



Exploration, Collection and Characterization of Horsegram [*Macrotyloma uniflorum* (Lam.) Verd.] Germplasm

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ABSTRACT

Background: Horsegram [*Macrotyloma uniflorum* (Lam.) verd.] is an underutilized arid food legume known to grow well in diverse environmental conditions like poor soils, low rainfall *etc.* Horsegram is a drought resistant crop used for fodder, feed, seed, green manuring and in ayurvedic medicine. It is grown as *Rabi* crop in Andhra Pradesh. Compared to other pulse crops, efforts in conservation horsegram germplasm is poor which is essential for the future breeding purpose. There will be a danger of loss of germplasm if they are not collected and conserved. The Eastern Ghats of Andhra Pradesh *i.e.*, Araku region is a rich source of diversified germplasm of legumes, medicinal plants, millets and ancient crops. Among which, horsegram is one of the crop with wide diversified germplasm. Hence the present effort is done in collection and characterization of the germplasm for further use in the breeding process. Broadening the genetic base in horsegram through interspecific hybridization employing diverse germplasm will be useful in improving pest and disease resistance, grain quality, protein percentage and nutritional factors.

Methods: Expedition was conducted during *Rabi* 2018 and 25 horse gram seed samples were collected from the local regions of tribal tracts of Eastern Ghats of Andhra Pradesh along with passport data using the GPS machine. The germplasm lines were evaluated and morphologically characterized during *Rabi* 2019 at Agricultural Research Station, Yellamanchili, Visakhapatnam, Andhra Pradesh, India, for fifteen characters. Principal component analysis was carried out to identify the diverse germplasm lines and to know the contribution of the variables.

Result: The investigation showed that all the horse germplasm lines are inherited to the farmers from their ancestors. Study revealed that, the seed yield per plant showed a range of 2.40 to 6.40 g and the days maturity recorded a range of 87 to 106 days. Principal component analysis showed that all the variables except 100 seed weight (g) showed positive loading. Among the variables plant height (cm), dry haulm weight (g) and seed yield per plant recorded maximum percentage of contribution. The genotypes HG-24, HG-7, HG-19, HG-15, HG-22 recorded highest positive scores. The genotypes HG-5, HG-10, HG-3, HG-16, HG-8, HG-4, HG-10, HG-24 and HG-7 has shown wide divergence which may be further adopted in the breeding programme for horsegram improvement.

Key words: Characterization, Collection, Germplasm, Horsegram, Principal component analysis.

INTRODUCTION

Horsegram [*Macrotyloma uniflorum* (Lam) verd.] is an underutilized arid food legume known to grow well in diverse environmental conditions like poor soils, low rainfall *etc.* Horsegram grows in a soil pH of 5.0 to 7.5 and at an altitude of 1800 range (Sunil *et al.* 2009). Horsegram is the fifth most important widely grown pulse crop species grown in India (Fuller 2018) indicating its wide spread and importance since the Neolithic period. Horsegram is also known as madras bean or poor man pulse. Archeological investigations have revealed that use of horsegram as food in India dates back to 2000 B.C (Mehra 2000). Horsegram is used for fodder, feed, seed, green manuring and in ayurvedic medicine. Horsegram is leguminous self-pollinated, drought tolerant *rabi* crop, generally used as cattle feed in Andhra Pradesh.

Globally, efforts in conservation of germplasm of horsegram is poor compared to other pulse crops. A total of 1721 accessions of horsegram are being conserved in different gene banks of the world (Chahota 2013) of these 95% are conserved at NBPGR; New Delhi. Horsegram is native to India (Bogdan 1977). The Eastern Ghats of Andhra Pradesh *i.e.*, Araku region is a rich source of diversified germplasm of legumes, medicinal plants, millets and ancient

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crops. Among which, horsegram is one of the crop with wide diversified germplasm. The tribals play a major role in conservation of the germplasm right from their ancestors. Mostly, they cultivate the ancestral local varieties. Broadening the genetic base in horsegram through interspecific hybridization employing diverse germplasm will be useful in improving pest and disease resistance, grain quality, protein percentage and also reducing nutritional factors (Dikshit 2014).

