

Research Article

Rain shelter and open field cultivation of tropical cabbage (*Brassica oleracea* L. var. capitata): A comparison between F1 hybrids based on vegetative characteristics

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ARTICLE INFO

Received: March 19, 2022
Revised: July 23, 2022
Accepted: July 28, 2022
Published: August 21, 2022

Keywords:

Cabbage; field cultivation;
cool season vegetables;
vegetative characteristics

ABSTRACT

The study's goals were to find the perfect tropical cabbage hybrid for the plains and to examine whether it was feasible to grow cabbage both during the growing season and outside of it. The experiment was laid out in a Randomized Block Design with four replications. Four F1 hybrids namely NS183, NS43, NS35 and Disha were used for the study during off season (July-Oct) and on season (Oct-Jan). Protected conditions were provided using a rainshelter of 100m² floor area. The results revealed that non-wrapping leaves which is a non-desirable trait in cabbage was less inside polyhouse during both seasons. Plant spread was more in rain shelter crop during off season and was maximum for NS43 which was on par with other varieties tested. During on-season NS35 recorded maximum plant spread under both growing conditions. NS43 and NS35 can be recommended for offseason and on season cultivation respectively. Rain shelter cultivation provides a conducive condition for the cultivation of an additional crop thereby providing extra income for the farmers.

INTRODUCTION

Cabbage (*Brassica oleraceae* var capitata L.) is an important cole crop grown under temperate to tropical conditions. It is cultivated in more than ninety countries throughout the world [1]. In India it ranks second next to cauliflower in area and production [2]. The potential yield of cabbage is determined by appropriate husbandry practices and the surrounding environment provided to crop.

Earlier, the cultivation of cool season vegetables like cabbage was not possible in Kerala plains. Recently due to the availability of tropical varieties, it has become a profitable venture in Kerala plains also. With the help of protected cultivation technologies like naturally ventilated poly tunnels and rainshelters, they can be cultivated even during off-season when prices are high [1].

Kerala being a high rainfall state with high humidity, water logging and biotic stresses are the major problems for outdoor production of vegetables during rainy season. Among the different protected structures, it was found that naturally ventilated polyhouse named as "rain shelter" is ideal for the humid conditions of Kerala. There is much scope for the cultivation of cool season vegetables inside these rain shelters during off-seasons.

Hence, this study was attempted to compare the vegetative growth of the F1 hybrids under open and protected conditions during off-season and main season and to study the feasibility of rain shelter as a protected structure for cultivation of cool season vegetables during the rainy season.

Materials and Methods

The present investigation was conducted in the Department of Olericulture, College of Horticulture, Vellanikkara during 2010-2011 with the objective to study the performance of F1 hybrids of cabbage (*Brassica oleracea* var capitata L.) under protected and open conditions.

The site is located 10031' N latitude and 76013'E longitude and at an altitude of 22.25m above sea level. The area enjoys a typical warm humid tropical climate and receives an average rainfall of 3400mm per year. The soil of the experimental site comes under the textural class of sandy clay loam and is acidic in reaction. The materials used and methods followed are presented below.

Protected structure

A low-cost rain shelter constructed in the Department of Olericulture was used for study and the design used was Randomized block design (RBD). The frame of the rain shelter is made up of G.I. pipes. Cladding is provided with UV stabilized low density polyethylene film (UVLDPE) having a thickness of 200micron. The floor area was 100m² (20m X 5m) with a side height of 2m and central height of 3.5m (Plate 1).



Plate 1. Rainshelter.



Open field

Plain land adjacent to rain shelter was utilized for evaluation of open field crop.

Varieties

Four F1 hybrids of cabbage were used for the study. They were evaluated during both the seasons in rain shelter and open field simultaneously in a randomized block design with four replications. Details of F1 hybrids used are given in Table 1.

Seasons

The research was carried out in two seasons viz. July – Oct 2010 (off-season) and Oct 2010- Jan 2011 (on-season) under two conditions (rain shelter and open field) (Plate 2).

