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Impact of different border crops on growth and yield performance of cauliflower (*Brassica oleracea* var *botrytis* L.) varieties

A.G. Iresha Jayamini, L. Pradheeban and K. Nishanthan*

Department of Agronomy, Faculty of Agriculture, University of Jaffna, Kilinochchi, Sri Lanka

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Abstract

The use of border crops in cauliflower was an eco-friendly method for the management of pests. The present study was conducted at the Faculty of Agriculture, Kilinochchi from December 2018 to April 2019. The experiment was carried out in a split-plot design with three replicates. Four different borders, such as sunflower (T_1), lemongrass (T_2), chrysanthemum (T_3), and no border (T_4) were selected as the main plot treatments, and two different cauliflower varieties such as Mareet (V_1) and White Shot (V_2) were used as subplot treatments. The cauliflower varieties were planted at the spacing of 60 cm × 45 cm. All the agronomic practices were done according to the recommendations of the Department of Agriculture except plant protection methods. The growth, plant protection measures, and yield parameters were recorded. ANOVA and Duncan's Multiple Range Test (DMRT) were used for data analysis. There was no interaction effect between the type

* Corresponding author
Postal address: Department of Agronomy, Faculty of Agriculture, University of Jaffna, Ariviyal Nagar, Kilinochchi, Sri Lanka
Email: knishanthan81@gmail.com
Phone: +94776238093
Fax: +94212060175
ORCID ID: https://orcid.org/0000-0001-8346-6559

of border crops and varieties in all measured parameters. The border and the variety were not significant for plant height and the number of leaves per plant. The curd weight, circumference, diameter, total yield, and marketable yield were significantly different among the border crops, while the greater performances were observed in the lemongrass border (T_2). The varieties of cauliflower showed a non-significant effect on the yield parameters, and the highest was recorded in the white shot variety. Marketable yield and infested yield have significantly (p=0.05) differed among the different border crop treatments and the highest marketable yield was obtained from lemongrass border (T_2) in both varieties. The plant protection parameters such as the number of damaged leaves per plant and damaged curds significantly differed among the border crops. The highest was recorded in the control (T_4) treatment in Mareet variety. It can be concluded that lemongrass border and white shot variety can be recommended as the best treatment combination for cauliflower cultivation in the Kilinochchi district of Sri Lanka during the *Maha* season.

Keywords: border crops, cauliflower, curd, growth and yield, plant protection parameters

INTRODUCTION

In agriculture, the vegetable sector is one of the most important, next to the rice. Most farmers are committed to vegetable cultivation throughout the country in both *Maha* and *Yala* seasons (Rupasena, 1999). The temperate vegetables (exotic) grow well in the hill country, which has cool and healthy climatic, and tropical vegetables that are suitable for the low- and mid-country area.

Cauliflower (*Brassica Oleracea* var. *botrytis* L.) belongs to the Brassicaceae family from Europe and Africa (Ajithkumar *et al*., 2014). It is one of the essential vegetables in the world and is consumed daily. It also has good demand in Sri Lanka. Cauliflower is naturally high in fiber and B-vitamins. It provides antioxidants and phytonutrients that can protect against cancer. It also contains fiber to enhance weight loss and digestion, choline essential for learning and memory, and many other important nutrients. In cauliflower, the curd is made up of abortive flowers (Shanmugavelu, 1989). Under a protective environment, the growers can cultivate this crop all season (Yasoda *et al*., 2018).

In brassica vegetable production, the number of insect species is the major limiting factor. The most common cauliflower pests are aphids, flea beetles, slugs and snails, leafhoppers, and several insect larvae. Commercial vegetable growers regard insecticides as a simple, effective, and reliable means of control despite their cost and the need for frequent applications whether or pests are not present (Alishah, 1987). Therefore, there is an urgent requirement to find out an alternative and non-chemical method for pest control. The vegetables are becoming poisonous, ecologically unsafe, and economically unviable due to the frequent use of systemic insecticides (Mannan *et al*., 2015).

Border crops are utilized as a cultural strategy to avoid the pests attack of economically important crops. The use of border crops to form a screen around the cultivated crop provides protection against several virus diseases. Border cropping can control pest populations and limit the damage caused to the crop via pest diversion process (Saha *et al*., 2016).

