Journal of Advances in Biology & Biotechnology

Volume 27, Issue 10, Page 37-46, 2024; Article no.JABB.123417
ISSN: 2394-1081

Study the Effect of Planting Dates and Reproductive Pruning on Yield Attributes of Yam Bean (*Pachyrrhizus erosus* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jabb/2024/v27i101427

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/123417

Original Research Article

Received: 11/07/2024
Accepted: 13/09/2024
Published: 18/09/2024

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Cite as: *Shevale, Priti P., Pradnya S. Gudadhe, Y. R. Parulekar, A.V. Mane, and S.B. Thorat. 2024. "Study the Effect of Planting Dates and Reproductive Pruning on Yield Attributes of Yam Bean (Pachyrrhizus Erosus L.)". Journal of Advances in Biology & Biotechnology 27 (10):37-46. https://doi.org/10.9734/jabb/2024/v27i101427.*

ABSTRACT

Flowers are reproductive organs that convert photosynthetic assimilates into seeds when flowers are developed the yield of the tuber decreases. So, it's prerequisite to pluck the flowers to increase the tuber yield [1] as well as its needs to find out suitable planting date for cultivation of yam bean in Konkan region. Therefore, an experiment on "Study the effect of planting dates and reproductive pruning on yield attributes of Yam bean (*Pachyrrhizus erosus* L.)" was conducted at Department of Vegetable Science, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during *Kharif* season of year 2023-24. Two factors were studied during the investigation using factorial randomized block design (*p*= .05) viz. Planting dates (D) *i.e.,* D_1-1st week of June, D_2-3rd week of June, D_3 -1st week of July, D_4 -3rd week of July and Interval of reproductive pruning (P) *i.e.,* P_1 – Weekly, P_2 – Fortnightly, P_3 – No pruning. The results showed that weekly reproductive pruning (P_1) with planting date 3rd week of June (D_2) gave best effect and significantly affect the yield per plant (642.03 g), average weight of tuber (407.70 g),yield per hectare (12.90 t ha^{-1}) and length and diameter of tuber (21.50 cm and 17.53 cm) respectively.

Keywords: Yam bean; planting dates; reproductive pruning; yield.

1. INTRODUCTION

Yam Bean (*Pachyrrhizus* spp.) is one of the multifunctional, underutilized minor tuber crops belongs to the family Leguminosae, under the subfamily Papillionaceae. There are five species under the genera Pachyrrhizus viz. *P. erosus*, *P. tuberosus* and *P. ahipa* are cultivated

species and *P. ferrugineus*, *P. panamensis* are wild species. Among this *P. erosus* is mostly cultivated all over the world. Yam beans have refreshing, crispy ice-white, fruit-flavoured tuber which can eaten raw or as cooked in various sweet dishes and in numerous savoury dishes worldwide. Tubers have very low-calories as well as high-quality dietary fiber (Oligofructose insulin) and antioxidants and some amount of minerals and vitamins. Yam bean tubers are also rich in vitamin C which is a powerful water-soluble antioxidant that helps the body scavenge harmful free radicals, thereby offering protection from cancers, inflammation, viral cough and cold. It contains a healthy amount of potassium which is responsible for keeping our heart in good shape [2]. Yam bean contributes to ensuring food security by providing food and feeds products, enrichment of other foods that are deficient in major nutrients with beneficial phytochemicals and bioactive compounds that reduce the risk of diseases. Yam bean cultivation is now becoming more popular among the farmers of the Konkan region due its nutritional properties. Yam bean can withstand in high rainy conditions due to their hardy nature. The lateritic soils of the Konkan region are generally sandy clay loam in texture with pH 5.0-6.0, highly base leached and sesquioxide soils favour the production of yam bean. Successful yam bean production in many regions depends upon selecting suitable times for sowing by the specific environment. Further, it is highly nutritious therefore increasing demand from consumers. Thus, there is good scope for increasing the production and productivity of yam bean in the Konkan region [3]. Yam bean, being an underutilized but nutritionally rich crop, has significant potential for enhancing food security, especially in region like the Konkan. The study's results could directly benefit farmers and agricultural playmakers in similar agro-climatic zones.

