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Investigation on genetic variability in horse gram [*Macrotyloma uniflorum* (Lam.) Verdc.] under moisture stress condition

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Abstract
Thirty horse gram genotypes were evaluated for yield and yield contributing characters under moisture stress condition at Farming System Research Station, Sadanandapuram under Kerala Agricultural University. Analysis of variance revealed significant variation among the horse gram genotypes for all character under investigation. For all the characters under consideration, genotypic coefficient of variation was found to be lower than phenotypic coefficient of variation. High heritability along with high GAM was observed in days to 50% flowering, number of primary branches per plant, plant height, number of pods per plant, harvest index, days to maturity, leaf area index, root dry weight, and seed yield per plant. Characters with high heritability (H^2) coupled with high genetic advance are governed by additive gene action and hence, selection based on the above said traits will aid in the improvement of horse gram.

Keywords: Horse gram, moisture stress condition, drought stress, genetic variability, heritability, GAM

Introduction
Sustaining the agriculture is need of the hour for addressing the growing food insecurity raised by the exploding population. But various challenges like abiotic stress including drought, cold, and salinity stresses etc. and biotic stress including pest and diseases are causing hindrance to sustain agricultural development. Water stress condition is an important abiotic stress limiting plant growth. Diversification of food sources and cropping systems by aligning to underutilized climate resilient crops as possible future crops to mainstream agriculture, can be undertaken to combat water scarcity issues (Mabhaudhi *et al.*, 2017) [4].
Horse gram [*Macrotyloma uniflorum* (Lam.) Verdc.] is an underutilized crop belonging to the family Fabaceae. Horse gram is a diploid species with chromosome number 2n=20, 22, 24 (Bhardwaj *et al.* 2013) [2]. It is dual purpose crop used as both food and fodder. It's also known as poor man's food as it is mostly consumed by poor sections of the society. Horse gram is a therapeutically and nutritionally potential pulse crop which is included under super food. Being a minor pulse, the crop has not got any due attention for its genetic upliftment.
Assessment of variability present in the population is the prerequisite in any breeding programme. Effective selection for elite genotypes can be carried out using different genetic parameters, if adequate variability is present. In this context, assessment of horse gram genotypes was conducted to evaluate the genetic variability for yield and its components under moisture stress condition.

Materials and Methods
The current study was undertaken at Farming Systems Research Station, Sadanandapuram, under Kerala Agricultural University, during November, 2020 – March, 2021. Thirty horse gram genotypes were studied for moisture stress tolerance, in randomized block design replicated thrice. The details of thirty genotypes included in the present study are presented in table 1. Seeds soaked overnight in water were dibbled in raised beds at a spacing of 30 × 30 cm in plots of $2.25 m^2$ area. The moisture stress was imposed in the field by withdrawing irrigation for 15 days at critical stages of growth *viz*. flowering and podding stage of the crop (reproductive stage). The yield, yield contributing and quality characters such as days to 50% flowering, number of primary branches per plant, plant height (cm), number of pods per plant, number of seeds per pod, 100 seed weight (g), days to maturity, harvest index (%), root length (cm), root dry weight (g), leaf area index, total phenol content (mg g^{-1}) in seed, crude protein

content of seeds (%) and seed yield per plant (g) were recorded. The data over replications for the selected characters were subjected to analysis of variance as suggested by Panse and Sukhatme (1985) [6] and various genetic parameters worked out.

Table 1: List of horse gram [*Macrotyloma uniflorum* (Lam.) Verdc.] genotypes used in the evaluation

Sl. No.	Name of genotype	Source	Sl. No.	Name of genotype	Source
1	IC145300	RARS Pattambi, KAU	16	HG 27 L	UAHS, Shivamooga
2	IC71841	RARS Pattambi, KAU	17	IC139470	RARS Pattambi, KAU
3	IC139464	RARS Pattambi, KAU	18	IC139435	RARS Pattambi, KAU
4	IC120753	RARS Pattambi, KAU	19	IC139554	RARS Pattambi, KAU
5	IC39353	RARS Pattambi, KAU	20	IC88926	RARS Pattambi, KAU
6	HG 34 L	UAHS, Shivamooga	21	IC67011	RARS Pattambi, KAU
7	IC15730	RARS Pattambi, KAU	22	HG 18 L	UAHS, Shivamooga
8	IC392329	RARS Pattambi, KAU	23	IC139453	RARS Pattambi, KAU
9	HG 26 L	UAHS, Shivamooga	24	IC22759	RARS Pattambi, KAU
10	IC277671	RARS Pattambi, KAU	25	IC26132	RARS Pattambi, KAU
11	IC406382	RARS Pattambi, KAU	26	IC123030	RARS Pattambi, KAU
12	IC22785	RARS Pattambi, KAU	27	IC283202	RARS Pattambi, KAU
13	IC26138	RARS Pattambi, KAU	28	IC22827	RARS Pattambi, KAU
14	HG 31 L	UAHS, Shivamooga	29	IC221105	RARS Pattambi, KAU
15	GDH-1	SDAU, Gujarat	30	HG 24 L	UAHS, Shivamooga

