Forage Res., **48**(1) : pp. 50-56 (2022) **http://forageresearch.in**

MORPHOLOGICAL CHARACTERIZATION OF LEAF, FLOWER, POD AND SEED TRAITS OF COWPEA [*VIGNA UNGUICULATA* (L.) WALP] GENOTYPES

PHYU PHYU OO[1], RAVISH PANCHTA[1]*, SOMVEER NIMBAL[1], DALVINDER PAL SINGH[2], NEERAJ KHAROR[3], SATYAWAN ARYA[1] AND SONU[1]

[1]Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar-125004, (Haryana) India
[2]Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125004, (Haryana) India
[3]Department of Biochemistry, CCS Haryana Agricultural University, Hisar-125004, (Haryana) India
**(e-mail : r.panchta@gmail.com)*

(Received : 10 April 2022; Accepted : 11 June 2022)

SUMMARY

The present study aimed at morphological characterization of leaf, flower, pod and seed traits of different 46 cowpea [*Vigna unguiculata* (L.) Walp] genotypes on the basis of qualitative and quantitative characters. The genotypes were grown in a randomized block design with three replications at Dry land research area, CCS HAU, Hisar, during *kharif*-2020. These were classified and grouped into different categories and established significant amount of variation and diversification among different genotypes for various morphological characters. The characters *viz.,* leaf colour, flower colour, pod shape, pod pigmentation at tip, number of branches per plant, number of pods per cluster and seed yield per plant were observed less amount of variation. Majority of the genotypes had indeterminate growth habit and spreading type growth. Wide variation was observed for the leaf shape and most of the genotypes had globose type leaf. In most of the genotypes the seed colour and seed eye colour was tan or brown while seed shape was rhomboid. The characters *viz.,* plant height, days to 50% flowering, days to maturity, number of clusters per plant, number of seeds per pod, number of pods per plant, pod length, 100 seed weight, crude protein content and digestibility had wide range of variation among all the genotypes. The present study suggested that characterization of morphological traits would help the breeders for utilizing the germplasm collection, evaluation and exploration to maintain genetic purity of genotypes as well as for providing the available knowledge of the present cowpea genotypes as a reference in future breeding programme.

Key words : Morphological characterization, cowpea, diversity, descriptors, germplasm

Cowpea [*Vigna unguiculata* L. Walp] is a self-pollinated annual legume, mostly grown in arid, semi-arid and subtropics. Cowpea belongs to the family *Fabaceae* (*Leguminosae* is also used as the family name with *Papilionoideae* as the subfamily), genus *Vigna*, and section *Catiang*. Annual cowpea has two botanical varieties, the cultivated *Vigna unguiculata unguiculata var. unguiculata* and the wild form *V. u. u.* var. *spontanea*, both of which are self-pollinated (OECD, 2016). It is commonly known as *lobia*. In India, cowpea is mostly grown as *Kharif* crop, but can be grown as a *Rabi* crop in peninsular India (Sharma *et. al.* 2019). Global production under cowpea cultivation was about 5.6 MT from an area of 12.6 M ha (FAOSTAT, 2019).

Cowpea is a multipurpose crop and can be used at all stages of the crop growth for both human and animal consumption (Nguyen *et al.,* 2016; Panchta *et al.,* 2020). Its dry seeds are consumed as pulse while, immature pod and green leaf and growing twig can be utilized as vegetable. It is also important as the source of green as well as dry fodder (Arya *et al.,* 2019). With high nutrient content and several mineral compositions, it is referred to as poor man's meat in developing countries. It is a good source of calories, vitamins and minerals and provides a significant amount of dietary protein (18-35%) and lysine to both humans and domestic animals (Nguyen *et. al.* 2019; Panchta *et al*., 2021).

The success of a crop improvement programme largely depends on the extent of variability available in the germplasm for various economic important characters (Vu *et al.,* 2017). The conservation of genetic diversity is also an important task especially in the modern era where most of the crop species are facing genetic uniformity and effects

of climate change. This makes these crops more vulnerable to both biotic and abiotic stresses. Therefore, concrete efforts need to be made towards effective characterization, evaluation, identification and then utilization of trait specific germplasm accessions. For this, knowledge of morphological variability on the basis of descriptors of a crop is very much important. Keeping this view, the present study was aimed to study morphological characterization of leaf, flower, pod and seed traits of different 46 cowpea genotypes on the basis of qualitative characters and quantitative characters.

