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Multivariate Analysis and Its Application for Characterizing Cowpea Landraces

M.S. Iqbal[1,2], M. Akbar[1], S. Akhtar[1], S. Fatima[1], A. Ghafoor[3]

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ABSTRACT

Background: Several major crops have been genetically eroded due to introduction of new material but cowpea have great potential and wide genetic base of novel significance. A new strategy of cowpea evaluation was adopted to investigate the potential of 71 landraces representing 31 districts of Pakistan through multivariate analysis to devise future plan for germplasm conservation.

Methods: Cowpea 71 landraces collected from 31 districts were planted under field conditions in an augmented design. Plant descriptors qualitative traits (plant color, leaf shape, plant type, twining tendency, anthocynin pigment and fodder types) and agronomic traits (plant height, branches, pods, grain yield, biomass and harvest index) were recorded. Protein banding pattern was established. Similarity index, variance were calculated and phylogenetic trees were constructed by software "Statistica".

Result: Four cowpea landraces showed tremendous performance to phenotypic as well as protein banding pattern variation *viz*., Pk-27154 (Jhang), Pk-27047 (Vehari), Pk-27029 (Sialkot) and Pk-27107 (Bahawalpur). High inter and intra variation suggested further genotype x environmental interaction trials at multi-locations. Sampling from the neglected areas especially Sindh and Baluchistan parts are hereby recommended to gather unique landraces and accessions before the genetic resources might be depleted through various environmental stresses.

Key words: Cowpea, Multivariate analysis, Plant genetic resources.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walpers] is widely cultivated legume in tropics and sub tropics especially Africa, Asia, Central and South America (Muchero *et al*., 2013). It contributes to food and nutritional security, fodder, soil fertility, income for farmers and food vendors (Fatokun *et al*., 2018). According to FAO 5.8 million tons of dry cowpea cereal is produced annually from 11 million hectares planted all over the world.

Cowpea is a composition of carbohydrates (63%), proteins (25%), fat (1.5%), vitamins, minerals, folate, thiamin and riboflavin (Xiong *et al*., 2016). In Pakistan it is cultivated in Khyber Pakhtun Khaw and Punjab on an area of 16.9 thousand hectares with an annual production of 7.8 thousand metric tons (Iqbal *et al*., 2017). Genetic resources conservation and preservation is an integral part of socioeconomic activities, its sustainable utilization keep balance of natural resources.

Although concentrations are concentrating more on molecular and recombination techniques to bring breakthroughs but facing challenges of rapid rate of biodiversity loss. Efforts are devoted towards preserving available genetic resources in gene banks, herbariums and breeders' collections. It is imperative to have accurate and better understanding of breeding material to develop desirable or target traits to achieve crop improvement objectives (Singh, 1997). It is reported that in the last few decades, Indonesia and China have lost 1,500 local rice and 651 soybean varieties. Cowpea in Asian countries have a very long domestication history that also poses similar threats (Fang *et al*., 2007). Therefore, protection, research, development and utilization are extremely important for cowpea breeding.

[1]Department of Botany, University of Gujrat, Gujrat, Pakistan.
[2]Plant Biology Section, Cornell University, Ithaca, NY, USA.
[3]Plant Genetic Resources Program, PARC, Islamabad, Pakistan.

Corresponding Author: M.S. Iqbal, Department of Botany, University of Gujrat, Gujrat, Pakistan. Email: mi254@cornell.edu

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Additionally, major crops like chickpea, maize, rice, soybean and wheat have been genetically eroded due to introduction of new material but crops like cowpea due to negligence (underutilized crops) still have great opportunities and genes of novel significance. Multivariate by means of Cluster analysis approach is an appealing technique for germplasm discrimination. Characters like quality characters, nutritional, mineral, protein or even DNA based distributed efficiently in to various groups. It enhances the utility of different groups on priority or performance basis. Present study aims to unveil genetic variability in current collections and to plan a future methodology for catering genetic diversity benefits.

