GROWTH AND YIELD OF OKRA AS INFLUENCED BY SOWING DATE AND FERTILIZER AMENDMENT

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CERTIFICATE

This is to certify that the thesis entitled '**Growth and Yield of Okra as Influenced by Sowing Date and Fertilizer Amendment**' submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE**, embodies the results of a piece of bona fide research work carried out by **Mohammad Sohel**, Registration No. **12-04824** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

Dated: June, 2018
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TO

MY BELOVED PARENTS

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ABSTRACT

The experiment was carried out in the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka from February to July 2018. BARI Dherosh-2 was used as planting materials. The experiment consisted of two factors: Factor A: Sowing dates (3 levels) as-S_1: Sowing at 1st March, S_2: Sowing at 15th March, and S_3: Sowing at 30th March; Factor B: Fertilizer amendment (4 levels) as- F_0: No nutrients (control), F_1: RFD of NPK fertilizer, F_2: Vermicompost @ 4 t ha^{-1} and F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer). The experiment was laid out in Randomized Complete Block Design with three replications. In case of sowing date, the tallest plant 32.42, 67.99, 91.08 and 123.39 cm were recorded from S_2 treatment at 30, 45, 60 and 75 DAS respectively. Treatment S_2 performed the maximum (24.07) number of pods plant^{-1} and the highest pod yield (15.24 t ha^{-1}). On the other hand, F_3 gave the highest plant height (33.63, 69.53, 93.27 and 127.10 cm in 30, 45, 60 and 75 DAS respectively). The maximum (25.16) number of pods plant^{-1} and the highest pod yield (16.42 t ha^{-1}) was contributed by F_3. The treatment combination of S_2F_3 provided the highest plant height (37.00, 75.75, 99.25 and 136.88 cm in 30, 45, 60 and 75 DAS respectively), number of pods plant^{-1} (27.07) and yield (17.90 t ha^{-1}). The highest benefit cost ratio (2.07) was found from the treatment combination of S_2F_3 and the lowest (1.28) from S_3F_0. So, sowing at 15th March and Vermicompost @ 2 t + 50% RFD of NPK fertilizer was suitable combination for growth and yield of okra.

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INTRODUCTION

Okra (*Abelmoschus esculentus* L.) locally known as "Dherosh" or "Bhindi" belongs to the family Malvaceae is a nutritious and multipurpose vegetable crop in tropical and subtropical parts of the world (Tindall, 1986). In Bangladesh it is an important summer vegetable although now it is growing year the round (BARI, 2014). It is an annual vegetable crop in the world that grown from seed and a semi woody, fibrous, herbaceous plant (Patel *et al*., 2008). Vegetable production in Bangladesh is not uniform round the year and it is plenty in winter but less in quantity in summer season. Around 30% of total vegetables are produced during kharif season and around 70% in rabi season (Rashid, 1999). Therefore, as vegetable okra can get an importance in kharif season as well as summer season in our country context.

Okra is specially valued for its rich sources of vitamins and minerals tender and delicious edible pods. Tender green pods of okra contains approximately 86.1% water, 2.2% protein, 0.2% fat, 9.7% carbohydrate, 1.0% fibre and 0.8% ash (BARI, 2014). It is one of the most widely grown vegetable, highlighted mainly for its nutritional value as a source of various compounds, such as vitamins, minerals, antioxidants, as well as its anticancer properties (Umar *et al*., 2013). In Bangladesh is about 55,000 tons okra were produced from 11024 hectares of land in the year 2016-17 with average yield about 4.99 t/ha (BBS, 2017) and the production is very low compared to other developed countries where yield is as high as 14.0-18.0 t/ha (FAOSTAT, 2014). The low yield of okra in Bangladesh however is not an indication of low yielding potentiality of this crop, but may be attributed to a number of reasons viz. unavailability of quality seeds of high yielding varieties, sowing time, fertilizer management, disease and insect infestation, irrigation facilities and other agronomic practices. Among the different reasons sowing date and fertilizer amendment is the important factor that greatly affects the growth, development and yield of okra.

Okra crop is sensitive to cold and cannot tolerate low temperature for long period (Miri, 2006). Sowing date is the most important factor that affects the physiological, morphological properties of any crop plants as well as yield (Akramghaderi *et al*., 2003). In general monthly mean optimum temperature range for growth, flowering and pod development of okra is reported between 21-30^{0}C, while the minimum and maximum temperature of this plant were 18^{0}C and 35^{0}C (Abd El-Kader *et al*., 2010). Okra sowing in April, compared with June, leading to the plant height, number of branches, pod number, pod length, pod diameter, pod size, pod weight and fruit yield was higher (Mondal *et al*., 1989; Hussain *et al*., 2006). In Bangladesh seed sowing between February and May the highest pod yield (3 t ha^{-1}) was obtained on 15th April sowing date (Moniruzzaman *et al*., 2007). Pod number and yield were significantly affected by planting dates, so that the highest yield at planting date of 6th April and the lowest value was obtained on 22th March (Dilruba *et al*., 2009).

To attain considerable production and quality yield for any crop it is necessary to proper amendment of fertilizer in appropriate doses. Generally, large amount of fertilizer is required for the growth and development of vegetable crops. Chemical fertilizer today hold the key role to success of production systems being responsible for about 50% of the total crop production. Imbalance fertilizer use and practice of inappropriate production technologies are common among farmers (Sharma *et al*., 2014). There is need to develop appropriate fertilizer management technique to evaluate the performance and to assess the nutrient requirement for okra cultivation in the country. For okra cultivation although fertilizer is a mandatory input materials but excessive fertilizer application would lead to increased production cost and negative effects of blocking agricultural sustainable development such as environmental pollution and pod quality of okra decline. Among various factors affecting successful cultivation of okra, the judicious chemical and vermicompost is one of the vital importance. Among plant nutrient nitrogen, phosphorus and potash influences vegetative and reproductive phase of crops (Attarde *et al*., 2012).

The use of inorganic fertilizer has not been helpful under intensive agriculture (Ekwu and Nwokwu, 2012). Vermicompost an organic source of plant nutrients contains a higher percentage of nutrients necessary for plant growth in readily available forms (Nagavallemma *et al*., 2004). Vermicompost plays a major role in improving growth and yield of different field crops, including vegetables, flowers and fruit crops. A wide range of vegetable and ornamental seedlings, showed earlier and better germination in a vermicompost compared with control (Gutierrez-Miceli *et al*., 2007). Significant accumulation of N, P, K, Ca and Mg in the roots shoots and leaves as a result of the application of humic acids derived from vermicompost (Baldatto *et al*., 2009). Vermicomposted animal manures tend to have a higher nutritional status, compared with that derived from organic municipal waste (Golchin *et al*., 2006).

Okra is cultivated under rain fed and in irrigated areas on a wide range of soils (Tiamiyu *et al*., 2012). The production is seriously affected by the use of low yielding, sub-optimal and inappropriate fertilizer doses as well as late sowing date (Kolo *et al*., 2012; Ayoub and Afrah, 2014). Sustainable increase in production is possible by adopting integrated fertilizer management, which not only increase the nutrient status of soil but also help to improve various physical, chemical and biological properties of soil leading to improved soil fertility and also to increase fertilizer use efficiency (Dick and Greorich, 2009). Appropriate sowing date also contribute to increase the fertilizer use efficiency. With this background information, and situation the present study was conducted for fulfilling the following objectives:

Objectives:

- To determine the optimum sowing date and fertilizer amendment for growth and yield of okra;
- To find out the suitable combination of sowing date and fertilizer amendment for ensuring the better growth and higher yield of okra.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

In Bangladesh, okra is a very important vegetable and specially valued for its tender and delicious edible pods. Different management practices influence the growth and yield of okra. Among them sowing date and fertilizer amendment especially inorganic and organic fertilizer and also their combination are the important factors that greatly affects the growth, development and yield of okra. So it is important to assess the effect of sowing date and fertilizer amendment especially inorganic and organic fertilizer and also their combination for the optimum growth and yield of okra. However, very limited research reports in this aspects have been done in various parts of the world including Bangladesh and the work so far done in Bangladesh is not adequate and conclusive. However, some of the important and informative works conducted at home and abroad in this aspect have been reviewed under the following headings:

2.1 Effect of sowing date on growth and yield of okra

Khan *et al*. (2000) conducted a field experiment to evaluate 4 okra varieties, sown on 3 different dates, 10th May, 25th May, and 10th June, 1998. It was found that variety, T-13, sown on May 25, 1998 gave significantly highest plant population percentage of 199.661. Variety, Green tech, sown on June 10, 1998 took more day's 148.331 from sowing to 1st flowering and remained the tallest variety at first and last picking with 58 and 167 cm plant height when sown on May 25, 1998. Variety, T-13 (check), gave long edible fruits of 10 cm. While significantly highest yield of 15.68 t ha^{-1} was obtained from variety, T-13 (check), sown on May 25.

A study was undertaken by Talukder *et al*. (2003) to find out the effect of sowing time; spacing and picking interval on yield and yield components of okra (BARI Dherosh-1). Green pod yield was significantly higher when crop was sown on April (18.92 t ha^{-1}) than March sown crop (16.24 t ha^{-1}). Significantly

highest yield (20.99 t ha^{-1}) was recorded at closer spacing (60 × 30 cm2) than wider spacing. Yield was gradually decreased with increasing picking interval. Higher yield was obtained at 2 days picking interval (21.74 t ha^{-1}), which was statistically similar to 3 days picking interval (19.53 t ha^{-1}). Interaction among the effects of sowing times, spacing and picking interval on yield and yield components were found significant except interaction of sowing time with picking interval. The results showed that 2 or 3 days picking interval with closer spacing sown in April were found higher yield (24.94 and 23.79 t ha^{-1}, respectively) in okra (var. BARI Dherosh-1).

A field experiment conducted by Moniruzzaman *et al*. (2007) at the Agricultural Research Station (ARS), Raikhali, Rangamati Hill District to find out the most suitable sowing time and optimum plant spacing for the two consecutive years on okra cv. BARI Dherosh-1 comprising four sowing times starting from February to May (15^{th} day of each month) at monthly interval and four spacing. The highest seed yield (2.97 t/ha) was recorded from 15 April sowing closely followed by 15 March sowing (2.77 t/ha) whereas the best quality seed was obtained from 16 February (88.7% germination and 29.75 seed vigour index) and 15 March (83.7% germination and 28.80 seed vigour index) sowing.

The research was conducted by Naz *et al*. (2009) under natural field conditions at Agricultural Research Institute, Tarnab, Peshawar to determine the effect of sowing dates and cultivars on Fusarium root rot in okra. Different sowing dates viz. 20^{th} March, 4^{th} April, 19^{th} April and 4^{th} May and five okra cultivars viz. Sabz pari, Irkabinabirka, Sharmely, Anmol and Evergreen, being tested against Fusarium solani. Sowing done on 19^{th} April proved to be the most effective in reducing plant mortality (%) and increasing yield. The interaction was also significant. Sabz Pari suffered the minimum plant mortality (28.3%) when sown on 19^{th} April. This cultivar when sown on 19^{th} April registered the greatest yield (5.0 Kg $plot^{-1}$), plant height (110.8 cm), pod length (16.4 cm), fresh shoot weight (313.8 g $plant^{-1}$) and dry shoot weight (194.8 g $plant^{-1}$).

Chattopadhyay *et al*. (2011) conducted field trials were at the Gangetic Alluvium of eastern India to find out the most suitable sowing time to achieve higher yield, comparatively less incidence of yellow vein mosaic virus (YVMV) and quality seed of okra over four consecutive years having seven sowing times at fortnight interval (1st February, 16th February, 1st March, 16th March, 1st April, 16th April and 1st May). The seed yield attributing characters differed significantly with different sowing dates. The maximum matured pods per plant (14.57) and the longest matured pod (18.00 cm) was observed from 1st April sowing which was statistically similar with that of number and length recorded between 16th February and 1st May sowing dates. However, seeds sown in 16th February significantly produced the highest mean seed yield (6.84 q/ha) followed by 1st March (6.18 q/ha) sowing over the years. Seeds sown in either 16th February or 1st March produced the best quality seed (85.30 and 80.0% germination; 45.0 and 44.0 g test weight 29.75; 11.79 and 11.64 vigour index, respectively). The income per rupee investment of okra seed crop was found to be the maximum (2.40) when sown at 2nd fortnight of February.

A field experiment was conducted by Dash *et al*. (2013) at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh to study the effect of variety and panting date on the growth and yield of okra. Three planting dates (1 February, 15 February and 2 March) and three varieties (BARI Dherosh-1, Arka Anamica and Annie Oakley) were used as treatment. Planting date had significant influence on yield contributing characters and yield of okra. Significantly higher yield was obtained (9.11 t/ha) from Annie Oakley variety when shown on 15 February, compared to other dates. Higher pod yield with 15 February sowing was mainly due to increased number of pods/plant, pod size and pod weight. Annie Oakley variety enhanced plant growth and resulted greater pod weight (22.28 g) to other varieties cultivated. The highest BCR was recorded from the treatment combination of variety Annie Oakley with 15 February planting date. Results revealed that 15 February sowing would be profitable for variety Annie Oakley under Mymensingh condition.

