Research Article

Tracking agronomic diversity in land races of cowpea [*Vigna unguiculata* (L.) Walpers] collected from Pakistan

Muhammad Sajjad Iqbal¹, Abdul Ghafoor², Sammer Fatima^{1*}, Shamim AKhtar¹, Muhammad Akbar¹ and Ejaz Hussain Saddiqi¹

1. Department of Botany, University of Gujrat, Gujrat, 50700-Pakistan

2. Plant Genetic Resources Institute, National Agricultural Research Centre, Islamabad-Pakistan

*Corresponding author's email: sammer.fatima@uog.edu.pk

Citation

Muhammad Sajjad Iqbal, Abdul Ghafoor, Sammer Fatima, Shamim AKhtar, Muhammad Akbar and Ejaz Hussain Saddiqi. Tracking agronomic diversity in land races of cowpea [*Vigna unguiculata* (L.) Walpers] collected from Pakistan. Pure and Applied Biology. Vol. 6, Issue 4, pp1260-1268. <http://dx.doi.org/10.19045/bspab.2017.600134>

Received: 25/05/2017

Revised: 20/09/2017

Accepted: 25/09/2017

Online First: 27/09/2017

Abstract

Seventy one accessions of *Vigna unguiculata* (L.) Walpers belonging to 31 districts of three provinces across Pakistan were characterized. High variation was recorded in plant height, branches per plant, pods per plant, grain yield, biomass and harvest index. It has been derived from current studies that migration of germplasm or seeds were observed across various areas that might be due to frequent exchange of grains, between different markets and transportation without any provincial laws implementations. High phenotypic diversity indicates the potential land races collected from farmer's field might be utilized for crop improvement programs viz., 27028, 27029, 27038, 27040, 27042, 27047, 27083 and 27097. Phenotypic diversity analyzed within each district indicated the possibility of migration of landraces at one hand and on the other hand variation appears attributable to different districts without influence that how frequently area was explored. Intra and inter-specific variances deviated from central tendency depicted on the map of Pakistan shall be proved beneficial for future germplasm collectors to devise strategy for collecting genes of interest. New expeditions may be conducted in the main cowpea growing areas with focusing geographically and ecologically distinct areas, rather than fields closer to motorable roads.

Keywords: Underutilized crops; Legumes; Landraces; Genetic diversity

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is an underutilized crop of tropical Africa, Asia, Central and South America [1, 2]. The crop is well adapted to diverse environmental conditions and can be easily grown in poor soils and semi arid regions [3]. It is rich in protein contents ranging from 22.5 to 25.6 %. Number of vitamins and minerals are

present in cowpea that makes it vital for human and animal dietary needs [4-6]. Despite its importance, the production of cowpea ranges from half to one tonne per hectare that is very low as compared to its potential [7]. It is cultivated on marginal soils in Pakistan, especially in NWFP and Northern Punjab on an area of 16.9 thousand hectares with an annual production of 7.8

thousand metric tonnes [8]. To cater biodiversity impact for socioeconomic values is based on indigenous genetic resources whereas information about agrobobotanicals is pre-requisite for collecting highest diversity and to devise a fruitful strategy for future collections [9-11].

Intra and inter specific variation played significant role in the improvement of agrobobotanical traits. Rate of loss of biodiversity have been studied throughout the world and efforts have been made to preserve the existing biodiversity by means of gene banks, ex-situ conservation at farmer's field, world herbaria and botanical museums by breeders and biologists. During last three decades eighty cowpea accessions have been collected and stored for short duration (5-10 years) at 5°C, medium term (15-20 years) at 0°C and long term (more than 50 years) at -20°C. These are suggested to be used for evaluation, characterization and planning future strategies for further collections. The cowpea is a neglected crop having potential to become more useful as its genetic diversity is preserved under CBD (Convention on Biological Diversity), whereas major crops like wheat, rice, chickpea and maize have been genetically eroded due to evolution of new cultivars. The aim of the current study was to uncover intra-accession variability occur in collections of 31 districts of three provinces with respect to agronomic traits. It will enable for developing future strategy to preserve high variation with respect to the needs of the growing population.

Materials and methods

Seventy one (71) landraces, collected predominantly from farmers' fields in 31 districts of three provinces were characterized for agronomic traits to choose high yielding landraces and to make future germplasm collection strategy. During 2013, 71 land races were planted in an augmented design with three replications in the mid of October. Ten single plants from all the

accessions were sampled at random, tagged, harvested and threshed individually. Progenies of these individual plants were sown under field conditions during October 2014 and harvested in March 2015. Bed length was maintained at 4 meter, whereas two rows of each accession were planted with 1 meter intra and inter row distance. Plant to plant spacing was kept as 15 cm. After 10 rows, a local check was repeated. Pesticides were sprayed to protect the crop from pests especially white fly (*Bemisia tabaci* Genn.), a vector for Mungbean Yellow Mosaic Virus (MYMV). Data was recorded following IPGRI descriptors for *Vigna unguiculata* (IBPGR 1983). Agronomic traits including plant height (cm), branches/plant (number), pods/plant (number), grain yield (g) and biomass yield (g) were recorded. Harvest index was calculated as grain yield over biomass in percentage.

