Int.J.Curr.Microbiol.App.Sci (2021) *10*(01): 3239-3248

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 01 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1001.377

Study on Genetic Variability, Heritability and Genetic Divergence for Character Association in Cucumber (*Cucumis sativus* L.) under Prayagraj Agro – Climatic Conditions

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Keywords

Cucumber, Genetic variability, Correlation, path coefficient, Genetic divergence growth and yield

Article Info

Accepted:
20 December 2020
Available Online:
10 January 2021

A B S T R A C T

An experiment was conducted on Genetic variability, correlation, path coefficient and genetic diversity D^2 analysis in the 16 genotypes of Cucumber during 2019-20 at the Horticulture Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The observations were recorded on various growths and yield attributes. The experiment was carried out with 16 genotypes procured from Local market of Prayagraj in randomized Block Design (RBD) with three replications. The results from the present investigation revealed that genotypes Swarn Agati identified as high fruit yield per vine, fruit yield per plot (kg)fruit yield (t ha^{-1})at Prayagraj Agro-climatic condition. The genotypic and phenotypic coefficient variance value were categorized as low (0-10%), moderate (10-20%) and high (20% and above). The heritability was categorized as low (0-30%), moderate (30- 60%) and high (60% and above).The Genetic advance and Genetic advance as percent mean was categorized as low (0-10%), moderate (10-20% and (≥20%). Genotypic and phenotypic correlation coefficient analysis revealed that yield (t/ha) showed positive significant association with Germination %, Vine Length (cm), No. of Secondary Branches, Fruit Length (cm), Fruit Diameter (cm), No. of Fruits per Vine, Avg. Fruit Weight (g), Yield per Vine (kg) and Yield per Plot (kg). Genotypic path coefficient analysis revealed that the direct positive effect on fruit yield (t ha-1) was exhibited by germination %,no. of secondary branches, node number to 1st male flower, days to 1st female flower appearance, fruit length (cm),avg. fruit weight (g),yield per vine (kg)and yield per plot (kg).Phenotypic path coefficient analysis revealed that the direct positive effect on fruit yield (t ha-1) was exhibited by germination %, node number to 1st male flower, days to 1st female flower appearance, number to 1st female flower, fruit diameter (cm, avg. fruit weight (g) and yield per plot (kg).On the other hand cluster I, comprised 5 genotype, cluster III comprised genotypes1 and cluster IV cluster comprised 3genotype. The inter cluster distance was maximum between cluster II and IV. Cluster I, II, III and IV was characterized by high mean value for vine length and low mean values for yield per vine (kg). The highest contribution in manifestation of genetic divergence was exhibited by Sex Ratio (M: F), Yield per Plot (kg), Fruit Length (cm), Yield (t/ha), Fruit Diameter (cm) and Yield per Vine (kg).

Introduction

Cucumber (*Cucumis sativus* L.*)* is an important vegetable crop of India cultivated throughout the country. It belongs to the family Cucurbitaceous, which has 120 genera and more than 800 species and is distinct from other *Cucumis* species, as it has seven pairs of chromosomes (2n=2x=14), whereas most of the other *Cucumis* species have 12 pairs of chromosomes, or multiple of 12 (i.e., 2n=2x=24, 2n=4x=48, etc.) (Deakin *et al.*, 1971).Cucumber is believed to be native to India or Southern Asia, and has been apparently cultivated for the last 3000 years (De Candolle, 1886). The fruit of cucumber is said to have cooling effect, prevents constipation and useful in Jaundice and indigestion. The fruits are eaten with salt and pepper or as an ingredient of salad, pickles and rayata. The fruits are used as an astringent and antipyretic. The seed oil also has antipyretic property. Production of cucumber in India is 11, 42,000 tones from an area of 78,000 hectares (NHB, 2017-18). The nutritive value per 100 g edible portion of cucumber is, moisture 96.3 g, protein0.4 g, fat 0.1g, fibre0.4g, carbohydrates 2.5 g, energy 13kcal, calcium 10 mg, phosphorus 25 mg, iron 1.5 mg, thiamine 0.03 mg, niacin 0.2 mg and vitamin C 7 mg (Fagaria *et al.,* 2012).