A field trial was conducted by Ali *et al*. (2014) to study the effect of organic manure and sowing date at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria on the growth and yield of okra. Treatments consist; no manure (control), cow manure, sheep manure and poultry manure and sowing date of 8th May, 2013, 22nd May, 2013, 5th June, 2013 and 19th June, 2013 cropping season. Results obtained indicated that growth and yield of okra was lowest in control treatments which showed that the organic manure and sowing date used in the study especially poultry manure and sowing date of 5th June, 2013 positively influenced the performance and yield of okra. Poultry manure and sowing date 5th June, 2013 positively increased okra plant height and number of leaves plant^{-1}, number of branches plant^{-1}, number of pods plant^{-1}, pod yield plot^{-1} and pod yield hectare^{-1} compared to control treatments. There was no significant effect with respect to leaf area plant^{-1}, pod length plant^{-1} and pod girth. Based on the findings of this experiment it could be deduced that poultry manure and sowing date of 5th June, 2013 promoted higher growth and yield of okra.

Amir and Madani (2014) carried out an experiment to evaluate the effects of irrigation intervals and planting dates on fresh pod yield and yield components of okra. Irrigation treatment at three levels and planting dates were applied at five levels (30th April, 7th May, 14th May, 21th May and 28th May). Results showed that the effect of planting date on the means of all traits were significant; so that delayed planting date from 30th April to 14th May, increased all means of above mentioned traits significantly and then to 28th May showed a decreasing trend. The highest fresh pod yields were obtained on 14th May (10235 kg ha^{-1}) and 5 days irrigation interval (9993.5kg ha^{-1}).

An experiment was conducted by Elhag and Ahmed (2014) for two consecutive years (2008/2009) at the Experimental farm, College of Agricultural Studies, Sudan University of Science and Technology. The effects of three sowing dates, 1st and 20th of July and 10th of August on seed yield of two okra cultivars

(Khartoumia and Wad Gammer) were studied. The results showed that late sowing (20th of July and 10th of August) had significant negative effects on both vegetative growth and seed yield of both cultivars in both years. The best vegetative growth and seed yield were obtained at 1st of July. Almost similar negative response of both cultivars to late sowing was noticed. It could be concluded that both okra growth and seed yield were significantly negative affected by late sowing (last week of July or later). Although no significant differences were noticed between the two cultivars in their response to sowing date okra cultivars might differ in their response to sowing date. Accordingly for high okra seed yield sowing on the first two weeks of July may be recommend for Khartoum State and areas of similar conditions.

Ghannad *et al*. (2014) carried out an experiment to study the effects of different sowing dates, irrigation regimes and sowing methods on morphological and yield related characters of okra. Experimental factors were including irrigation regime at two levels of 7 days and 10 days in which placed in vertical plots, sowing date at three levels of 15 May, 31 May and 15 June, and sowing method in two levels of top of the furrow and within the furrow. The effect of sowing date was also significant in all traits, so that delaying the sowing date from 15 May to 31 May, led to decrease the average of all the studied traits and this trend was continued to 15 June. The results of this study was also showed that sowing the seeds within the furrow was better than top of the furrow. In conclusion, sowing date of 15 May and irrigation interval of 7 days accompanied by seed sowing within the furrow led to achieve highest yield and yield components.

Zeb *et al*. (2015) conducted an experiment to monitor the effect of different sowing dates on the yield and seed production of okra cultivars, an experiment was conducted at Agricultural Research Station, Baffa Mansehra. Six cultivars of okra i.e. Irka, Sabz Pari, Pusa Green, Pusa Sawani, Sarhad Green and Green Star were sown on three different sowing dates with 15 days interval i.e. 15th March, 30th March and 14th April, 2008. Maximum number of pods plant^{-1}

(32.12), pod length (11.12 cm), pod diameter (1.54 cm), pod weight (15.24 g), plant height (184.28 cm), number of branches plant^{-1} (9.12), pod yield (16.24 t ha^{-1}), seed yield (1601.92 kg ha^{-1}) and 1000-seed weight (86.92 g) were recorded in cultivars, sown on 30th March, 2008. Sowing of okra cultivar Sabz Pari on 30th March is recommended for realizing maximum fresh pod and seed yields under the agro-climatic conditions of Mansehra District.

A field experiment was undertaken by Bake *et al*. (2017) to find out the individual as well as the interaction effects along with the suitable combinations of sowing date and planting distance to evaluate the growth, yield, and quality of okra at two locations viz., Vegetable Research Farm, BHU, Varanasi and Lalganj Village, Mirzapur, Uttar Pradesh during the year 2015 and 2016. Three sowing dates at ten days interval i.e., 10th (D_1), 20th (D_2), and 30th June (D_3), and three planting distances were used for these experiment. Among the different treatments intermediate spacing (60 × 60 cm) with D_3 (30th June sowing) performed better than other treatments for most of the growth, flowering, yield, and quality characteristics. Therefore this combination can be recommended after conducting more trials so as to arrive at conclusive findings for the farmers of Varanasi, Mirzapur, and adjoining areas.

A field experiment was carried out by Morwal and Patel (2017) out during kharif season at Dantiwada Agricultural University, Sardarkrushinagar to study the effect of sowing dates and spacing on growth and yield of okra var. Parbhani Kranti. The experiment was laid out with sixteen treatment combinations consisted of four dates of sowing viz., 15th August (D_1), 1st September (D_2), 15th September (D_3) and 1st October (D_4) and four plant spacing. The growth and yield attributes like plant height (cm), stem girth, leaf area index, average length of internodes, flower parameters, number of fruits per plant and fruit yield per hectare were significantly higher under sowing on 15th August with plant spacing 30 cm × 30 cm but fruit yield per plant was significantly higher on 15th August at 45 cm × 45 cm.

2.2 Effect of fertilizer amendment on growth and yield of okra

2.2.1 Effect of recommended doses of chemical fertilizer

Gowda *et al*. (2001) was conducted a field experiment in Bangalore, Karnataka, India in summer season to determinate the response of okra cultivars Arka Anamika, Varsha and Vishal to 3 NPK fertilizer rates (125:75:60 kg/ha, 150:100:75 kg/ha and 175:125:100 kg/ha). The highest dry matter production in leaves (20.40 g), stems (35.17 g), roots (18.03 g), fruits (31.11 g) and whole plants (104.71 g) was recorded with 175:125:100 kg NPK/ha treatments. Varsha recorded significantly higher dry matter production in leaves (17.48 g), stems (31.44 g), roots (17.61 g), fruits (29.98 g) and whole plants (96.51 g) compared with the other cultivars. In the interaction effect, the highest total dry matter production (1111.48 g/plant) was recorded in Varsha supplemented with 175:125:100 kg NPK/ha, which was at per with Arka Anamika supplemented with 175:125:100 kg NPK/ha.

An experiment was conducted by Patton *et al.* (2002) to study effect of different levels of nitrogen and phosphorus on growth, flowering and yield of okra cv. Arka Anamika grown under the foothills of Nagaland. Three doses N (50, 100, and 150 kg/ha) and P (0, 60, and 90 kg/ha) were used. P as single superphosphate was applied along with half of the N (urea) rate during sowing. The remaining N was applied at 30 days after sowing. N at 150 kg/ha and P at 90 kg/ha gave the greatest plant height (159.15 and 137.37 cm) and number of leaves per plant (24.98 and 23.57), the longest flowering duration (86.19 and 84.77 days), and the lowest number of days to flowering (40.93 and 41.48 days after sowing). N at 100 and 150 kg/ha resulted in the longest pods (15.81 and 16.72 cm) and the highest pod diameter (1.81 and 1.82), pod weight (19.74 and 20.19 g), pod number per plant (13.88 and 14.53), and pod yield per plant (274.14 and 293.75 g). P at 60 and 90 kg/ha recorded the greatest pod length (15.06 and 15.27 cm), pod diameter (1.75 and 1.77 cm), seed number per pod (50.00 and 49.87), pod weight (18.75 and 18.63 g), and pod yield (248.35 and 252.00 g). In general, the interaction between N and P rates was not significant.

A study was undertaken by Shanke *et al.* (2003) to assess the seed yield potential and other growth characters of okra cv. Parbhani Kranti under 5 levels of N (0, 50, 75, 100 and 125 kg/ha) and 4 levels of P (0, 25, 50 and 75 kg/ha) with agro-climatic conditions of Akola, Maharashtra, India. There was a linear increase in plant height with the application of N and P. The tallest plant (68.88 cm) was recorded under 125 kg N/ha and the shortest (54.90 cm) under no N. A similar trend was observed in respect of P application. The interaction effect between N and P was found to be significant, indicating maximum plant height with higher N and P levels. The number of fruits per plant increased significantly with an increase in N level. The highest number of fruits (5.78) was observed with 125 kg N/ha. Full fruit length and weight were also found highest (15.61 and 19.6 cm, respectively) in this treatment. The effect of application of P was also observed significant for fruit length, fruit number per plant and fruit weight, the highest values for these parameters being recorded at 75 kg P/ha. The maximum seed yield per plot (0.330 kg) was observed with the highest levels of N and P.

Aslam and Bose (2003) reported that excessive use of nitrogen fertilizer is a factor of nitrate accumulation in vegetable, which cause health problems to the consumers. A study was conducted to assess the effect of NPK fertilizer on NO_3 accumulation in okra (*Abelmoschus esculentus*) and carrot (*Daucus carota*) at Ayub Agricultural Research Instute, Faisalabad, Pakistan. For okra five (0, 100, 150, 175 and 200 kg N/ha) and two P_2O_5 rates (0, 75 kg/ha) were tested with 60 kg K_2O/ha as basal dose. Increasing fertilizer rates increased NO_3 concentration over the control in okra. Additionally, the doses of NPK fertilizer applied in this study did not pose health hazards to the consumers.

Bamel and Sing (2003) conducted a plot experiment to study the effect of different fertilizer sources on *M. incognita* in okra under greenhouse condition. Better plant growth and reduced nematode damage when a combination of N, P, K and Zn fertilizer was applied at recommended dose. Individually, murate of potash and potassium sulfate at higher doses recorded maximum plant growth.

Field experiments were conducted by Sunita *et al*. (2006) for two consecutive years at the Feirsa Agricultural University, Ranchi, Jharkhand, India, to determine the effects of intercrop and NPK fertilizer application on the performance of okra. Treatments comprised: two intercrops (cowpea and French bean) and five fertilizer rates (0, 25, 50, 75 and 100% recommended dose of NPK). The results revealed that treatment with 100% recommended dose of fertilizer recorded higher okra equivalent yield (153.16 q/ha) and net returns (Rs. 30,709.91/ha) than the rest of the fertilizer rates. The best performance of okra in terms of yield, number of fruits per plant, fruit weight and plant height were observed with 100% recommended dose of fertilizer.

A study was conducted by Omotoso and Shittu (2007) to determine the effect of NPK fertilizer application rates and method of application on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) at the Teaching and Research Farm, University of Ado-Ekiti. Okra seed variety LD88 were treated to three levels of NPK fertilizer rates (0, 150 and 300 kg NPK ha^{-1}) and two methods of fertilizer application. Treatments were arranged in a split-plot design with fertilizer application method as main plot factor and NPK rates as sub-plot factor. The treatments were replicated three times to give a total of eighteen experimental field plots. The result indicated that the fertilizer NPK significantly increase growth parameters (plant height, leaf area, root length, number of leaves), yield and yield components with optimum yield of okra obtained from NPK @ 150 kg ha^{-1}.

The influence of NPK 20-10-10 on the fresh pod yield and root growth of okra variety, V 35 grown in the lowland humid tropics was investigated by Awe *et al*. (2009). Four rates (0, 150, 300 and 450 kg/ha) of the fertilizer were applied to the crop. The treatments were replicated three times in a Randomized Complete Block design. The results suggest that the optimum NPK 20-10-10 level for okra variety, V 35 in the study area lies between 300-450 kg NPK 20-10-10/ha.

Therefore, application rates above 450 kg NPK 20-10-10/ha for okra production in the study area will not be economical.

Field experiments were conducted by Philip *et al*. (2010) at the Teaching and Research Farm of the Department of Crop Science, Adamawa State University, Mubi with the aim of assessing the effect of spacing and NPK fertilizer on the yield and yield components of okra. Treatments consisted of four spacing and four NPK rates (0, 100, 150 and 200 kg ha^{-1}). Results showed that number of fruits per plant and length of fruits were significantly affected by fertilizer levels. There was significant interaction in respect to fresh weight of fruits per hectare and the results also indicated that spacing of 90×30 cm and application of 150 kg ha^{-1} (22.5 kg N, 22.5 kg P_2O_5 and 22.5 kg K_2O_5) of NPK gave the highest yield of okra in Mubi.

The study was designed by Achebe *et al*. (2013) to investigate the effect of different levels of N.P.K fertilizer on six cultivars of Okra (*Abelmoschus esculentus*). Data collected at different sampling periods included plant height, total leaf area, number of pods and fresh weight of pods. The application of N.P.K 20:10:10 at 250kg/ha level was significantly different from others in growth and yield parameters. Higher mean values were observed with 250kg/ha level followed by 150kg/ha. Cultivar LD –88 performed better in number of pods and fresh pod weight. Other cultivars had areas where they performed well. The application of 250kg/ha level of N.P.K.20:10:10 fertilizer is appropriate in attaining high pod yield in Asaba and Cultivar LD-88 showed the best performance in Asaba soil.

