American-Eurasian Journal of Agronomy 13 (2): 39-45, 2020
ISSN 1995-896X

DOI: 10.5829/idosi.aeja.2020.39.45

Varietal Performances of Spinach (*Spinacia oleracea* L.) at Coastal Region in Bangladesh

[1]Chumki Rani Nath, [1]Nusrat Jahan Methela, [2]Roksana Aftab Ruhi and [3]Mohammad Shafiqul Islam

[1]Department of Agriculture, Noakhali Science and Technology University, Noakhali-3814, Bangladesh
[2]Department of Plant Pathology, Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[3]Department of Agriculture, Noakhali Science and Technology University, Noakhali-3814, Bangladesh

Abstract: Spinach is a common vegetable crop which are grown widely in everywhere at Bangladesh. A field study was conducted during Rabi season, 2019-2020 at Agricultural Research Fields in Noakhali Science and Technology University, Noakhali which is situated at coastal part of Bangladesh. Mainly 4 varieties of spinach (*Spinacia oleracea* L.) were used to evaluate the varietal performances in the coastal region of Bangladesh. The treatments used in the experiment were T^1 (Punjab all green), T^2 (Kopi Palong), T^3 (Sathi) and T^4 (Evan) which was laid out in Randomized Complete BlockDesign (RCBD) method with three replications. The T^3 variety reported the maximum germination percentage (85%), highest moisture content (92.37%), tallest plant height (25.52 cm), maximum number of leaves (9.6) and highest leaf length (15.52 cm).The minimum germination percentage (68.33%) was recorded in T^2 variety whereas the lowest moisture content (90.60%), shortest plant height (20.24 cm), minimum number of leaves (8.2) and minimal leaf length (12.2 cm) were observed in T^1 variety. Among all the treatments, T^3 variety produced the highesttotal yield (18.08 t/ha) followed by T^4 variety (16.72 t/ha). On the contrary, T^1 variety was recordedthe lowesttotal yield (10.44 t/ha) than other varieties. The findings of the experiment suggested that the overall best performance was obtained by the T^3 variety compared to theotherthree varietal treatments for spinach cultivationin the coastal area of Bangladesh.

Key words: Spinach (*Spinacia oleracea* L.) Variety · Germination Percentage · Moisture Content · Growth · Yield

INTRODUCTION

Spinach (*Spinacia oleracea* L.), an important vegetable crop in the world which is known as 'Palong Shak' or Bengal Spinach in Bangladesh. It is an annual plant with a short growth cycle which belongs to the family Chenopodiaceae with chromosome number 2n=12. Spinach is a valuable crop for food and medicinal purposes with production of over 26 million tons on about 921000 ha in the world [1] whereas in Bangladesh, the area of spinach cultivation is about 23000 acres with the production of about 55000 metric tons having an average yield of 2431 kg per acre [2]. Although there are different types of spinach varieties viz. smooth leaved, crinkle leaved, round leaved, semi round leaved, pointed leaved, 'Savoy' type etc., in Bangladesh semi round and round smooth leaf type are generally cultivated [3]. Two types of spinach, green and red, are in cultivation former being heavier in growth and bears thicker. Spinach can be grown all the year round, in fact the major portion of spinach is harvested during October and November when most other winter vegetables are still at their early stage of growth. During this period, there is a general shortage of vegetable in the market and spinach contributes substantially towards meeting this shortage [4]. Spinach is a highly desirable leafy vegetable with a good cooking adoptability, a high nutritive value and many important vitamins and minerals [5]. It is also called as "Life Protective Food" with its therapeutic action on each and every system. Spinach protects our life from cradle to grave as development of fetus in womb to degeneration in old age [6]. Spinach-derived phytochemicals and bioactive are able to scavenge reactive oxygen species and prevent macromolecular oxidative damage, modulate expression and activity of genes involved in metabolism, proliferation, inflammation and antioxidant defense and also curb food intake by inducing secretion of satiety hormones [7]. In our country, most of the people,