The scope of improvement of any crop depends upon the magnitude of genetic variability present in the available germplasm. Greater the variability in the available germplasm, better would be the chances of selecting superior genotypes (Simmonds, 1962). In cucumber too, fruits vary in shape, size, colour, maturity and taste. Genetic variability in breeding genotypes is important for successful introgression of desired traits specific genes. The genotypic and phenotypic coefficients of variability are helpful in exploring the nature of variability in the breeding populations. Determining variability in quality and quantitative traits of different cucumber genotypes will enable a breeder to know to what extent the environment affects the yield of the crop (Ahmed and Khaliq, 2007; Ullah *et al.,* 2012). The genetic variability among cucumber genotypes have been studied (Veena *et al.,* 2012; Yadav *et al.,* 2012; Kumar *et al.,* 2013 and Ranjan *et al.,* 2015; Pandey *et al.,* 2013).

While selecting for yield, one should take into account the improvement of yield contributing traits, provided that the association of such traits with yield is known. Moreover, correlation and path coefficient analysis have been of immense help in selecting suitable plant type. So, in order to identify the desirable genotypes, there is an urgent need to assess the existing variability for higher yield and quality under specific conditions. Hence, the present investigation was chosen to evaluate the genotypes for better parent for hybridization programme.

Correlation coefficient empowers a breeder to know the degree of association between the independent and dependent variable fruits. Path coefficient analysis measures direct influence of one variable upon another and permits separation of correlation coefficient in component direct and indirect effect, which can be used for crop improvement through selection of component traits Kumar *et al.,* (2018).

Assessment of genetic diversity could be suitable in crop breeding for diverse applications such as identifying diverse parental genotypes. Genetic diversity is the amount of heritable variability between varieties or populations of organisms. Variability occurs from differences in DNA sequences, biochemical characteristics like protein structure or is enzyme properties, physiological properties like growth rate and morphological characters. Substantial effort

has been directed towards collecting, preserving and evaluating genetic variability in crops (Golabadi *et al.*, 2012).

Materials and Methods

The present study was conducted under Prayagraj agro-climatic conditions, on genetic variability, heritability, correlation, path coefficient analysis and genetic divergence in cucumber during 2019-2020 at the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Science and Technology, Prayagraj, The experiment was carried out with 16 genotypes procured from Local market of Prayagraj.

The experiment was laid out in randomized block design with three replication. The sowing was done on raised bed method with spacing of 1.0 m and 1.5m, plant to plant and row to row, respectively, each plot with 6 plants. For the analysis of this experiment observations recorded on growth, yield attributes of cucumber.

Results and Discussion

Analysis of variance

The analysis of variance for different characters is presented in table 1. The mean sum of squares due to genotypes showed significant differences for all characters at 1% level and 5% level of significance, indicating the presence of substantial amount of genetic variability among the cucumber genotypes.

Mean performance

Through this study an attempt was made to assess the mean performance and extent of variability in sixteen genotypes of cucumber. Table 2 depicts the mean performance of sixteen genotypes of cucumber for seventeen growth and yield characters. The highest fruit yield per vine (3.49kg), fruit yield per plot (15.24kg) and fruit yield (51.17t/ha) for Swarn Agati and the lowest fruit yield per vine (kg) (192.18), fruit yield per plot (kg) (3.79) and fruit yield (t/ha) (192.18) was observed in var. Heena.

Table.1 Analysis of variance (mean squares) for seventeen characters in cucumber

Source of Variations	Replication (df= 2)	Treatments (due to 15)	Error = 30
Germination %	1.473	175.324 ***	2.468
Vine Length (cm)	0.146	1645.839 ***	11.679
No. of Secondary Branches	1.186 *	29.027 ***	0.342
Days to 1st Male Flower Appearance	1.379	13.881 ***	0.821
Node Number to 1st Male Flower	0.024	1.894 ***	0.083
Days to 1st Female Flower Appearance	4.576 *	20.115 ***	1.05
Number to 1st Female Flower	0.126	3.878 ***	0.294
Days to 50% flowering	0.037	23.038 ***	1.771
Days Taken to 1st harvest	1.134	30.416 ***	1.315
Sex Ratio (M: F)	0.014	0.856 ***	0.007
Fruit Length (cm)	1.65	41.749 ***	1.108
Fruit Diameter (cm)	0.373	6.612 ***	0.323
No. of Fruits per Vine	1.165	47.710 ***	0.962
Avg. Fruit Weight (g)	7.855	1248.731 ***	16.583
Yield per Vine (kg)	0.029	1.987 ***	0.011
Yield per Plot (kg)	0.597	29.264 ***	0.311
Yield (t/ha)	1.247	147.881 ***	3.88