Data recorded were then subjected to statistical analysis by means of variance to find intra and inter-specific variation along with average agronomic performance for individual accessions with deviation from central tendency using the methods provided by Steel and Torrie [12]. Further, variance was derived from summery of statistics and then presented as percent of mean for all characters. Aggregated variances were then calculated for each set of accession, as collections were made from 31 districts. Standard deviation from aggregated variance were taken as an indicator for genetic biodiversity which are represented as in percentage plant samples differed i.e., from none to 100 percent and consequently depicted on the map along with total number of accessions.

Results and discussion

Average data in 71 accessions collected from 31 districts of Pakistan along with standard error and deviation from means for all the six traits viz., plant height/plant, branches/plant, pods/plant, grain yield/plant,

biomass/plant and harvest index/plant is presented in Table 1. It is obvious from the results that almost all the characters exhibited a wide inter-accession range which reflecting an idea to choose accessions for high genetic potential. Although variation within accessions was statistically insignificant for most of the accessions but higher magnitude for variation that is reflected in deviation from central point indicated the presence of land races or heterogeneous mixture of homozygous lines (Table 2). Five accessions, 27009, 27029, 27038, 27083 and 27097 gave high yield along with high intra-accession variation that could be evaluated to isolate superior plant progenies within these accessions. Further it could help in identifying plants to be used in hybridization for cowpea improvement.

For strengthening gene pool one way is to collect material from geographically diverse origins from proposed centers of diversity in case of individual samples. Authentic samples from the complete geographical range of the crop species can help maintaining conservation of co-adapted genes [13-15]. Cowpea is an important summer pulse crop and widely cultivated under rainfed areas. Current collection was made from different areas of the country with more emphasis have been provided to those areas which were closer and approachable to motorable roads, that is also indicated in intra accession variance. One of the reasons might be strategy to provide first priority to those areas which are easily approachable and more prominent to genetic erosion and have adaptability to accept advanced breeding material near major towns and cities. Alternatively to gather

maximum diversity, it is important to plan and explore those areas which are not explored earlier, preferably like interior territories, remote areas, cross border and mountainous areas.

On the basis of correlation results, pods were observed as the best basic criteria for selection in almost all the collection districts except material from Gujrat, Jhang, Mansehra, Muzzafargarh and Pakpattan (Table 2). This might be due to less presentation of area for diversity or uniformity of germplasm collected from these areas. The accessions collected from the districts of Chakwal, Dir, Faisalabad, Jehlum, Lahore, Loralai, Muzzafargarh, Okara, Sheikhpura and Swat were observed low for variance that indicated less representation of these areas although high number of accessions were collected from some of these districts (Figure 1). It could be explained as those maximum accessions might be pure lines with common ancestors. Another threat is exchange of material is frequent within and between various districts which violates seed quarantine laws.

Genetic variation played key role in the determination of genetic diversity (phenotypic & genotypic) within and between collection sites and it also has expresses an indication for heritable characters potential as reported in brassica [16] barley [17], lentil [18], lupin [19], soybean [20] and cowpea [2, 7]. The variation indicated by the quantitative traits is useful in focusing and designing strategies for exploring and preserving the regions of high genetic diversity. Current findings also support cowpea genetic diversity with respect to the center of genetic diversity [21].

Table 1. Means along with standard error and deviation for six traits in 71 accessions of cowpea collected from Pakistan

