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"Genetic assessment of Superfood crop winged bean [*Psophocarpus Tetragonolobus* (L.) DC.] Under foothill condition of Nagaland"

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Abstract
Winged bean [*Psophocarpus tetragonolobus* (L.) DC] is an important leguminous crop. It's all parts consumed as leaves, flowers, pods, seeds and also tuberous roots because of their great nutritional values. The present investigation was carried out to assess the genetic variability, character association and path coefficient among the 40 genotypes of winged bean. The research trial was conducted at the instructional farm of the department of Genetics & Plant Breeding, School of Agricultural Sciences, Nagaland University, Medziphema, India during summer season of 2023-2024. Analysis of variance (ANOVA) indicates statistically significant differences at (5%) level Among all the genotypes for the yield contributing traits. It was observed that Day to 50% flowering showed high GCV, PCV, Genetic Advance, and Genetic Advance % of mean coupled with the highest heritability followed by green pod weight and number of secondary branches. The character association indices at genotypic and phenotypic levels clearly revealed that seed index, number of pods per plant, pod length, and number of seeds per pod, are significantly positive correlated with seed yield per plant. The path coefficient analysis clearly exhibited the highest positive direct effect of seed index on seed yield per plant. The traits *viz*. Day to 50% flowering, number of secondary branches, green pod weight, and Seed yield per plant exhibited high heritability and high GCV, PCV, Genetic Advance and Genetic Advance as % of mean. It provided a direction to focus on the traits such as seed index, pod length, seeds per pod and secondary branches to improve the selection efficiency. There is tremendous potential in the local genotypes *viz*. Local Wokha-2 and Local Pangti-2 of the Winged bean for genetic improvement under the foothill condition of the hill state owing to its popularity and commercial viability owing to their outstandingly at par performance with that of released varieties *viz*. VRWB-17 and VRWB-23.

Keywords: Winged bean, Genetic Variability, GCV, PCV, Path coefficient, correlation Genetic Advance, Heritability, Protein,

INTRODUCTION

The winged bean (*Psophocarpus tetragonolobus* (L.) DC) is a self-pollinating legume from the Fabaceae family, with a diploid chromosome count of 2n=2x=18/22. Winged bean is widely recognised by consumers and farmers in South Asia and South East Asia for its variety of uses and disease resistance. Winged bean is nutrient-rich and all parts of the plant are edible. It is extensively cultivated in tropical regions such as Central and South America, the Caribbean, Africa, Oceania, and Asia, particularly in hot and humid equatorial countries like India, Burma, Sri Lanka, Thailand, and the Philippines (Ojuederie *et al.* 2020). Known by various names including God-sent vegetable, princess pea, choughula sem, goa bean, and four-angled beans. The winged bean is recognized for its high protein content and versatility as a crop. Developed nations grapple with providing high-quality food to all their citizens due to their high levels of nutrition. The entire winged bean plant is edible. The leaves, flowers, roots, and bean pods can be eaten raw or cooked; the pods are edible even when raw and unripe.

Theseeds are edible after cooking. Each of these parts contains vitamin A, vitamin C, calcium and iron, among other nutrients. The tender pods, which are the most widely eaten part of the plant, are best when eaten before they exceed 2.5 cm in length. This crop has garnered attention for its potential to address food security, particularly in tropical regions where it thrives in hot and humid climates. Despite the nutritional benefits and adaptability of winged beans, their cultivation and consumption remain limited. The lack of awareness and understanding about their agricultural and nutritional advantages has hindered their widespread adoption. This research addresses the question: How can the cultivation and consumption of winged beans be promoted to enhance food security and nutritional health in tropical regions. Winged bean is an important vegetable crop with potential yet to be thoroughly exploited. All parts of this plant, *viz.,* immature pods (2.9-21.5% protein), ripe seeds (31.8% protein), tender shoots (2.8-5.6% protein), flowers (2.92% protein), young leaves (3.24% protein) and tuberous roots (8-20% protein) are consumed as protein, calcium and iron-rich vegetable (Neeliyara *et al.* 2001).

Lepcha *et al.* (2017) suggested three areas of focus to enhance the cultivation, utilization, and exploitation of winged beans: (1) elucidating the domestication and evolutionary history to guide future germplasm exploration and collection, (2) characterizing germplasm collections and identifying potential parental lines for breeding, and (3) developing genomic resources and employing genomic technologies in breeding programs.