MATERIALS AND METHODS

Exploration and collection

Exploration and collection of horsegram germplasm was carried out during *Rabi* 2018 in Tribal tracts and Eastern Ghats of Andhra Pradesh (Araku region) in India. Araku hill station is located in Visakhapatnam district of Andhra Pradesh in the Eastern ghats at 18.333°N and 82.866°E, altitude of 1300 m from Mean Sea level. The tribals residing in the regions are majorly belong to Bhagatas, Kondadoras, Kondulu, Valmikias, Kotiya, Kondakumaras and Bondalu tribes. The soil type of the region is red and sandy loams. Temperatures range from 8°C to 37°C with an annual rainfall of 1700 mm. A total of 25 germplasm lines were collected using GPS co-ordinates using Garmin etrex 30x hand held GPS machine. Random and bulk sampling methods were adopted for collecting the germplasm data. Passport data of each accession line was collected as per the standard procedures provided by ICAR-NBPGR, New Delhi (Pareek *et al.*, 2000). The horsegram germplasm lines were collected from the farm fields, threshing floors and house hold stores of the farmers by scientist of Agricultural Research Station Yellamanchili, with the aid of local Agricultural departmental officials during *Rabi* 2018.

Morphological characterization

The 25 germplasm lines collected were evaluated during *Rabi* 2019 at Agricultural Research Station, Yellamanchili, Visakhapatnam (DT.) Andhra Pradesh. The germplasm lines were laid out in randomized block design with two replications in a plot of size of 3.6 m² and spacing of 30 X 15 cm. Each entry was sown in three rows. The statistical analysis was carried out for the biometrical parameters. Germplasm lines were morphologically characterized and observations were recorded from five randomly selected plants in each genotype, for, plant height (cm), no. of branches per plant; no. of pods per plant, 100 seed weight (g), dry haulm weight (g) per plant, number of seeds per pods, leaf colour, flower colour, stem hairiness, twining habit and seed yield per plant (g). Days to 50% flowering; days to maturity, leaf hairiness and seed coat colour were recorded on plot basis.

Statistical analysis

Statistical analysis is performed for randomized block design; mean, range, CV% is recorded. Principal components analysis was performed to examine the contribution percentage of each parameters to the total genetic variation. Principal component analysis was carried out according to procedure described by Rao (1984).

RESULTS AND DISCUSSION

Exploration and collection

Expeditions were conducted in nine mandals of Visakhapatnam and Vizianagaram districts from Eastern

Ghats of Andhra Pradesh from Paderu, Araku, Hukkumpeta, Vizianagaram and Chodavaram regions collecting the 25 seed samples of horsegram germplasm. The tribal tracts of all these mandals are very rich source of germplasm of varied crops. The collection site was having 17° and 18° North latitude and 82° and 83° East longitude with an altitude ranging from 58 m to 994 m from the mean sea level. The passport data of the germplasm accessions collected during the expeditions is presented in Table 1. The passport data showed that most of the biological status accessions are ancestral. This shows the conservation of horsegram germplasm from ancestors.

Morphological characterisation

The mean, range and morphological characterized data is presented in Table 2 and 3. Days to 50 % flowering ranged from 56 to 67 days with a mean of 62 days. Days to maturity recorded a wide variation of 87 to 106 days duration with a mean of 97 days. This study revealed wide variation in early and late maturing germplasm lines. There is no much variation recorded in no. of branches per plant. Wide range of variation was observed for number of pods per plant *i.e.*, from 29-67 pods per plant with a mean of 43.96 pods per plant. All the germplasm lines had sparsely hairy or hairy leaf and stem habit. All the germplasm lines showed green leaf colour except HG-7 which showed variegated nature. The horsegram germplasm lines showed variation for twining habit with prominent, moderate and very less twining. Seed coat colour recorded was either brown, straw brown or black. Test weight (100 seed weight) showed range of 2.0 g to 4.6 g. Dry haulm weight per plant recorded a range of 1.9 to 6.0 g. Number of seeds per pod showed a range of 5.0 to 7.0 with a mean of 5.78. Seed yield per plant (g) ranged from 2.4 to 6.8 g with a mean of 4.19 g per plant. Wide variation was observed in seed yield per plant (g); 100 seed weight (g), number of pods per plant, dry haulm weight per plant (g); number of seeds per pod and days to maturity. The results are in accordance with Chahota *et al.*, 2005 and 2013.

