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Original Contribution

PHENOTYPIC RESPONSES OF F1 AND F2 HYBRIDS OF UPLAND COTTON IN SALT AND NON- STRESS ENVIRONMENTS

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ABSTRACT
Selection to salt resistance in crops is the most important method for yield increasing in salinity soils in arid and semi- arid locations. Crosses between crop resistance to salinity and maximum yield are the economical method in salinity area. In this research, the high phenotypic variance was showed for first harvesting traits in parents, F1 and F2 hybrids in salt stress condition. As results, first harvesting is controlled by many genes. Deltapine 25 parent had the highest phenotypic diversity for early maturity in salinity location (700.13), so selection could use in this parent population for yield increasing. F2 population of Deltapine 25 × Sahel had the lowest variance (189.89) for 1th yield in salt stress location. F1 population Deltapine 25 × P.U had the highest first harvesting (53.17 g/plant). Sahel cultivar had the lowest yield (37.11 g/plant) in salinity test center.

Key words: cotton, crosses, salt stress

INTRODUCTION

The problem of salinity is of global significance because saline and alkaline soils are found all over the word. Higher concentrations of salt in the soil adversely affect the growth and development of plants by disturbing various physiological processes (1).

Most characteristics for improving cotton are inherited as quantitative traits. Factors such as yield, earliness, lint percentage, and resistance to pests are conditioned by quantitative genes. Many researchers have been frustrated in attempting to solve their genetic problems by using simple genetic models; where, a few genetic parameters are used to describe complex situations (2). Quantitative traits are difficult to study because: (a) their expression is modified by environmental and management fluctuations; (b) a trait, such as yield, is a composite of many other traits, each influenced by many genes, each of which has variable effects; (c) the expression of an individual gene is often modified by the expression of other genes; (d) linkage blocks are difficult to breakup; (e) the optimum genotype for a given environment management system may require gene contribution from many divers sources; and (f) the best genotype for any environment management system is likely to be different for another system (3).

Due to its importance, plant breeders have been working to improving its yield and quality. Consequently, they achieved a great success in this respect through the development of varieties having higher yield and better qualities (4). Vigor of F1 hybrids to yield and disease, pest and tolerance to stress conditions has long been realized. However, only limited heterosis has been exploited because of both complicated logistics of producing F1 seed and disappointingly small improvement in most fiber characteristics (3, 5). These limitations have warranted plant breeders to seek potential alternative to increase cotton production. Theoretically, vigor of F2 hybrids decreases half to that expressed in F1 generation. The prospects of F2 hybrids naturally raise question about

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positive and negative effects on yield and fiber prosperities of F2 hybrids against parents and F1 hybrids (6).

The study on phenotypic expression of higher plants under extreme conditions as salt, drought, ultraviolet, light, PH and temperature- stresses is still limited as it is controlled by both gene and environmental factors (7). The interaction between genotype and environment is generally used to select of superior genotypes multi environment trials, because of the difficulty of selecting test environments that adequately represent the entire target population of environments (8).

For this reason, investigation on various aspects of salt on cotton and hybrids response to the stress is of much importance. In this research, parents, F1 and F2 hybrids response were studied in salt and non- stress conditions.

MATERIALS AND METHODS

This study was conducted to evaluate the response of cotton genotypes as well as their F1 and F2 hybrids to non stress in Gorgan cotton research station, north of Iran and salt stress condition in Aghghala, 15 km to Gorgan in 2005. Four varieties of cotton (*Gossypim hirsutum*) together with their six F1 and six F2 hybrids were studied using Randomize Complete Block Design (RCBD) in both locations with four replications for asses traits mean and their phenotypic variance. Every plot was 4 rows, 6 m long. Parents and hybrids include to:

Parents: Sahel, P.U, Deltapine 25 and Sindose
F1 and F2 hybrids: Sindose × Deltapine 25, Sindose × Sahel, Sindose × P.U,
Deltapine 25 ×Sahel, Deltapine 25 × P.U, and P.U × Sahel