Table 1. Name and source of hybrids used for the study.

Sl no.	Name of hybrids	Source
1	NS 183	Namdhari seeds Pvt Ltd
2	NS 43	Namdhari seeds Pvt Ltd
3	NS 35	Namdhari seeds Pvt Ltd
4	Disha	Seminis India Ltd



(a)

Open field crop



Rain shelter crop



(b)

Open field crop



Rain shelter crop

Plate 2. General view of open field crop and protected crop during (a) off-season and (b) main season.

Cultural operations

Nursery practices

Seeds were sown in plug trays filled with rooting medium of vermicompost and sand in the ratio 1:1 and one-month old seedlings were transplanted to the prepared main field.

Preparation of main field

The experimental field was (open field and rain shelter) cleared and ridges were taken in each plot (3 m²) and a basal dose of farmyard manure at the rate of 25t/ha was applied before transplanting. Seedlings were transplanted at a spacing of 45 X 45 cm [4]. The field was laid out in RBD with four replications. There were ten plants per replication. Gap filling was done ten days after transplanting.

Fertilizer application

Urea, superphosphate and potash were the source materials for supplying nutrients N, P₂O₅ and K₂O respectively. These nutrients were mixed based on the package of practices recommendation 150:100:125 kg/ha. Full dose P₂O₅ and half dose of N and K₂O were applied before transplanting and the remaining half dose was applied one-month transplanting [4].

After cultivation

Regular weeding and earthing up were done inside the rain shelter and in open field. Diseased and damaged plants were removed regularly.

Plant protection

Seedlings were drenched with *Pseudomonas fluorescence* (20g/L) to prevent nursery diseases. *Alternaria* leaf spot was controlled by spraying Mancozeb 2g/ L in the main field. Ekalux 2ml/L was sprayed in nursery to prevent caterpillar attack. Fipronil 2g/l was sprayed in the main field to control *Spodoptera litura*.

Harvesting

Heads were harvested at marketable stage for observations.

Observations

Five plants per replication of each treatment were selected for recording observations. Qualitative and quantitative observations were recorded as per description of NBPGR [5] like early plant vigor, leaf color, number of wrapping and non-wrapping leaves, plant spread and stalk length. Characteristics of the head like compactness, shape, length, breadth, core length and head index were also recorded. Pest and disease incidences and meteorological data were recorded daily during cropping period.

Statistical analysis

The data recorded on vegetative and yield characters were statistically analyzed by using statistical package [6]. Simple correlation between plant characters like days to 50% head formation, 50% head maturity and yield per harvest with weather parameters like maximum and minimum temperature, relative humidity and rainfall were computed.

RESULTS

The observations recorded on various growth and yield characters and weather parameters during the experimental period were analyzed statistically and the results are discussed below.

Early plant vigor

All the hybrids namely NS183, NS43, NS35 and Disha exhibited good early plant vigor during both seasons.

Leaf colour

The off-season crop showed colour variation in leaves both under protected and in open conditions. Under protected condition all the plants showed blue green colour for leaves irrespective of the hybrids while in open field the leaf colour was green (Plate 3). During main season, all the hybrids showed blue green leaf colour irrespective of growing conditions.

Number of non-wrapping leaves

During the off season, the lowest number of non-wrapping leaves was observed inside the rain shelter. Hybrid NS43 had the minimum number of leaves with a mean value of 7.40 which was on par with NS35 (7.50) followed by the variety Disha (10.60) and NS183 (11.70). The mean number of non-wrapping leaves inside the rain shelter during off season was 9.30. In the open field, the lowest number of non-wrapping leaves

was observed in the hybrid NS43 (9.42). NS 35 was (10.25) followed by NS 183 (13.00) and Disha (14.95). Mean value in the open field was found to be 11.85 (Table 2).



Green coloured leaves (open field)



Blue green coloured leaves (rain shelter)

Plate 3. Leaf colour difference between open & protected crop during rainy season.

Table 2. Number of wrapping and non-wrapping leaves as influenced by growing condition during off season.