2. MATERIALS AND METHODS

2.1 Site and Weather

The current study was conducted during the *Kharif* season of 2023-24 at Research Farm, Department of Vegetable Science, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Which is located at 280 m above MSL with 17°45'N Latitude and 73°12' E Latitude. The area has a high rainy condition with hot and humid climate. The south-west monsoon occurs from June to September contributing to around 80% of total rainfall. The meteorological data (Table. 7) recorded during the growth and yield period of the crop. The average maximum and minimum weekly temperature was between 17.00℃ to 20.95℃ and overall 3978mm of rainfall was recorded throughout the crop (June- December).

2.2 Experimental Details

The current study was undertaken to study the effect of planting dates and reproductive pruning on yield attributes of Yam bean (*Pachyrrhizus*

erosus L.). The experimental study was laid out in a factorial randomized block design with three replications. Two factors were studied during the investigation viz. a) Planting dates (D) D_1-1st week of June, D_2-3rd week of June, D_3 -1st week of July, D_4 -3rd week of July and b) Interval of reproductive pruning (P) P_1 – Weekly, P_2 – Fortnightly, P_3 – No pruning Individual plot size was 3 m x 3 m. The spacing between the ridges was 60cm and seed to seed distance was 20 cm respectively. In between two replications the spacing 1m was added to maintain plants and avoid the nutrients uptake from the other block. The area of experimental field was 21.2m X 21m. Single seed was sown on the ridge at the spot of fertilizer application which were made as per the desired spacing at the depth of 2-3 cm and seeds are sown four different planting dates i.e. 1st week of June, 3rd week of June, 1st week of July and 3rd week of July respectively. Six to seven weeks after sowing yam bean starts flowering. Removal of flower buds is done at intervals of weekly and fortnightly. Removal of flower bud is a practice for better production of yam bean tubers. The flower buds were removed at the purple colour and particularly opened stage.

2.3 Observations Recorded

The yield-related parameters such as yield per plant (g), yield per hectare (t ha^{-1}) and average tuber weight (g) was measured by using digital weighing balance. Tuber length (cm) was measured by using meters scale and tuber diameter (cm) was measured by using vernier calliper. The average of 5 tubers from each treatment at 120 days after sowing (DAS) was taken for calculations.

2.4 Statistical Analysis

The data collected on different yield-related attributes were analysed using analysis of variance (ANOVA) in factorial randomized block design using the method suggested by Panse and Sukhatme [4]. The standard error (S.E.) of means was worked and a critical difference (CD) at 5% i.e. (p=0.05) was also worked out whenever the result was significant.

3. RESULTS AND DISCUSSION

3.1 Yield Per Plant (g)

In present investigation, the data presented in Table 1 demonstrated that for planting dates the highest yield was recorded in D_2 (547.89 g). Whereas D_4 (316.67 g) recorded the lowest yield and difference among them was significant. In case of the reproductive pruning significant difference among the treatment was observed. The highest yield was obtained in P_1 (494.48 g) which was followed by the P_2 (457.74 g). However, the lowest was found in P_3 (345.95 g). The combined effect was significant on tuber yield per plant (g). The highest yield was recorded in D_2P_2 (642.03 g), which was followed by the treatment D_2P_1 (607.83 g), the lowest yield per plant was recorded in D_4P_3 (250.13 g). The interaction effect of planting dates and interval of reproductive pruning may give more yield per plant due to the June often coincides with favourable weather conditions, including adequate rainfall and sunlight. The similar trend observed by Karhale et al. [5] in kharif sorghum, Bobade et al. [6] in kharif green gram, Lowrence et al. [7] in pigeon pea, Nisha Kumari et al. [8] in sweet potato and Mishra et al [9] in sweet potato. Pruning practice could increase the tuber yield of plant due to plants shifts energy from reproductive parts to vegetative parts (leaf and tuber). The similar findings were reported by the Mardhiana et al. [10] in cucumber, Gao et al. [11] in *Helianthus tuberosus* L. and Kim et al. [12] in *Platycodon grandiflorus* roots.

