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Assessments of the Relationship between growth, phonological and Yield Attributes of Two Sorghum Cultivars (*Sorghum bicolor* L. Moench) and Plant Population at Gash Delta, Eastern Sudan.

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ABSTRACT

The experiment was conducted to study the effect of varying plant population of two sorghum cultivars on growth and yield at three sites (Degain, Tendeli 8 and Tendeli 12) within the Gash delta Eastern Sudan, during 2014/15 and 2016/17) seasons. The RCBD design used for split-split plot trail. The treatments include two cultivars (Tabat and Aklamoi) and three planting densities spacing within the row of 30, 45 and 60 cm between holes. Correlation analysis technique has been used for finding association between agronomic characters in the three sites. Generally the mean number of tillers, phonology, seeds/panicle, panicle length and 100-seed weight had positive strong significant correlation with plant height, and phonological attributes but they had moderate positive correlation with LAI, panicles/m2 and grain yield/ha. 100-Seed weight and panicle length were positively correlated with all characters except stem diameter, panicles/m2 and grain yield/ha. Likewise, LAI and number of tillers had significant and positive correlation with all characters. Grain yield per hectare was positively and significantly correlated with most of the studied traits. Results of analysis revealed significant and positive correlation among the variables and showed that these variables could play a vital role in increasing yield of sorghum hybrid.

INTRODUCTION

Sorghum (Sorghum bicolor (L) Monech) is a main staple crop in Gedarif state. Beside its use as energy source to human consumption, it draws its great value as source of grain and straw that is used for animal feed[1]. Some researcher[2] stated that growing sorghum as sole crop year after year had caused a serious infestation by noxious weeds like striga and Sudan grass, beside the depletion of soil fertility. Accordingly, the grain yield of sorghum in these areas especially during the last two decades was only about 100 kg/ha. [3] suggested that grain sorghum's ability to compensate for decreased plant density was related to plant space uniformity. Therefore, when assessing a grain sorghum stand, it is important to characterize both stand density and stand uniformity. Also, [4] stated that crop row spacings < 30inches will increase grain yield in high yield environments with little risk of reduced yield in low yield environments. Increased crop yield in narrow row spacings may be related to decreased soil water depletion or increased evapotranspiration efficiency [5-7].

Correlation analysis technique has been applied by different studies, such as [8] found that grain yield plant-1 was positive and significantly correlated with number of kernels ear-1, ear weight and ear insertion height. High correlation of grain yield with plant height is also reported by other researchers [9,10].

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The relationship between seedling emergence and number of grains ear-1 was also positive and significant, indicating that early emergence genotypes could result in increased number of grains ear-1 and consequently increase grain yield. Also [11] used correlation analysis technique for finding association among maize yield and other agronomic characters. Crop scientists are also interested in studying the relationship between those biometrical characters which have positive effect on the yield of crop. For this purpose, they use different statistical techniques, such as, correlation and regression analysis. With regards to correlation analysis, such as, in groundnut [12] and in sorghum by [13]. The strength of relationship between yield and its component variables is easily determined by correlation technique.

Therefore, the objective of this investigation was to establish the relationship among effective growth traits , phonological and yield attributes characters in Sorghum *(Sorghum bicolor (L) Monech.)*

MATERIALS AND METHODS

This study was carried out in the Gash Delta During two seasons (2014/15 and 2016/17) at three sites within the delta. Degain (55 km north of Kassala city), Tendeli 8 and Tend 12 in the northern part of the delta 65 and 75 km, respectively, north of Kassala. Specifically, there are two main types of soil in the Gash Delta; the best one locally known as "Lebad" is rich in silt and highly permeable.

