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Studies of Genetic Variability and Inter-Relationship among Some Pumpkin (*Cucurbita moschata* L.) Landrace of Assam, India

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Authors' contributions

This work was carried out in collaboration among all authors. During the experiment program the authors GCB was the major advisor he supervised the experiment. Authors DS and AS did the experimental works and the statistical works. The author TT contributes on writing and details of the submitting the manuscript and preparation. All authors read and approved the final manuscript.

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ABSTRACT

Thirty diverse landraces of pumpkin comprising from eight districts of Assam *viz.*, four landraces from each district, Sivasager, Dibrugarh, Karbi Anglong, Haflong, Jorhat & Majuli and three landraces from each Lakhimpur and Kokrajhar. The landraces were subjected to analyses of variance and covariance for estimation of genetic variability parameters and correlation coefficients among the 19 characters. The experiment was carried out during the *rabi* season of 2017-18 at the Instruction Cum and Research (ICR) Farm of Assam Agricultural University in a Randomized Block Design with three replications. From the analysis of variance, it was recorded that the presence of

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variation among thirty pumpkin landraces for all characters. The highest genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was recorded for single fruit weight with 51.47 per cent and 54.88 per cent, indicating presence of greater variability for the trait. The heritability in the broad sense was recorded highest for the petiole length. The GA calculated as per cent of the mean was recorded for single fruit weight (99.44%), followed by yield per plant. In character association five traits were positively correlated with fruit yield per plant out of 18 characters.

Keywords: Genetic variability; quantitative; landrace; correlation coefficient.

1. INTRODUCTION

Pumpkin (*Cucurbita moschata* L.) is a one of the most important cucurbitaceous crops cultivated all around the world. The production of pumpkin in India is mainly used for domestic consumption as fresh vegetable. In Assam pumpkin were mostly cultivated as a summer vegetable crops. Being a source of vitamin A, pumpkin can play important role in the fight against the vitamin A deficiency and it might improve certain functions of the immune system. Pumpkin is an excellent source of vitamin, minerals, fibres, antinutrients, antioxidants, and phytonutrients Pandey et al. [1] and this makes the fruit wholesome and healthy for human consumptions. Besides the fruits, the tender leaves and flowers are cooked and consumed as pot herb in Assam.

Among the cucurbitaceous vegetable, pumpkin has received little attention in crop improvement. Since ancient times, wide ranges of germplasm are available but exploitation of them has not been attended until recently. They have a wide range of variability for maturity, use, yield and fruit characters like shape and size. There was a wide range of genetic variability among the existing genotypes Aliu et al. [2] and thus, the utilization of such variability in the breeding programmes of this crop is possible. In the North-Eastern part of India, particularly Assam is a rich source of cucurbitaceous germplasm are usually seen, which are having a wide variability in respect of their size, shape, and colour and even resistance to various pest and disease. This is very helpful for a pant breeder in developing a commercial variety with market and consumer preference by studies of the yield and quality characters [3]. The pre-requisite of any systemic breeding programme for increasing yield, quality, and resistance to disease and pest is the exploration of genetic variability in available germplasm material. So, evaluation of the local germplasm is necessary. Collecting the broad-spectrum germplasm material to form a wide variability from which selection could be made for an introduction and choosing donor parent for further utilization in breeding programme. The variability present in the population could be useful into heritable components with the aid of genetical parameters such as genotypic variance, phenotypic variance, heritability, genotypic co-efficient of variation and genetic advance which serve as a basis for effective selection.

2. MATERIALS AND METHODS

The material for the present investigation consists of diverse group of 30 landrace of Assam, which were collected from eight different districts. The selection of the landraces was made on the basis of the variability of shape of the fruits, length of the fruit, colour of the fruit, single fruit weight and consumer preference. The experiment was laid out in Randomised Block Design with 3 replications in 2 rows per plot during*Rabi* seasons of 2017-18, at the Instruction cum Research (ICR) Farm, Assam Agricultural University, Jorhat. The names of thirty pumpkin landraces along with the source of collections are presented in the Table 1. The size of each plot was allotted 4.0 m x 3.75 m (2 rows of 3 m). The 30 pumpkin land races were sown in the main field on 22nd September 2017. The experimental field was prepared as per Package of Practices of Assam.

