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Studies on winged bean (*Psophocarpus tetragonolobus* L.) genotypes under Konkan agro-climatic conditions for growth and yield traits

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Abstract

The experiment entitled “Studies on winged bean (*Psophocarpus tetragonolobus* L.) genotypes under Konkan agro-climatic conditions for growth and yield traits” was carried out during the year 2022-23 and 2023-24 at College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (MS). Significant difference is observed in all quantitative characters. The results of pooled data of the experiment revealed that the mean value for days to germination of seeds (6.46 days), vine length (889.07 cm), number of primary branches (13.86), crop duration (239.58 days), initiation of flowering (68.80 days), pod yield per vine (1.939 kg) and yield per hectare (21.54 t), respectively. The genotype DPL-WB-13 found promising for pod yield per plant and pod yield per hectare than other genotypes. DPL-WB-13 and DPL-WB-1 exhibited better yield attributing characters in comparison to other.

Keywords: Winged bean, growth, yield, and mean performance

Introduction

The winged bean (*Psophocarpus tetragonolobus* (L.)) is classified as an underutilized or orphan legume commonly found in tropical regions. This plant exhibits a strong twining growth habit, nitrogen-fixing ability and a tuberous root system (Eagleton, 2020; Vatanparast *et al.*, 2016)^[3, 17]. It thrives in diverse agro-ecological zones, particularly in hot and humid equatorial climates, making it a promising crop for agricultural development (Afridatul *et al.*, 2021; Lepcha *et al.*, 2017)^[1]. Belonging to the Fabaceae family, the winged bean has a chromosome number of $2n=2x=18$ or $2n=22$. The winged bean is also known by various names, including four-angled bean, princess pea, asparagus pea, dambala, Manila bean, kok-tau, and Goa bean. Despite its high nutritional value, it remains relatively underutilized. Nearly all parts of the plant including tender leaves, flowers, green pods, dried seeds and tuberous roots are edible and have commercial value (Sriwichai *et al.*, 2021; Singh *et al.*, 2013)^[14, 15]. It can be cultivated as a cover crop, green vegetable, grain legume, forage or tuber crop (Sriwichai *et al.*, 2021)^[15]. Despite its nutritional and agricultural potential, research on the winged bean has been limited. Genetic diversity is a key factor in crop improvement, enabling plant breeders to select genetically diverse parents for targeted hybridization programs. Its genetic diversity is essential for developing efficient breeding strategies and identifying heterotic combinations for crop improvement (Laido *et al.*, 2013)^[17]. Expanding research on the winged bean could enhance its agricultural viability and promote its adoption as a sustainable and highly nutritious food source. In Maharashtra, winged bean cultivation is confined to hilly areas even though it is suitable for all parts of the state. It is grown in homestead gardens of tribal people.

Materials and Methods

The experiment was conducted at College of Horticulture, Dapoli, Dist. Ratnagiri (MS) during the year 2022-23 and 2023-24. It was laid out in Randomized Complete Block Design and replicated twice. Total twenty winged bean genotypes were evaluated for growth and yield traits. The seeds of each genotype were sown in spacing of 1.2 m between the rows and 0.75 m between the

individual plants. Several important traits viz. days to germination of seeds, vine length, number of primary branches, crop duration, initiation of flowering, pod yield per vine and yield per hectare, were studied. Data were collected from five competitive plants

within each replication of the genotype under study. Analysis of variance was carried out as per the procedure given by Panse and Sukhatme (1995)^[9].

