indicates that selection for these traits leads to the improvement of high yielding and early genotypes (Srinivas et al., 2015). On the opposite, a positive and significant association between these two traits was reported by Reddy, Kumari (2004). These results clearly indicate that selection for either of these traits leads to simultaneous improvement of the other traits as well as seed cotton yield.

CONCLUSION

The analysis of the correlation between yield and some agronomic and morpho-physiological traits is of tremendous importance in plant breeding.

The results observed in the present study showed a highly significant positive correlation between boll weight, number of bolls per plant and number of plants per hectare. This indicates that selection based on the above traits will be useful in increasing seed cotton yield per plant under the agroecological conditions in which this study was conducted. This successful correlation may be useful in the breeding program for improving cotton varieties towards yield.

Breeders are advised to be very careful in the breeding program based on associations (correlations) between seed cotton yield and different agronomic and morphophysiological traits, as often significant negative correlations of some traits can be useful as well as significant positive correlations of other traits.

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