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Impact of different sowing time and plant spacing on yield of winged bean (*Psophocarpus tetragonolobus* L.) in Konkan region

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ABSTRACT

A field experiment was conducted during 2025–26 at the Vegetable Research Field, College of Horticulture, Dapoli, Maharashtra, India, to evaluate the effect of different sowing time and plant spacing on yield and yield attributes of winged bean (*Psophocarpus tetragonolobus* L.) under Konkan conditions. The experiment was laid out in a Factorial Randomized Block Design with three replications and nine treatments. Comprising of three sowing times (First fortnight of August, First fortnight September and First fortnight October) and three plant spacings (50 × 50 cm, 50 × 75 cm and 50 × 100 cm). Sowing time and plant spacing significantly influenced yield and yield attributes. Crop sown on First fortnight of August at 50 × 100 cm recorded highest pod length (14.41 cm), pod girth (4.43 cm), pod weight (8.20 g), number of pickings (20.10) and green pod yield per vine (521.83 g), whereas the longest harvesting span (85.20 days) and the highest green pod yield 14.02 kg plot⁻¹ and 184.21 q ha⁻¹ was observed in crop sown on First fortnight of August at 50 × 50 cm. Thus, sowing during the first fortnight of August at 50 × 50 cm spacing can be recommended for achieving higher green pod yield and productivity of winged bean under Konkan conditions.

Keywords: Winged bean, Sowing time, Plant spacing, Yield, Konkan

Introduction

Winged bean (*Psophocarpus tetragonolobus* L.) is a protein-rich, underutilized tropical leguminous vegetable belonging to the family Fabaceae (Leguminosae) and subfamily Papilionoideae. It is commonly known as Goa bean, four-angled bean or four-cornered bean and has a chromosome number of 2n = 18 or 22 (Saran *et al.*, 2024) [1]. It is believed to have originated in Papua New Guinea and Southeast Asia. Among *Psophocarpus* species, *P. tetragonolobus* is the most widely cultivated and economically important species. Owing to its nutritional value and adaptability, it is cultivated in several tropical and subtropical regions, particularly under warm and humid conditions (Singh *et al.*, 2021) [2].

Botanically, winged bean is a herbaceous perennial climber, though it is usually grown as an annual crop under cultivation. It is a vigorous climbing legume with green to purple stems and trifoliate leaves. Its axillary racemes bear 4–10 flowers, varying from white to deep purple. The pods are characteristically four-angled with frilled wings, measuring about 15–22 cm long and 2–3 cm wide, and contain approximately 5–20 seeds (Jene *et al.*, 2018) [3]. Winged bean possesses several properties such as anti-fungal, antibacterial, anti-microbial and anti-inflammatory and useful to treat ulcer (Bassal *et al.*, 2020) [4]. Winged bean is a nutritionally rich legume containing appreciable amounts of protein, lipids, vitamins and essential minerals such as calcium, magnesium, phosphorus, iron, copper and manganese. Its high protein and oil content, comparable to soybean, makes it a promising crop for nutritional security and diversified vegetable production (Tiwari *et al.*, 2013) [5].

Therefore, the present investigation entitled “Impact of sowing time and plant spacing on yield of winged bean (*Psophocarpus tetragonolobus* L.) in Konkan region” was undertaken to identify the most suitable sowing time and optimum plant spacing for enhancing yield attributes and green pod yield of winged bean under Konkan conditions.

Materials and methods

The present investigation was conducted during the *Kharif-Rabi* seasons of 2025–26 at the Vegetable Research Field, Department of Vegetable Science, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, District Ratnagiri, Maharashtra, India. The experiment was carried out using a Factorial Randomized Block Design (FRBD) with three replications. The experiment comprised two factors, viz., sowing time (*P*) and plant spacing (*S*). Factor A consisted of three sowing times: T₁ – First fortnight of August, T₂ – First fortnight of September and T₃ – First fortnight of October. Factor B consisted of

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three plant spacings: $S_1 - 50 \times 50$ cm, $S_2 - 50 \times 75$ cm and $S_3 - 50 \times 100$ cm. Thus, a total of nine treatment combinations were evaluated. The experimental field covered an area of 27×32 m, with an individual plot size of 8×1 m. The crop received vermicompost @ 5 t ha^{-1} along with 50 kg N , $80 \text{ kg P}_2\text{O}_5$ and $50 \text{ kg K}_2\text{O ha}^{-1}$. The entire quantity of vermicompost and phosphorus was incorporated into the soil during final land preparation. Nitrogen and the remaining potassium were applied as a top dressing approximately one month after sowing. Urea, single super phosphate (SSP) and muriate of potash (MOP) were used as the respective sources of nitrogen, phosphorus and potassium. Irrigation and other essential intercultural operations were carried out at regular intervals or whenever required to ensure proper crop growth. The data obtained from the experiment were subjected to statistical analysis using the analysis of variance (ANOVA) appropriate for Factorial Randomized Block Design. The significance of differences among the treatment means was tested according to the procedure described by Panse and Sukhatme (1985).