Field studies were carried out by Iyagba *et al*. (2013) at the Federal University of Technology, Owerri, Nigeria to determine the response of okra (*Abelmoschus esculentus* (L.) Moench) to NPK fertilizer rates at different weeding regimes. Okra seeds variety, NHAe47-4 were treated to four levels of NPK fertilizer rates (0, 100, 200 and 300 kg ha^{-1}) and five weeding regimes. Plant height and leaf area were in the increasing order of 0>100>200>300 kg ha^{-1}. More flowers/plant

were obtained by applying 300kg ha^{-1} of NPK while the least number of flowers/plant aborted was obtained with the application of 200 and 300 kg ha^{-1} in both years. Among the weeded plots, okra plots applied with 300 kg ha^{-1} of NPK fertilizer produced the highest fruit yield (26.50 t ha^{-1}) which was not significantly different with the application of 200 kg ha^{-1} of NPK fertilizer in both years.

The study was conducted by Khetran *et al*. (2016) at Vegetable Seed Production Farm Quetta to investigate the effect of different doses of NPK fertilizer on growth of okra. Data regarding height of plant revealed that T_5 (140 kg N/ha, 100 kg P/ha and 60 kg K/ha) had significant superiority over other means. M5 was at the top position and Control was at the bottom because there was no application of fertilizer. Analysis of variance regarding number of flowers per plant, fruits per plant, pod yield indicated highly significant results for fertilizer treatments for this factor of study. It was also noted from that with increase of fertilizer applications, number of flower increased accordingly while results expressed the more the fertilizer better length of green pods. K is needed for good quality of yield.

The experiment was carried out by Gloria *et al*. (2017) at Federal College of Forestry, Jos to examine the effect of different levels of NPK fertilizer on the growth and yield of Okra. The treatments comprises of 10grams of NPK 15:15:15, 13 grams of NPK 15:15:15 and Control. The result showed that there was no significant difference in the effect of different levels of NPK fertilizer on plant height, number of leaf, leaf area, leaf length, number of fruits per plant, collar girth and yield of okra. But however, 13grams had the highest number of plant emergence count followed by 10grams while in terms of fresh pod yield, 10grams did better followed by the control treatment. It can therefore be concluded that 13 grams of NPK fertilizer has the best potentials of increasing okra growth in the study area.

2.2.2 Effect of recommended doses of chemical fertilizer and vermicompost

Prabu and Pramanik (2002) conducted an experiment in Parbhani, Maharashtra, India, during the summer season of 2001 to investigate the effects of organic fertilizer at 0, 1/3, 2/3 and full rate (N: P: K at 100: 50: 50 kg/ha), in the presence or absence of farmyard manure (FYM at 10 t/ha), and bio-fertilizer (un inoculated; *Azospirillum* + phosphate sollubilizing bacteria, and *Azospirillum* + vesicular arbuscular mycorrhiza) on the performance of okra cultivar Parbhani Kranti. Result showed that the treatment 2/3 recommended NPK dose + FYM + *Azospirillum* vesicular arbuscular mycorrhiza produced the highest yield.

Yadav *et al.* (2004) conducted an experiment at Jobner, India to study the effects of different levels of organic manures and N fertilizer (urea) on the growth and yield of okra cv. Varsha Upahar. The treats consisted of 100% recommended dose of N, 75% N as urea + 25% N as Farm Yard Manure (FYM), Poultry Manure (PM) or Vermicompost (VC), 50% N as urea + 50% N as FYM, PM or VC, 25% N as urea + 75% N as FYM, PM or VC and 100% N as VC. The treatment involving 50% N as urea + 50% N as FYM, PM or VC recorded the highest yield (90.61 q/ha).

An experiment was conducted by Rajpaul *et al*. (2006) in Haryana, India, to determine the effects of saline water, farmyard manure (FYM) and phosphorus on the performance of four okra cultivars. The cultivars were grown under irrigation with 0.65 (canal), 2.75 (EC_1), 5.00 (EC_2) and 8.50 dS/m (EC_3) saline water. FYM at 15 t/ha, FYM + phosphorus at 50% above the recommended dose, and FYM + phosphorus at 100% above the recommended dose were applied in the highest EC saline water. The addition of a double dose of phosphorus further increased the germination from 78.6 to 79.2% and plant height from 44.8 to 47.2 cm. HRB 108 had the highest germination (87.4%) followed by Versa Uphar (85.3%), Hisar Unnat (83.8%) and HRB 107 (83.4%). Addition of FYM and phosphorus had no significant effect on the number of plants of okra.

A field experiment was conducted by Khan *et al*. (2007) in Medziphema, Nagaland, India, on a sandy loam soil having 5.3 pH, 4.5% organic carbon, 208.0 kg/ha available N, 12.3 kg P_2O_5/ha and 189.6 kg K_2O/ha to study the response of okra to biofertilizer and N application in terms of growth, yield and leaf nutrient (N, P and K) status. The treatments consisted of five levels of N (0, 30, 60, 90 and 120 kg/ha) and four levels of biofertilizer. The application of N and biofertilizer significantly increased the growth and yield.

To study the effect of sources of nutrients (organic and inorganic and biofertilizer on growth, yield and economic of okra cv. VRO-6 the present experiment was conducted by Mishra *et al*. (2009) at Indian Institute of Vegetable Research, Varanasi. The results revealed significant improvement in all the growth and yield parameters over recommended dose of NPK. The maximum length of fruit, diameter of fruit, fresh weight of fruit, dry weight of fruit and yield was recorded with application of vermicompost @ 2.5 t/ha+NPK (120:60:60 kg/ha) + PSB + Azotobacter over rest of the treatments. The maximum net profit Rs 40,332.53 and cost benefit ratio 1:1.06 was recorded under the source treatment.

Sharma *et al*. (2009) carried out an experiment to find out the effect of applying organic manures (vermicompost and farmyard manure) and inorganic fertilizer on yield and nutrient uptake by okra *(Abelmoschus esculentus*) and onion (*Allium cepa*) and nutrient build up in the soil was studied under field conditions. Highest yield of okra was recorded in the treatment comprising 100% recommended NPK + vermicompost @ 10 t ha^{-1}, 11.10 and 11.63 t ha^{-1}. Also revealed that yield of okra obtained at 5 t vermicompost ha^{-1} plus 100% NPK (9.73 and 10.83 t ha^{-1}) was at par with that under 10 t farmyard manure plus 100% NPK (10.03 and 10.46 t ha^{-1}).

An investigations were carried out by Ansari and Sukhraj (2010) at University of Guyana, Georgetown focusing on recycling organic waste using vermitechnology and use of vermicompost and vermiwash obtained from the

vermitech in varied combinations for exploring the effect on soil and productivity of Okro in Guyana. The study revealed that combination organic fertilizer vermicompost and vermiwash combination compared with control and chemical fertilizer had great influence on plant growth parameters. The average yield of okra during trial showed a significantly greater response in comparison with the control by 64.27%.

The experiment was carried out Sharma *et al*. (2014) by to see the effect of NPK, vermicompost and various sprays of vermiwash on growth, yield and economics of okra var. Kashi Pragati. The treatment combination vermicompost @ 5 t/ha+vermiwash 5 sprays at 10 days interval after 30 DAS showed maximum plant height (128.09 cm), nodes per plant (40.80), internodal length (8.03 cm), days taken to 50% flowering (46 days) and nodes to first flowering (8.20). Among the fruit characters, number of fruits per plant (21.36), fruit length (13.31 cm), fruit girth (17.01 mm), fruit weight (14.33 g), fruiting span (48.66 days), fruit yield per plant (134.48 g) and yield per hectare (74.62 q) were observed maximum by the application of vermicompost @ 5 t/ha + vermiwash 5 sprays at 10 days interval after 30 DAS. However, the maximum C:B ratio of 1:1.94 was obtained by application of Recommended dose of NPK + vermiwash as soil treatment + vermiwash 3 sprays at 10 days interval after 30 DAS followed by the treatment vermicompost @ 5 t/ha + vermiwash 5 sprays at 10 days interval after 30 DAS.

A field experiment was conducted by Das *et al*. (2014) to study the response of chemical fertilizer and vermicompost on okra (*Abelmoschus esculentus* L.) var. Pravani kranti. The treatments involved was T_1: 100% chemical fertilizer + 0% vermincompost, T_2: 75% chemical fertilizer + 25% vermincompost, T_3: 50% chemical fertilizer + 50% vermicompost, T_4: 25% chemical fertilizer + 75% vermincompost, and T_5: 0% chemical fertilizer + 100% vermincompost. The results revealed that the application of T_3 had a significant effect on growth and yield of okra. Results showed that maximum plant height (106.13 cm), node per

plant (7.75), pod per plant (18.65), pod yield per plant (149.46 g), length of pod (17.60cm), 50% flower initiation (40 DAS) and yield per ha (110.24 q) were produced with T_3 whereas number of seed per pod were found with the T_1.

The field experiment was carried out by Lakra *et al*. (2017) at soil science research farm of Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad with three levels of NPK @ 0, 50, and 100 % ha^{-1}, three levels of vermicompost @ 0, 50 and 100% ha^{-1} respectively. The result obtained from NPK@ 50% + Vermicompost @ 100% showed that the highest yield regarding, gave the best results with respect to plant height 115.69 cm, number of leaves per plant 49.33, Number of branch 48.50, Number of Fruit per plant 20.71, it gave highest yield, 199.21 q ha^{-1}. The maximum cost benefit ratio was recorded 1: 8.55 and net profit. Rs. 37,154.6 ha^{-1} in treatment combination @ 50%NPK ha^{-1} + 100% Vermicompost ha^{-1} combined use of N, P and K resulted in significant increase on enrichment of soil fertility status. It was also revealed that the application of NPK with Vermicompost were excellent source for fertilization than fertilizer. The treatment NPK@ 50% + Vermicompost @ 100% showed greater benefit cost ratio followed by other treatments.

Esther and Iren (2018) carried out an experiment at two locations within the University of Calabar Teaching and Research Farm with applying different rates of inorganic fertilizer (NPK 20:10:10) and organic fertilizer (neem seed) and their combinations on plant nutrient concentration and yield of okra. Amongst the two rates (100 and 120 kg N/ha) of sole application of either NPK or neembased organic fertilizer, the 120 kg N/ha recorded highest number of fruits set and okra fresh fruit yield. The combination of 60 NPK + 60 Neem kg N/ha increased the yield (8.43 t/ha) and yield components of okra while the 90 NPK + 30 Neem kg N/ha and 30 NPK + 90 Neem kg N/ha increased nutrient concentration in the okra plant. Thus for sole application, the 120 kg N/ha of either nutrient source is appropriate, but for optimum yield of okra in the tropical

rainforest zone of Nigeria, the combination of both organic and inorganic fertilizer especially at 60 kg N/ha of each nutrient source is recommended.

Meena and Meena (2018) conducted a field experiment at the Horticulture Research Farm II, Department of Horticulture, School of Agricultural Science & Technology, Babasaheb Bhimrao Ambedkar University, to find out the effect of integrated nutrient management (INM) on growth of okra. The results indicated that application of treatment T_{13} (RDF + Vermicompost) were maximum plant height (cm) 30 DAS, 60 DAS and 90 DAS, number of branch per plant, stem diameter (mm), number of flower buds and days to 50% flowering under the treatment T_{13} has obtained better response of okra over the control.

A field experiment was carried out by Singh *et al*. (2018) at Vegetable Research Farm, Department of Horticulture, Bihar Agricultural University, Sabour to study the integrated effect of bio-inoculants, organic and chemical fertilizer on growth, yield and economics of okra. Results revealed that the application of 75% RDN through chemical fertilizer + 25% N through vermicompost + Azotobacter @ 20 g kg^{-1} of seed+ PSB @ 20 g kg^{-1} of seed (T_{14}) influenced most of the characteristics significantly and recorded the highest values of plant height, number of branches per plant, fruit length, average fruit weight, number of fruits per plant, yield per hectare and B:C ratio (1.62) except number of nodes to first flower appearance, days taken to 50% flowering and days to first picking, which were the minimum under same treatment (T_{14}).

From the review of literature cited above it is clear that sowing date and fertilizer amendment especially inorganic and organic fertilizer have tremendous influence on the growth and yield attributes and yield okra. Therefore, research on aforesaid issues emerges an integrate part for okra production.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out to find the growth and yield of okra as influenced by sowing date and fertilizer amendment. The details materials and methods that were used for conducting the experiment have been presented in this chapter under the following headings and sub-headings-

3.1 Experimental location

The experiment was conducted at the period of February to July 2018 in the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the experimental site is $23^0 74^/$N latitude and $90^0 35^/$E longitude with an elevation of 8.2 meter from sea level.

3.2 Characteristics of soil

The soil of the experimental field belongs to the Tejgaon series under the Agroecological Zone, Madhupur Tract (AEZ-28) and the General Soil Type is Deep Red Brown Terrace Soils. The soil was having a texture of sandy loam with pH and organic matter capacity 5.6 and 0.78%, respectively and the the soil composed of 27% sand, 43% silt, 30% clay. Details descriptions have been presented in Appendix I.