Parental cultivars used in creating hybrid populations were selected on the basis of their yield and salt tolerance, as determined by previous testing. The parental genotypes were crossed in a half diallel mating design except reciprocals to develop six F1 during 2003 (9) and these F1 hybrids then open pollinated to develop six F2 hybrids during 2004. Physical and chemical properties of the soil in non stress condition, Gorgan and salt stress condition, Aghghala condition are given in **Tables 1 and 2.**

All the inputs and recommended cultural practices like fertilizer, irrigation, weed management and insecticides application etc. were performed at the recommended level, while maintaining constancy among all the treatments.

Ten plants from each repeat were selected to making total of 40 plants from each entry randomly tagged to record the observations. The data on seed cotton yield per plant weighed grams, monopodial and sympodial branch no., height, boll no./plant and early maturity were studied. Data means and phenotypic variances were analyzed with MSTATC computer program.

Table 1. *Physical and chemical properties of the soil in non- stress condition (Gorgan)*

Deep (cm)	Ec (ds/m)	PH	O.C (%)	ava.P (mg/kg)	ava.K (mg/kg	Clay (%)	Silt (%)	Sand (%)	Texture
0-30	0.61	7.9	1.12	7.2	460	34	62	4	Si-C-L

Table 2. *Physical and chemical properties of the soil in salt stress condition (Aghghala)*

Deep (cm)	Ec (ds/m)	PH	O.C (%)	ava.P (mg/kg)	ava.K (mg/kg	Clay (%)	Silt (%)	Sand (%)	Texture
0-30	9.4	8.1	1.4	12.8	300	26	68	6	Si- L
30-60	6.4	8.0	0.8	4.8	140	18	70	12	Si-L

RESULTS

Non-stress environment

Results were showed that Deltapine 25 had the highest boll numbers in non stress conditions (13.825). The lowest boll number had in F1 progeny of Sindose × P.U (8.625). F2 population of Sindose × Deltapine 25 had the highest phenotypic diversity of boll number. Selection could be useful for boll number improvement. Phenotypic variance of boll number was medium that resulted boll number was controlled by multiple genes **(Table 3).**

The greatest mathematic mean for sympodial branch number was in F1 population of P.U × Sahel (4.075 number / plant). So if canopy improvement and sympodial branch number increasing will be target in breeding program in sunshine environment, could use this population. The lowest branch number was showed in F1 population. The least determinate of sympodial branch number was showed in F1 cross combination of Deltapine 25 with Sahel (1.675 no. / plant). In wet and rainy condition, F1 population of Deltapine 25×Sahel could be useful for canopy decreasing in breeding program. Diversity was estimated low to medium in populations and parents based on phenotypic variance. That was showed this character was controlled by a little gene number. F1 population (Deltapine 25 × P.U) had the lowest phenotypic variance (0.44) and F1 population (Sindoes × Sahel) and F1 population (P.U × Sahel had the highest phenotypic variance (15.68 and 15.52 respectively**) (table 3).**

The highest monopodial branch number had by Sindose genotype (17.950 no. / plant). F1 crosses of Deltapine 25 × Sahel was created 13.875 monopodial branch no. and had the lowest monopodial number in genotypes and crosses. The most phenotypic diversity was created by F2 population, Deltapine 25 × P.U and the lowest phenotypic diversity was produced by F1 population of Sindose × Sahel (5.52). phenotypic diversity was medium in population and showed this character controlled by multiple genes.

