

Assessment of variability of Horse gram (*Macrotyloma uniflorum* (Lam.) Verdc) germplasm lines for morphological and physiological traits

KARTHIK M¹, BANGAREMMA WADEYAR¹, SOREGAON C D¹ AND ASHWATHAMA V H²

¹Department of Genetics and Plant Breeding, ²Department of Crop Physiology
College of Agriculture, Vijayapura-586 101
University of Agricultural Sciences, Dharwad - 580 005, India
Email: karthik181998@gmail.com

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Abstract: The study was conducted to assess the mean, range and variance of various morphological and physiological traits. The total of 108 horse gram germplasm lines along with checks (GPM-6, CRIDA-18R, CRHG-4) were grown in augmented block design during *kharif* 2021-22 at the College of Agriculture, Vijayapur. Analysis of variance revealed that the mean sum of squares attributable to germplasm lines vs checks were significant for all the traits except seed yield per plant, fodder yield per plant, test weight and SPAD chlorophyll meter reading at 30 and 60 days. The mean and range of horsegram germplasm lines for different characters like days to 50 percent flowering was 78.34 days and 58.00-87.48 days, respectively and for other traits like days to maturity was (147.83 days and 119.14 days to 171.81 days), plant height (29.36 cm and 10.28 to 42.70 cm), number of pods per plant (28.58 and 17.02 to 41.02), number of seeds per pod (4.52 and 3.29 to 6.02), test weight (3.69 g and 2.26 - 4.61 g), fodder yield per plant (8.24 g and 4.02 to 10.98 g), seed yield per plant (4.38 g and 2.33 g (CG-Kulthi) to 7.67 g (GPM-19) and some of physiological traits like specific leaf weight (3.41 mg/cm² and 1.18-5.90 mg/cm²), leaf area index which ranged from 1.13 to 5.54 with mean of 2.96. The range of genotypic variance and phenotypic variance for seed yield and yield attributing traits was 0.04 to 56372.89, 0.08 to 67584.39, while the magnitude of genotypic variance and phenotypic variance was maximum for seed yield (56372.89 and 67584.39, respectively) and the range of genotypic variance and phenotypic variance for physiological traits was 0.28 to 64.80, 0.44 to 100.30, the maximum genotypic variance and phenotypic variance was recorded in seed yield (64.80 and 100.30, respectively).

Key words: Genotypic variance, Horsegram, Mean, Phenotypic variance, Range

Introduction

Horse gram (*Macrotyloma uniflorum* (Lam.) Verdc) is an important crop in the dry land condition. It is renowned for its hardiness and capacity to adapt to challenging environmental factors including poor soil and harsh climates. Similar to other pulses, it serves as both food and fodder crop (dual purpose), besides a good cover crop for reducing soil erosion, boosting soil fertility and has the capacity to fix atmospheric nitrogen into the soil. Typically, it is planted as a late-season catch crop. Horsegram is a pulse and fodder crop, growing to a height of about 60 cm. It is clad in varying amounts of whitish hairs and bears alternate, trifoliate leaves with petioles. The leaflets are elliptical and up to 7 cm long. The flowers are borne from the leaf axils and are typical of the bean family having standard wings and keel. The diploid (2n) chromosome number of horsegram is (2n=2x=20) with a genome size estimated to be 400 Mbp.

India is the world's largest producer of horse gram. The crop is native to the southeast parts of India, where it is most widely grown (Smartt, 1990). In India, the total area, production and productivity under horse gram is 0.34 million hectares and 0.22 million tonnes with 650 kg/ha respectively. Karnataka is at the first position in India contributing 0.14 million hectares and 0.096 million tonnes production, followed by Tamil Nadu with area of 0.075 million ha and production of 0.056 million tonnes. The highest productivity was recorded by the state of Telangana 1500 kg/ha followed by Bihar 918 kg/ha, Tamil Nadu 745 kg/ha and Karnataka 655 kg/ha (Anon., 2020-21). Horsegram being

highly drought tolerant crop and having nutritionally rich seeds, plays major role in climate change resilient agriculture and forms potential food source for future. However, work on genetic improvement is meagre and it needs to be strengthened. Therefore, present study was undertaken to assess the mean, range and variance among horsegram germplasm lines for morphological and physiological traits.

Material and methods

The experimental material consisted of 105 horsegram germplasm lines and three checks *viz.*, GPM-6, CRIDA-18R and CRHG-4 which were grown in an Augmented Block Design with seven blocks each block contained 15 horse gram germplasm lines along with three checks and the size of each block was 9.3 m length and 4 m width. The experiment was conducted at 'C' block, College of Agriculture, Vijayapur. (University of Agricultural Sciences, Dharwad) during late *kharif* 2021-22. The germplasm lines considered for the study were collected from Regional Research Centre, Indian Institute of Pulse Research, Dharwad. All the recommended package of practices (POP) were followed to raise the good crop under rainfed condition, here the R software was used for data analysis. The detailed list of germplasm lines used in this investigation is given in Table 1.