Table 1: Sources of genotypes

Sr. No.	Accession No./ Genotypes	Sources and GPS Location	Sr. No.	Accession No./ Genotypes	Sources and GPS Location
1.	DPL- WB -1	Dahod, Gujrat 22.8345° N, 74.2606° E	11.	DPL -WB -11	Wai, Satara 17.9528° N, 73.8886° E
2.	DPL -WB -2	Amarpar, Gujrat 21.7176° N, 70.0384° E	12.	DPL- WB -12	Hiyanglam, Manipur 24.5189° N, 93.9253° E
3.	DPL- WB -3	Jamgaon, Chhattisgarh 21.8523° N, 83.5217° E	13.	DPL- WB -13	Rahimatpur, Satara 17.5904° N, 74.1989° E
4.	DPL- WB -4	Ratanpur, Chhattisgarh 22.2859° N, 82.1652° E	14.	DPL- WB -14	Gorivade, Gaganbavda, Kolhapur 16.5435° N, 73.8316° E
5.	DPL- WB -5	Ozarde, Satara 17.9155° N, 73.9499° E	15.	DPL- WB -15	Panhala, Kolhapur 16.8107° N, 74.1181° E
6.	DPL- WB -6	Hivare, Mohol, Solapur 17.8522° N, 75.5335° E	16.	DPL- WB -16	Karad, Satara 17.2777° N, 74.1844° E
7.	DPL -WB -7	Machi, Manipur 24.5088° N, 94.1416° E	17.	DPL- WB -17	Bhatmarali, Satara 17.6002° N, 73.9859° E
8.	DPL- WB -8	Dahiwadi, Satara 17.7032° N, 74.5434° E	18.	DPL- WB -18	Lilong, Manipur 24.6821° N, 93.9452° E
9.	DPL- WB -9	Kurul, Mohol, Solapur 17.6705° N, 75.6557° E	19.	DPL- WB -19	Munambam, Kerala 10.1789° N, 76.1697° E
10.	DPL- WB -10	Pavas, Ratnagiri 16.8727° N, 73.3296° E	20.	DPL- WB -20 (Revathi)-Check	Kerala Agriculture University, Kerala 10.5449° N, 76.2864° E

Results and discussion

Days to germination

During the year 2022-23, the minimum days to germination (6.50 days) was observed in genotype DPL-WB-3 which was at par with genotype DPL-WB-1 (6.55 days), DPL-WB-2 (6.70 days), DPL-WB-14 (6.70 days) and DPL-WB-12 (6.85 days) whereas, the maximum days to germination was recorded in genotype DPL-WB-17 (8.65 days). During the year 2023-24, the minimum days to seed germination (6.42 days) was seen in genotype DPL-WB-3 which was at par with genotype DPL-WB-12 (6.61 days) and DPL-WB-1 (6.81) whereas, the maximum days required to germination was recorded in genotype DPL-WB-6 (8.91 days). The perusal of data revealed that the difference in various genotypes with respect to days to germination was significant. The minimum days to seed germination (6.46 days) was recorded in genotype DPL-WB-3 which was at par with genotype DPL-WB-1 (6.68 days) and DPL-WB-12 (6.73 days) whereas, the maximum days required to germination was registered in genotype DPL-WB-6 (8.73 days). These results confirmed with findings reported by Prasanth *et al.* (2015)^[11] in winged bean.

Vine length (cm) at harvest

Vine length is an important growth parameter which has significance not only in accelerating growth of the plant but also in canopy spread which ultimately determines the production potential of the plant. Early peak up in vine length may accelerate early growth. The vine length of various genotypes was recorded two consecutive years (i.e., 2022-23 and 2023-24) at harvest. The data regarding vine length are presented in Table 2. During the year 2022-23, the maximum vine length (889.52 cm) was registered in genotype DPL-WB-13 which was significantly superior over all other genotypes. Whereas, the minimum vine length was recorded in genotype DPL-WB-11 (555.69 cm). During the year 2023-24, the maximum vine length (888.61 cm) was recorded in genotype DPL-WB-13 which was significantly superior over all other genotypes under study whereas, the minimum vine length was registered in genotype DPL-WB-11

(558.86 cm). The perusal of data revealed that the difference in various genotypes with respect to vine length was significant. The maximum vine length (889.07 cm) was recorded in genotype DPL-WB-13 which was significantly superior over all other genotypes under study whereas, the minimum vine length was found in genotype DPL-WB-11 (557.27 cm). It was also observed that the magnitude of vine length increases with increase in age of the plant. It might be due to genetic characters as well as environmental factors, which ultimately responsible for increasing the photosynthetic activities, rate of chlorophyll formation, nitrogen metabolism and auxin contents in such plants of winged bean, which ultimately improved the vine length. These results confirmed with findings reported by Prasanth *et al.* (2015)^[11], Kumbhar (2021)^[6], Hansda *et al.* (2023)^[4] and Thapa *et al.* (2024)^[16] in winged bean.

