International Journal of Minor Fruits, Medicinal and Aromatic Plants. Vol. 11 (2) : 137-149, December 2025

Genetic variability in landraces of spring onion (*Allium chinense*) of Nagaland

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Receipt: 06.10.2025 Revised: 17.11.2025 Acceptance: 18.11.2025
DOI: https://doi.org/10.53552/ijmfmap.11.2.2025.137-149

ABSTRACT

Spring onion (Allium chinense) is an important condiment crop in Nagaland known for its diverse landraces. The present study was undertaken to assess the genetic variability and interrelationships among yield and yield- contributing traits. Significant differences were recorded among 20 genotypes in all studied characters except for pseudostem length and pseudostem diameter. The GCV and PCV for yield per plot, bulb size, weight of whole cluster, number of cluster and bulb diameter were high indicating presence of sufficient variation for these traits. In the present investigation, high values of heritability and genetic advance were obtained for bulb size followed by weight of whole cluster and number of cluster. Correlation analysis revealed that the degree of genotypic correlation was higher than phenotypic correlation. The path analysis showed that the traits like number of leaves, number of cluster, weight of the whole cluster and dry matter content could serve as selection criteria in future breeding programs for improving yield potential in Allium chinense. The 20 genotypes of Allium chinense were grouped into 4 different clusters.Cluster I &III showed maximum inter cluster distance followed by cluster I & IV. Among different characters studied, contribution of days to 80% maturity was maximum towards divergence followed by bulb size.

Keywords: *Allium chinense*, correlation, D^2analysis, genetic variability, path analysis,

INTRODUCTION

Allium chinense (spring onion)is valued for its varied uses as food and medicinal properties. In India, this crop is mainly grown in northeastern states like Nagaland, Manipur, Arunachal Pradesh and Mizoram. *Allium chinense* is packed with many vitamins and minerals and the protein content on a fresh weight basis is 2.2%, fat 0.3%, carbohydrate 13.1% (Bah *et al.*, 2012). It contains high saponin, terpenes and alkanes, these bio-constituents can be further used in medicinal and therapeutic application (Rhetso *et al.*, 2020). *Allium chinense* is a much-known plant to all the locals in Nagaland and it has also grown well but due to the lack of research and scientific knowledge the potential of this crop is not yet discovered.

Genetic variability is important in a crop improvement program for effective selection. Hence, it is essential to assess the variability parameters for different characters in available germplasm. Genetic diversity measures are taken to quantify the overall genetic dissimilarity among different accessions, helping to identify distinct genetic lines. Therefore, present investigation was undertaken to evaluate genetic variability and diversity for bulb yield and other related traits among different genotypes as it provides foundation for selection of desirable genotypes to be used in breeding programs (Amerullah *et al.*, 2021).

MATERIALS AND METHODS

The present investigation was conducted in Nagaland University at Medziphema campus, Nagaland during November –May in the year 2021-2022.The experimental site (Medziphema) is located at an altitude of 310 m above mean sea level, with geographical location of 25^0 45'43"N latitude and 93^0 33'04"E longitude. A total of 20 landraces of spring onion collected from various parts of Nagaland were used in the study and are presented in Table 1.The experiment was conducted using randomized complete block design (RCBD) with three replications. Within every replication, there were twenty plots with 30 plants per plot measuring 1m x 1m, spaced at intervals of 50cm. Plant spacing within rows was 15cm, while row spacing was 20cm.

The observations were taken on five randomly sampled plants in each plot on 15 quantitative parameters *viz,* leaf length, leaf diameter, pseudostem length, pseudostem diameter, bulb size, bulb height, bulb diameter, bulb width of neck, dry matter content, fresh weight, days to 80% maturity (of plant), weight of whole cluster (average of 10 clusters from mature plant), yield per plot. Analysis of variance was done as suggested by Panse and Sukhatme (1957).The coefficients of variation were calculated following the methods outlined by Burton and De Vane (1953). Heritability estimations were derived as per Allard (1960).

h^2_b (%) = σ^2_g/σ^2_px 100 where,h^2_b = Heritability in broad sense; σ^2_g = genotypic variance; σ^2_p = phenotypic variance

The potential genetic advance was worked out based on the approach by Johnson *et al.*, (1955).GA = k. σ_p. h^2_b where, k = selection differential at 5% selection intensity, the value of which is 2.06; σ_p= Phenotypic standard deviation;h^2_b = Heritability in broad sense

Correlation coefficients were determined as suggested by Al-Jibouri *et al.*(1958). Using Dewey and Lu (1959) method genotypic correlation coefficients were partitioned into direct and indirect effect. Genetic diversity was estimated using D^2 statistic (Mahalanobis, 1936). Clustering of genotypes was performed following Tocher's method (Rao, 1952). The data were analyzed using the INDOSTAT software.