Corresponding Author: Roksana Aftab Ruhi, Department of Plant Pathology, Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

especially the children suffer from malnutrition tremendously, which affect their national life. According to WHO (World Health Organization) and FAO (Food and Agriculture Organization), an adult person should take 250 g vegetable daily. Nevertheless, we, the Bangladeshi take only 28 g (bating potato and sweet potato) on an average [8]. Moreover, in Bangladesh the productivity of spinach per unit area is quite low as compared to developed countries of the world. This low yield may be attributed to the method of production practices followed by farmer specially use of low quality of seeds, maintenance of lower soil fertility, inadequate irrigation and time of sowing is an important inputs for realizing higher spinach yield and its nutrient content [9]. Exotic varieties did not performed well as they do not produce higher yield at Bangladesh climatic condition and flower very quickly and ultimately seed yield as well as leaf production adversely affected [10]. The increasing land use intensity without adequate and balanced use of chemical fertilizers and with little or no use of organic manures have caused severe fertility deterioration of soils resulting in stagnating or even declining of crop productivity. The above discussion will suffice to understand the importance of giving adequate attention in the production of spinach using organic fertilizers in association with limited chemical fertilizers for maintaining soil fertility, sound environment as well as human health. The present study was therefore was conducted to evaluate the overall performance of spinach varieties which is suitable for coastal region spinach cultivation.

MATERIALS AND METHODS

Location of the Experiment: The present investigation was carried out at Agricultural Research Field at Noakhali Science and Technology University, Noakhali, Bangladesh during Rabi season 2019-2020. Before laid out the experiment, initial soil samples were drawn at five randomly selected spots at depth of 0-30 cm from field having sandy loam soil, moderately alkaline, with pH value 7.5.

Treatments:

Table 1: Treatments Used in the Experiment

Treatments	Name of the Variety
T^1	Punjab all green
T^2	Kopi palong
T^3	Sathi
T^4	Evan

Seed Sowing: The plots were prepared by spade and the soil was converted into loose friable. All weeds and unwanted materials were removed. The experimental area consists of $10m^2$ and each plot is $2.5m^2$. On 2nd December 2019 seeds were sown to the plots.

Fertilizer Application: Cowdung was applied before the land preparation. Then, Urea and half of Murate of Potash were applied at three installments (15 days interval) after seed germination. The amount of fertilizer which was applied to the plots listed below:

Table 2: Application of Fertilizer (dose /plot)

Name of the Fertilizer	Amount (Quantity/plot)
Cowdung	16 kg
Urea	109 g
TSP	54 g
MOP	54 g

Intercultural Operations: Recommended cultural operations were carried out uniformly for all the treatments throughout the experimental period like irrigation, weeding and thinning. First irrigation was given after seed sowing and later irrigation was given at interval of 5-6 days. Regular weeding was carried out on the plot in order to prevent competition, infestation and ensure maximum growth of crops. In addition, thinning out of spinach plants was done in order to allow enough space for the remaining plants to grow uniformly.

Data Collection: The plots were tagged of each variety for recording the observation. Plant height was measured using a meter scale from the ground level to the tip of the plant. The mean height of each plant was measured and expressed in centimeter. Average number of fully expanded leaves per plant was calculated. In counting the number of leaves, the old and senescing leaves were discarded and only the eatable leaves were taken into consideration. The mean length and width of leaves of each plant was measured and expressed in centimeter. The yield of the crop was calculated as kilogram per plot while total yield was recorded as ton per hectare.

Germination Percentage (GP): Germination percentage was recorded starting from 2 to 7 DAS. In 2nd and 3rd DAS some treatments had zero percent germination. Then data was recorded at 7 days and germination percentage was calculated by the following formula:

$$Germination\ percentage = \frac{Total\ number\ of\ seed\ germinated}{Total\ number\ of\ seed\ taken\ for\ germination} \times 100$$

Moisture Content (%): Immediately after the harvest, the weight of the plants was taken by using electrical balance. Then the samples were placed in an oven at 70°C for 72 hours. The final weights of plants were taken by electrical balance. Percent moisture accumulation was computed using formula on fresh weight basis moisture content:

$$Moisture\ content\ (\%) = \frac{Fresh\ weight - dry\ weight}{Fresh\ weight} \times 100$$

Statistical Analysis: The recorded data on different parameters of the study were analyzed statistically; Analysis of variance of different parameters was performed by "F test"at 5% level of significance which was suggested by Gomez and Gomez [11].

RESULT AND DISCUSSION

Plant Height (cm): Figure 1 showthat there was significant difference among spinach varieties in which maximum plant height was obtained from T^3 variety i.e. 25.52cm followed by the T^4 variety, 24.74 cm. But it also indicated the lowest plant height which was recorded from the T^1 variety i.e. 20.24 cm. Ambia, *et al.* [10] reported that the maximum plant height was produced in local cultivar (Gazipur) and Kopi palong had the lowest plant height but Dabhi, *et al.* [12] observed that maximum plant height found in Pusabharti variety while minimum value of plant height obtained from Delhi green.