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Two cultivars Tabat, an improved variety, the seeds were obtained from Arab Seed Company, Girba station for both seasons. The second variety is Aklamoi a local variety in the delta. Its such were obtained from Tendeli local market. Three plant spacing within the row of 30, 45 and 60 cm between holes. The number of seeds per hole factor with 3, 4, 5, 6, 7, and ten seeding per hole. Spacing between rows was kept at 80c throughout. At each experiment the design used was a split-split plot design the varieties comprised the whole plot factor arranged in a randomized block design with four blocks. The subplot factor was the three spacing between holes while seeds per hole were in the subplot level. The parameters measured growth attributes was plant height (cm), stem girth(cm). leaf area index, number of tillers. Phonological attributes: days to 50% flowering and 90% physiological maturity. Yield attribute: panicles/m2, panicle length(cm), number of seeds/ panicle, 100-seed weight(g), grain yield ton/ha,

Statistical analysis

Data was statistically analyzed. So a correlation analysis was determined by using SPSS computer software package version 16.

Correlation coefficient between some growth, phonological and yield attributes in Degain site

The results of the correlation analysis between growth, phonological and yield attributes were presented in table (1). Generally, most these characters were positively and significantly correlated with each other. In this regard, the mean number of tillers, days to 50% flowering, days to physiological maturity, seeds/panicle, panicle length and 100seed weight had significant($p \le 0.05$) and strong ($r \ge 0.75$) positive correlation) with plant height, and phonological attributes but they had moderate positive correlation with LAI, panicles/m2 and grain yield/ha. 100-Seed weight and panicle length were positively correlated with all characters except stem diameter, panicles/m2 and grain yield/ha in the first season only. Likewise, LAI and number of tillers had significant and positive correlation with all characters particularly in the second season. Similarly, most yield attributes showed highly significant and positive correlation with each other in both seasons. Grain yield per hectare was positively and significantly correlated with most of the studied traits in both seasons.

Correlation coefficient between some growth, phonological and yield attributes in Tedelai12site

Correlation coefficient analysis showed that both plant height, tillers number and LAI were significantly correlated positively with each other and with all characters studies except number of panicles/m² but seeds/panicle were negatively correlated with LAI in both seasons (Table 2). Moreover, stem girth was positively significant correlated with all studied trails except seed/panicle and number of panicles/m². phonological characters had positive significant correlation with all growth trails, 100seedwieght, panicle

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Degain16	flower	physio	Yield	100seedwt	Seed	pncle	pncl	stem	Plant	Tillers	LAI
			На		Pcle	m2	length	dim	hgt		
flower		0.81**	0.40^{**}	0.75**	0.33**	0.42^{**}	0.74**	0.40^{**}	0.81**	0.72**	0.51**
physily	0.85^{**}		0.36**	0.94**	0.34**	0.43**	0.93**	0.51**	0.97^{**}	0.82^{**}	0.51**
yieldHa	0.19 ^{NS}	0.17 ^{NS}		0.29^{*}	0.20 ^{NS}	0.28^{*}	0.35**	0.28^{*}	0.33**	0.29^{*}	0.13 ^{NS}
100seedwt	0.82^{**}	0.89^{**}	0.12 ^{NS}		0.31**	0.40^{**}	0.93**	0.46^{**}	0.95^{**}	0.80^{**}	0.54**
Seed	0.75^{**}	0.81**	0.58^{**}	0.74^{**}		0.40^{**}	0.34**	0.34**	0.31**	0.23 ^{NS}	0.26^{*}
Pancle											
pancle m2	0.00^{NS}	0.09 ^{NS}	0.48^{**}	0.05 ^{NS}	0.07^{NS}		0.37**	0.08 ^{NS}	0.45^{**}	0.50^{**}	0.02
panc	0.86^{**}	0.96**	0.21 ^{NS}	0.92**	0.83**	0.06^{NS}		0.45^{**}	0.94^{**}	0.80^{**}	0.51**
length											
stem dim	0.19 ^{NS}	0.13 ^{NS}	0.16 ^{NS}	0.06 ^{NS}	0.15 ^{NS}	0.01 ^{NS}	0.19 ^{NS}		0.47^{**}	0.36**	0.28^*
plant	0.87^{**}	0.95**	0.21 ^{NS}	0.93**	0.82^{**}	0.02^{NS}	0.97^{**}	0.11 ^{NS}		0.84^{**}	0.54**
hight											
tilers	0.84^{**}	0.93**	0.27^{*}	0.91**	0.82**	0.01 ^{NS}	0.96**	0.14 ^{NS}	0.98^{**}		0.48^{**}
LAI	0.03 ^{NS}	0. 21 ^{NS}	0.03 ^{NS}	0.35**	0.20 ^{ns}	0.28*	0.30*	0.01 ^{NS}	0.27^{*}	0.32**	

Table 1. Correlation coefficient between means growth, phonological and yield attributes characters of two sorghum cultivars as affected by plant population 2014/2015/ (below) and 2015/2016 (above) seasons at Degain.

