

Characterization and Pattern of Seed Development in Horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.] Genotypes Under Gangetic West Bengal Condition

Soham Mukherjee¹, Amitava Dutta^{2*}, R. N. Sadhukhan³

^{1,2}Department of Seed Science and Technology, ³Department of Genetics and Plant Breeding
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

***Corresponding Author**

E-Mail Id: amitavapors@gmail.com

ABSTRACT

Horsegram is a minor pulse crop growing on 1.85 lakh hectares with 1.28 lakh tonne production and 690 kg ha⁻¹ productivity. The cultivation of horsegram in West Bengal is mainly restricted in the western tract which includes Purulia, Birbhum, West Midnapore as also Malda district. The main difficulty in growing horsegram is unavailability of high yielding varieties. The current study, which involved 11 genotypes, was carried out at Mundoury Teaching Farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, during the Rabi season of 2021 and 2022. The objective of this study was to identify the promising genotypes under the gangetic West Bengal condition. The experiment also included seed development pattern of selected genotypes to determine the exact time of harvesting for maximum seed yield and quality. The genotype VLG-53 showed promising results in terms of seed yield, primary branch plant⁻¹, pod branch⁻¹ and pod plant⁻¹. HPKM 191 recorded maximum days to 50% flowering and maturity. IPHG 18-9 and BSP 21-1 also produced higher seed yield but IPHG 18-9 was earlier in maturity than BSP 21-1. The pattern of seed development is important to determine the best time of harvesting for maximum yield and seed quality. Pod length and pod breadth increased gradually up to 42 days of anthesis for all genotypes, with maximum germination percentage at 49 days after anthesis. Based on the seed yield and physiological characters, VLG-53 was found promising, for cultivation under Gangetic West Bengal conditions.

Keywords: Horsegram, seed quality, seed yield

INTRODUCTION

Except for major cereals and legumes, there are several underutilized crops which are grown under poor management practices and gives out high nutritive value in low cost. But due to low market demand and low profit, such crops are often overlooked. One such fascinating and underused crop is horsegram. Horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.] is a crop under Fabaceae family of Fabales order. It has chromosome number 2n= 20, 22, 24 (Cook *et al.*, 2005).[2] Historical investigation suggested that the crop is

native to South Asia and Africa in the countries and regions like Bangladesh, Eastern Himalaya, Ethiopia, India, Kenya, Pakistan, Senegal, Somalia, Sri Lanka, Sudan, Tanzania, Uganda, Western Himalaya etc. These countries have the evidence of being native to this crop (<https://powo.science.kew.org>).[5] From the old-world tropics, this crop later distributed in countries like Philippines, Australia etc. In 2019-20, India produced near about 1.28 lakh tonnes of horsegram from 1.85 lakh hectare area, with a productivity of 690 kg ha⁻¹

(https://aps.dac.gov.in/APY/Public_Report_1.aspx).[4] Tamil Nadu comprised the maximum area, i.e., 76619 ha (41.38%), followed by Karnataka (76212 ha, 41.16%) and Andhra Pradesh (29995 ha, 16.20%). In terms of production also, Tamil Nadu has maximum production (59679 t, 46.5%), followed by Karnataka (50531 t, 39.37%) and Andhra Pradesh (16670 t, 12.99%). In terms of productivity, Telangana is on top rank with 870 kg ha⁻¹, followed by Tamil Nadu (780 kg ha⁻¹) and Karnataka (660 kg ha⁻¹). In West Bengal, the major producing districts of horsegram are Purulia (589 t in 1290 ha), West Midnapore (93 t in 150 ha), Birbhum (90 t in 130 ha), Malda (71 t in 95 ha). There is declining trend of area and production since 2016-17 (2160 ha area, 1185 t production with a productivity of 550 kg ha⁻¹) to 2019-20 (1739 ha area, 919 t production with productivity of 530 kg ha⁻¹). Highest productivity is recorded in Malda with 750 kg ha⁻¹, followed by Birbhum (690 kg ha⁻¹), Jalpaiguri and West Midnapore (620 kg ha⁻¹). At present no improved varieties are available under Gangetic West Bengal condition. The physiological maturity of genotypes is not well established. A good quality seed or improved variety is the milestone and catalyst for agro-technologies. We can guarantee improved seed quality and reduced seed shattering loss by determining the ideal physiological and harvest maturity stage. Hence, the present study was conducted with the objectives for characterization of new genotypes and study of pattern of seed development of selected genotypes suitable under Gangetic West Bengal condition.