MATERIALS AND METHODS

46 cowpea genotypescollected from different partsof India (Table 1) which have been maintained in Forage section, Genetics and Plant Breeding Department, CCS Haryana Agricultural University, Hisar were used in this study. Each genotype was grown with two rows of 2 m length and row to row of 45 cm and plant to plant of 15 cm spacing. The experiment was carried out in a randomized block design with three replications at Dry land research area, CCS Haryana Agricultural University, Hisar, during *Kharif* season of 2020. The weather conditions during experiment were also recorded. The wide range of temperature and relative humidity were from 9.8°C to 38.7°C and from 22% to 94%. The highest rainfall was 111.1 mm and also found 4 rainy days during this experiment.

Five competitive plants were randomly selected excluding border plants in each genotype from each replication. The data were recorded on 10 qualitative and 13 quantitative traits. Each genotype was observed at specified stage of crop growth having full expression so that breeders can obtain the characters under study with good result. For qualitative traits, seed colour, seed shape and seed eye colour were recorded after harvesting. Pod pigmentation at tip and pod shape were recorded at the time of pod maturity. Flower colour was recorded at the time of flowering. The remaining characters such as plant growth habit, plant twining nature, leaf colour and leaf shape, were recorded at the time of maturity. According to germplasm catalog developed by International Board for Plant Genetic Resources, Rome, Italy (IBPGR, 1983).

RESULTS AND DISCUSSION

Qualitative characteristics

Variation showing for ten qualitative

TABLE 1
List of genotypes evaluated along with their sources

S. No.	Genotype	Source	S. No.	Genotype	Source
1.	GC3	SDAU, S.K. Nagar	24.	PGCP67	GBPUA&T, Pantnagar
2.	GC1602	SDAU, S.K. Nagar	25.	PGCP68	GBPUA&T, Pantnagar
3.	GC1601	SDAU, S.K. Nagar	26.	PL7	GBPUA&T, Pantnagar
4.	GC1712	SDAU, S.K. Nagar	27.	PGCP71	GBPUA&T, Pantnagar
5.	GC1612	SDAU, S.K. Nagar	28.	PGCP72	GBPUA&T, Pantnagar
6.	SKAU407	SDAU, S.K. Nagar	29.	KBC13	UAS, Bangalore
7.	GC1501	SDAU, S.K. Nagar	30.	KBC11	UAS, Bangalore
8.	GC1506	SDAU, S.K. Nagar	31.	PCP1124-1	ARS, Pardharpur
9.	GC01802	SDAU, S.K. Nagar	32.	PCP1122	ARS, Pardharpur
10.	GC01805	SDAU, S.K. Nagar	33.	Phule CP 1123	ARS, Pardharpur
11.	RC101	RARI, Durgapura	34.	PCP1131	ARS, Pardharpur
12.	CPD311	RARI, Durgapura	35.	PCP1118	ARS, Pardharpur
13.	CPD313	RARI, Durgapura	36.	TC901	BARC, Trombay
14.	CPD301	RARI, Durgapura	37.	TC172	BARC, Trombay
15.	CPD304	RARI, Durgapura	38.	VCP12006	NPRC,Vamban
16.	CPD221	RARI, Durgapura	39.	VCP14005	NPRC,Vamban
17.	CPD249	RARI, Durgapura	40.	VCP14001	NPRC,Vamban
18.	CPD317	RARI, Durgapura	41.	VCP13001	NPRC,Vamban
19.	CPD319	RARI, Durgapura	42.	VCP12005	NPRC,Vamban
20.	Pant Lobia3	GBPUA&T, Pantnagar	43.	VCP15006	NPRC,Vamban
21.	Pant Lobia4	GBPUA&T, Pantnagar	44.	PTBCP4	RARS, Pattambi
22.	PGCP69	GBPUA&T, Pantnagar	45.	PTBCP5	RARS, Pattambi
23.	PGCP70	GBPUA&T, Pantnagar	46.	TPTC29	ARS, Tirupati

TABLE 2
Classification and grouping of 46 cowpea genotypes based on qualitative characters

