

Original Research Article

<https://doi.org/10.20546/ijcmas.2026.1507.022>

Pod Set Efficiency in Relation to Crossing Time in Yardlong Bean (*Vigna unguiculata* subsp. *sesquipedalis*) Using Diallel Hybridization

Bavithra Balakrishnan^{ID*}, V. Kanthaswamy^{ID}, M. S. Marichamy^{ID},
V. Krishnan^{ID}, S. Nadaradjan^{ID}, U. Bagavathi Ammal^{ID}, N. Bavya^{ID}
and Priyanga Sivaramakrishnan^{ID}

Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute,
Karaikal – 609603, Pondicherry University, India

*Corresponding author

ABSTRACT

Keywords

Yardlong bean,
Diallel cross,
Pod set percentage,
Hybridization
timing, Vegetable
cowpea

Article Info

Received:
20 May 2026
Accepted:
28 June 2026
Available Online:
10 July 2026

Efficient hybridization is a major constraint in yardlong bean owing to its highly self-pollinated and cleistogamous floral nature. The present investigation was undertaken during June–September 2025 at the Department of Horticulture, PAJANCOA & RI, Karaikal, to assess the influence of crossing time on pod set percentage in yardlong bean using a 6 × 6 diallel mating design. A total of 69 genotypes were initially evaluated, from which six superior parents, namely Arka Mangala, Vyjayanthi, Lola, Vellayani Jyothika, VS 28 and VS 54, were selected based on yield and floral traits. Hand pollinations were carried out at three different time intervals viz., 6:00–7:00 a.m., 7:00–8:00 a.m. and 8:00–9:00 a.m. Pod set percentage was recorded for individual parental crosses as well as all possible diallel combinations. The experiment was laid out in Randomized Block Design (RBD) and data were statistically analysed. Results revealed significantly higher pod set during 6:00–7:00 a.m., with pod set ranging from 90.2 to 95.6% across crosses, followed by 7:00–8:00 a.m., while the lowest pod set was recorded during 8:00–9:00 a.m. Among the parents, Arka Mangala and Vellayani Jyothika exhibited superior combining ability for pod set. The study conclusively identifies early morning hours as the most effective crossing window for successful hybridization in yardlong bean breeding programmes.

Introduction

Yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt), a pole type vegetable cowpea, is an important leguminous vegetable widely cultivated in tropical and subtropical regions of Asia. It is particularly

valued for its long, tender pods, high protein content and ability to improve soil fertility through biological nitrogen fixation. In India, the crop holds considerable commercial importance, especially in southern states, where it forms an integral component of smallholder vegetable farming systems.

Despite its economic significance, productivity improvement in yardlong bean remains limited due to the absence of publicly released hybrids and difficulties associated with artificial hybridization. The crop is predominantly self-pollinated because of its cleistogamous flowers, synchronous pollen release and stigma receptivity, and enclosure of reproductive organs within the keel petals. These floral characteristics severely restrict natural cross-pollination and reduce hybrid seed recovery.

Hybrid breeding offers a promising approach for improving yield and pod quality in yardlong bean; however, success depends largely on optimizing hybridization techniques, particularly the time of pollination, which directly influences pod set. Previous studies in cowpea have emphasized the importance of early morning pollination for achieving higher fruit set, as environmental conditions during this period favour pollen viability, stigma receptivity and successful fertilization.

In this context, the present study was undertaken to systematically evaluate pod set efficiency at different crossing times using selected elite parents and their diallel cross combinations, with the objective of identifying the most suitable time window for hybridization in yardlong bean.

Materials and Methods

Experimental site and season: The experiment was conducted at the Department of Horticulture, PAJANCOA & RI, Karaikal, during June to September 2025. The location falls under a tropical coastal climate with warm temperatures and moderate relative humidity during the cropping season.

Genetic material: A total of 69 yardlong bean genotypes were initially evaluated. Based on superior performance for yield, floral behaviour and adaptability, six parents were selected for hybridization: Arka Mangala, Vyjayanthi, Lola, Vellayani Jyothika, VS 28 and VS 54.

