Asian Journal of Advances in Agricultural Research

Volume 22, Issue 2, Page 6-15, 2023; Article no.AJAAR.99363
ISSN: 2456-8864

Influence of Plant Density and Fertilization on the Growth and Seed Yield of Bunching Onion (*Allium fistulosum* 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: 10.9734/AJAAR/2023/v22i2435

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/99363

Original Research Article

Received: 01/03/2023
Accepted: 02/05/2023
Published: 17/05/2023

ABSTRACT

An experiment was conducted at the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2020 to April 2021 to study the influence of plant density and fertilization on the growth and seed yield of bunching onion. The experiment consisted of three levels of spacing (Viz. S_1= 20 cm x 10 cm, S_2= 20 cm x 15 cm, S_3= 20 cm x 20 cm) and four levels of fertilizers (Viz. F_0= No Application (control), F_1= $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}V_{6t/ha}$,

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F_2= $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}$ $PM_{6t/ha}$, $F_{3=}$ $N_{115kg}P_{132kg}K_{90kg}S_{20kg}V_{3t}PM_{3t/ha}$). The two-factor experiment was carried out in Randomized Complete Block Design (RCBD) with three replications and 12 treatments. Growth and yield of bunching onion were influenced by the different spacing. The S_3 treatment resulted in the highest number of leaves (8.16), dry matter content in leaves (10.098%), number of seeds per umbel (496.56), thousand seed weight (3.64g). The maximum seed yield per hectare (1065 kg) was observed from S_1 treatment. Different levels of fertilizer had also significant influence on yield of bunching onion. The highest number of leaves (8.80), thousand seed weight (4.08g) and seed yield per hectare (1056.3 kg) were found from the F_3 treatment. The highest seed yield (1260 kg/ha) with net income (Tk.699991.4) and BCR (2.26) were observed from S_1F_3 treatment combination, while the lowest seed yield (700.2 kg/ha) with net income (Tk.258214.25) and BCR (1.56) were observed from S_3F_0 treatment combination. So, economic analysis revealed that the S_1F_3 treatment combination appeared to the best for achieving the higher yield and economic benefit of bunching onion.

Keywords: Bunching onion; fertilizer; spacing; seed yield.

ABBREVIATIONS

V: Vermicompost; PM: Poultry Manure

1. INTRODUCTION

The perennial onion known as the bunching onion (*Allium fistulosum* L.) is a member of Amaryllidaceae family originated in China [1]. One of the most significant crops in eastern Asia, particularly in China, Japan, and Korea [2]. Commercially, it is grown as an annual or a biennial, typically seed propagated and tender green onions may be called scallions, welsh onions, green onions, spring onions, salad onions, Negi, Japanese bunching onions. The growth of bunching onions is quick in the spring and autumn and slows down in the summer and winter [3]. In any type of well-drained soil that is rich in organic matter, bunch onions can be grown very easily [4]. Welsh onion leaves have significant concentrations of quercetin, a flavanol molecule that may have positive benefits on human health, including lowering the risk of cardiovascular disease, acting as an anticancer agent due to its antiprotonic and anti-inflammatory responses, and slowing DNA deterioration [5,6]. Japanese bunch onion is rich in vitamin C but it also contains other beneficial substances including carotenoids, macro- and micronutrients, particularly Ca and K, as well as flavonoids, which are strong antioxidants [7,8,9].

Proper spacing ensures optimum plant growth [10]. Due to competition for growth factors among nearby plants, the yield per unit area decreases as plant yields continue to diminish with increasing plant density.