Three representative plants for each landrace in each replication were randomly selected to record the observations on vine length(m), leaf blade breadth (cm),leaf blade length (cm),total chlorophyll content (mg 100 g^{-1}),petiole length (cm),peduncle length (cm),days to 1st flowering, days to opening 1st female flower, days of maturity, no. of female flower/plant, no. of male flower/plant, Female: Male percentage (%), no. of fruit/plant, fruiting percentage (%), fruit length (cm),fruit diameter (cm),flesh thickness (cm), single fruit weight (kg) and yield/plant (kg), and data was subjected to statistical analysis. Mean data for the characters were subjected to

Table 1. List of 30 pumpkin landrace of Assam with the source of collection

Entry No.	Name of the entry	Accession no.	Place of collection
V1	Lakhimpur-1	L-1	Laluk, North Lakhimpur
V2	Karbi Anglong-1	KA-1	Manja, Karbi Anglong
V3	Haflong-1	H-1	Purana maibang, Dima Hasao
V4	Haflong-2	H-2	Hading, Dima Hasao
V5	Sivasager-1	S-1	Disangmukh, Sivasager
V6	Karbi Anglong-2	KA-2	Nilapur, Karbi Anglong
V7	Haflong-3	H-3	Harangajag, Dima Hasao
V8	Sivasager-2	S-2	Dikhowmukh, Sivasager
V9	Lakhimpur-2	L-2	Konwar gaon, North Lakhimpur
V10	Jorhat-1	J-1	Dangdhara, Jorhat
V11	Majuli-1	M-1	Rauna gaon,Majuli
V12	Karbi Anglong-3	KA-3	Khatkhati, Karbi Anglong
V13	Dibrugarh-1	D-1	Khowang, Dibrugarh
V14	Kokrajhar-1	K-1	Goskata, Kokrajhar
V15	Jorhat-2	J-2	Alegmara, Jorhat
V16	Dibrugarh-2	D-2	Moran, Dibrugarh
V17	Lakhimpur-3	L-3	Nahoroni, North Lakhimpur
V18	Kokrajhar-2	K-2	Sikargaon, Kokrajhar
V19	Majuli-2	M-2	Totera gaon, Majuli
V20	Jorhat-3	J-3	Sodiyal, Jorhat
V21	Sivasager-3	S-3	Sumoni, Sivasager
V22	Dibrugarh-3	D-3	Hatigarh, Dibrugarh
V23	Jorhat-4	J-4	Sekuriya, Jorhat
V24	Sivasager-4	S-4	Afhala, Sivasager
V25	Majuli-3	M-3	Bihimpur Satra, Majuli
V26	Haflong-4	H-4	Yabkidisa, Dima Hasao
V27	Karbi Anglong-4	KA-4	Dhansiri, Karbi Anglong
V28	Kokrajhar-3	K-3	Taktara, Kokrajhar
V29	Majuli-4	M-4	Kumar gaon, Majuli
V30	Dibrugarh-4	D-4	Goroimari, Dibrugarh

analyses of variance following Randomized Block Design considering replication and genotype as fixed effects as advocated by Panse and Sukhatme [4]. The correlation coefficients among various characters were calculated at genotypic and phenotypic level using the formulae given by Al-Jibouri et al. [5].