Results and discussion

Effect of sowing time

Sowing time had significantly influenced on yield and yield attributing characters. The minimum days to 1st harvest was recorded in T_2 (70.93), whereas the maximum was recorded in T_3 (76.50). Similar results were reported by Sermenali *et al.* (2011) [6] in broccoli.

The maximum pod length was recorded under T_1 (14.29 cm) while minimum was observed in T_3 (13.19 cm). Early sowing increases the pod length due to the favourable growing conditions during the pod development stage including sufficient soil moisture and suitable temperature. Similar results were reported by Choudhary *et al.* (2020) [7] in Indian bean and Haque *et al.* (2020) [8] in dwarf hyacinth bean, Ahamad *et al.* (2021) [9] in mungbean and Khushboo *et al.* (2025) [10].

The highest pod girth was observed under the T_1 treatment (3.98 cm), while the lowest pod girth was recorded in T_3 (3.66 cm). Early sowing promoted greater pod girth due to favourable environmental conditions, which enhanced vegetative growth, nutrient uptake and pod development. Similar results were also reported by Singh *et al.* (2015) [11] in tomato.

The highest pod weight (7.88 g) was recorded in T_1 (First fortnight of August), while the lowest was observed in T_3 (7.39 g). The higher pod weight under early sowing may be due to favourable conditions that enhanced nutrient uptake, pod retention and photosynthate accumulation during pod development. Similar findings have been reported by Singh *et al.* (2015) [11] in tomato and Hossain *et al.* (2014) [12] in tomato.

The maximum number of pickings (19.22), harvesting span (82.67 days) was recorded under the early sowing treatment T_1 , while the minimum number of pickings (15.87), harvesting span (77.84 days) was observed under the late sowing treatment T_3 .

The green pod yield per vine was highest in T_1 ($488.38 \text{ g vine}^{-1}$) which was significantly superior among other treatments, while the lowest was observed in T_3 (437.90 g). Early sowing favoured vegetative growth and pod development, resulting in higher green pod yield per plant due to better pod quality, more pickings and a longer harvesting span. Similar observations were reported by Singh *et al.* (2015) [11] in tomato, Haque *et al.* (2020) [8] in dwarf hyacinth bean and Pravina *et al.* (2023) [13] in vegetable cowpea.

The maximum ($11.14 \text{ kg plot}^{-1}$) green pod yield per plot was observed in T_1 (First fortnight of August), while the minimum ($7.70 \text{ kg plot}^{-1}$) was observed in T_3 (First fortnight of October). Higher yield under early sowing may be attributed to favourable conditions that promoted vegetative growth, extended harvesting and increased pickings, whereas late sowing exposed the crop to adverse conditions, reducing pod development and yield. Similar results were obtained by Singh *et al.* (2015) [11] in tomato and Haque *et al.* (2020) [8] in dwarf hyacinth bean.

August sowing (T_1) produced the highest green pod yield (139.57 q ha^{-1}), whereas the minimum green pod yield was recorded in T_3 (128.92 q ha^{-1}). Higher green pod yield under early sowing may be attributed to favourable weather conditions that enhanced plant growth, increased pickings and extended the harvesting period. Late sowing exposed the crop to unfavourable conditions during flowering and pod development, resulting in poor pod set and reduced yield. Similar trends have also been reported by Sermenali *et al.* (2011) [6] in broccoli, Rajani *et al.* (2014) [14] in vegetable pea, Haque *et al.* (2020) [8] in dwarf hyacinth bean, Choudhary *et al.* (2020) [7] in Indian bean and Ahmed *et al.* (2023) [15] in green gram.

Effect of spacing

The earliest first harvest (71.98 days) was observed under treatment S_3 (50×100 cm) In contrast, treatment S_2 (50×75 cm) required the longest time to reach the first harvest (74.29 days). The longest pods were recorded under S_3 (14.09 cm), which was significantly superior to S_1 (13.43 cm) and S_2 (13.86 cm). The superior pod growth under wider spacing may be attributed to reduced competition for light, water and nutrients, promoting better root development, canopy expansion, photosynthesis and assimilate translocation. Comparable observations have also been reported by Shashi *et al.* (2015) [16] in Indian bean, Manjesh *et al.* (2019) [17] in yardlong bean and Roy *et al.* (2022) [18] in yardlong bean.