There are several limitations found in the cultivation of cauliflower in the Dry zone of Sri Lanka. one of the important limitations is high temperature. Due to high temperature, cauliflower plant remains vegetative and continues to form new foliage (Chatterjee and Kabir, 2002), a temperature higher than the optimum level (15 – 20 °C) affect the curd formation due to that cultivars may show physiological disorder viz. riceyness, leafy curd, and blindness (Wheeler *et al*., 1995). Cauliflower plant and curd are easily affected by severe pest and disease attacks, due to which farmers use more chemicals to control pests in open fields to get the optimum yield.

Even though several studies are available regarding border crops effect on growth and yield performances of vegetable cultivation in the world, the information on research studies conducted in Sri Lanka is limited on the growth and yield performance of cauliflower, especially in the Northern Province. By considering this gap, the research was conducted to evaluate the impact of different border crops on the growth and yield performance of cauliflower varieties in Kilinochchi District with the objectives of finding the suitable border crop for cauliflower cultivation and evaluating the varietal performance of cauliflower under different border crops.

MATERIALS AND METHODS

A field experiment was carried out at the Faculty of Agriculture, Ariviyal Nagar, Kilinochchi which is located in the Northern Province of Sri Lanka belongs to the agro-ecological region of Low Country (DL_3) to evaluate the impact of different border crops on the growth and yield performance of cauliflower (*Brassica oleracea* var *botrytis* L.) varieties during December 2018 to April 2019.

The experiment was conducted in split-plot design, including four main plots and six sub-plots. The main plots contained different types of borders. Each main plot was divided into six sub-plots that include two cauliflower varieties with 3 replicates. The cauliflower varieties Mareet and white-shot were selected due to their excellent performance in warm conditions. The main plot factors were T_1 – Sunflower border, T_2 – Lemongrass border, T_3 – Chrysanthemum border, and T_4 – No border (control) (Figure 1). The treatments and their combinations are given in Table 1.

Table 1: Treatment Combinations of Cauliflower Varieties

Varieties	Sunflower (T_1)	Lemongrass (T_2)	Chrysanthemum (T_3)	Control (T_4)
Mareet (V_1)	T_1V_1	T_2V_1	T_3V_1	T_4V_1
Whiteshot (V_2)	T_1V_2	T_2V_2	T_3V_2	T_4V_2

Seeds were treated with fungicide captan (4 g/kg) for nursery preparation and were sown in a nursery tray. Rooting media was prepared by using 1:1:1 ratio of topsoil, compost, and cattle manure treated with fungicide captan, and media was kept for incubation for seven days. Two seeds were planted in a nursery tray per cell. In the field, four blocks were made parallel to each other with a spacing of 1.2 m. Each block was further divided into six plots. The size of each plot was 1.8 m × 1.8 m with a spacing of 0.5 m. The cow dung was incorporated at the rate of 10 kg/ plot before the preparation of the ridges. Three ridges were prepared in each plot with a spacing of 60 cm for planting. Irrigation channels were prepared around the plots.

Figure 1: Borders for cabbage; (A) Sunflower, (B) Lemongrass, (C) Chrysanthemum, (D) Control

The border crops (treatments) such as sunflower (T_1), lemongrass (T_2), and chrysanthemum (T_3) were grown in bags and planted around the plots in each block two weeks before transplanting cauliflower seedlings. Each border crop was planted as a double row cropping system. As a treatment, all border crop seedlings were transplanted at the spacing of 20 cm within a row. Thirty days old cauliflower seedlings were transplanted with a spacing of 60 cm x 45 cm. After planting, watering was done by a water bucket and the soil was kept in wet condition while avoiding excess watering. All management practices were done as a recommendation made by the Department of Agriculture except for plant protection. Blanching is an important operation for getting quality curd to protect the curds from yellowing due to direct exposure to the sun. Leaves were tied up with twine when curd started to protect the curd from sun burning and browning (Figure 2).