Crossing programme: The six parents were crossed in a 6×6 diallel mating design (excluding reciprocals), generating 15 hybrid combinations. In addition, pod set was also recorded for individual parental crosses.

Crossing time intervals: Hand pollination was performed

at three distinct time intervals: T1 – 6:00–7:00 a.m.; T2 – 7:00–8:00 a.m.; T3 – 8:00–9:00 a.m. Emasculation was carried out in the previous afternoon, and pollination was done using freshly dehiscent pollen on the following morning.

Experimental design and statistical analysis: The experiment was laid out in a Randomized Block Design (RBD) with three replications. Pod set percentage was calculated based on the number of pods formed relative to the number of successful crosses made. Data were subjected to analysis of variance (ANOVA), and significance was tested at the 5% level.

Results and Discussion

Pod set in individual parents: Pod set percentage among individual parental crosses was significantly influenced by crossing time. The highest pod set was recorded during 6:00–7:00 a.m. (92.4–95.6%), followed by 7:00–8:00 a.m. (85.3–89.7%), while the lowest was observed during 8:00–9:00 a.m. (70.5–78.6%). Arka Mangala and Vellayani Jyothika consistently exhibited superior pod set across all time intervals.

Pod set in diallel cross combinations: All diallel crosses showed significantly higher pod set during early morning hours. The cross Arka Mangala $\times$ Vellayani Jyothika recorded the maximum pod set (95.6%) during 6:00–7:00 a.m., followed by Vyjayanthi $\times$ VS 54 and Lola $\times$ VS 28. Delayed pollination resulted in a gradual decline in pod set across all combinations.

The present study clearly demonstrates that crossing time plays a critical role in determining pod set success in yardlong bean. Higher pod set during early morning hours may be attributed to favourable microclimatic conditions, synchronized pollen release and maximum stigma receptivity. Similar observations have been reported in vegetable cowpea, where early morning pollinations resulted in higher fertilization success (Ige *et al.*, 2011).

The superior performance of Arka Mangala and Vellayani Jyothika indicates their suitability as effective parents in hybrid breeding programmes. The consistently high pod set observed in several diallel combinations further highlights the feasibility of exploiting heterosis in yardlong bean through optimized hybridization techniques.

Table.1 Pod set percentage (%) of individual parents at different crossing time intervals

Parent	6:00–7:00 a.m.	7:00–8:00 a.m.	8:00–9:00 a.m.	Mean
Arka Mangala	95.6	89.7	78.6	88.0
Vyjayanthi	93.8	88.5	76.9	86.4
Lola	92.4	87.3	75.8	85.2
Vellayani Jyothika	94.9	89.1	77.5	87.2
VS 28	91.8	86.4	74.6	84.3
VS 54	93.1	88.2	76.2	85.8
Mean	93.6	88.2	76.6	–

Table.2 Pod set percentage (%) of diallel crosses at different crossing time intervals

Cross combination	6:00–7:00 a.m.	7:00–8:00 a.m.	8:00–9:00 a.m.
Arka Mangala × Vyjayanthi	94.8	89.3	77.4
Arka Mangala × Lola	93.9	88.6	76.8
Arka Mangala × Vellayani Jyothika	95.6	90.1	78.2
Arka Mangala × VS 28	92.7	87.4	75.6
Arka Mangala × VS 54	94.3	88.9	77.1
Vyjayanthi × Lola	92.5	87.1	75.4
Vyjayanthi × Vellayani Jyothika	94.1	88.7	76.9
Vyjayanthi × VS 28	91.9	86.2	74.8
Vyjayanthi × VS 54	94.6	89.2	77.6
Lola × Vellayani Jyothika	93.4	88.1	76.3
Lola × VS 28	92.1	86.9	75.1
Lola × VS 54	93.7	88.4	76.7
Vellayani Jyothika × VS 28	94.2	89.0	77.0
Vellayani Jyothika × VS 54	95.1	89.8	78.0
VS 28 × VS 54	92.8	87.6	75.9
Mean	93.9	88.4	76.7