Results and discussion

The statistical analysis was carried out for the data recorded for different morphological and physiological traits for 105

Table 1. Details of horsegram germplasm lines used in the present study

Germplasm lines	Germplasm lines	Germplasm lines	Germplasm lines
11-SS	GPM-05	GPM-62	TRC-1503
14-61-4-1	GPM-118	GPM-64	GPM-08
AC-18-11	GPM-12b	GPM-73	TRC-1520
AK-12-7	GPM-15	GPM-93	TCR-1423
AK-42	GPM-171	HL-1	TCR-1593
ATPHG-11	GPM-18b	IC-100938	TCR-1517
Bailahongal local	GPM-19	Indirakulthi-1	TCR-1598
Basterkulthi-15	GPM-22	KBHG-01	TCR-1554
BHG-13-1	GPM-23	KGP-14-09	TCR-1801
BHG-13-17	GPM-24	49-08	TCR-1690
BHG-14-1	GPM-26	LONE-1	TCR-1675
BHG-15-1	GPM-28	LONE-2	TCR-1734a
BSP-17-1	VLG-8	PHG-02a	TCR-1734b
BSP-17-2	GPM-30	PHG-02b	TCR-1762
BSP-17-3	GPM-32a	GPM-66	TCR-1771
CG-KULTI-2	GPM-32b	PHG-09	TRR-1799
CG-KULTI-3	GPM-36a	PHG-62	TRC-1801
CRHG-5	GPM-36b	SHG-317	TRC-1805
CRHG-7	GPM-44-2	TCR-1488	TRC-1813
CRHG-8	GPM-45	TCR-1493	TRC-1816
CRHG-9	GPM-48	TCR-1517	TRC-18205
CRHG-17	GPM-49	TCR-1635	
CRHG-19	GPM-50	TCR-1675	
CRHG-22	GPM-52	TCR-1690	
DHG-04	GPM-57	TCR-1700	
GHD-1	GPM-58	TCR-1743	
VLG-19	GPM-59	TCR-140	
GPM-04	GPM-61	TRC-1488	
Checks	GPM-6	CRIDA-18R 3	CRHG-4

germplasm lines along with three check varieties. The analysis of variance (ANOVA) revealed mean sum of squares for horsegram germplasm lines (ignoring blocks) were significantly different for days to germination (1.1), days to 50 per cent flowering (85.8), days to maturity (189.45), plant height (53.71), pod length (0.21), pod yield per plant (2.66), seed yield per plant (1.67), test weight (0.13), leaf area index (0.92), specific leaf weight (0.49) and relative water content (103.70). The mean sum of squares attributable to germplasm lines vs checks

indicated significant difference for days to germination (19.91), days to 50 per cent flowering (5473.73), days to maturity (3638.41), plant height (116.66), number of pods per plant (1005.21), pod length (13.91), number of seeds per pod (5.19), pod yield per plant (1.14), seed yield (2738316.84), SPAD chlorophyll meter reading at 90 days (13.91), leaf area index (7.02) and specific leaf weight (4.48). The ANOVA also indicated high significant differences among the horsegram germplasm lines for days to germination (0.9), days to 50 percent flowering (33.55), days to maturity (159.66), plant height (53.64), pod yield per plant (2.28), seed yield per plant (1.71), test weight (0.13), leaf area index (0.87), specific leaf weight (0.44) and relative water content (100.30). The significant differences between physio-morphological traits reveals the existence of variability in the horse gram germplasm lines. These results suggest that there is an ample opportunity for improvement of horse gram crop by simple selection. Similar result was reported by Kanavi *et al.* (2020) in green gram. (Table 2 and 3).

The minimum number of days required to germinate was 4 days which was observed in CRHG-17, CRHG-19, DHG-04, CRHG-22, GHD-1 horse gram germplasm lines and maximum number required was 7 days which was noticed in LONE-1, PHG-02a, TCR-1493, TCR-1700, TCR-1743 horse gram germplasm lines. Similarly, other important trait for early maturity is days to 50 per cent flowering, interestingly in the present study 50 percent flowering was observed at 58 days in germplasm line CRHG-4 and another important trait *i.e* days to maturity was 119.14 days recorded in AK-42 and contrarily maximum days to maturity was observed in GPM-93 with 171.81 days. These results are in accordance with the earlier reports of Khulbe *et al.* (2013), Poornima *et al.* (2015), Arun (2020) and Bhikhabhai (2022) (Table 4).