3. RESULTS AND DISCUSSION

The analysis of variance (ANOVA) for the 30 pumpkin landraces revealed significantly high amount of variability among the genotypes for all the 19 characters (Table 2 a, 2 b) suggesting that existing of an inherent genetic variability among the landraces. The highest environmental coefficient of variation was recorded for yield per plant (28.78%) indicating presence of micro-environmental effects and also sampling error for these characters. Similar types of results were recorded by Tamilselvi and Jansirani [3] for earliness and yield attributes characters. Sultana et al. [6] evaluated 21 genotypes of pumpkin for different characters and observed high variability in number of female flowers, number of male flowers, single fruit weight and yield per plant. Yadav *et al.* (2013) showed significant difference among all the bitter gourd genotypes for yield and its attributing traits.

Mean values for various characters studies were presented in Table 3.a and 3.b. from the mean data analysis, it was recorded that landrace Lakhimpur-1 showed longest vine length with 7.24 m length. The total chlorophyll content was recorded highest for the landrace Jorhat-4. It was observed that landrace Majuli-3 was earliest in respect of days to appearance of first male flowering in 40.17 days, while landrace Kokrajhar-2 was earliest in respect to days to first

female flower appearance (45 days). Landrace Haflong-3 recorded minimum days required for maturity with 85 days. The number of female flowers per plant is an important character for yield purpose. Landrace Lakhimpur-2 was recorded highest number of female flower (9), while landrace Sivsagar-2 was observed lowest number of female flower (4.67). The ratio of Female: Male was recorded for all the 30 landraces and it was observed that highest ratio was recorded for the landrace Karbi Anglong-2 (38.33). The number of fruits per plant is an important trait in aspects to yield of the plant. The highest number of fruits per plant was recorded for landrace Kokrajhar-3 (5.67) and the maximum single fruit weight (1.86 kg) was recorded for landrace Majuli-4. The highest fruiting percentage was recorded for the landrace Sivsagar-3 (74.29 per cent). The maximum length of fruit was recorded in landrace Dibrugarh-4 (28.33 cm), while widest diameter of fruit was observed for landrace Majuli-4 (21.16 cm). The maximum flesh thickness 4.53 cm was recorded for the landrace Majuli-4. The total yield per plant was recorded for the landrace Majuli-4 with 6.87 kg per plant. Srikanth [7] studied on 23 pumpkin genotypes revealed that variation was observed for vine length, number of seed per fruit and number of fruits per plant.

The success of any crop improvement programme depends on the availability and magnitude of genetic variability for the different characters and extent to which the desirable trait is heritable. To assess the magnitude and nature of genetic variation range, mean, genotypic coefficient of variability (GCV, %) and phenotypic coefficient of variability (PCV, %), heritability in broad sense ($h^2_{bs)}$ and expected genetic advance (GA, % of mean) for 19 different characters are presented in Table 4.

The range for all the characters indicates the presence of wide diversity among the landraces. A wide range of phenotypic and genotypic variability was apparent for various characters. The genotypic coefficient of variability (GCV) ranged from 4.06 % for days to first female flowering to 51.47 % for single fruit weight. High estimates of GCV were recorded for single fruit weight (51.47%) and yield per plant (43.58%). High values of PCV were recorded for single fruit weight (54.88%), yield per plant (52.23%) and female: male flower ratio (41.71%).

Estimates of high GCV and PCV were recorded for both yield per plant and single fruit weight, indicating presence of greater variability for the traits. There is an observation of the difference between genotypic and phenotypic variance to be narrow for all the characters except fruit per plant and fruiting percentage indicating that influence of environment on these characters. Saha et al. [8] also reported high GCV and PCV for single fruit weight and yield per plant. Higher estimates of PCV than GCV for all the characters indicating that the variation among the landraces were not only genetic but also due to the influence of environment.

