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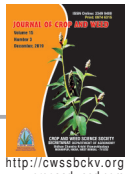

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Characterization and variability analysis in pointed gourd (*Thichosanthes dioica* Roxb.)

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ABSTRACT

To study the morphological characteristics and variability component of 31 genotypes of pointed gourd, an experiment was undertaken with randomized block design with three replications. Results revealed that there was a significant variation among the different genotypes for morphological as well as yield and quality characters. Highest range of deviation was found foraverage number of fruits per plant (56.15-219.75) followed by average fruit weight (19.12-38.04 g). Highest phenotypic coefficient of variation and genotypic coefficient of variation was observed for yield per plant (41.24 and 40.82, respectively) followed by fruits per plant (31.66 and 31.07, respectively). The high heritability was recorded for node number at which first female flower appears(99.33 %). High heritability alongwith high genetic advance as percentage of mean was found for different yield, quality and yield contributing attributes. However selection may be forwarded based on the yield per plant,fruits per plant and seeds per fruit.

***Keywords*:** Pointed gourd, characterization, variability, GCV, PCV, heritability

Pointed gourd (2n=2x=22) is a dioecious, perennial, nutritious, remunerative vegetable belongs to the family Cucurbitaceae. The total cultivated land in India is about 20000 ha with the production of 325000 MT per annum (Anon., 2019). In West Bengal it is grown in almost all the districts at different undocumented corners of villages having different yield contributing genotypes not properly documented. In West Bengal, pointed gourd performs well and is grown commercially with high economical return. It is known as king of gourds being rich source of different nutrients and vitamins compared to other cucurbitaceous vegetables.The roots have a notable purgative effect where green fruits and succulent shoots (used in soup) have good laxative property (Rahman *et al.*, 2008). Khatua *et al.* (2016) also described that the leaves are used in treatment of edema, baldness, fever, heart and also have laxative property. Dora *et al.* (2001) and Ram (2001) reported a huge variability among the different genotypes in respect to quantity and quality attributes in India. The utilization of this variation builds base materials for hybridization programs for its desirable improvement and subsequent selection of existing clones.Very few improved cultivars have been developed from local collection for commercial cultivation. Swarna Rekha and Swarna Alaukik are two well reputed varieties with sustainable yield in different agroclimatic situation for large scale commercial cultivation (Prasad *et al.,* 1999). As per description of Singh and Whitehead (1999) as a cross pollinated crop the most effective method to develop improved cultivars is selection of promising genotypes from existing diverse genotypes of pointed gourd. Dioecious sex form of pointed gourd leads to complete cross-pollination and shown remarkable heterozygosity (Kumar *et al.,* 2008). Identification of a genotype with desirable characters from existing germplasm may form the basis of raw materials for development of new cultivars. Once superior genotypes with desirable features are characterized they can easily be multiplied by vegetative propagation. Genotypic and phenotypic analysis of yield and its attributes along with quality traits provide a base material with strong basis for future improvement. Knowledge on genetic variability that is present in the existing germplasm helps to select an ideal parent for improvement of genotypes in a breeding programme. In the northern parts of Bengal and Assam huge variation was observed in pointed gourd germplasm. This region is considered as the primary centre of diversity of this crop (Singh *et al*., 1992). Though India is considered as a centre of origin of pointed gourd but there is a lack of information about the existing clones and a very few location specific improved varieties or accession for commercial cultivation at farmers level. In *Terai* region of West Bengal pointed gourd is cultivated without any documented information though the natural resources are favorable. However, insufficient information is available about characterization and variability present in existing germplasm in the *Terai* zone of West Bengal. So, the present research programme was carried out to

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study the different morphological, yield and quality characters and variability in the collected germplasm for development of suitable selection indices for future crop improvement programmes.