MATERIALS AND METHODS

Cowpea 71 landraces collected from 31 districts were planted at Department of Botany, University of Gujrat, Gujrat, Pakistan. Sowing was accomplished in first week of July in an augmented design while in March 2017, ten single plants

were sampled at random, tagged, harvested and threshed. Progenies were sown under field conditions during July 2017 and harvested in March 2018. Two rows of 4 meter length for each plant progeny were planted with 15 cm and 1 m intra and inter-row spacing with a local check repeated after 10 rows. Data were recorded following IPGRI descriptors for *Vigna unguiculata* (IBPGR, 1983). Selected qualitative traits (plant color, leaf shape, plant type, twining tendency, anthocynin pigment and fodder types) and agronomic traits (plant height, branches, pods, grain yield, biomass and harvest index) were recorded.

Protein banding pattern was obtained by following Laemmli (1970) with some modifications. Similarity index was calculated for all possible pairs of protein types (+/-). Variance based on inter and intra variability with average agronomic performance for individual landraces were analysed (Steel and Torrie, 1980). Phylogenetic trees were constructed with the help of computer software "Statistica" version 6.0.

RESULTS AND DISCUSSION

Cowpea phenotypic diversity

Qualitative traits showed high variation as landraces were collected across the country ranging 100 to 2200 masl. Kurlovich (1998) emphasized phenotypic traits as plant description and consumers preference. Plant color was categorized into pale green in 17 landraces and dark green in 54. Leaf shape was observed at physiological maturity divided into four descriptors (Table 1). 47 landraces were ovate, 8 lanceolate narrow, 10 lanceolate broad whereas 6 lines were as rhombic. Plants with ovate leaf shape were found to be best for moisture absorption and synthesis of food proteins while lanceolate broad and narrow leaf shape is also a distinguishing trait in cowpea which could have the ability to resist drought and hence suggested for future breeding (Iqbal *et al*., 2017). Al-Saady *et al*. (2018) reported significant variation in seed color, seed length, seed width and 100 seed weight in collections of Sultanat of Oman.

All plants were found to be glabrous *i.e*. without hairs (100%) which helps in harvest and trample. In current studies erect plant type was recorded in 50 landraces was dominant trait as compared to prostrate (14), pronounced (2) and spreading (5). Erect plant type is preferred for fodder use and during humid conditions to avail more sunlight while prostrate type is preferred for planting under rainfed conditions as it facilitates moisture uptake and its efficient use. Genetic variation was recorded low in twinning tendency and anthocynin pigment, further evaluation with known material might help to improve this one. 33 landraces were selected as fodder types and 38 as non-fodder. Fodder types can be utilized as dual purpose (Fatokun *et al*., 2018).

Diversity in agronomic traits

Highest plant height mean±SD 177.50+0.57 cm was recorded in Pk-27011 collected from Rawalpindi, with CV as 0.32%. Whereas lowest plant height was recorded in Pk-27096 (Chitral) as 76.33±2.05 cm with CV 2.69%, this trait showed continuous variation (Table 2). Highest number of branches were recorded in Pk-27036 (Rawalpindi) with mean±SD 12.03±1.13 whereas smallest number of branches were recorded in Pk-27078 (Kasur) with mean±SD 3.90±0.16. This trait also couples with low values for pods/ plants, biomass, grain yield and harvest index which showed that number of branches played significant role in biological as well as grain yield of the crop. Pk-27107 Bahawalpur showed best performance for pods per plant (50 pods) followed by Pk-27083 (42 pods) Gujranwala, Pk-27047 Vehari (39 pods) and Pk-27018 Rawalpindi (38 pods), prominently. Harvest index is used as best selection criterion

Table 1: Plant descriptors (qualitative traits) studied in cowpea [*Vigna unguiculata* (L.) Walp.] germplasm consisted of 71 landraces.