3.3 Climatic condition

The climate of experimental site is subtropical, characterized by three distinct seasons, the monsoon, pre-monsoon period or hot season and the monsoon period. The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix II. In relation to the temperature of the study period the maximum temperature (35.1^0C) was recorded in the month of July 2018, while the minimum temperature (16.7^0C) in the month of February 2018. The highest humidity (81%) was recorded in the month of June, 2018, whereas the highest rainfall (298 mm) was recorded in the month of July, 2018 and highest sunshine hour (7.8 hour) was recorded in May, 2018.

3.4 Planting materials

BARI Dherosh-2 was used as planting materials for this experiment and the seeds were collected from Bangladesh Agricultural Research Institute.

3.5 Treatments of the experiment

The experiment consisted of two factors:

Factor A: Sowing dates (3 levels) as

i. S_1: Sowing at 1st March, 2018
ii. S_2: Sowing at 15th March, 2018
iii. S_3: Sowing at 30th March, 2018

Factor B: Fertilizer amendment (4 levels) as

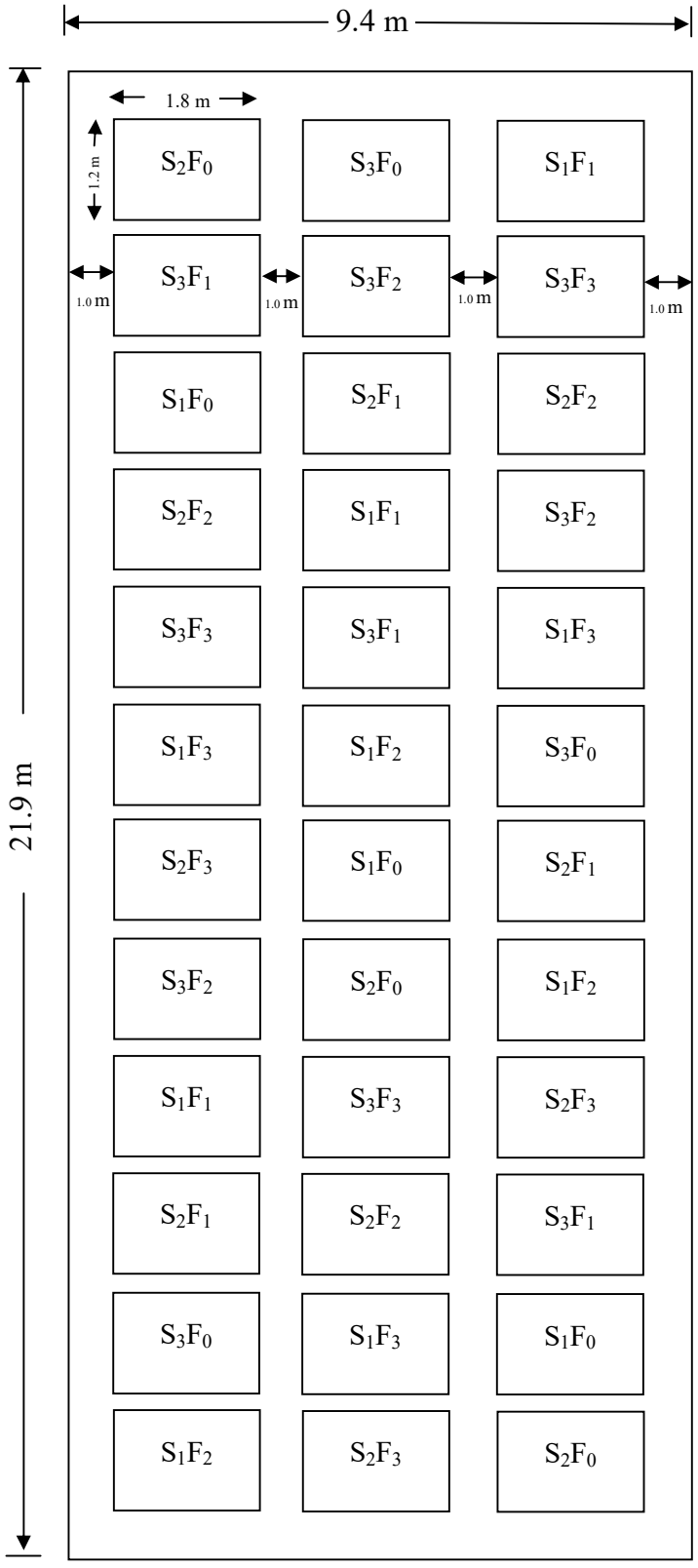
i F_0: No nutrients (control)
ii. F_1: RFD of NPK fertilizer
iii. F_2: Vermicompost @ 4 t ha^{-1}
iv. F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively as per Bangladesh Agriculture Research Institute-BARI)

There were 12 (3×4) treatments combination such as S_1F_0, S_1F_1, S_1F_2, S_1F_3, S_2F_0, S_2F_1, S_2F_2, S_2F_3, S_3F_0, S_3F_1, S_3F_2 and S_3F_3.

3.6 Design and layout

The two-factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The total area of the experimental plot was 205.86 m^2 with length 21.9 m and width 9.4 m which were divided into three equal blocks. Each block was divided into 12 plots where 12 treatments combination allotted at random. There were 36 unit plots and the size of each plot was 1.8 m × 1.2 m. The distance between two blocks and two plots were 1.0 m and 0.5 m, respectively. The layout of the experiment is shown in Figure 1.



Plot size: 1.8 m × 1.2 m

Plot spacing: 0.50 m

Between block: 1.00 m

Plant spacing: 60 cm × 40 cm

Factor A: Sowing dates (3 levels) as

i. S_1: Sowing at 1st March, 2018

ii. S_2: Sowing at 15th March, 2018

iii. S_3: Sowing at 30th March, 2018

Factor B: Fertilizer amendment (4 levels) as

i F_0: No nutrients (control)

ii. F_1: RFD of NPK fertilizer

iii. F_2: Vermicompost @ 4 t ha^{-1}

iv. F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

Figure 1. Layout of the experimental plot

3.7 Land preparation

The selected experimental plot was opened in the 2nd week of February 2018 with a power tiller, and left exposed to the sun for a week. Subsequently cross ploughing was done with a country plough followed by laddering to make the land suitable for seeds sowing. All weeds, stubbles and residues were eliminated and finally, a good tilth was achieved. The soil was treated with Cinocarb 3G @ 4 kg/ha at the time of final land preparation to protect young plants from the attack of soil inhibiting insects such as cutworm and mole cricket.

3.8 Application of manures and fertilizer

Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MoP) were used as a source of nitrogen, phosphorous, and potassium, respectively. Vermicompost and NPK fertilizer that were applied as per treatment of fertilizer amendment. The total amount of Vermicompost, TSP and MoP was applied as basal dose at the time of final land preparation dated at 27 April, 2018. The total amount of urea was applied in three equal installments at 15, 30 and 45 day after sowing.

3.9 Seeds sowing

The okra seeds were sown in the main field at at 1st March, 2018, 15th March, 2018 and 30th March, 2018 as per treatment. Seeds were treated with Bavistin before sowing the seeds to control the seed borne diseases. Two seeds were sown in every pit in rows having a depth of 2-3 cm with maintaining distance from 60 cm and 40 cm from plant to plant and row to row, respectively. So there were 18 seeds were sown in a plot.

3.10 Intercultural operation

After raising seedlings, various intercultural operations such as gap filling, weeding, irrigation pest and disease control etc. were accomplished for better growth and development of the okra seedlings.

3.10.1 Gap filling

The seedlings in the experimental plot were kept under careful observation. Very few seedlings were damaged after germination and such seedling were replaced

by new seedlings. Replacement was done with healthy seedling in the afternoon having a boll of earth which was also planted on the same date by the side of the unit plot. The seedlings were given watering for 7 days starting from germination for their proper establishment.

3.10.2 Weeding

The weeding was done by nirani with roots at 15, 30 and 45 days after sowing to keep the plots free from weeds.

3.10.3 Irrigation

Light watering was given by a watering cane at every morning and afternoon and it was continued for a week for rapid and well establishment of the germinated seedlings.

3.10.4 Pest and disease control

Insect infestation was a serious problem during the period of establishment of seedings in the field. In spite of Cirocarb 3G applications during final land preparation few young plants were damaged due to attack of mole cricket and cut worm. Cut worms were controlled both mechanically and spraying Darsban 29 EC @ 3%. Some discolored and yellowish diseased leaves were also collected from the plant and removed from the field.

3.11 Harvesting

Fruits were harvested at 5 days interval based on eating quality at soft and green condition. Harvesting was started from 16 May, 2018 and was continued up to the last July 2018.

3.12 Data collection

Five plants were randomly selected from the middle rows of each unit plot for recording growth parameters except yields of plots, which was recorded plot wise. Data were recorded on plant height, number of leaves/plant, leaf length petiole length, number of branches/plant and stem diameter were collected at 30,

45, 60 and 75 DAS. All other yield contributing characters and yield was also recorded as per the suitable time of data collection.

3.12.1 Plant height

Plant height was measured from sample plants in centimeter (cm) from the ground level to the tip of the longest stem of five plants and mean value was calculated. Plant height was also recorded at 15 days interval starting from 30 days after sowing (DAS) upto 75 days to observe the growth rate of plants.

3.12.2 Number of leaves/plant

The total number of leaves/plant was counted from each selected plant. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot from 30 DAS to 75 DAS at 15 days interval.

3.12.3 Leaf length

Leaf length was measured from sample plants in centimeter (cm) from the one side to another side of leaf of the longest five leaves and mean value was calculated. Length of petiole was also recorded at 15 days interval starting from 30 days after sowing (DAS) upto 75 days to observe the growth rate of plants.

3.12.4 Petiole length

Petiole length was measured from the longest petiole of 5 sample plants in centimeter (cm) and mean value was calculated. Length of petiole was also recorded at 15 days interval starting from 30 days after sowing (DAS) upto 75 days to observe the growth rate of the plants.

3.12.5 Number of branches/plant

The total number of branches/plant was counted from each selected plant. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot from 30 DAS to 75 DAS at 15 days interval.

3.12.6 Stem diameter

Stem diameter was measured from sample plants with a digital calipers-515 (DC-515) from the three different parts of five plants and mean value was calculated in centimeter (cm). Stem diameter was recorded at 15 days interval

starting from 15 days after sowing (DAS) upto 75 days to observe the growth rate of plants.

3.12.7 Days to starting of flowering

Days to starting of flowering was recorded from the date of sowing to the initiation of 1st flower bud.

3.12.8 Fresh weight/plant

At 75 DAS selected okra plants from inner rows were pulled out then clean and weighted by a digital weighing machine and average was weight was taken and express in gram (g).

3.12.9 Dry matter content in plant (%)

At 75 DAS after taking fresh weight the sample it was sliced into very thin pieces and put into envelop then placed in oven maintained at 68^{0}C for 72 hours. It was then transferred into desiccators and allowed to cool down at room temperature. The final dry content was taken by following formula:

$$\text{Dry matter content of leaves} = \frac{\text{Dry weight of leaves (g)}}{\text{Fresh weight of leaves (g)}} \times 100$$

3.12.10 Number of flower buds/plant

The number of flower buds/plant was counted from the sample plants and the average numbers of flower buds produced per plant were recorded.

3.12.11 Number of pods/plant

The number of pods/plant was counted from the sample plants for the whole growing period and the average number of pods produced/plant was recorded and expressed in pods/plant.

3.12.12 Pod length

Pod length was measured and expressed with a meter scale from the neck of the fruit to the bottom of 10 selected marketable fruits from each plot and there average was taken and expressed in centimeter (cm).

3.12.13 Pod diameter

Pod diameter was measured at the middle portion of 10 selected marketable fruit from each plot with a digital calipers-515 (DC-515) and average was taken and expressed in centimeter (cm).

3.12.14 Weight of individual pods

The weight of individual pod was measured with a digital weighing machine from 10 selected marketable fruits from each selected plots and there average was taken and expressed in gram.

3.12.15 Pod yield/hectare

Pod yield per hectare of okra fruits was estimated by converting the weight of plot yield/plant into hectare and was expressed in ton.