Accession	Collection site	Plant height	σ	Branches/plant	σ	Pods/plant	σ	Biomass/plant	σ	Grain yield	σ	Harvest index	σ
27008	Rawalpindi	142.7 $\pm$ 6.35	20.09	7.5 $\pm$ 0.77	2.46	25.4 $\pm$ 3.2	10.15	33.6 $\pm$ 4.32	13.66	11.81 $\pm$ 1.55	4.92	35.51 $\pm$ 2.19	6.93
27009	Chakwal	152.3 $\pm$ 6.11	19.33	8.7 $\pm$ 0.53	1.70	34.3 $\pm$ 5.59	17.69	45.95 $\pm$ 9.21	29.14	13.83 $\pm$ 2.65	8.39	31.24 $\pm$ 2.71	8.58
27010	Rawalpindi	130.0 $\pm$ 9.49	30.04	5 $\pm$ 0.59	1.88	13.6 $\pm$ 0.93	2.95	33.55 $\pm$ 4.97	15.73	6.47 $\pm$ 0.39	1.23	22.08 $\pm$ 2.74	8.67
27011	Rawalpindi	176.8 $\pm$ 13.25	41.90	7 $\pm$ 0.61	1.94	24.3 $\pm$ 2.92	9.25	45.76 $\pm$ 7.12	22.53	9.66 $\pm$ 1.17	3.72	23.6 $\pm$ 2.74	8.68
27012	Rawalpindi	143.5 $\pm$ 13.21	41.80	5.8 $\pm$ 0.61	1.93	20.2 $\pm$ 2.6	8.23	35.23 $\pm$ 6.04	19.10	11.77 $\pm$ 1.74	5.50	34.53 $\pm$ 2.13	6.75
27018	Rawalpindi	153.7 $\pm$ 6.08	19.25	7.7 $\pm$ 0.65	2.06	38.5 $\pm$ 6.69	21.16	41.42 $\pm$ 7.89	24.96	12.03 $\pm$ 1.88	5.95	29.72 $\pm$ 1.45	4.61
27022	Jehlum	99.6 $\pm$ 6.42	20.32	5.1 $\pm$ 0.31	0.99	8.3 $\pm$ 1.35	4.30	35.1 $\pm$ 4.71	14.90	7.36 $\pm$ 1.16	3.67	25.81 $\pm$ 4.54	14.36
27025	Jehlum	112.1 $\pm$ 10.72	33.92	6.4 $\pm$ 0.47	1.50	5.3 $\pm$ 1.39	4.40	32.35 $\pm$ 5.52	17.47	7.18 $\pm$ 1.17	3.72	23.44 $\pm$ 3.19	10.09
27028	Sialkot	116.3 $\pm$ 4.69	14.84	8 $\pm$ 0.64	2.05	23.1 $\pm$ 1.82	5.78	38.9 $\pm$ 1.79	5.68	16.05 $\pm$ 1.5	4.75	41.25 $\pm$ 6.67	21.12
27029	Sialkot	131.5 $\pm$ 12.41	39.27	9.48 $\pm$ 0.7	2.24	29 $\pm$ 4.49	14.22	44.74 $\pm$ 3.8	12.03	18.21 $\pm$ 2.76	8.74	40.68 $\pm$ 14.28	45.16
27036	Rawalpindi	129.1 $\pm$ 9.43	29.84	10.5 $\pm$ 0.61	1.96	30.1 $\pm$ 2.03	6.42	48.03 $\pm$ 2.23	7.06	21.44 $\pm$ 1.8	5.70	44.63 $\pm$ 5.52	17.49
27038	Rawalpindi	134.0 $\pm$ 15.17	47.99	8.9 $\pm$ 0.82	2.60	29.5 $\pm$ 5.12	16.22	52.85 $\pm$ 3.64	11.51	18.72 $\pm$ 2.62	8.32	35.42 $\pm$ 23.54	74.47
27039	Rawalpindi	119.0 $\pm$ 9.87	31.21	9.6 $\pm$ 0.83	2.63	20.5 $\pm$ 2.2	6.98	34.62 $\pm$ 1.08	3.44	13.04 $\pm$ 1.71	5.42	37.66 $\pm$ 13.85	43.80
27040	Rawalpindi	122.1 $\pm$ 10	31.62	9.1 $\pm$ 0.67	2.13	25 $\pm$ 1.04	3.30	46.61 $\pm$ 1.18	3.75	18.65 $\pm$ 0.77	2.44	40.01 $\pm$ 12.84	40.62
27041	Muzaffargarh	131.2 $\pm$ 4.27	13.52	9 $\pm$ 0.64	2.05	19.1 $\pm$ 2.07	6.56	31.75 $\pm$ 1.98	6.27	12.79 $\pm$ 1.16	3.67	40.28 $\pm$ 19.35	61.22
27042	Rawalpindi	119.6 $\pm$ 14.11	44.63	9.1 $\pm$ 0.72	2.28	23.3 $\pm$ 2.07	6.55	38.7 $\pm$ 1.89	6.00	15.29 $\pm$ 0.92	2.93	39.50 $\pm$ 4.38	13.88
27043	Lodhran	98.5 $\pm$ 10.5	33.23	9.2 $\pm$ 0.8	2.53	20.7 $\pm$ 2.66	8.42	45.83 $\pm$ 2.23	7.08	14.44 $\pm$ 2.39	7.58	25.46 $\pm$ 3.51	80.51