MATERIALS AND METHODS

The experiment was carried out during two consecutive years of 2019-20 and 2020-21 in randomized block design with three replications. The experimental location is situated at Instructional Field of the Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar (26º 40′ N latitude and 89 º 38′ E longitude, 43 m above MSL). In this experiment thirty genotypes and one named variety (Rajendra Parwal-1) were evaluated to study different characters (Table 1). The experimental site is an upland condition. The soil is sandy loam with pH 5.8, organic carbon 0.96%, available nitrogen 128.49 kg ha^{-1}, available phosphorus 47.28 kg ha^{-1} and available potassium 63.41 kg ha^{-1}. Well rooted vine cuttings were planted during the month of November-December with spacing 5 meter row to row and 2 meter for plant to plant distance. Recommended dose of fertilizer was applied as FYM @25 t $ha^{-1}$and N, P_2O_5 and K_2O at the ratio of 90: 60: 60 kg ha^{-1}, respectively. Full dose of phosphorus and one third of both nitrogen and potassium was supplied as basal. Remaining amount of nitrogen and potassium was applied as two split doses at 45 and 90 days after planting the rooted cutting. Observation on different morphological and yield contributing characters was taken for ten numbers of frequencies from each replication. Characterization was done following the Distinctness, Uniformity and Stability (DUS) test guidelines of pointed gourd developed by protection of plant varieties and farmers' rights authority, Government of India. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was analyzed according to the formula given by Burton (1952). The heritability (broad scene) was analyzed according to the formula given by Jhonson *et al.* (1955). By using the Allard (1960) formula genetic advance for different characters were estimated.

RESULTS AND DISCUSSION

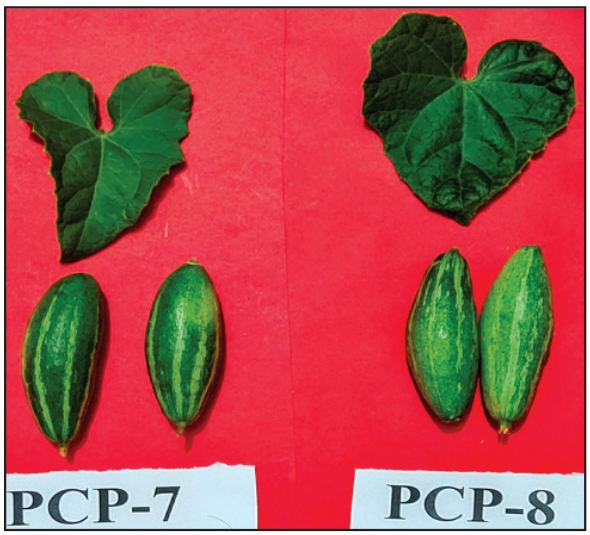
a. Characterization of pointed gourd genotypes

1. Stem and leaf characters

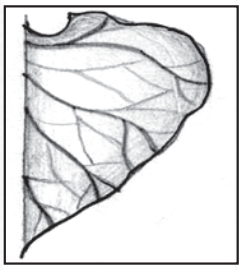
A huge range of differences was found in the germplasm under study for stem and leaf characters (Table 2). Stem pubescence nature of 30 genotypes were categorized in two types, sparse and dense and majority of the genotypes (74.19 %) had sparse type pubescence. In case of stem shape only four genotypes were found to be of round shape and the remaining were angular. Similar findings related to stem pubescence and stem shape were reported by Sharma (2015). Leaf shape was categorized as cordate and auriculate; 70.96 per cent of the genotypes produced cordate shaped leaf and remaining (29.04 %) were auriculate shaped. Pubescence of leaf was absent for majority of the genotypes though only three (9.68%) recorded leaf pubescence. Sharma (2015) also reported absence of leaf pubescence in different genotypes. Majority of the genotypes (61.29 %) recorded undulated leaf margin and the remaining recorded entire (22.58%) and lobed (16.13 %). Leaf colours of different genotypes were divided into three groups namely light green, dark green and in between light to dark green (green to dark green). Among the 31 genotypes leaf colours of 6, 4 and 21 numbers of genotypes were categorized into light green, dark green and green to dark green, respectively. Pointed leaf was produced by 87.10% of the genotypes, remaining (12.9 %) were of blunt type. This finding related to leaf margin, leaf colour and leaf end nature had a similarity with Ara *et al*. (2012).

2. Fruit characters

Fruit characters of different genotypes under study shown large range of deviation and were categorized as per DUS guidelines (Table 2). Fruit shapes of different genotypes were categorized into seven groups namely, club, cylindrical, oval, spindle, spindle tapering, elongated spindle and spheriod. Maximum frequency (29.90 %) was observed in case of club shaped fruits followed by spindle (25.81 %), spindle tapering (16.13), cylindrical (12.90 %), oval (6.45 %), spheroid (6.45 %), and spindle tapering (3.23 %.). Sixty eight female clones were characterized by Hazra *et al.* (1998) and found four groups of pointed gourd based on fruit shape namely, small-sized fruits, spindle, oval and near cylindrical. Ara *et al*. (2012) also grouped pointed gourd on the basis of their fruit shape and size which gave conformity to the present study. For surface colour of fruits at marketable stage, results revealed that 54.84 % of genotypes exhibit appearance of green colour fruit surface, 25.81% light green and 19.35 % as dark green. A similar trend of fruit surface colour has also been reported by Kumar and Singh (2012). Fruit striped pattern is an important morphological indicator which may play an important role to identify the difference between two or more genotypes. Based on this character all the genotypes under study were divided into three groups namely, uniform, mottled and striped. Striped pattern was found in higher frequency of genotypes (74.20 %) than mottled (19.35%) and uniform (6.45%). Unique genetical identity of the individual genotypes is