Principal component analysis

Principal component (eigen value greater than one) percent variability, cumulative % variability and component loading of different characters are presented in Table 4 and 5. In the present investigation, principal component analysis identified 9 principal components contributing 100% cumulative variance. The first four factors eigen values greater than one contributed high to the total variability. The first principal component showed maximum contribution to cumulative variance (37.52%). All the parameters showed positive loading except 100 seed weight (g) which showed negative loading. The second principal component contributed 16.39% to cumulative variance. All the parameters showed positive loading except no. of branches per plant and number of pods per plant. They showed negative loading. The third principal component contributed 12.47% to cumulative variance. All the parameters showed negative loading except plant height, no. of pods per plant

Table 1: Passport data of the Horse gram [*Macrotyloma uniflorum* (Lam.) Verd.] germplasm collected from the Eastern ghats of Andhra Pradesh.

Collection number	Location	Mandal	District	North Latitude(0)	East Longitude(0)	Elevation (m)	Biological status of accession	Seed coat colour
HG-1	S.kota Seetharamapuram	Vepada	Vizianagaram	18.0665	083.0892	102 m	Land race	Brown
HG-2	S.kota Seetharamapuram	Vepada	Vizianagaram	18.0663	083.0841	107 m	Ancestral	Brown
HG-3	Kondagangupudi	Vepada	Vizianagaram	18.0719	083.0448	158m	Ancestral	Brown
HG-4	Chintalapudi	Devarapalli	Visakhapatnam	18.0722	083.0317	156m	Ancestral	Black
HG-5	Balluguda	Aruku valley	Visakhapatnam	18.2863	082.9360	964m	Ancestral	Black
HG-6	Tadipattu	Hukkumpeta	Visakhapatnam	18.1593	082.7118	838	Ancestral	Black
HG-7	Kotapadu	Kotapadu	Visakhapatnam	17.8774	083.0380	78m	land race	Straw brown
HG- 8	Gondupalem	Kotapadu	Visakhapatnam	17.8728	083.0317	74m	land race	Brown
HG-10	Lingalatrugudu	chodavaram	Visakhapatnam	17.8191	083.0317	123m	Ancestral	Brown
HG-11	Boddam	Vepada	Vizianagaram	18.0495	083.1459	101m	landrace	Brown
HG-13	Sameda	Devarapalli	Visakhapatnam	18.0680	083.0135	141m	Ancestral	Straw brown
HG-14	Dumbriguda	dumbriguda	Visakhapatnam	18.2975	082.8038	920m	Ancestral	Black
HG-15	Kuridi	dumbriguda	Visakhapatnam	18.3227	082.8245	917m	Ancestral	Brown
HG-16	Bokavanipalem	Kotapadu	Visakhapatnam	17.8922	083.0892	102m	landrace	Brown
HG-17	Kotturu	Ananthagiri	Visakhapatnam	18.2081	083.0746	204m	Ancestral	Black
HG-18	Medacherla	Kotapadu	Visakhapatnam	17.8922	083.0294	58 m	landrace	Brown
HG-19	Kinchurmandu	dumbriguda	Visakhapatnam	18.1639	082.7242	850	Ancestral	Straw brown
HG- 20	Patamamimidi	Hukkumpeta	Visakhapatnam	17.7197	083.3158	807	Ancestral	Black
HG- 21	Masada	Hukkumpeta	Visakhapatnam	18.1864	082.7525	884	Ancestral	Black
HG- 22	Burmamguda	Hukkumpeta	Visakhapatnam	18.1294	082.6810	812	Ancestral	Black
HG- 23	Rangasela	Hukkumpeta	Visakhapatnam	18.2096	082.7787	994	Ancestral	Black
HG-25	Paderu	paderu	Visakhapatnam	18.0659	82.43120	821	Ancestral	Black
HG-26	Adduru	chodavaram	Visakhapatnam	17.8038	083.0046	86m	Ancestral	Brown
HG-27	Sameda	Devarapalli	Visakhapatnam	18.0680	083.0133	141m	Ancestral	Black
HG-28	Kokkirapalli	Yellamanchili	Visakhapatnam	17.3419	082.5112	21 m	Ancestral	Brown

Table 2: Mean, Range and Standard deviation of the Horsegram [*Macrotyloma uniflorum* (Lam.) verd.] genotypes for the yield attributing Characters.