27044	Bahawalpur	131.8 $\pm$ 9.49	30.02	11.2 $\pm$ 1.03	3.26	19.6 $\pm$ 2.33	7.40	27.18 $\pm$ 1.46	4.63	12.07 $\pm$ 1.34	4.27	44.40 $\pm$ 9.95	31.48
27045	Bahawalpur	121.4 $\pm$ 4.48	14.19	9.33 $\pm$ 0.63	2.00	20.66 $\pm$ 2.86	9.07	43.14 $\pm$ 1.98	6.27	13.92 $\pm$ 1.4	4.43	32.26 $\pm$ 42.26	133.66
27047	Vehari	138.7 $\pm$ 10.61	33.56	7.7 $\pm$ 0.74	2.36	39.6 $\pm$ 4.17	13.19	58.07 $\pm$ 8.37	26.48	16.16 $\pm$ 1.54	4.88	29.49 $\pm$ 2.14	6.77
27052	Chakwal	121.7 $\pm$ 7.64	24.18	6.55 $\pm$ 0.51	1.64	33.55 $\pm$ 7.45	23.58	75.11 $\pm$ 11.57	36.62	10.11 $\pm$ 2.3	7.30	12.81 $\pm$ 1.82	5.76
27064	Islamabad	91.4 $\pm$ 9.91	31.35	6.66 $\pm$ 0.51	1.63	7.22 $\pm$ 1.78	5.65	44.97 $\pm$ 8.62	27.28	1.25 $\pm$ 0.31	0.99	4.06 $\pm$ 1.58	5.00
27075	Lahore	111.8 $\pm$ 6.79	21.50	5.33 $\pm$ 0.47	1.49	6 $\pm$ 2.25	7.12	46.33 $\pm$ 7.82	24.74	2.94 $\pm$ 1.19	3.77	5.53 $\pm$ 1.43	4.53
27076	Lahore	106.0 $\pm$ 8.13	25.72	4.88 $\pm$ 0.37	1.20	11.55 $\pm$ 1.66	5.27	12.13 $\pm$ 1.9	6.02	3.35 $\pm$ 0.42	1.36	30.8 $\pm$ 3.92	12.41
27077	Lahore	134.4 $\pm$ 12.93	40.90	7.4 $\pm$ 0.4	1.26	20.3 $\pm$ 6.1	19.30	62.43 $\pm$ 9.12	28.84	4.83 $\pm$ 1.43	4.53	8.63 $\pm$ 3.08	9.74
27078	Kasur	82.0 $\pm$ 5.78	18.29	3.7 $\pm$ 0.3	0.95	7.2 $\pm$ 1.94	6.16	7.37 $\pm$ 1.91	6.05	1.5 $\pm$ 0.56	1.78	18.7 $\pm$ 2.75	8.72
27081	Kasur	118.1 $\pm$ 6.97	22.07	7.2 $\pm$ 0.46	1.47	18.6 $\pm$ 3.63	11.48	70.69 $\pm$ 10.69	33.80	7.22 $\pm$ 1.38	4.38	10.18 $\pm$ 1.05	3.33
27082	Kasur	78.2 $\pm$ 6.3	19.95	6 $\pm$ 0.51	1.63	15.9 $\pm$ 3.1	9.83	13.36 $\pm$ 2.23	7.08	3.78 $\pm$ 0.92	2.99	30.17 $\pm$ 4.43	14.03
27083	Gujranwala	113.4 $\pm$ 7.83	24.78	7.8 $\pm$ 0.57	1.81	42.8 $\pm$ 3.99	12.63	50.51 $\pm$ 5.03	15.94	18.17 $\pm$ 3.05	9.64	35.7 $\pm$ 4.07	12.88
27084	Sahiwal	114.7 $\pm$ 10.39	32.88	8 $\pm$ 0.91	2.91	19.2 $\pm$ 3.74	11.86	15.09 $\pm$ 3.77	11.94	6.12 $\pm$ 1.56	4.94	40.21 $\pm$ 1.31	4.14
27087	Khushab	100.6 $\pm$ 9	28.48	7.5 $\pm$ 0.77	2.46	12.7 $\pm$ 1.25	3.97	10.98 $\pm$ 1.26	4.01	3.67 $\pm$ 0.43	1.36	33.36 $\pm$ 1.7	5.38
27088	Okara	97.3 $\pm$ 15.67	49.58	4.9 $\pm$ 0.92	2.92	21.2 $\pm$ 4.05	12.81	32.1 $\pm$ 6.31	19.97	8.89 $\pm$ 1.84	5.82	27.89 $\pm$ 3.71	11.74
27089	Gujranwala	104.5 $\pm$ 2.87	9.09	7.6 $\pm$ 0.33	1.07	16.3 $\pm$ 2.45	7.76	37.05 $\pm$ 2.86	9.07	13.19 $\pm$ 2.14	6.78	35.60 $\pm$ 21.30	67.36
27091	Gujrat	101.7 $\pm$ 9.73	30.78	7.6 $\pm$ 0.63	2.01	19.3 $\pm$ 2.99	9.46	47.84 $\pm$ 2.32	7.34	14.07 $\pm$ 1.49	4.73	29.41 $\pm$ 16.66	52.68
27093	Haripur	107.9 $\pm$ 8.58	27.15	6 $\pm$ 0.61	1.94	16.2 $\pm$ 3.05	9.65	36.47 $\pm$ 7.16	22.66	6.63 $\pm$ 0.87	2.76	20.75 $\pm$ 2.97	9.40
27094	Quetta	93.5 $\pm$ 5.31	16.80	6 $\pm$ 0.66	2.11	14.8 $\pm$ 2.69	8.51	17.46 $\pm$ 2.36	7.48	5.75 $\pm$ 1.09	3.46	32.58 $\pm$ 3.75	11.88