Treatment	Non-Wrapping leaves		Wrapping leaves	
	Polyhouse	Open field	Polyhouse	Openfield
T1(NS183)	11.70	13.00	4.75	6.16
T2(NS43)	7.40	9.42	4.00	3.91
T3(NS35)	7.50	10.25	4.30	6.08
T4(Disha)	10.60	14.73	4.75	4.99
Mean	9.30	11.85	4.45	5.29
CD	1.825		0.968	

During the main season also, the number of non-wrapping leaves was found to be minimum in the hybrid NS43 both inside the rain shelter and in open field. Inside the rain shelter the hybrid had a mean value of 9.0 which was on par with NS183 (9.08) and NS35 (10.08). In open field, NS43 was on par with NS35 (9.50) followed by Disha (14.66) and NS183 (16.08). Mean number of leaves inside the rain shelter during on season was 10.16 and in open field it was 12.39 (Table 3).

Number of wrapping leaves

Number of wrapping leaves formed during off season were more in open field when compared to the rain shelter and maximum number of wrapping leaves was found in NS183 (6.16) followed by NS35 (6.08)

which were on par and inside the rain shelter the hybrids NS183 and NS35 had maximum number of wrapping leaves (4.75) and they were on par with other treatments. The mean number of wrapping leaves inside the rain shelter was 4.45 and in open field it was 5.28 (Table 2).

In the main season crop, there was no significant difference between the number of wrapping leaves with respect to treatments and growing conditions. Inside the rain shelter maximum number of leaves was observed in the hybrid Disha (5.00) followed by NS35 (4.66). NS183 had 4.33 leaves and NS43 (4.25). Under open field conditions, maximum number of wrapping leaves was observed in the hybrid NS35 (5.25) followed by NS183 (4.91) and Disha (4.50) and NS43 (4.16). The mean number of leaves inside the rain shelter was 4.56 and that in open field were 4.70 (Table 3).

Table 3. Number of non-wrapping and wrapping leaves as influenced by growing condition during main season.

Treatment	Non wrapping leaves		Wrapping leaves	
	Polyhouse	Open field	Polyhouse	Open field
T1(NS183)	9.08	16.08	4.33	4.92
T2(NS43)	9.00	9.33	4.25	4.16
T3(NS35)	10.08	9.50	4.66	5.25
T4(Disha)	12.50	14.66	5.00	4.50
Mean	10.16	12.39	4.56	4.70
CD	3.20		NS	

Plant spread

During off season, plant spread was found to be more inside the rain shelter than in the open field. Maximum plant spread was observed inside the rain shelter for the hybrid NS43 (48.20cm) which was on par with the other varieties. The hybrids NS183 and Disha were having a plant spread of 43.30 cm and 41.15 cm respectively inside the rain shelter and in open field during the same season their plant spread were 22.16cm and 22.17 cm respectively which were the highest. Hybrid NS43 had a plant spread of 21.67cm and NS35 (17.83cm) (Table 4).

Table 4. Plant spread (cm) and stalk length (cm) as influenced by growing condition during off season.

Treatment	Plant spread		Stalk length	
	Polyhouse	Open field	Polyhouse	Open field
T1(NS183)	43.30	22.16	10.00	9.42
T2(NS43)	48.20	21.67	6.99	10.50
T3(NS35)	39.75	17.83	11.99	7.41
T4(Disha)	41.15	22.17	10.45	8.08
Mean	43.10	20.96	9.86	8.85
CD	4.506		3.314	

It was observed that during the main season, inside the rain shelter plant spread was more in NS35 (65.41cm) which was on par with NS43 (61.91cm). The hybrid NS183 had a plant spread of 55.33cm and Disha (57.08cm). NS35 was found to have the maximum plant spread in open field (67.66cm) followed by NS43 (59.25cm). Mean plant spread inside the rain shelter was found to be slightly higher than that in the open field (Table 5).

Table 5. Plants spread and stalk length as influenced by growing condition during main season.