“Fertilizer management is one of the important factors that contribute in the production and yield of bunching onion. The most crucial nutrients for vegetative growth of the crop are nitrogen, phosphorus, potassium, and sulfur. Nitrogen is a very significant ingredient due to its impact on plant height, leaf number per plant, bulb weight, and yield per plant” [11]. “Phosphorus aids in promoting the growth of roots, boosting stalk and stem strength, enhancing flower formation and seed production, promoting more uniform and earlier crop maturity, enhancing crop quality, and boosting plant disease resistance. Increased crop resistance to numerous diseases, stalk and stem breaking, and under stressful conditions is a result of adequate potassium levels” [12]. An effective dressing of sulfur fertilizer boosted trace element availability while enhancing growth, yield, and pungent flavor [13]. Vermicompost is a fantastic, nutrient-rich organic fertilizer, plant promoter, protector and soil conditioner since it includes water-soluble compounds [14]. It expands macro pores, which improves the soil's air-water connection and benefits plant growth [15]. Poultry manures are particularly high in nitrogen and phosphorus when composted [16]. This research will help the farmers to produce quality seeds of bunching onion which will increase production as well as will help to ensure income benefit of the farmers. The purpose of this study is to ascertain the ideal plant spacing for bunching onion in order to achieve the maximum growth and seed production along with identify the suitable combination of NPKS fertilizer, vermicompost and poultry manure for maximum growth and seed yield of bunching onion. It also helps to determine the combined effect of fertilizer combination and plant spacing for maximum growth and seed yield of bunching onion.

2. MATERIALS AND METHODS

2.1 Description of the Site

The research work was conducted at Horticulture Farm, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from November 2020 to April 2021. The location of the site was 23° 77′ N Latitude and 90° 35′ E Longitude with an elevation of 8.6 meters from the sea level. The experimental site was under the subtropical climate with three distinct seasons: winter from November to February, pre-monsoon or hot season from March to April, and monsoon season from May to October. Site of study has cold winter and hot summer. The yearly average precipitation (30- years long term period) which is mostly occurred during the monsoon months is 490 mm. The mean annual average maximum and minimum temperature was 28 and 19°C respectively.

2.2 Soil Sampling and Analysis

Prior to the beginning of experiment, soil samples were taken in order to determine the physical and chemical properties. The texture of the soil in the experimental field was silty loam. The soil in the experimental area is part of the Modhupur Tract and belongs to AEZ No. 28. The soil sample from the experimental plot was obtained from a depth of 0-30 cm, PH of the soil is 7.1 and examined at the Soil Resources Development Institute (SRDI), Soil Testing Laboratory, Kamarhati, Dhaka. It was air dried, crushed, and tested for physical and chemical properties.

2.3 Statistical Analysis

The recorded data on different parameters were statistically analyzed using Statistic 10 software. The significance of the difference among the treatments means was estimated by the least significant difference test (LSD) at 5% level of probability.

2.4 Field Preparation and Treatment Allocation

The plot selected for the experiment was opened with a power tiller in the middle of November 2020 and left exposed to the sun for 10 days. To achieve good tilth, the land was harrowed, ploughed, and cross-ploughed several times, followed by laddering. The experiment was laid out in a Randomized Complete Block Design (RCBD) having double factor with three replications. The experiment comprised as two factors. Factor A: plant spacing (3 levels of plant spacing (Viz S_1= 20 cm x 10 cm, S_2= 20 cm x 15 cm, S_3= 20 cm x 20 cm, and four levels of fertilizers (Viz. F_0= No Application (control), F_1= $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}V_{6t/ha}$, F_2= $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}PM_{6t/ha}$, $F_{3=}$ $N_{115kg}P_{132kg}K_{90kg}S_{20kg}V_{3t}PM_{3t/ha}$). Each block was divided into 12 plots where 12 treatments combination were distributed randomly and 36-unit plots altogether in the experiment. The size of each plot was 1.2 m × 1.2 m. The distance maintained between two blocks were 1.00 m and two plots were 0.50 m. The plots were raised up to 10 cm.

2.5 Planting Materials

The seeds of bunching onion were collected from Bangladesh Agricultural Research Institute (BARI), Gazipur.

2.6 Manuring and Fertilization

Full amount of TSP and full amount of Gypsum were applied in the field as basal dose as per treatment during final land preparation. Urea, Mop, Vermicompost and Poultry manure were applied as top dressing in 3 equal splits at 15 days intervals.