Result and Discussion

Analysis of variance

The soil moisture content was estimated at weekly interval when water stress was imposed in field by using gravimetric method. The average soil moisture content of the treatment plot was 10.10% and 8.84% at 8th and 15th day respectively.

The analysis of variance revealed significant difference among the genotypes under moisture stress conditions for all characters studied (table 2). Similar results were observed by Poornima (2015) [7], Priyanka *et al.* (2019) [8] and Sivan (2019) [11] for days to 50% flowering, number of primary branches per plant, plant height, number of pods per plant, number of seeds per pod, hundred seed weight, days to maturity, harvest index, and seed yield per plant in horse gram. Days to 50% flowering which ranged from 34.33 to 87 days, number of primary branches per plant from 5.41 to 12.5, plant height from 50.92 cm to 103.66 cm, number of pods per plant from 12.77 to 63.99, number of seeds per pod from 2.47 to 5.06, hundred seed weight from 3.10 g to 4.14 g, harvest index from 13.11% to 67.68%, days to maturity from 78.67 to 130.33, root length from 16.60 to 28.15 cm, root dry weight from 1.16 g to 3.46 g, Leaf area index from 0.48 to 1.75, 84.59 mg g^{-1} to 151.42 mg g^{-1}, total phenol content in seed, crude protein content of seed from 21.27% to 23.72% and seed yield per plant from 2.08 g to 9.61 g. The considerable variation among genotypes signals scope for improvement.

Estimates of variability parameters of various traits in horse gram genotypes are furnished in table 3.

Table 2: Analysis of variance for 14 characters in 30 horse gram genotypes

Sl. No.	Characters	Mean Sum of Square			S.Em	CD @5%
		Replication	Genotype	Error		
1.	Days to 50% flowering	23.244	1184.766	5.727	1.382	3.911
2.	Number of primary branches per plant	11.013	11.137	1.561	0.740	2.094
3.	Plant height (cm)	721.141	615.428	107.874	5.898	16.600
4.	No. of pods per plant	38.946	824.773	42.944	3.783	10.710
5.	No. of seeds per pod	0.905	1.371	0.257	0.293	0.829
6.	100 Seed weight (g)	0.302	0.161	0.068	0.151	0.427
7.	Harvest index (%)	10.875	629.000	17.643	0.031	0.087
8.	Days to maturity	89.644	681.519	36.530	3.489	9.878
9.	Root length (cm)	37.052	18.941	9.188	1.750	4.954
10.	Root dry weight (g)	0.088	0.801	0.097	0.180	0.508
11.	Leaf area index	0.515	0.416	0.053	0.127	0.359
12.	Phenol content (mg g^{-1}) in seed	1609.356	1173.250	196.373	8.091	22.903
13.	Crude Protein content (%)	0.579	1.253	0.702	0.484	1.369
14.	Seed yield per plant (g)	1.526	15.701	0.606	0.450	1.273

Table 3: Estimates of genetic variability parameters of various traits in horse gram genotypes

Character	Mean	PCV (%)	GCV (%)	H^2 (%)	GAM (5%)
Days to 50% flowering	52.889	37.756	37.483	98.600	76.659
No. of primary branches/plant	8.735	25.409	20.755	66.700	34.925
Plant height (cm)	80.829	20.285	15.9	61.400	25.674
No. of pods per plant	34.556	50.419	46.717	85.900	89.170
No. of seeds per pod	3.580	22.142	17.022	59.100	26.956
100 seed weight (g)	3.558	8.843	4.948	31.300	5.704
Harvest index (%)	36.267	49.581	47.225	90.700	92.660
Days to maturity	103.722	15.29	14.137	85.500	26.924

