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Research Article

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Hybrid evaluation for yield and yield attributes in Okra (*Abelmoschus esculentus* L. Moench) during monsoon season

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ABSTRACT

The present investigation aimed to evaluate Okra hybrids for growth and yield characteristics during the monsoon season in the dry and humid regions of Telangana. The experiment was conducted under augmented design with nineteen numbers of checks over 335 okra hybrids. The analysis of variance showed significant differences for all the traits under adjusted and unadjusted treatment effect and moreover checks also, except the number of days for flowering. The comparative mean performance deduced the hybrids like 21A014, 21A046, 21A064, 21A077, 21A079, 21A095, 21A112, 21A121, 21A181, 21A235, 21A252 and Check-12 has performed well under monsoon condition for various characters. The genetic parameter revealed that the traits like number of branches, stem internode distance (cm), average fruit weight (g), seed count, yield per plant (g/plant) and yield per hectare (t/ha) resulted in moderate Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV), with high broad sense heritability coupled with high Genetic Advance over Mean (GAM). The selected hybrids can be potentially evaluated for the summer season in various locations for yield prospective and viral tolerance.

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INTRODUCTION

Okra is commonly known as Bhendi in Hindi and lady's finger in English. It belongs to the family *Malvaceae* with genetic diversification for chromosome number and ploidy level. Okra is commercially grown in India for its tender greenishness and cultivation spread across tropical, sub-tropical as well as dry humid regions of the world as being a drought and heat tolerant crop. Okra is having a rich amount of iodine percentage which down-regulates goiter incidence and is known to reduce weight, cholesterol levels and maintain the good-healthy condition of the liver in the human body. Okra fruits are known to have vitamins A, B and C which prevent oxidative damage by free radicals (Rajesh *et al.*, 2018). Furthermore, the presence of an enormous percentage of fiber content in fruits and leaves can helps in easy bowel movement upon consumption. Industrial use of crude okra stems and leaves fiber as raw material for paper manufacturing and preparation of ayurvedic drug for diabetic patients.

Okra as being an upright, average duration annual crop occupies well in multiple cropping systems. And, it's one of the important cash crops for marginal and small farmers of India. Economically and ecologically, the production of okra depends upon cultivar resistance against biotic and abiotic stress. Upon high usage of low-yielding varieties and hybrids along with the higher incidence of yellow vein mosaic virus (YVMV) impacts serious scenarios in okra production and productivity (Singh *et al.*, 2007). As well as, due to low germination percentage, optimum plant density and early flowering cause farmers to unadapt the okra cultivation in India. Presently, in India, farmers are traditionally cultivating open-pollinated varieties (OPV) of okra which are emphasized selected from landraces that compromise with yield in the case of okra.

Thus, with this preview we designed our experiment to evaluate and select prominent okra hybrids for high fruit yield and yield attributes during monsoon season in dry and humid climatic areas (one season, one location).

METHODS AND MATERIALS

Experimental Design & Crop Management

About 335 okra hybrids were sown in such a manner that around 67 hybrids per block with a total number of five blocks and 5

replications of 19 commercial checks in an augmented design with the spacing of 45 X 45 cm apart. Field was fertigated through drip lines a with recommended dosage of fertilizer at a proper interval. And, appropriate pest and disease protection steps were taken.

Evaluation of Fruit Data

Upon cropping period growth observation was recorded. Like, (a) number of branches, (b) length of stem internode (c) Number of days for flower initiation and (d) Number of days for 50% flowering. Over the harvesting stage subsequently fruit trait observations were recorded after 65-70 DAT for a period of four weeks. Traits like (a) Fruit length, measured in centimeters from pedicel attachment to its apex; (b) Fruit circumference, expressed in centimeters and measured using thread; (c) Fruit width, measured using vernier caliper in terms of centimeters; (d) seed count, measured in number; (e) Fruit yield per plant, expressed in terms of grams and (f) Fruit yield per hectare, measured in terms of tones.

Biometrical Analysis

Statistical analysis like Analysis of Variance, descriptive statistics and genetic parameter estimations were done using *R*-software with a package of 'AugmentedRCBD'.

RESULTS AND DISCUSSION

The analysis of variance for 335 okra hybrids had shown significantly different values (P <= 0.01 & 0.05) for the mean sum of squares for all traits except the number days for the flower initiation in varieties versus check as mentioned in Table 1. The sources of variation like adjusted blocks, adjusted as well as unadjusted treatment entries along with varieties versus check effect were significant. Similarly, significance was also found for the adjusted block effect, this is because of heterogeneity of land. The augmented design is used to analyze the maximum number of germplasms in a limited area. Whenever the initial quantity of seed was limited, the number of checks was replicated in order to adjust the entries or varieties value.