Table.2 Estimates of range, grand mean, phenotypic, genotypic, environmental, coefficients of variation, heritability in broad (h2bs) sense and genetic advance in per cent of mean GA for seventeen characters in cucumber genotypes

Genetic parameters	Germination %	Vine Length (cm)	No. of Secondary Branches	Days to 1st Male Flower Appearance	Node Number to 1st Male Flower	Days to 1st Female Flower Appearance	Number to 1st Female Flower	Days to 50% flowering	Days Taken to 1st harvest	Sex Ratio (M: F)
GCV	10.258	14.507	24.961	5.733	20.092	5.770	17.725	5.695	5.796	15.584
PCV	10.476	14.661	25.404	6.250	21.421	6.229	19.788	6.367	6.176	15.770
h² (Broad Sense)	95.900	97.900	96.500	84.100	88.000	85.800	80.200	80.000	88.100	97.700
Genetic Advancement 5%	15.312	47.572	6.259	3.942	1.501	4.811	2.017	4.906	6.021	1.083
Gen.Adv as % of Mean 5%	20.694	29.569	50.525	10.833	38.821	11.011	32.706	10.495	11.204	31.724

Table.3 Estimates of phenotypic, genotypic coefficients of variation, heritability in broad (h2bs) sense and genetic advance in per cent of mean GA for seventeen characters in cucumber genotypes

Genetic parameters	Fruit Length (cm)	Fruit Diameter (cm)	No. of Fruits per Vine	Avg. Fruit Weight (g)	Yield per Vine (kg)	Yield per Plot (kg)	Yield (t/ha)
GCV	20.392	26.142	25.761	15.560	42.791	32.554	17.793
PCV	21.210	28.082	26.545	15.871	43.156	33.074	18.498
h² (Broad Sense)	92.400	86.700	94.200	96.100	98.300	96.900	92.500
Genetic Advancement 5%	7.290	2.777	7.892	40.930	1.658	6.299	13.728
Gen.Adv as % of Mean 5%	40.388	50.132	51.501	31.425	87.405	66.007	35.256

Table.4 Estimates of genotypic and phenotypic correlation coefficient between seventeen characters in cucumber genotypes