Traits	Notions	When and where measured	Classification and frequency in parenthesis
Plant color	PC	After two weeks of germination	Light green (17), dark green (54)
Leaf pigment	LP	After four weeks of germination	present (28), absent (43)
Anthocynin pigment	AP	After six weeks of germination	present (64), absent (7)
Leaf shape	LS	At physiological maturity	ovate (47), lanceolate narrow (8), lanceolate broad (10), rhombic (6)
Twining tendency	TT	At physiological maturity	present (67), absent (4)
Flower color	FC	At 50% flowering	white (26), blue (5), purple blue (39), yellow (1)
Immature pod color	IPC	At pod formation duration	green color (49) light green (16), purple green tip (2), light gree tip (4)
Pod position	PP	After pods formation	erect (26), intermediate (12), pendent (33)
Mature pod color	MPC	At maturity	Cream color (9), spotted cream color (4), brown (39), spotted green (12), violet (7)
Stay green	SG	At maturity	green till mature (45), leaf shatter (26)
Fodder	F	At maturity	Fodder types (33), non-fodder types (38)
Seed color	SC	After harvesting	cream color (30), pink (25), green (4), orange (8), black (4)
Seed shape	SS	After thrashing	Kidney (27), rhomboid (26), ovoid (18)
Eye color	EC	After thrashing	white (4), brown (32), tan brown (17), red (14), green (4)
Seed surface	Ss	After thrashing	smooth (57), wrinkle (14)

Table 2: Means, standard deviation and CV for six traits in 71 cowpea landraces collected from 31 districts.