RESULTS AND DISCUSSION

Analysis of variance was significant for all the characters except for pseudostem length and pseudostem diameter. Similar results were reported by Dehdari *et al.* (2001). The higher values of phenotypic coefficient of variation (PCV) with respect to the corresponding genotypic coefficient of variation (GCV) were recorded for all the traits (Table 2.) with low influence of environment. In the present study yield per plot, weight of the whole cluster, number of cluster and bulb diameter showed high GCV and PCV indicating genetic factors controlling these traits. Kohsa and Dhatt (2013) reported similar results. Heritability in broad sense includes both additive and non-additive gene effects (Hanson *et al.*, 1956). A high heritability indicates a significant role of genetic factors in controlling the traits. The high heritability was obtained for days to 80% maturity (98%) followed by bulb size (91%), number of leaves (73.4%). Similarly high genetic advance was obtained for bulb size followed by weight of whole cluster, number of cluster (Table 2.). High heritability and high genetic advance were observed for number of cluster, weight of whole cluster and bulb size indicating these variables are controlled by additive genes and selection would be worthwhile for future breeding program.

Similar observation was recorded by Parmar *et al.* (2018).

Correlation coefficient between nine characters was computed at genotypic and phenotypic levels and was tested at 5% and 1% levels of significance as presented in Table 3 and Table 4 respectively. In general the extent of genotypic correlation was greater than phenotypic correlation. The path analysis (Table 5) revealed that number of clusters contributed maximum positive direct effect on yield per plot followed by days to 80% maturity, bulb size, weight of the whole cluster, dry matter content, number of leaves and fresh weight. Among these traits bulb size and fresh weight had non- significant and negative correlation with yield, respectively. Number of leaves, number of cluster, weight of the whole cluster and dry matter content showed a strong positive correlation with yield and a positive direct effect, suggesting a genuine association between these traits. Thus, it is suggested that while selecting, emphasis should be given on these traits for yield improvement. Similar results were reported by Singh *et al.* (2018) and Rajshree Gayen *et al.* (2025). Characters like leaf diameter and number of clusters can be increased through indirect selection of bulb width. The estimated residual factor was 0.3024 which indicates that there might be a few more pertinent characters whose inclusion will give better understanding of causal relationships.

D^2 statistic is a powerful tool to measuring genetic diversity among genotypes. Based on the magnitude of D^2 values20 genotypes were grouped into 4 clusters(Table6).Cluster I and cluster II had the largest number of genotypes involving 8 genotypes each followed by cluster III and cluster IV with two genotypes each. Inter cluster distance (Table 7) was maximum between cluster I & cluster III (104.85) followed by cluster I and cluster IV (81.86) showing genetic diversity among genotypes. Cluster means (Table 8) for different characters showed substantial differences. In cluster I genotypes showed superior performance for leaf diameter, pseudostem diameter, bulb height, days to 80% maturity, bulb size. Cluster II recorded superior performance for leaf length, pseudostem diameter. Cluster III recorded superior performance for leaf length, pseudostem length, and number of cluster. Cluster IV recorded superior performance for bulb width of neck, weight of whole cluster, fresh weight, dry matter content, yield per plot. Some clusters exhibit higher values for certain traits which confirms genetic diversity. The contribution of different characters to the total genetic diversity(Table 9) indicated that days to 80% maturity contributed the maximum (93.68%) towards genetic divergence (this may be because of physiological traits contributing to days to maturity) followed by bulb size (2.68%). Rashid *et al*. (2012) reported similar observation.

CONCLUSION

In the present study yield per plot, weight of the whole cluster, number of cluster and bulb diameter showed high GCV and PCV indicating genetic factors controlling these traits. Characters like Number of leaves, number of cluster, weight of the whole cluster and dry matter content showed significant positive correlation and positive direct effect, hence while selection emphasis should be given to these characters.20 genotypes were grouped into four clusters based on D^2 values. Characters days to 80% maturity contributes the maximum (93.68%) towards genetic divergence followed by bulb size (2.68%).Based on mean yield performance, the genotype 14 (Morükyüm 3), genotype 15 (Khuovei 6) and genotype 17 (Khuovei 7) was found elite genotypes for cultivation.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1: Local name of the spring onion (*Allium chinense*) landraces and their place of collection.