Characters		Germination %	Vine Length (cm)	No. of Secondary Branches	Days to 1st Male Flower Appearance	Node Number to 1st Male Flower	Days to 1st Female Flower Appearance	Number to 1st Female Flower	Days to 50% flowering	Days Taken to 1st harvest	Sex Ratio (M: F)	Fruit Length (cm)	Fruit Diameter (cm)	No. of Fruits per Vine	Avg. Fruit Weight (g)	Yield per Vine (kg)	Yield per Plot (kg)	Yield (t/ha)
Germination %	G	1.00	0.9699 ***	0.9579 ***	-0.7453 ***	-0.7728 ***	-0.7875 ***	-0.7331 ***	-0.7637 ***	-0.8060 ***	-0.9254 ***	0.8869 ***	0.8842 ***	0.9214 ***	0.9554 ***	0.9382 ***	0.9548 ***	0.943 **
	P	1.00	0.9706 ***	0.9558 ***	-0.7856 ***	-0.7969 ***	-0.7893 ***	-0.7578 ***	-0.7948 ***	-0.8167 ***	-0.9246 ***	0.8989 ***	0.8767 ***	0.9244 ***	0.9545 ***	0.9208 ***	0.9552 ***	0.943 **
Vine Length (cm)	G		1.00	0.9529 ***	-0.7667 ***	-0.7943 ***	-0.8037 ***	-0.7725 ***	-0.7561 ***	-0.8145 ***	-0.9160 ***	0.8973 ***	0.8929 ***	0.9023 ***	0.9771 ***	0.9309 ***	0.9542 ***	0.929 **
	P		1.00	0.9534 ***	-0.8108 ***	-0.8156 ***	-0.8150 ***	-0.7874 ***	-0.7921 ***	-0.8209 ***	-0.9056 ***	0.9120 ***	0.8886 ***	0.9212 ***	0.9773 ***	0.9259 ***	0.9522 ***	0.932 **
No. of Secondary Branches	G			1.00	-0.7363 ***	-0.7800 ***	-0.8181 ***	-0.7665 ***	-0.7458 ***	-0.7852 ***	-0.8985 ***	0.9075 ***	0.9074 ***	0.9193 ***	0.9641 ***	0.9601 ***	0.9629 ***	0.934 **
	P			1.00	-0.7881 ***	-0.8036 ***	-0.8114 ***	-0.7739 ***	-0.7788 ***	-0.7945 ***	-0.8931 ***	0.9191 ***	0.8963 ***	0.9258 ***	0.9625 ***	0.9445 ***	0.9567 ***	0.931 **
Days to 1st Male Flower Appearance	G				1.00	0.9093 ***	0.8794 ***	0.8364 ***	0.8767 ***	0.8992 ***	0.7044 ***	-0.7842 ***	-0.7283 ***	-0.8384 ***	-0.7735 ***	-0.8122 ***	-0.7703 ***	-0.796 **
	P				1.00	0.9235 ***	0.8915 ***	0.8581 ***	0.8862 ***	0.9092 ***	0.7241 ***	-0.8242 ***	-0.7862 ***	-0.8533 ***	-0.8070 ***	-0.8324 ***	-0.7837 ***	-0.807 **
Node Number to 1st Male Flower	G					1.00	0.8732 ***	0.8359 ***	0.8716 ***	0.9027 ***	0.7021 ***	-0.8074 ***	-0.7774 ***	-0.7995 ***	-0.7952 ***	-0.8265 ***	-0.8013 ***	-0.809 **
	P					1.00	0.8877 ***	0.8698 ***	0.8904 ***	0.9058 ***	0.7045 ***	-0.8363 ***	-0.8023 ***	-0.8131 ***	-0.7995 ***	-0.8310 ***	-0.8034 ***	-0.805 **
Days to 1st Female Flower Appearance	G						1.00	0.8630 ***	0.8609 ***	0.9424 ***	0.7653 ***	-0.8190 ***	-0.8116 ***	-0.8232 ***	-0.8311 ***	-0.8454 ***	-0.8118 ***	-0.816 **
	P						1.00	0.8797 ***	0.8620 ***	0.9212 ***	0.7310 ***	-0.8358 ***	-0.8294 ***	-0.8287 ***	-0.8150 ***	-0.8278 ***	-0.7880 ***	-0.800 **
Number to 1st Female Flower	G							1.00	0.7555 ***	0.8949 ***	0.6824 ***	-0.7792 ***	-0.7829 ***	-0.7573 ***	-0.7715 ***	-0.7813 ***	-0.7508 ***	-0.767 **
	P							1.00	0.8123 ***	0.9012 ***	0.6757 ***	-0.7994 ***	-0.7989 ***	-0.7772 ***	-0.7617 ***	-0.7711 ***	-0.7510 ***	-0.755 **
Days to 50%	G								1.00	0.8729	0.7183	-0.7571	-0.7847	-0.8167	-0.7742	-0.7938	-0.7584	-0.781

flowering										***	***	***	***	***	***	***	***	**
	P								1.00	0.8991 ***	0.7221 ***	-0.8101 ***	-0.8313 ***	-0.8452 ***	-0.7879 ***	-0.8202 ***	-0.7847 ***	-0.797 **
Days Taken to 1st harvest	G									1.00	0.7424 ***	-0.8411 ***	-0.8040 ***	-0.8186 ***	-0.8309 ***	-0.8336 ***	-0.8075 ***	-0.833 **
	P									1.00	0.7442 ***	-0.8444 ***	-0.8455 ***	-0.8335 ***	-0.8163 ***	-0.8351 ***	-0.7982 ***	-0.829 **
Sex Ratio (M: F)	G										1.00	-0.7858 ***	-0.7830 ***	-0.8678 ***	-0.8920 ***	-0.8572 ***	-0.8855 ***	-0.881 **
	P										1.00	-0.7796 ***	-0.7698 ***	-0.8707 ***	-0.8787 ***	-0.8380 ***	-0.8886 ***	-0.875 **
Fruit Length (cm)	G											1.00	0.9173 ***	0.9250 ***	0.9126 ***	0.9456 ***	0.9081 ***	0.875 **
	P											1.00	0.9199 ***	0.9271 ***	0.9227 ***	0.9421 ***	0.9090 ***	0.889 **
Fruit Diameter (cm)	G												1.00	0.8880 ***	0.9047 ***	0.9220 ***	0.8973 ***	0.853 **
	P												1.00	0.9046 ***	0.9011 ***	0.9241 ***	0.8842 ***	0.862 **
No. of Fruits per Vine	G													1.00	0.9003 ***	0.9732 ***	0.9270 ***	0.884 **
	P													1.00	0.9144 ***	0.9666 ***	0.9355 ***	0.899 **
Avg. Fruit Weight (g)	G														1.00	0.9390 ***	0.9504 ***	0.940 **
	P														1.00	0.9383 ***	0.9493 ***	0.944 **
Yield per Vine (kg)	G															1.00	0.9663 ***	0.917 **
	P															1.00	0.9566 ***	0.926 **
Yield per Plot (kg)	G																1.00	0.950 **
	P																1.00	0.956 **