3.13 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference for different levels of GA_3 and phosphorus on growth and yield of okra. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

3.14 Economic analysis

The cost of production was analyzed in order to find out the most economic combination of different levels of GA_3 and phosphorus for okra cultivation. All input cost included in computing the cost of production and the interests were calculated @ 12% in simple rate. The market price of okra was considered for estimating the cost and return. Analyses were done according to the procedure of Alam *et al*. (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}$$

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

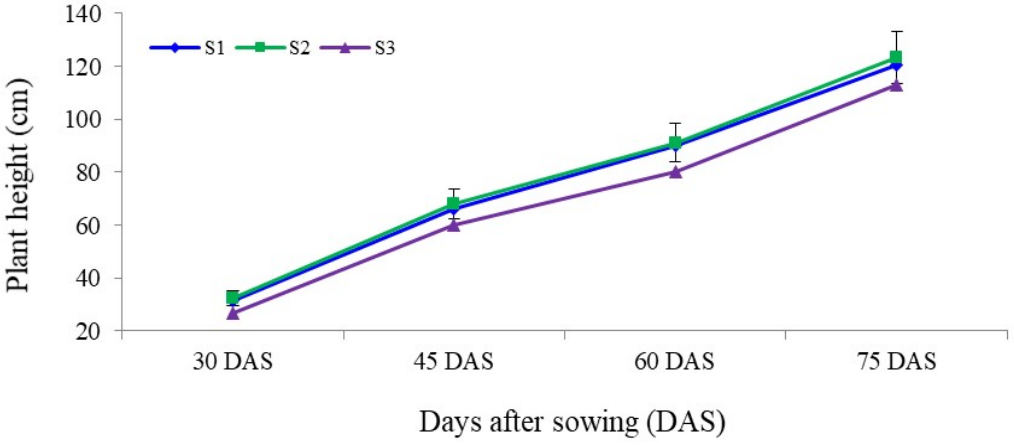
RESULTS AND DISCUSSION

The experiment was carried out to find the growth and yield of okra as influenced by sowing date and fertilizer amendment. The analyses of variance (ANOVA) of the data on different growth, yield contributing characters and yield are presented in Appendix III-X. The results have been presented and discusses with the help of table and graphs with possible interpretations under the following headings:

4.1. Plant height

Plant height of okra showed statistically significant differences at 30, 45, 60 and 75 DAS (days after sowing) due to different sowing date (Figure 2 and Appendix III). At 30, 45, 60 and 75 DAS, the tallest plant (32.42, 67.99, 91.08 and 123.39 cm, respectively) were recorded from S_2 (sowing at 15th March, 2018) treatment which was statistically similar (31.45, 66.02, 89.99 and 120.51 cm, respectively) to S_1 (sowing at 1st March, 2018) treatment, whereas the shortest plant (26.98, 60.02, 79.98 and 113.14 cm, respectively) was observed from S_3 (sowing at 30th March, 2018) treatment. Variety is the key component to produce plant height of okra depending upon their genotypic differences, input requirements and response, growth process and off course the prevailing environmental conditions during the growing season. Naz *et al*. (2009) reported that sown on 19th April registered the greatest plant height (110.8 cm) of okra.

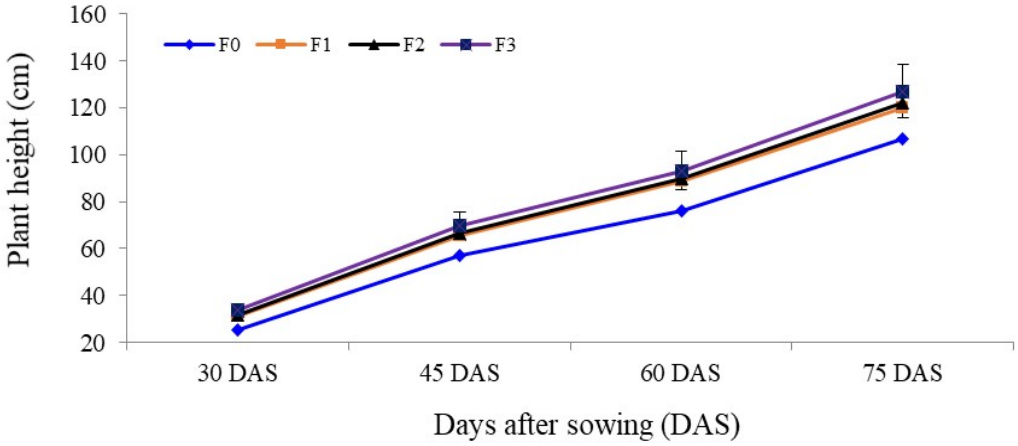
Statistically significant variation was recorded in terms of plant height of okra at 30, 45, 60 and 75 DAS for different fertilizer amendment (Figure 3 and Appendix III). At 30, 45, 60 and 75 DAS, the tallest plant (33.63, 69.53, 93.27 and 127.10 cm, respectively) was found from F_3 (vermicompost @ 2 t + 50% RFD of NPK fertilizer) treatment which was statistically similar (31.79, 66.48, 89.81 and 121.95 cm, respectively) to F_2 (vermicompost @ 4 t ha^{-1}) and followed (30.96, 65.79, 88.94 and 120.10 cm, respectively) by F_1 (RFD of NPK



S_1: Sowing at 1st March, 2018 S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

Figure 2. Effect of different sowing date on plant height of okra at different days after sowing. (Vertical bars represent LSD value at 5% level of probability)



F_0: No nutrients (control) F_1: RFD of NPK fertilizers

F_2: Vermicompost @ 4 t ha^{-1} F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizers

Figure 3. Effect of different fertilizer amendment on plant height of okra at different days after sowing (Vertical bars represent LSD value at 5% level of probability)

fertilizer), while the shortest plant (25.29, 56.91, 76.04 and 106.91 cm, respectively) from recorded from F_0 (no nutrients, i.e. control) treatment. Das *et al*. (2014) reported that maximum plant height (106.13 cm) were produced with 50% chemical fertilizer + 50% vermicompost.

Combined effect of different sowing date and fertilizer amendment showed significant variation on plant height of okra at 30, 45, 60 and 75 DAS (Table 1 and Appendix III). At 30, 45, 60 and 75 DAS, the tallest plant (37.00, 75.75, 99.25 and 136.88 cm, respectively) was found from S_2F_3 (sowing at 15th March, 2018 and Vermicompost @ 2 t + 50% RFD of NPK fertilizer), whereas the shortest plant (23.21, 56.12, 74.76 and 105.30 cm, respectively) from S_3F_0 (sowing at 30th March, 2018 and no nutrients i.e. control) treatment combination.

4.2. Number of leaves plant^{-1}

Different sowing date showed statistically significant variation in terms of number of leaves plant^{-1} of okra at 30, 45, 60 and 75 DAS (Figure 4 and Appendix IV). At 30, 45, 60 and 75 DAS, the maximum number of leaves plant^{-1} (14.62, 24.97, 34.78 and 42.92, respectively) was observed from S_2 treatment which was statistically similar (14.25, 24.17, 31.68 and 40.07, respectively) to S_1 treatment, while the minimum number (12.63, 22.48, 29.32 and 34.70, respectively) was recorded from S_3 treatment. Ali *et al*. (2014) reported that sowing date 5th June positively increased okra number of leaves plant^{-1}.

Number of leaves plant^{-1} of okra at 30, 45, 60 and 75 DAS varied significantly due to different fertilizer amendment (Figure 5 and Appendix IV). At 30, 45, 60 and 75 DAS, the maximum number of leaves plant^{-1} (15.49, 26.33, 34.53 and 42.33, respectively) was found from F_3 treatment which was followed (14.53, 24.76, 33.16 and 40.84, respectively) by F_2 treatment and also (14.20, 24.36, 32.36 and 39.82, respectively) by F_1, while the minimum number (11.11, 20.04, 27.67 and 33.91, respectively) was observed from F_0 treatment. Lakra *et al*. (2017) obtained that the best results with respect to number of leaves per plant 49.33 from NPK@ 50% + Vermicompost @ 100%.

Table 1. Combined effect of different sowing date and fertilizer amendment on plant height at different days after sowing (DAS) of okra

Treatments	Plant height (cm) at			
	30 DAS	45 DAS	60 DAS	75 DAS
S_1F_0	26.16 gh	57.16 ef	76.23 d	107.15 de
S_1F_1	31.44 c-e	66.56 b-d	93.24 ab	121.73 bc
S_1F_2	32.44 b-d	68.20 bc	93.90 ab	125.61 b
S_1F_3	35.75 ab	72.14 ab	96.61 ab	127.56 ab
S_2F_0	26.49 f-h	57.45 ef	77.12 d	108.28 de
S_2F_1	31.66 cd	68.03 bc	92.10 b	122.36 bc
S_2F_2	34.53 a-c	70.73 ab	95.84 ab	126.03 b
S_2F_3	37.00 a	75.75 a	99.25 a	136.88 a
S_3F_0	23.21 h	56.12 f	74.76 d	105.30 e
S_3F_1	29.78 d-f	62.77 c-e	81.50 cd	116.22 b-e
S_3F_2	26.79 fg	60.51 d-f	79.69 cd	114.20 c-e
S_3F_3	28.14 e-g	60.69 d-f	83.96 c	116.85 b-d
$LSD_{(0.05)}$	3.222	5.629	6.301	10.14
Level of significance	0.05	0.05	0.05	0.05
CV(%)	6.28	5.14	4.28	5.03

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

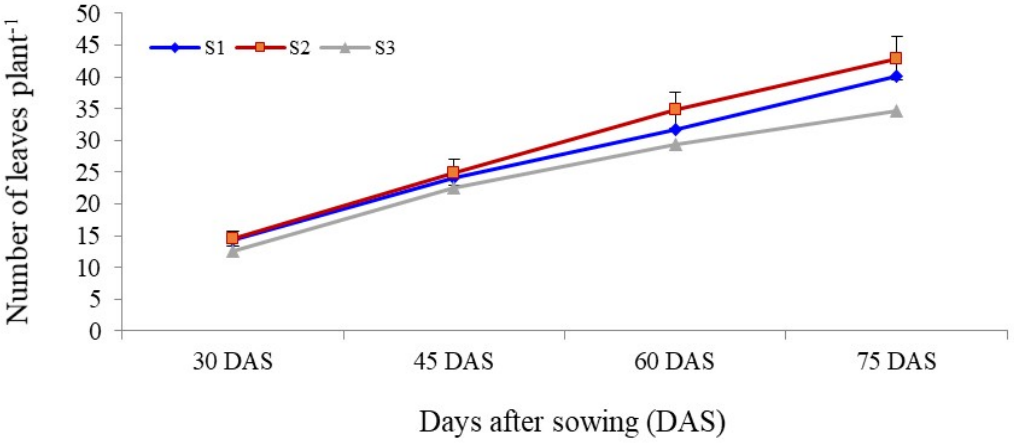
F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

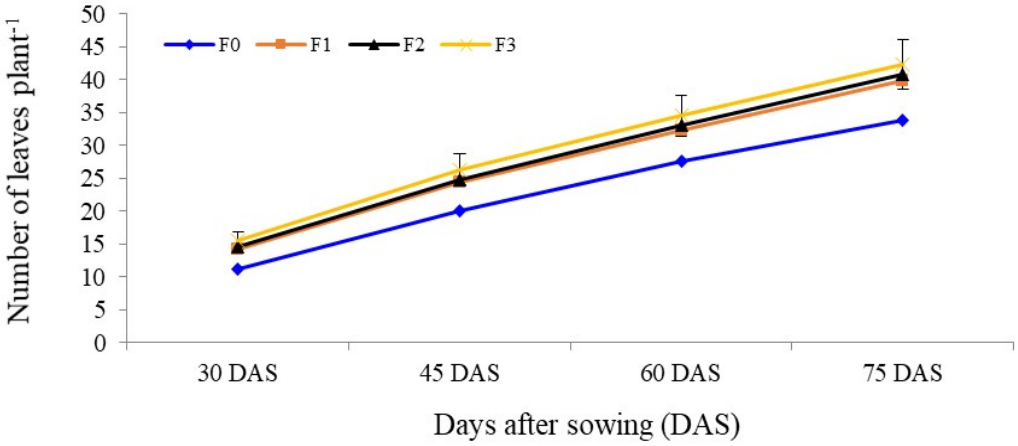
RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)



S_1: Sowing at 1st March, 2018 S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

Figure 4. Effect of different sowing date on number of leaves plant^{-1} of okra at different days after sowing. (Vertical bars represent LSD value at 5% level of probability)



F_0: No nutrients (control) F_1: RFD of NPK fertilizers

F_2: Vermicompost @ 4 t ha^{-1} F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizers

Figure 5. Effect of different fertilizer amendment on number of leaves plant^{-1} of okra at different days after sowing (Vertical bars represent LSD value at 5% level of probability)

Statistically significant variation was recorded for number of leaves plant^{-1} of okra at 30, 45, 60 and 75 DAS due to the combined effect of different sowing date and fertilizer amendment (Table 2 and Appendix IV). At 30, 45, 60 and 75 DAS, the maximum number of leaves plant^{-1} (16.60, 28.80, 39.07 and 47.53, respectively) was recorded from S_2F_3 treatment combination and the minimum number (10.80, 19.80, 24.07 and 28.40, respectively) was found from S_3F_0 treatment combination.

4.3. Leaf length

Statistically significant variation was observed on number of leaves plant^{-1} of okra at 30, 45, 60 and 75 DAS due to different sowing date (Table 3 and Appendix V). At 30, 45, 60 and 75 DAS, the longest leaf (12.97, 15.10, 18.01 and 20.79 cm, respectively) was observed from S_2 treatment which was followed (12.01, 13.96, 16.67 and 18.89 cm, respectively) by S_1 treatment, while the shortest leaf (12.35, 14.31, 17.21 and 19.92 cm, respectively) was recorded from S_3 treatment.

Different fertilizer amendment showed statistically significant differences in terms of leaf length of okra at 30, 45, 60 and 75 DAS (Table 3 and Appendix V). At 30, 45, 60 and 75 DAS, the longest leaf (13.69, 16.08, 19.15 and 22.20 cm, respectively) was recorded from F_3 treatment which was followed (13.16, 15.08, 18.32 and 21.29 cm, respectively) by F_2 treatment and also (12.55, 14.40, 18.00 and 20.88 cm, respectively) by F_1, while the shortest leaf (10.38, 12.26, 13.72 and 15.10 cm, respectively) was found from F_0 treatment.

Leaf length of okra at 30, 45, 60 and 75 DAS showed statistically significant differences due to the combined effect of different sowing date and fertilizer amendment (Table 4 and Appendix V). At 30, 45, 60 and 75 DAS, the longest leaf (14.72, 17.60, 20.38 and 23.52 cm, respectively) was observed from S_2F_3 treatment combination and the shortest leaf (10.09, 12.02, 13.31 and 14.39 cm, respectively) was recorded from S_3F_0 treatment combination.