Heritability is an essential selection parameter, useful for the identification of traits and also provides clues on possible improvement of the crop Makeen et al. [9]. In the present investigation, vine length, leaf blade length and breadth, total chlorophyll content, petiole and peduncle length, days to 1st flowering, fruit length and diameter, and flesh thickness exhibited high heritability, indicating usefulness of phenotypic selection for these traits. High heritability estimates for fruit length, days to 1st flowering and petiole length were also reported by Sultana et al. [6] and Chowdhury and Sarma [10]. Estimates of high genetic advance were observed for single fruit weight (99.44%) and yield per plant (74.91%) indicating least influence of environment.

Estimates of high GCV, PCV, GA and moderate heritability were observed for the characters single fruit weight and yield per plant, indicating predominance of additive gene action. It implies that there was presence of genetic variability for the traits. Low heritability and low genetic advance were observed for the character fruiting percentage indicating high influence of environment and the selection on the basis of this character would be ineffective and improvement for this character depends on breeding method which provides adequate progeny testing Singh et al. [11]. High heritability coupled with moderate genetic advance for characters total chlorophyll content, petiole length, peduncle length, number of male flower, female/male ratio, fruit length, fruit diameter, flesh thickness, indicating scope for improvement through simple selection. Similar results were reported by Singh and Lal [12]. Chowdhury and Sharma [10] reported the presence of additive gene action for single fruit weight and yield per plant of pumpkin.

Table 2a. Analysis of variance for the 19 traits of the 30 Pumpkin landraces of Assam

Source of Variations	DF	Vine length(m), VL	Leaf blade breadth (cm) LB	Leaf blade length (cm) LL	Total Chlorophyll content (mg 100 g^{-1}) TCHL	Petiole length (cm) PT	Peduncle length (cm) PD	Days to 1st flowering, DF	Days to opening 1st female flower, DFF	Days of maturity, DM
Replicate	2	0.001	0.021	0.013	4.918	0.417	0.010	0.134	0.345	61.344
Landraces	29	2.426**	19.766**	33.131**	61.372**	19.857**	14.376**	14.797**	11.666**	105.349**
Error	58	0.017	0.051	0.039	2.152	0.206	0.003	0.034	0.724	7.551
CV		2.27	0.78	0.78	10.23	3.39	0.48	0.42	1.81	2.94

**, ** Significant at 5% and 1% level, respectively*

Table 2b. Analysis of variance for the 19 traits of the 30 Pumpkin landraces of Assam

Source of Variations	DF	No. of female flower per plant, FF	No. of male flower per plant, MF	Female: Male percentage (%) F:M	No. of fruit per plant, NFP	Fruiting percentage (%) FP	Fruit Length (cm) FL	Fruit diameter (CM) FD	Flesh thickness (cm) FT	Single fruit weight (kg), SFW	Yield per plant (kg), YPP
Replicate	2	1.011	22.633	41.789	0.011	150.239	0.006	0.459	0.014	0.010	0.001
Landraces	29	4.178**	216.739**	172.547**	2.402**	142.693**	56.751**	26.381**	1.894**	0.460**	5.608**
Error	58	1.023	12.921	11.946	0.620	60.133	0.081	0.106	0.010	0.020	0.712
CV		15.53	9.57	17.82	19.11	12.36	1.87	2.11	3.28	19.03	28.78

**, ** Significant at 5% and 1% level, respectively*

Table 3a. Comparative mean performance for 19 traits of the 30 Pumpkin landraces of Assam