Characters	Descriptors	No. of genotypes	Name of genotypes
1.Plant growth habit	Determinate	9	RC101, Pant Lobia4, PGCP69, VCP13001, GC01802,GC01805, VCP15006, CPD319, PGCP72
	Indeterminate	37	GC 3, Pant Lobia 3, CPD 311, KBC 13, CPD 313, PCP 1124-1, KBC 11, GC 1602, TC 901, GC 1712, PGCP 70, CPD 301, VCP 12006, VCP 14005, PGCP 67, CPD 304, VCP 14001, GC 1601, PCP 1122, PGCP 68, PTBCP 4, PTBCP 5, GC 1612, SKAU 407, TPTC 29, Phule CP 1123, VCP 12005, CPD 221, TC 172, CPD 249, GC 1501, PCP 1131, PCP 1118, GC 15006, PL 7, CPD 317, PGCP 71
2.Plant Twining nature	Spreading	30	GC3, Pant Lobia3, CPD311, KBC13, CPD313, KBC11, GC 1602, TC 901, GC 1712, PGCP 70, VCP 12006, VCP 14005, PGCP 67, CPD 304, VCP14001, GC1601, PCP1122, VCP13001, PTBCP 5, SKAU 407, TPTC29, VCP12005, CPD221, TC172, GC1501, PCP 1131, PCP1118,PL 7, CPD317, PGCP71
	Intermediate spreading	9	RC101, PCP1124-1, CPD301, PTBCP 4, GC 1612, GC 15006, VCP 15006, CPD319, PGCP72
	Erect	6	Pant Lobia4, PGCP69, PGCP68, Phule CP 1123, GC01802, GC01805
	Intermediate erect	1	CPD249
3.Leaf colour	Green	23	CPD313, KBC11,GC1602,PGCP70,VCP12006,CPD304, PTBCP4, PTBCP 5, GC1612, TPTC29, VCP12005, CPD221, TC172,CPD249, GC1501, PCP1118, GC15006, PL 7, GC01802, CPD317, PGCP71, VCP15006, PGCP72
	Dark green	23	GC3, RC101, Pant Lobia 3, Pant Lobia 4, CPD311, KBC13, PGCP69, PCP1124-1, TC901,GC1712,CPD301, VCP14005, PGCP67, VCP14001, GC1601, PCP1122, PGCP68, VCP13001, SKAU407, Phule CP1123, PCP1131, GC01805, CPD319
4.Leaf shape	hastate	10	GC3, CPD 311, PGCP 70, CPD 304, SKAU 407, TPTC29, VCP12005, CPD221, CPD249,PL7
	Sub-hastate	4	Pant Lobia 4, PGCP69, PGCP67, CPD317
	Globose	23	CPD311, PCP1124-1, KBC11, GC1602, TC901, GC1712, CPD301, VCP12006, VCP14005, VCP14001, GC1601, PCP1122, VCP13001, PTBCP5, GC1612, Phule CP1123, TC172, PCP1131, PCP1118, GC01802, PGCP71, GC01805, VCP15006
	Sub-globose	9	RC101,Pant Lobia 3, CPD313, PGCP68, PTBCP4, GC1501, GC15006, CPD319, PGCP72
5.Flower colour	Purple	25	GC3, Pant Lobia 3, CPD311, GC1602, GC1712, PGCP70, VCP12006, VCP14005, PGCP67, VCP14001, GC1601, PGCP68, VCP13001, PTBCP 5, GC1612, TPTC29, VCP12005, CPD221, TC172, CPD249, GC1501, PCP1118, PL 7, CPD317, PGCP71
	White	21	RC101, Pant Lobia 4, KBC13, CPD313, PGCP69, PCP1124-1, KBC11, TC901, CPD301, CPD 304, PCP 1122, PTBCP 4, SKAU 407, Phule CP1123, PCP1131, GC15006, GC01802, GC01805, VCP15006, CPD319, PGCP72
6. Pod pigmentation at tip	None	44	GC3, RC101, Pant Lobia3, CPD311, KBC13, CPD313, PGCP69, PCP1124-1, KBC11, GC1602, TC901, GC1712, PGCP70, CPD301, VCP12006, VCP14005, PGCP67, CPD304, VCP14001, GC1601, PCP1122, VCP13001, PTBCP4, PTBCP5, GC1612, SKAU407, TPTC29, PhuleCP1123, VCP12005, CPD221, TC172, CPD249, GC1501, PCP1131, PCP1118, GC1506, PL7, GC01802, CPD317, PGCP71, GC01805, CPD319, VCP15006, PGCP72
	Small tip	1	Pant Lobia 4
	Complete	1	PGCP68

Contd..

Table 2 contd.