Number of primary branches per vine

Winged bean is having potential to produce varying number of primary branches. Number of primary branches produced by the plant is an important growth parameter which deciding the pod bearing ability of the vine. The number of branches of various genotypes was recorded during two consecutive years (i.e., 2022-23 and 2023-24) at harvest. During the year 2022-23, the maximum number of primary branches per vine (13.68) was recorded in genotype DPL-WB-13 which was at par with genotype DPL-WB-8 (13.0.3) and DPL-WB-18 (12.99) whereas, the minimum number of primary branches per vine was registered in genotype DPL-WB-17 (7.22). During the year 2023-24 the maximum number of branches per vine (14.03) was found in genotype DPL-WB-13 followed by DPL-WB-8 and DPL-WB-18 whereas, the minimum number of primary branches per vine (7.26) was recorded in genotype DPL-WB-17. The data revealed that, the maximum number of primary branches per vine (13.86) were recorded in genotype DPL-WB-13 followed by DPL-WB-8 and DPL-WB-18 whereas, the minimum number of primary branches per vine (7.24) was registered in genotype DPL-WB-17

which was at par with genotypes DPL-WB-2. The variation in number of primary branches is dependent on the plant architecture which is in turn dependent on genetic constituent as well as the edaphic factors under which the crop is being grown, it might be due to the increased rates of photosynthesis supply for the maximum branches, growth change in endogenous auxins in apical dominance, which initiated more buds converting into branching in climber like winged bean. These results confirmed with findings reported by Hansda *et al.* (2023)^[4] and Thapa *et al.* (2024)^[16] in winged bean.

Crop duration

Crop duration is an important trait in legumes as it determines the adaptability of a genotype to a particular agro-climate zone, facilitates efficient crop planning and influence the timing of cultural operations. The perusal of the data revealed significant difference among the various winged bean genotypes under study for crop duration during both the year (i.e., 2022-23 and 2023-24) as well as in pooled data. The data regarding crop duration are presented in Table 2.

