



Varietal Evaluation of Pak Choi (*Brassica rapa* subsp. *Chinensis*) under Agro-climatic Conditions of Prayagraj, India

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Authors' contributions

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

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ABSTRACT

A study was conducted on the Varietal Evaluation of Pak Choi using ten different varieties at the Horticultural Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh). This study was carried out to determine the most suitable cultivar of Pak Choi under the agro-climatic conditions of Prayagraj during the winter growing season in 2022. The observations were recorded on various growth and yield contributing characters. At the end of the research, it is evident that Pak Choi White Stem was found to be superior on the basis of growth, having the maximum plant height (22.57cm) and gross weight (133.75g). In terms of yield/ha (q), Pak Choi White Stem (70.67) and Desi Pak Choi (69.22) was found to be superior. In terms of economics, the maximum gross return per hectare was obtained by Pak Choi White Stem i.e. 212010 INR followed by Desi Pak Choi i.e., 207660 INR.

Keywords: Pak choi; growth; yield; economics.

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1. INTRODUCTION

Pak Choi or Bok Choy (*Brassica rapa* subsp. *chinensis*) is an important leafy vegetable which belongs to the family Brassicaceae. It has a chromosome number $2n=18$. This member of the cabbage family has a number of different names, including pak choi, bok choy, Chinese celery cabbage and white mustard cabbage [1]. It is grown in Asia, where the earliest reports of their use are from the fifth century A.D. and traces its origins from China. It has been cultivated in southern China, particularly in the East, Northeast, and Southeast Asia for more than 1600 years ago [2].

Pak choi is a non-heading type of Chinese cabbage that typically grows to a height of about 20-30 cm (8-12 inches) and forms a cluster of glossy, dark green leaves [3]. While it grows slower in less light, it can easily tolerate as little sun as 2 hours a day. This annual vegetable has optimal growth and development at temperatures between 15°C and 20°C.

Pak Choi are consumed in different forms. It is used mostly for its leaves and leaf stalks. Botanically, pak choi is classified as a cool-season crop and is known for its ability to tolerate colder temperatures. Its leaves are smooth and shiny, with a shape that ranges from long and slender to round and broad. The plant also features thick, succulent stalks that are crisp and tender [4]. This vegetable crop is characterized by high water content, low caloric value, containing high quality of protein, carbohydrates, fibre, vitamins and minerals. It is a good alternative crop as it is found to have similar characteristics with other *Brassicaceae* members.

Pak Choi is not commonly grown under Prayagraj agro-climatic conditions, hence different cultivars of Pak Choi were selected for cultivation. The objective is to determine the most suitable Pak Choi cultivars in terms of growth and yield attributes as well as to work out the economics of different cultivars.

2. MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm in the Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj between 2022 and 2023. The area is situated on the south of Prayagraj on the right bank of Yamuna at Rewa road at a distance of about 6 km from Prayagraj city. It is situated at the 25.08°N

Latitude and 810.50°E meters from sea level. Prayagraj has a sub-tropical climatic with uttermost in summer (in the month of May and June) with temperate reaching around 115°F with hot blazing winds and in winter (December and January) the temperature falls down as low as 32°F. The average rainfall is around 1013.4 (mm) annually with maximum concentration during July to September with occasional showers in winter.

In this study, ten different cultivars of Pak Choi namely, Baby Pak Choi, Desi PakChoi, Pak Choi White Stem, Pak Choi All Green, Green Imported Oriental, Emerald Green, Canton Milky Dwarf, Hong Tae, Pe-Tsai and Purple Lady Pak Choi were evaluated. The experiment was laid out in Randomized Block Design (RBD) with three replications each. The seeds of different cultivars were sown in nursery beds at an interval of 15 days with two sowing dates (21/10/22, 5/11/22). The seedlings were transplanted in the main field at three to four true leaf stage in the Horticulture Farm in the Department of Horticulture. Standard fertilization, irrigation and weed control practices were applied in this experiment. No pesticides were applied during the growing period.

The following parameters were measured and evaluated in this study.

A. Growth Parameters :

1. Days taken to germination
2. Number of leaves
3. Plant height(cm)
4. Diameter of loose head(cm)
5. Chlorophyll content
6. Days to harvest

B. Yield Parameters :

7. Net weight (g)
8. Gross weight (g)
9. Average weight of plant (g)
10. Yield per plant(g)
11. Yield quintal per hectare(q/ha)

C. Economics

12. Cost of cultivation
13. Gross return
14. Net return
15. B.C. ratio

3. RESULTS AND DISCUSSION

The performances and adaptations of different varieties of pak choi (*Brassica rapa* subsp.

chinensis) were evaluated and determined at the Horticulture Farm, Department of Horticulture, Prayagraj. The morphological growth parameters are namely days taken to germination, number of leaves, plant height (cm), diameter of loose head(cm), chlorophyll content and days to harvest and yield parameters are net weight(g), gross weight(g), yield per plot(kg) and yield per hectare(q).