S. No.	Accession	Collection site	PH	SD	B/p	SD	Pods/p	SD	Biom/p	SD	GY	SD	Hi	SD	CV%
1	27008	Rawalpindi	143.80	0.90	8.13	0.46	26.43	0.86	33.93	0.29	12.11	0.31	36.16	0.61	0.62
2	27009	Chakwal	153.67	1.03	9.13	1.03	35.30	1.03	46.64	1.03	14.24	1.03	31.48	1.03	0.67
3	27010	Rawalpindi	131.67	1.70	6.00	0.82	14.00	0.37	34.21	0.54	6.71	0.21	22.64	0.40	1.29
4	27011	Rawalpindi	177.50	0.57	8.67	1.25	25.00	0.54	46.02	0.23	9.91	0.19	23.77	0.12	0.32
5	27012	Rawalpindi	144.57	1.00	6.53	0.66	20.67	0.37	35.56	0.27	12.23	0.42	34.66	0.16	0.69
6	27018	Rawalpindi	154.97	1.11	8.67	0.78	38.83	0.25	41.87	0.42	12.52	0.39	29.86	0.11	0.72
7	27022	Jehlum	100.47	0.84	6.40	0.93	8.60	0.24	36.17	0.86	7.60	0.22	26.01	0.16	0.83
8	27025	Jehlum	113.30	0.91	7.17	0.76	5.60	0.24	32.59	0.18	7.51	0.29	23.62	0.13	0.80
9	27028	Sialkot	117.47	0.83	9.07	0.86	23.67	0.42	39.27	0.29	16.41	0.30	41.64	0.36	0.71
10	27029	Sialkot	132.47	0.82	10.79	1.38	29.27	0.31	44.84	0.07	19.11	0.69	40.90	0.24	0.62
11	27036	Rawalpindi	132.03	2.15	12.03	1.13	30.57	0.34	48.59	0.40	21.99	0.56	44.88	0.20	1.63
12	27038	Rawalpindi	135.67	1.25	9.10	0.16	29.83	0.25	53.51	0.48	18.98	0.21	35.69	0.19	0.92
13	27039	Rawalpindi	120.80	1.71	9.93	0.29	20.90	0.43	34.79	0.15	13.69	0.50	37.92	0.19	1.42
14	27040	Rawalpindi	123.57	1.11	9.53	0.33	25.53	0.41	46.93	0.29	18.98	0.27	40.82	0.58	0.90
15	27041	Muzaffer Garh	133.03	1.30	9.50	0.41	19.50	0.33	32.29	0.39	12.96	0.13	41.11	0.64	0.98
16	27042	Rawalpindi	123.67	3.23	9.57	0.41	23.63	0.25	39.17	0.37	15.57	0.24	39.80	0.24	2.61
17	27043	Lodhran	99.53	0.78	9.67	0.37	20.87	0.17	46.38	0.43	14.70	0.22	32.23	0.57	0.79
18	27044	Bahawalpur	133.47	1.22	11.30	0.29	19.83	0.21	27.76	0.51	12.51	0.34	44.70	0.22	0.92
19	27045	Bahawalpur	123.03	1.60	9.41	0.11	20.84	0.13	43.57	0.31	14.26	0.30	32.63	0.28	1.30
20	27047	Vehari	140.53	1.70	8.07	0.39	39.73	0.12	59.02	0.71	16.57	0.30	29.83	0.30	1.21
21	27052	Chakwal	123.73	1.60	7.25	0.55	33.84	0.27	75.81	0.58	10.35	0.31	12.99	0.21	1.29
22	27064	Islamabad	93.50	1.61	6.81	0.13	7.34	0.14	45.36	0.39	1.78	0.38	4.63	0.41	1.72
23	27075	Lahore	113.90	1.80	5.64	0.24	6.60	0.43	46.95	0.49	3.33	0.38	5.84	0.22	1.58
24	27076	Lahore	107.77	1.28	4.99	0.15	11.80	0.18	12.85	0.74	3.70	0.26	30.96	0.17	1.19
25	27077	Lahore	135.60	0.88	7.87	0.34	20.57	0.25	63.51	0.80	5.13	0.25	8.91	0.20	0.65
26	27078	Kasur	85.03	2.21	3.90	0.16	7.47	0.25	7.60	0.21	1.70	0.16	19.17	0.41	2.60
27	27081	Kasur	119.70	1.44	7.57	0.29	18.80	0.16	71.19	0.37	7.62	0.31	10.58	0.33	1.21
28	27082	Kasur	79.93	1.29	6.53	0.41	16.13	0.17	14.03	0.57	3.96	0.13	30.52	0.29	1.62
29	27083	Gujranwala	115.13	1.23	8.03	0.26	42.93	0.12	35.71	0.10	18.53	0.48	35.93	0.21	1.07
30	27084	Sahiwal	115.23	0.62	8.50	0.41	19.43	0.26	16.18	0.78	6.36	0.30	41.22	0.78	0.54
31	27087	Khushab	101.83	1.07	7.73	0.17	12.87	0.17	11.29	0.29	4.10	0.36	33.81	0.35	1.05
32	27088	Okara	98.20	0.73	5.37	0.41	21.53	0.29	32.50	0.33	9.26	0.44	28.22	0.33	0.75
33	27089	Gujranwala	106.00	1.15	7.77	0.12	16.60	0.24	37.53	0.38	13.40	0.20	35.77	0.12	1.09
34	27091	Gujrat	102.87	1.08	7.80	0.16	19.57	0.21	48.24	0.30	14.50	0.37	29.56	0.11	1.05
35	27093	Haripur	109.20	1.06	7.00	0.82	16.60	0.29	37.15	0.54	6.80	0.14	20.91	0.14	0.97
36	27094	Quetta	95.33	1.51	7.00	0.82	15.13	0.25	17.78	0.27	6.02	0.23	32.86	0.22	1.58
37	27095	Loralai	140.23	1.47	6.20	0.01	10.75	0.16	35.99	0.11	5.70	0.16	18.98	0.58	1.05

Table 2: Continue...