The objectives of this study are to assess the genetic performance of various genotypes under foothill region of the hill state of Nagaland. The state is richly endowed with variety of natural flora of various beans as they are very popular among the local tribal dwellers. Another objective is to explore the prospects for genetic improvement of local types of the crop in order to further popularize the outstanding genotypes in the area. The significance of this research lies in uncovering the potential of winged beans as a sustainable and nutritious food source that can address global food security challenges, provide a viable solution for improving the dietary diversity and nutritional status of populations in tropical regions, and increase agricultural biodiversity and resilience against climate change by promoting a versatile crop that thrives in diverse environmental conditions.

Methodology:
The present investigation was carried out during *kharif* season of 2023 under the agro-climatic condition of Medziphema (Nagaland), which falls under sub-tropical climate with high humidity and moderate temperature with medium to high rainfall. The experimental site was located in the foothill of Nagaland having an elevation of 310 m above sea mean level with geographical location of 25 45'43" N latitude and 95 53'04" E longitudes. The temperature ranges from 12°C during winter to 32°C during summer. The average annual rainfall varies from 2000 to 2500 mm.

The experiment material for the present investigation consisted of 40 Germplasms collected from the different parts of Nagaland and also recruited from the ICAR institution Indian Institute of Vegetable Research, Varanasi. The experiment was laid out in Randomized Block Design (RBD) with three replications. The observations were recorded for different quantitative characters. The observations on 12 quantitative traits *viz*. number of secondary branches, days to 50% flowering, day to maturity, plant length (cm), plant width (cm), number of pods per plant, number of seeds per pod, dry pod weight (g), green pod weight (g), crude protein percentage, 100 seed weight (g), and seed yield per plant (g) have been have been recorded on five randomly selected plants in each replication. The analysis of variance (ANOVA) was carried out the following the Panse and Sukhatme (1954) procedure.

Results and Discussion
The analysis of variance (ANOVA) for the mean data of all 12 Characters was statistically tested at 5% level of significance in table no. 1. It revealed that there were highly significant differences among the genotypes for all 12 Characters under investigation, showing extensive range of variation in 40 genotypes of winged bean. Consequently, it can be assumed that systematic crossing between chosen genotypes will result in increased genetic diversity in subsequent generations. This approach will enhance the effectiveness of selection for desirable traits, leading to improved plant varieties with higher yield and better adaptability.

Mean performance
The mean values and range of variability for the 12 traits are summarized in Table 2. The findings for each character are described below. In genotypes with high seed yield per plant, Local wokha-2 (144.997g) came in first, followed by VRWB-20 (144.37g), VRWB-17 (132.47g), VRWB-36 (121.367g), VRWB-59 (118.95g), and VRWB-116 (118.92g). A considerable number of pod yields per plant were observed in VRWB-88, VRWB-23, VRWB-24, VRWB-85, VRWB-116, VRWB-32, Local Medziphema, VRWB-59, Local Peren, and Local Wokha-2 and highest Crude Protein in VRWB-23 (50.7%) and local pangti-2 (48.7%), in the 40 genotypes. These genotypes were selected based on their overall highest yield performance. As a result, these land races could be utilized in future breeding programs to break the yield barrier. The local genotypes like Wokha-2, Local Wokha-1, Local Dimapur-1, Local Suchonoma and Local Pangti-2 performed better for various yield contributing traits. The performance of these local genotypes can be compared with that of released varieties of Winged bean procured from IIVR.

Genetic variability parameters
In the investigation, genetic variability parameters such as mean, range, PCV, GCV, heritability, genetic advance, and genetic advance as a percentage of the mean are summarized in Table 2. For all 12 Characters studied, the Genotypic Coefficient of Variation (GCV) was lower than the Phenotypic Coefficient of Variation (PCV). The high GCV and PCV value were observed in days to 50% flowering, followed by number of secondary branches per plant, while moderate GCV and PCV value were recorded green pod weight (g), seed yield per plant(g), pod width (cm), 100 seed weight (g), number of seed per pod, number of pods per plant, and dry pod weight (g). The lowest GCV and PCV value were noted in pod length (cm), days to maturity, Crude protein percentage. The variability parameters indicate a balance between genetic and environmental influences on these traits.

These results align with previous studies, such as those by Adegboyega *et al.* (2021), Bhadmus *et al.* (2023), Silva and Omran (1986), and Thapa *et al.* (2024), which reported similar findings Prasanth *et al.* (2014, 2015), Sarode and Dodake (2019) Yadav (2018) and Nandan *et al.* (2010) also observed high PCV and GCV for these traits. In this study, two traits days to 50% flowering, and the number of secondary branches showed high GCV suggesting that selection for these traits will be very effective. According to the interpretation, high GCV indicate that selection is highly effective because these traits are controlled by additive gene action.