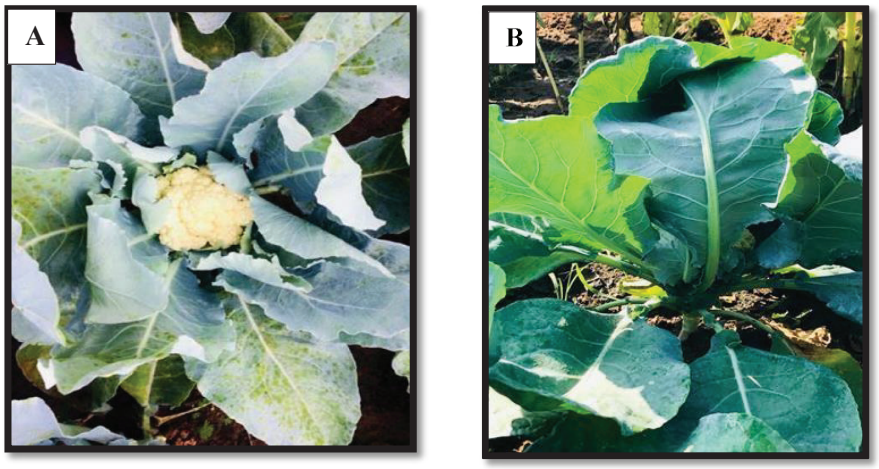

Figure 2: (A) Curd initiation (B) Blanching of cauliflower

Cauliflower was harvested 55 - 65 days after transplanting when the curd reaches proper size, bright white colour, and compactness. The harvesting was done by using a sharp knife in the morning.

Figure 3: Harvested Cauliflower

The growth parameters such as plant height and number of leaves/ plants were recorded at biweekly intervals started from two weeks after transplanting. The yield components of cauliflower such as curd weight, diameter, circumference, and total yield (t/ha) were measured at harvesting. The protection parameters such as the number of damaged leaves and curds were counted every data collection time**.** Data were analyzed by using the SAS 9.1 computer software package and mean separation was done by using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Growth parameters

Plant height

There was no significant difference in plant height among the treatments in both varieties and there is no interaction effect between border crops and varieties at 6th week after planting. At 6th weeks after planting, the maximum plant height (31 cm) was recorded from sunflower border crop treatment (T_1) in Mareet variety and the minimum plant height (27.6 cm) was observed in the no border crop treatment that is control (T_4) in White Shot variety. The shade level in the sunflower treatment was higher than other border crop treatments. Due to the shade effect cauliflower plants may increase the height (Haque *et al.,* 2009 and Rajasekar *et al.*, 2013) in that treatment. The height was non-significant among the varieties within the same border; this may be due to the genetic character of the cauliflower crop.

Number of leaves per plant

There was no significant difference among the treatments in both varieties at all weeks after planting. The number of leaves per plant was not significantly influenced by the interaction between border crops and varieties at 6th week after planting. The maximum number of leaves was obtained in no border treatment (T_4) in both cauliflower varieties. In Mareet, the maximum number of leaves (22) was recorded at the 6th week after planting. In the White shot variety, the maximum number of leaves (20) was recorded at the 6th week after planting. It may be due to more exposure to sunlight in the control treatment. The number of leaves per plant was non-significant among the varieties within the same border.

Plant protection measures

Number of damaged leaves

The number of damaged leaves is influenced by different border treatments. The number of damaged leaves was significantly differed in control compared to other border crop treatments in both varieties. There is no interaction effect between border crops and varieties. The minimum and the maximum number of damaged leaves were recorded from lemongrass border treatment (T_2) and the control (T_4) in both varieties. Damaged leaves were minimum under lemon grass border (T_2) due to the repellent effect of the border. The damaged leaves were maximum under control treatment due to the absence of any border facilitating the laying of eggs by caterpillars on cauliflower leaves. The number of damaged leaves per plant was non-significant among the varieties within the same border. Hasheela *et al*. (2010) reported that the damaged percentage of diamondback moth on cabbage had significantly reduced by border cropping compared to control without border cropping. Fouche and Mitchell (2000) had reported that field borders or stripes within border crops act as a habitat and slow down the spread of insect pests to the field.