Treatment	Plant spread		Stalk length	
	Poly house	Open field	Poly house	Open field
T1(NS183)	58.16	55.33	8.83	8.40
T2(NS43)	61.91	59.25	5.37	4.20
T3(NS35)	65.41	67.66	7.12	4.97
T4(Disha)	57.08	56.75	9.15	11.17
Mean	60.64	59.75	7.62	7.18
CD	4.180		2.173	

Stalk length

During off season, inside the rain shelter minimum stalk length was observed in the hybrid NS43 (6.99cm) and it was on par with the hybrid NS183 (10.00cm). NS35 recorded a stalk length of 11.99cm and Disha was having a stalk length of 9.15cm. In open field, minimum stalk length was observed in the hybrid NS35 (7.41cm) which was on par with all other hybrids. Disha had a stalk length of 8.08cm followed by Ns183 (9.42) and NS43 (10.5). stalk length within this range was observed by Rana and Singh (2010) in some other cultivar (Table 4).

Mean stalk length during on-season crop in open field conditions was slightly lower than that inside the rain shelter. Inside the rain shelter, minimum stalk length was observed in NS43 (5.37cm) and it was on par with NS35 (7.12cm). NS183 and Disha had a stalk length of 8.83cm and 9.51cm respectively. In open field also, minimum stalk length was found in the hybrid NS43 with 4.20cm and it was on par with NS35 (4.97cm).

NS183 and Disha had a stalk length of 8.4cm and 11.17cm respectively (Table 5).

DISCUSSION

The hybrids are given in Plate 4. Plug tray seedlings of all hybrids exhibited good early plant vigour in both seasons (Plate 5). This may be due to better growing conditions provided to individual seedlings in the plug tray. According to previous study [7] technique of raising seedlings in plug tray is capable of producing vigorous root development. Seedlings of all hybrids had good germination, thick root growth and uniformity in size.

Rainshelter crop and open field crop showed huge difference especially during the off-season. Optimum conditions inside the rainshelter resulted in healthy plants while the open field plants were small and unhealthy and head formation was absent.

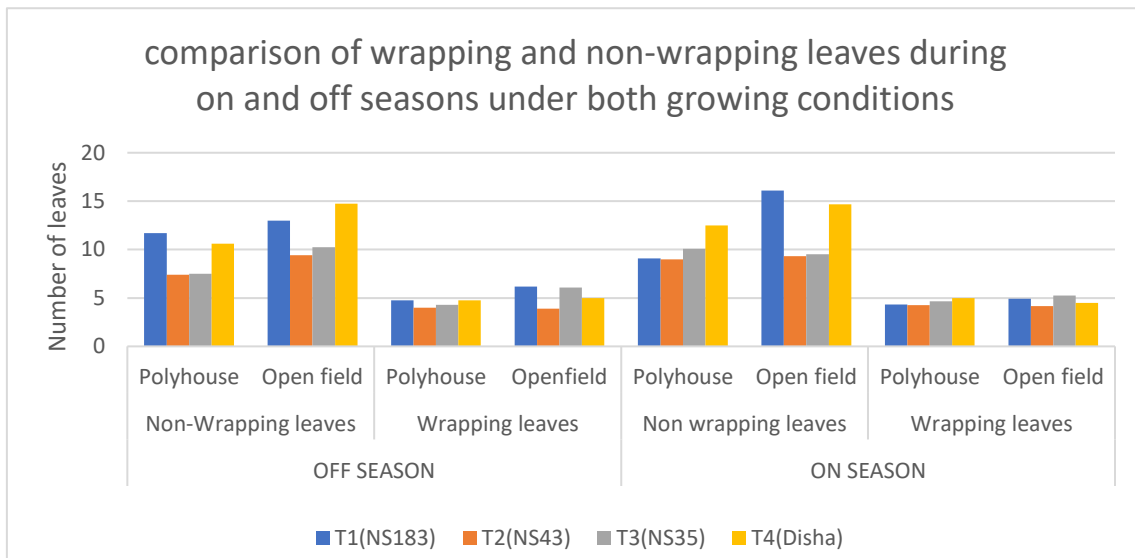


Fig. 1. Comparison of wrapping and non-wrapping leaves during on and off seasons under both growing conditions.