Leaf area index	1.113	34.687	28.558	67.800	48.436
Total phenol content of seed (mg g^{-1})	120.147	19.016	15.019	62.400	24.436
Crude Protein content (%)	22.342	4.212	1.918	20.700	1.799
Root length (cm)	20.303	17.315	8.852	26.100	9.322
Root dry weight (g)	1.833	31.341	26.362	70.800	45.680
Seed yield per plant (g)	5.181	45.827	43.294	89.300	84.256

Phenotypic and Genotypic coefficients of Variation (PCV and GCV)

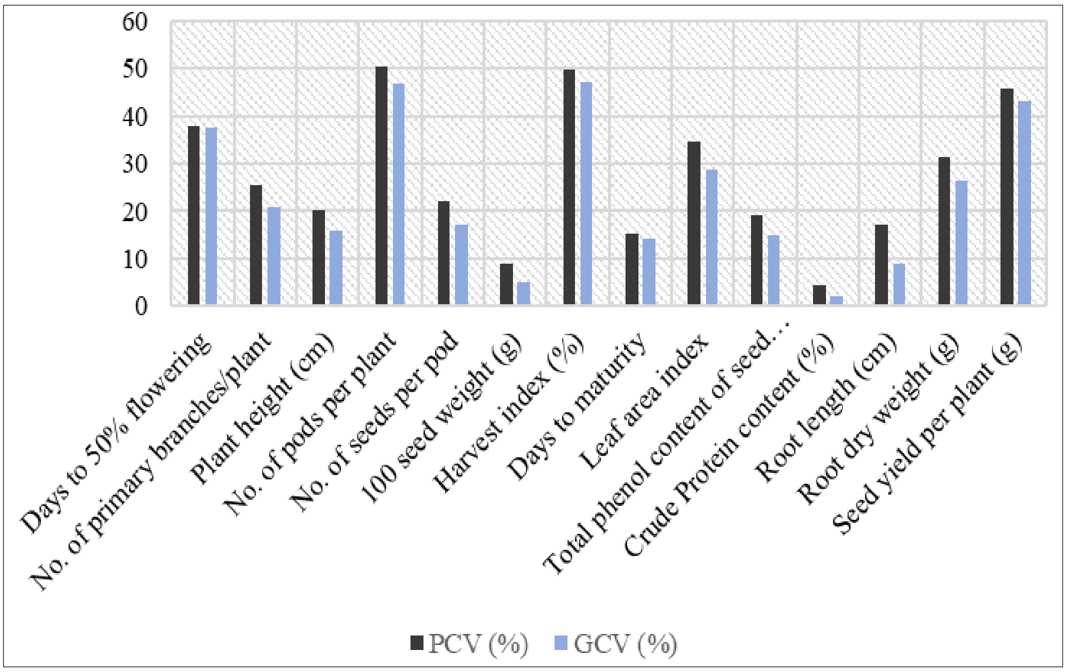

Fig 1: PCV and GCV of selected characters

High PCV and GCV were observed in days to 50% flowering, number of primary branches per plant, number of pods per plant, harvest index, leaf area index, root dry weight and seed yield per plant. The plant height and number of seeds per pod recorded high PCV but moderate GCV. Similar findings were made by Alle *et al.* (2016) [1] for seed yield per plant; Shivaji (2011) [13], Priyanka *et al.* (2019) [8] for number of pods per plant, number of primary branches per plant and seed yield per plant; Sivan (2019) [11] for number of pods per plant, number of primary branches per plant, harvest index and seed yield per plant in horse gram. Moderate PCV and GCV were recorded in days to maturity and total phenol content in seed. Rishishwar (2002) [9] also reported moderate PCV and GCV for days to maturity in horse gram. Root length exhibited moderate PCV and low GCV. Low PCV and GCV were shown by hundred seed weight and crude protein content of seed. This was consistent with reports of Swapna (1993) [12], Poornima (2015) [7] for hundred seed weight; Joshi *et al.* (2007) [3], Shivaji (2011) [13] and Sivan (2019) [11] for hundred seed weight and crude protein content in horse gram.