Table 2. Combined effect of different sowing date and fertilizer amendment on number of leaves plant^{-1} at different days after sowing (DAS) of okra

Treatments	Number of leaves plant^{-1} at			
	30 DAS	45 DAS	60 DAS	75 DAS
S_1F_0	10.93 e	20.07 e	28.33 e	33.60 f
S_1F_1	14.87 c	25.00 bc	32.40 b-d	41.20 b-d
S_1F_2	15.13 bc	25.93 b	34.13 bc	45.33 ab
S_1F_3	16.07 ab	25.67 bc	31.87 cd	40.13 cd
S_2F_0	11.60 e	20.27 e	30.60 c-e	39.73 c-e
S_2F_1	14.87 c	24.60 bc	33.60 bc	42.13 bc
S_2F_2	15.40 bc	26.20 b	35.87 b	42.27 bc
S_2F_3	16.60 a	28.80 a	39.07 a	47.53 a
S_3F_0	10.80 e	19.80 e	24.07 f	28.40 g
S_3F_1	12.87 d	23.47 cd	31.07 c-e	36.13 d-f
S_3F_2	13.07 d	22.13 de	29.47 de	34.93 ef
S_3F_3	13.80 d	24.53 bc	32.67 b-d	39.33 c-e
$LSD_{(0.05)}$	0.946	2.178	3.189	4.668
Level of significance	0.05	0.05	0.05	0.05
CV(%)	4.04	5.39	5.90	7.03

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Table 3. Effect of different sowing date and fertilizer amendment on leaf length at different days after sowing (DAS) of okra

Treatments	Leaf length (cm) at			
	30 DAS	45 DAS	60 DAS	75 DAS
Sowing date				
S_1	12.35 b	14.31 b	17.21 b	19.92 b
S_2	12.97 a	15.10 a	18.01 a	20.79 a
S_3	12.01 b	13.96 b	16.67 b	18.89 c
$LSD_{(0.05)}$	0.479	0.621	0.549	0.598
Level of significance	0.01	0.01	0.01	0.01
Fertilizer amendment				
F_0	10.38 c	12.26 c	13.72 c	15.10 c
F_1	12.55 b	14.40 b	18.00 b	20.88 b
F_2	13.16 b	15.08 b	18.32 b	21.29 b
F_3	13.69 a	16.08 a	19.15 a	22.20 a
$LSD_{(0.05)}$	0.553	0.717	0.634	0.691
Level of significance	0.01	0.01	0.01	0.01
CV(%)	4.54	5.07	6.75	3.55

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Table 4. Combined effect of different sowing date and fertilizer amendment on leaf length diameter at different days after sowing (DAS) of okra

Treatments	Leaf length (cm) at			
	30 DAS	45 DAS	60 DAS	75 DAS
S_1F_0	10.54 e	12.30 d	13.85 e	15.08 fg
S_1F_1	12.63 cd	14.61 bc	18.12 cd	21.05 cd
S_1F_2	13.38 bc	15.27 bc	18.58 bc	21.75 bc
S_1F_3	12.84 cd	15.07 bc	18.28 bc	21.81 bc
S_2F_0	10.50 e	12.47 d	14.01 e	15.82 f
S_2F_1	12.79 cd	14.66 bc	18.28 bc	21.24 cd
S_2F_2	13.88 ab	15.66 b	19.37 ab	22.59 ab
S_2F_3	14.72 a	17.60 a	20.38 a	23.52 a
S_3F_0	10.09 e	12.02 d	13.31 e	14.39 g
S_3F_1	12.24 d	13.91 c	17.59 cd	20.36 de
S_3F_2	12.22 d	14.31 bc	16.99 d	19.55 e
S_3F_3	13.50 bc	15.58 b	18.79 bc	21.26 cd
$LSD_{(0.05)}$	0.958	1.242	1.099	1.196
Level of significance	0.05	0.05	0.05	0.05
CV(%)	4.54	5.07	6.75	3.55

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

4.4. Petiole length

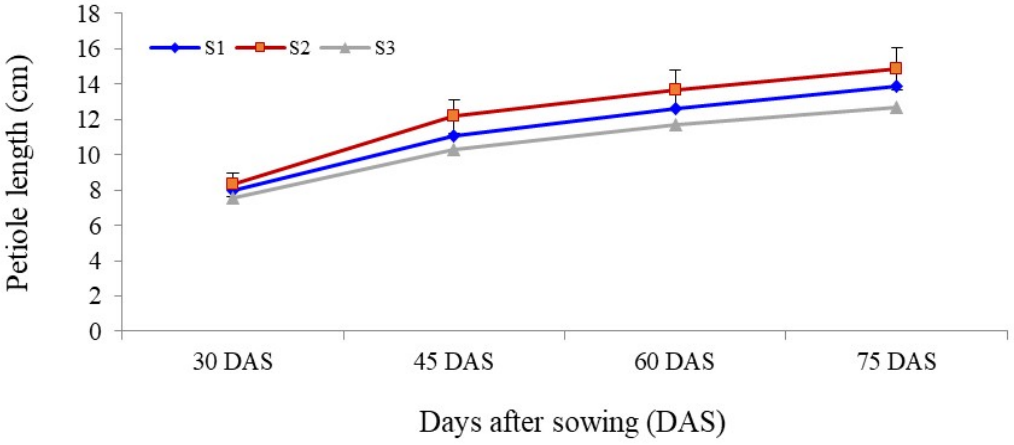
Petiole length of okra at 30, 45, 60 and 75 DAS showed statistically significant differences due to different sowing date (Figure 6 and Appendix VI). At 30, 45, 60 and 75 DAS, the longest petiole (8.32, 12.16, 13.68 and 14.84 cm, respectively) was found from S_2 treatment which was followed (7.97, 11.08, 12.62 and 13.89 cm, respectively) by S_1 treatment, while the shortest petiole (7.55, 10.28, 11.72 and 12.67 cm, respectively) was observed from S_3 treatment.

Statistically significant variation was observed due to different fertilizer amendment in terms of petiole length of okra at 30, 45, 60 and 75 DAS (Figure 7 and Appendix VI). At 30, 45, 60 and 75 DAS, the longest petiole (9.07, 12.45, 14.10 and 15.40 cm, respectively) was found from F_3 which was followed (8.19, 11.63, 13.11 and 14.47 cm, respectively) by F_2 and (7.93, 11.30, 12.75 and 13.98 cm, respectively) by F_1 and they were statistically similar, while the shortest petiole (6.60, 9.31, 10.73 and 11.36 cm, respectively) from F_0 treatment.

Combined effect of different sowing date and fertilizer amendment showed statistically significant differences in terms of petiole length of okra at 30, 45, 60 and 75 DAS due to the (Table 5 and Appendix VI). At 30, 45, 60 and 75 DAS, the longest petiole (9.53, 13.94, 15.66 and 17.14 cm, respectively) was found from S_2F_3 treatment combination and the shortest petiole (6.08, 8.23, 10.10 and 10.38 cm, respectively) was observed from S_3F_0 treatment combination.

4.5. Number of branches plant^{-1}

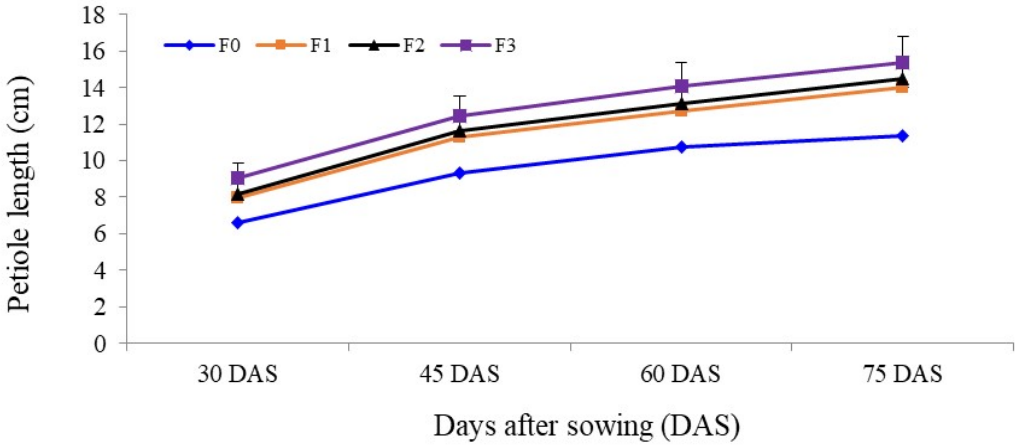
Statistically significant variation was recorded in terms of number of branches plant^{-1} of okra at 30, 45, 60 and 75 DAS due to different sowing date (Table 6 and Appendix VII). At 30, 45, 60 and 75 DAS, the maximum number of branches plant^{-1} (2.22, 3.47, 4.62 and 5.73, respectively) was found from S_2 treatment which was followed (2.05, 3.30, 4.15 and 5.32, respectively) by S_1 treatment, whereas the minimum number (1.82, 3.07, 3.65 and 4.52, respectively) was recorded from S_3 treatment. Ali *et al*. (2014) reported that sowing date 5th June positively increased okra number of branches plant^{-1}.



S_1: Sowing at 1st March, 2018 S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

Figure 6. Effect of different sowing date on petiole length of okra at different days after sowing. (Vertical bars represent LSD value at 5% level of probability)



F_0: No nutrients (control) F_1: RFD of NPK fertilizers

F_2: Vermicompost @ 4 t ha^{-1} F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizers

Figure 7. Effect of different fertilizer amendment on petiole length of okra at different days after sowing (Vertical bars represent LSD value at 5% level of probability)

Table 5. Combined effect of different sowing date and fertilizer amendment on petiole length at different days after sowing (DAS) of okra

Treatments	Petiole length (cm) at			
	30 DAS	45 DAS	60 DAS	75 DAS
S_1F_0	6.71 fg	9.43 fg	10.88 fg	11.76 ef
S_1F_1	8.08 cd	11.57 b-d	12.82 cd	13.72 cd
S_1F_2	8.32 b-d	12.04 bc	13.57 bc	15.32 b
S_1F_3	8.77 bc	11.27 c-e	13.22 c	14.76 bc
S_2F_0	7.01 ef	10.28 d-f	11.21 ef	11.95 e
S_2F_1	8.08 cd	11.59 b-d	13.36 c	14.58 bc
S_2F_2	8.67 bc	12.84 ab	14.48 b	15.71 b
S_2F_3	9.53 a	13.94 a	15.66 a	17.14 a
S_3F_0	6.08 g	8.23 g	10.10 g	10.38 f
S_3F_1	7.64 de	10.74 c-f	12.06 de	13.64 cd
S_3F_2	7.57 de	9.99 ef	11.28 ef	12.37 de
S_3F_3	8.91 ab	12.15 bc	13.41 bc	14.30 bc
$LSD_{(0.05)}$	0.698	1.314	1.024	1.404
Level of significance	0.01	0.05	0.01	0.05
CV(%)	5.19	6.94	4.77	6.00

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Table 6. Effect of different sowing date and fertilizer amendment on number of branches plant^{-1} at different days after sowing (DAS) of okra

Treatments	Number of branches plant^{-1} at			
	30 DAS	45 DAS	60 DAS	75 DAS
Sowing date				
S_1	2.05 b	3.30 b	4.15 b	5.32 b
S_2	2.22 a	3.47 a	4.62 a	5.73 a
S_3	1.82 c	3.07 c	3.65 c	4.52 c
$LSD_{(0.05)}$	0.123	0.152	0.207	0.276
Level of significance	0.01	0.01	0.01	0.01
Fertilizer amendment				
F_0	1.69 c	2.67 c	3.56 c	4.33 c
F_1	2.02 b	3.33 b	4.18 b	5.22 b
F_2	2.07 b	3.47 b	4.29 b	5.51 b
F_3	2.33 a	3.64 a	4.53 a	5.69 a
$LSD_{(0.05)}$	0.142	0.175	0.240	0.318
Level of significance	0.01	0.01	0.01	0.01
CV(%)	7.17	5.46	5.93	6.27

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Number of branches plant^{-1} of okra at 30, 45, 60 and 75 DAS varied significantly due to different fertilizer amendment (Table 6 and Appendix VII). At 30, 45, 60 and 75 DAS, the maximum number of branches plant^{-1} (2.33, 3.64, 4.53 and 5.69, respectively) was found from F_3 treatment which was followed (2.07, 3.47, 4.29 and 5.51, respectively) by F_2 and (2.02, 3.33, 4.18 and 5.22, respectively) by F_1 and they were statistically similar, while the minimum number (1.69, 2.67, 3.56 and 4.33, respectively) was observed from F_0 treatment. Lakra *et al*. (2017) obtained that the highest yield regarding, gave the best results with respect to number of branch 48.50 from NPK@ 50% + Vermicompost @ 100%.

Due to the combined effect of different sowing date and fertilizer amendment statistically significant variation was recorded in terms of number of branches plant^{-1} of okra at 30, 45, 60 and 75 DAS (Table 7 and Appendix VII). At 30, 45, 60 and 75 DAS, the maximum number branches plant^{-1} (2.60, 3.80, 4.73 and 6.40, respectively) was recorded from S_2F_3, whereas the minimum number (1.40, 2.33, 3.07 and 3.73, respectively) from S_3F_0 treatment combination.