Auriculate shape leaf and Cordate shape leaf



Entire margin

Lobed margin

Undulated margin

Table 1: Brief description of the pointed gourd genotypes

Germplasm No.	Local name	Place of collection	Latitude	Longitude
PCP-1	Matiyapotol	Pundibari, Coochbehar, West Bengal	26° 24′ 30.6″ N	89° 22′ 29.2″ E
PCP-2	-	Monipur, Patiram, DakshinDinajpur, West Bengal	25° 18′ 45.8″ N	88° 44′ 51.9″ E
PCP-3	-	Pundibari, Coochbehar, West Bengal	26° 24′ 29.2″ N	89° 22′ 24.6″ E
PCP-4	-	Chak-barham, DakshinDinajpur, West Bengal	25° 23′ 5.3″ N	88° 45′ 11.2″ E
PCP-5	Dheba	Nahit, 2 no. Karanji Gram Panchayat, Kushmundi, Dakshin Dinajpur, West Bengal	25° 32′ 10.1″ N	88° 24′ 29.8″ E
PCP-6	Shampuri	VaktipurHarigram, Kushmundi , DakshinDinajpur, West Bengal	25° 28′ 48.1″ N	88° 17′ 23.6″ E
PCP-7	Hilli	Khagrakuri, Kushmundi , DakshinDinajpur, West Bengal	25° 31′ 31.3″ N	88° 22′ 24.6″ E
PCP-8	Sadapatol	Nahit, 2 no. Karanji Gram Panchayat, Kushmundi, DakshinDinajpur, West Bengal	25° 32′ 9.9″ N	88° 24′ 29.4″ E
PCP-9	-	Angrakata, Pundibari, Coochbehar, West Bengal	26° 24′ 3.5″ N	89° 24′ 5.1″ E
PCP-10	-	Angrakata, Pundibari, Coochbehar, West Bengal	26° 24′ 3.4″ N	89° 24′ 4.5″ E
PCP-11	-	1 km away (south west) from UBKV main gate, Pundibari, Coochbehar, West Bengal	26° 24′ 24.9″ N	89° 22′ 23.0″ E
PCP-12	-	Haringhata, Nadia, West Bengal	22° 55′ 58.2″ N	88° 32′ 12.9″ E
PCP-13		Ramsai, Jalpaiguri, West Bengal	26° 42′ 1.0″ N	88° 51′ 15.5″ E
PCP-14	Singapuri	BaghmaraSukandighi, Mathabhanga, Coochbehar, West Bengal	26° 25′ 4.5″ N	89° 18′ 20.3″ E
PCP-15	-	Hatidhura, Pundibari, Coochbehar, West Bengal	26° 26′ 14.3″ N	89° 25′ 41.8″ E
PCP-16	-	Baramaricha, Sitalkuchi, Coochbehar, West Bengal	26° 8′ 25.2″ N	89° 13′ 26.4″ E
PCP-17	Shampuri	Hatidhura, Pundibari, Coochbehar, West Bengal	26° 26′ 12.6″ N	89° 25′ 39.5″ E
PCP-18		Patakamari, Ghoksadanga, Coochbehar, West Bengal	26° 23′ 39.9″ N	89° 15′ 26.1″ E
PCP-19		Ramsai, Jalpaiguri, West Bengal	26° 41′ 46.8″ N	88° 52′ 2.3″ E
PCP-20	-	MatiarKuthi, Dholongmore, Mathabhanga, Coochbehar, West Bengal	26° 19′ 55.4″ N	89° 15′ 22.9″ E
PCP-21		ChhotoSalbari, Sitalkuchi, Coochbehar, West Bengal	26° 20′ 0.7″ N	89° 15′ 15.2″ E
PCP-22		Pancharhat, Sitalkuchu, Coochbehar, West Bengal	26° 20′ 0.7″ N	89° 15′ 15.2″ E
PCP-23		Sarola, , Kushmundi , DakshinDinajpur, West Bengal	25° 27′ 54.5″ N	88° 17′ 29.3″ E
PCP-24		Sarola, , Kushmundi , DakshinDinajpur, West Bengal	25° 27′ 26.0″ N	88° 19′ 40.2″ E
PCP-25		Sabour, Bihar	25° 14′ 20.1″ N	87° 3′ 25.9″ E
PCP-26		Sabour, Bihar	25° 14′ 15.7″ N	87° 2′ 38.2″ E
PCP-27		Ramsai, Jalpaiguri, West Bengal	26° 42′ 1.3″ N	88° 51′ 18.6″ E
PCP-28	-	Mohanpur, Nadia, West Bengal	22° 55′ 58.2″ N	88° 32′ 12.9″ E
PCP-29		Ramthanga, Gumani, Coochbehar, West Benga	26° 28′ 0.3″ N	89° 13′ 29.1″ E
PCP-30		Sarola, Kushmundi , DakshinDinajpur, West Bengal	25° 28′ 1.9″ N	88° 19′ 40.2″ E
Rajendra Parwal-1		Bihar Agriculture University, Sabour, Bihar	25° 14′ 15.4″ N	87° 3′ 2.6″ E