Cultivars	Vine length(m), VL	Leaf blade breadth (cm) LB	Leaf blade length (cm) LL	Total Chlorophyll content (mg 100 g^{-1}) TCHL	Petiole length (cm) PT	Peduncle length (cm) PD	Days to 1st flowering, DF	Days to opening 1st female flower, DFF	Days of maturity, DM
Lakhimpur – 1	7.24	25.03	21.70	10.34	12.77	9.83	45.33	48.33	97.00
Karbi Anglong – 1	6.45	30.13	23.03	19.38	11.30	11.25	45.33	46.67	96.67
Haflong – 1	5.43	26.20	28.60	18.18	12.50	10.43	44.00	46.00	85.00
Haflong – 2	7.05	26.77	21.42	14.18	10.63	9.75	43.33	45.33	84.67
Sivasager – 1	6.02	27.17	32.13	14.66	13.33	12.30	45.17	51.67	81.67
Karbi Anglong - 2	5.67	32.28	26.38	11.14	14.27	14.73	48.33	48.67	93.67
Haflong – 3	6.57	31.41	26.40	23.06	9.73	12.28	45.33	47.00	80.00
Sivasager – 2	5.90	27.12	23.10	10.08	11.47	17.22	45.00	48.67	92.00
Lakhimpur – 2	6.66	28.40	25.36	13.46	10.57	13.68	45.83	49.00	92.33
Jorhat – 1	5.25	24.42	19.60	11.43	10.73	14.18	43.83	46.67	99.00
Majuli – 1	5.56	26.31	25.43	11.26	12.63	12.83	42.50	46.33	100.00
Karbi Anglong – 3	5.80	24.32	20.22	15.75	15.77	11.63	40.83	43.67	96.67
Dibrugarh – 1	5.79	26.72	24.35	11.35	13.73	8.17	42.00	44.67	88.33
Kokrajhar – 1	6.17	29.85	26.67	15.96	12.67	9.32	41.67	44.33	85.00
Jorhat – 2	5.49	34.37	30.03	19.35	15.37	10.58	43.00	46.00	95.33
Dibrugarh – 2	5.61	31.43	28.93	10.82	14.33	8.65	41.83	46.33	86.67
Lakhimpur – 3	6.25	29.30	26.22	11.63	11.53	9.82	40.50	45.33	94.67
Kokrajhar – 2	6.41	26.49	23.80	10.22	12.30	13.10	44.33	45.00	100.67
Majuli – 2	4.84	31.58	29.87	11.54	10.70	10.30	41.50	45.33	94.67
Jorhat – 3	5.49	26.78	22.77	11.20	17.67	9.47	42.67	46.00	90.67
Sivasager – 3	3.65	30.38	25.40	9.63	11.33	13.40	44.50	47.00	95.00
Dibrugarh – 3	4.66	28.46	21.43	14.13	12.13	11.62	49.50	51.33	100.67
Jorhat – 4	6.19	27.78	24.67	30.73	14.37	14.80	42.50	46.67	99.00
Sivasager – 4	4.91	28.40	25.44	17.34	18.50	10.25	45.50	49.00	103.00
Majuli – 3	5.48	31.52	26.07	10.84	11.13	11.40	40.17	46.00	94.67
Haflong – 4	7.04	33.11	26.42	14.16	13.57	14.15	43.67	48.33	97.33
Karbi Anglong- 4	6.17	28.03	23.07	14.80	12.67	10.22	42.17	47.00	97.33
Kokrajhar – 3	3.56	29.38	22.90	16.43	17.57	8.58	46.33	50.33	91.33
Majuli – 4	4.54	28.09	26.03	12.41	16.80	11.20	41.17	45.67	97.33
Dibrugarh – 4	4.96	30.34	33.48	14.86	19.43	9.35	44.50	48.00	92.00
Mean	5.69	28.72	25.36	14.34	13.38	11.48	43.74	47.01	93.41
S.E.	0.07	0.13	0.11	0.85	0.26	0.03	0.11	0.49	1.59
C.D. 5%	0.21	0.37	0.32	2.40	0.74	0.09	0.30	1.39	4.49

Table 3b. Comparative mean performance for 19 traits of the 30 Pumpkin landraces of Assam