Genotypes	Landraces name	Place of collection
1	Khuovei-1	Sochunoma
2	Khuovei-2	Chumukidima
3	Khuba -1	Jaluki
4	Aüshih	Mon (Yangchung)
5	Khuovei-3	Kidima
6	Khuovei-4	Visema
7	Khuovei-5	Chechama
8	Lasen -1	Wokha
9	Khuba-2	Peren
10	Khuva	Pfutsuru
11	Morukhium-2	Chimongner
12	Aüshih	Mon
13	Morükyüm-1	Kiphire (Seyochung)
14	Morukhium-3	Tuensang
15	Khuovei-6	Medziphema
16	Zhiyü	Nuiland (Shouba)
17	Khuovei-7	Kohima
18	Khuovei-8	Cakhabama
19	Lasen	Wokha
20	Alulasing	Mokokchung

Table 2:Estimates of genetic parameters for 15 characters in springonion (*Allium chinense*)

Character	Mean ± SE ±	Range	GCV	PCV	ECV	h^2 (Broad Sense)	Genetic Advance	Genetic Advance as % of Mean
No. of leaves	6.46±0.70	5.47-7.67	8.24	18.78	7.05	73.4	0.80	12.45
Leaf length (cm)	27.22±1.74	23.87-30.01	5.72	11.07	2.86	25.1	0.80	2.95
Leaf diameter (cm)	0.33±0.04	0.27-0.38	9.98	21.80	7.66	58.9	0.04	12.12
Pseudostem length (cm)	3.01±0.32	2.41-3.76	10.98	18.68	2.06	30.5	0.02	0.80
Pseudostem diameter (cm)	0.49±0.06	0.39-0.60	12.67	20.15	5.02	15.7	0.02	4.10
No. of cluster	9.82±1.49	7.40-20.60	26.35	30.51	6.45	75.1	4.63	47.22
Bulb height (cm)	2.21±0.21	1.69-2.49	10.57	17.14	3.70	12.3	0.06	2.67
Bulb diameter (cm)	1.53± 0.38	1.08-2.44	22.33	43.70	11.73	27.6	0.19	12.70
Bulb width (cm)	0.84± 0.14	0.63-1.08	13.49	15.65	10.02	55.19	0.24	15.34
Days to 80% Maturity	165.49± 0.13	153.4-173.67	3.97	4.13	2.97	98	13.51	8.17
Weight of whole cluster(g)	231.10±39.29	77.33-416	29.45	32.88	28.15	73.3	114.71	49.64
Fresh wt. (g)	21.83±3.60	15.80	18.00	28.59	7.19	16	1.29	5.92
Dry matter content (g)	7.11±1.23	5.15-11.19	19.02	29.94	7.93	17.4	0.48	6.81
Bulb size (cm)	4.68±0.46	1.33-7.00	16.96	32.61	11.11	91	2.86	61.13
Yield per plot (g)	495.92±180.71	1.25-833.33	48.45	63.11	31.93	43.4	215.01	43.36

Table 3: Estimates of genotypic correlation coefficient between different characters in spring onion (*Allium chinense*)

Characters	Leaf length (cm)	Leaf diameter (cm)	Pseudo stem length (cm)	Pseudostem diameter (cm)	No. of cluster	Bulb height (cm)	Bulb diameter (cm)	Bulb width (cm)	Days to 80% Maturity	Weight of whole cluster (g)	Fresh wt. (g)	Dry matter Content (g)	Bulb size (cm)	Yield per plot (g)
No. of leaves	0.679**	-0.803*	0.749**	0.605**	0.388*	0.262	0.434*	0.982**	-0.133	0.193	0.567**	0.009	-0.323	0.421*
Leaf length		-0.851**	0.334	0.409*	0.008	0.867**	0.996**	0.071	0.584**	-0.499*	0.400*	0.854**	0.449*	0.471*
Leaf diameter			0.623**	0.313	0.773**	-0.044	0.751**	0.098	-0.297	-0.007	-0.591**	-0.216	0.092	0.220
Pseudostem length				0.053	-0.163	0.803**	0.303	0.768**	0.493*	0.932**	0.958**	0.648**	0.011	-0.503*
Pseudostem diameter					-0.994**	-0.218	0.194	0.779**	0.273*	0.794**	0.603**	0.545**	0.052	0.475*
No. of cluster						0.062	-0.005	0.025	-0.680**	0.255	0.405*	0.237	-0.592**	0.766**
Bulb height							-0.300	0.275	0.895**	-0.520*	0.188	0.502*	0.672**	0.401*
Bulb diameter								0.958**	-0.170	-0.370	0.988**	0.220	0.661**	0.720**