The highest heritability was observed in seed yield per plant (98.54), Other characters with recorded heritability included number of secondary branches (98.22), green pod weight (98.18), dry pod weight (98.34), days to 50% flowering (98.12), 100 seed weight (96.73), number of pods per plant (96.93), days to maturity (95.50), pod width (93.87), number of seeds per pod (90.89) and pod length (74.20), indicating high heritability for these traits and the lowest was found in crude protein percentage (62.59). In the all-recorded traits, high heritability was noted which is showed high heritable variation in the studied characters. According to high heritability estimates, the characters had a high capacity for transmission to succeeding generations and were least affected by environmental influences. Specifically, Thapa *et al.* (2024), Silva and Omran (1986), Singh and Khanna (1995), Mohamadali and Madalageri (2007), Prasanth *et al.* (2015), Nandan *et al.* (2009), Nandan *et al.* (2010), Yadav (2018), Saisupriya *et al.* (2022), Suhaisini *et al.* (2016) and Thapa *et al.* (2024). They were reports same high heritability estimates for these characters. High heritability implies that the trait is largely controlled by genetic factors and could exhibit high genetic variability and characters transmission from one generation to next generation. In this study, all traits exhibited high heritability which is suggests that selection for these traits might be effective for further investigation for crop improvement.
The maximum genetic advance was observed in days to 50% flowering (52.02), Other characters with recorded genetic advances included seed yield per plant (38.88) and days to maturity (36.88), showing high genetic advance, while moderate G.A. were recorded number of secondary branches (16.48) and number of pods per plant (11.05) and the lowest was noted in pod width (0.45). The highest genetic advance as % mean was observed in days to 50% flowering (50.30) followed by other characters with high genetic advance as % means included the number of secondary branches (43.56), seed yield per plant (39.68), green pod weight (39.86), and dry pod weight (39.95), while the lowest was noted in pod length (11.23). The same result report in winged bean (Adegboyega *et al.* 2021; Bhadmus *et al.* 2023; Rakhmad *et al.* 2021; Thapa *et al.* 2024). Additionally, traits with high genetic advance and high heritability can be effectively because characters governed by additive gene action which is used for selection in further studies.

Estimation of Character association:
Understanding the association between yield and its components is of paramount importance for making the best use of these relationships in selection. Yield is a complex trait and is dependent on other determinant traits which are mostly inherited quantitatively. The characters which have high and positive correlation with yield can be used in the indirect selection for yield and as an alternate mode of selection for yield improvement. Knowledge of genetic association between selection indices, yield and morpho-physiological yield determinants can be useful to improve the efficiency of breeding programs. The current study identified significant positive correlations between grain yield per plant and various important agronomic traits in Winged bean [*Psophocarpus tetragonolobus* (L.) DC], highlighting the intricate and multifaceted nature of grain yield determination. Most breeding programs focus on increasing productivity per unit area per unit time as their major goal. Direct selection for seed yield may not be at a sufficient level since it has complex, highly variable characteristics that come from the cumulative influence of its component characteristics. These component characters are not dependent in their action but are interlinked and in this interlinked complex genetic system selection practiced for one individual character might eventually bring about a simultaneous change in the other. As a result, choosing traits with high heritability and a strong correlation to yield may aid in indirect selection for yield. Twelve characters were evaluated for correlation in the current study in all feasible combinations at both the phenotypic and genotypic levels.
The present study demonstrates that at the genotypic level, there is a positive and significant correlation between seed yield and the pod length (cm) (0.411**), number of pods per plant (0.464), 100 seed weight (0.617**). They were positively and significantly correlated with the dependent variable yield per plant at both the 1% and 5% significance levels. A positive and significant correlation between desirable traits benefits plant breeders by facilitating the simultaneous improvement of both characteristics. The findings of Vijay *et al.* (1980), Pandita *et al.* (1989), Mohammadali and Madalageri (2004), Nandan *et al.* (2009), Mohammadali and Madalageri (2012), Prasanth *et al.* (2015) Jeena *et al.* (2005), Padmavathi *et al.* (2013), Pandey *et al.* (2013), and Dehal *et al.* (2016) also found similar results. In this study, it was observed that the genotypic correlation values for most traits were higher than their corresponding phenotypic correlation values.