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38	27096	Chitral	76.33	2.05	6.40	0.24	18.63	0.21	38.20	0.29	12.49	0.39	30.76	0.14	2.69
39	27097	Chitral	115.73	1.58	5.63	0.17	18.27	0.39	37.79	0.31	16.53	0.27	36.76	0.60	1.36
40	27098	Chitral	94.17	1.59	8.57	0.29	18.27	0.33	49.45	0.36	8.97	0.26	19.33	0.33	1.69
41	27099	Sheikhupura	110.43	2.14	6.80	0.05	10.70	0.16	66.01	0.23	9.83	0.12	16.63	0.31	1.93
42	27102	Gilgit	109.17	1.67	7.86	0.10	4.84	0.13	23.93	0.18	2.04	0.19	8.04	0.07	1.53
43	27106	Layyah	144.67	1.25	7.33	0.17	3.56	0.39	34.70	0.19	3.94	0.12	10.99	0.11	0.86
44	27107	Bahawalpur	130.33	1.25	7.47	0.29	50.67	0.45	69.84	0.37	18.93	0.12	29.63	0.32	0.96
45	27115	Mansehra	147.33	2.62	8.60	0.16	9.97	5.78	55.65	0.40	5.80	0.06	9.93	0.10	1.78
46	27116	Swat	130.73	1.52	7.13	0.26	17.70	0.16	52.68	0.17	7.01	0.16	12.76	0.10	1.16
47	27118	Swat	116.37	0.60	8.53	0.39	14.57	0.29	37.73	0.13	6.65	0.28	17.96	0.15	0.52
48	27119	Mansehra	112.27	2.10	6.09	0.17	8.79	0.15	58.05	0.20	10.37	0.28	17.73	0.17	1.87
49	27120	Mansehra	113.90	2.54	8.53	0.25	6.80	0.24	35.97	0.25	1.97	0.12	5.98	0.13	2.23
50	27121	Dir	106.63	1.14	7.60	0.16	15.13	0.48	43.56	0.70	4.39	0.26	11.05	0.31	1.07
51	27122	Dir	101.33	1.47	6.77	0.12	8.27	0.33	24.51	0.29	6.15	0.21	29.90	0.17	1.45
52	27123	Dir	132.63	2.36	7.70	0.16	9.83	0.34	32.20	0.37	5.84	0.14	17.10	0.60	1.78
53	27124	Dir	97.00	1.63	5.70	0.22	8.53	0.21	19.75	0.38	6.57	0.23	33.70	0.20	1.68
54	27125	Chitral	122.33	2.49	7.07	0.12	9.13	0.21	31.18	0.44	3.80	0.14	13.13	0.31	2.04
55	27126	Chitral	107.77	1.72	6.69	0.14	8.00	0.08	21.51	0.31	2.98	0.19	11.08	0.31	1.60
56	27127	Chitral	117.50	1.36	6.03	0.26	12.63	0.21	28.50	0.41	6.02	0.14	24.24	0.25	1.16
57	27140	Dir	135.33	1.47	9.47	0.21	24.97	0.25	58.46	0.29	12.22	0.46	21.26	0.38	1.09
58	27142	Multan	104.47	1.35	9.64	0.09	22.70	0.16	21.86	0.76	5.23	0.42	27.53	0.37	1.29
59	27143	Bahawalpur	129.17	1.67	9.47	0.21	19.87	0.21	20.99	0.29	4.70	0.27	28.58	0.30	1.30
60	27144	Lahore	146.90	1.75	9.57	0.29	26.73	0.21	26.94	0.47	7.16	0.44	25.72	0.17	1.19
61	27145	Gujranwala	127.20	1.68	8.53	0.33	18.27	0.33	25.93	0.74	7.66	0.32	28.91	0.08	1.32
62	27149	Dir	124.03	2.46	10.41	0.13	14.38	0.27	45.25	0.66	3.38	0.25	7.17	0.12	1.98
63	27151	Dir	118.40	1.48	5.57	0.29	21.93	0.29	25.17	0.72	6.54	0.21	27.53	0.18	1.25
64	27154	Jhang	151.67	2.23	11.71	0.11	7.86	0.11	37.65	0.54	3.20	0.30	7.87	0.05	1.47
65	27158	Faisalabad	100.53	1.09	5.26	0.20	18.10	0.24	17.45	0.27	5.66	0.20	31.71	0.12	1.08
66	27160	Okara	121.23	3.04	6.37	0.41	18.27	0.33	24.40	0.36	6.90	0.25	29.73	0.23	2.51
67	27161	Pakpattan	96.43	4.55	6.35	0.42	15.05	5.59	30.51	0.31	7.41	1.06	20.62	5.08	4.71
68	27170	Dir	123.53	1.68	9.45	0.08	16.24	0.25	49.47	0.43	2.34	0.32	3.87	0.19	1.36
69	27171	Chitral	105.67	2.05	8.01	0.07	9.86	0.06	44.89	0.29	2.47	0.25	6.94	0.20	1.94
70	27172	Chitral	105.97	1.84	8.30	0.37	8.47	0.33	64.92	0.42	2.07	0.21	6.34	0.18	1.74
71	Check	Narowal	111.03	1.27	8.60	0.33	27.60	0.41	99.23	0.73	6.01	0.15	10.11	0.10	1.14