The standard errors for different components comparisons of test entries and check treatment, check treatment means, two test entries (different blocks) and two test entries (same block) were mentioned in Table 2. A comparative heatmap was generated using perse mean value data of individual hybrid for the selection of better performed hybrid over all the traits (Figure 1). In which, the hybrids like 21A014, 21A046, 21A064, 21A077, 21A079, 21A095, 21A112, 21A121, 21A181, 21A235, 21A252 and Check-12 has performed well under monsoon condition for different okra traits like more number branches, relative short internode, earliness, preferable fruit traits and high yield potential (Figure 2).

The genetic parameter assessment presented in Table 3 revealed no traits have been recorded with high genotypic and phenotypic Coefficient of Variation. The traits like number of branches (GCV=18.19% & PCV=18.2%), internode distance (GCV=13.98% & PCV=14.0%) (Adeoluwa & Kehinde, 2011), average fruit weight (GCV=10.19% & PCV=10.24%) (Mehta *et al.*, 2006), seed count (GCV=16.48% & PCV=16.49%), yield per plant (GCV=10.29% & PCV=10.31%) and yield per hectare (GCV=10.27% & PCV=10.32%) recoded moderate GCV and PCV with low ECV (Sharma *et al.*, 2007). Whereas, traits like the number of days for flower initiation (GCV=6.04% & PCV=6.71%) (Das *et al.*, 2012), number of days for 50 percent flowering (GCV=7.60% & PCV=7.63%),

Table 1: Analysis of variance of augmented block design for eleven quantitative traits in 335 hybrids of okra

Source	Df	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Block (ignoring Treatments)	4	2.76**	1.45**	75.1**	422.01**	13.22**	0.02**	8.6**	0.3**	160.63**	2544.07**	6.97**
Treatment (eliminating Blocks)	353	0.78**	0.31**	11.34**	15.65**	1.01**	0.01**	2.68**	0.13**	30.31**	1652.82**	2.13**
Check	18	1.98**	2.41**	57.81**	57.63**	0.98**	0.02**	9.69**	0.39**	93.66**	6013.51**	7.28**
Block (eliminating Treatments)	4	0.49**	0.18**	15.29**	394.41**	42.31**	0.04 **	36.18**	0.56**	30.56**	11998.33**	28.75**
Treatment (ignoring Blocks)	353	0.8**	0.33**	12.02**	15.96**	0.68**	0.01**	2.37**	0.12**	31.79**	1545.69**	1.89**
Varieties vs. Check	1	1.49**	6.18**	6.5 ns	43.28**	6.19**	0.03 **	0.27**	0.02**	225.81**	725.81**	0.11**
Varieties	334	0.74**	0.2**	9.57**	13.64**	0.65**	0.01**	1.98**	0.11**	27.87**	1307.37**	1.6**
Residuals	72	0.00044	0.00053	1.8	0.11	0.0025	0.00	0.02	0.00	0.03	6.07	0.01

Where, X1: No. of branches; X2: Internode distance (cm); X3: Number of days for flower initiation (Days); X4: Number of days for 50% flowering (Days); X5: Fruit Length (cm); X6: Fruit Width (cm); X7: Average Fruit weight (g); X8: Fruit circumference (cm); X9: Seed Count; X10: Yield per plant (g/plant); X11: Yield per hectare (t/ha). Non-Significant @ P > 0.05; Significance @ * P <= 0.05; ** P <= 0.01

Table 2: Standard errors of mean for comparison of adjusted means

Comparison	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
A test entries and a check treatment	0.02	0.03	1.51	0.36	0.06	0.0024	0.16	0.01	0.2	2.77	0.14
Check Treatment Means	0.01	0.01	0.85	0.21	0.03	0.0013	0.09	0.01	0.11	1.56	0.08
Two test entries (Different Blocks)	0.03	0.03	1.95	0.47	0.07	0.003	0.2	0.01	0.25	3.58	0.18
Two test entries (Same Block)	0.03	0.03	1.9	0.46	0.07	0.003	0.2	0.01	0.25	3.49	0.17

Where, X1: No. of branches; X2: Internode distance (cm); X3: Number of days for flower initiation (Days); X4: Number of days for 50% flowering (Days); X5: Fruit Length (cm); X6: Fruit Width (cm); X7: Average Fruit weight (g); X8: Fruit circumference (cm); X9: Seed Count; X10: Yield per plant (g/plant); X11: Yield per hectare (t/ha).