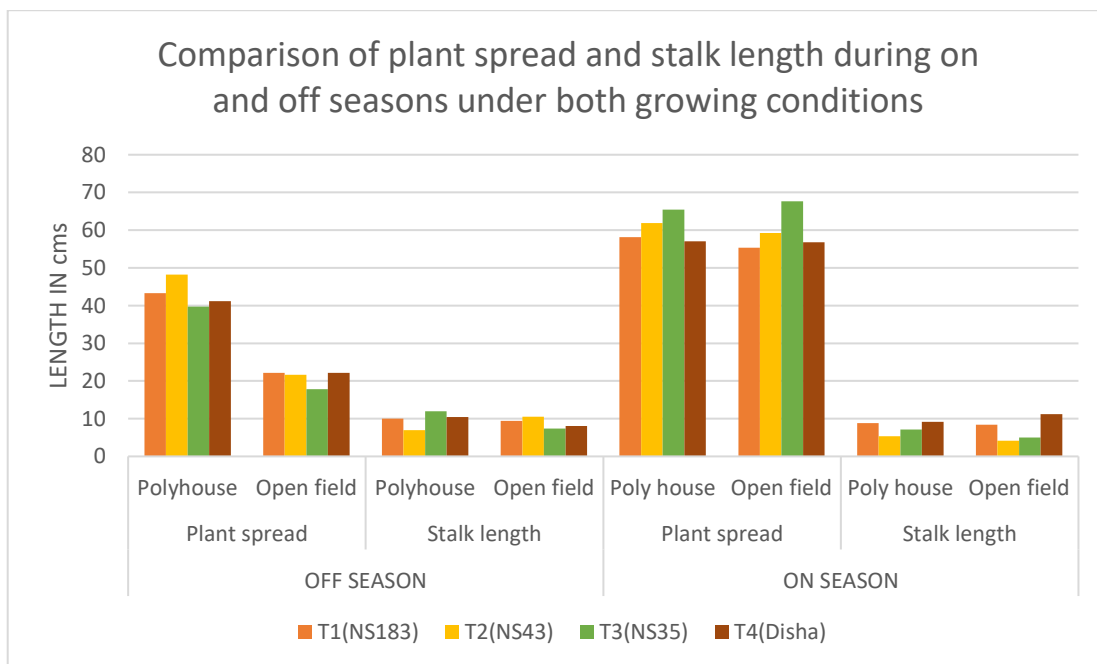


Fig. 2. Comparison of plant spread and stalk length during on and off seasons under both growing conditions.