PH: Plant height; SD: Standard Deviation; B/p: Branches/plant; Pods/p: Pods/plant; Biom/p: Biomass/plant; GY: Grain yield; HI: Harvest index; CV%: Coefficient of Variation in percentage.

Table 3: Best performer landraces of cowpea based on quantitative traits.

Plant height (gram)	27011 Rawalpindi 177.5, 27018 Rawalpindi 154.9, 27009 Chakwal 153.6, 27154 Jhang 151.6, 27115 Mansehra 147.3
Branches/plant (Number)	27036 Rawalpindi 12.0, 27154 Jhang 11.7, 27044 Bahawalpur 11.3, 27029 Sialkot 10.7, 27149 Dir 10.4
Pods/plant (Number)	27107 Bahawalpur 50.6, 27083 Gujranwala 42.9, 27047 Vehari 39.7, 27018 Rawalpindi 38.8, 27009 Chakwal 35.3
Biomass/plant (grams)	Check Narowal 99.2, 27052 Chakwal 75.8, 27081 Kasur 71.2, 27107 Bahawalpur 69.8, 27099 Sheikhupura 66.0
Grain yield (grams)	27029 Sialkot 19.1, 27040 Rawalpindi 18.9, 27038 Rawalpindi 18.9, 27107 Bahawalpur 18.9, 27083 Gujranwala 18.5
Harvest index (per cent)	27170 Dir 3.8, 27064 Islamabad 4.6, 27075 Lahore 5.8, 27120 Mansehra 5.9

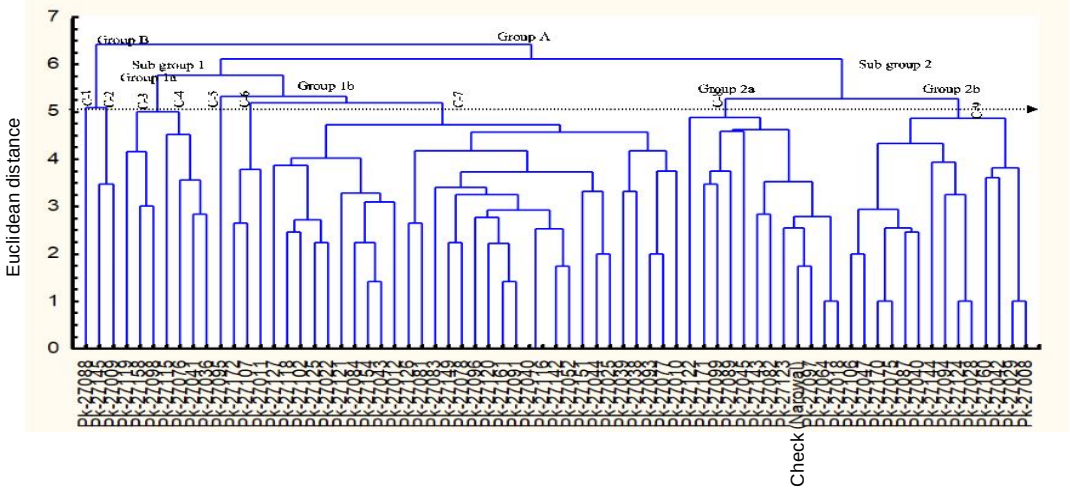


Fig 1: Phylogenetic tree for 71 landraces of cowpea for qualitative traits based on UPGMA.

for legumes. Lowest harvest index 3.87% was calculated in Pk-27170 collected from Dir, followed by Pk-27064 (Islamabad) with 4.63% for best one performance for future improvement are suggested (Ajayi and Adesoye, 2013). Doumbia *et al*., (2013) emphasized selection of discriminating traits between and within local and regional gene banks.