MATERIALS AND METHOD

The present investigation was conducted in Teaching Farm, Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia during Rabi season of 2021 and 2022.[1] The farm is situated at 22°56'N latitude and 88°30'E longitude with an average altitude

of 14 m above mean sea level. The soil type is sandy loam in nature with near to neutral pH (6.5) and having good drainage facility. Seeds of 11 genotypes were collected from AINP (All India Network Project) on Arid Legumes. The seeds of the genotypes were sown in plot size of 3 meter X 3 meter with three replications. Uniform dose of fertilizer @ 40 kg N, 20 kg P₂O₅ and 60 kg K₂O hectare⁻¹ was applied. The Randomized Block Design (RBD) called for a plant-to-plant spacing of 15 cm and a row spacing of 60 cm. Every plot was spaced one meter apart. Data on plant height (cm), flowering and maturity duration (days), number of primary branches, Pod branch-1, pod plant-1, 100 seed weight (g), seeds pod-1, and seed yield (g plant-1 and g m-2) were gathered in order to analyze the characteristics that contribute to plant growth and yield. Characters like pod length (cm), pod breadth (mm), seed length (mm), seed breadth (mm), fresh seed weight (mg seed⁻¹) were measured at different plant growth stages. For study of pattern of seed development, Factorial Randomised Block Design (FRBD) was used. Genotypes were used as first factor and stages of seed development as second factor. Statistical analysis of data of different parameters was carried out using the statistical package OPSTAT (Sheoran *et al.*, 1998).[6] The appropriate standard error [SEm (±)] was computed in each case, critical difference (CD) at 5 percent level of probability was worked out to compare to treatments means.

RESULTS AND DISCUSSION

Characterization of Morphological Parameters [Table 1]

For all characters, including plant height (cm), flowering and maturity (days), number of primary branches, number of pods branch-1, number of pods plant-1, 100 seed weight (g), and seed yield (g plant-1 and g m-2) there was a noticeable variance in average performance between

genotypes (table 1). Concerning taller plants, Results for IPHG 18-9 were positive. It was preceded by BSP 21-2 with 60.3 cm plant height at maturity. VLG-54 had lowest plant height (cm). VLG-54 had earliest flowering, probably due to its low plant height. It was preceded by VLG-15 and it was earliest in days to 50% flowering and maturity (32.7 and 83 days respectively). Considering the average performance of individual genotypes for number of primary branches, number of pods branch⁻¹ and number of pods plant⁻¹ (table 1), IPHG 18-9 had maximum number of primary branch plant⁻¹, number of pods branch⁻¹ and number of pods plant⁻¹ (7.7, 23.7, 165.7 respectively). Although number of pods branch⁻¹ was higher in BSP 21-1 and HPKM 191 (18.5 and 18.3) but due to a smaller number of primary branch plant⁻¹, the above two

genotypes had lower number of pods plant⁻¹. But HPKM 191 had second position in number of pods plant⁻¹ (97.3), after IPHG 18-9. VLG-54 recorded lowest number of pods plant⁻¹ due to very few primary branches plant⁻¹ as well as number of pods branch⁻¹. It can be noted that 100 seed weight (g) ranged from 2.7 to 5.5 g indicating there is large variation among the 11 genotypes. VLG-15 and HPKC-101 had maximum 100 seed weight (g) with 5.5 g followed by HPKM 191 (4.6 g). VLG-15 and HPKM 191 possess highest number of seeds pod⁻¹ (5.5), followed by Chhattisgarh Kulthi-3 (5.2 seeds pod⁻¹). HPKM 191 recorded maximum seed yield plant⁻¹ with 23.9 g plant⁻¹ followed by VLG-53 and IPHG 18-9 (15.2 and 12.8 g plant⁻¹). HPKM 191 recorded maximum seed yield m⁻² (198.0 g) followed by VLG-53.

Table 1: Morphological characters of horsegram genotypes.