Table 2. Correlation coefficient between means growth, phonological and yield attributes characters of two sorghum cultivars as affected by plant population 2014/2015/ (below) and 2015/2016 (above) seasons at Tendlie 8.

Tedelai 8	flower	physio	Yield	100seedwt	Seed	pncle	pncl	stem	Plant	Tillers	LAI
16			Ha		Pcle	m2	length	dim	hgt		
flower		0.79^{**}	0.16^{NS}	0.80^{**}	0.59**	0.17 ^{NS}	0.75^{**}	0.27^{*}	0.80^{**}	0.19 ^{NS}	0.41**
physily	0.66^{**}		0.09^{NS}	0.91**	0.69**	0.37**	0.93**	0.42^{**}	0.96**	0.28^*	0.47^{**}
yieldHa	0.07^{NS}	$0.05^{\rm NS}$		0.06^{NS}	0.23^{*}	0.01 ^{NS}	0.09^{NS}	0.09 ^{NS}	0.04^{NS}	0.17 ^{NS}	0.21 ^{NS}
100seedwt	0.64^{**}	0.89**	0.00^{NS}		0.64^{**}	0.76^{*}	0.89^{**}	0.45^{**}	0.93**	0.34**	0.46^{**}
seedPancle	0.51^{**}	0.80^{**}	0.23 ^{NS}	0.79^{**}		0.76^{**}	0.73**	0.47^{**}	0.74^{**}	0.07^{NS}	0.43**
pancle m2	0.21 ^{NS}	0.09 ^{NS}	0.54^{**}	0.00 ^{NS}	0.16 ^{NS}		0.42^{**}	0.37**	0.39**	0.04^{NS}	0.33**
panicl	0.64^{**}	0.79^{**}	0.02^{NS}	0.81**	0.85**	0.03 ^{NS}		0.46^{**}	0.95**	0.23^{NS}	0.47^{**}
length											
stem dim	0.27^{*}	0.44^{**}	0.19 ^{NS}	0.49^{**}	0.53**	0.06^{NS}	0.50^{**}		0.41**	0.31**	0.01 ^{NS}
plant hight	0.61**	0.76^{**}	0.06^{NS}	0.78^{**}	0.84^{**}	0.05 ^{NS}	0.98^{**}	0.51**		0.25^{*}	0.57^{**}
tillers	0.58^{**}	0.69**	0.11 ^{NS}	0.71**	0.78^{**}	0.02^{NS}	0.91**	0.53**	0.92**		0.21 ^{NS}
LAI	0.15 ^{NS}	0.40**	0.10 ^{NS}	0.50^{**}	0.28*	0.04 ^{NS}	0.27^{*}	0.40^{**}	0.25*	0.19 ^{NS}	