Table.5 Direct and indirect effects of seventeen characters on yield at genotypic and phenotypic level in cucumber genotypes

Characters		Germination %	Vine Length (cm)	No. of Secondary Branches	Days to 1st Male Flower Appearance	Node Number to 1st Male Flower	Days to 1st Female Flower Appearance	Number to 1st Female Flower	Days to 50% flowering	Days Taken to 1st harvest	Sex Ratio (M: F)	Fruit Length (cm)	Fruit Diameter (cm)	No. of Fruits per Vine	Avg. Fruit Weight (g)	Yield per Vine (kg)	Yield per Plot (kg)	Yield (t/ha)
Germination %	G	**0.54**	0.53	0.52	-0.40	-0.42	-0.43	-0.40	-0.41	-0.44	-0.50	0.48	0.48	0.50	0.52	0.51	0.52	0.943**
	P	**0.36**	0.34	0.34	-0.28	-0.28	-0.28	-0.27	-0.28	-0.29	-0.33	0.43	0.43	0.42	0.43	0.43	0.43	0.943**
Vine Length (cm)	G	-0.57	**-0.59**	-0.56	0.45	0.47	0.47	0.45	0.44	0.48	0.54	-0.53	-0.52	-0.53	-0.57	-0.55	-0.56	0.929**
	P	-0.34	**-0.35**	-0.34	0.29	0.29	0.29	0.28	0.28	0.29	0.32	0.31	0.31	0.31	0.32	0.31	0.32	0.932**
No. of Secondary Branches	G	0.17	0.17	**0.17**	-0.13	-0.14	-0.14	-0.13	-0.13	-0.14	-0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.934**
	P	-0.09	-0.09	**-0.09**	0.07	0.08	0.08	0.07	0.07	0.07	0.08	-0.08	-0.08	-0.07	-0.08	-0.08	-0.08	0.931**
Days to 1st Male Flower Appearance	G	0.26	0.27	0.26	**-0.35**	-0.32	-0.31	-0.30	-0.31	-0.32	-0.25	0.28	0.26	0.30	0.27	0.29	0.27	-0.796**
	P	0.15	0.16	0.15	**-0.19**	-0.18	-0.17	-0.16	-0.17	-0.17	-0.14	-0.12	-0.13	-0.12	-0.12	-0.12	-0.12	-0.807**
Node Number to 1st Male Flower	G	-0.08	-0.08	-0.08	0.09	**0.10**	0.09	0.09	0.09	0.09	0.07	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.809**
	P	-0.11	-0.11	-0.11	0.13	**0.14**	0.12	0.12	0.13	0.13	0.10	-0.50	-0.60	-0.45	-0.48	-0.47	-0.47	-0.805**
Days to 1st Female Flower Appearance	G	-0.14	-0.14	-0.14	0.15	0.15	**0.17**	0.15	0.15	0.16	0.13	-0.14	-0.14	-0.14	-0.14	-0.15	-0.14	-0.816**
	P	-0.01	-0.01	-0.01	0.01	0.01	**0.01**	0.01	0.01	0.01	0.01	0.21	0.22	0.20	0.20	0.20	0.20	-0.800**
Number to 1st Female Flower	G	0.04	0.04	0.04	-0.04	-0.04	-0.04	**-0.05**	-0.04	-0.04	-0.03	0.04	0.04	0.04	0.04	0.04	0.04	-0.767**
	P	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	-0.59	-0.61	-0.57	-0.55	-0.54	-0.55	-0.755**