Variable	Minimum	Maximum	Mean	Coefficient of variation (CV%)
Days to 50 % flowering (days)	56.0	67.0	62.0	2.89
Plant height (cm)	34.80	63.30	50.30	4.95
Number of branches per plant	5.0	6.0	5.60	4.93
Number of pods per plant	29.0	67.0	43.96	6.41
Days to maturity (days)	87.0	106.0	97.3	0.46
100 seed weight (g)	2.00	4.60	2.86	3.75
Dry haulm weight per plant (g)	1.90	6.00	3.72	21.50
Number of seeds per pod	5.0	7.00	5.78	7.75
Seed yield per plant (g)	2.40	6.80	4.20	21.46

Table 3: Morphological Characters recorded for the horsegram [*Macrotyloma uniflorum* (Lam.) verd.] genotypes.

Character	Variants
Leaf hairiness	Hairy, sparsely hairy
Leaf colour	Green, light green, variegated green
Stem hairiness	Hairy, sparsely hairy
Twining habit	Prominent, moderate, very less
Flower colour	Greenish white
Seed coat colour	Brown, straw brown, black, straw

Table 4: Eigen values, proportion of the total variance represented by first principal components and component loading of different characters in horsegram [*Macrotyloma uniflorum* (Lam.) verd.] genotypes.

	F1	F2	F3	F4	F5	F6	F7	F8	F9
Eigenvalue	3.377	1.476	1.123	1.009	0.707	0.618	0.397	0.158	0.135
Variability (%)	37.519	16.395	12.477	11.216	7.856	6.872	4.413	1.751	1.502
Cumulative %	37.519	53.914	66.390	77.606	85.462	92.334	96.747	98.498	100.000
Days to 50% flowering	0.386	0.084	-0.701	0.361	-0.332	-0.286	-0.166	-0.010	0.061
Plant height (cm)	0.807	0.024	0.401	-0.253	-0.215	0.015	-0.079	-0.040	0.262
No.of branches per plant	0.652	-0.453	-0.276	-0.341	-0.059	0.315	-0.154	0.214	-0.071
Number of pods per plant	0.666	-0.564	0.060	0.099	-0.295	0.024	0.310	-0.169	-0.112
Days to maturity	0.520	0.020	-0.035	0.679	0.324	0.387	0.074	0.023	0.086
100 seed weight (g)	-0.010	0.750	-0.347	-0.277	-0.220	0.378	0.216	-0.055	-0.001
Dry haulm weight per plant (g)	0.800	0.237	-0.080	-0.197	0.365	-0.025	-0.263	-0.210	-0.108
Number of seeds per pod	0.498	0.526	0.501	0.294	-0.293	-0.042	-0.103	0.118	-0.161
Seed yield per plant (g)	0.741	0.222	-0.114	-0.165	0.297	-0.377	0.334	0.143	0.011

Table 5: Percentage contribution of the variables in nine principal components in horsegram [*Macrotyloma uniflorum* (Lam.) verd.] genotypes.

	F1	F2	F3	F4	F5	F6	F7	F8	F9
Days to 50 % flowering	4.410	0.482	43.715	12.877	15.551	13.221	6.955	0.068	2.722
Plant height (cm)	19.297	0.039	14.341	6.335	6.509	0.036	1.574	0.996	50.873
No.of branches per plant	12.600	13.904	6.777	11.519	0.497	16.000	6.007	28.950	3.746
Number of pods per plant	13.140	21.562	0.324	0.967	12.307	0.090	24.182	18.107	9.321
Days to maturity	7.993	0.027	0.107	45.607	14.889	24.166	1.365	0.334	5.511
100 seed weight (g)	0.003	38.085	10.696	7.614	6.833	23.151	11.704	1.914	0.001
Dry haulm weight per plant (g)	18.958	3.801	0.575	3.862	18.836	0.098	17.355	27.888	8.628
Number of seeds per pod	7.358	18.761	22.312	8.537	12.137	0.292	2.693	8.794	19.117
Seed yield per plant (g)	16.242	3.340	1.153	2.682	12.442	22.946	28.164	12.949	0.082