Number of damaged curds

The number of damaged curds is influenced by different border treatments. There is no interaction effect between border crops and varieties. The lemongrass border treatment significantly differed for the number of damaged curds from other border crop treatments in both varieties. The sunflower and chrysanthemum borders were non-significant and the control treatment (T_4) had the maximum number of damaged curds in both varieties. The maximum number of damaged curds (14 and 13) were recorded from Mareet and White Shot varieties, respectively. The minimum damaged curds were observed in the lemongrass border crop treatment (T_2) in both varieties. The minimum number of damaged curds (5 and 4) were recorded from Mareet and White Shot varieties, respectively. In the number of damaged curds parameter, there was a non-significant difference among the varieties within the same border (Figure 4).

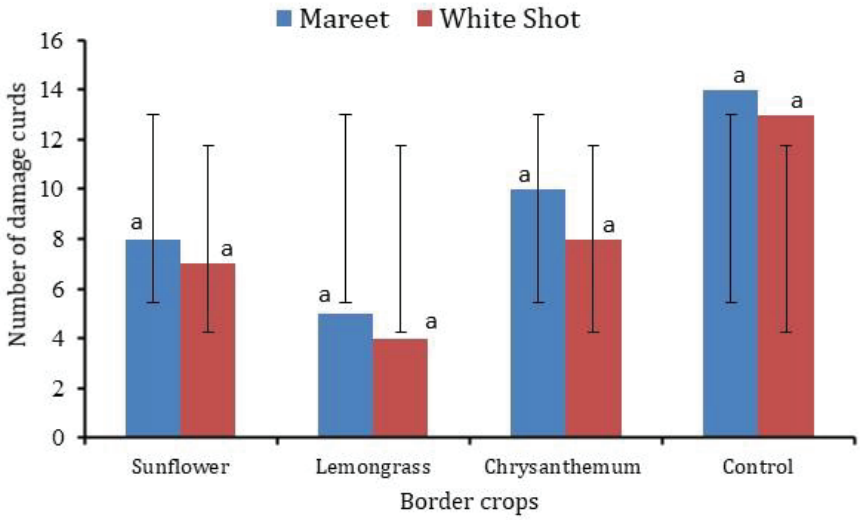

Figure 4: Number of damaged curds of different cauliflower varieties within same border crop treatment. Means with the same letter within a given border crop are not significantly different at p=0.05.

Yield components

Curd weight

There was a significant difference between the border crop treatments (Figure 5). There is no interaction effect between border crops and varieties. In both varieties, the highest average curd weight was recorded in the lemongrass border (T_2). The highest average curd weight (654.5 g and 723.3 g) was recorded from Mareet and White shot varieties, respectively. In Mareet variety there was non-significant difference between sunflower border (T_1) and no border treatment (T_4). In the White shot variety, there was a non-significant difference between sunflower (T_1) and the chrysanthemum border (T_3). The lowest curd weight was recorded in no border treatment (T_4) in both varieties. The lowest average curd weight (458.3 g and 432.2 g) was recorded from Mareet and White shot varieties, respectively. There is a non-significant difference between the varieties of cauliflower within the same border.

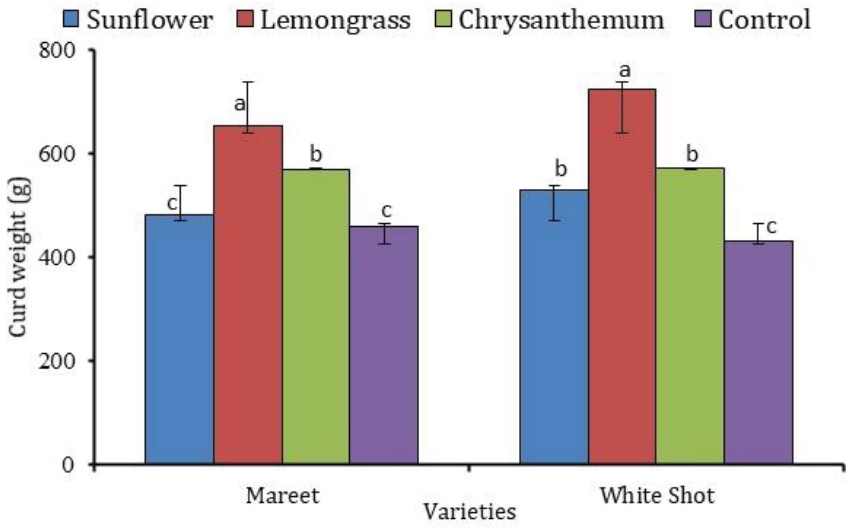

Figure 5: Average curd weight of different varieties of cauliflower under different border crop treatments. Means with the same letter within a given variety are not significantly different at p=0.05.