Number of Leaves: It is evident from the Figure 2 that there was slight variation among the spinach varieties in case of leave numbers per plant. The highest number of leaf (9.6) was recorded in treatment T^3variety while the lowest number (8.2) was obtained from T^1variety. The variation in number of leaves in this finding may be insignificant due to difference in agro-ecological conditions and soils of the experimental site. However, Biswas [13] was reported that the highest number of leaves was produced by Sufolapalong–1 (14.77) among other varieties such as Sathi, Evan and a local cultivar.

Lengthand Width of Leaves (cm): In case of leaf length and width Figure 3 clearly showed that there were differences recorded among all the treatments used in the experiment. T^3 variety gave maximum length and width i.e 15.52 cm and 7.26 cm individually followed by T^1 variety which was observed the minimal length as well as width was about 12.2cm and 5.02 cm respectively (Figure 3). Similarly, the other two treatments, T^2 and T^4 were also gave approximately nearest results i.e.12.44 cm and 15.06 cm respectively in length with 6.16 cm and 7.12 cm in width individually.The results were reported similarity in Tewani, *et al.* [6] research in which theyreported that the length of spinach leaf was generally 13-18 cm. Moreover, the spinach leaf width of the variety of Karaj 2 was 10.50 cm among fifty-four spinach variety which was observed by Sabaghnia, *et al.* [14].

Yield Per Plot (kg): From the means data which was illustrated in Figure 4 showed that there was nosignificant variation in yield per plot (kg) among studied treatments. From the observation it was found that the T^3 variety produced maximum yield per plot (4.52 kg) while the T^1 variety had minimum yield per plot (2.61 kg). However, among all the treatments there was no wide variation between T^3 and T^4 varieties which were 4.53 kg and 4.18 kg respectively. In the research of Dhaulakhandi, *et al.* [15] were observed that Olympia variety gave the highest yield (1.350 kg/m^2), while Banarasivariety produced the least yield (0.375 kg/m^2) per plot which was confirm the present work that different varieties are given individual yields due to several factors.

Total Yield (t/ha): It was observed that the highest yield per hectare in T^3 variety which was 18.08 t/ha followed by T^4 variety i.e.16.72 t/ha.On the other hand, minimal yield per hectare in T^1 variety that was 10.44t/harecorded. There was a significant difference between the varieties in case of total yield per hectare. Similar results have been reported by some other researchers where they found variation in yield per hectare of spinach varieties. Biswas, [13] was reported that Sufola palong-1 performed better in respect of yield (20-22 Mt/ha) in comparison with other varieties. Another spinach variety, Spiros F_1 yielded better (22.6 t/ha) than Rembrandt F_1 (20.2 t/ha)variety which was recorded by Kunicki, *et al.* [16].

Percentage of Germination (%): The result indicated that significant variation in germination percentage was observed among all the treatments. The maximum germination percentage was recorded in the T^3variety which was 85% while the minimum percentage was found in the T^2 variety i.e. Kopi Palong about 68.33% (Figure 7). Similar results have been reported by some other researchers. Ambia, *et al.* [10] reported that Kopi Palong variety showed germination percentage is about 75.05% which is much relevant to our result.

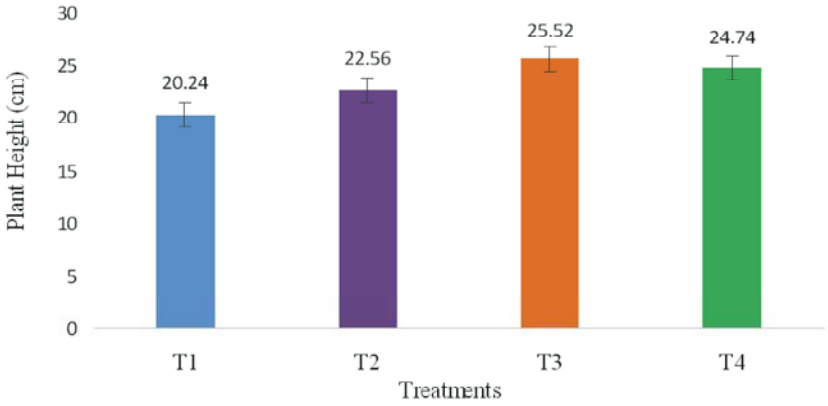

Fig. 1: Plant Height (cm) in Different Treatments of Spinach Varieties
(N.B.: Data were presented on mean with three replications where P ≤ 0.05 and calculated in 1% and 5% level of significance)