The maximum pod girth was recorded under S_3 (4.14 cm), whereas the minimum was observed under S_1 (3.56 cm). The higher pod girth under wider spacing may be attributed to reduced resource competition, better canopy development and efficient assimilate translocation, promoting pod growth. Similar results were obtained by Manjesh *et al.* (2019) [17] in yardlong bean. The highest mean pod weight (8.00 g) was recorded in S_3 and lowest in S_1 (7.20 g). The wider spacing reduced the interplant competition and increases the pod weight. Similar observations have been documented by Mozumder *et al.* (2003) [19] in bush bean and Haque *et al.* (2020) [8] in dwarf hyacinth bean.

The number of pickings was maximum in S_1 (17.71) which was followed by S_2 (17.04) and minimum was recorded in S_3 (16.79). The higher number of pickings under closer spacing may be attributed to greater plant population and cumulative pod production per unit area, despite increased inter-plant competition. A significantly longer harvesting span (81.09 days) was observed in S_1 which was statistically at par with S_2 (79.89 days). However, S_3 recorded the shortest harvesting span (78.47 days). The longer harvesting span under closer spacing may be attributed to higher plant population, which favoured continuous flowering and successive pod development, thereby extending the harvest period. The maximum green pod yield per vine was recorded under the S_3 treatment ($489.30 \text{ g vine}^{-1}$), whereas the minimum yield was observed in the S_1 treatment ($444.71 \text{ g vine}^{-1}$). Higher green pod yield per plant under wider spacing may be attributed to reduced inter-plant competition and improved resource utilization, enhancing photosynthesis and pod production. Similar outcomes were obtained by Manjesh *et al.* (2019) [17] in yardlong bean, Pravina *et al.* (2023) [13] in vegetable cowpea and Thakur *et al.* (2025) [20] in garden pea.

The highest green pod yield per plot was recorded in S_1 ($11.72 \text{ kg plot}^{-1}$) which was significantly superior than other treatments, while the minimum was observed in S_3 ($7.78 \text{ kg plot}^{-1}$). Higher yield per plot under closer spacing may be attributed to greater plant population per unit area, which compensates for increased inter-plant competition. Similar observations were reported by Haque *et al.* (2020) [8] in dwarf hyacinth bean, Painginker *et al.* (2021) [21] in yard long bean, Pravina *et al.* (2024) in vegetable cowpea.

The maximum green pod yield per hectare was observed in S_1 (177.33 q ha^{-1}), whereas the lowest yield was noted in S_3 (103.21 q ha^{-1}). Higher green pod yield per hectare under closer spacing was attributed to greater plant population per unit area. Similar results were obtained by result recorded by Mozumder *et al.* (2003) [19] in

bush bean, Painginker *et al.* (2021) [21] in yard long bean, Pravina *et al.* (2024) in vegetable cowpea.

Interaction effect

The interaction between sowing time and plant spacing significantly affected the yield and yield attributing characters. Among the treatment combinations, T₂S₃ (70.03 days) recorded the earliest first harvest followed by T₂S₂ (71.10 days), whereas T₃S₁ (74.00 days) exhibited the longest duration to first harvest. the maximum pod length (14.41 cm) was recorded under T₁S₃ which was at par with T₁S₂ (14.40 cm), T₂S₃ (14.19 cm) and T₁S₁ (14.07 cm). Whereas the minimum pod length (12.82 cm) was observed in T₃S₁. The maximum pod girth (4.43 cm) and pod weight (8.20 g) was observed in treatment T₁S₃. However, the minimum pod girth (3.49 cm) and pod weight (6.70 g) was recorded in treatment T₃S₁.

Among the treatment combinations, T₁S₁ recorded the highest number of pickings (20.10), followed by T₁S₂ (18.97). In contrast, the lowest number of pickings was observed under the T₃S₃ treatment (15.63). T₁S₁ recorded the longest harvesting span (85.20 days), which was followed by T₁S₂ (82.63 days) and T₁S₃ (80.17 days). Conversely, the shortest harvesting span (76.93 days) was observed under the T₃S₃ treatment combination. The highest green pod yield per vine was observed in T₁S₃ (521.83 g) followed by T₂S₃ (498.23 g). The lowest was reported in T₃S₁ (419.80 g).

The maximum green pod yield per plot was recorded in the T₁S₁ treatment (14.02 kg) which was followed by T₂S₁ treatment (12.23 kg). In contrast, the minimum was obtained from the T₃S₃ treatment, with a yield of 6.42 kg. The maximum yield was achieved

with the T₁S₁ treatment combination (184.21 q ha⁻¹), which was followed by T₂S₁ (179.85 q ha⁻¹), whereas the minimum yield was recorded in T₃S₃ (99.89 q ha⁻¹).