Curd circumference

There was a significant difference among the border crops but there was a non-significant effect in sunflower (T_1) and chrysanthemum (T_3) border in the White shot variety (Figure 6). There is no interaction effect between border crops and varieties. In both varieties, the highest average curd circumference was recorded in the lemongrass border (T_2), because of favorable micro-climate around the cauliflower plants. The highest curd circumference (47.94 cm and 51.03 cm) was recorded from Mareet and White shot varieties, respectively. The lowest average curd circumference was recorded in the control treatment (T_4) in both varieties. The lowest curd circumference (44.19 cm and 41.83 cm) was recorded from Mareet and White shot varieties, respectively. The average curd circumference was not significantly differed among the varieties within the same border.

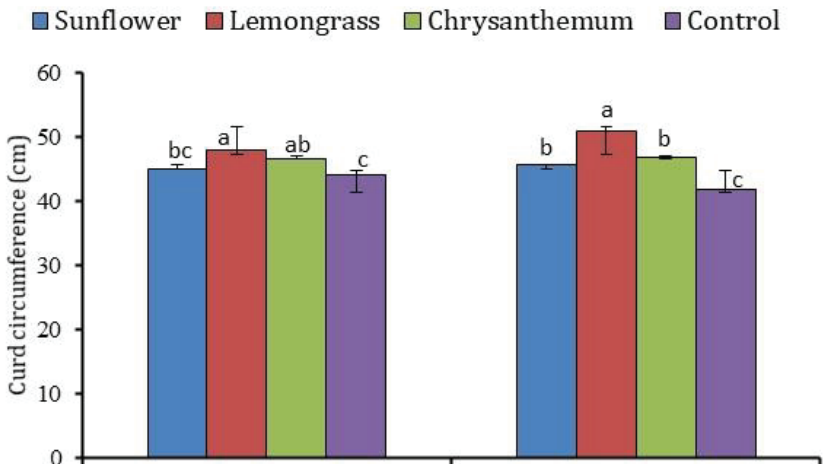

Figure 6: Average curd circumference of different cauliflower varieties under different border crop treatments. Means with the same letter within a given variety are not significantly different at p=0.05.

Curd diameter

The curd diameter was significantly different among the border crops. But no significant difference in sunflower and chrysanthemum border in the White shot variety (Figure 7). There is no interaction effect between border crops and varieties. The highest curd diameter was recorded in the lemongrass border (T_2) in both varieties. The highest curd diameter of 30.54 cm and 32.5 cm was recorded from Mareet and White shot varieties, respectively. The lowest average curd diameter was recorded in the control treatment (T_4) in both varieties. The lowest curd diameter of 28.15 cm and 26.65 cm was recorded from Mareet and White shot varieties, respectively. There was a non-significant difference among the varieties within the same border treatment.

Total yield

The total yield significantly differed among the border crop treatments (Figure 8). There is no interaction effect between border crops and varieties. In Mareet variety, the highest total yield (32.7 t/ha) was obtained

in the lemongrass border (T_2) and the lowest (21.6 t/ha) was obtained from the control (T_4). The yield obtained in the chrysanthemum border and sunflower border was 28.5 t/ha and 24.1 t/ha, respectively. Similarly, in the White shot variety, the highest total yield (36.2 t/ha) was obtained