Direct and indirect effects of 10 characters on grain yield per plant in wheat genotypes:
The path coefficient analysis helps breeders to explain direct and indirect effects (complete determination of impact of independent variable on dependent one) and hence been extensively used in breeding experiments in different crop

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species. A plant breeder can distinguish between the direct and indirect effects of independent variables on the dependent variable using path coefficient analysis. When traits were analysed in terms of their direct effect on seed yield per plant *via.* day to 50% flowering (0.124), number of secondary branches (0.067), pod length (0.203), pod width (0.086), number of pods per plant (0.374), number of seed per pod (0.095), 100 seed weight (g) (0.521), exhibited the positive direct effect, while the traits dry pod weight (-0.227), days to maturity (-0.065), green pod weight (-0.074), crude protein percentage (-0.083), showed negatively direct effect on seed yield per plant. Similar results were reported by various studies. Pandita *et al.* (1989), Ahmed and Kamaluddin (2013) while Mohamadali *et al.* (2004), Prasanth *et al.* (2015), Dawane *et al.* (2020).

Figure 1.: Variability among Green pods of Winged bean

Figure 2.: Variability in seeds and leaves of winged bean

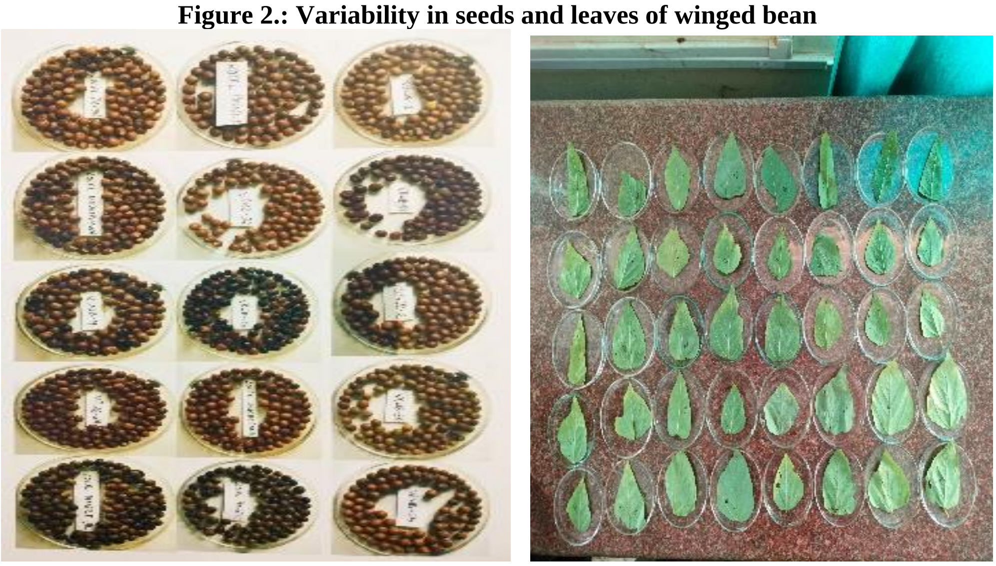

Figure 3: Estimation of Protein content using Kjeldahl apparatus

Figure: 4 GCV and PCV for various traits in Winged bean genotypes

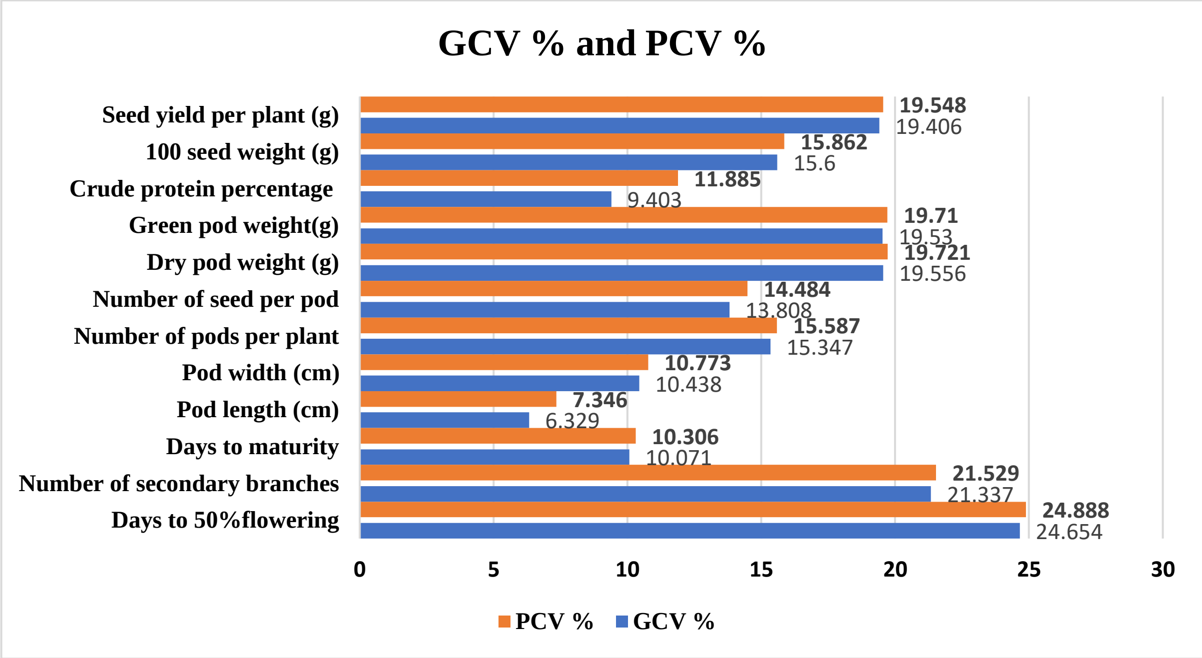

Table 1. Mean performance of genotypes for 12 morpho-physiological and quality traits:

SL.NO	Genotypes	Days to 50% flowering	Number of secondary branches	Days to maturity	Pod length (cm)	Pod width (cm)	Number of pods per plant	Seed per pod	Dry pod weight (g)	Green pod weight (g)	Crude protein percentage	100 seed weight (g)	Seed yield per plant (g)
1	NUWB-2	145.667	40	197.333	14.54	2.133	29	8.98	3.71	24.057	39	31.113	95.82
2	VRWB-116	159.667	49.733	195.333	17.843	2.333	40	12.003	5.95	16.937	35.767	29.25	**118.927**
3	VRWB-115	115	31.667	205	16.07	2.303	33.333	10.003	4.14	24.243	40.933	29.467	94.883
4	VRWB-112	83.733	56	192.333	14.57	2.203	36	10.003	5.587	32.02	41.567	31.813	108.38
5	LOCAL MONGSENYIMTI	75	34.003	207	15.503	2.167	30.667	9.007	4.15	22.45	42.233	32.393	95.623
6	VRWB-104	87.667	43.333	165	14.37	2.367	27	8.007	5.263	18.733	46.8	31.907	70.86
7	VRWB-100	84.667	35.333	**145.333**	14.37	2.47	38	10.667	5.763	30.17	39.633	31.06	108.74
8	VRWB-93	89.4	35.333	177.233	15.673	2.103	35.997	8.003	5.593	33.06	35.767	34.633	110.727
9	LOCAL BAGHTY	75.4	52.333	164	15.133	2.133	27.333	8.003	4.343	31.073	40.933	24.873	67.373
10	VRWB-88	79.167	48.667	215	16.437	1.833	49.667	9.003	6.04	27.917	38.333	36.013	114.58
11	VRBW-85	85	38.403	207.333	15.34	2.133	42.67	10.003	4.84	24.927	37.7	30.217	100.567
12	VRWB-77	104.667	47	**143**	13.4	1.87	31.233	12.007	5.14	26.313	34.433	26.907	66.003
13	VRWB-75	74.333	25.667	193.333	14.473	2.1	34	13.4	4.473	24.143	47.5	27.08	81.06