27095	Loralai	138.5±3.57	11.30	6.18±0.51	1.62	10.61±2.03	6.45	35.86±6.61	20.93	5.5±1.03	3.26	18.25±3.86	12.22
27096	Chitral	74.0±9.35	29.59	6.1±0.48	1.52	18.4±3.98	12.62	37.82±6.81	21.55	12.03±3.13	9.92	30.57±3.45	10.92
27097	Chitral	114.2±13.09	41.42	5.4±0.45	1.43	17.9±3.19	10.09	37.38±5.2	16.46	16.25±8.32	26.32	36.42±11.64	36.82
27098	Chitral	92.2±5.7	18.04	8.2±0.99	3.15	17.9±4.01	12.71	49.01±9.53	30.17	8.71±1.54	4.88	18.99±1.72	5.46
27099	Sheikhupura	108.0±7.24	22.90	6.75±0.44	1.39	10.5±1.86	5.91	65.82±12.73	40.27	9.72±1.35	4.28	16.2±1.45	4.59
27102	Gilgit	107.1±10.86	34.36	7.78±0.44	1.40	4.66±0.85	2.71	23.75±4.54	14.38	1.78±0.42	1.36	7.97±1.71	5.44
27106	Layyah	143.0±10.85	34.32	7.1±0.5	1.59	3.24±0.72	2.30	34.44±2.36	7.47	3.82±0.65	2.05	10.84±1.2	3.80
27107	Bahawalpur	129.0±7.04	22.28	7.1±0.82	2.60	50.1±8.75	27.67	69.42±12.95	40.95	18.8±2.9	9.19	29.18±2.08	6.60
27115	Mansehra	145.0±11.95	37.80	8.4±0.85	2.71	13.9±4.01	12.70	55.08±8	25.30	5.74±1.86	5.89	9.79±1.73	5.49
27116	Swat	129.2±10.89	34.45	6.9±0.58	1.85	17.5±3.42	10.83	52.48±4.78	15.13	6.83±1.36	4.31	12.63±2.13	6.75
27118	Swat	115.8±7.18	22.71	8±0.74	2.36	14.2±1.45	4.59	37.74±2.98	9.43	6.29±0.81	2.58	17.81±2.73	8.66
27119	Mansehra	110.4±5.07	16.03	5.96±0.61	1.95	8.62±1.16	3.68	57.85±6.24	19.76	10.12±1.58	5.03	17.5±2.63	8.32
27120	Mansehra	111.2±5.71	18.07	8.2±0.87	2.78	6.5±1.96	6.20	35.72±4.96	15.71	1.86±0.69	2.20	5.81±2.33	7.39
27121	Dir	105.5±6.86	21.71	7.4±0.68	2.17	14.7±3.11	9.85	42.93±3.69	11.69	4.19±0.87	2.75	10.71±2.26	7.16
27122	Dir	99.6±3.62	11.45	6.6±0.56	1.77	7.9±0.95	3.03	24.19±5.15	16.30	5.91±1.88	5.94	29.7±7.71	24.40
27123	Dir	129.5±9.25	29.23	7.5±0.74	2.37	9.5±2.01	6.36	31.8±6.12	19.36	5.65±1.98	6.27	16.49±2.69	8.53
27124	Dir	95.0±8.36	26.44	5.4±0.45	1.43	8.3±2.29	7.26	19.27±2.94	9.31	6.38±2.83	8.97	33.42±14.83	46.92
27125	Chitral	119.0±5.83	18.45	6.9±0.65	2.08	8.9±1.66	5.28	30.76±5.68	17.97	3.64±0.84	2.68	12.83±3.31	10.48
27126	Chitral	106.0±7.99	25.29	6.53±0.3	0.95	7.91±2.03	6.43	21.08±2.71	8.59	2.75±0.79	2.52	10.82±2.13	6.75
27127	Chitral	116.0±5.32	16.84	5.8±0.57	1.81	12.4±3.24	10.25	27.98±4.56	14.43	5.87±1.25	3.97	23.96±5.1	16.13
27140	Dir	133.6±11.15	35.26	9.2±0.89	2.82	24.7±2.97	9.39	58.18±7.15	22.64	11.66±1.69	5.35	20.89±3.07	9.71
27142	Multan	102.9±14.77	46.72	9.54±0.75	2.40	22.5±1.74	5.50	20.91±2.47	7.83	4.78±1.06	3.36	27.02±7.33	23.20
27143	Bahawalpur	127.1±10.91	34.52	9.2±0.98	3.12	19.6±2.82	8.95	20.63±3.11	9.84	4.34±0.59	1.88	28.25±6.89	21.80
27144	Lahore	145.2±10.68	33.79	9.2±0.62	1.99	26.5±3.11	9.83	26.39±3.87	12.25	6.59±1.14	3.63	25.5±2.42	7.66
27145	Gujranwala	125.1±8.17	25.86	8.1±0.69	2.18	17.9±2.4	7.59	25.05±1.75	5.55	7.22±1.14	3.63	28.82±15.8	49.98
27149	Dir	121.6±11.13	35.20	10.25±0.99	3.16	14.14±4.14	13.11	44.31±4.06	12.85	3.18±0.92	2.93	7.08±1.66	5.27
27151	Dir	116.7±5.46	17.27	5.2±0.46	1.47	21.6±1.93	6.13	24.18±2.47	7.82	6.28±1.06	3.38	27.37±4.77	15.11
27154	Jhang	149.2±9.39	29.72	11.62±0.76	2.42	7.72±1.57	4.97	37.25±4.34	13.75	2.83±0.56	1.78	7.81±1.09	3.45
27158	Faisalabad	99.0±8.15	25.80	5.11±0.37	1.20	17.88±2.14	6.77	17.14±1.99	6.32	5.41±0.68	2.16	31.58±2.21	7.00
27160	Okara	118.0±8.93	28.25	5.9±0.72	2.28	17.9±1.71	5.42	23.99±3.29	10.41	6.61±1.15	3.64	29.43±4.13	13.09
27161	Pakpattan	103.9±1.17	3.72	5.43±0.14	0.45	25.96±0.53	1.69	29.94±2.46	7.78	8.91±0.62	1.97	30.64±1.75	5.55
27170	Dir	121.6±16.68	52.77	9.38±0.57	1.82	15.96±3.45	10.92	48.86±6.66	21.06	2.01±0.57	1.80	3.84±0.81	2.58
27171	Chitral	103.0±13.96	44.15	7.94±0.72	2.31	9.78±3.11	9.84	44.54±7.73	24.46	2.2±0.49	1.55	6.73±1.89	6.00
27172	Chitral	103.8±7.57	23.95	7.8±1.07	3.39	8.1±1.2	3.81	64.42±12.98	41.07	1.8±0.24	0.78	6.12±2.29	7.27
Check	Narowal	109.9±8.95	28.31	8.2±0.66	2.10	27.1±2.21	7.01	98.46±14.53	45.97	5.88±1.19	3.77	9.99±4.68	14.82
CV (%)		15.17		17.86		14.98		24.46		16.28		11.12	