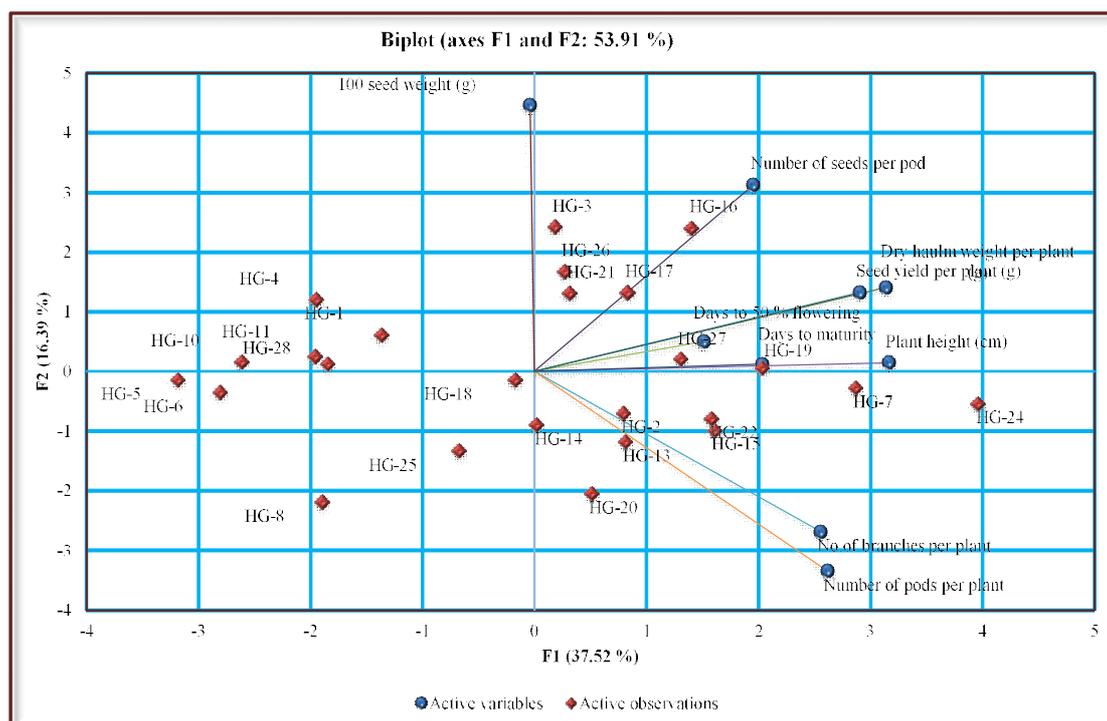


Fig 1: Biplot depicting the active variables (yield parameters) and 25 active observations (genotypes) of horsegram [*Macrotyloma uniflorum* (Lam.) Verd.] based on PCA scores (Genotype numbers as per Table 1).

and no. of seeds per pod. The fourth principal component contributed 11.21 % towards cumulative variance. All the parameters showed negative loading except days to 50 % flowering number of pods per plant, days to maturity and no. of seeds per pod. The results are in accordance with Bhartiya *et al.* 2017 and Gupta *et al.* 2010.

In the first principal component, plant height (19.29%), dry haulm weight (g) (18.95%), seed yield per plant (g) (16.24%) variables contributed highest contribution. The results are in accordance with Gupta *et al.* 2010.

The biplot (Fig 1) shows HG-24 (3.96), HG-7 (2.86); HG-19 (2.03); HG-15 (1.60) and HG-22 (1.58) recorded highest positive scores. The biplot also shows that the genotypes HG-5, HG-10, HG-3, HG-16, HG-8, HG-4, HG-10, HG-24 and HG-7 has wide divergence which may be further adopted in the breeding programme for horsegram improvement programme. Among all the active variables (yield characters) plant height, dry haulm weight per plant and seed yield per plant recorded high score.

CONCLUSION

The twenty five germplasm lines collected from the tribal tracts of Andhra Pradesh showed the predominance of ancestral biological status of accession. The seed yield per plant recorded a range of 2.40 g to 6.80 g and the days to maturity recorded a range of 87 to 106 days. The principal component analysis showed that all the variables except 100 seed weight (g) showed positive loading. Among all the variables plant height (cm), dry haulm weight (g) and seed yield per plant recorded maximum percentage of

contribution in the first principal component. The genotypes HG-24, HG-7, HG-19, HG-15, HG-22 recorded highest positive scores. The genotypes HG-5, HG-10, HG-3, HG-16, HG-8, HG-4, HG-10, HG-24 and HG-7 has shown wide divergence which may be further adopted in the breeding programme for horsegram improvement.

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