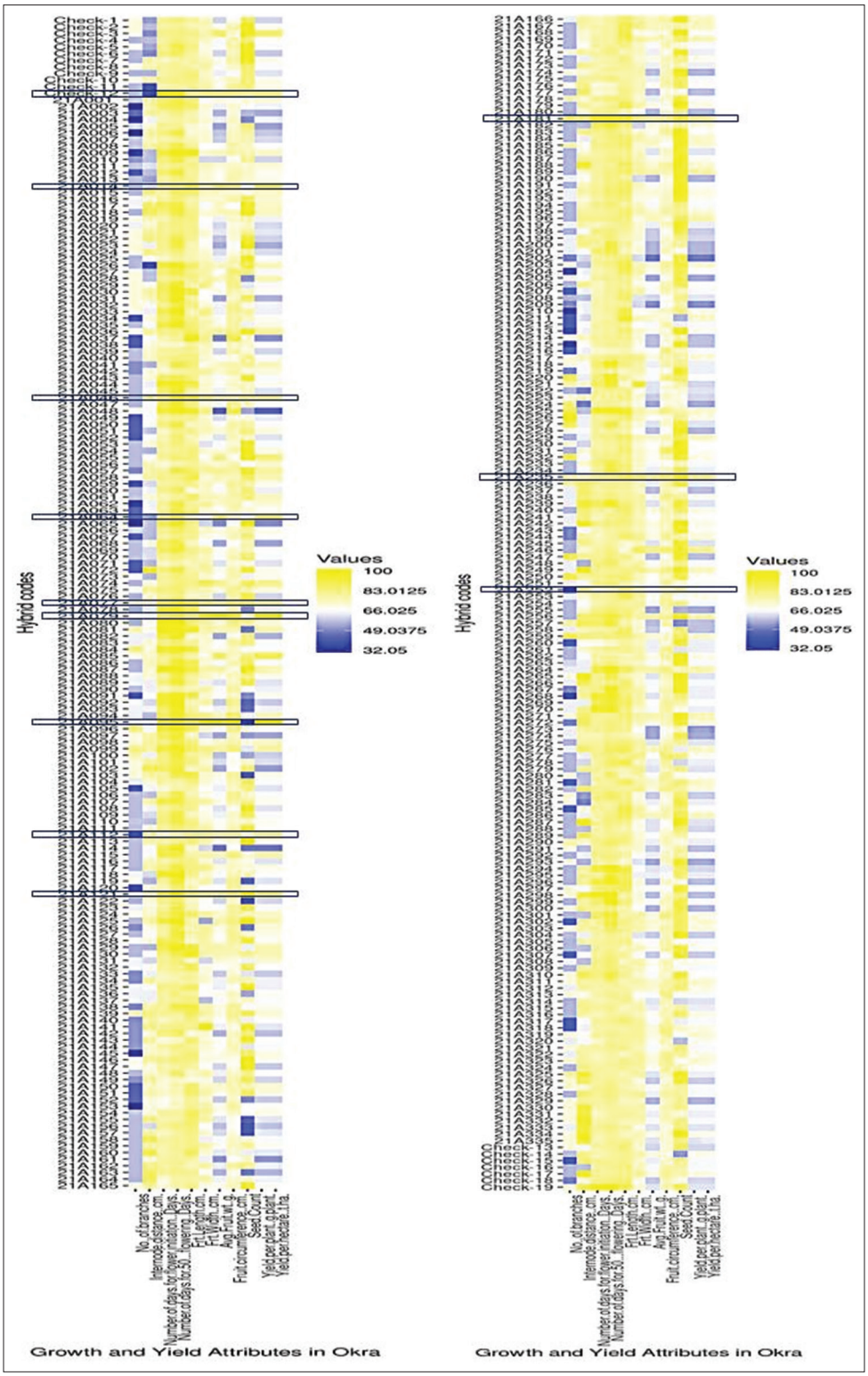

Figure 1: Heat map for comparative mean performance of 335 21A' okra hybrids for different growth and growth characters

fruit length (GCV=6.19% & PCV=6.21%), fruit width (GCV=7.59% & PCV=7.60%) and fruit circumference (GCV=7.35% & PCV=7.36%) documented lowest PCV and GCV.

All the characters had recorded high broad sense heritability ranging from 81.18 percent to 99.96 percent whereas high genetic advance over mean recorded by the number of branches (37.52%) (Reddy *et al*., 2012), internode distance

Table 3: Estimation of genetic parameter for various eleven parameters in okra F_1's

Trait	Mean	PV	GV	EV	GCV (%)	PCV (%)	ECV (%)	h_{BS} (%)	GAM (%)
X1	4.72	0.74	0.74	0.00044	18.19	18.2	0.44	99.94	37.52
X2	3.17	0.2	0.2	0.00053	13.98	14	0.73	99.73	28.8
X3	46.12	9.57	7.76	1.8	6.04	6.71	2.91	81.18	11.23
X4	48.4	13.64	13.53	0.11	7.6	7.63	0.67	99.23	15.62
X5	12.99	0.65	0.65	0.0025	6.19	6.21	0.38	99.62	12.75
X6	1.44	0.01	0.01	0.00	7.59	7.6	0.15	99.96	15.66
X7	13.75	1.98	1.96	0.02	10.19	10.24	1.01	99.02	20.92
X8	5.18	0.11	0.11	0.00	6.35	6.36	0.18	99.92	13.1
X9	32.02	27.87	27.84	0.03	16.48	16.49	0.55	99.89	33.97
X10	350.66	1307.37	1301.29	6.07	10.29	10.31	0.7	99.54	21.17
X11	12.27	1.6	1.59	0.01	10.27	10.32	0.98	99.09	21.09