The number of days taken to germination emergence was recorded minimum in the varieties Emerald Green (3.27), Pe-Tsai (3.60), Desi Pak Choi (3.67) and Pak Choi White Stem (3.73), Baby Pak Choi (3.73), Hong-Tae(3.87), which were on par with each other, while the maximum number of days taken for germination was reported in the variety Purple Lady Pak Choi (4.45) , Canton Milky Dwarf (4.40). The seed germination and seedling growth parameters showed different variation in their performance with respect to the different cultivars taken.

The number of leaves per plant at 45 days in different varieties of pak choi was recorded minimum in the varieties Purple Lady Pak Choi (4.73) and Canton Milky Dwarf (4.80) which were found to be at par with each other, whereas the maximum was recorded in the varieties Pe-Tsai (11.20), followed by Pak Choi White Stem (8.93) and Hong-Tae (8.67) and the results are presented in Table 1.

The plant height at 45 DAS was found to be the maximum in the varieties Pak Choi White Stem (22.57 cm) followed by Desi Pak Choi (19.80 cm) , Green Import Oriental (18.67cm), Pak Choi All Green(18.16 cm), Canton Miky Dwarf (17.63cm), Emerald Green (17.47cm) and Pe-Tsai (17.47cm) which were on par. Similar variation to plant growth were also observed by Meena *et al.*, [5], Ansari *et al.*, (2018), Suhaida *et al.*, [6] , Tripathi *et al.*, [7].

Whereas the minimum plant height was found to be in Baby Pak Choi (8.80 cm), Hong Tae (14.07 cm) and Purple Lady Pak Choi (16.87 cm). There are several reports indicating variation with respect to plant height by several workers, Funda [8], Cho *et al.*, [9], Purbajanti *et al.* [10] and Ansari *et al.*, (2018).

The diameter of loose head was measured and recorded the maximum in the variety Pak Choi White Stem (58.27), Desi Pak Choi (54.60), Pe Tsai (46), Green Import Oriental (43.47), Pak Choi All Green (42.07) which were on par with

each other while the minimum diameter was found in Canton Milky Dwarf (16.07), Hong Tae (32.95), Purple Lady Pak Choi (34.07), Emerald Green (37.27) and Baby Pak Choi (41.07).

The maximum chlorophyll content was recorded in Pak Choi All Green (54.83), Green Imported Oriental (45.0), Emerald Green (44.81), Pe-Tsai (44.30) and Pak Choi White Stem(43.31) which were found to be at par. Whereas the minimum chlorophyll content was recorded in Purple Lady Pak Choi (34.91), Desi Pak Choi (36.55), Baby Pak Choi (38.33) respectively. There are several reports indicating variation with respect to leaf area by several workers, Wang, X. and Kole, C. [2], Acikgoz FE, Altintas S. [11].

The minimum number of days of first harvesting was recorded in the genotypes Desi Pak Choi (42), Pak Choi White Stem (43) , Baby Pak Choi (45), Green Import Oriental (45) which were on par with each other and maximum number of days to first harvesting (65.67) was reported in the variety Purple Lady Pak Choi, Canton Milky Dwarf (48), Hong Tae (46.8), All Green (46), Emerald Green (45.67).

Yield parameters: The maximum plant weight was recorded in Pak Choi White Stem (90.07g) followed by Desi Pak Choi (89.57), Pak Choi Emerald Green (89), Pak Choi All Green (76.60) and Pe-Tsai (72.30) which were found to be at par. Whereas the minimum plant weight was recorded in Purple Lady Pak Choi (50.77g), Canton Milky Dwarf (53.08), Green Import Oriental (53.23) followed by Baby Pak Choi (55.8g),respectively.

The maximum gross weight of each plant was recorded in Pak Choi White Stem (133.75g) followed by Desi Pak Choi (125.35g) and Green Import Oriental (108.76g) which were found to be at par. Whereas the minimum plant gross weight was recorded in Purple Lady Pak Choi (46.70g), Emerald Green (53.17g), Canton Milky Dwarf (55.80g), Baby Pak Choi (77.48g), Pe-Tsai (78.85), All Green (80.46) and Hong-Tae (82.40) [12-15].

The yield of pak choi was recorded minimum in the variety Purple Lady Pak Choi (461.10g), Canton Milky Dwarf (615.15g), Green Import Oriental (645.13g), Hong Tae (608.35g), Baby Pak Choi (620.10g), Pak Choi All Green (668.5g), Emerald Green(743.21g), Pe-Tsai (608.35g) which was found to be at par, and the maximum yield was recorded in Pak Choi White Stem (1225.30g), .Desi Pak Choi (790.10g) and Emerald Green (743.21).