Table 3 was contained average value for height. The data showed the greatest height was in Sindose genotype and the lowest height was in Deltapine 25 cultivar. Deltapine 25 was 98.4 cm height. Hybrids had the medium height. F2 hybrid, Deltapine 25× P.U had the 391.25 phenotypic diversity (the highest diversity), for phenotypic variance regarding this character, monopodial branch no. would be readily modified by selection procedures. The least values of phenotypic diversity was in F1 (Deltapine 25 × P.U). Phenotypic variance was high in genotypes and hybrids and showed that height trait probably was controlled by many genes **(table 3).**

For mean performance regarding early maturity trait, F2 crosses of Deltapine 25 with Sahel exhibited maximum early maturity (92.6 g /plant 1th yield). F1 population of Sindose × P.U had the lowest early maturity (62.8 g/plant). For the maximum phenotypic variance, early maturity controlled by many genes. Sindose cultivar hd the lowest phenotypic diversity (275.24). F2 progeny of Sindoes × Deltapine 25 had the highest variance (1229.90). Selection for early maturity will be useful in F2 hybrid (Sindose × Deltapine 25).

Table 3 showed F2 population (Sindose × Deltapine 25) had the gratest yield (93.552 g/plant). F1 population of Sindose × Deltapine 25 and Sindose were produced the lowest seed cotton yield/plant (62.28 and 62.68 g/plant, respectively). The phenotypic variance was high in parents, F1 and F2 hybrids. F2 population of Sindose × Deltapine 25 had the highest phenotypic diversity (1310.04). F1 progeny (Sindose × P.U) was the lowest phenotypic variance value with 207.65 for this trait. The attainment of early crop maturity and high yield has been a primary objective of cotton breeders and agronomist. It is also recognized that plant breeder cannot consider this characters separately in a cotton breeding program, since early cultivars must be relatively high yielder to be successful (2). Turcotte and Percy (1990) observed that through F2 hybrids on an average yielded significantly lower than mid parents or better parents (10).

Table 3. *Mean and phenotypic variance of different traits in non-stress environment*

		boll No		Sympodial No.		Monopodial No.		height cm		early maturity		yield g	
treatment		Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
parents	Sindose	13.025	18.84	2.325	0.88	17.950	9.67	120.60	173.45	67.182	275.24	73.82	341.66
	Deltapine 25	13.825	22.85	2.425	1.02	15.050	6.92	98.38	290.02	85.552	693.27	98.52	908.48
	Sahel	12.300	13.99	1.825	1.23	.950	11.49	113.92	284.60	77.835	492.40	89.77	619.19
	P.U	11.250	17.31	1.775	0.74	16.200	12.89	109.70	169.78	80.040	685.92	87.673	802.34
F1 hybrids	Sindose×Deltapine 25	12.250	23.91	2.100	0.61	15.225	8.53	108.45	187.42	75.585	677.56	78.915	703.98
	Sindose × Sahel	10.200	9.73	3.750	15.68	15.850	5.52	113.25	132.25	76.757	466.99	81.918	560.89
	Sindose × P.U	8.625	6.81	1.850	0.64	14.150	11.29	113.10	165.64	62.842	280.90	67.88	462.07
	Deltapine 25 × Sahel	9.725	11.56	1.675	0.58	13.875	10.89	101.72	201.36	71.100	349.69	78.39	470.25
	Deltapine 25 × P.U	10.525	11.22	2.150	0.44	15.550	6.3	110.40	85.38	81.662	308.70	85.14	338.08
	P.U × Sahel	10.000	11.56	4.075	15.52	15.375	9.55	112.40	157.50	79.255	474.37	85.97	559.75
F2 hybrids	Sindose×Deltapine 25	12.625	68.06	2.375	1.42	15.375	10.24	109.72	347.82	88.860	1229.90	93.552	1300.12
	Sindose × Sahel	10.050	21.44	2.300	0.98	14.275	9.49	102.38	349.32	70.847	689.06	74.80	738.76
	Sindose × P.U	10.050	29.16	3.275	4.71	14.775	9.06	102.35	167.18	77.927	979.06	80.721	1018.00
	Deltapine 25 × Sahel	12.100	18.49	2.250	1.17	16.000	9.67	119.10	242.11	92.592	532.22	103.67	1108.22
	Deltapine 25 × P.U	12.600	19.89	2.125	0.94	15.925	13.76	114.55	391.25	86.435	773.95	91.46	824.62
	P.U × Sahel	10.375	15.13	1.750	0.71	14.750	6.92	100.10	188.51	73.297	438.90	76.12	469.26