Cultivars	No. Of Female flower per plant, FF	No. Of male flower per plant, MF	Female: Male percentage (%) F:M	No. Of fruit per plant, NFP	Fruiting percentage (%) FP	Fruit Length (cm) FL	Fruit diameter (CM) FD	Flesh thickness (cm) FT	Single fruit weight (kg), SFW	Yield per plant (kg), YPP
Lakhimpur – 1	7.67	23.00	33.63	4.67	60.71	17.18	19.03	3.28	1.13	5.27
Karbi Anglong – 1	6.67	32.33	20.78	3.67	54.76	11.77	17.34	3.34	1.02	3.74
Haflong – 1	8.00	21.00	38.33	4.67	58.33	14.90	15.34	2.65	0.93	4.34
Haflong – 2	8.33	25.33	33.38	5.33	64.55	16.84	14.13	2.32	0.36	1.94
Sivasager – 1	4.67	32.33	14.41	2.67	56.67	19.56	18.65	3.33	1.22	3.26
Karbi Anglong - 2	8.00	21.00	38.89	5.00	62.10	13.95	12.31	2.33	0.56	2.78
Haflong – 3	5.33	29.00	19.37	2.67	50.00	12.38	18.48	2.35	0.42	1.12
Sivasager – 2	4.67	42.00	11.11	2.33	50.00	11.73	18.59	3.62	1.70	4.11
Lakhimpur – 2	9.00	32.33	27.88	5.33	58.98	9.91	12.20	2.23	0.41	2.21
Jorhat – 1	7.33	39.00	19.05	5.00	54.17	14.20	14.50	2.37	0.41	2.05
Majuli – 1	4.67	41.33	11.28	2.67	56.67	15.28	16.41	2.70	0.80	2.14
Karbi Anglong – 3	7.33	41.00	18.16	4.33	59.72	12.48	14.93	2.68	0.65	2.80
Dibrugarh – 1	6.00	35.00	17.32	4.00	67.14	21.07	10.86	2.50	1.00	4.14
Kokrajhar – 1	5.67	32.00	15.15	3.00	52.38	11.43	13.43	2.63	0.52	1.54
Jorhat – 2	6.67	39.00	23.16	4.33	64.05	16.35	15.63	3.60	1.22	5.03
Dibrugarh – 2	5.33	38.67	16.75	3.33	63.89	12.50	14.47	3.58	0.81	2.69
Lakhimpur – 3	7.67	40.67	19.64	5.00	65.08	15.17	15.93	3.55	1.01	5.05
Kokrajhar – 2	6.33	40.67	16.26	4.00	63.06	15.80	15.80	3.17	0.64	2.53
Majuli – 2	6.33	45.00	15.66	3.67	57.94	19.28	15.53	3.88	0.54	1.99
Jorhat – 3	6.00	42.00	14.76	4.33	72.70	24.27	9.69	1.44	0.88	3.81
Sivasager – 3	6.33	44.00	14.22	4.67	74.29	10.30	14.38	3.52	0.35	1.64
Dibrugarh – 3	5.67	44.67	13.54	4.00	71.11	16.40	17.43	3.40	0.42	1.67
Jorhat – 4	6.67	38.00	15.15	4.00	59.72	14.49	16.87	4.12	0.52	2.07
Sivasager – 4	6.67	37.67	15.04	4.67	70.64	15.53	18.34	4.15	0.57	2.67
Majuli – 3	5.00	37.33	13.08	3.33	67.22	18.52	20.33	4.22	0.72	2.41
Haflong – 4	7.67	38.00	20.42	5.33	69.84	8.50	12.59	2.13	0.40	2.13
Karbi Anglong- 4	5.67	42.00	15.22	4.00	71.11	9.22	13.53	2.40	0.30	1.21
Kokrajhar – 3	8.00	40.33	21.20	5.67	71.03	13.60	16.20	2.53	0.46	2.60
Majuli – 4	5.67	52.00	13.49	3.67	64.44	17.18	21.16	4.53	1.86	6.87
Dibrugarh – 4	6.33	60.33	15.71	4.33	69.72	28.33	9.03	1.52	0.49	2.12
Mean	6.51	37.57	19.40	4.12	62.73	15.27	15.44	3.00	0.74	2.93
S.E.	0.58	2.08	2.00	0.45	4.48	0.16	0.19	0.06	0.08	0.49
C.D. 5%	1.65	5.87	5.65	1.29	12.67	0.47	0.53	0.16	0.23	1.38