Further more the maximum plant height was recorded by germplasm line AK-42 (42.70 cm) and the lowest was recorded by germplasm line BHG-15-1 (10.28 cm). Among the horsegram germplasm lines, seeds per pod varied from 3.29 (CG-Kulthi-2) to 6.02 (TCR-1517) with a mean of 4.52 seeds per pod. The number of pods per plant is the main yield contributing trait in

Table 2. Analysis of variance for seed yield and yield attributing traits in horsegram germplasm lines

Sources	Df	GD	DFD	DM	PH(cm)	NPPP	PL(cm)	NSPP	PYPP(g)	SYPP(g)	FYPP(g)	TW(g)	SY(Kg/ha)
Germplasm lines (ignoring Blocks)	107	1.1**	85.8**	189.45**	53.71**	28.38	0.21**	0.25	2.66**	1.67**	2.85	0.13**	92122.27**
Checks	2	2.33**	109**	13.9	25.80**	90.73*	0.08	0.61	23.09**	0.00048	5.62	0.30**	44883.47*
Germplasm lines vs. Check	1	19.91**	5473.73**	3638.41**	116.66**	1005.21**	13.91**	5.19**	1.14*	0.40	1.23	0.03	2738316.84**
Germplasm lines	104	0.9**	33.55**	159.66**	53.64**	17.79	0.08	0.19	2.28**	1.71**	2.81	0.13**	67586.53**
Blocks	6	2.8	10.43	46.98	16.27	46.84	0.36	0.25	0.17	2.21	1.70	0.02	48092.31
Error	12	1.8	6.17	7.13	3.54	19.18	0.04	0.47	0.23	0.20	1.59	0.01	11214.14
S.Em.±		0.09	0.63	1.28	0.71	0.60	0.05	0.04	0.15	0.11	0.17	0.03	26.77
C.V(%)	-	5.60	3.27	1.83	6.33	14.77	5.02	14.92	7.81	10.23	15.24	3.07	11.12
C.D(5%)	-	7.91	6.68	7.18	5.06	11.78	0.55	1.85	1.29	1.20	3.39	0.30	284.82

**and* significant at 1.0 and 5.0 percent of probability

GD - Days to germination, DFD - Days to 50 per cent flowering, DM - Days to maturity, PH - Plant height (cm), NPPP - Number of pods per plant, PL - Pod length (cm), NSPP - Number of seeds per pod, PYPP - Pod yield per plant (g), SYPP - Seed yield per plant (g), FYPP - Fodder yield per plant, TW - 100 seed weight (g), SY - Seed yield (Kg/ha).

Table 3. Analysis of variance for physiological traits in horsegram germplasm lines

Sources	Df	SCMR30	SCMR60	SCMR90	LAI	SLW(mg/cm ²)	RWC(%)
Germplasm lines (ignoring Blocks)	107	3.22	1.67	1.43	0.92**	0.49**	103.70*
Checks	2	0.89	0.06	0.63	0.60**	0.97**	305.44**
Germplasm lines vs. Check	1	2.09	4.19	13.91**	7.02**	4.48**	54.04
Germplasm lines	104	3.27	1.68	1.33	0.87**	0.44**	100.30*
Block	6	5.16	5.05	2.27	0.02	0.06	28.95
Error	12	1.93	0.92	1.46	0.02	0.01	31.90
S.Em.±	-	0.21	0.15	0.13	0.09	0.06	1.02
C.V(%)	-	5.30	2.86	5.21	4.47	3.20	7.20
C.D(5%)	-	3.73	2.58	3.25	0.37	0.30	15.19

**and* significant at 1.0 and 5.0 per cent probability

SCMR30–SPAD chlorophyll meter reading 30 days, SCMR60 -SPAD chlorophyll meter reading 60 days, SCMR90-SPAD chlorophyll meter reading 90 days, LAI- Leaf area index, SLW-Specific leaf weight (mg/cm²), RWC-Relative water

horsegram and the germplasm line GPM-24(41.02) yielded maximum number of pod per plant. The highest 100 seed weight was recorded by the germplasm line GPM-23 (4.61g) with a mean of 3.69 g. The seed yield per plant is one of the important trait which ranged from 2.33 g (CG-Kulthi) to 7.67g (BSP-17-3) with a mean performance of 4.38 g and the germplasm line GPM-19 recorded highest seed yield per plant. These outcomes are in conformity with reports by Venkateswarlu (2000), Kalia and Dorga (2007), Sahoo *et al.* (2010), Latha *et al.* (2013), Vishwanatha *et al.* (2018), Sudhagar *et al.* and Priyanka *et al.* (2019), Visakh and Bindu (2022). (Table 4)

