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Heritability studies in organically grown cotton genotypes

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Abstract
Heritability coupled with genetic advance proves a reliable measure for selecting the characters which have high yielding ability. Heritability study in 22 cotton genotypes (including checks) were undertaken at Center of Organic Agriculture Research and Training center (COART), Department of Agronomy, Dr. PDKV, Akola during *kharif* season 2020-2021. Results revealed that characters trichomes density cm^{-2}, number of gossypol glands cm^{-2} and total soluble sugar recorded high heritability and high genetic advance indicating additive gene action whereas, total nitrogen, crude protein, number of whiteflies per plant and number of aphids per plant recorded low heritability and low genetic advance indicating the non-additive gene action. Low heritability and high genetic advance was observed for seed cotton yield per plant indicating the presence of additive and non-additive gene action. High values of genotypic variances (GV) and phenotypic variances (PV) were observed for the characters *viz*., trichome density cm^{-2}, number of gossypol glands cm^{-2}, chlorophyll content index and total soluble sugar and high values of genotypic coefficient of variances (GCV) and phenotypic coefficient of variances (PCV) were recorded for number of leafhoppers per leaf, number of thrips per leaf, number of aphids per leaf and number of whiteflies per leaf and moderate values of GCV and PCV were recorded for total soluble sugar, number of gossypol glands cm^{-2}, trichome density cm^{-2} and boll weight.

Keywords: Organic, heritability, genetic advance, variance, trichomes density, gossypol glands, total soluble sugar, total nitrogen, crude protein

Introduction
Cotton is an important cash crop in which heritability along with genetic advance proves a reliable measure for selecting the characters which have high yielding ability. Estimates of heritability are helpful for plant breeder in selection of elite genotypes from diverse genetic populations whereas, genetic advance is the measure of gain under selection. Characters having high heritability and high genetic advance indicate additive gene action and selection may be effective in them whereas low heritability and low genetic advance indicate non-additive gene action which means that the character is highly influenced by the environment. On the other hand low heritability and high genetic advance indicates the presence of additive and non-additive gene action and considerable environmental influence. Consequently, the identification and use of genotypes with better genetic potential is a continuous prerequisite for synthesis of physiologically efficient and genetically superior genotypes.

Material and Methods
The present study was carried out at Centre for Organic Agriculture Research and Training (COART), Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif*, 2020-2021. Twenty SGF (Seeding the Green Future) cotton genotypes along with one resistant check DHY-286 and one susceptible check DCH-32 were grown in Randomized Block Design with three replications on the plot size of 1.8 X 6.0 m^2 and the seeds were dibbled with spacing 90 X 30 cm^2 (varieties) and 90 X 60 cm^2 (hybrids). All package of practices for organic cotton cultivation were followed to raise good crop except plant protection measures (Unprotected). The observations were recorded on five randomly selected plants of each genotype from each replication on various sucking pests, morpho-physiological, biochemical and morphological traits. The sucking pests observation were recorded visually by examining the top, middle and bottom leaf. The morpho-physiological characters *viz*., gossypol glands per cm^2 and trichome density per cm^2 were recorded with help of microscope whereas, chlorophyll content index was determined with help of SPAD 2.0 meter.

The biochemical characters like total soluble sugar was estimated by Anthrone's method and total nitrogen as well as crude protein by Kjeldhal method. All these observations were recorded at 45, 60, 90 and 120 days after sowing (DAS). However, morphological observations such as number of bolls per plant, boll weight, number of sympodia per plant and seed cotton yield were recorded at maturity of the crop.

Results

From the present study, it was observed that characters trichomes density cm^{-2}, number of gossypol glands cm^{-2} and total soluble sugar exhibited high heritability and high genetic advance indicating preponderance of additive gene action. The characters such as total nitrogen, crude protein, number of whiteflies per plant and number of aphids per plant recorded low heritability and low genetic advance indicating non-additive gene action, whereas low heritability and high genetic advance was observed for seed cotton yield per plant which indicated the presence of additive and non-additive gene action. (Table 1)

High values of genotypic variances (GV) and phenotypic variances (PV) were observed for the characters such as trichome density cm^{-2}, number of gossypol glands cm^{-2}, chlorophyll content index and total soluble sugar. High values of genotypic coefficient of variances (GCV) and phenotypic coefficient of variances (PCV) were recorded for the characters such as number of leafhoppers per leaf, number of thrips per leaf, number of aphids per leaf and number of whiteflies per leaf. On the other hand moderate values of GCV and PCV were recorded by the characters such as total soluble sugar, number of gossypol glands cm^{-2}, trichome density cm^{-2} and boll weight. (Table 1)

Discussion

Heritability coupled with genetic advance proves a reliable measure for selecting the characters which have high yielding ability. From the study it was observed that characters with high heritability and high genetic advance were trichomes density cm^{-2}, number of gossypol glands cm^{-2} and total soluble sugar which indicated additive gene action and the characters such as total nitrogen, crude protein, number of whiteflies per plant and number of aphids per plant recorded low heritability and low genetic advance indicating the non-additive gene action. Whereas, low heritability and high genetic advance was observed for seed cotton yield per plant which indicated the presence of additive and non-additive gene action. On the contrary high heritability and high genetic advance for seed cotton yield per plant were reported by Chaudhari *et al*. (2017) [1], Dhamayanathi *et al*. (2010) [2], Erande *et al*. (2014) [3], Gnanasekaran *et al*. (2020) [4], Jarwar *et al*. (2018) [5], Khan *et al*. (2009) [6], Kumar *et al*. (2019) [7], Dahiphale *et al*. (2015) [8] and Soomro *et al*. (2010) [9] but Natera *et al*. (2012) [10] reported low heritability and low genetic advance for seed cotton yield per plant.