Table 1. The following doses of organic and inorganic fertilizers were applied in the experimental plots

Organic and inorganic fertilizer	Dose /ha	Dose for F_1 treatment	Dose for F_2 treatment	Dose for F_3 treatment
Urea	250 kg	18 g	18 g	36 g
Triple super phosphate (TSP)	275 Kg	19.8 g	19.8 g	39.6 g
Muriate of Potash (MP)	150 Kg	10.8 g	10.8 g	21.6 g
Gypsum	110 Kg	7.92 g	7.92 g	15.84 g
Vermicompost	6ton	864 g	-	432 g
Poultry Manure	6ton	-	864 g	432 g

3. RESULTS AND DISCUSSION

3.1 Effect of Spacing

Significant differences were observed in the different parameters of plant due to different levels of spacing. The maximum plant height (54.35 cm) was measured at 100 DAT from S_1 followed by S_2 treatment (Fig. 1). The highest number of leaves (8.16) per plant at 75 DAT was recorded from S_3 treatment which was statistically identical (7.69) to S_2 treatment (Fig. 2). The treatment S_3 recorded the maximum plant base diameter (2.69 cm), length of flowering stem (43.92 cm), diameter of flowering stem (2.18 cm), dry matter content of leaves (10.098%) and minimum days required for first flower bud initiation (61.67 days) (Table 2). The maximum number of umbels (2.87) per plant, umbel diameter (6.46 cm), number of flowers (187.46) per umbel, number of seeds (496.56) per umbel was obtained from S_3 treatment (Table 2). The data revealed that highest 1000 seed weight (3.64g), seed yield (3.61g) per plant, seed germination percentage (85.73) was obtained from S_3 treatment and maximum seed yield (153.36 g) per plot, seed yield (1065 kg) per hectare was found from S_1 treatment (Table 2).

"The plant height was decreased with increasing in row spacing. The increased plant height at closer spacing was due to competition for air and light. The present findings are agreed with the findings of [17] and [18]. Kumar, et al. [19] reported that the 20 cm x 20 cm spacing was the best with regard to number of leaves per plant". Umesh-Thapa, [20] found that 50% flowering occurred earlier in wider spaced plant. Wider spacing increased the quantity of flower stalks per plant. Singh and Sacachan [21], Nehra, et al. [22], Bhardwaj [23] also found the same result.

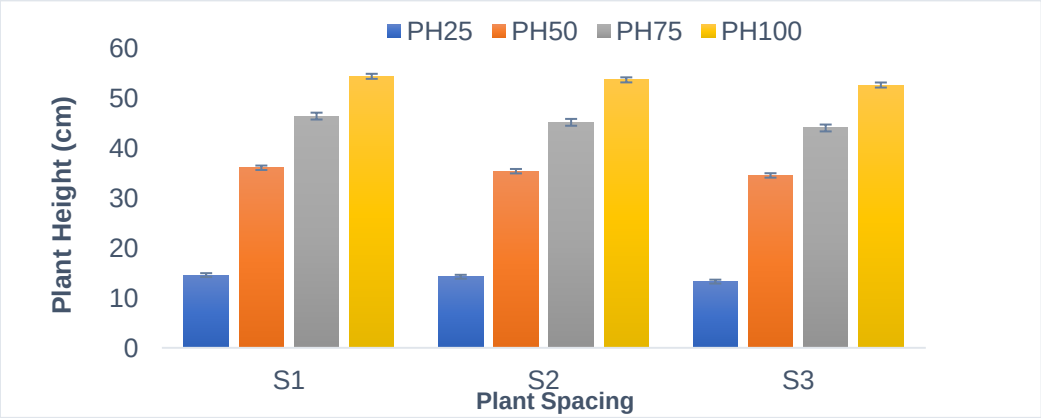

Fig. 1. Effect of spacing on plant height (cm) of bunching onion (*Allium fistulosum* L.)
Here, S_1: 20cm×10cm, S_2: 20cm×15cm, S_3: 20cm×20 cm