Four genotypes showed best performance; Pk-27154 (Jhang), Pk-27047 (Vehari), Pk-27029 (Sialkot) and Pk-27107 (Bahawalpur) as in Table 3. Pk-27047 was chooses for four traits plant height, pods, biomass and grain yield per plant whereas Pk-27029 for three traits branches, pods and grain yield. Five landraces were selected on the bases of high yield out of 71, *viz.*, Pk-27029 Sialkot 19.11g, Pk-27040 Rawalpindi 18.98 g, Pk-27038 Rawalpindi 18.98 g, Pk-27107 Bahawalpur 18.93 g, Pk-27083 Gujranwala 18.53 g, are hence recommended for crop improvement. Accessions understudies might also test and trialed at various locations to unveil the hidden potential is therefore suggested (Akhtar *et al*., 2019; Karigiotidok *et al*., 2019).

Multivariate analysis based on qualitative traits

Nine clusters were formed, cluster 7 was the largest with 31 landraces that represented Punjab (20), KPK (10) and GB (1) showed dissimilarities out of clusters (Fig 1). Cluster 9 consisted of 14 landraces including 11 Punjab, 2 KPK and 1 from Baluchistan. Whereas in the cluster 1, 1 Okara (Punjab) and in cluster 5, 1 landrace from Loralai (Baluchistan), showed variability for qualitative traits. Pigeon peas and cowpeas are known to grown at low elevations while common beans, are adapted to higher elevations, indicates that genetic material is introduced from foothills of KPK to high mountains of KPK and GB (Iqbal *et al*., 2003b). In another study Xiong *et al*., (2016) also reported no clustering based on origin of country, however, it seems difficult to separate ecogeographic factors in plants with respect to genetic diversity.

Multivariate analysis based on quantitative traits

Out of 8 clusters largest was C-5, 34 including 1 Islamabad, 16 Punjab, 15 KPK, 1 Baluchistan and 1 from GB showed similarities and harmony (Fig 2). This cluster represented almost all provinces except Sindh and AJK. C-4, 2 landraces both from Kasur (Punjab) with unique characteristics. C-8 was the interesting one, have one landrace of KPK whereas others all were from Punjab, rich cultivated areas hub of the most of the primitive land races of different species. Though cluster analysis grouped together landraces with greater morphological similarity, the cluster did not necessarily include all of the landraces from the same or nearby sites. It is evident that diverse landraces could tolerate stresses as compared to landraces with narrow genetic base

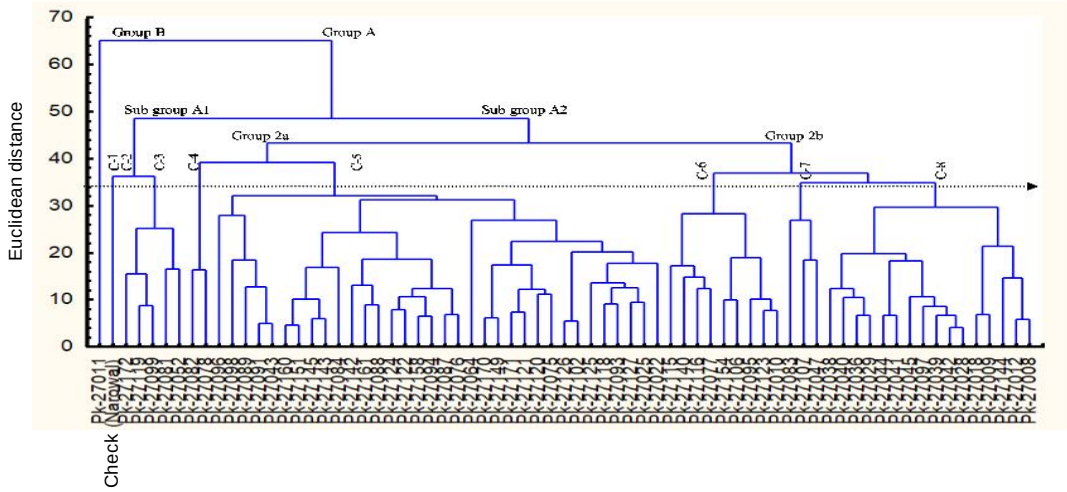


Fig 2: Phylogenetic tree for 71 landraces of cowpea for quantitative traits based on UPGMA.