14	LOCAL DIMAPUR-3	143.333	50.07	169.667	16.84	2.47	34.003	12.003	8.09	28.82	30.567	28.833	81.757
15	VRWB-59	128.333	36.4	182.333	15.503	2.133	38.333	10	4.767	26.387	40.3	33.147	118.953
16	LOCAL WOKHA-1	124.667	37.667	194.667	15.24	2.267	36.003	9.007	4.273	22.82	44.833	34.94	102.37
17	VRWB-54	103.667	40	212	17.173	2.367	33	12.007	4.59	27.657	42.233	30.567	96.533
18	VRWB-50	113.667	47	197.5	15.94	2.333	35.003	9.73	4.263	26.023	46.8	25.157	70.413
19	LOCAL AKUK	152.333	23.33	191.667	16.773	2.297	29	11.007	6.76	30.63	43.567	25.237	71.877
20	LOCAL DIMAPUR-2	153	27.667	200	15.207	2.633	36	10	7.08	20.07	42.233	26.46	91.403
21	LOCAL PANGIT-2	122.333	38.667	171.667	15.377	2.3	25	8	4.73	26.677	48.767	32.19	97.243
22	VRWB-45	84.333	39.333	176	14.873	1.7	36	9.007	6.107	26.01	44.2	29.827	81.373
23	LOCAL DIMAPUR-1	82.333	25.333	182	16.47	2.227	33.997	10.003	4.32	22.66	37.067	29.983	106.3
24	LOCAL PANGTI-1	137	45.667	160.667	15.403	2.083	30.627	9.103	5.647	22.583	48.767	22.317	92.933
25	VRWB-36	95.333	46.333	184.333	14.173	2.467	33.667	12.007	4.903	16.163	39.633	31.367	**121.367**
26	VRWB-35	99.133	37.333	184.333	14.937	2.033	36	12.34	6.68	28.573	41.567	24.703	93.567
27	VRWB-32	85	29.667	195.833	15.47	2.19	39.667	9.84	5.587	20.917	45.5	24.263	69.947
28	VRWB-68	94.667	32.333	189	14.97	2	27	10.67	4.84	14.317	42.233	21.59	79.4
29	VRWB-27	76	32.333	167.667	15.673	2.2	42	11.34	5.103	22.823	45.5	27.78	103.07
30	VRWB-26	76.333	39.333	187	16.44	2.25	39	10.223	5.117	18.407	42.9	34.543	103.413
31	NUWB-3	86.667	24.003	176.333	15.503	2.433	31	10.667	4.08	16.927	46.133	40.733	102.483
32	VRWB-24	91.667	39	162.333	16.573	2.663	44	11.337	6.357	17.96	40.933	27.117	97.64
33	VRWB-23	69	44	**145.667**	13.733	1.733	46	10.07	5.84	19.913	50.733	33.463	99.173
34	VRWB-20	89.667	40.333	163.667	17.067	2.297	42.003	11.44	6.143	25.277	39	**40.71**	**144.37**
35	VRWB-17	91.333	30.333	195	17.943	1.967	42.003	10.307	7.037	21.593	40.3	35.543	**132.47**
36	LOCAL MEZDIPHEMA	84	33.333	178	15.503	2.103	38.667	10.813	6.327	31.823	42.233	31.747	87.917
37	LOCAL PEREN	122	31.667	159	15.303	2.2	35	12.507	3.683	23.08	42.233	28.037	92.593
38	NUWB-4	123	28	163.333	16.77	1.597	36.003	13.403	5.367	21.563	46.8	35.07	102.21
39	LOCAL SUCHONOMA	125	38.333	195	15.21	2.133	31	10.003	6.64	28.717	35.767	**42.677**	99.36
40	LOCAL WOKHA-2	125.667	38.663	184.333	16.207	2.297	35.667	12.67	3.983	23.423	42.233	34.097	**144.997**
RANGE (MIN)		**69**	**23.33**	**143**	**13.4**	**1.597**	**25**	**8**	**3.683**	**14.317**	**30.567**	**21.59**	**66.003**
RANGE (MAX)		**159.667**	**56**	**215**	**17.943**	**2.663**	**49.667**	**13.403**	**8.09**	**33.06**	**50.733**	**42.677**	**144.997**
CD at 5%		**5.727**	**1.764**	**6.463**	**0.946**	**0.095**	**1.574**	**0.743**	**0.22**	**1.045**	**4.943**	**1.432**	**3.734**
CV %		**3.405**	**2.868**	**2.186**	**3.731**	**2.666**	**2.727**	**4.37**	**2.541**	**2.656**	**7.268**	**2.868**	**2.345**
Overall Mean		**103.471**	**37.84**	**181.906**	**15.6**	**2.188**	**35.514**	**10.465**	**5.333**	**24.196**	**41.841**	**30.721**	**97.967**