3.2 Average Tuber Weight (g)

The data presented in Table 2 demonstrated that the effect of planting dates was significant in case of the average tuber weight, the highest tuber weight was recorded in D_2 (335.30 g) which was followed by the D_1 (304.20 g). However, the lowest average tuber weight was observed in D_4 (161.11 g). Among the reproductive pruning the highest average tuber weight was recorded in P_1 (333.88 g) which was significantly followed by the P_2 (300.83 g). The lowest average tuber weight was found in P_3 (183.13 g). However, for combined effect of the highest average tuber weight was recorded in treatment D_2P_1 (407.70 g) which was followed by the treatments D_1P_2 (387.17), D_3P_1 (386.67 g), D_2P_2 (382.83 g) and D_1P_1 (331.36 g). The lowest were recorded in D_4P_3 (183.13 g). Interaction effect between planting dates and reproductive pruning was found statistically significant. The similar findings were reported by the Thakur et al. [13] in coriander, Denna et al. [14] in yam bean, Vishwas et al. [15] in potato and Nam Hyo-hun et al. [16] in yam bean.

3.3 Yield Per Hectare (t ha^{-1})

The data presented in Table 3 of demonstrated that the planting dates on yield (t ha^{-1}) showed significant effect and the highest yield was recorded in D_2 (10. 16 ton) which was followed by the D_1 (8.72 ton) and the lowest yield was recorded in D_4 (4.55 tons). However, for reproductive pruning highest yield was obtained in P_1 (9.09 tons) which was significantly followed by the P_2 (8.33 t ha^{-1}) while, the lowest yield was found in P_3 (5.61 t ha^{-1}). The interaction effect of planting dates and interval of reproductive pruning on tuber yield per hectare (t ha^{-1}) was found to be significant. The highest yield was recorded in D_2P_1 (12.90 t ha^{-1}) which was followed by the treatment D_2P_2 (10.41 t ha^{-1}). However, the lowest yield was obtained in D_4P_3 (2.74 t ha^{-1}). The planting dates 1st week of June (D_1) and 3rd week of June (D_2) gave maximum yield due to better growth and thrive well in heavy rain as compared to 1st week of July (D_3) and 3rd week of July (D_4) where more mortality of plants was observed. Similar findings were reported by the Kang et al. [17] in soybean, Canavar and Kaynak [18] in peanut, Bashir et al. [19] in rice, Karhale et al. [15] in kharif sorghum and Bobade et al. [7] in kharif green gram. While the Pruning practices increase the yield per hectare. Similar findings were reported by Belford et al. [20] in yam bean, Adjahossou, [21] in yam bean, Chakraborty et al. [22] in mungbean, Gibregwergis et al. [23] in potato, Kumar and Kumar [24] in black gram and Great at al. [25] in sweet potato.

3.4 Tuber Length (cm)

It is evident from the data the various planting dates on length of tubers had significant effect. However, the highest length of tuber was recorded in D_2 (20.66 cm) which was superior over rest of treatments. However, the lowest length was observed in D_4 (16.90 cm). However, for reproductive pruning the highest tuber length was found in P_1 (18.80 cm) which was followed by the P_2 (18.34 cm) and the lowest tuber length recorded in P_3 (17.59 cm). For the combined effect was found significant and the highest tuber length was found in D_2P_1 (21.50 cm) which followed by the treatment D_2P_2 (20.77 cm). However, the lowest tuber length was recorded in D_4P_1 (16.17 cm). This might be due to the planting at the right time could have helped to avoid stress from extreme weather conditions and allowed plants to allocate more energy to tuber growth. Regular pruning also encouraged bushier growth and increased leaf area, enhancing photosynthesis and ultimately leading to larger tubers. Similar findings were reported by Gibregwergis et al. [23] in potato, Denna et al. [14] in yam bean, Kim et al. [12] in *Platycodon grandiflorus* roots and Gao et al. [11] in *Helianthus tuberosus* L.