7.Pod shape	Straight	21	GC3, RC101, CPD311, KBC13, PGCP69, KBC11, TC901, PGCP68, VCP13001, PTBCP4, SKAU407, TPTC29, PhuleCP1123, GC1501, GC1506, PL7, PGCP71, GC01805, CPD319, VCP15006, PGCP72
	Slightly curved	23	Pant Lobia3, Pant Lobia4, CPD313, PCP1124-1, GC1602, PGCP70, CPD301, VCP12006, VCP14005, CPD304, VCP14001, GC1601, PCP1122, PTBCP5, GC1612, VCP12005, CPD221, TC172, CPD249, PCP1131, PCP1118, GC01802, CPD317
	Curved	2	GC1712, PGCP67
8.Seed colour	Creamy	17	GC3, RC101, CPD311, KBC13, CPD313, PCP1124-1, CPD301, PGCP67, CPD304, PCP1122, PTBCP4, SKAU407, PhuleCP1123, TC172, PCP1131, CPD317, CPD319
	Brown	28	Pant Lobia3, Pant Lobia4, PGCP69, KBC11, GC1602, TC901, GC1712, PGCP70, VCP12006, VCP14005, VCP14001, GC1601, VCP13001, PTBCP5, GC1612, TPTC29, VCP12005, CPD221, CPD249, GC1501, PCP1118, GC1506, PL7, GC01802, PGCP71, GC01805, VCP15006, PGCP72
	Black	1	PGCP68
9.Seed shape	Rhomboid	28	GC3, RC101 ,Pant Lobia3, Pant Lobia4, KBC13, PGCP69, GC1602, TC901, GC1712, CPD301, PGCP67, CPD304, GC1601, VCP13001, PTBCP5, GC 1612, V P12005, CPD221, CPD249, GC1501, GC1506, PL7, GC01802, CPD317, GC01805, CPD319, VCP15006, PGCP72
	Ovoid	14	CPD311, CPD313, KBC11, PGCP70, VCP12006, PCP1122, PGCP68, PTBCP4, SKAU407, TPTC29, PhuleCP1123, PCP1131, PCP1118, PGCP71
	Crowder	4	PCP1124-1, VCP14005, VCP14001, TC172
10.Seed eye colour	Reddish brown	3	GC3, TC901, CPD249
	Tan/brown	30	RC101, Pant Lobia3, Pant Lobia4, KBC13, CPD313, PGCP69, KBC11, GC1602, GC1712, VCP14005, PGCP67, CPD304, VCP14001, GC1601, PCP1122, PGCP68, PTBCP4, PTBCP5, VCP12005, CPD221, TC172, GC1501, PCP1118, GC01802, CPD317, PGCP71, CPD319, VCP15006, CPD311, PCP1131
	Greenish	11	PCP1124-1, PGCP70, CPD301, VCP12006, VCP13001, GC1612, TPTC29, PhuleCP1123, GC1506, GC01805, PGCP72
	Black	2	SKAU407, PL7

characters among 46 cowpea genotypes was presented in figure 1. Morphological characterization of cowpea genotypes was presented in Table 2. Majority of the genotypes *i.e.* 37 had indeterminate type and the remaining nine genotypes had determinate type for plant growth habit.Wide variation observed for plant twining nature *i.e.* spreading, intermediate spreading, erect and intermediate erect. Spreading type was the largest group having 30 genotypes, intermediate spreading had nine genotypes and six genotypes of erect type are found. The smallest group had only one genotype *i.e.*CPD 249. Similar findings were also substantiated by Kaur *et al.* (2017) in *Vigna radiata;* Kumar *et al*. (2015) and Hutchinson *et al.* (2017) in cowpea.

Leaf colour of all genotypes were occurred as equivalent group having 23 genotypes with green and 23 genotypes with dark green leaf colour showing little variation among them. Measurement on leaf shape of all genotypes observed high variation *i.e.*hastate, sub-hastate, globose and sub-globose. 23 genotypes had globose, ten genotypes were hastate, 9 genotypes were sub-globose and four genotypes possessed sub-hastate leaves. Similar findings were also reported by Yadav *et al*. (2013) in Indian mustard; Kaur *et al.* (2017) in *Vigna radiata;* Kumar *et al*. (2015) and Bello *et al.* (2021) in cowpea.

In flower colour, two categories classified among the genotypes *i.e.,* purple and white. 25 genotypes had purple flowers and remaining 21 genotypes showed white flowers indicating there was little variation in 46 cowpea genotypes. Previous workers were similarly reported by Kaur *et al.* (2017) in *Vigna radiata;* Stoilova and Pereira (2013), Kandait *et al.* (2016) and Bello *et al.* (2021) in cowpea.