Table 2: Morphological characterization of pointed gourd germplasms

DUS characters	Types	Notes	Stage of observation (Code)	No. of genotypes	Frequency
Stem pubescence nature	Sparse	3	20	23	74.19
	Dense	7	20	8	25.81
Shape of stem	Round	3	10	4	12.90
	Angular	5	10	27	87.09
Shape of leaf	Auriculate	3	10	9	29.04
	Cordate	5	10	22	70.96
Leaf pubescence nature	Present	-	-	3	9.68
	Absent	-	-	28	90.32
Leaf margin (entire, undulated, serrated or lobed)	Entire	3	10	7	22.58
	Undulated	5	10	19	61.29
	Lobed	7	10	5	16.13
Leaf colour (Light/dark green/green to dark green)	Light green	-	-	6	19.36
	Dark green	-	-	4	12.90
	Green to dark green	-	-	21	67.74
Leaf type (Blunt/Pointed)	Blunt	-	-	4	12.90
	Pointed	-	-	27	87.10
Fruit shape (club shaped, cylindrical, oval, spindle and tapering)	Club	1	30	9	29.03
	Cylindrical	2	30	4	12.90
	Oval	3	30	2	6.45
	Spindle	4	30	8	25.81
	Spindle tappering	8	30	5	16.13
	Elongated spindle	5	30	1	3.23
	Spheriod	7	30	2	6.45
Fruit: skin primary colour (green or dark green)	Light green (138 C)	1	30	8	25.81
	Green (138 A)	2	30	17	54.84
	Dark green (N 137 A)	3	30	6	19.35
Fruit striped pattern (surface colour pattern uniform, mottled or striped)	Uniform	1	30	2	6.45
	Mottled	2	30	6	19.36
	Striped	3	30	23	74.19
Colour of fruit stripe (light green or white)	Light green	-	-	14	45.16
	White	-	-	17	54.84
Fruit glossiness (non-glossy or glossy)	Non-glossy	1	30	**5**	16.13
	Glossy	9	30	**26**	83.87
Fruit curvature (straight/curved)	Straight	-	-	26	83.87
	Curved	-	-	5	16.13
Pericarp hardness of the fruit (soft or hard)	Soft	3	30	24	77.42
	Hard	5	30	**7**	22.58
Flesh color (white, creamy white or any other colour)	White	-	-	23	74.19
	Creamy white	-	-	8	25.81
Blossom end fruit shape (depressed, flatten, round, or pointed)	Depressed	1	30	0	0
	Flatten	3	30	9	29.03
	Round	5	30	8	25.81
	Pointed	7	30	14	45.16
Seediness	Absent	1	40	0	0
	Present	9	40	31	100

responsible for such type of variation. Similar findings were also recorded by Ara *et al*. (2012), Ghosh (2000) and Sharma (2015). Colour of the fruit stripe varies from light green to white and maximum frequency was observed for white colour (54.84%) followed by light green colour (45.16 %). Fruit glossyness is one of the important indices which determined the market value of pointed gourd. The present study recorded that twenty six (83.87%) genotypes had glossy and five (16.13%) had non-glossy fruit surface. This result was supported by findings of Ghosh (2000). Depending upon the fruit curvature 31 genotypes were categorized into two groups straight and curved. Majority of the genotypes (87.10%) produced straight whereas very few (12.90%)