3.5 Tuber Diameter (cm)

The various planting date significantly affected the diameter of the tubers. The highest diameter of tuber was reported in D_2 (14.14 cm) which was superior over rest of treatments. Whereas, lowest was recorded in D_4 (6.58 cm). In case of the interval of reproductive pruning significant difference among them was observed. The highest tuber diameter was reported in P_1 (13. 16 cm). However, the lowest tuber diameter was found in P_3 (7.49 cm). The interaction on tuber diameter the highest tuber diameter was reported in D_2P_2 (17.53 cm) which was followed by the D_2P_1 (16.38 cm). However, the lowest tuber diameter was reported in D_4P_3 (4.57 cm). This may due to the optimal planting dates and strategic reproductive pruning help to maximize resource allocation and growth conditions for yam beans. This approach allows the plants to thrive and produce larger and healthier tubers. Similar findings were reported by Mardhiana et al. [10] in cucumber, Balogun and Nwokah [26] in sweet potato, Mishra et al. [9] in sweet potato and Shravika et al. [27] in tomato.

3.6 Economics

The data presented in Table 6 revealed that the highest net profit of Rs. 346855 with B:C ratio (1:2.59) were obtained in treatment T_4 (D_2P_1) which was followed by treatment T_5 (D_2P_2) with net profit Rs. 218735 and B:C ratio (1:2.1). However, the lowest net profit Rs. - 84565 was observed in treatment T_{12} (D_4P_3) with B:C ratio (1:0.56). The price of yam bean tuber was Rs. 40 /kg.

Plate 1. General view of experimental plot

Table 1. Effect of planting dates and interval of reproductive pruning and their interaction on yield per plant (g) in yam bean

Treatments	Yield per plant (g)			
	Interval of reproductive pruning (P)			
Planting dates (D)	**P_1**	**P_2**	**P_3**	**Mean**
D_1	490.73	486.10	453.00	**476.61**
D_2	607.83	642.03	393.82	**547.89**
D_3	475.67	406.67	286.87	**389.73**
D_4	403.72	296.17	250.13	**316.67**
Mean	**494.48**	**457.74**	**345.95**	**432.72**
	Result	S.E m ±	CD@5%	
D	**SIG**	±20.65	60.57	
P	**SIG**	±17.89	52.46	
DxP	**SIG**	±35.77	104.90	

(D_1- 1st week of June, D_2- 3rd week of June, D_3- 1st week of July, D_4- 3rd week of July, P_1- Weekly pruning, P_2- Fortnightly pruning and P_3- No pruning.)

Table 2. Effect of planting dates and interval of reproductive pruning and their interaction on average tuber weight (g) of yam bean

Treatments	Average tuber wt. (g)			
	Interval of reproductive pruning (P)			
Planting dates (D)	**P_1**	**P_2**	**P_3**	**Mean**
D_1	331.16	387.17	194.50	**304.20**
D_2	407.70	382.83	215.37	**335.30**
D_3	386.67	293.33	189.33	**289.77**
D_4	210.00	140.00	133.33	**161.11**
Mean	**333.88**	**300.83**	**183.13**	**272.61**
	Result	S.E m ±	CD@5%	
D	**SIG**	±16.59	48.67	
P	**SIG**	±14.37	42.15	
DxP	**SIG**	±28.74	84.29	

(D_1- 1st week of June, D_2- 3rd week of June, D_3- 1st week of July, D_4- 3rd week of July, P_1- Weekly pruning, P_2- Fortnightly pruning and P_3- No pruning)

Table 3. Effect of planting dates and interval of reproductive pruning and their interaction on yield per hectare (ton) of yam bean