Considering pod pigmentation at tip, all the 46 genotypes were classified into three categories which are small pigmented, complete and non-

1: Spreading **2: Intermediate spreading/ Indeterminate** **3: Erect/Determinate** **4: Intermediate erect**

Fig. 1. Variation showing for ten qualitative characters among 46 genotypes.
Fig. 1.1. Plant growing habit and Plant twining nature.

1: Green **2: Dark green** **3: Purple** **4: White**

Fig. 1.2. Leaf colour and flower colour.

1: Hastate **2: Sub-hastate** **3: Globose** **4: Sub-globose**

Fig. 1.3. Leaf Shape

pigmented. Majority of the genotypes (45) found no pigmentation, the genotype Pant Lobia 4 had small pigmentation and the genotype PGCP 68 completely pigmented. For pod shape, all the genotypes classified into three categories *i.e.* straight, slightly curved and curved. 23 genotypes had slightly curved pod, 21 genotypes had straight pod shape and the remaining two genotypes *viz.,* GC 1712 and PGCP 67 had curved pod shape. It was revealed that there was little variation among the 46 cowpea genotypes according to pod characteristics. Similar findings were also reported by Katiyar *et al*. (2008), Kaur *et al.* (2017) in *Vigna radiata*; Yadav *et al*. (2013) in Indian mustard, Kumar *et al*. (2015) and Kandait *et al.* (2016) in cowpea.

On the basis of seed colour, all the genotypes were grouped into three categories *i.e.* creamy, brown and black. 28 genotypes showed brown, 17 genotypes had creamy seed and the only PGCP 68 had black in colour. According to seed shape, three groups were occurred into rhomboid, ovoid and crowder shape. 28 genotypes showed rhom boid 14 genotypes had ovoid and the remaining four genotypes possessed crowder seed shape. All the genotypes were classified into five groups *i.e.* reddish brown, brown, tan/brown,

1: None/ Straight **2: Small tip/Slightly curved** **3: Curved** **4: Complete**

Fig. 1.4. Pod Pigmentation at tip and Pod shape

1: Creamy/ Ovoid **2: Rhomboid** **3: Brown/ Crowder** **4: Black**

Fig. 1.5. Seed colour and Seed shape

1: Reddish brown **2: Tan/brown** **3: Greenish** **4: Black**

Fig. 1.6. Seed eye colour

greenish and black for seed eye colour. The largest group had 30 genotypes of tan/brown eyed seed, eleven genotypes had greenish eyed seed, three genotypes possessed reddish brown in eye colour and two genotypes (SKAU 407 and PL 7) had black-eyed seed. It is suggested that the group patterns in seed colour, seed shape and seed eye colour had significant variation among the 46 genotypes of cowpea. Similar findings were earlier reported by Katiyar *et al*. (2008), Kaur *et al.* (2017) in *Vigna radiata;* Yadav *et al*. (2013) in Indian mustard; Stoilova and Pereira (2013), Kumar *et al*. (2015), Kandait *et al.* (2016) and Bello *et al.* (2021) in cowpea.

CONCLUSION

Results obtained that all the genotypes were grouped into different categories on the basis of

qualitative and quantitative characters studied. Majority of the characters under study showed considerable variation among the genotypes except plant grow habit, leaf colour, flower colour, pod pigmentation at tip, pod shape, number of branches per plant, number of pods per cluster and seed yield per plant.The present study suggested that characterization of morphological traits would help the breeders for utilizing the germplasm collection, evaluationand exploration to maintain genetic purity of genotypes as well as for providing the available knowledge of the present cowpea genotypes as a reference in future breeding programme.

REFERENCES

Bello, S., R. Maliki, A. Adandonon, A. Azonkpin, T. A. Houndete and G. Dagbenonbakin, 2021 : Agro-morphological Characterization of Eight Cowpea Accessions [(*Vigna unguiculata* (L.) Walp.)] from Benin and Ghana Introduced in Center-Benin. *American Journal of Plant Biology*, **6** (1): 1-10.

Arya, R. K., Ravish Panchta and Nguyen Ngoc Vu. 2021: Morphological characterization of cowpea genotypes and its utility for DUS testing. *Range Management. & Agro-forestry,* 41 (1): 49-58.