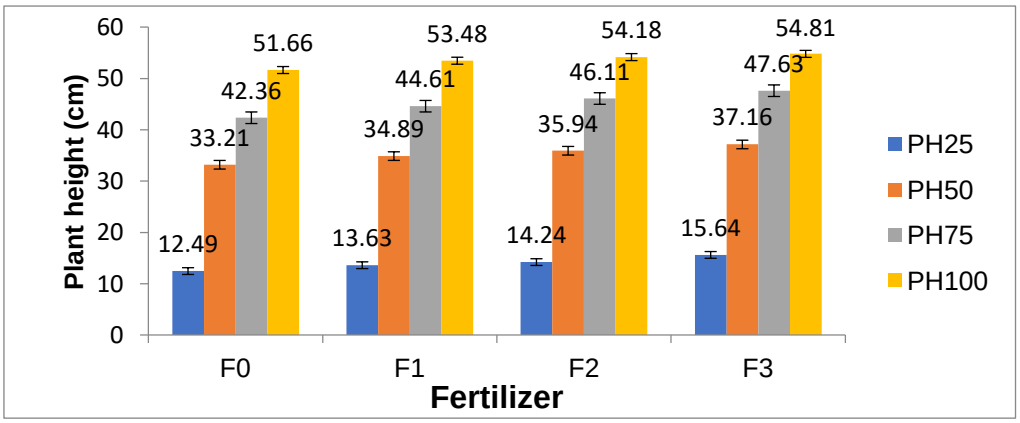

Fig. 2. Effect of different levels of fertilizer on plant height (cm) of bunching onion (*Allium fistulosum* L.)
F_0: Control, F_1: $N_{57.5kg}$ P_{66kg} K_{45kg} S_{10kg} $V_{6t/ha}$, F_2: $N_{57.5kg}$ P_{66kg} K_{45kg} S_{10kg} $PM_{6t/ha}$, F_3: N_{115kg} P_{132kg} K_{90kg} S_{20kg} $V_{3t}PM_{3t/ha}$

3.2 Effect of Fertilizer

The data revealed that the effectiveness of different levels of chemical fertilizers along with organic manures affected the growth and seed yield of bunching onion. The maximum plant height (54.81cm) at 100 DAT (Fig. 3) and number of leaves per plant (8.80) at 75 DAT (Fig. 4) was measured from F_3 treatment followed by F_2 treatment. The treatment F_3 recorded the maximum plant base diameter (2.91 cm), length of flowering stem (44.47 cm), diameter of flowering stem (2.26cm), dry matter content of leaves (10.459%) and minimum days required for first flower bud initiation (58.31 days) (Table 3). The maximum number of umbels (3.52) per plant, umbel diameter (6.81 cm), number of flowers (202.94) per umbel, number of seeds (443.22) per umbel was obtained from F_3 treatment (Table 3). The data revealed that highest 1000 seed weight (4.08 gm), seed yield (3.29 gm) per plant, seed yield (157.48g) per plot, seed yield (1056.3 g) per hectare, seed germination percentage (87.22) was obtained from F_3 Treatment (Table 3).

Vachhani and Patel [11] reported that "the height of plant increased with increasing levels of nutrients. The result might be due to the fact that vermicomposting enhances the vegetative growth of bunching onion". The present findings are agreed with the findings of [24] and [25]. Rizk, et al. [26] found that "the increasing levels of NPK increased the number of leaves". Nasiruddin, et al. [27] also reported that "the number of leaves per plant increased due to application of K and S [28] stated that application of N, K and S significantly increased yield and yield attributes". Tiwari, et al. [29] stated that "1000 seed weight was affected significantly by NPKS at recommended doses". "The reason for higher seed yield per plant due to increase of photosynthesis rate and translocation of food materials to seed. Ali, et al. [30] reported similar result. They obtained higher seeded fruits, number of seeded fruits /umbels, weight of seeds/umbel, seed yield, gemination percentage with the application of different levels of nitrogen and potassium".

3.3 Combined Effect of Plant Spacing and Fertilizer

Combined effect of plant spacing and different levels of fertilizer was found to be statistically significant. The maximum plant height (55.95 cm) at 100 DAT was obtained from S_1F_3 treatment combination and number of leaves per plant (9.27) at 75 DAT from S_3F_3 treatment combination (Table 4). The treatment S_3F_3 recorded the maximum plant base diameter (2.967cm), length of flowering stalk (46.79cm), diameter of flowering stalk (2.36 cm), minimum days required for first flower bud initiation (57 days), dry matter content of leaves (10.893%) (Table 4). The maximum number of umbels (3.79) per plant, umbel diameter (7.24 cm), number of flowers (217.67) per umbel, number of seeds (592.42) per umbel was obtained from S_3F_3 treatment (Table 5). The data revealed that highest 1000 seed weight (4.28 g), seed yield (4.11 g) per plant, seed germination percentage (88.33) was obtained from S_3F_3 treatment and maximum seed yield (181.44 g) per plot, seed yield (1260 kg) per hectare was found from S_1F_3 treatment (Table 5). Khan, et al. [31] also indicated that "lower leaf number per plant of was recorded from the treatment interaction effects of control nitrogen level and narrow intra-row spacing".