Table 2: Growth performance of winged bean genotypes

Genotypes	Days to germination			Vine length (cm)			Number of primary branches			Crop duration (Days)		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
DPL -WB -1	6.55	6.81	6.68	811.94	814.69	813.32	12.24	12.44	12.34	237.58	241.575	239.575
DPL -WB -2	6.70	7.44	7.07	570.80	572.80	571.80	7.35	7.45	7.40	182.15	179.475	180.813
DPL- WB -3	6.50	6.42	6.46	675.30	677.41	676.35	7.45	7.51	7.48	207.34	212.335	209.835
DPL- WB -4	7.15	7.42	7.28	752.99	750.11	751.55	10.02	9.82	9.92	185.67	183.165	184.415
DPL -WB -5	7.70	8.04	7.87	815.87	818.53	817.20	12.67	12.75	12.71	213.38	219.475	216.425
DPL -WB -6	8.55	8.91	8.73	670.22	671.59	670.90	7.73	7.78	7.76	194.02	195.52	194.77
DPL -WB -7	7.40	7.54	7.47	727.17	734.57	730.87	9.80	9.58	9.69	200.81	210.805	205.805
DPL -WB -8	7.70	7.66	7.68	833.01	838.74	835.87	13.03	13.15	13.09	193.04	190.28	191.66
DPL -WB -9	7.40	7.58	7.49	687.39	686.57	686.98	7.49	7.62	7.55	205.03	207.095	206.06
DPL -WB -10	7.25	8.08	7.67	691.87	699.95	695.91	7.86	7.74	7.80	217.61	219.86	218.735
DPL -WB -11	6.90	7.39	7.15	555.69	558.86	557.27	7.62	7.42	7.52	189.58	190.075	189.825
DPL -WB -12	6.85	6.61	6.73	691.81	693.38	692.59	9.74	9.89	9.81	228.11	225.105	226.605
DPL -WB -13	8.25	8.43	8.34	889.52	888.61	889.07	13.68	14.03	13.86	225.07	230.07	227.57
DPL -WB -14	6.70	7.20	6.95	634.78	641.83	638.30	9.94	10.14	10.04	232.66	237.66	235.16
DPL -WB -15	8.25	8.51	8.38	779.82	780.23	780.03	9.59	9.90	9.75	211.81	217.305	214.555
DPL -WB -16	7.45	7.76	7.61	738.85	736.06	737.45	12.44	12.49	12.46	212.28	215.275	213.775
DPL -WB -17	8.65	8.59	8.62	743.44	743.81	743.62	7.22	7.26	7.24	193.05	188.045	190.545
DPL -WB -18	8.08	8.32	8.20	818.91	820.77	819.84	12.99	13.19	13.09	195.06	196.56	195.81
DPL -WB -19	7.81	8.05	7.93	675.88	677.12	676.50	7.48	7.51	7.50	190.13	192.125	191.125
DPL -WB -20 (Revathi)- Check	7.66	7.52	7.59	746.40	750.57	748.48	12.50	12.70	12.60	214.70	216.195	215.445
Range	6.50- 8.65	6.42- 8.91	6.46- 8.73	555.69- 889.52	558.86- 888.61	557.27- 889.07	7.22- 13.68	7.26- 14.03	7.24- 13.86	182.15- 237.58	179.48- 241.58	180.81- 239.58
Mean	7.47	7.71	7.59	725.58	727.81	726.69	9.94	10.02	9.98	206.45	208.40	207.43
Result	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em±	0.12	0.15	0.14	1.59	0.89	1.54	0.25	0.09	0.08	1.84	1.91	1.87
CD@5%	0.35	0.42	0.40	4.59	2.57	4.46	0.74	0.27	0.23	5.32	5.51	5.41

During the year 2022-23 the maximum crop duration (237.58) was recorded in genotype DPL-WB-1 which was at par with genotype DPL-WB-14 (232.66 days) whereas, the minimum crop duration was observed in genotype DPL-WB-2 (182.15 days). During the year 2023-24 the maximum crop duration (241.58 days) was seen in genotype DPL-WB-1 which was at par with genotype DPL-WB-14 (237.66 days) whereas, the minimum crop duration was recorded in genotype DPL-WB-2 (179.48 days). The perusal of data revealed that the difference in various genotypes with respect to crop duration was significant. The maximum crop duration (239.58 days) was recorded in genotype DPL-WB-1 which was at par with genotype DPL-WB-14 (235.16 days) whereas, the minimum crop duration was registered in genotype DPL-WB-2 (180.81 days). Less or more duration of this crop might be due to the inherent genetic make-up of the genotype

which may change it or otherwise environmental reaction on vegetative and reproductive growth of the crop. These results confirmed with findings reported by Prasanth *et al.* (2015)^[11], Hansda *et al.* (2023)^[4] and Thapa *et al.* (2024)^[16] in winged bean.

Days to initiation of flowering

Commencement of flowering is one of the most important characters which decide the earliness of the variety. Number of days required for commencement of flowering is usually governed by the genetic makeup of the plant as well as the prevailing environmental conditions under which the crop is being grown. The number of days required for commencement of flowering after sowing were counted during two successive seasons (i.e., 2022-23 and 2023-24). The data regarding days to initiation of flowering are presented in Table 3.