Table 3: Analysis of variability and its components for different attributes of pointed gourd

S.No	Attributes	Mean	Ranges	PV (%)	GV (%)	EV (%)	GCV (%)	PCV (%)	Heritability (%)	Genetic Advance (GA)	Genetic Advance (% of Mean)
1	Leaf blade: Length (cm)	8.77	7.06-10.86	0.80	0.73	0.08	9.73	10.22	90.55	1.67	19.07
2	Leaf width (cm)	7.17	5.83-8.44	0.48	0.43	0.05	9.18	9.69	89.74	1.28	17.92
3	Petiole: length (cm)	3.37	2.16-4.86	0.61	0.53	0.08	21.73	23.27	87.14	1.41	41.78
4	Average internodal length (cm)	9.56	7.60-13.15	2.32	2.29	0.03	15.83	15.95	98.59	3.10	32.39
5	Days taken for production of first female flower	55.03	46.83-63.33	23.76	21.56	2.20	8.44	8.86	90.73	9.11	16.56
6	Node numbers at first female flower appearance	12.16	7.68-16.6	9.83	9.77	0.07	25.71	25.80	99.33	6.42	52.78
7	Fruit length (cm)	8.03	5.42-11.53	2.84	2.68	0.16	20.39	20.98	94.49	3.28	40.84
8	Fruit diameter (cm)	2.52	1.80-3.17	0.19	0.17	0.02	16.40	17.43	88.49	0.80	31.78
9	Number of fruits per plant	136.29	56.15-219.75	1861.34	1792.60	68.74	31.07	31.66	96.31	85.59	62.80
10	Number of seeds per fruit	18.07	11.42-29.45	31.09	30.24	0.85	30.43	30.85	97.28	11.17	61.82
11	Average fruit weight (g)	28.25	19.22-38.04	25.74	24.39	1.35	17.48	17.96	94.75	9.90	35.05
12	Days taken from fruit set to harvest maturity	7.45	5.65-9.17	1.09	1.01	0.09	13.48	14.05	92.16	1.99	26.67
13	Yield per plant (kg)	3.84	1.13-6.28	2.51	2.46	0.05	40.82	41.24	97.96	3.20	83.22
14	Ascorbic acid content of fruit (mg/100 g):	17.09	11.53-20.81	7.17	6.95	0.22	15.43	15.67	96.95	5.35	31.30
15	Beta carotene (mg/100g)	139.93	128.25-150.46	34.53	23.26	11.27	3.45	4.20	67.36	8.15	5.83
16	Chlorophyll a content of leaf: mg/100 g tissue	99.04	64.81-142.27	718.71	711.14	7.57	26.93	27.07	98.95	54.64	55.18
17	Chlorophyll b content of leaf: mg/100 g tissue	31.13	15.77- 43.89	64.61	58.45	6.15	24.56	25.82	90.48	14.98	48.12
18	Total Chlorophyll content of leaf: mg/100 g tissue	128.28	58.953-179.227	1109.80	1100.26	9.53	25.86	25.97	99.14	68.04	53.04

were curved in shape. As per pericarp hardness of fruit at marketable stage all the genotypes were grouped into two categories soft and hard. Present study revealed that soft pericarp found higher frequency (77.42 %) over hard pericarp (22.58 %) and it had conformity with the findings of Ghosh (2000). Flesh colour of the fruit varied from white to creamy white in nature for all the genotypes and utmost germplasm were categorized as white flesh colour (74.19 %) followed by creamy white (25.81 %). All germplasm were characterized into four different groups depending upon blossom end fruit shape namely, depressed, flattened, round and pointed. There is no depressed fruit shape, fourteen genotypes were recorded as pointed, nine were flattened and remaining eight were round in shape. Seeded fruit was produced by all the genotypes under study characterized as seeded type and absence of non-seedy fruit.

b. Genetic variability

Pooled analysis of variability and its components for different attributes recorded (Table 3) that the highest range was found in fruits number per plant (56.15-219.75) followed by total chlorophyll content of leaf (58.95-179.23 mg), chlorophyll a (64.81-142.27 mg), beta carotene (128.25-150.46 µg), average fruit weight (19.22-38.04 g), and least in fruit diameter (1.80-3.17). The attributes having higher range of variation might indicate high degree of variation forwarded for direct selection. Maximum range was achieved for the average number of fruits per plant (32-159) by Malek *et al*. (2007) in their research experiment for pointed gourd and Yadav (2014) for ridge gourd. Set of genes carried by an organism is considered as genotypes, though all genes may not be expressed exactly due to environmental intervention. Physical expression of an actual character at existing environment is considered as phenotype. The phenotypic coefficient of variation (PCV) is considered as combined expression of genotype and its environmental coefficient of variation, which indicated that some genes may be affected by the environment.