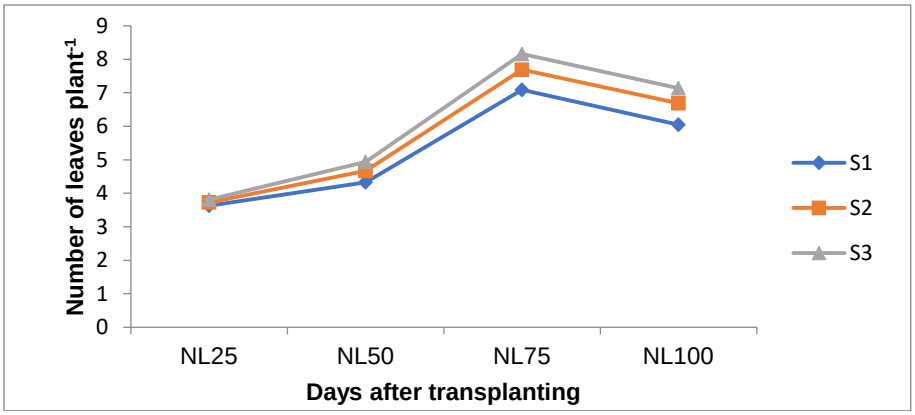

Fig. 3. Effect of spacing on the number of leaves of bunching onion (*Allium fistulosum L.*)
Here, S_1: 20cm×10cm, S_2: 20cm×15cm, S_3: 20cm×20 cm

Table 2. Effect of spacing on plant base diameter (cm), length of flower stem(cm), diameter of flower stem(cm), Days required for flower bud initiation, Dry matter content in leaves (%), no. of umbel /plant, umbel diameter (cm), no. of flowers/plant, no. of seeds/plant, 1000 seed wt (g), Seed yield per plant (g), Seed Yield per plot (g), Seed yield per ha (kg/ha), Seed Germination (%) of bunching onion (*Allium fistulosum* L.)

Treatment	Plant Base Diameter (cm)	Length of Flower Stem (cm)	Diameter of Flower stem (cm)	Days required for flower bud initiation	Dry matter content in leaves (%)	No of Umbel /plant	Umbel Diameter (cm)	No of Flowers per plant	No of Seeds per Umbel	1000 Seed wt (g)	Seed Yield per plant (g)	Seed Yield per Plot (g)	Seed Yield per ha (kg/ha)	Seed Germination (%)
S_1	2.44	40.03 c	1.98	63.82 a	9.226 c	2.46 b	5.92 b	169.67 c	443.22 b	3.32 c	2.13 c	153.36 a	1065.00 a	84.29
S_2	2.66	42.42 b	2.02	62.58 b	9.542 b	2.81 a	6.07 b	178.16 b	438.56 b	3.42 b	2.85 b	133.56 b	896.02 b	84.12
S_3	2.69	43.92 a	2.18	61.67 c	10.098 a	2.87 a	6.46 a	187.46 a	496.56 a	3.64 a	3.61 a	129.60 c	821.00 c	85.73
LSD (0.05)	0.7765 ^{NS}	0.705	0.7793^{NS}	0.629	0.2532	0.1753	0.2458	5.7308	20.573	0.0801	0.2292	1.2237	5.2781	3.8406 ^{NS}
CV%	6.88	7.28	9.29	4.21	5.25	7.45	4.70	3.84	5.16	2.79	5.24	6.23	6.23	5.49

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
Here, S_1: 20cm×10cm, S_2: 20cm×15cm, S_3: 20cm×20cm

Table 3. Effect of different levels of fertilizer on plant base diameter (cm), length of flower stem(cm), diameter of flower stem(cm), days required for flower bud initiation, dry matter content in leaves (%), no. of umbel /plant, umbel diameter (cm), no. of flowers/plant, no. of seeds/plant, 1000 seed wt (g), Seed yield per plant (g), Seed Yield per plot (g), Seed yield per ha (kg/ha), Seed Germination (%) of bunching onion (*Allium fistulosum* L.)