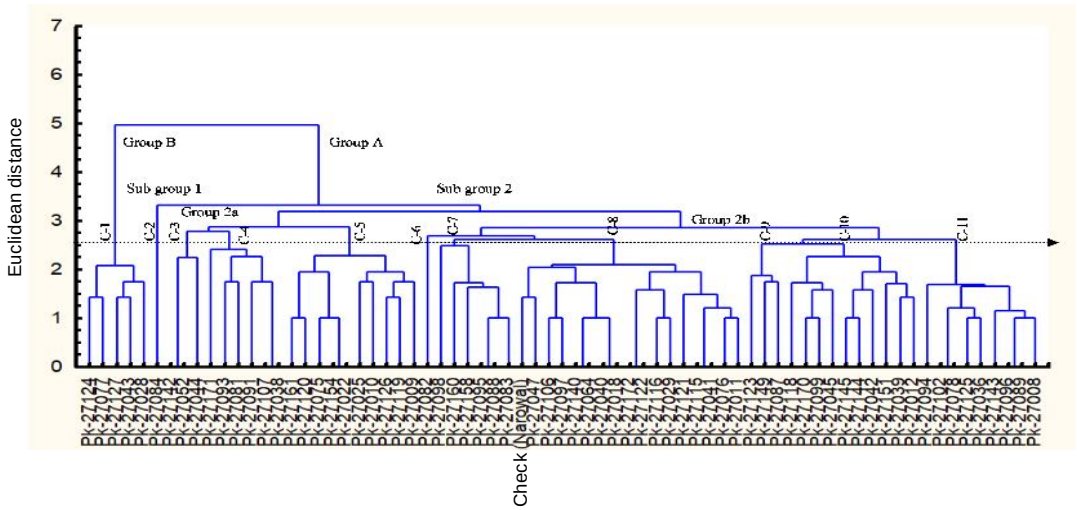


Fig 3: Phylogenetic tree for 71 landraces of cowpea for seed protein peptide variation based on UPGMA.

(Kouam *et al*., 2018). Cowpea, locally known as dal lobia and safaid lobia is nutritious, local germplasm has ability to cater nutritious requirements of the increasing population therefore, it is suggested to explore more remote areas across country.

Multivariate analysis of protein peptides

Eleven clusters were formed based on eleven protein peptide bands ranging from 0.6 Kd to 66.0 Kd, cluster 8 was the largest consisted of 13 landraces, in which check (Narowal) present along with 1 landrace from Islamabad, Chitral (2), Dir (3), Rawalpindi (3) and one each from other districts (Fig 3). Low level of variability in banding pattern might be due to lesser representation of material from Islamabad, Gilgit Baltistan and Baluchistan (Alghamdi *et al*., (2019). SDS-PAGE showed a low level of diversity in our accessions, but higher than in other legumes and it can be increased by the addition of more extensively sourced germplasm (Iqbal *et al*., 2003a). Pk-27082 (Kasur) was present in separate clusters in both total seed protein peptide banding pattern and quantitative traits basis. Favoring current findings, Fatokun *et al*. (2018) also elaborated that IITA's cowpea collection did not necessarily grouped in the same cluster according to countries of origin, geographically with agronomic and botanical descriptors (Xiong *et al*., 2016; Manjesh *et al*., 2019).

CONCLUSION

In conclusion four accessions Pk-27029, Pk-27047, Pk-27107 and Pk-27154 showed best performance are therefore recommended for crop improvement.

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