Table 4. *Mean and phenotypic variance of different traits in salt stress environment*

		boll	No	Sympodial	No.	Monopodial	No.	height	cm	early	maturity	yield	g
treatment		Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
parents	Sindose	11.497	33.29	1.800	1.04	15.350	15.68	100.62	335.62	47.028	448.59	51.89	492.81
	Deltapine 25	10.449	41.99	2.175	0.76	13.400	14.36	93.00	694.85	44.823	700.13	51.58	795.39
	Sahel	8.277	10.89	1.843	1.10	13.803	13.18	96.80	380.25	37.108	355.70	41.46	386.06
	P.U	8.425	7.62	1.750	1.12	13.350	23.52	94.45	694.32	39.040	129.28	42.40	166.00
F1 hybrids	Sindose×Deltapine 25	8.825	22.00	1.625	1.00	13.750	10.69	91.00	386.12	41.865	586.12	45.64	677.70
	Sindose × Sahel	8.975	11.70	1.300	1.04	15.700	25.10	107.80	639.58	47.977	235.01	50.34	242.79
	Sindose × P.U	8.248	9.86	1.100	0.81	14.300	16.89	92.45	371.72	38.758	249.96	39.86	260.98
	Deltapine 25 × Sahel	8.775	11.42	1.550	0.86	11.975	11.49	73.35	214.92	39.853	185.50	44.461	220.31
	Deltapine 25 × P.U	10.425	25.10	2.200	0.77	12.275	8.47	81.78	246.49	53.170	535.00	58.156	631.63
	P.U × Sahel	10.542	22.85	1.700	0.77	13.575	15.84	95.98	299.98	52.615	565.01	54.25	578.77
F2 hybrids	Sindose×Deltapine 25	7.960	8.82	1.475	0.86	14.975	11.83	106.62	347.82	40.438	128.14	44.00	150.89
	Sindose × Sahel	8.645	14.98	1.685	1.17	15.039	17.39	106.00	470.02	41.183	449.44	43.318	499.28
	Sindose × P.U	10.915	21.07	1.800	1.44	15.425	17.06	101.55	437.65	49.621	392.83	54.43	478.02
	Deltapine 25 × Sahel	9.497	7.08	1.500	0.46	15.500	12.96	100.12	261.47	44.233	189.89	45.93	198.13
	Deltapine 25 × P.U	8.956	14.98	1.325	0.88	14.300	16.32	94.00	406.43	21.408	385.73	26.12	423.31
	P.U × Sahel	9.000	19.80	1.650	1.17	15.350	17.47	106.60	293.78	43.655	484.88	49.58	566.6