Treatment	Plant Base Diameter (cm)	Length of Flower Stem (cm)	Diameter of Flower stem (cm)	Days required for flower bud initiation	Dry matter content in leaves (%)	No of Umbel /plant	Umbel Diameter (cm)	No of Flowers per plant	No of Seeds per Umbel	1000 Seed wt (g)	Seed Yield per plant (g)	Seed Yield per Plot (g)	Seed Yield per ha (kg/ha)	Seed Germination (%)
F_0	2.1	39.95 d	1.79	67.44 a	8.64 d	1.89 d	5.50 d	155.60 d	385.99 d	2.78 d	2.36 c	113.87 d	773.40 d	83.24
F_1	2.63	41.31 c	2.05	63.33 b	9.39 c	2.35 c	5.94 c	170.28 c	446.92 c	3.28 c	2.79 b	136.44 c	910.50 c	83.22
F_2	2.76	42.75 b	2.14	61.67 c	10.003 b	3.09 b	6.34 b	184.89 b	484.50 b	3.68 b	2.99 b	146.36 b	969.10 b	85.16
F_3	2.9111	44.47 a	2.26	58.31 d	10.459 a	3.52 a	6.81 a	202.94 a	520.36 a	4.08 a	3.29 a	157.48 a	1056.30 a	87.22
LSD (0.05)	0.8966 ^{NS}	0.8141	0.8998^{NS}	0.7263	0.2924	0.2024	0.2838	6.6173	23.755	0.0925	0.2646	1.4130	6.0946	4.4348 ^{NS}
CV%	6.88	7.28	9.29	4.21	5.25	7.45	4.7	3.84	5.16	2.79	5.24	6.23	6.23	5.49

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
Here, F_0: Control, F_1: $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}V_{6t/ha}$, F_2:$N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}PM_{6t/ha}$ and F_3:$N_{115kg}P_{132kg}K_{90kg}S_{20kg}V_{3t}PM_{3t/ha}$

Table 4. Combined effects of spacing and different levels of fertilizer on plant base diameter (cm), length of flower stem(cm), Diameter of flower stem(cm), Days required for flower bud initiation, Dry matter content in leaves (%), no. of umbel /plant, umbel diameter (cm), no. of flowers/plant, no. of seeds/plant, 1000 seed wt (g), Seed yield per plant (g), Seed Yield per plot (g), Seed yield per ha (kg/ha), Seed Germination (%) of bunching onion (*Allium fistulosum* L.)