Heritability (H^2) and genetic advance as per cent mean (GAM)

High heritability was recorded in days to 50% flowering, number of primary branches per plant, plant height, number of pods per plant, harvest index, days to maturity, leaf area index, total phenol content of the seed, root dry weight and seed yield per plant. Medium heritability was recorded in number of seeds per pod and hundred seed weight. Crude protein content of seed and root length exhibited low heritability. Days to 50% flowering recorded the highest heritability (98.60%), while crude protein content of seed recorded the lowest (20.70%).

Low GAM was observed in hundred seed weight, crude protein content of the seed and root length. Days to 50% flowering, number of primary branches per plant, plant height, number of pods per plant, number of seeds per pod, harvest index, days to maturity, leaf area index, total phenol content of the seed, root dry weight and seed yield per plant expressed a high GAM. High heritability along with high GAM was observed in days to 50% flowering, number of primary branches per plant, plant height, number of pods per plant, harvest index, days to maturity, leaf area index, total phenol content of the seed, root dry weight and seed yield per plant. The result was in consonance with findings of Rishishwar (2002) [9] for days to 50% flowering, days to maturity, number of pods per plant; Joshi *et al.* (2007) [3] for plant height, number of primary branches per plant, number of pods per plant, harvest index and seed yield per plant; Poornima (2015) [7] for days to 50% flowering; Priyanka *et al.* (2019) [8] for plant height, number of primary branches per plant, number of pods per plant and seed yield per plant; Sivan (2019) [11] for days to 50% flowering, plant height, number of pods per plant and seed yield per plant; Neelima *et al.* (2021) [5] for plant height, number of primary branches per plant and seed yield per plant in horse gram. Characters with high heritability coupled with high genetic advance are governed by additive gene action and hence, selection based on the above said traits will aid in the improvement of horse gram.

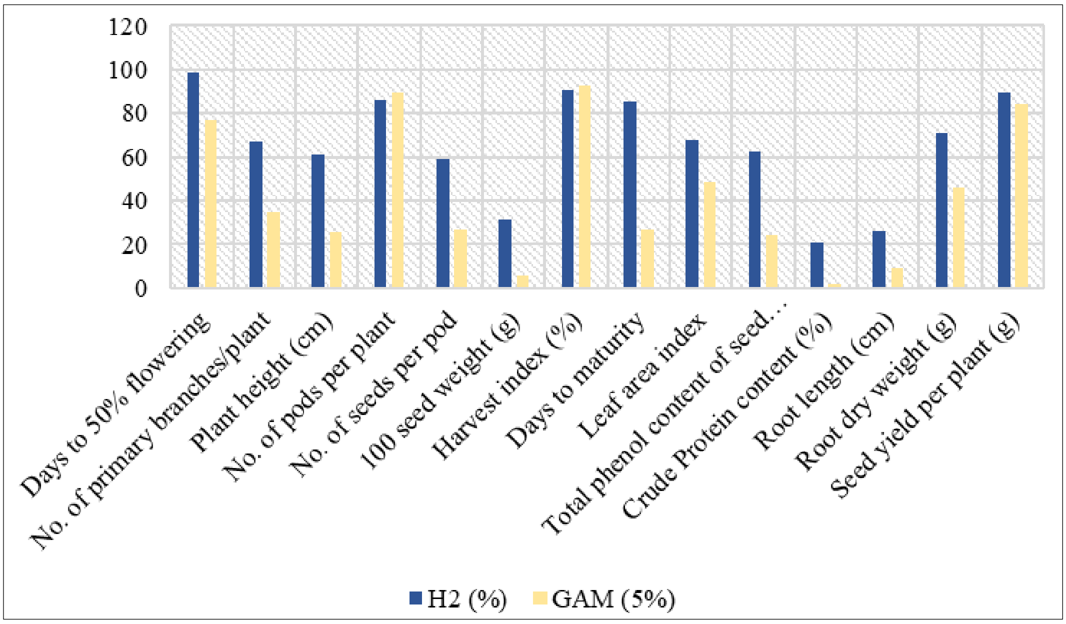

Fig 2: Heritability and GAM of selected characters

Conclusion

Based on the present investigation, it can be concluded that significant difference was present among the horse gram genotypes for all the traits studied. Due to high heritability and GAM, selection based on days to 50% flowering, number of primary branches per plant, plant height, number of pods per plant, harvest index, days to maturity, leaf area index, root dry weight and seed yield per plant will aid in the improvement of horse gram under moisture stress conditions.

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