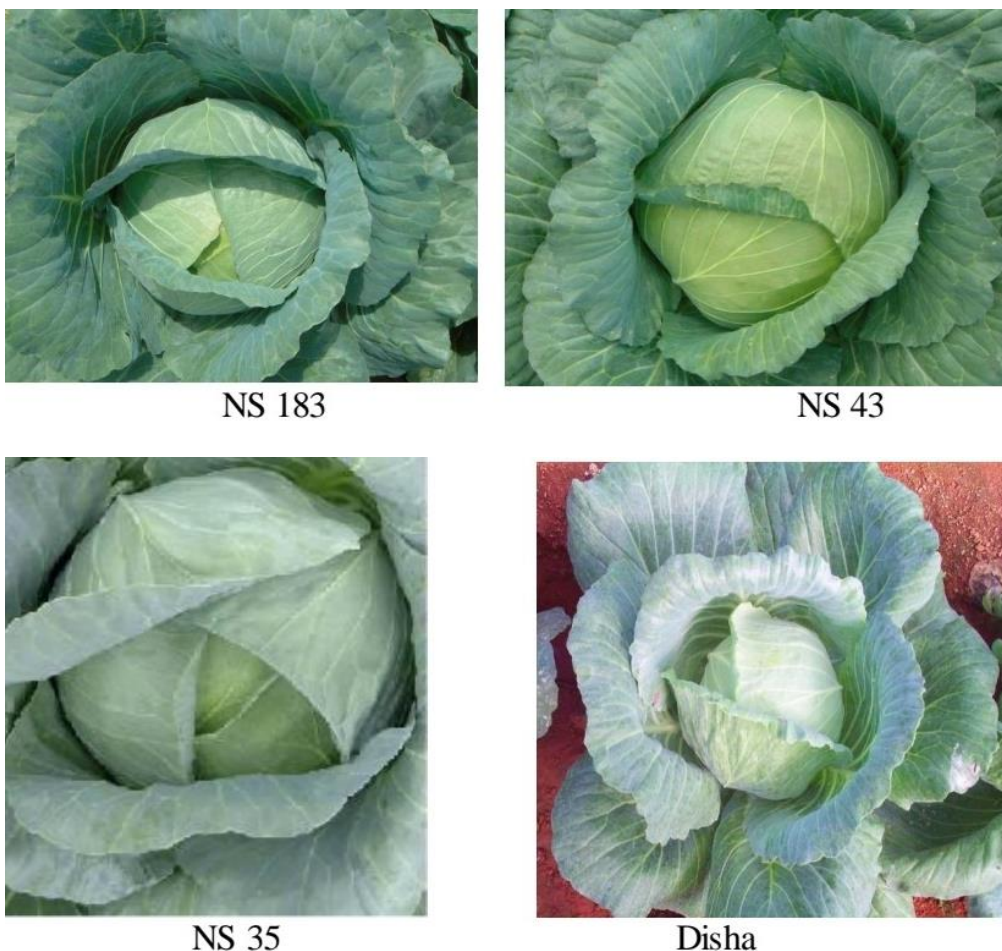


Plate 4. F1 hybrids used for the study.



Plate 5. Plug tray seedlings.

In cabbage, higher number of non-wrapping leaves is considered as an undesirable trait [8]. During both seasons, lowest number of non-wrapping leaves was observed in NS43 while highest was observed in Disha and NS 183 in open field during off- and on-seasons respectively. Chaubey et al. [9] reported that most of the early maturing genotypes showed a lower number of non-wrapping leaves. Similar results were obtained in this study also. He also reported that unfavorable climatic conditions during the growth period results in the formation of a greater

number of non-wrapping leaves and thus more energy is diverted for the production of these leaves. Thus, rainfall received during the off-season can be a factor which led to the production of more non-wrapping leaves under open field conditions (Fig. 1).

In a similar experiment conducted to compare the growth of cabbage inside and outside the polyhouse it was found that the number of leaves were higher inside the protected structure and the length and width of leaves were comparatively greater for crop grown inside the polyhouse [10].

Suseela [11] reported that in cauliflower when grown in two seasons, yield was found to increase with increase in plant spread. In the present study also, it was noticed that maximum yield during on-season was noticed for the hybrid NS35 which is having a plant spread of 65.41 cm inside rain shelter and 67.66 cm in open field.

From Fig. 2, it's clear that plant spread under both growing conditions during on-season crop is higher when compared to the off-season crop. This suggests that during on-season, irrespective of growing condition there was good vegetative growth while during off-season only the rainshelter crop was able to produce a reasonable vegetative growth which resulted in a good yield inside the rainshelter.

CONCLUSION

Rainshelters are low-cost way of cultivating vegetables during the rainy season. From the present study it can be concluded that the cool season vegetables which were not able to be cultivated during the long rainy

seasons in Kerala, can be profitably cultivated using this technology. They are easy to construct with the local materials and local artisanship. It will help the farmers to cultivate an additional crop of cabbage during the off-season while the prices are high. More study should be done to have a better understanding about the effect of microclimate on the physiology of the crop.

ACKNOWLEDGEMENTS

The authors are grateful to Kerala Agriculture University for providing the funding and infrastructure facilities.

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