Where, X1: No. of branches; X2: Internode distance (cm); X3: Number of days for flower initiation (Days); X4: Number of days for 50% flowering (Days); X5: Fruit Length (cm); X6: Fruit Width (cm); X7: Average Fruit weight (g); X8: Fruit circumference (cm); X9: Seed Count; X10: Yield per plant (g/plant); X11: Yield per hectare (t/ha). PV: Phenotypic variation; GV: Genotypic variation; EV: Environmental variation; PCV: Phenotypic Coefficient of Variation; GCV: Genotypic Coefficient of Variation; ECV: Environmental Coefficient of Variation; h_{BS}: Broad sense heritability; GAM: Genetic Advance over Mean

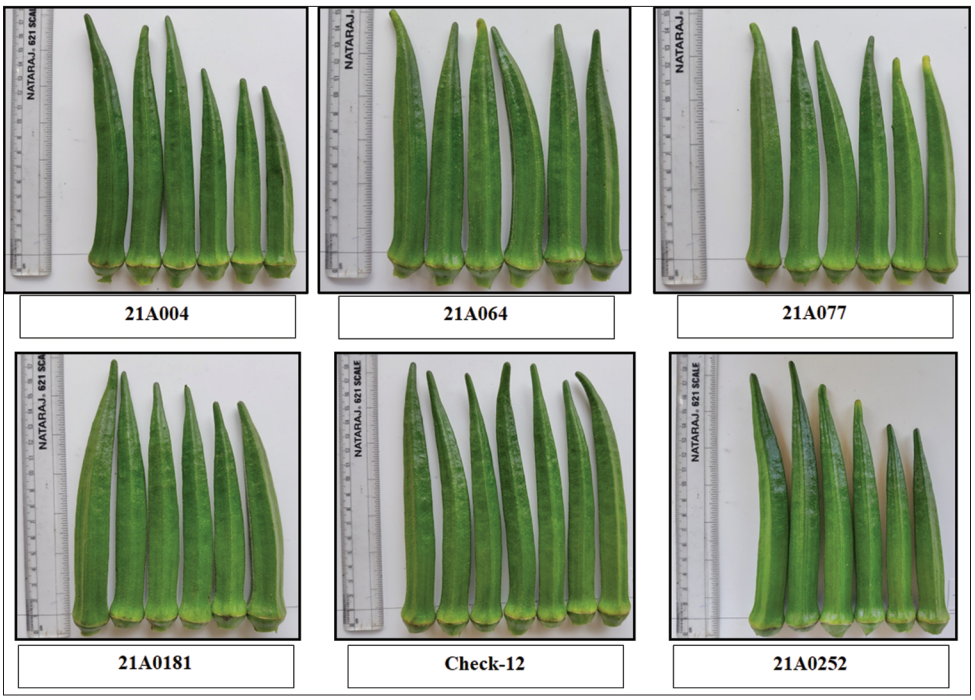

Figure 2: High yielding 21A' Okra hybrids under monsoon condition

(28.8%), average fruit weight (20.92%), seed count (33.97%), yield per plant (21.17%) and yield per hectare (21.09%). However, traits like Number of days for flower initiation (11.23%), Number of days for 50 percent flowering (15.62%), Fruit Length (12.75%), Fruit Width (15.66%), Fruit circumference (13.1%) recorded moderate genetic advance over mean with no low GAM.

The moderate PCV and GCV with negligible amounts of ECV indicate the presence of genetic variability for desired traits. However, in this study, PCV values are slightly higher than GCV which mean environmental factors influence over traits to express which are confirmed by ANOVA for adjusted block effect (Singh *et al.*, 2017). Whereas, to improve selection criteria parameters like high broad sense heritability and high genetic advance over mean this indicates the additive gene effect and efficiency of selection. Whereas, other traits which express moderate GAM which indicate traits are governed by non-additive genes in which selection can't intensify.

CONCLUSION

It is concluded that from the comparative mean performance the hybrids like 21A014, 21A046, 21A064, 21A077, 21A079, 21A095, 21A112, 21A121, 21A181, 21A235, 21A252 and Check-12 has performed well under monsoon condition in kothagudem (TS). The genetic parameter assessment revealed that the traits like number of branches, internode distance, average fruit weight, seed count, yield per plant and yield per hectare were recorded as high broad sense heritability coupled with high genetic advance over mean.

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