The combine effect of earliest sowing with closer spacing gives the highest yield in winged bean. Early sowing along with closer spacing provided a favourable growing environment for the crop by promoting better utilization of available resources. The reduced spacing increased the plant population per unit area, which enhanced light interception and resource utilization efficiency, whereas timely sowing allowed the crop to benefit from suitable climatic conditions during different growth stages.

Conclusion

The study concluded that optimum sowing time and plant spacing are essential for enhancing green pod yield and productivity in winged bean. The closer spacing resulted in higher yield per unit area due to greater plant population, while the favourable sowing time promoted better crop growth and pod development. Hence, the treatment combination of First fortnight of August at 50 x 50 cm (T₁S₁) can be recommended for achieving higher green pod yield of winged bean in the Konkan region.

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Table 1. Effect of sowing time on yield attributes of winged bean

Sowing time	Days to first harvest	Pod length (cm)	Pod girth (cm)	Pod weight (g)	Total number of pickings	Harvesting span (days)	Green pod yield per vine (g vine ⁻¹)	Green pod yield per plot (kg)	Green pod yield per hectare (q ha ⁻¹)
T ₁	72.54	14.29	3.98	7.88	19.22	82.67	488.38	11.14	139.57
T ₂	70.93	13.63	3.72	7.61	16.46	78.93	474.91	9.94	136.63
T ₃	76.50	13.19	3.66	7.39	15.87	77.84	437.90	7.70	128.92
Result	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em. (±)	0.24	0.08	0.03	0.08	0.11	0.32	2.95	0.13	0.93
CD at 5%	0.72	0.24	0.08	0.24	0.32	0.97	8.86	0.40	2.80

Table 2. Effect of spacing on yield attributes of winged bean

Spacing	Days to first harvest	Pod length (cm)	Pod girth (cm)	Pod weight (g)	Total number of pickings	Harvesting span (days)	Green pod yield per vine (g vine ⁻¹)	Green pod yield per plot (kg)	Green pod yield per hectare (q ha ⁻¹)
S ₁	74.29	13.43	3.56	7.20	17.71	81.09	444.71	11.72	177.33
S ₂	73.71	13.86	3.67	7.68	17.04	79.89	467.18	9.28	124.58
S ₃	71.98	14.09	4.14	8.00	16.79	78.47	489.30	7.78	103.21
Result	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em. (±)	0.38	0.10	0.04	0.10	0.14	0.46	4.50	0.33	1.19
CD at 5%	1.14	0.30	0.11	0.30	0.41	1.37	13.48	0.97	3.56

Table 3. Interaction effect of sowing time and spacing on yield attributes of winged bean

Spacing	Days to first harvest	Pod length (cm)	Pod girth (cm)	Pod weight (g)	Total number of pickings	Harvesting span (days)	Green pod yield per vine (g)	Green pod yield per plot (kg)	Green pod yield per hectare (q ha ⁻¹)
T ₁ S ₁	73.07	14.07	3.67	7.70	20.10	85.20	460.53	14.02	184.21
T ₁ S ₂	72.67	14.40	3.83	7.73	18.97	82.63	482.77	10.34	128.74

(continued on next page)

Spacing	Days to first harvest	Pod length (cm)	Pod girth (cm)	Pod weight (g)	Total number of pickings	Harvesting span (days)	Green pod yield per vine (g)	Green pod yield per plot (kg)	Green pod yield per hectare (q ha ⁻¹)
T ₁ S ₃	71.90	14.41	4.43	8.20	18.60	80.17	521.83	9.06	105.75
T ₂ S ₁	71.67	13.38	3.51	7.20	17.00	79.50	453.80	12.23	179.85
T ₂ S ₂	71.10	13.32	3.63	7.67	16.23	79.00	472.70	9.73	126.05
T ₂ S ₃	70.03	14.19	4.02	7.97	16.13	78.30	498.23	7.87	103.99
T ₂ S ₁	78.13	12.82	3.49	6.70	16.03	78.57	419.80	8.91	167.92
T ₂ S ₂	77.37	13.06	3.53	7.63	15.93	78.03	446.07	7.76	118.95
T ₂ S ₃	74.00	13.68	3.97	7.83	15.63	76.93	447.83	6.42	99.89
Result	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG	SIG
S.Em.(±)	0.34	0.12	0.04	0.11	0.15	0.45	4.18	0.19	1.32
CD at 5%	1.01	0.35	0.12	0.34	0.45	1.37	12.52	0.56	3.96

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