Table 4. Estimates of range, mean, genotypic coefficient of variability (GCV), phenotypic coefficient of variability (PCV), heritability in broad sense (h^2_{bs}) and genetic advance (5%) as per cent of mean (GA, % of mean) for the 19 traits among 30 Pumpkin landraces of Assam

Characters	Range	Mean	GCV (%)	PCV (%)	h^2_{bs}	GA, % of mean
Vine length	3.56-7.24	5.69	15.74	15.90	97.97	32.09
Leaf blade breadth	24.32-34.37	28.72	8.93	8.96	99.23	18.32
Leaf blade length	19.60-33.48	25.36	13.09	13.12	99.65	26.93
Total chlorophyll	9.63-30.73	14.34	30.97	32.62	90.17	60.59
Petiole length	9.73-19.43	13.38	19.12	19.42	96.95	38.79
Peduncle length	8.17-17.22	11.48	19.06	19.07	99.94	39.25
Days to first flowering	40.17-49.50	43.74	5.07	5.09	99.32	10.41
Days to first female flowering	43.67-51.67	47.01	4.06	4.45	83.44	7.64
Days to maturity	80.00-103.00	93.41	6.11	6.78	81.19	11.34
No. of female flower	4.67-9.00	6.51	15.75	22.12	50.70	23.10
No. of male flower	21.00-60.33	37.57	21.94	23.94	84.02	41.43
Female/ Male	11.11-38.89	19.40	37.71	41.71	81.76	70.24
Fruits per plant	2.33-5.67	4.12	18.69	26.73	48.91	26.93
Fruiting percentage	50.00-74.29	62.73	8.36	14.92	31.40	9.65
Fruit length	8.50-28.33	15.27	28.46	28.52	99.57	58.51
Fruit diameter	9.03-21.16	15.44	19.17	19.29	98.81	39.26
Flesh thickness	1.43-4.53	3.00	26.39	26.59	98.48	53.95
Single fruit weight	0.30-1.88	0.74	51.47	54.88	87.97	99.44
Yield per plant	1.13-6.87	2.93	43.58	52.23	69.63	74.91

Table 5. Genotypic correlation coefficients among the 18 traits with yield per plant of the 30 pumpkin landraces of Assam