The SPAD chlorophyll meter reading at 30 and 90 days was less with the mean value of 26.17 and 23.10, respectively. Interestingly, the SPAD chlorophyll meter reading recorded at 60 days was higher compared to SPAD chlorophyll meter reading at 30 and 90 days with the mean value of 33.41. Leaf area index (LAI) is one of the main driving forces of net primary production, it maintains leaf chlorophyll content, net photosynthetic rate and it also balances the carbon content in horsegram. The maximum leaf area index (LAI) was observed in

Table 4. Estimates of range, mean and variance for seed yield and yield attributing traits in horsegram germplasm lines

Traits	Range	Mean	Genotypic variance	Phenotypic variance
GD	4.00-7.00	5.37	0.67	0.90
DFF	58.00-87.48	78.34	47.38	65.10
DM	119.14 -171.81	147.83	152.53	159.66
PH(cm)	10.28 -42.70	29.36	50.18	53.65
NPPP	17.02 -41.02	28.58	11.51	17.74
PL(cm)	3.06 -5.02	3.97	0.04	0.08
NSPP	3.29 -6.02	4.52	0.10	0.19
PYPP(g)	2.81 -9.88	6.16	2.05	2.28
SYPP(g)	2.33 -7.67	4.38	1.50	1.72
FYPP(g)	4.02-10.98	8.24	1.22	2.81
TW(g)	2.26 -4.61	3.69	0.11	0.12
SY(kg/ha)	355.49-1524.9	1006.91	56372.89	67584.39

GD-Days to germination, DFF-Days to 50 percent flowering, DM-Days to maturity, PH-Plant height(cm), NPPP-Number of pods per plant, PL-Pod length(cm), NSPP-Number of seeds per pod, PYPP-Pod yield per plant(g), SYPP-Seed yield per plant(g), FYPP-Fodder yield per plant, TW-100 seed weight (g), SY- Seed yield (kg/ha).

the germplasm line GPM-24 (5.54). Similar results were reported by Kalia and Dorga (2007) Table 5.

Specific leaf weight (SLW) is also one of the physiological trait which indicates the thickness of the leaf and it directly increases the photosynthetic rate in horse gram and it was recorded more in the horsegram germplasm line CRHG-19 with 5.90mg/cm². Generally, the horse gram germplasm lines can maintain the optimum relative water content, in the current study the germplasm line TCR-1743 recorded maximum relative water content (96.02%) with average of 78.64 percent and it helps plant to produce good yield under drought stress condition. (Table 5).

The range of genotypic variance for seed yield and yield attributing traits was 0.04 to 56372.89 while the magnitude of genotypic variance was maximum for seed yield 56372.89 followed by days to maturity (152.53), plant height (50.18), days to 50 percent flowering (47.38), number of pods per plant (11.51) and pod yield per plant (2.05). Maximum phenotypic variance observed for seed yield 67584.39 followed by days to maturity (159.66), days to 50 percent flowering (65.10), plant height (53.65), number of pods per plant (17.74) and pod yield per plant (2.28) in case of physiological traits, the genotypic variance was maximum for relative water content (64.80) followed by SPAD chlorophyll meter reading at 30 days (1.34) and SPAD chlorophyll meter reading at 90 days (1.21) while, maximum phenotypic variance was observed for relative water content (100.30) followed by SPAD chlorophyll meter reading at 30 days (3.27)

Table 5. Estimates of range, mean and variance for physiological traits in horsegram germplasm lines

Traits	Range	Mean	Genotypic variance	Phenotypic variance
SCMR30	20.38 -34.78	26.17	1.34	3.27
SCMR60	29.66 -37.19	33.41	0.76	1.68
SCMR90	19.63 -27.40	23.10	1.21	1.33
LAI	1.13 -5.54	2.96	0.48	0.86
SLW(mg/cm ²)	1.18 -5.90	3.42	0.28	0.44
RWC(%)	52.67-96.02	78.64	64.80	100.30

SCMR30–SPAD chlorophyll meter reading 30 days, SCMR60-SPAD chlorophyll meter reading 60 days, SCMR90-SPAD chlorophyll meter reading 90 days, LAI-Leaf area index, SLW-Specific leaf weight (mg/cm²), RWC-Relative water content (%)

and SPAD chlorophyll meter reading at 60 day (1.68) respectively. The results indicated that magnitude of phenotypic variance was higher compare to genotypic variance for all the morphological and physiological traits. Similar results were reported by Vishwanatha *et al.* (2018), Sudhagar *et al* (2019), Arun (2020) and Visakh and Bindu (2022). The results are presented in the tables 4 and 5.

Conclusions

The analysis of variance revealed significant differences for days to germination, days to 50 per cent flowering, days to maturity, plant height, pod length, pod yield per plant, seed yield per plant, test weight, leaf are index, specific leaf weight and relative water content. Thus, indicating that choice of germplasm lines and traits under study were genetically diverse.

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