4.6. Stem diameter

Stem diameter of okra at 30, 45, 60 and 75 DAS varied significantly due to different sowing date (Table 8 and Appendix VIII). At 30, 45, 60 and 75 DAS, the highest stem diameter (0.84, 1.36, 1.52 and 1.66 cm, respectively) was found from S_2 which was followed (0.80, 1.29, 1.46 and 1.56 cm, respectively) by S_1, while the lowest (0.72, 1.13, 1.39 and 1.52 cm, respectively) from S_3 treatment.

Statistically significant variation was recorded in terms of stem diameter of okra at 30, 45, 60 and 75 DAS due to different fertilizer amendment (Table 8 and Appendix VIII). At 30, 45, 60 and 75 DAS, the highest diameter of stem (0.89, 1.40, 1.62 and 1.73 cm, respectively) was recorded from F_3 which was followed (0.83, 1.32, 1.52 and 1.66 cm, respectively) by F_2 and (0.78, 1.23, 1.47 and 1.62, respectively) by F_1, whereas the lowest stem diameter (0.64, 1.08, 1.21 and 1.32, respectively) from F_0 treatment. Meena and Meena (2018) reported that application of RDF + Vermicompost produced the maximum stem diameter.

Table 7. Combined effect of different sowing date and fertilizer amendment on number of branches plant^{-1} at different days after sowing (DAS) of okra

Treatments	Number of branches plant^{-1} at			
	30 DAS	45 DAS	60 DAS	75 DAS
S_1F_0	1.67 e	2.73 e	3.40 ef	4.47 g
S_1F_1	2.07 bc	3.33 bc	4.07 cd	5.20 d-f
S_1F_2	2.27 b	3.67 ab	4.27 bc	5.93 a-c
S_1F_3	2.20 b	3.47 ab	4.87 a	5.67 b-d
S_2F_0	2.00 b-d	2.93 de	4.20 bc	4.80 fg
S_2F_1	2.13 bc	3.53 ab	4.60 ab	5.53 c-e
S_2F_2	2.13 bc	3.60 ab	4.93 a	6.20 ab
S_2F_3	2.60 a	3.80 a	4.73 a	6.40 a
S_3F_0	1.40 f	2.33 f	3.07 f	3.73 h
S_3F_1	1.87 c-e	3.13 cd	3.87 cd	4.93 fg
S_3F_2	1.80 de	3.13 cd	3.67 de	4.40 g
S_3F_3	2.20 b	3.67 ab	4.00 cd	5.00 e-g
$LSD_{(0.05)}$	0.245	0.303	0.415	0.551
Level of significance	0.05	0.05	0.05	0.05
CV(%)	7.17	5.46	5.93	6.27

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Table 8. Effect of different sowing date and fertilizer amendment on stem diameter at different days after sowing (DAS) of okra

Treatments	Stem diameter (cm) at			
	30 DAS	45 DAS	60 DAS	75 DAS
Sowing date				
S_1	0.80 b	1.29 b	1.46 b	1.56 b
S_2	0.84 a	1.36 a	1.52 a	1.66 a
S_3	0.72 c	1.13 c	1.39 c	1.52 b
$LSD_{(0.05)}$	0.027	0.054	0.046	0.046
Level of significance	0.01	0.01	0.01	0.01
Fertilizer amendment				
F_0	0.64 d	1.08 d	1.21 c	1.32 c
F_1	0.78 c	1.23 c	1.47 b	1.62 b
F_2	0.83 b	1.32 b	1.52 b	1.66 b
F_3	0.89 a	1.40 a	1.62 a	1.73 a
$LSD_{(0.05)}$	0.031	0.062	0.054	0.054
Level of significance	0.01	0.01	0.01	0.01
CV(%)	3.86	5.00	4.02	6.63

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Combined effect of different sowing date and fertilizer amendment showed statistically significant differences in terms of stem diameter of okra at 30, 45, 60 and 75 DAS (Table 9 and Appendix VIII). At 30, 45, 60 and 75 DAS, the highest stem diameter (0.98, 1.52, 1.69 and 1.86 cm, respectively) was recorded from S_2F_3 treatment combination and the lowest diameter (0.60, 1.03, 1.18 and 1.25, respectively) was observed from S_3F_0 treatment combination.

4.7. Days to starting of flowering

Different sowing date showed statistically significant differences in terms of days to starting of flowering of okra (Table 10 and Appendix IX). The maximum days to starting of flowering (45.83) was observed from S_1 treatment, whereas the minimum days to starting of flowering (40.17) was recorded from S_3 treatment which was statistically similar (41.92) to S_2 treatment.

Days to starting of flowering of okra showed statistically significant differences due to different fertilizer amendment (Table 10 and Appendix IX). The maximum days to starting of flowering (45.11) was found from F_0 treatment. On the other hand, the minimum days (41.11) was observed from F_3 treatment which was statistically similar (42.00 and 42.33) by F_2 and F_1 treatment. Das *et al*. (2014) reported that maximum 50% flower initiation (40 DAS) were produced with 50% chemical fertilizer + 50% vermicompost.

Statistically significant variation was observed due to the combined effect of different sowing date and fertilizer amendment in terms of days to starting of flowering (Table 11 and Appendix IX). The maximum days to starting of flowering (49.00) was recorded from S_1F_3 treatment combination, while the minimum days (36.33) was found from S_2F_3 treatment combination.

Table 9. Combined effect of different sowing date and fertilizer amendment on stem diameter at different days after sowing (DAS) of okra

Treatments	Stem diameter (cm) at			
	30 DAS	45 DAS	60 DAS	75 DAS
S_1F_0	0.64 fg	1.09 ef	1.24 e	1.33 fg
S_1F_1	0.80 cd	1.25 b-d	1.47 cd	1.63 c-e
S_1F_2	0.84 c	1.34 b	1.54 bc	1.68 b-d
S_1F_3	0.92 b	1.49 a	1.59 ab	1.62 c-e
S_2F_0	0.67 f	1.13 ef	1.22 e	1.38 f
S_2F_1	0.82 c	1.31 bc	1.52 bc	1.65 cd
S_2F_2	0.91 b	1.47 a	1.65 a	1.76 b
S_2F_3	0.98 a	1.52 a	1.69 a	1.86 a
S_3F_0	0.60 g	1.03 f	1.18 e	1.25 g
S_3F_1	0.73 e	1.14 ef	1.42 d	1.58 de
S_3F_2	0.76 de	1.17 de	1.38 d	1.54 e
S_3F_3	0.78 c-e	1.20 c-e	1.59 ab	1.70 bc
$LSD_{(0.05)}$	0.054	0.107	0.093	0.093
Level of significance	0.05	0.05	0.05	0.01
CV(%)	3.86	5.00	4.02	6.63

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Table 10. Effect of different sowing date and fertilizer amendment on yield contributing characters of okra

Treatments	Days to starting of flowering	Fresh weight plant^{-1} (g)	Dry matter content of plant (%)	Number of flower buds plant^{-1}
Sowing date				
S_1	45.83 a	236.89 b	11.95 b	32.37 b
S_2	41.92 b	258.76 a	12.57 a	33.62 a
S_3	40.17 b	215.83 c	11.55 b	25.88 c
$LSD_{(0.05)}$	2.273	11.67	0.448	1.116
Level of significance	0.01	0.01	0.01	0.01
Fertilizer amendment				
F_0	45.11 a	204.33 b	10.56 c	22.76 d
F_1	42.33 b	244.03 a	11.99 b	31.42 c
F_2	42.00 b	245.47 a	12.42 b	33.00 b
F_3	41.11 b	254.82 a	13.14 a	35.31 a
$LSD_{(0.05)}$	2.625	13.48	0.517	1.288
Level of significance	0.05	0.01	0.01	0.01
CV(%)	6.30	5.81	4.40	6.30

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Table 11. Combined effect of different sowing date and fertilizer amendment on yield contributing characters of okra

Treatments	Days to starting of flowering	Fresh weight plant^{-1} (g)	Dry matter content of plant (%)	Number of flower buds plant^{-1}
S_1F_0	46.00 ab	205.86 fg	10.78 e	23.80 d
S_1F_1	44.00 a-c	243.68 cd	11.85 cd	33.13 b
S_1F_2	44.33 a-c	256.90 bc	12.76 bc	34.33 b
S_1F_3	49.00 a	241.12 cd	12.42 bc	38.20 a
S_2F_0	46.33 ab	215.21 e-g	10.49 e	24.13 d
S_2F_1	40.33 c-e	260.30 bc	12.33 bc	33.73 b
S_2F_2	44.67 a-c	271.43 ab	13.17 b	37.20 a
S_2F_3	36.33 e	288.10 a	14.30 a	39.40 a
S_3F_0	43.00 bc	191.91 g	10.40 e	20.33 e
S_3F_1	42.67 b-d	228.11 d-f	11.79 cd	27.40 c
S_3F_2	37.00 e	208.09 fg	11.33 de	27.47 c
S_3F_3	38.00 de	235.23 c-e	12.70 bc	28.33 c
$LSD_{(0.05)}$	4.547	23.34	0.896	2.231
Level of significance	0.01	0.05	0.01	0.01
CV(%)	6.30	5.81	4.40	6.30

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

4.8. Fresh weight plant^{-1}

Fresh weight plant^{-1} of okra showed statistically significant differences due to different sowing date (Table 10 and Appendix IX). The highest fresh weight plant^{-1} (258.76 g) was found from S_2 treatment which was followed (236.89 g) by S_1 treatment and the lowest fresh weight (215.83 g) was recorded from S_3 treatment. Naz *et al*. (2009) reported that sown on 19th April registered the greatest fresh shoot weight (313.8 g plant^{-1}) of okra.

Different fertilizer amendment showed statistically significant differences in terms of fresh weight plant^{-1} of okra (Table 10 and Appendix IX). The highest fresh weight plant^{-1} (254.82 g) was recorded from F_3 treatment which was statistically similar (245.47 g and 244.03 g) to F_2 and F_1 treatment, respectively, while the lowest fresh weight (204.33 g) was observed from F_0 treatment.

Combined effect of different sowing date and fertilizer amendment varied significantly due to the in terms of fresh weight plant^{-1} (Table 11 and Appendix IX). The highest fresh weight plant^{-1} (288.10 g) was recorded from S_2F_3 treatment combination, whereas the lowest fresh weight (191.91 g) was observed from S_3F_0 treatment combination.

4.9. Dry matter content of plant

Different sowing date showed statistically significant differences on dry matter content of plant of okra (Table 10 and Appendix IX). The highest dry matter content of plant (12.57%) was observed from S_2 treatment, while the lowest (11.55%) was recorded from S_3 treatment which was statistically similar (11.95%) to S_1 treatment. Naz *et al*. (2009) reported that sown on 19th April registered the greatest dry shoot weight (194.8 g plant^{-1}) of okra.

Dry matter content of plant of okra showed statistically significant differences due to different fertilizer amendment (Table 10 and Appendix IX). The highest dry matter content of plant (13.14%) was found from F_3 treatment which was followed (12.42% and 11.99%) by F_2 and F_1 treatment, respectively and they

were statistically similar, while the lowest (10.56%) was observed from F_0 treatment.

Statistically significant variation was observed due to the combined effect of different sowing date and fertilizer amendment in terms of dry matter content of plant (Table 11 and Appendix IX). The highest dry matter content of plant (14.30%) was recorded from S_2F_3 treatment combination and the lowest (10.40%) was found from S_3F_0 treatment combination.

4.10. Number of flower buds plant^{-1}

Statistically significant differences was observed in terms of number of flower buds plant^{-1} of okra due to d sowing date (Table 10 and Appendix IX). The maximum number of flower buds plant^{-1} (33.62) was found from S_2 treatment which was followed (32.37) by S_1 treatment, whereas the minimum number (25.88) was recorded from S_3 treatment.

Different fertilizer amendment showed statistically significant differences in terms of number of flower buds plant^{-1} of okra (Table 10 and Appendix IX). The maximum number of flower buds plant^{-1} (35.31) was observed from F_3 treatment which was followed (33.00) by F_2 treatment. On the other hand, the minimum number (22.76) was counted from F_0 treatment which was followed (31.42) by F_1 treatment. Meena and Meena (2018) reported that application of treatment T_{13} (RDF + Vermicompost) produced maximum number of flower buds.

Statistically significant variation was observed due to the combined effect of different sowing date and fertilizer amendment in terms of number of flower buds plant^{-1} (Table 11 and Appendix IX). The maximum number of flower buds plant^{-1} (39.40) was found from S_2F_3 treatment combination, while the minimum number (20.33) was observed from S_3F_0 treatment combination.

4.11. Number of pods plant^{-1}

Different sowing date varied significantly in terms of number of pods plant^{-1} of okra (Figure 8 and Appendix IX). The maximum number of pods plant^{-1} (24.07) was recorded from S_2 which was followed (23.00) by S_1 treatment, while the minimum number (21.35) from S_3. Ali *et al*. (2014) reported that sowing date 5th June positively increased number of pods plant^{-1} of okra.