Arya, R.K., R. Panchta, N.N. Vu and S.K. Pahuja 2019: Meteroglyph analysis of cowpea (*Vigna unguiculata* L.Walp) elite genotypes. *Ekin J.* **5**(2): 97-102.

FAOSTAT, Food and Agriculture Organization of the United Nations, 2019:(http://www.fao.org/faostat/en/#data/QC).

Hutchinson, M.J., Muniu, F.K., Ambuko, J., Mwakangalu, M., Mwang'ombe, A.W., Okello, J.J., Olubayo, F. and Kirimi, J., 2017: Morphological and agronomic characterization of local vegetable cowpea accessions in coastal Kenya. *African Journal of Horticultural Science*, **11**: 47-58.

IBPGR, International Board for Plant Genetic Resources, 1983:Cowpea Descriptors. Rome, Italy.

Jain, P., M. L. Saini and R. N. Arora, 2006 : Genetic divergence in cowpea. *Forage Res.*, **32**: 12-14.

Khandait, R., P. K. Jain, S. Prajapati, and A. S. Dangi, 2016 : Correlation and Path Coefficient Analysis for Yield and its Attributing Traits in Diverse Genotypes of Cowpea (*Vigna unguiculata* L.). *International Journal of Bio-resource and Stress Management*, **7** (1): 008-017.

Katiyar, P. K., G. P. Dixit and B. B. Singh, 2008 : Morphological characterization of green gram (*Vigna radiata*) varieties and their application for distinctness, uniformity and stability testing. *Indian Journal of Agricultural Sciences*, **78** : 439-444.

Kaur, H., M. Goyal, and D. P. Singh, 2018 : Comparative evaluation of cowpea (*Vigna unguiculata* L.) genotypes for nutritional quality and antioxidant potential. *Range Management. & Agroforestry*, **39**(2) : 260-268.

Kumar, S., D. Phogat and N. Bhusa, 2015 : Characterization of elite forage cowpea genotypes for various DUS traits. *Forage Research*, **40**: 232-236.

Nguyen N. V., R. K. Arya, R. Panchta, and S. K. Pahuja, 2016 : Studies on meteroglyph analysis in cowpea [*Vigna unguiculata* (L.) Walp]. *Forage Research*, **41**: 255-258.

Nguyen Ngoc Vu, R. K. Arya, and R. Panchta, 2019 : Studies on genetic parameters, correlation and path coefficient analysis in cowpea. *Range Management. & Agroforestry*, **40**: 49-58.

OECD, 2016: "Cowpea (*Vignaunguiculata*)", in Safety Assessment of Transgenic Organisms in the Environment, **6**: *OECD Consensus Documents, OECD Publishing, Paris*. DOI: https://doi.org/10.1787/9789264253421-8-en.

Panchta R., S. Arya, D. P. Singh Satpal, Preeti, R. Kumar 2020 : Genetic variability and association studies in cowpea [*Vigna unguiculata* (L.) Walp] for seed yield and related traits. *Forage Research*, **46**(3): pp. 232-235.

Panchta R., R. K. Arya, N. N. Vu and R. K. Behl, 2021 : Genetic Divergence in Cowpea (*Vigna unguiculata* L.Walp) - an Overview. *Ekin J.* **7**(1):1-20.

Kaur, R., A. K. Toor, G. Bassi and T. S. Bains, 2017 : Characterization of Mungbean (*Vigna radiata* L. Wilczek) Varieties using Morphological and Molecular Descriptors. *International Journal of Current Microbiology and Applied Sciences*, **6** (6): 1609-1618.

Sharma, A., S. P. Mishra and L. Gour, 2019 : Heritable relationship and variability of yield and yield determinants in cowpea. *International journal of chemical studies*, **7** (3): 3605-3611.

Stoilova, T. and G. Pereira, 2013 : Assessment of the genetic diversity in a germplasm collection of cowpea (*Vigna unguiculata* (L.) Walp.) using morphological traits. *African Journal of Agricultural Research*, **8**(2): 208-215.

Vu Nguyen Ngoc, R. K. Arya, R. Panchta and J. Tokas, 2017: Studies on genetic divergence in cowpea (*Vigna unguiculata*) by using D2 Statistics under semi-arid conditions. *Forage Res.*, **43** (3): 197-201.

Yadav, A. K., D. Singh and R. K. Arya, 2013 : Morphological characterization of Indian mustard (*Brassica juncea*) genotypes and their application for DUS testing. *Indian Journal of Agricultural Sciences*. **83** : 1305-1316.