Also, high values of genotypic variances (GV) and phenotypic variances (PV) were observed for the characters such as trichome density cm^{-} [2], number of gossypol glands cm^{-2}, chlorophyll content index and total soluble sugar. From the studies of Erande *et al*. (2014) [3] high values of GV and PV were observed for number of bolls per plant, plant height and days to 50% flowering whereas, Soomro *et al*. (2010)[9] observed high GV and PV values for plant height as well as seed cotton yield per plant.

The high values of genotypic coefficient of variances (GCV) and phenotypic coefficient of variances (PCV) were recorded for the characters such as number of leafhoppers per leaf, number of thrips per leaf, number of aphids per leaf and number of whiteflies per leaf. On the other hand moderate values of GCV and PCV were recorded for the characters such as total soluble sugar, number of gossypol glands cm^{-2}, trichome density cm^{-2} and boll weight. High values of GCV and PCV were observed by Dhivya *et al*. (2013) [11], Erande *et al*. (2014) [3] and moderate values were recorded by Chaudhari *et al*. (2017) [1], Kumar *et al*. (2019) [6], Manonmani *et al*. (2019) [12] however, Nawaz Bilal *et al*. (2019) [13] recorded lowest values of GCV and PCV for character boll weight. For seed cotton yield per plant higher values of GCV and PCV were recorded by Chaudhari *et al*. (2017) [1], Jarwar *et al*. (2018) [5], Kumar *et al*. (2019) [7], Gnanasekaran *et al*. (2020) [4], Dahiphale *et al*. (2015) [8] and Erande *et al*. (2014) [3].

Table 1: Parameters of genetic variability at 45, 60, 90 and 120 DAS

	Heritability				Genetic advance				Genotypic variance (GV)				Phenotypic variance (PV)			
	45 DAS	60 DAS	90 DAS	120 DAS	45 DAS	60 DAS	90 DAS	120 DAS	45 DAS	60 DAS	90 DAS	120 DAS	45 DAS	60 DAS	90 DAS	120 DAS
No. of aphids/leaf	87.25	81.19	93.51	94.86	13.4716	10.9763	1.4283	2.1853	49.0151	34.9686	0.5141	1.1863	56.177	43.071	0.5498	1.2506
No. of leafhoppers/leaf	68.73	95.45	73.82	67.09	0.4758	4.5528	1.0696	0.7993	0.0776	5.1176	0.3652	0.2244	0.1129	5.3618	0.4947	0.3345
No. of thrips/leaf	89.2	92.15	50.78	77.58	4.5774	24.7392	0.1453	0.2943	5.5351	156.5126	0.0098	0.0263	6.2051	169.85	0.0193	0.0339
No. of whitefly/leaf	93.33	94.16	91.42	97.08	1.5387	3.0019	1.55	3.4676	0.5978	2.2554	0.6193	2.9186	0.6405	2.3954	0.6774	3.0063
Trichome density cm^{-2}	99.97	99.82	99.82	98.92	64.6352	42.3292	62.4802	62.9729	984.7321	422.9809	921.549	944.6698	984.99	423.74	923.18	954.9649
Gossypol glands cm^{-2}	99.67	99.67	98.71	97.06	30.6237	25.4314	13.2127	8.0918	221.725	152.9119	41.6766	15.8965	222.46	153.42	42.222	16.3775
Chlorophyll content index	98.27	95.4	54.88	95.6	22.4737	19.4682	3.6302	23.7236	121.1136	93.6228	5.6581	138.7278	123.25	98.14	10.309	145.1104
Total Soluble Sugar (%)	99.82	98.74	99.01	99.58	21.9025	12.3823	12.7935	14.01	113.2541	36.592	38.9534	46.4503	113.46	37.06	39.341	46.6481
Total Nitrogen (%)	95.94	96.86	97.13	98.72	0.605	0.4358	0.5414	1.0338	0.0899	0.0462	0.0711	0.2551	0.0937	0.0477	0.0732	0.2584
Crude protien (%)	95.92	96.92	97.08	98.72	3.7802	2.7252	3.3828	6.4608	3.5106	1.8056	2.7775	9.9636	3.6599	1.8629	2.8609	10.0924
No. of bolls per plant	81.18	81.18	81.18	81.18	2.6796	2.6796	2.6796	2.6796	2.0843	2.0843	2.0843	2.0843	2.5675	2.5675	2.5675	2.5675
No. of sympodia per plant	79.82	79.82	79.82	79.82	3.1451	3.1451	3.1454	3.1451	2.9202	2.9202	2.9202	2.9202	3.6585	3.6585	3.6585	3.6585
Boll weight (g)	84.7	84.7	84.7	84.7	1.408	1.408	1.408	1.408	0.5515	0.5515	0.5515	0.5515	0.6511	0.6511	0.6511	0.6511
Seed cotton yield (g)	78.23	78.23	78.23	78.23	5.997	5.997	5.997	5.997	10.8336	10.8336	10.8336	10.8336	13.849	13.849	13.849	13.8486