Table 2. Simple correlation of grain yield with other five agronomic traits for cowpea germplasm collected from Pakistan

District	Frequency	Plant height	Branches per plant	Pods per plant	Biomass per plant	Harvest index
Bahawalpur	40	0.06	0.10	0.76**	0.67**	0.31
Chakwal	20	0.10	0.40	0.90**	0.66**	0.37
Chitral	80	0.11	-0.06	0.66**	0.09	0.89**
Dir	80	0.05	0.11	0.36**	0.34**	0.68**
Faisalabad	10	0.72*	0.05	0.74*	0.85**	0.50
Gilgit	10	0.11	0.69*	0.74*	0.75*	0.53
Gujranwala	30	-0.52**	0.41*	0.82**	0.21	0.25
Gujrat	10	-0.15	-0.25	-0.21	-0.11	0.84**
Haripur	10	-0.08	0.35	0.79**	0.65*	0.20
Islamabad	10	-0.13	0.34	0.97**	0.28	0.87**
Jehlum	20	0.16	0.56**	0.85**	0.82**	0.06
Jhang	10	0.04	-0.14	0.08	0.09	0.70*
Kasur	30	0.18	0.39*	0.43*	0.90**	0.48**
Khushab	10	0.11	0.51	0.67*	0.32	0.41
Lahore	40	-0.27	0.32*	0.91**	0.65**	0.94**
Layyah	10	-0.08	0.15	0.97**	0.07	0.66*
Lodhran	10	-0.29	0.17	0.64*	0.69*	0.78**
Loralai	10	0.54	-0.12	0.91**	0.01	0.86**
Mansehra	30	0.14	0.29	-0.25	-0.40*	0.94**
Multan	10	0.01	0.28	0.73*	0.52	0.12
Muzaffargarh	10	0.20	0.33	0.11	-0.07	0.66
Okara	20	0.15	0.38	0.58**	0.86**	0.33
Pakpattan	10	0.00	-0.87**	-0.59**	0.74*	0.25
Quetta	10	0.36	0.60	0.94**	0.83**	0.60
Rawalpindi	100	0.01	0.53**	0.83**	0.65**	0.34**
Sahiwal	10	0.46	0.82**	0.82**	0.94**	0.20
Sheikhupura	10	0.46	0.78**	0.91**	0.91**	-0.25
Sialkot	20	0.71**	0.69**	0.94**	0.58**	0.47*
Swat	20	-0.20	-0.10	0.91**	-0.17	0.87**
Vehari	10	0.07	0.43	0.95**	0.84**	-0.10