Table 2. Assessment genetic variability parameters for 12 Characters of winged bean

SL. No	Characters	Range	GCV %	PCV %	h^2(b.s.) (%)	G.A.	G.A as % of mean
1	**Days to 50%flowering**	69-159.66	24.654	24.888	98.128	52.055	50.309
2	**Number of secondary branches**	23.33-56	21.337	21.529	98.225	16.484	43.562
3	**Days to maturity**	143-215	10.071	10.306	95.502	36.882	20.275
4	**Pod length (cm)**	13.4-17.94	6.329	7.346	74.209	1.752	11.23
5	**Pod width (cm)**	1.59-2.66	10.438	10.773	93.877	0.456	20.834
6	**Number of pods per plant**	25-49.66	15.347	15.587	96.938	11.054	31.127
7	**Number of seed per pod**	8-13.40	13.808	14.484	90.894	2.838	27.119
8	**Dry pod weight (g)**	3.68-8.09	19.556	19.721	98.34	2.13	39.95
9	**Green pod weight(g)**	14.31-33.06	19.53	19.71	98.184	9.646	39.865
10	**Crude protein percentage**	30.56-50.73	9.403	11.885	62.597	6.412	15.325
11	**100 seed weight (g)**	21.59-42.67	15.6	15.862	96.731	9.71	31.607
12	**Seed yield per plant (g)**	66.0-144.99	19.406	19.548	98.561	38.882	39.689