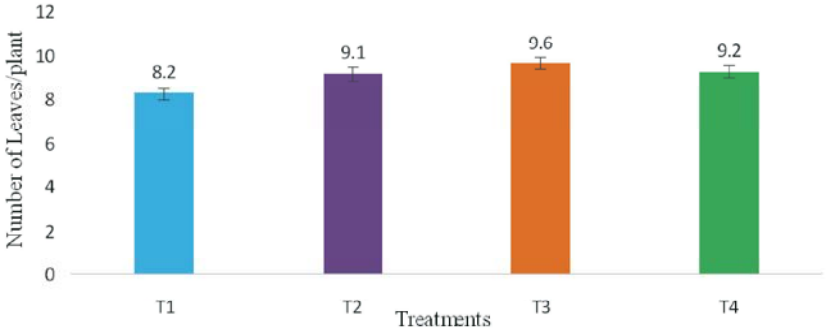

Fig. 2: Number of Leaves in Different Treatments of Spinach
(N.B.: Data were presented on mean with three replications where P ≤ 0.05 and calculated in 1% and 5% level of significance)

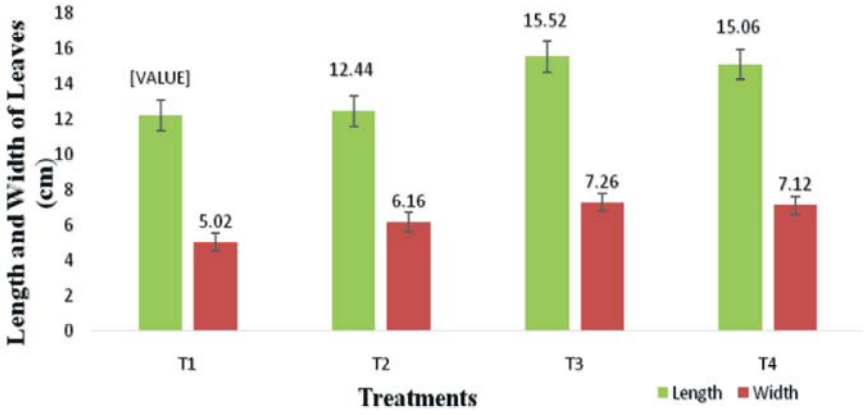

Fig. 3: Length and Width of Leaves in Different Treatments of Spinach

Percentage of Moisture Content (%): There was no significant differences in moisture content percentage found in different spinach varietal treatments application. From the Figure 7 it was illustrated that in each treatments it was much similar percentage i.e. 90.66%, 91.28%, 92.37% and 91.66% respectively. However, among all of these varietal treatments, the maximum moisture content (92.37%) was recorded in T^3varietywhile minimum moisture content was recorded (90.60%) T^1. Similar result was found by Islam, [17] in spinach, when he examined the moisture content in spinach (92.1%), jute (76.52%) and Indian spinach (90.44%).

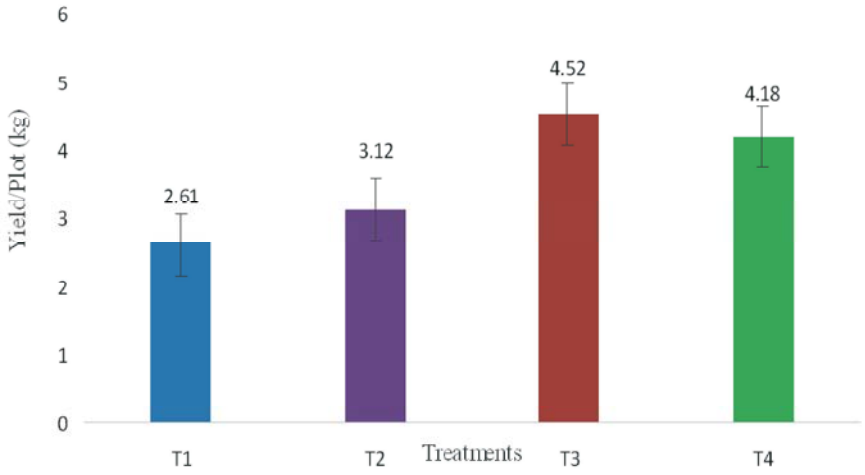

Fig. 4: Yield per Plot of Different Spinach Treatments
(N.B.: Data were presented on mean with three replications where P ≤ 0.05 and calculated in 1% and 5% level of significance)