Treatment	Plant height (cm) at			Number of leaves at			Plant Base Diameter (cm)	Length of Flower Stem (cm)	Diameter of Flower stem (cm)	Days required for flower bud initiation	Dry matter content in leaves (%)
	50 DAT	75 DAT	100 DAT	50 DAT	75 DAT	100 DAT					
S_1F_0	33.75 f	44.43 e	53.14 e	3.68 e	6.28 f	4.80 g	1.63	37.05 f	1.64	69.33 a	8.09 f
S_1F_1	35.46cde	44.90 cde	53.88 cd	4.40 cd	6.40 ef	5.71 ef	2.6	39.51 e	2.02	64.33 c	8.89 e
S_1F_2	36.40 bc	46.51 bc	54.42bc	4.54 bcd	7.62 cd	6.15 e	2.7	41.58 cd	2.08	62.33 de	9.83 cd
S_1F_3	38.54 a	49.71 a	55.95 a	4.68 bcd	8.07 bc	7.52 bc	2.83	41.98 cd	2.19	59.27 g	10.093 bc
S_2F_0	33.74 f	42.60 f	52.02 f	4.30 de	6.31 f	5.54 f	2.3	40.72 de	1.69	67.00 b	8.4 ef
S_2F_1	34.77 ef	44.70 de	53.70 d	4.53 bcd	7.32 cde	5.93 ef	2.63	41.86 cd	2.05	63.00 d	9.49 d
S_2F_2	36.12bcd	46.24 bcd	54.28bcd	4.66 bcd	8.05 bc	7.26 cd	2.77	42.46 c	2.09	61.67 ef	9.89 bcd
S_2F_3	36.81 b	47.02 b	54.49 b	5.19 ab	9.07 a	8.04 b	2.93	44.62 b	2.22	58.67 g	10.39 ab
S_3F_0	32.14 g	40.05 g	49.82 g	4.37 cd	6.76 def	5.65 ef	2.37	42.09 cd	2.06	66.00 b	9.42 d
S_3F_1	34.47 ef	44.22 ef	52.78 e	4.57 bcd	7.77 c	7.13 cd	2.65	42.57 c	2.07	62.67 de	9.79 cd
S_3F_2	35.30 de	45.57bcde	53.86 cd	5.04 bc	8.83 ab	6.90 d	2.8	44.22 b	2.24	61.00 f	10.29 bc
S_3F_3	36.13bcd	46.17 bcd	53.99bcd	5.78 a	9.27 a	8.85 a	2.9667	46.79 a	2.36	57.00 h	10.893 a
LSD (0.05)	1.0465	1.7152	0.6004	0.6729	0.9804	0.5979	1.5530^{NS}	1.4101	1.56^{NS}	1.2579	0.5064
CV%	5.74	6.29	4.26	8.44	7.9	5.42	6.88	7.28	9.29	4.21	5.25

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, S_1: 20cm×10cm, S_2: 20cm×15cm, S_3: 20cm×20cm, F_0: Control, F_1: $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}V_{6t/ha}$, F_2: $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}PM_{6t/ha}$ and F_3:$N_{115kg}P_{132kg}K_{90kg}S_{20kg}V_{3t}PM_{3t/ha}$

Table 5. Combined effects of spacing and different levels of fertilizer on plant base diameter (cm), length of flower stem(cm), Diameter of flower stem(cm), Days required for flower bud initiation, Dry matter content in leaves (%), no. of umbel /plant, umbel diameter (cm), no. of flowers/plant, no. of seeds/plant, 1000 seed wt (g), Seed yield per plant (g), Seed Yield per plot (g), Seed yield per ha (kg/ha), Seed Germination (%) of bunching onion (*Allium fistulosum* L.)

Treatment	No of Umbel /plant	Umbel Diameter (cm)	No of Flowers per plant	No of Seeds per Umbel	1000 Seed wt (g)	Seed Yield per plant (g)	Seed Yield per Plot (g)	Seed Yield per ha (kg/ha)	Seed Germination (%)
S_1F_0	1.67 h	5.17 f	146.17 g	345.80 f	2.66	1.72 i	123.84 ef	860.00 h	83.00
S_1F_1	2.16 efg	5.78 de	164.67 f	443.07 cd	3.09	2.04 hi	146.88 c	1020.02 c	84.00
S_1F_2	2.86 d	6.19 bcd	179.50 de	460.67 c	3.58	2.24 gh	161.28 b	1120.00 b	84.83
S_1F_3	3.17 cd	6.53 b	188.33 cd	523.33 b	3.96	2.52 efg	181.44 a	1260.01 a	85.33
S_2F_0	1.93 gh	5.34 ef	158.30 f	394.33 e	2.72	2.37 fgh	113.76 i	760.00 j	83.16
S_2F_1	2.38 ef	6.01 cd	168.84 ef	446.40 cd	3.31	2.82 def	135.36 g	898.90 g	81.33
S_2F_2	3.33 bc	6.28 bc	182.67 cd	468.17 c	3.62	2.96 de	142.08 e	926.70 e	84.00
S_2F_3	3.59 ab	6.65 b	202.83 b	445.33 cd	4.01	3.26 cd	143.04 d	998.50 d	88.00
S_3F_0	2.08 fg	5.98 cd	162.34 f	417.83 de	2.97	2.99 d	107.64 k	700.20 k	83.58
S_3F_1	2.50 e	6.04 cd	177.33 de	451.30 cd	3.45	3.53 bc	127.08 j	812.70 i	84.33
S_3F_2	3.09 cd	6.56 b	192.50 bc	524.67 b	3.84	3.77 ab	135.72 h	860.50 h	86.67
S_3F_3	3.79 a	7.24 a	217.67 a	592.42 a	4.28	4.11 a	147.96 fg	910.50 f	88.33
LSD (0.05)	0.3506	0.4916	11.462	41.145	0.1602	0.4583	2.4474	10.556	7.6813 ^{NS}
CV%	7.45	4.7	3.84	5.16	2.79	5.24	6.23	6.23	5.49