Table 3: Mean performance for flowering and yield attributing traits in various winged bean genotypes

Genotypes	Days to initiation of flowering			Yield per plant (kg)			Pod yield per hectare (t)		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
DPL -WB -1	83.36	86.13	84.74	1.325	1.414	1.369	14.72	15.71	15.21
DPL -WB -2	75.32	79.06	77.19	1.283	1.087	1.185	14.26	12.08	13.17
DPL- WB -3	76.74	75.11	75.92	0.936	1.119	1.028	10.40	12.43	11.42
DPL- WB -4	67.31	70.30	68.80	0.892	0.904	0.898	9.91	10.04	9.97
DPL -WB -5	77.78	81.80	79.79	1.541	1.550	1.545	15.53	15.80	15.66
DPL -WB -6	76.71	78.12	77.41	1.291	1.350	1.320	14.34	14.99	14.67
DPL -WB -7	73.41	74.66	74.03	1.482	1.543	1.512	16.47	17.14	16.80
DPL -WB -8	78.40	81.95	80.18	1.398	1.422	1.410	17.12	17.22	17.17
DPL -WB -9	74.21	78.51	76.36	1.433	1.637	1.535	15.92	18.18	17.05
DPL -WB -10	81.82	83.48	82.65	1.563	1.693	1.628	17.36	18.81	18.08
DPL -WB -11	73.72	76.87	75.30	1.077	1.430	1.254	11.97	15.89	13.93
DPL -WB -12	78.54	80.74	79.64	1.455	1.613	1.534	16.16	17.92	17.04
DPL -WB -13	79.01	82.00	80.50	1.898	1.975	1.939	21.08	22.00	21.54
DPL -WB -14	81.81	79.80	80.81	1.558	1.634	1.596	17.31	18.16	17.73
DPL -WB -15	83.61	82.00	82.80	1.812	1.685	1.748	20.13	18.72	19.42
DPL -WB -16	83.70	84.22	83.96	1.512	1.601	1.556	16.23	17.49	16.86
DPL -WB -17	84.74	82.23	83.48	1.815	1.987	1.901	20.16	22.07	21.12
DPL -WB -18	76.00	80.53	78.27	1.675	1.841	1.758	18.61	20.46	19.53
DPL -WB -19	76.43	78.14	77.28	1.314	1.214	1.264	14.59	13.49	14.04
DPL -WB -20 (Revathi)-Check	75.30	73.44	74.37	1.461	1.575	1.518	16.80	17.78	17.29
Range	67.31-84.74	70.30-86.13	68.80-84.74	0.892-1.898	0.904-1.987	0.898-1.939	9.91-21.08	10.04-22.07	9.97-21.54
Mean	77.89	79.45	78.67	1.436	1.514	1.475	15.95	16.82	16.39
Result	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em±	1.67	0.92	1.16	0.08	0.05	0.06	0.93	0.60	0.69
CD@5%	4.84	2.66	3.35	0.24	0.16	0.18	2.70	1.75	1.99

During the year 2022-23, the minimum days required for initiation of flowering (67.31 days) was recorded in genotype DPL-WB-4 which was significantly superior over other genotypes whereas, the maximum days required for initiation of flowering was noted in genotype DPL-WB-17 (84.74 days). During the year 2023-24 the minimum days required for initiation of flowering (70.30 days) was recorded in genotype DPL-WB-4 which was significantly superior over other genotypes whereas, the maximum days required for initiation of flowering was registered in genotype DPL-WB-1 (86.13 days). The data showed that, the minimum days required for initiation of flowering (68.80 days) was recorded in genotype DPL-WB-13 which was significantly superior over other genotypes. Commencement of early flowering is desirable trait in winged bean. It usually starts early harvesting as well as may increase the harvesting span of the particular variety. Also the possible reason of early flowering in certain genotypes indicated adaptability of these genotypes in a particular environment, better and efficient utilization of nutrients in a relatively hostile environment, which might have resulted in early termination of vegetative phase and initiation of reproductive stage as compared to those genotypes. These results confirmed with findings reported by Mohamadali *et al.* (2005)^[8], Prasanth *et al.* (2015)^[11], Kumbhar (2021)^[6], Bhadmus *et al.* (2023)^[2], Hansda *et al.* (2023)^[4] and Thapa *et al.* (2024)^[16] in winged bean.