Genotypes	Plant height (cm)	50% Flowering (Days)	Maturity (Days)	Numbers of primary branches plant ⁻¹	Number of pods branch ⁻¹	Number of pods plant ⁻¹	100 seed weight (g)	Seeds pod ⁻¹	Seed yield (g plant ⁻¹)	Seed yield (g m ⁻²)
Bilasa Kulthi	47.6	51.1	101.3	4.8	4.9	22.8	2.9	5.0	3.4	38.8
Chhattisgarh Kulthi-3	53.3	60.3	111.7	3.9	11.6	42.0	3.0	5.2	7.2	71.2
VLG-15	39.9	32.7	83.0	6.1	3.0	25.0	5.5	5.5	7.7	102.5
IPHG 18-9	71.7	72.7	124.0	7.7	23.7	165.7	3.5	2.2	12.8	153.3
BSP 21-2	60.3	54.7	106.0	4.5	13.5	67.9	2.7	4.6	9.6	108.9
HPKC-101	36.6	33.3	84.0	3.3	3.2	14.9	5.5	4.9	5.1	34.3
VLG-53	35.7	34.3	85.0	4.1	13.9	62.8	4.5	5.0	15.2	172.2
BSP 21-1	46.8	42.7	95.0	4.6	18.5	73.9	3.0	4.8	11.5	137.3
BSP 21-3	50.1	56.7	106.0	6.5	14.4	84.6	2.8	3.8	10.2	122.6
HPKM 191	39.1	33.3	87.0	5.1	18.3	97.3	4.6	5.5	23.9	198.0
VLG-54	31.1	32.7	86.0	2.1	6.2	14.3	3.5	4.7	3.1	33.1
Mean	46.3	45.8	97.2	4.8	11.9	61.0	3.8	4.7	10.0	106.6
SEm (±)	1.519	0.478	0.367	0.198	0.496	1.889	0.067	0.054	0.396	1.603
CD (P=0.05)	4.513	1.419	1.089	0.588	1.475	5.612	0.200	0.160	1.178	4.776

Pattern of Seed Development

Five genotypes, namely VLG-15, HPKC-101, VLG-54, HPKM 191 and VLG-54 were selected based on differences in flowering pattern for study of seed development pattern (table 2). Different seed morphological characters, such as pod length (cm), pod breadth (mm), seed length (mm), seed breadth (mm), seed

weight (mg seed⁻¹), numbers of seeds pod⁻¹ were studied from the harvested pods starting from 14 days after anthesis (S1) to 49 days after anthesis (S6) at an interval of 7 days. Different physiological parameters, such as germination percentage, seedling length (cm), Vigour Index-I were calculated to determine the variation of different parameters at different stages of

crop growth. The length of pod increased significantly with the progression of grain filling stage (Table 2) up to 42 days after anthesis (S5), with value 4.34 cm, thereafter decreased slightly at 49 days after anthesis (S5). Among the genotypes, HPKM 191 followed by VLG-54 showed superiority (4.27 and 4.22 cm respectively). The mean value of pod breadth (mm) was maximum at 42 days after anthesis (S5) with 7.70 mm. HPKC-101 showed highest mean pod breadth (7.73 mm), preceded by VLG-15 (7.39 mm). There was a significant variation between genotypes, stages of crop as well as interaction values for the character seed length (mm). It was not possible to separate seeds at 14 days after anthesis. Seed length (mm) recorded from 21 days after anthesis, revealed that HPKC-101 registered maximum mean seed length (8.64 mm) followed by VLG-53 (8.39 mm) at 42 days after anthesis. Similarly, seed breadth was maximum with 6.36 mm at 42 days after anthesis, where both HPKC-101 and VLG-53 genotypes registered with 6.04 mm. Before seed growth actually starts, the pod wall grows to a large extent due to the maximum accumulation of dry matter, and as the seed grows, the pod wall weight gradually decreases as the amount of dry matter in the seed increases, which increase linearly

followed by decrease in growth rate at the end of seed filling completion (Davies *et al.*).[3] Maximum mean fresh seed weight was observed in S5 (42 days after anthesis) with 90.30 mg seed⁻¹, followed by decline at 49 days after anthesis (73.21 mg seed⁻¹). Among the genotypes, VLG-53 had maximum mean fresh seed weight (78.94 mg seed⁻¹) followed by HPKC-101 (76.87 mg seed⁻¹) although there was non-significant variation between them. At 21 days after anthesis (S2) seed development was poor due to lower accumulation of storage material and immature embryo. The overall mean values at different stages indicated that S6 (49 days after anthesis) had maximum germination percentage (85.73%), Maximum mean germination was recorded for HPKM 191 (75.3%) indicating superiority of this genotype over the other genotypes. From table 2, it can be observed that, S6 (49 days after anthesis) recorded maximum mean seedling length (44.59 cm), followed by S5 (37.88 cm). Highest vigour index (3821.27) was observed in S6 (49 days after anthesis), followed by S5 (3821.87 and 3155.17 respectively). Among genotypes, HPKM 191 recorded highest vigour index (2591.02) followed by VLG-53 (2502.56), although there is non-significant variation between HPKM 191 and VLG-53 as shown in Table 2.