Treatments	Yield per ha. (ton)			
	Interval of reproductive pruning (P)			
Planting dates (D)	**P_1**	**P_2**	**P_3**	**Mean**
D_1	8.45	9.31	8.40	**8.72**
D_2	12.90	10.41	7.18	**10.16**
D_3	10.27	7.49	4.12	**7.29**
D_4	4.77	6.14	2.74	**4.55**
Mean	**9.09**	**8.33**	**5.61**	**7.67**
	Result	S.E m ±	CD@5%	
D	**SIG**	±0.51	1.49	
P	**SIG**	±0.44	1.29	
DxP	**NS**	±0.88	2.58	

(*D_1- 1st week of June, D_2- 3rd week of June, D_3- 1st week of July, D_4- 3rd week of July, P_1- Weekly pruning, P_2- Fortnightly pruning and P_3- No pruning.)*

Table 4. Effect of planting dates and interval of reproductive pruning and their interaction on length (cm) of yam bean

Treatments	Length (cm)			
	Interval of reproductive pruning (P)			
Planting dates (D)	**P_1**	**P_2**	**P_3**	**Mean**
D_1	19.17	17.90	17.40	**18.15**
D_2	21.50	20.77	19.73	**20.66**
D_3	18.43	16.30	17.07	**17.26**
D_4	16.13	18.40	16.17	**16.9**
Mean	**18.80**	**18.34**	**17.59**	**18.24**
	Result	S.E m ±	CD@5%	
D	**SIG**	±0.29	0.83	
P	**SIG**	±0.25	0.72	
DxP	**SIG**	±0.49	1.44	

(D_1- 1st week of June, D_2- 3rd week of June, D_3- 1st week of July, D_4- 3rd week of July, P_1- Weekly pruning, P_2- Fortnightly pruning and P_3- No pruning.)

Table 5. Effect of planting dates and interval of reproductive pruning and their interaction on diameter (cm) of yam bean tuber

Treatments	Diameter (cm)			
	Interval of reproductive pruning (P)			
Planting dates (D)	**P_1**	**P_2**	**P_3**	**Mean**
D_1	13.23	15.38	10.53	**13.04**
D_2	16.38	17.53	8.53	**14.14**
D_3	13.67	9.10	6.33	**9.70**
D_4	9.36	5.83	4.57	**6.58**
Mean	**13.16**	**11.96**	**7.49**	**10.87**
	Result	S.E m ±	CD@5%	
D	**SIG**	±0.32	0.92	
P	**SIG**	±0.28	0.79	
DxP	**SIG**	±0.55	1.59	

(*D_1- 1st week of June, D_2- 3rd week of June, D_3- 1st week of July, D_4- 3rd week of July, P_1- Weekly pruning, P_2- Fortnightly pruning and P_3- No pruning.*

Table 6. Effect of planting dates and interval of reproductive pruning and their interaction on economics

Sr. No.	Treatment	Total cost of production (Rs.)	Gross return (Rs.)	Net profit	B:C Ratio
1	T_1 (D_1P_1)	199145	338000	138855	1:1.69
2	T_2 (D_1P_2)	197665	372400	174735	1:1.88
3	T_3 (D_1P_3)	194165	336000	141835	1:1.73
4	T_4 (D_2P_1)	199145	516000	346855	1:2.59
5	T_5 (D_2P_2)	197665	416400	218735	1:2.1
6	T_6 (D_2P_3)	194165	287200	93035	1:1.47
7	T_7 (D_3P_1)	199145	410800	211135	1:2.06
8	T_8 (D_3P_2)	197665	299600	101935	1:1.51
9	T_9 (D_3P_3)	194165	164800	-29365	1:0.84
10	T_{10} (D_4P_1)	199145	190800	-8345	1:0.95
11	T_{11} (D_4P_2)	197665	245600	47935	1:1.24
12	T_{12} (D_4P_3)	194165	109600	-84565	1:0.56

(Note: The price of 1kg yam bean tuber= Rs.40)

Table 7. Weekly meteorological data of the year 2023((From 04.06.2023 to 09.12.2023) Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli, Maharashtra, India