Days to 50% flowering	G	0.06	0.06	0.06	-0.07	-0.07	-0.07	-0.06	**-0.08**	-0.07	-0.05	0.06	0.06	0.06	0.06	0.06	0.06	-0.781**
	P	0.05	0.05	0.05	-0.05	-0.05	-0.05	-0.05	**-0.06**	-0.05	-0.04	0.50	0.51	0.49	0.47	0.47	0.47	-0.797**
Days Taken to 1st harvest	G	0.03	0.04	0.03	-0.04	-0.04	-0.04	-0.04	-0.04	**-0.04**	-0.03	0.04	0.03	0.04	0.04	0.04	0.03	-0.833**
	P	0.09	0.09	0.09	-0.10	-0.10	-0.10	-0.10	-0.10	**-0.11**	-0.08	0.64	0.65	0.61	0.60	0.59	0.60	-0.829**
Sex Ratio (M: F)	G	0.16	0.16	0.15	-0.12	-0.12	-0.13	-0.12	-0.12	-0.13	**-0.17**	0.14	0.13	0.15	0.15	0.15	0.15	-0.881**
	P	0.08	0.08	0.08	-0.06	-0.06	-0.06	-0.06	-0.06	-0.07	**-0.09**	-0.89	-0.89	-0.91	-0.93	-0.90	-0.92	-0.875**
Fruit Length (cm)	G	0.15	0.15	0.16	-0.13	-0.14	-0.14	-0.13	-0.13	-0.14	-0.14	**0.17**	0.16	0.16	0.16	0.16	0.16	0.875**
	P	0.05	0.05	0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	**-0.60**	-0.59	-0.57	-0.58	-0.59	-0.58	0.889**
Fruit Diameter (cm)	G	-0.05	-0.05	-0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	-0.05	**-0.05**	-0.05	-0.05	-0.05	-0.05	0.853**
	P	-0.05	-0.05	-0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.34	**0.34**	0.33	0.34	0.34	0.33	0.862**
No. of Fruits per Vine	G	-0.51	-0.49	-0.50	0.46	0.44	0.45	0.42	0.45	0.45	0.48	-0.51	-0.49	**-0.55**	-0.49	-0.53	-0.51	0.884**
	P	-0.37	-0.37	-0.37	0.34	0.33	0.33	0.31	0.34	0.33	0.35	-0.10	-0.10	**-0.10**	-0.09	-0.10	-0.10	0.899**
Avg. Fruit Weight (g)	G	0.28	0.29	0.29	-0.23	-0.24	-0.25	-0.23	-0.23	-0.25	-0.26	0.27	0.27	0.27	**0.30**	0.28	0.28	0.940**
	P	0.36	0.37	0.37	-0.31	-0.30	-0.31	-0.29	-0.30	-0.31	-0.33	0.57	0.57	0.55	**0.58**	0.57	0.57	0.944**
Yield per Vine (kg)	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.917**
	P	0.21	0.21	0.21	-0.19	-0.19	-0.19	-0.17	-0.18	-0.19	-0.19	-0.33	-0.33	-0.33	-0.33	**-0.34**	-0.33	0.926**
Yield per Plot (kg)	G	0.58	0.58	0.58	-0.47	-0.49	-0.49	-0.46	-0.46	-0.49	-0.54	0.55	0.54	0.56	0.58	0.59	**0.61**	0.950**
	P	0.59	0.59	0.59	-0.48	-0.49	-0.49	-0.46	-0.48	-0.49	-0.55	1.18	1.16	1.15	1.18	1.18	**1.20**	0.956**
Partial R2	G	0.51	-0.54	0.16	0.28	-0.08	-0.14	0.04	0.06	0.04	0.15	0.15	-0.05	-0.48	0.28	0.00	0.58	
	P	0.33	-0.33	-0.09	0.15	-0.11	-0.01	0.00	0.05	0.09	0.08	-0.58	0.33	-0.09	0.56	-0.33	1.17	