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, S_1: 20cm×10cm, S_2: 20cm×15cm, S_3: 20cm×20cm, F_0: Control, F_1: $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}V_{6t/ha}$, F_2: $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}PM_{6t/ha}$ and F_3:$N_{115kg}P_{132kg}K_{90kg}S_{20kg}V_{3t}PM_{3t/}$

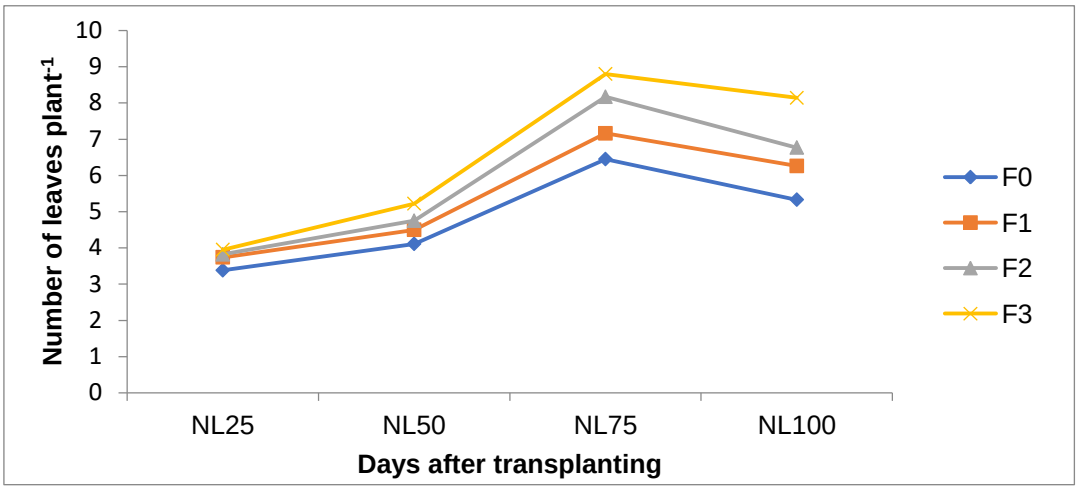

Fig. 4. Effect of different levels of fertilizer on the number of leaves bunching onion (*Allium fistulosum L.*)

F_0: Control, F_1: $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}V_{6t/ha}$, F_2: $N_{57.5kg}P_{66kg}K_{45kg}S_{10kg}PM_{6t/ha}$, F_3: $N_{115kg}P_{132kg}K_{90kg}S_{20kg}V_{3t}PM_{3t/ha}$

4. CONCLUSION

On the basis of present study, it is concluded that the S_1 treatment gave highest plant height at 100 DAT of bunching onion. S_3 treatment gave highest number of leaves, plant base diameter, earlier flower bud initiation, no of umbel, umbel diameter, no of seeds per umbel, seed yield per plant, seed germination percentage and dry matter content in leaves. In this experiment plant spacing S_1 (20 cm×10 cm) treatment gave highest seed yield (1065 kg/ha) per hectare of bunching onion. Combination of inorganic ($N_{115kg}P_{132kg}K_{90kg}S_{20kg/ha}$) and organic ($V_{3t/ha}$ + $PM_{3t/ha}$) treated plants gave highest growth and seed yield (1056.3 kg /ha) of bunching onion. However, from the present study it may be concluded that, the most suitable combination for a higher yield of bunching onion was S_1 (20 cm×10 cm) with F_3 ($N_{115kg}P_{132kg}K_{90kg}S_{20kg/ha}V_{3t/ha}$ + $PM_{3t/ha}$).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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