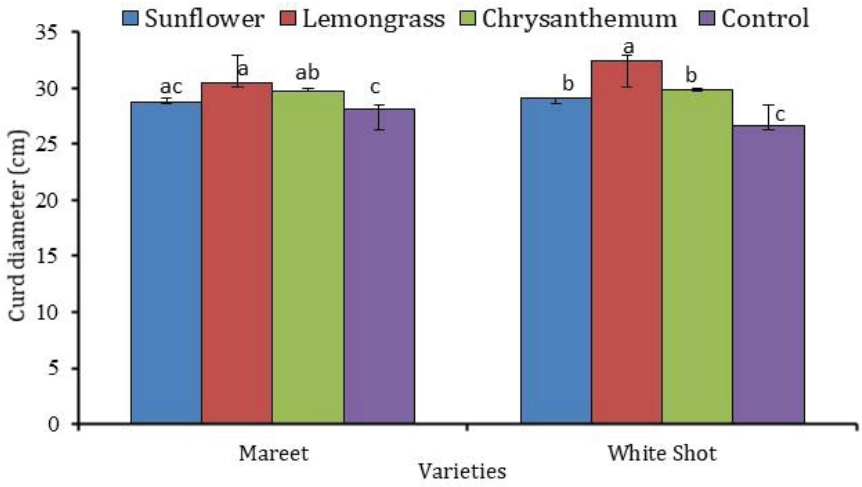

Figure 7: Average curd diameter of different varieties of cauliflower under different border crop treatments. Means with the same letter within a given variety are not significantly different at p=0.05.

in the lemongrass border (T_2) and the lowest (22.9 t/ha) was obtained from the control (T_4). The yield obtained in the chrysanthemum border and sunflower border was 28.6 t/ha and 26.5 t/ha, respectively. Total yield was not significantly differed among the cauliflower varieties within the same border (Figure 9). Tatgar *et al*. (2011) reported that border cropping significantly increased the yield on different crops such as chilli and onion by reducing the impact of leaf curl complex damage and thrips attack.

Marketable and infested yield

Marketable yield and infested yield significantly differed among the different border crop treatments (Figure 10). The highest number of quality curds without holes was obtained from the lemongrass border (T_2) in both varieties. In Mareet variety, the highest marketable yield (29.1 t/ha) and the lowest infested yield (3.6 t/ha) were recorded in lemongrass border crop treatment. Similarly, in the White shot variety, the highest

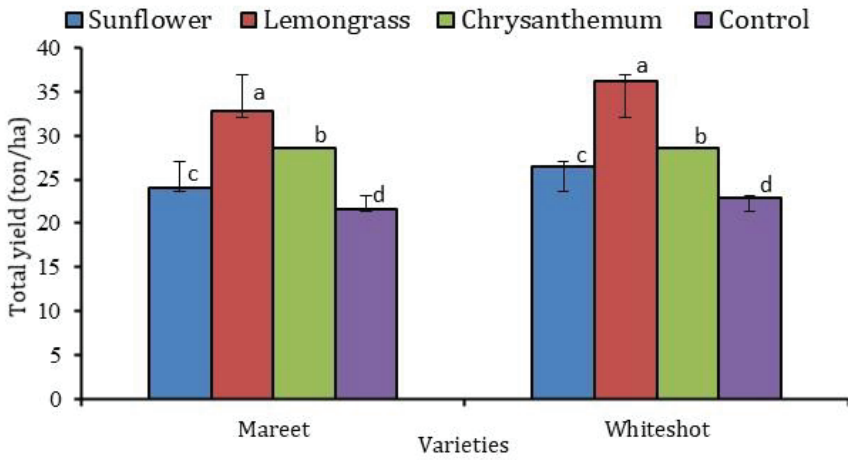

Figure 8: Total yield of different varieties of cauliflower under different border crop treatments. Means with the same letter within a given variety are not significantly different at p=0.05.