Table.6 Clustering pattern of 16 genotypes on the basis of Mahalanobis D^2statistics

Cluster number	No. of genotypes	Genotypes
I	5	Maharaja, CCH-1, SL-40, Prasad-100 and Super Kheera 40
II	7	Moti, Super green,Rani, Barsati No. 12, Farmer variety, Kohinoor and Local variety
III	1	SwarnAgati
IV	3	F-999, Sun –L Heena

Table.7 Average of intra- and inter- clusters D^2 values for five clusters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Cluster 1	41.5	250.05	142.91	986.25
Cluster 2	250.05	68.92	666.2	358.82
Cluster 3	142.91	666.2	0	1745.4
Cluster 4	986.25	358.82	1745.4	98.99

Table.8 Intra-cluster group means for seventeen parameters in cucumber

	Germination %	Vine Length (cm)	No. of Secondary Branches	Days to 1st Male Flower Appearance	Node Number to 1st Male Flower	Days to 1st Female Flower Appearance	Node Number to 1st Female Flower	Days to 50% flowering	Days Taken to 1st harvest	Sex Ratio (M: F)	Fruit Length (cm)
Cluster 1	80.05	181.34	15.15	34.64	3.26	41.53	5.18	44.44	51.08	3.07	21.73
Cluster 2	73.26	157.1	11.71	37.28	4.21	44.77	6.64	47.91	55.07	3.37	16.33
Cluster 3	85.58	191.17	17.1	32.67	2.29	39.33	4.56	42.08	48.38	2.69	24.11
Cluster 4	61.76	125.52	7.78	38.5	4.6	46.22	7.22	49.46	56.86	4.33	13.91

Table.9 Intra-cluster group means for seventeen parameters in cucumber

	Fruit Diameter (cm)	No. of Fruits per Vine	Avg. Fruit Weight (g)	Yield per Vine (kg)	Yield per Plot (kg)	Yield (t/ha)
Cluster 1	6.98	18.69	148.64	2.64	12.02	44.54
Cluster 2	4.89	14.01	126.11	1.57	8.96	37.77
Cluster 3	7.76	22.98	157.79	3.49	15.24	51.17
Cluster 4	3.89	10.23	100.07	0.9	4.86	28.25

Table.10 Per cent contribution in seventeen characters towards total genetic divergence in cucumber

S. No.	Source	Contribution %	Times ranked 1st
1	**Germination %**	0	0.00
2	**Vine Length (cm)**	1.67	2.00
3	**No. of Secondary Branches**	0	0.00
4	**Days to 1st Male Flower Appearance**	0	0.00
5	**Node Number to 1st Male Flower**	0	0.00
6	**Days to 1st Female Flower Appearance**	1.67	2.00
7	**Node Number to 1st Female Flower**	0	0.00
8	**Days to 50% flowering**	0	0.00
9	**Days Taken to 1st harvest**	5	6.02
10	**Sex Ratio (M: F)**	20	24.10
11	**Fruit Length (cm)**	15	18.07
12	**Fruit Diameter (cm)**	10	12.05
13	**No. of Fruits per Vine**	0	0.00
14	**Avg. Fruit Weight (g)**	5.83	7.02
15	**Yield per Vine (kg)**	8.33	10.04
16	**Yield per Plot (kg)**	20	24.10
17	**Yield (t/ha)**	12.5	15.06

Genetic variability, GCV, PCV, heritability, genetic advance and genetic advance as percent of mean

The simple measure of variability like mean, phenotypic and genotypic coefficients of variation (PCV and GCV), heritability in broad sense genetic advance and genetic advance as percent of mean is presented in Table 3. Higher magnitude of genotypic coefficient of variance GCV and phenotypic coefficient of variance was recorded for node number to 1st male flower (20.092 & 21.421), fruit length (cm) (20.392 & 21.210), fruit diameter (cm)(26.142 & 28.082), no. of fruits per vine (25.761 & 26.545), yield per vine (kg) (42.791 & 43.156) and yield per plot (kg) (32.554 & 33.07). The heritability estimate were found to be high (>60) for almost all the characters *viz.*, germination % (95.900),vine length (cm) (97.900), no. of secondary branches(96.500), days to 1st male flower appearance (84.100), node number to 1st male flower (88.000), days to 1st female flower appearance(85.800), number to 1st female flower (80.200), days to 50% flowering (80.000), days taken to 1st harvest (88.100), sex ratio (m: f) (97.700), fruit length (cm) (92.400), fruit diameter (cm) (86.700), no. of fruits per vine(94.200), avg. fruit weight (g) (96.100), yield per vine (kg) (98.300),yield per plot (kg) (96.900) and yield (t/ha) (92.500). The highest Genetic advance was recorded for characters like Vine Length (cm) (47.572) and Avg. Fruit Weight (g) (40.930). The genetic advance as per cent of mean was highest for germination %(20.694),vine length (cm) (29.569), no. of secondary branches (50.525), node number to 1st male flower (38.821), number to 1st female flower (32.706), sex ratio (m: f)(31.724), fruit length (cm) (40.388), fruit diameter (cm) (50.132), no. of fruits per vine(51.501), avg. fruit weight (g) (31.425), yield per vine (kg) (87.405), yield per plot (kg) (66.007) and yield (t/ha) (35.256).