Table 1: Cont…

	Environmental variance				Genotypic coefficient of variance (GCV)				Phenotypic coefficient of variance (PCV)				Environmental coefficient of variance			
	45 DAS	60 DAS	90 DAS	120 DAS	45 DAS	60 DAS	90 DAS	120 DAS	45 DAS	60 DAS	90 DAS	120 DAS	45 DAS	60 DAS	90 DAS	120 DAS
No. of aphids/leaf	7.1616	8.1021	0.0357	0.0643	54.868	45.9474	60.9433	80.0507	58.7398	50.9932	63.0238	82.1915	20.976	22.117	16.05	18.6352
No. of leafhoppers/leaf	0.0353	0.2442	0.1295	0.1101	70.2004	82.5944	64.1753	73.6856	84.675	84.5421	74.6919	89.964	47.36	18.044	38.216	51.6037
No. of thrips/leaf	0.67	13.335	0.0095	0.0076	60.3861	45.7643	62.2254	149.0724	63.9365	47.6741	87.3239	169.2464	21.01	13.358	61.18	80.0749
No. of whitefly/leaf	0.0427	0.14	0.0581	0.0877	49.9849	67.9012	54.4349	80.1491	51.7393	69.9769	56.9311	81.3444	13.367	16.918	16.669	13.892
Trichome density cm^{-2}	0.2578	0.7558	1.6302	10.2951	33.0459	36.9169	37.9901	49.308	33.0502	36.9498	38.0237	49.576	0.5347	1.5605	1.5978	5.1475
Gossypol glands cm^{-2}	0.7339	0.5066	0.5452	0.481	38.8329	36.3375	24.8503	22.35	38.8972	36.3976	25.0124	22.6856	2.2342	2.0915	2.8423	3.8878
Chlorophyll content index	2.1324	4.5173	4.6511	6.3826	31.1859	21.0554	8.9223	24.689	31.4592	21.5574	12.0436	25.2506	4.1381	4.625	8.0894	5.2957
Total Soluble Sugar (%)	0.2092	0.4676	0.3879	0.1978	46.8602	27.3147	24.3007	32.5982	46.9034	27.4887	24.4214	32.6675	2.014	3.0877	2.425	2.1271
Total Nitrogen (%)	0.0038	0.0015	0.0021	0.0033	14.3607	11.2759	32.8529	35.3994	14.661	11.4574	33.3345	35.6276	2.9609	2.0099	5.6938	4.0242
Crude protien (%)	0.1493	0.0573	0.0834	0.1288	14.3584	11.2787	32.8538	35.3972	14.6605	11.4563	33.3434	35.6252	2.9609	2.0099	5.6938	4.0242
No. of bolls per plant	0.4832	0.4832	0.4832	0.4832	17.461	17.461	17.461	17.461	19.3796	19.3796	19.3796	19.3796	8.4073	8.4073	8.4073	8.4073
No. of sympodia per plant	0.7383	0.7383	0.7383	0.7383	13.5088	13.5088	13.5088	13.5088	15.1203	15.1203	15.1203	15.1203	6.7923	6.7923	6.7923	6.7923
Boll weight (g)	0.0996	0.0996	0.0996	0.0996	24.7919	24.7919	24.7919	24.7919	26.9377	26.9377	26.9377	26.9377	10.533	10.533	10.533	10.5333
Seed cotton yield (g)	3.015	3.015	3.015	3.015	15.2606	15.2606	15.2606	15.2606	17.254	17.254	17.254	17.254	8.0506	8.0506	8.0506	8.0506

Conclusion

Characters having high heritability and high genetic advance such as trichomes density cm^{-2}, number of gossypol glands cm^{-2} and total soluble sugar indicated additive gene action and these traits can be utilize to increase the seed cotton yield by using appropriate breeding. On the other hand, high values of genotypic variances (GV) and phenotypic variances (PV) were observed for the characters such as trichome density cm^{-2}, number of gossypol glands cm^{-2}, chlorophyll content index and total soluble sugar and higher values of genotypic coefficient of variances (GCV) and phenotypic coefficient of variances (PCV) were recorded for the characters such as number of leafhoppers per leaf, number of thrips per leaf, number of aphids per leaf and number of whiteflies per leaf. Selections made on the basis of these parameters will be helpful for further crop improvement work.

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