T 12 16	flower	physio	Yield	100seedwt	Seed	pnicle	pancle	stem	Plant	Tillers	LAI
			Ha		Panicle	m2	length	dim	hgt		
flower		0.77^{**}	0.53**	0.65^{**}	0.22^{NS}	0.11 ^{NS}	0.70^{**}	0.69**	0.76^{**}	0.73**	0.23
physily	0.73**		0.70^{**}	0.84^{**}	0.22^{NS}	0.14^{NS}	0.91**	0.76^{**}	0.94**	0.93**	0.49**
yieldHa	0.01^{NS}	0.16^{NS}		0.71^{**}	0.31**	0.10^{NS}	0.69**	0.61**	0.72^{**}	0.73**	0.62**
	0.80^{**}	0.92**	0.11 ^{NS}		0.20^{NS}	0.15^{NS}	0.84^{**}	0.71**	0.89**	0.88^{**}	0.59^{**}
100seedwt											
seedPancle	0.52^{**}	0.73**	0.13 ^{NS}	0.72^{**}		0.69**	0.23*	0.13 ^{NS}	0.25^{*}	0.26^{*}	0.16 ^{NS}
pancle m2	0.02^{NS}	0.14^{NS}	0.22^{NS}	0.11 ^{NS}	0.27^{*}		0.19 ^{NS}	0.01 ^{NS}	0.18 ^{NS}	0.17^{NS}	0.04^{NS}
panc	0.83**	0.92**	0.07^{NS}	0.97^{**}	0.74^{**}	0.15^{NS}		0.77^{**}	0.95**	0.94**	0.50^{**}
length											
stem dim	0.08^{NS}	0.12^{NS}	0.22^{NS}	0.01 ^{NS}	0.18 ^{NS}	0.03 ^{NS}	0.01 ^{NS}		0.81**	0.80^{**}	0.39**
plant hight	0.83**	0.93**	0.10 ^{NS}	0.98^{**}	0.74^{**}	0.09^{NS}	0.98**	0.01 ^{NS}		0.98**	0.55**
tilers	0.80^{**}	0.91**	0.10 ^{NS}	0.95**	0.72^{**}	0.14^{NS}	0.95**	0.07^{NS}	0.95**		0.53**
LAI	0.30^{*}	0.19 ^{NS}	0.45**	0.32**	0.07^{NS}	0.32**	0.31**	0.09^{NS}	0.31**	0.19 ^{NS}	

Table 3. Correlation coefficient between means growth, phonological and yield attributes characters of two sorghum cultivars as affected by plant population 2014/2015/ (below) and 2015/2016 (above) seasons at Tendlie 12

length and grain yield/ha particularly in the second season . Further, yield attributes characters i.e 100seed weight, panicle length and seed yield/ha were significantly had positive correlation with each others. The strong positive significant correlation between panicle length and 100seed weight with phonological characters indicated that the later characters contributed in increasing seed yield of sorghum through its effects on heavier seeds weight.

Correlation coefficient between some growth, phonological and yield attributes in Tedelai8 site

All growth attributes characters (plant height, stem diameter, tillers and LAI were significantly had positive correlation with all studied characters except yield/ha and LAI with panicle/m² in both seasons(Table 3).. In respect to phonological characters they had significant positive strong correlation with plant height, panicle length, seeds/panicle and 100 seed weight but had moderate positive significant correlation with LAI, tillers and stem diameter in both seasons. There were strong positive significant correlation between panicle length, seeds/panicle and 100seed weight.

DISCUSSION

The results indicated that late headed plants produced higher agnitude of mean value of these characters. The significant positive correlation of heading date(days to flowering) with plant height indicated that lateness was associated with tallness of sorghum plants, this finding supported by those reported by[13]

In this study, plant height showed highly significant positive correlation with LAI, number of tillers, yield attributes in both seasons, indicating that taller plants performed better for these characters. In this regard, the association between height and yield suggests that height might be used to estimate yield[14] which would assist farmers with feed budgeting. A strong positive correlation between stem diameter and total yield in sorghum has previously been reported by [15-17]. The days to maturity could probably be seen to have had appositive correlation with days to flowering because cultivars with fewer days to flowering matured earlier than those with more days to flowering[18]. The significant positive correlation of panicle length with all yield attributes, could be suggested that the longer the panicle length would be the higher the number of tillers, number of grains per panicle, grains yield per plant and as a result increased in other yield attributes.

These results indicated the contribution of yield per plant to all attributing characters. However,[19]reported that as there might not be a significant relationship between some traits and the yield in correlation analysis.

The correlation analysis technique has proven to be useful for finding association among different measured characters of sorghum hybrid yield. Results of analysis revealed significant and positive correlation among the variables and showed that these variables could play a vital role in increasing yield of sorghum hybrid.

In conclusion, These results showed that plant height, LAI and panicle traits has greater contribution to grain yield and yield attributing characters.

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