Period	MW	Tmax (oC)	Tmin (oC)	RH-I (%)	RH-II (%)	Wind speed (Kmph)	Rain (mm)	RD day	BSS (hrs.)	Epan (mm)
04.06 - 10.06	**23**	34.3	24.1	81	60	6.6	1.2	0	10.2	5.9
11.06 - 17.06	**24**	33.2	25.0	84	67	9.6	52.8	4	7.6	4.9
18.06 - 24.06	**25**	31.9	24.6	85	67	6.6	27.2	1	7.2	4.9
25.06 - 01.07	**26**	28.2	22.6	96	93	7.0	596.6	7	0.2	2.0
02.07 - 08.07	**27**	27.9	23.1	97	93	6.5	632.8	7	0.0	2.1
09.07 - 15.07	**28**	28.8	23.5	93	89	6.7	159.2	7	1.7	2.8
16.07 - 22.07	**29**	28.0	23.1	94	92	10.7	511.6	7	0.9	2.5
23.07 - 29.07	**30**	26.9	23.0	97	93	10.2	618.8	7	0.0	2.1
30.07 - 05.08	**31**	28.1	24.1	95	90	8.8	181.6	6	0.1	3.1
06.08 - 12.08	**32**	29.2	23.7	92	83	5.6	31.6	5	2.6	3.4
13.08 - 19.08	**33**	28.9	23.6	91	85	6.1	54.0	6	4.7	3.3
20.08 - 26.08	**34**	28.7	22.6	94	87	5.0	124.8	7	3.2	3.0
27.08 - 02.09	**35**	29.5	22.5	94	82	3.3	121.4	4	5.2	2.8
03.09 - 09.09	**36**	28.8	22.3	93	85	3.7	353.4	2	2.8	3.6
10.09 - 16.09	**37**	29.3	22.9	92	79	4.1	110.0	5	4.1	2.7
17.09 - 23.09	**38**	29.3	23.1	95	85	5.7	158.8	6	3.8	2.8
24.09 - 30.09	**39**	29.5	22.4	93	87	2.8	141.8	5	1.5	2.8
01.10 - 07.10	**40**	28.6	21.7	95	82	3.2	126.2	2	3.9	2.6
08.10 - 14.10	**41**	32.4	22.3	94	72	2.7	0.0	0	8.3	3.8
15.10 - 21.10	**42**	33.9	22.3	92	73	2.4	0.0	0	6.4	4.1
22.10 – 28.10	**43**	34.1	19.2	89	54	2.5	0.0	0	7.6	3.9
29.10 – 04.11	**44**	33.9	17.9	90	48	2.2	0.0	0	7.8	4.0
05.11 – 11.11	**45**	33.3	20.5	88	59	2.8	0.0	0	5.8	4.0
12.11 – 18.11	**46**	33.9	17.9	91	51	2.2	0.0	0	8.1	4.0
19.11 – 25.11	**47**	34.1	17.7	91	46	2.5	0.0	0	8.0	4.0
26.11 – 02.12	**48**	32.1	18.4	94	53	3.1	1.4	0	6.5	3.7
03.12–09.12	**49**	32.6	16.6	94	56	2.8	0.0	0	7.2	3.7

4. CONCLUSION

Among the different treatments it was concluded that for better yield attributing characters of yam bean, it should be planted in 3rd week of June with weekly reproductive pruning i.e. D_2P_1 which gave best effect on yield per plant (642.03 g), average weight of tuber (407.70 g), yield per hectare (12.90 t ha^{-1}) and length and diameter of tuber (21.50 cm and 17.53 cm) respectively under Konkan agro-climatic conditions.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

ACKNOWLEDGEMENT

The authors sincerely acknowledge the department of Vegetable Science, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli, Maharashtra, India for providing all the necessary facility for conducting of this experiment. Special thanks owed to Dr. Pradnya. S. Gudadhe for providing guidance in manuscript preparation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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https://www.sdiarticle5.com/review-history/123417