	Vine length (m)	Leaf blade breadth (cm)	Leaf blade length (cm)	Total Chlorophyll content (mg 100 g^{-1})	Petiole length (cm)	Peduncle length (cm)	Days to 1st flowering	Days to opening 1st female flower	Days of maturity	No. Of Female flower per plant	No. Of male flower per plant	Female : Male percentage (%)	No. Of fruit per plant	Fruiting percentage (%)	Fruit Length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Single fruit weight (kg)	Yield per plant (kg)
VL																			
LBB	-0.121																		
LBL	-0.131	0.560**																	
TCHL	0.131	0.131	0.091																
PTL	-0.392**	0.021	0.213*	0.114															
PDL	0.145	-0.038	-0.165	0.046	-0.350**														
DFF	-0.101	0.046	-0.114	0.063	-0.004	0.296*													
DFFF	-0.169	0.092	0.096	0.029	0.109	0.239*	0.736**												
DM	-0.170	-0.101	-0.343**	-0.086	0.165	0.255*	0.043	0.024											
NFF	0.135	-0.048	-0.194	0.107	0.003	-0.035	0.177	0.052	0.050										
NMF	-0.495**	0.086	0.160	-0.140	0.385**	-0.052	-0.236*	-0.044	0.331*	-0.308*									
F/M	0.311*	-0.009	-0.049	0.059	-0.130	-0.054	0.302*	0.054	-0.214*	0.728**	-0.709**								
FPP	-0.059	-0.009	-0.215*	-0.004	0.148	-0.115	0.173	0.099	0.180	0.828**	-0.095	0.516**							
FP	-0.302*	0.130	-0.021	-0.154	0.340*	-0.279*	0.029	0.120	0.230*	0.049	0.284*	-0.104	0.508**						
FL	-0.201	-0.119	0.337*	-0.135	-0.441**	-0.418**	-0.099	-0.036	-0.098	-0.158	0.298*	-0.107	-0.060	0.180					
FD	-0.049	-0.069	-0.101	0.138	-0.222*	0.198	0.011	0.167	0.151	-0.273*	-0.085	-0.175	-0.328*	-0.220*	-0.190				
FT	-0.218*	0.131	0.089	0.078	-0.097	0.113	-0.198	-0.012	0.315*	-0.251*	0.110	-0.280*	-0.245*	-0.043	-0.116	0.776**			
SFW	0.018	-0.127	0.139	-0.168	0.133	0.035	-0.189	-0.044	-0.045	-0.254*	0.076	-0.102	-0.314*	-0.188	0.199	0.432**	0.418**		
YPP	0.008	-0.119	0.051	-0.136	0.212*	-0.147	-0.171	-0.089	0.048	0.180	0.007	0.189	0.201	0.101	0.224*	0.266*	0.306*	0.832**	

**, ** Significant at 5% and 1% level, respectively*

The correlation coefficients analysis (Table 5) revealed that the fruit yield per plant had a significant positive correlation with petiole length (0.294), fruit length (0.273), fruit diameter (0.309), flesh thickness (0.357), single fruit weight (0.902). Similar results reported by Sampath and Krishnamoorthy [13] for fruit length, fruit diameter, and single fruit weight. Positive correlation of fruit yield per plant with single fruit weight, fruit diameter and flesh thickness at genotypic level was also reported by Chaudhari et al. [14]. The characters days to first flowering (-0.207) and first female flower opening (-0.162) showed negatively correlated with yield indicating the early flowering increase in fruit yield per plant. In 1998, Ananthan and Pappiah [15] reported that days to first female flowering was negatively correlated with total fruit yield per plant in bitter gourd. Borthakur and Baruah (2006) reported vine length, number of leaves per plant, fruit length and number of fruits per plant had positive and significant effect on yield per plant in bitter gourd.

The inter correlation among the yield traits such as single fruit weight had positive significant correlation with flesh thickness (0.445), fruit diameter (0.452), fruit length and yield per plant. Similar results were recorded by Sampath and Khrishnamoorthy [13]. Singh and Rajeshkumar [16] also recorded similar results in bottle gourd.

From the correlation studies it could be concluded that, intentional selection based on yield traits like single fruit weight, fruit length and fruit diameter may result in improvement of fruit yield per plant and also, they were inter correlated among themselves. It indicates that these characters are highly reliable yield related traits which may very well be utilized as yield indicator in selection programme.

4. CONCLUSION

In the present investigation, which include 30 pumpkin landraces of Assam was carried out in order to study the nature and amount of variability, heritability and genetic advance for 19 quantitative characters. Analysis of variance among 30 landraces showed significant difference for all the characters studied. The highest genotypic and phenotypic coefficient of variance was observed for fruit yield per plant and single fruit weight indicating presence of greater availability for the traits and these traits could be used as select for crop improvement. The high estimates of heritability were observed for vine length, leaf blade length & breadth, total chlorophyll content, petiole and peduncle length, days to first flowering,. High genetic advance were observed for single fruit weight and fruit yield per plant, indicating predominance of additive gene effects and possibilities of effective selection for the improved these characters. The correlation coefficient analysis observed petiole length, fruit length, fruit diameter, flesh thickness, and single fruit weight recorded significant positive relationship with yield per plant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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