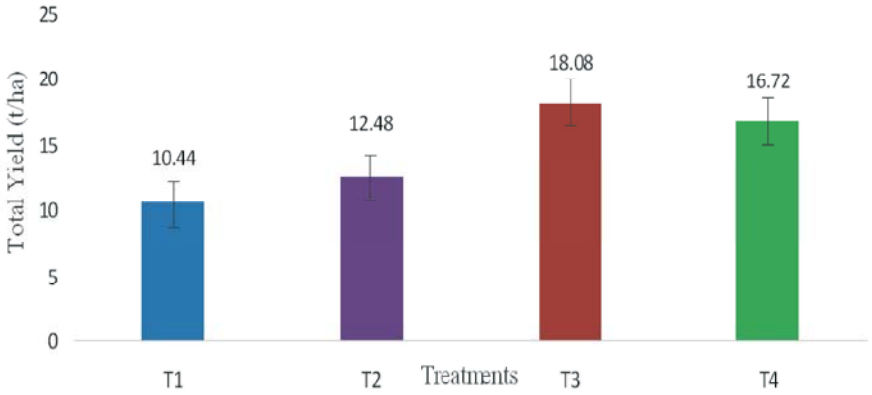

Fig. 5: Total Yield of Different Spinach Treatments
(N.B.: Data were presented on mean with three replications where P ≤ 0.05 and calculated in 1% and 5% level of significance)

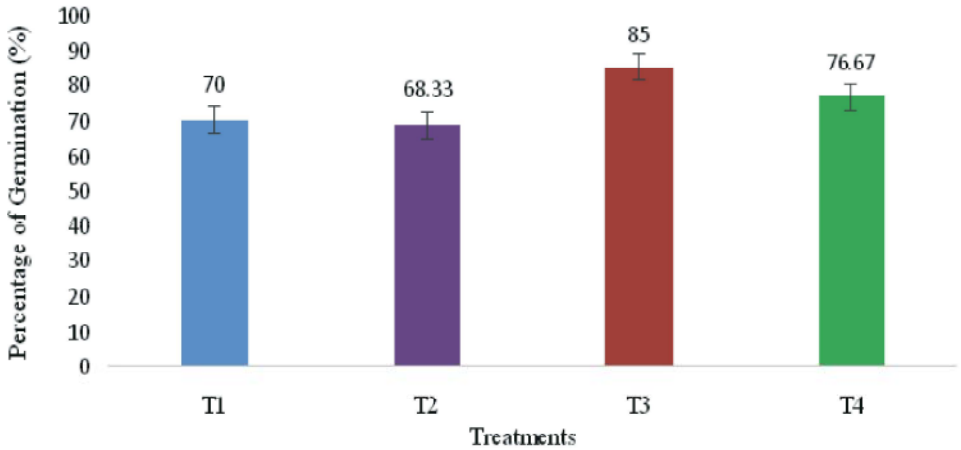

Fig. 6: Percentage of Germination (%) in Different Treatments of Spinach Varieties
(N.B.: Data were presented on mean with three replications where P ≤ 0.05)

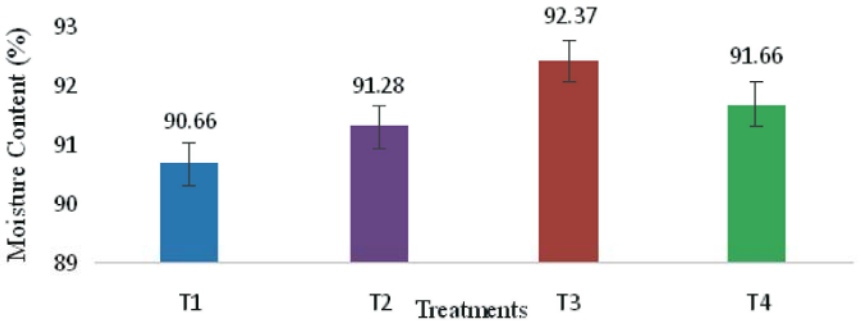

Fig. 7: Percentage of Moisture Content (%) in Different Treatments of Spinach Varieties. (N.B.: Data were presented on mean with three replications where $P \leq 0.05$)

CONCLUSION

The spinach varieties differed significantly in their growth and yield components. The results showed that there was significant variation among the varieties in respect of plant height, length of leaves, yield per plot and total yield parameters.In the experiment, T^3provided better growth as well as yield than other varietal treatments. Similar results also found in moisture content and germination percentage components where maximum percentage wererecorded in T^3 variety i.e.92.37% and 85% respectively.At the meantime, T^1 variety i.e. Punjab all green was recorded minimal response in all parameters. Therefore, it may be concluded that studied varieties behaved significantly different from each other concerning various parameters. And the findings of the experiment indicated that the best yield and the highest financial benefit could be obtained fromT^3 which wasSathi variety of Spinach in compare to Punjab all green, Kopi palong, Evanvarieties at all saline prone areas in Bangladesh.

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