Genotypic and phenotypic correlation coefficient analysis

In the present investigation the genotypic and phenotypic correlation coefficient of different characters with fruit yield (t ha-1) and their relationship among themselves are presented in table 4. Genotypic correlation coefficient analysis revealed that yield (t/ha) showed positive significant association with Germination % (0.943**) Vine Length (cm) (0.929**), No. of Secondary Branches (0.934**), Fruit Length (cm) (0.875**), Fruit Diameter (cm) (0.853**), No. of Fruits per Vine (0.884**), Avg. Fruit Weight (g) (0.940**), Yield per Vine (kg) (0.917**) and Yield per Plot (kg) (0.950**) where as the phenotypic correlation coefficient analysis revealed that Yield (t/ha) showed positive significant association with Germination % (0.943**), Vine Length (cm) (0.932**), No. of Secondary Branches (0.931**), Fruit Length (cm) (0.889**), Fruit Diameter (cm) (0.862**), No. of Fruits per Vine (0.899**), Avg. Fruit Weight (g) (0.944**), Yield per Vine (kg) (0.926**) and Yield per Plot (kg) (0.956**).

Genotypic and phenotypic path coefficient analysis

The genotypic and phenotypic path coefficient among the different fruit yield (t ha-1) traits in cucumber was worked out to assess the association among themselves. Perusal of Table-5. Genotypic path coefficient analysis revealed that the direct positive effect on fruit yield (t ha-1) was exhibited by germination %(0.54), no. of secondary branches (0.17), node number to 1st male flower (0.10), days to 1st female flower appearance (0.17), fruit length (cm)(0.17), avg. fruit weight (g) (0.30), yield per vine (kg) (0.00) and yield per plot (kg)(0.61). where as the phenotypic path coefficient analysis revealed that the direct positive effect

on fruit yield (t ha-1) was exhibited by germination % (0.36), node number to 1st male flower (0.14), days to 1st female flower appearance (0.1), number to 1st female flower (0.000), fruit diameter (cm(0.34), avg. fruit weight (g) (0.58) and yield per plot (kg)(1.20).

Genetic diversity (D2) analysis

Clustering pattern of eighteen genotype of cucumber were grouped into clusters following Mohalanobis D^2 analysis (Table 6) Clustering pattern indicated that cluster II is largest cluster comprising 7 out of sixteen genotype. On the other hand cluster I, comprised 5 genotype, cluster III comprised genotypes1 and cluster IV cluster comprised 3 genotype. The pattern of group constellation proved the existence of significant amount of variability. The distribution of genotypes also indicated that the genotypes originated from different states were grouped into same cluster and genotypes of same states into different clusters. The inter and intra average distances among five clusters were computed and have been given in the Table.7. The inter cluster distance was maximum between cluster II and IV (1745.4) followed by cluster I and Cluster IV (986.25), Cluster II and cluster III (666.2), cluster I and II (250.05), Cluster I and III (142.91). A comparison of the mean value of seventeen characters of different clusters has been presented in Table (7). Considerable differences in cluster mean values were evident for all the characters. Cluster I, II, III and IV was characterized by high mean value for vine length and low mean values for yield per vine (kg). The percent contribution of sixteen characters towards total genetic divergence is listed in Table.9. The selection and choice of parents mainly depends upon contribution of characters towards divergence. In the present investigation the highest contribution in manifestation of genetic divergence was exhibited by Sex Ratio (M: F) (20), Yield (t/ha) (12.5), Fruit Length (cm) (15),Fruit Diameter (cm) (10), Avg. Fruit Weight (g) (5.83), Yield per Vine (kg) (8.33), Yield per Plot (kg) (20), Days to 1st Female Flower Appearance (1.67) and Vine Length (cm)(1.67). In other words, selection for these characters may be rewarding.

From the present study it is concluded that cucumber genotypes under investigation showed significant genetic variability. Based on mean performance for fruit yield per plant (3.49kg), fruit yield per plot (15.24kg) and fruit yield (51.17t ha-1) was found in Swarn Agati genotypes were considered suitable genotypes in Prayagraj climatic condition.

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How to cite this article:

Yogesh Kumar, Samir Ebson Topno and Vijay Bahadur. 2021. Study on Genetic Variability, Heritability and Genetic Divergence for Character Association in Cucumber (*Cucumis sativus* L.*)* under Prayagraj Agro – Climatic Conditions. *Int.J.Curr.Microbiol.App.Sci.* 10(01): 3239-3248. doi: https://doi.org/10.20546/ijcmas.2021.1001.377