*Significant and **highly significant, respectively

Eight accessions, *i.e.*, 27028, 27029, 27038, 27040, 27042, 27047, 27083 and 27097 were found as high grain yielding and could be used for crop improvement programs. Van Hintum and Elings reported that rare alleles are also functional as mutants or elements of migratory populations which may be results of various events [22]. In the countries like Pakistan there is no restriction for seed material from one area to other, due to it migration of landraces may not be pure lots and chances of contamination are high. The area with high stress may have the ability to show tolerance against abiotic and biotic stresses but mixing poses serious threat to

sampling of genetic resources from that area. Whereas pure lots or sampling at right time with appropriate conditions may prove helpful for collecting such materials using them in the future hybrid development programs.

Supporting the view in another study, Laghetti considered oppressive prolonged drought a serious threat to the conservation of gene pool of *Vigna savi* in natural habitat and thus recommended germplasm collection mission for conservation of maximum genetic diversity from the areas under environmental stresses [23]. Although cowpea is being cultivated in the Province

of Sindh but no representation is available in the gene bank that is needed to explore this area prior to genetic erosion due to introduction of superior cultivars of cowpea or other alternative crops. This material is expected to provide some good lines tolerant to drought.

Additionally it is suggested from current findings that areas with rich biodiversity of cowpea should be explored systematically and efforts should also be concentrated on geographically and ecologically distinct areas as possible, rather approachable sites only. Remote areas and provinces which have more genetic resources to focus

required number of expeditions and collection missions with the involvement of local community who are the ultimate stake holders as also been advocated for tetraploid wheat [24, 25]. Further building of genetic stocks required expeditions of those areas where genetic erosion is expected like in cowpea along with the locations from where existing genetic diversity has not yet gathered is recommended to explore for genepool establishment and starting successful breeding program [26]. Current work could help in devising future strategy for cowpea germplasm collections across the country.

Fig. 1:- Map explaining diversity pattern of *Vigna unguiculata* (L.) Walper based on agronomic performance. The symbols represent as, ○ - Insignificant differences, ◐ < 25% plants differed, ◑ < 50% plants differed, ◒ < 75% plants differed and ● - 100% plant samples differed for inter and intra-accession performance.

Conclusion

Cowpea is a protein rich food crop which is recommended for not only marginal lands but for areas with low irrigation. There is need to conserve and preserve cowpea genetic resources on comprehensive basis before they might be lost due to various environmental factors. Small scale crop specific genetic resources conservation station is also suggested to be establish in the remote areas to save unique genes of interest.

Authors' contributions

Conceived and designed the experiments: A Ghafoor, Performed the experiments: MS Iqbal, Analyzed the data: MS Iqbal & A Ghafoor, Contributed materials/ analysis/ tools: S Fatima, S Akhtar, M Akbar & EH Saddiqi Wrote the paper: MS Iqbal & A Ghafoor.

References

1. Iqbal MS, Ghafoor A, Qureshi AS & Ahmad Z (2003). Genetic dissimilarities in Cowpea (*Vigna unguiculata* (L.) Walp.) for protein peptides and their significance for quantitative traits loci. *Pak J Bot* 35(3): 377-386.
2. Coulibaly S, Pasquet RS, Papa R & Gepts P (2002). AFLP analysis of the phenetic organization and genetic diversity of *Vigna unguiculata* L. Walp., reveals extensive gene flow between wild and domesticated types. *Theor Appl Genet* 104: 358-366.
3. Boye J, Zare F & Pletch A (2010). Pulse proteins: processing, characterization, functional properties and applications in food and feed. *Food Res Int* 43: 414-43.
4. Rachie KO (1985). Introduction in: eds. S. R. Singh and K. O. Rachie, Cowpea Researches, Production and Utilization. John Wiley, New York.
5. Nielsen S, Ohler T & Mitchell C (1997). Cowpea leaves for human consumption: production, utilization, and nutrient composition. In: Singh B, D. Mohan Raj, K. Dashiell and L. Jackai (eds.) advances in cowpea research. IITA-JIRCAS, Ibadan, Nigeria. 326-332.
6. Antova GA, Stoilova TD, Ivanova MM (2014). Proximate and lipid composition of cowpea (*Vigna unguiculata* L.) cultivated in Bulgaria. *J Food Comp Anal* 33:146-152.
7. Fall L, Diouf D, Fall-Ndiaye MA, Badiane FA & Gueye M (2003). Genetic diversity in cowpea (*Vigna unguiculata* (L.) Walp.) varieties determined by ARS and RAPD techniques. *Afr J Biotech* 2(2): 48-50.
8. Iqbal MS, Qureshi AS, Ghafoor A and Qayyum A (2003). Identification of superior genotypes based on morphological, physiological and agronomic traits in local and exotic cowpea germplasm. *Pak J Bot* 35(1): 69-77.
9. Bashir M (1992). Serological and biological characterization of seed borne isolates of blackeye cowpea mosaic and cowpea aphid-borne mosaic potyviruses in *Vigna unguiculata* (L.) Walp. PhD thesis, Oregon State University, OR, USA. 222 pp.
10. Iqbal MS, Qureshi AS & Ghafoor A (2010). Evaluation of *Nigella sativa* L. for genetic variation and ex-situ conservation. *Pak J Bot* 42(4): 2489-2495.
11. Ghafoor A, Gill MA, Hassan A, **Murtaza** G & Qadir M (2001). Gypsum: An economical amendment for amelioration of saline-sodic waters and soils for improving crop yields. *Int J Agri Biol* 3: 266-275.
12. Steel RGD & Torrie JH (1980). Principles and procedures of statistics. A Biometrical Approach, 2nd Ed. McGraw-Hill, New York.