Environment has an important role for expression of different morphological characters of an organism. If environment become changed, the expression of different characters may also be changed. Selection cannot be accepted based on the only phenotypic variation as this is not stable in nature. Comparing both the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) the decision regarding identification process should be taken based on some particular characters. Some characters expressed in the next generation with minimum effect of environment create a narrow range of differences between GCV and PCV which implies direct selection. Present study revealed that very less range of differences between GCV and PCV which indicated minimum environmental effect for all the characters and are mostly governed by genes. Highest PCV was achieved for individual plant yield (41.24) followed by average number of fruit per plant (31.66), seed number per fruit (30.85) and minimum for days taken to production of first female flower (8.86). Highest genotypic coefficient of variation was also noted for individual plant yield (40.82) followed by average number of fruit per plant (30.43) and minimum for days taken to production of first female flower (8.44). A close PCV and GCV value confirms minimum environmental effect on different characters and may be selected directly based on phenotypic value. Similar trends of finding also had been reported by various workers *viz*., highest GCV for fruit yield by Malek *et al*. (2007) and Dubey *et al*. (2013) number of seed per fruit by Kumar *et al*. (2013), average number of fruits per plant by Pathak *et al*., (2014), individual fruit weight by Devi and Mariappan (2014). The amount of genetic variation presents for different attributes can be identified by GCVwhile heritability provides a clear concept about the proportion of inherent variation *i.e*. variation transferred to the next generation out of the total variation. In this study all the characters had shown high heritability (above 80%) except beta carotene which was moderate type. The high heritability was noted for node of the first female flower (99.33%) followed by total chlorophyll content of leaf (99.14%), chlorophyll a content of leaf (98.95%), average internodal length (98.59%), yield per plant (97.96 %) and moderate but the lowest in beta carotene (67.36 %). Similar trends of finding was recorded by Malek *et al*. (2007) in case of yield and average number of fruit per plant and Dubey *et al*. (2013) for fruit yield per plant, weight of individual fruit and seeds per fruit. Analysis of both heritability and genetic advance (GA) at the same time of a character gave an exact idea than heritability alone for any crop improvement programme through selection (Falconer, 1960 and Fisher, 1918). High heritability coupled with high genetic gain as per cent of mean was found in average production per plant, number of edible fruits per plant, number of undesirable seeds per fruit, chlorophyll a content of leaf, amount of total chlorophyll present in leaf,total chlorophyll b present in leaf, nodes number of the first female flower, fruit length, fruit diameter, individual fruit weight, ascorbic acid content, days taken from fruit set to harvest maturity, petiole length, and average inter-nodal length which might be due to additive gene interaction. High

heritability and moderate genetic gain as per cent of mean was found for leaf length, leaf width, days to first female flowering which may be contributed both additive and non additive gene interaction and low genetic advance as percent of mean was found in beta carotene which may be contributed bynon additive gene interaction. This finding had a similarity with the research results of Verma *et al*. (2017), Jena *et al*. (2017) and Singh (2015).

CONCLUSION

Wide range of variation was recorded for different morphological, quantitative and qualitative traits. The significant differences for different genotypes indicated that these genotypes might be used in crop improvement programmes. Narrow range of deviation between PCV and GCV implied minimum effect of environment in expression of these attributes. High heritability and high genetic advance as per cent of means were found in average number of fruits per plant, average fruit weight per plant, numbers of seeds per fruit, chlorophyll a content of leaf, total chlorophyll content of leaf, chlorophyll b content of leaf, nodes number at which first female flower appear, length of fruit, diameter of fruit, individual fruit weight, ascorbic acid content of fruit, days taken from fruit set to harvest maturity, petiole length, and average inter-nodal length which indicated additive gene interaction. Therefore on the basis of these attributes selection might be rewarding for future improvement programme of pointed gourd.

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