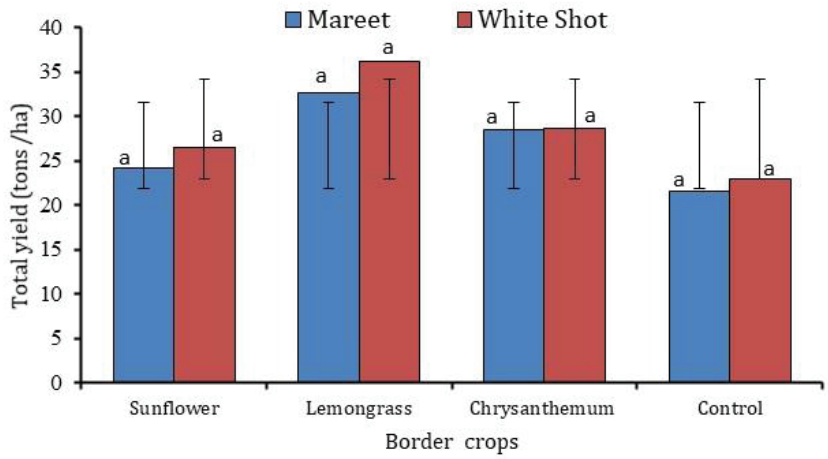

Figure 9: Total yield of different cauliflower varieties within the same border treatment. Means with the same letter within a given variety are not significantly different at p=0.05.

marketable yield (32.5 t/ha) and the lowest infested yield (3.7 t/ha) were recorded in lemongrass border. In Mareet variety, the maximum infested yield (8.4 t/ha) and the minimum marketable yield (14.6 t/ha) were recorded in the control treatment. Similarly, in the White shot variety, the

maximum infested yield (7.9 t/ha) and the minimum marketable yield (13.7 t/ha) were recorded in the control treatment. Cauliflower crop can be easily attacked by pests in control treatment because of the absence of physical barriers in the control treatment.

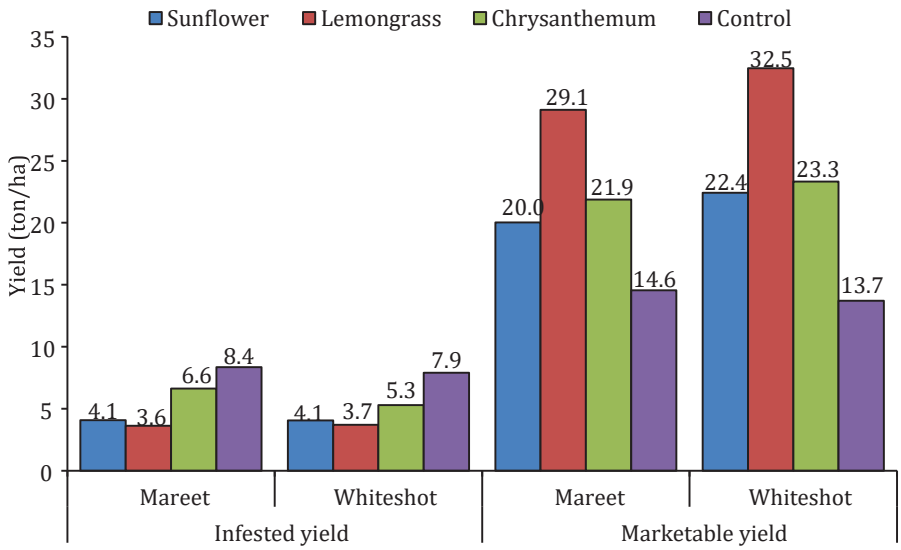

Figure 10: Effect of different treatments on the marketable and infested yield of different cauliflower varieties.

CONCLUSIONS

The experiment confirmed that different border crop treatments have influenced on growth and yield performance of cauliflower varieties. The highest mean curd weight, curd circumference, curd diameter, total yield, and marketable yield were obtained in lemongrass border treatment in both cauliflower varieties. White shot variety showed the highest curd diameter, curd circumference, curd weight, total yield, and marketable yield than Mareet cauliflower variety. It can be concluded that White shot cauliflower variety can be cultivated under lemon grass border to obtain the highest yield in the Kilinochchi district.

LIMITATIONS AND SUGGESTIONS

The high temperature in the dry zone is the limitation for the quality curd formation and causes severe pest and disease attacks. To bring down the temperature effect in the field, cauliflower can be cultivated under alley cropping.

This experiment should be carried out during the *Yala* season for evaluating the performance under different weather conditions. This experiment should be repeated with the same season to confirm results. This experiment also can be repeated with different border crops to evaluate the growth and yield performance of cauliflower varieties and with different varieties of cauliflower.

DECLARATION OF CONFLICT OF INTEREST

Authors have no conflict of interest to declare.

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