13. Omoigui LO, Ekeuro GC, Kamara AY, Bello LL, Timko MP, & Ogunwolu GO (2017). New sources of aphids [*Aphis craccivora* (Koch)] resistance in cowpea germplasm using phenotypic and molecular marker approaches. *Euphytica* 213(8): 178.
14. Omoigui LO, Kamara AY, Alunyo GI, Bello LL, Oluoch M, Timko MP & Boukar O. (2017). Identification of new sources of resistance to *Striga gesnerioides* in cowpea *Vigna unguiculata* accessions. *Genet Resour Crop Evo* 64(5): 901-911.
15. Tani E, Abraham E, Chachalis D & Travlos I (2017). Molecular, genetic and agronomic approaches to utilizing pulses as cover crops and green manure into cropping systems. *Int J Mol Sci* 18(6): 1202.
16. Zhang W, Hu D, Raman R, Guo S, Wei Z, Shen X, Meng J, Raman H & Zou J (2017). Investigation of the genetic diversity and quantitative trait loci accounting for important agronomic and seed quality traits in *Brassica carinata*. *Front Plant Sci* 8: 615.
17. Allel D, Ben-Amar A, Lamine M & Abdelly C (2017). Relationships and genetic structure of North African barley (*Hordeum vulgare* L.) germplasm revealed by morphological and molecular markers: Biogeographical considerations. *S Afr J Bot* 112: 1-10.
18. Tahir NAR & Omer DA (2017). Genetic variation in lentil genotypes by morpho-agronomic traits and RAPD-PCR. *J Anim Plant Sci* 27(2): 468-480.
19. Clements JC & Cowling WA (1994). Pattern of morphological diversity in relation to geographical origins of wild *Lupinus angustifolius* from the Aegean region. *Genet Resour Crop Evo*, 41: 109-122.
20. Oliveira MM, Sousa LB, Reis MC, Silva JE, Cardoso DBO, Hamawaki OT & Nogueira APO (2017). Evaluation of genetic diversity among soybean (*Glycine max*) genotypes using univariate and multivariate analysis. *Genet Mol Res* 16(2): 1-10.
21. Menssen M, Linde M, Omondi EO, Abukutsa-Onyango M, Dinssa FF & Winkelmann T (2017). Genetic and morphological diversity of cowpea (*Vigna unguiculata* (L.) Walp.) entries from East Africa. *Sci Hort* 226: 268-276.
22. Van Hintum TJL & Elings A (1991). Assessment of glutenin and phenotypic diversity of Syrian durum wheat landraces in relation to their geographical origin. *Euphytica*, 55: 209-215.
23. Laghetti G, Pienaar BL, Padulosi S & Perrino P (1998). Ecogeographical distribution of *Vigna savi* in Southern Africa and some areas of the Mediterranean basin. *Plant Genet Resour News* 115: 6-12.
24. Pecetti L, Annicchiaro P & Damania AB (1992). Biodiversity in a germplasm collection of durum wheat. *Euphytica* 60: 229-238.
25. Pecetti L, Annicchiaro P & Damania AB (1996). Geographic variation in tetraploid wheat (*Triticum turgidum* spp. *Turgidum* convar. Durum) landraces from two provinces in Ethiopia. *Euphytica*, 43: 395-407.
26. Padulosi S (1993). Genetic diversity, taxonomy and ecogeographic survey of the wild relatives of cowpea (*Vigna unguiculata* L. Walp.). Ph. D. Thesis, Catholic University of Louvain-La-Neuve, Belgium.