Table 2: Seed and pod character at different growth stages of horsegram genotypes.

Genotypes	Pod length (cm)	Pod breadth (mm)	Seed length (mm)	Seed Breadth (mm)	Fresh seed weight (mg seed ⁻¹)	Germination % (Tr value)	Seedling length (cm)	Vigour Index-I
Genotypes								
VLG-15	4.00	7.39	8.31	5.53	66.25	74.0 (59.3)	31.27	2405.7
HPKC-101	4.01	7.73	8.64	6.04	76.87	69.6 (56.5)	31.88	2342.0
VLG-53	4.20	7.34	8.39	6.04	78.94	72.7 (58.5)	32.16	2502.6
HPKM 191	4.27	7.10	7.69	5.61	66.54	75.3 (60.2)	33.18	2591.0
VLG-54	4.22	7.01	7.89	5.39	64.51	74.9 (60.0)	31.11	2473.3
SEm (±)	0.051	0.127	0.104	0.153	1.583	0.617	0.124	30.355
CD (P=0.0)	0.169	0.419	0.345	0.507	5.241	2.043	0.410	100.53

5)								
Stages of crops								
S1 (14 DAA)	3.75	6.50	0.00	0.00	0.00	0.0	0.0	0.0
S2 (21 DAA)	4.26	7.41	7.03	4.80	39.82	51.9 (46.1)	13.79	709.9
S3 (28 DAA)	4.19	7.35	8.23	5.60	66.90	68.9 (56.1)	30.02	2069.0
S4 (35 DAA)	4.28	7.53	8.56	5.95	82.87	76.8 (61.2)	33.32	2558.7
S5 (42 DAA)	4.34	7.70	8.73	6.36	90.30	83.2 (65.8)	37.88	3155.2
S6 (49 DAA)	4.01	7.40	8.37	5.91	73.21	85.7 (67.8)	44.59	3821.9
SEm ($\pm$)	0.038	0.055	0.080	0.099	2.383	0.585	0.213	28.621
CD (P=0.05)	0.110	0.155	0.230	0.283	6.835	1.678	0.612	82.108
Interaction								
S.Em ($\pm$)	0.125	0.310	0.233	0.342	3.539	1.379	0.277	67.877
CD (P=0.05)	0.257	0.379	0.537	NS	NS	3.879	1.386	189.82

CONCLUSION

Based on overall performance of morphological and physiological characters, VLG-53 and HPKM 191 can be recommended for cultivation in Gangetic West Bengal condition and crop should be harvested within 49 days after anthesis for obtaining maximum seed yield with best quality seed.

REFERENCES

1. Lohitha, B., & Dutta, A. (2022). Biopriming in chickpea (*Cicer arietinum* L.): An eco-friendly approach for quality seed production. *Pharma Innovation*, 11(2), 375-379.
2. Cook, B. G., Pengelly, B. C., Brown, S. D., Donnelly, J. L., Eagles, D. A., Franco, M. A., ... & Peters, M. Schultze-Kraft; R. 2005. Tropical Forages: an interactive selection tool,[CD-ROM]. CSIRO, DPI&F (Qld), CIAT and ILRI, Brisbane, Australia.
3. Davies, S. L., Turner, N. C., Siddique, K. H. M., Leport, L., & Plummer, J. A. (1999). Seed growth of desi and kabuli chickpea (*Cicer arietinum* L.) in a short-season Mediterranean-type environment. *Australian Journal of Experimental Agriculture*, 39(2), 181-188.
4. https://aps.dac.gov.in/APY/Public_Report1.aspx
5. <https://powo.science.kew.org>
6. Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R. C., & Pannu, R. S. (1998). Statistical software package for agricultural research workers. *Recent advances in information theory, statistics & computer applications by DS Hooda & RC Hasija Department of Mathematics Statistics, CCS HAU, Hisar*, 8(12), 139-143.