Figure 5: Heritability and G.A. as % mean

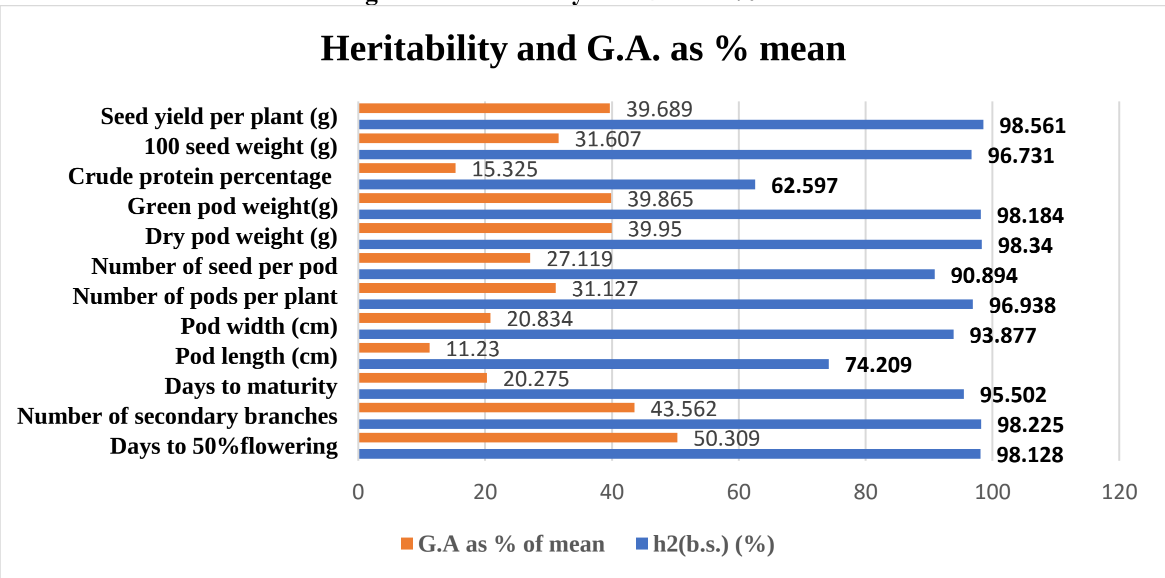

Table 3. Genotypes (G) correlation among yield and yield attributing traits of winged bean

Characters	Days to 50% flowering	Number of sec. branches	Days to maturity	Pod length (cm)	Pod width (cm)	Number of pods per plant	Number of seed per pod	Dry pod weight (g)	Green pod weight (g)	Crude protein percentage	100 seed weight (g)	Seed yield per plant
Days to 50% flowering	1	0.009	0.128	0.282*	0.256	-0.302*	0.15	0.152	-0.004	-0.2	-0.135	0.009
Number of sec. branches		1	-0.118	-0.156	-0.025	0.073	-0.205	0.103	0.197	-0.274*	-0.039	0.015
Days to maturity			1	0.364*	0.114	0.046	-0.136	-0.107	-0.006	-0.137	0.057	0.097
Pod length (cm)				1	0.18	0.294*	0.206	0.273*	-0.043	-0.263*	0.19	**0.411***
Pod width (cm)					1	-0.156	0.025	0.006	-0.143	-0.17	-0.071	0.075
Number of pods per plant						1	0.199	0.328*	-0.043	-0.115	0.233	**0.464***

Number of seed per pod							1	0.102	-0.172	-0.138	-0.08	0.187
Dry pod weight (g)								1	0.205	-0.312*	0.008	0.009
Green pod weight (g)									1	-0.305*	0.053	-0.108
Crude protein percentage										1	-0.154	-0.229
100 seed weight (g)											1	**0.617****

Table 4. Estimate of direct (diagonal) and indirect effects of yield component at genotypic level in winged bean genotypes