Table 1. Growth parameters of different pak choi cultivars

Varieties	Days taken to germination	No. of leaves	Plant height (cm)	Diameter of loose head (cm)	Chlorophyll content	Days to harvest
Baby Pak Choi	3.73	7.47	8.80	41.07	38.33	45
Desi Pak Choi	3.67	8.67	19.80	54.60	36.55	42
Pak Choi White Stem	3.73	8.93	22.57	58.27	43.31	43
Pak Choi All Green	4.27	7.07	18.16	42.07	54.83	46
Green Import Oriental	4.33	8.73	18.67	43.47	45.0	45
Emerald Green	3.27	8.67	17.47	32.27	44.81	45.67
Canton Milky Dwarf	4.40	4.80	17.63	16.07	44.15	48
Hong Tae	3.87	8.67	14.07	32.95	44.8	46.8
Pe-tsai	3.60	11.20	17.47	46.0	44.30	45.73
Purple Lady Pak Choi	4.45	4.73	16.87	34.07	34.91	65.67

Table 2. Yield parameters of different Pak choi varieties

Varieties	Net weight (g)	Gross weight (g)	Yield per plot (g)	Yield per hectare (q/h)
Baby Pak Choi	55.8	774.8	620.10	50.15
Desi Pak Choi	89.57	125.35	790.10	69.25
Pak Choi White Stem	90.07	133.75	1225.30	70.67
Pak Choi All Green	76.60	80.46	668.55	68.23
Green Import Oriental	53.23	108.76	645.13	63.92
Emerald Green	89.0	53.17	743.21	58.76
Canton Milky Dwarf	53.08	55.80	615.15	63.16
Hong Tae	65.27	82.40	681.25	67.17
Pe-tsai	72.30	78.85	608.35	68.17
Purple Lady Pak Choi	50.77	46.70	461.10	45.80

Table 3. Economics of different cultivars of Pak Choi

Variety	Total cost of cultivation/ha.	Selling Rate (Rs/q)	Yieldq/ha.	Gross return @Rs. 3000/q) (Rs./ha.)	Net return (Rs/ha)	Cost Benefitratio
Baby Pak Choi	81,800	3000	50.15	150,450	68,650	1.83
Desi Pak Choi	81,800	3000	69.22	207,660	125,860	2.5
Pak Choi White Stem	81,800	3000	70.67	212,010	130,210	2.6
Pak Choi All Green	81,800	3000	68.23	204,690	122,890	2.5
Green Imported Oriental	81,800	3000	63.92	191,760	109,960	2.3
Emerald Green	81,800	3000	58.76	176,280	94,480	2.1
Canton MilkyDwarf	81,800	3000	63.16	189,480	107,680	2.3
Hong Tae	81,800	3000	67.17	201,510	119,710	2.4
Pe-Tsai	81,800	3000	68.24	204,720	122,920	2.5
Purple Lady Pak Choi	81,800	3000	45.80	137,400	55,600	1.6

The yield per hectare was recorded and observed to be the minimum in the variety Purple Lady Pak Choi (45.80), Baby Pak Choi (50.15), Emerald Green (58.76), Canton Milky Dwarf (63.16), Green Imported Oriental (63.92), Hong Tae (67.17) and Pak Choi All Green (68.23) which was found to be at par, and the maximum yield per hectare was recorded in Pak Choi White Stem (70.67), Desi Pak Choi (69.22) and Pe-Tsai (68.25).

Economics of different pak choi cultivars:

The economics of the pak choi genotypes was calculated by summed cost of all agronomic practices, protection measures, land etc including labour and farm machinery. The total cost of cultivation is (INR 81,800). The total yield of a particular variety is multiplied by marked price of pak choi at a time. The total cost of cultivation is subtracted from total income, all the middleman margins and market charges were subtracted from total income to determine the net return.

Table 3 shows the economics of different cultivars of Pak Choi used for this study.

The maximum gross return per hectare was obtained by Pak Choi White Stem i.e. 212010 INR followed by Desi Pak Choi i.e., 207660 INR and the minimum gross return hectare by Purple Lady Pak Choi i.e. 137400 INR. The maximum net income per hectare was obtained by Pak Choi White Stem i.e. 130210 INR followed by Desi Pak Choi i.e., 125860 INR and the minimum net return per hectare was obtained by Purple Lady Pak Choi i.e., 55600 INR. Among the different pak choi genotypes Pak Choi White Stem has the highest cost benefit ratio i.e. 2.6, followed by Desi Pak Choi i.e., 2.5 and the minimum cost benefit ratio was obtained in Purple Lady Pak Choi i.e. 1.6.

4. CONCLUSION

From the above experiment, the results showed that Pak Choi White Stem displayed the highest performance in terms of growth and yield parameters. The highest gross return was also found in the cultivar Pak Choi White Stem with a B:C ratio of 2.6. Therefore, it can be concluded that Pak Choi White Stem was found to be the most suitable cultivar over the other cultivars for the agro-climatic conditions of Prayagraj.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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