Yield per vine (kg)

Yield per plant is an important contributor of the yield per unit area. It is the important character in breeder's perspective which applying selection criteria in crop improvement. The data regarding yield per plant are presented in Table 3. The critical observation of the data presented revealed that there was significant difference among the different winged bean genotypes under study during both the year (i.e., 2022-23 and 2023-24) as well as in pooled data.

During the year 2022-23, the highest pod yield per vine (1.898 kg) was recorded in genotype DPL-WB-13 which was at par with genotype DPL-WB-15 (1.812 kg), DPL-WB-17 (1.815 kg) and DPL-WB-18 (1.615 kg) whereas, the lowest pod yield per vine was registered in genotype DPL-WB-4 (0.892 kg).

During the year 2023-24, the highest pod yield per vine (1.987 kg) was recorded in genotype DPL-WB-17. Whereas, the lowest pod yield per vine was found in genotype DPL-WB-4 (0.904 kg). The perusal of data revealed that the difference in various genotypes with respect to yield per plant was significant. From the pooled data, it is observed that, the highest pod yield per vine (1.939 kg) was recorded in genotype DPL-WB-13 which was at par with genotype DPL-WB-17 (1.901 kg) whereas, the lowest pod yield per vine as registered in genotype DPL-WB-4 (0.898 kg). Yield per plant is complex character and is dependent on number of other characters like pod length, number of pods per plant and average pod weight etc. Though, it is basically genetically controlled character, it is also deviated by season of cultivation as well as management practices. Similar results were observed by Prasanth *et al.* (2015)^[11], Sarode and Dodake (2019)^[13], Kumbhar (2021)^[6], Bhadmus *et al.* (2023)^[2], Hansda *et al.* (2023)^[4], Patel *et al.* (2023)^[10] and (Thapa *et al.* 2024)^[16] in winged bean.

Yield per hectare (t)

The yield of all twenty genotypes was recorded during two successive years (2022-23 and 2023-24) as well as in pooled during investigation. The yield data are presented in Table 3.

During the year 2022-23 the highest pod yield per hectare (21.08 t) was observed in genotype DPL-WB-13 which was at par with genotype DPL-WB-15 (20.13 t), DPL-WB-17 (20.16 t) and DPL-WB-18 (18.61 t) whereas, the lowest pod yield per hectare was recorded in genotype DPL-WB-4 (9.91 t). During the year 2023-24 the highest pod yield per hectare (22.07 t) was recorded in genotype DPL-WB-17 which was at par with genotype DPL-WB-

13 (22.00 t) and DPL-WB-18 (20.46 t) whereas, the lowest pod yield per hectare was registered in genotype DPL-WB-4 (10.04 t). In pooled data the difference in various genotypes with respect to pod yield per hectare was significant. The highest pod yield per hectare (21.54 t) was recorded in genotype DPL-WB-13. Whereas, the lowest pod yield per hectare as registered in genotype DPL-WB-4 (9.97 t). Genetic makeup of genotype is the support of favourable climatic conditions as well as agronomical practices might provide appropriate conditions for more vegetative and reproductive growth i.e. vigour of crop like winged bean. Similar results were observed by Raiger and Jajoria (2019)^[12] in winged bean.

Conclusion

From the study, it is concluded that the winged bean genotypes had shown significant variation in growth and yield characters. The results of the experiment revealed that the genotype DPL-WB-13 recorded highest vine length (889.07 cm), more number of primary branches (13.86), early initiation of flowering (68.80 days), highest pod yield per vine (1.939 kg) and highest yield per hectare (21.54 t), respectively. Whereas, DPL-WB-3 and DPL-WB-1 recorded minimum days to germination (6.46 days) and highest crop duration (239.58 days), respectively. It is also observed that the DPL-WB-1 and DPL-WB-13 exhibited better growth and yield attributing characters with comparison to other genotypes in the experiment.

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