Characters	Days to 50% flowering	Number of sec. branches	Days to maturity	Pod length (cm)	Pod width (cm)	Number of pods per plant	Number of seed per pod	Dry pod weight (g)	Green pod weight (g)	Crude protein seed	100 Seed Weight	Seed yield per plant
Days to 50% flowering	**0.124**	0.001	-0.008	0.057	0.022	-0.113	0.014	-0.034	0	0.017	-0.07	**0.009**
Number of sec. branches	0.001	**0.067**	0.008	-0.032	-0.002	0.027	-0.02	-0.023	-0.014	0.023	-0.02	**0.015**
Days to maturity	0.016	-0.008	**-0.065**	0.074	0.01	0.017	-0.013	0.024	0	0.011	0.03	**0.097**
Pod length (cm)	0.035	-0.01	-0.024	**0.203**	0.015	0.11	0.02	-0.062	0.003	0.022	0.099	**0.411**
Pod width (cm)	0.032	-0.002	-0.007	0.037	**0.086**	-0.058	0.002	-0.001	0.011	0.014	-0.037	**0.075**
Number of pods per plant	-0.037	0.005	-0.003	0.06	-0.013	**0.374**	0.019	-0.075	0.003	0.01	0.121	**0.464**
Number of seed per pod	0.019	-0.014	0.009	0.042	0.002	0.074	**0.095**	-0.023	0.013	0.011	-0.042	**0.187**
Dry pod weight (g)	0.019	0.007	0.007	0.055	0.001	0.123	0.01	**-0.227**	-0.015	0.026	0.004	**0.009**
Green pod weight (g)	-0.001	0.013	0	-0.009	-0.012	-0.016	-0.016	-0.047	**-0.074**	0.025	0.027	**-0.108**
Crude protein seed	-0.025	-0.018	0.009	-0.053	-0.015	-0.043	-0.013	0.071	0.022	**-0.083**	-0.08	**-0.229**
100 seed weight	-0.017	-0.003	-0.004	0.039	-0.006	0.087	-0.008	-0.002	-0.004	0.013	**0.521**	**0.617**

RESIDUAL EFFECT = 0.37655

Conclusion

These selected line on the based on mean performance of seed yield per plant (g) and other yield attributing characters which is above the all over mean. The chosen lines transform into the anticipated lines, which represent a fresh genotype with exceptional genetic traits. As per Kuswanto *et al.* (2016), the preference of consumers for winged beans leaned towards rectangular pods that had a broad shape, a vibrant green hue, and a sweet and crunchy flavor. These landraces could potentially be employed in future breeding programs to enhance crop production.

Table 5. Selected lines based on yield and yield attributing characters

Sl. No.	Lines name	Potential yield attributing characters
1	LOCAL WOKHA-2	100 Seed Weight (g), crude protein percentage, green pod weight (g), number of seed per pod, number of pods per plant, pod length (cm), pod width (cm),
2	VRWB-20	100 Seed Weight (g), green pod weight (g), dry pod weight (g), number of seed per pod, number of pods per plant, pod length (cm), pod width (cm), days to initial maturity, days to 50% initial flowering,
3	VRWB-17	days to 50% initial flowering, pod length (cm), number of seed per pod, dry pod weight (g), 100 Seed Weight (g),
4	VRWB-36	days to 50% initial flowering, 100 Seed Weight (g), number of seed per pod, pod length (cm), pod width (cm),

5	VRWB-59	100 Seed Weight (g), green pod per plant, number of seed per pod, number of pods per plant, pod length (cm), pod width (cm),
6	VRWB-116	Dry pod weight (g), number of seed per pod, number of pods per plant, pod length (cm),

These selected lines could potentially be employed in future breeding programs to enhance crop production. The highest values of genotypic coefficient of variation (GCV) and of phenotypic coefficient of variation (PCV) was recorded for the traits *viz*. days to 50% flowering, number of secondary branches, green pod weight, Seed yield per plant and dry pod weight. It indicated that tremendous variability is present among the genotypes for all above traits. The best traits for breeding programs can leverage heritability and genetic advance as a percentage of the mean to identify the most impactful traits for improvement. Traits with high genetic advance as % mean are days to 50% flowering, number of secondary branches, seed yield per plant, green pod weight, dry pod weight, 100 seed weight, number of pods per plant. Future selection strategies should be based on special focus on these traits for improving the efficiency of selection in winged bean.

Studies of correlation found a substantial positive association between seed yield per plant at the genotypic. It was observed that 100 seed weight, number of pods per plant, pod length is positively correlated with seed yield per plant. In order to improve the seed yield of winged beans, these features should be prioritized. In the path analysis days to 50% flowering, number of secondary branches, pod length (cm), pod width (cm), number of pods per plant, number of seed peer pod, 100 seed weight revealed positive direct effect on seed yield as per the findings of path analysis. Studying genetic variability is crucial for sustainable agriculture, as it enables the identification and selection of robust genotypes that can thrive under diverse environmental conditions. This approach enhances crop resilience and productivity, ensuring long-term food security and agricultural sustainability.

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