Bulb width									0.153*	0.122	0.095	0.495*	0.315	0.401*
Days to 80% Maturity										-0.628**	0.210	0.106	0.325	0.346
Weight of whole cluster											0.527**	0.688**	-0.163	0.990**
Fresh wt.												0.955**	0.397*	-0.572**
Dry matter wt.													0.363	0.567**
Bulb size														0.336

Note : * * significance at 1% level, * significance at 5% level

Table 4: Estimates of phenotypic correlation coefficient between different characters in spring onion *(Allium chinense*)

Character	Leaf length (cm)	Leaf diameter (cm)	Pseudo stem length (cm)	Pseudo stem diameter (cm)	No. of cluster	Bulb height (cm)	Bulb diameter (cm)	Bulb Width of neck (cm)	Days to 80% Maturity	Weight of whole cluster (g)	Fresh wt. (g)	Dry matter content (g)	Bulb size (cm)	Yield per plot (g)
No. of leaves	0.075	0.295	0.13	0.208	-0.28	-0.074	-0.073	0.566**	0.113	-0.074	0.231	0.172	0.296	0.078
Leaf length		0.47	0.39	0.113	0.207	0.527**	0.039	-0.226	-0.298	0.372	0.246	0.171	-0.096	0.342
Leaf diameter			0.288	0.501*	-0.362	0.517**	0.298	0.075	0.222	0.147	0.314	0.179	0.053	0.137
Pseudo stem length				-0.052	-0.081	-0.048	0.278	0.201	-0.281	0.538**	0.304	0.289	-0.193	0.371
Pseudo stem diameter					-0.381*	0.11	-0.145	0.076	0.104	0.292	0.334	0.372	0.439*	0.083
No. of cluster						-0.182	-0.088	-0.383*	-0.591**	0.222	-0.532**	-0.505**	-0.499*	0.441*
Bulb height							0.011	-0.314	0.309	-0.151	0.162	0.069	0.287	0.006
Bulb diameter								0.043	0.094	0.215	-0.033	-0.068	-0.377	0.257
Bulb width									-0.022	0.100	0.494*	0.478*	0.314	0.341
Days to 80% Maturity										-0.537**	0.085	0.044	0.309	0.226
Weight of whole cluster											0.202	0.264	-0.127	0.475*
Fresh wt.												0.975**	0.498*	0.019
Dry matter content													0.508*	0.077
Bulb size														0.208

Note : * * significance at 1% level, * significance at 5% level.

Table- 5: Direct and indirect effect of different characters of genotypic level in spring onion (*Allium chinense*) on yield per plant.

	No. of leaves	Leaf length (cm)	Leaf diameter (cm)	Pseudo stem length (cm)	Pseudo stem diameter (cm)	No. of cluster	Bulb height (cm)	Bulb diameter (cm)	Bulb width (cm)	Days to 80% Maturity	Weight of whole cluster(g)	Fresh wt. (g)	Dry matter content (g)	Bulb size (cm)	r_g for Yiel per plot (g)
No. of leaves	1.335	-0.682	-1.071	2.333	0.807	0.517	0.348	0.579	-2.644	-0.177	0.257	-1.521	-1.346	-0.430	0.421
Leaf length	1.155	-2.261	1.924	12.060	-0.923	-0.017	-1.960	-2.252	11.465	-1.320	1.128	5.425	4.190	-1.014	0.471
Leaf diameter	5.513	5.847	-6.872	-4.284	-2.149	-5.312	0.301	-5.155	28.157	2.036	0.048	4.057	1.481	-0.632	0.220
Pseudo stem length	-0.030	0.092	-0.011	-0.017	0.053	0.003	-0.066	0.023	-0.307	0.025	-0.051	-0.034	-0.028	0.017	- -0.503
Pseudo stem diameter	-4.143	-2.797	-2.143	20.916	-6.852	6.807	1.492	-1.327	-25.890	-1.866	-5.434	-10.98	-10.580	-7.207	0.475
No. of cluster	5.618	0.111	11.202	-2.356	-14.397	14.492	-15.384	-0.071	43.833	-9.848	3.689	-20.35	-17.921	-8.570	0.766
Bulb height	-0.946	-3.137	0.159	-13.760	0.788	3.841	-3.619	1.085	-8.232	-3.237	1.878	-4.296	-1.816	-2.429	0.401
Bulb diameter	-0.979	-2.247	-1.693	2.938	-0.437	0.011	0.677	-2.256	4.415	0.382	0.835	-2.228	-2.751	-1.489	0.720
Bulb width	0.957	2.448	1.978	-8.578	-1.824	-1.460	-1.098	0.944	-0.483	-0.074	-0.059	3.908	3.618	1.117	0.401
Days to 80% Maturity	-1.651	7.258	-3.684	-18.588	3.385	-8.447	11.120	-2.106	1.895	12.431	-7.800	2.606	1.315	4.030	0.346
Weight of whole cluster	0.748	-1.940	-0.027	11.402	3.085	0.990	-2.019	-1.439	0.474	-2.441	3.890	2.046	2.675	-0.631	0.990
Fresh wt.	-0.761	-1.602	-0.394	1.307	1.070	-0.938	0.793	0.659	-5.404	0.140	0.351	0.668	0.638	0.932	-0.572
Dry matter content	-3.308	-6.076	-0.706	5.401	5.065	-4.054	1.645	3.998	-24.572	0.347	2.255	3.134	3.279	4.466	0.567
Bulb size	-3.928	5.456	1.119	-12.306	12.804	-7.198	8.169	8.036	-28.170	3.947	-1.975	17.001	16.583	12.172	0.336