Table.3 Analysis of variance (ANOVA) for pod set percentage

Source of variation	df	Mean sum of squares
Replications	2	1.24
Crossing time (T)	2	842.65**
Genotypes (G)	14	216.37**
T × G	28	38.91**
Error	88	4.12
Total	134	–

SE(d): 1.29

CD (P = 0.05): Crossing time = 3.78; Genotypes = 4.96; Interaction = 6.12

*(** Significant at P ≤ 0.05)*

The study conclusively establishes 6:00–7:00 a.m. as the most efficient time for hand pollination in yardlong bean. Early morning crossing significantly enhances pod

set percentage in both individual parents and diallel hybrid combinations. The findings provide a practical and reliable protocol for improving hybrid seed

production efficiency in yardlong bean breeding programmes.

Acknowledgement

The authors are grateful to the Department of Horticulture, PAJANCOA & RI, Karaikal, for providing the necessary facilities to carry out this research.

Author Contributions

B. Bavithra: Investigation, formal analysis, writing—original draft. V. Kanthaswamy: Validation, methodology, writing—reviewing. M. S. Marichamy:—Formal analysis, writing—review and editing. V. Krishnan: Investigation, writing—reviewing. S. Nadaradjan: Resources, investigation writing—reviewing. U. Bagavathi Ammal: Validation, formal analysis, writing—reviewing. N. Bavya: Conceptualization, methodology, data curation, supervision, writing—reviewing the final version of the manuscript. S. Priyanga: Investigation, formal analysis, writing—original draft.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

References

- Animasaun, D.A., Oyedeji, S., Azeez, M.A. and Onyegwukwu, F. 2014. Growth performance and pollen fertility in relation to fruit set among selected vegetable crops. *Agronomski Glasnik*, 76: 203–218.
- Blackhurst, H.T. and Miller, J.C. 1980. Cowpea. In: Fehr, W.R. and Hadley, H.H. (eds.), *Hybridization of Crop Plants*. University of Wisconsin Press, Madison, pp. 327–337.
- Ehlers, J.D. and Hall, A.E. 1997. Cowpea (*Vigna unguiculata* L. Walp.). *Field Crops Research*, 53: 187–204.
- Faisal, E.A., Hall, A.E. and DeMason, D.A. 1992. Heat injury during floral development in cowpea. *American Journal of Botany*, 79: 784–791.
- Ige, O.E., Olotuah, O.F. and Akerele, V. 2011. Floral biology and pollination ecology of cowpea (*Vigna unguiculata* L. Walp.). *Modern Applied Science*, 5: 74–82.
- Lakshmi, K.M. 2016. Development of hybrids in yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis*). MSc (Hort.) Thesis, Kerala Agricultural University, Thrissur.
- Rachie, K.O., Rawal, K. and Franckowiak, J.D. 1975. A rapid method of hand crossing cowpeas. *Technical Bulletin No. 1*, IITA, Ibadan, Nigeria.
- Resmi, R. and Gopalakrishnan, T.R. 2004. Effect of plant growth regulators on performance of yardlong bean. *Journal of Tropical Agriculture*, 42: 55–57.
- Warrag, M.O.A. and Hall, A.E. 1983. Reproductive responses of cowpea to heat stress. *Crop Science*, 23: 1088–1092.

How to cite this article:

Bavithra Balakrishnan, V. Kanthaswamy, M. S. Marichamy, V. Krishnan, S. Nadaradjan, U. Bagavathi Ammal, N. Bavya and Priyanga Sivaramakrishnan. 2026. Pod Set Efficiency in Relation to Crossing Time in Yardlong Bean (*Vigna unguiculata* subsp. *sesquipedalis*) Using Diallel Hybridization. *Int.J.Curr.Microbiol.App.Sci*. 15(7): 235-238.
doi: <https://doi.org/10.20546/ijcmas.2026.1507.022>