Table 5. *Mean and phenotypic variance of different traits in combined analysis*

		bol l No		Sympodial No.		Monopodial No.		height cm		early maturity		yield g	
treatment		Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
parents	Sindose	12.261	26.32	2.063	1.02	16.650	14.21	110.61	352.31	57.105	558.85	62.86	614.20
	Deltapine 25	12.137	34.81	2.300	0.90	14.225	11.22	95.69	493.73	65.187	1107.56	75.05	1270.63
	Sahel	10.288	16.40	1.834	1.14	14.876	13.32	105.36	402.40	57.471	838.10	65.61	93.26
	P.U	9.838	14.29	1.763	0.92	14.775	19.98	102.08	485.32	59.540	827.71	65.03	907.99
F1 hybrids	Sindose×Deltapine 25	10.538	25.60	1.863	0.85	14.488	10.05	99.72	360.24	58.725	912.04	62.28	970.26
	Sindose × Sahel	9.588	10.96	2.525	9.80	15.775	15.13	110.52	388.48	62.367	556.49	66.13	608.62
	Sindose × P.U	8.436	8.29	1.475	0.86	14.225	13.91	102.78	373.26	50.800	408.85	53.87	507.65
	Deltapine 25 × Sahel	9.250	11.56	1.613	0.72	12.925	11.97	87.54	409.25	55.476	511.66	61.43	590.16
	Deltapine 25 × P.U	10.475	17.98	2.175	0.61	13.913	9.99	96.09	371.33	67.416	622.00	71.65	684.88
	P.U × Sahel	10.271	17.06	2.888	9.49	14.475	13.40	104.19	294.12	65.935	692.74	70.11	748.24
F2 hybrids	Sindose×Deltapine 25	10.292	43.23	1.925	1.35	15.175	10.96	108.18	345.59	64.649	1263.80	68.78	1310.04
	Sindose × Sahel	9.348	18.49	1.993	1.14	14.657	13.40	104.19	407.64	56.015	785.12	59.06	835.10
	Sindose × P.U	10.482	25.00	2.538	3.61	15.100	13.03	101.95	298.60	63.774	880.31	67.58	942.72
	Deltapine 25 × Sahel	10.799	14.36	1.875	0.94	15.750	11.22	109.61	339.66	68.412	948.64	74.80	1259.10
	Deltapine 25 × P.U	10.778	20.61	1.725	1.06	15.113	15.52	104.28	500.42	63.921	1085.70	68.81	1129.26
	P.U × Sahel	9.688	17.72	1.700	0.92	15.050	12.11	101.85	241.18	58.476	678.60	62.85	736.36

Salt stress environment*:*
Cotton is sometimes grown in saline soils and genotypic differences to salt tolerance have been reported. Most varieties are tolerant during late growth stages. The Acala SJ-2 variety has some salt tolerance during germination and early growth as well as during late vegetative growth (11).

Table 4 presented medium value for boll no. traits in the parents, F1 and F2 progenies in salt stress environment. The maximum number of boll was in Sindose genotype (11.5 boll no./ plant). Crosses combination of Sindose × Deltapine 25 (F2) exhibited 8 boll no. / plant and was the minimum boll no. in parents and populations. Phenotypic variance of boll no. was medium that showed boll no. was controlled by multiple genes. Deltapine 25 genotype was the highest phenotypic variance (41.99). Selection procedures will be useful in this population for boll no. improvement. The lowest phenotypic variance was showed in F2 population (Deltapine 25 × Sahel) (7.08) **(table 4).**

Table 4 reflected Deltapine 25 × P.U (F1) crosses had the maximum sympodial branch no. (2.2) in salt stress environment. The minimum sympodial branch no. was in F1 hybrid of Sindose × P.U (1.1). The low phenotypic variance could result this trait controlled by a little genes. The highest phenotypic variance was estimated in Sindose with P.U (F2) (1.44). The lowest phenotypic variance had in Deltapine 25, so selection method for sympodial branch improvement will be difficult **(Table 4).**

The maximum monopodial branch no. was produced in F1 crosses of Sindose × Sahel (15.2). The least monopodial branch no. was in Deltapine 25 × sahel (F1) in stress condition. As result of character controlled by multiple genes, phenotypic variance was medium. Phenotypic variance (25.10) was showed in F1 (Sindose × Sahel) That was the highest variance. Monopodial branch no. increasing will be useful by selection method. High salt concentrations have been shown to reduce growth (12).