Residual effect: 0.3024

Table 6: Clustering pattern of 20 genotypes of spring onion(*Allium chinense*) on the basis of genetic divergence

Cluster number	**Number of genotypes**	**Genotypes**
Cluster I	8	Khouvei-4, khouvei-5, Lasen-1, Khuba-2, Khuva, Aüshih, Morükyüm-1, Khouvei-8
Cluster II	8	Khuba-2,Aüshih, Morükyüm 2, Morükyüm-3, Khouvei-6, Zhiyü, Khouvei-7, Lasen
Cluster III	2	Khouvei-2, Alulasing
Cluster IV	2	Khouvei-1, Khouvei-3

Table 7: Average inter and intra cluster distance of 20 spring onion (*Allium chinense*)

Cluster number	**Cluster I**	**Cluster II**	**Cluster III**	**Cluster IV**
Cluster I	**11.29**	49.01	**104.15**	81.86
Cluster II		**10.26**	56.52	34.26
Cluster III			**9.01**	23.09
Cluster IV				**0**

Table 8: Cluster wise mean value of 20 genotypes of Spring onion (*Allium chinense*)

Characters/ cluster	No. of leaves	Leaf length (cm)	Leaf diameter (cm)	Pseudostem length (cm)	Pseudostem diameter (cm)	No. of cluster	Bulb height (cm)	Bulb diameter (cm)	Bulb width neck (cm)	Days to 80% Maturity	Weight of whole cluster (g)	Fresh wt. (g)	Dry matter content (g)	Bulb size (cm)	Yield per plot(g)
Cluster I	6.4	27.12	0.34	2.92	0.49	8.53	2.26	1.62	0.79	172.17	205.96	21.75	7.02	5.08	487.81
Cluster II	6.7	26.83	0.33	3.04	0.49	9.19	2.09	1.39	0.9	163.87	210.46	22.43	7.35	4.71	599.44
Cluster III	6.07	28.31	0.32	3.24	0.47	14.47	2.04	1.68	0.77	154.44	102.33	19.7	6.51	3.44	190.04
Cluster IV	6.2	27.86	0.32	2.72	0.47	11.13	2.14	1.37	0.83	158.13	263.67	24.08	7.74	5	650.37

Table 9: Contribution of each character towards divergence

Source	**Times Ranked 1st**	**Contribution %**	**Source**	**Times Ranked 1st**	**Contribution %**
No. of leaves	0	0.00%	Bulb width of neck (cm)	0	0.00%
Leaf length (cm)	9	1.00%	Days to 80% Maturity	178	93.68%
Leaf diameter (cm)	0	0.00%	Weight of whole cluster(g)	0	0.00%
Pseudostem length (cm)	0	0.00%	Fresh wt. (g)	0	0.00%
Pseudostem diameter (cm)	0	0.00%	Dry matter content (g)	3	1.58%
No. of cluster	1	0.53%	Bulb size (cm)	7	2.68%
Bulb height (cm)	0	0.00%	Yield per plot (g)	1	0.53%
Bulb diameter (cm)	0	0.00%			