In salt stress condition, F1 opulation (Sindose × Sahel) had the maximum height (107.8 cm) and F1 crosses of Deltapine 25 × Sahel had the minimum height (73.4 cm). Phenotypic variance was high for this trait and was resulted height controlled by multiple genes. The highest variance for height had in Deltapine 25 (694.85) and P.U the lowest variance was in F1 (Deltapine 25 × Sahel) (214.92) **(Table 4).**

Phenotypic variance was the maximum for early maturity in parents and populations in salinity environment. That showed early maturity was controlled by the many genes. Deltapine 25 had the greatest phenotypic diversity (700.13) in salt environment. Early maturity can be modified by selection in salt stress condition. F1 population (Deltapine 25 × P.U) had the highest early maturity (53.17 g/plant the first yield) Sahel cultivars had the least early maturity (37.11 g/plant) **(Table 4).**

The highest seed cotton yield/plant was produced by F1 population of Deltapine 25 × P.U (58.156). The lowest yield was produced by F2 population (Deltapine 25 × P.U) (26.16 g/plant). The phenotypic variance was high for yield in salt environment. Deltapine 25 had the highest phenotypic variance (795.39), Selection will be useful for yield improvement in Deltapine 25 in salt stress condition. F2 population (Sindose with Deltapine 25) was the lowest phenotypic variance (150.89). Seed cotton yield and lint yield showed little additive variance and, correspondingly, very low heritability estimates (2). Baker and Verhale in 1975 presented similar results in their study (13). Schoenhals and Gannaway (1990) evaluated five F1s and their F2s for yield, agronomic and fiber properties and its was revealed that two of the six F2 hybrids gave greater yield as compared to corresponding F1 hybrids(14).

Combined Analysis
Different traits were studied combined in both salt and non-stress environment. Sindose cultivars had the greatest boll no. (12.3 boll no. /plant) and F1 progeny (Sindose × P.U) had the least boll no./plant (8.4). Phenotypic variance was medium in parents, F1 and F2 hybrids, that result boll no. was controlled by multiple genes. F2 crosses combination of Sindose with Sahel had the highest phenotypic diversity (43.23) and selection for boll no. increasing will be useful in F2 progeny of Sindose × Sahel. The lowest phenotypic diversity was in F1 population (Sindose × P.U) **(Table 5).**

For mean performance regarding sympodial branch no. F2 population (Sindose × P.U) had the highest sympodial branch no. (2.538). F1 hybrid (Sindose with P.U) had the lowest sympodial branch no**. (Table 5).**

Phenotypic diversity of monopodial branch no. was average in hybrids. P.U genotype had the greatest phenotypic diversity (19.98). Deltapine 25 with Sahel had the minimum monopodial no.

(12.925) and Sindose had the highest phenotypic variance for monopodial branch no. (916.650) **(Table 5).**

Phenotypic variance was the high for height trait. As result height was controlled by many genes. Sindose genotype and F1 hybrid of Sindose × Sahel were the highest height (110.61 and 110.52, respectively) **(Table 5).**

F2 hybrid of deltapine 25 with Sahel had the greatest early maturity (68.412 g 1st yield/plant). F1 population (Sindose × P.U) had the least early maturity (50.80 g 1st yield / plant). Many genes controlled early maturity for the high phenotypic variance and environment effects are high on early maturity. F1 population of Sindose with Deltapine 25 had the highest phenotypic diversity (1263.8) and F1 hybrid (Sindose × P.U had the lowest phenotypic variance(408.85) **(Table 5).**

Deltapine 25 had the greatest yield (75.05 g/plant) and F1 progeny of Sindose with P.U had the least yield (53.87). Phenotypic variance was high for yield in parents and its progenies. As result, Yield was controlled by many genes. F2 hybrid, Sindose with Deltapine 25 had the maximum phenotypic diversity. Selection will be useful for yield improvement in F2 hybrid of Sindose with Deltapine 25. F1 population of Sindose with P.U had the minimum Phenotypic variance (507.65) **(Table 5).** Merredith (1990) recorded the yield of seed cotton of parents, F1 and F2 hybrids as 953, 1065 and 1025 kg/ha respectively and two highest yielding F1 hybrids gave 8.0 % higher yield in F2 generation than their respective parental line (15). The yield of cotton varieties varies widely due to variation in climatic and soil factors, which complicates the identification of superior genotypes (16).

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