Number of pods plant^{-1} of okra showed statistically significant variation due to different fertilizer amendment (Figure 9 and Appendix IX). The maximum number of pods plant^{-1} (25.16) was recorded from F_3 which was statistically similar (24.27) to F_2 treatment and followed (23.53) by F_1, while the minimum number (18.27) from F_0 treatment. Das *et al*. (2014) reported that maximum pod per plant (18.65) with 50% chemical fertilizer + 50% vermicompost.

Statistically significant variation was observed due to the combined effect of different sowing date and fertilizer amendment in terms of number of pods plant^{-1} (Figure 10 and Appendix IX). The maximum number of pods plant^{-1} (27.07) was recorded from S_2F_3 treatment combination and the minimum number (17.60) was found from S_3F_0 treatment combination.

4.12. Pod length

Pod length of okra showed statistically significant differences due to different sowing date (Table 12 and Appendix X). The longest pod (15.18 cm) was observed from S_2 treatment which was followed (14.42 cm) by S_1 treatment, whereas the shortest pod (11.89 cm) from S_3 treatment. Naz *et al*. (2009) registered the greatest pod length (16.4 cm) of okra sown on 19th April.

Different fertilizer amendment varied significantly in terms of pod length of okra (Table 12 and Appendix X). The longest pod (15.27 cm) was recorded from F_3 treatment which was statistically similar (14.48 cm) to F_2 treatment and followed (13.70 cm) by F_1, while the shortest pod (11.86 cm) was found from F_0 treatment. Das *et al*. (2014) reported that maximum length of pod (17.60 cm) were produced with 50% chemical fertilizer + 50% vermicompost.

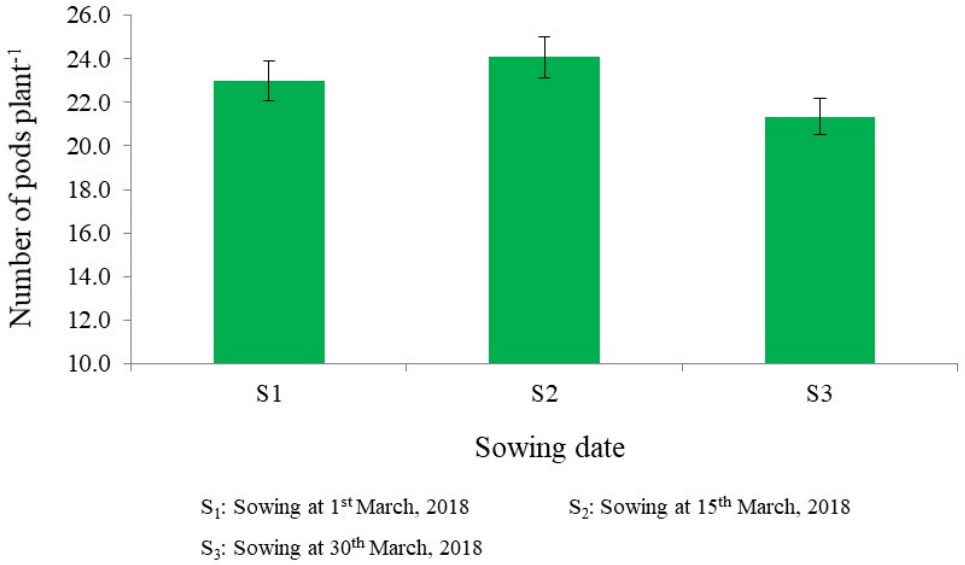


Figure 8. Effect of different sowing date on number of pods plant^{-1} of okra. (Vertical bars represent LSD value at 5% level of probability)

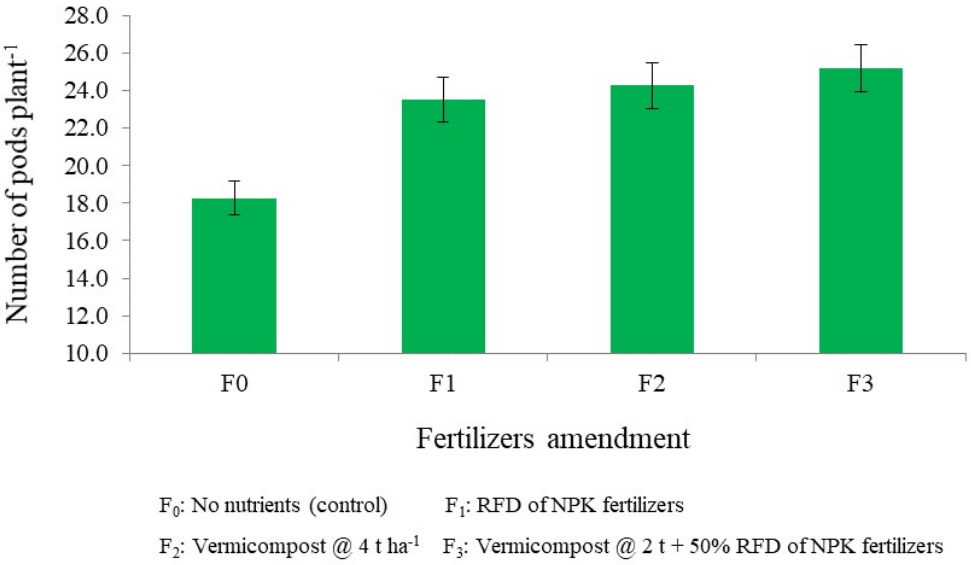
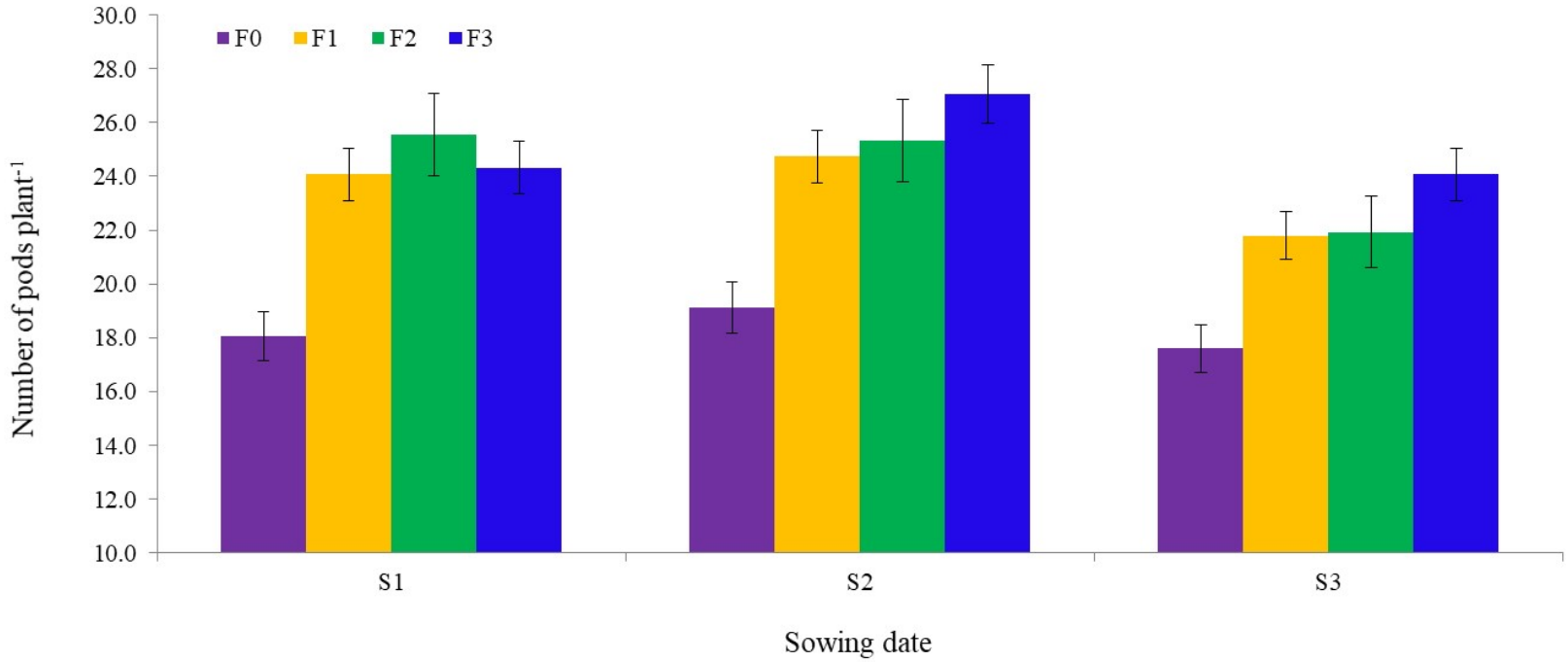


Figure 9. Effect of different fertilizers amendment on number of pods plant^{-1} of okra. (Vertical bars represent LSD value at 5% level of probability



S_1: Sowing at 1st March, 2018 S_2: Sowing at 15th March, 2018 F_0: No nutrients (control) F_1: RFD of NPK fertilizers

S_3: Sowing at 30th March, 2018 F_2: Vermicompost @ 4 t ha^{-1} F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizers

Figure 10. Combined effect of different sowing date and fertilizers amendment on number of pods $plant^{-1}$ of okra. (Vertical bars represent LSD value at 5% level of probability)

Table 12. Effect of different sowing date and fertilizer amendment on yield contributing characters and yield of okra

Treatments	Pod length (cm)	Pod diameter (cm)	Weight of individual pod (g)	Pod yield (t ha^{-1})
Sowing date				
S_1	14.42 b	1.96 a	19.86 a	14.70 a
S_2	15.18 a	2.02 a	20.25 a	15.24 a
S_3	11.89 c	1.83 b	17.67 b	12.88 b
$LSD_{(0.05)}$	0.730	0.072	0.637	0.616
Level of significance	0.01	0.01	0.01	0.01
Fertilizer amendment				
F_0	11.86 c	1.75 c	15.83 c	10.60 c
F_1	13.70 b	1.94 b	19.95 b	14.92 b
F_2	14.48 ab	1.99 b	20.25 b	15.15 b
F_3	15.27 a	2.08 a	21.00 a	16.42 a
$LSD_{(0.05)}$	0.843	0.618	0.736	0.712
Level of significance	0.01	0.01	0.01	0.01
CV(%)	8.82	6.94	6.91	5.10

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Statistically significant variation was observed due to the combined effect of different sowing date and fertilizer amendment in terms of pod length (Table 13 and Appendix X). The longest pod (17.45 cm) was observed from S_2F_3 and the shortest pod (11.15 cm) was performed by S_3F_0 treatment combination.

4.13. Pod diameter

Different sowing date showed statistically significant differences in terms of pod diameter of okra (Table 12 and Appendix X). The highest pod diameter (2.02 cm) was observed from S_2 treatment which was statistically similar (1.96 cm) by S_1 treatment, whereas the lowest pod diameter (1.83 cm) was recorded from S_3 treatment. Zeb *et al*. (2015) recorded that pod diameter (1.54 cm) in cultivars, sown on 30th March.

Pod diameter of okra showed statistically significant differences due to different fertilizer amendment (Table 12 and Appendix X). The highest pod diameter (2.08 cm) was found from F_3 treatment which was followed (1.99 cm and 1.94 cm) by F_2 and F_1 treatment, respectively and they were statistically similar, while the lowest pod diameter (1.75 cm) was observed from F_0 treatment.

Statistically significant variation was observed due to the combined effect of different sowing date and fertilizer amendment in terms of pod diameter (Table 13 and Appendix X). The highest pod diameter (2.20 cm) was recorded from S_2F_3 treatment combination, whereas the lowest pod diameter (1.74 cm) was found from S_3F_0 treatment combination.

4.14. Weight of individual pod

Statistically significant variation was observed due to different sowing date in terms of weight of individual pod of okra (Table 12 and Appendix X). The highest weight of individual pod (20.25 g) was observed from S_2 treatment which was statistically similar (19.86 g) by S_1 treatment, whereas the lowest weight (17.67 g) was found from S_3 treatment. Zeb *et al*. (2015) recorded that pod weight (15.24 g) in cultivars, sown on 30th March.

Table 13. Combined effect of different sowing date and fertilizer amendment on yield contributing characters and yield of okra

Treatments	Pod length (cm)	Pod diameter (cm)	Weight of individual pod (g)	Pod yield (t ha^{-1})
S_1F_0	12.05 d	1.76 ef	15.86 d	10.39 f
S_1F_1	14.26 c	1.97 b-d	20.75 b	15.54 bc
S_1F_2	15.10 bc	2.03 b	21.04 ab	16.15 b
S_1F_3	16.27 ab	2.08 b	21.79 ab	16.73 ab
S_2F_0	12.39 d	1.78 ef	16.21 d	11.25 f
S_2F_1	15.10 bc	2.00 bc	20.79 b	15.56 bc
S_2F_2	15.77 bc	2.06 b	21.59 ab	16.24 b
S_2F_3	17.45 a	2.20 a	22.41 a	17.90 a
S_3F_0	11.15 d	1.74 f	15.41 d	10.15 f
S_3F_1	11.74 d	1.56 cd	18.32 c	13.66 de
S_3F_2	12.58 d	1.91 de	18.12 c	13.06 e
S_3F_3	12.08 d	1.96 cd	18.81 c	14.63 cd
$LSD_{(0.05)}$	1.461	0.107	1.274	1.233
Level of significance	0.05	0.05	0.05	0.05
CV(%)	8.82	6.94	6.91	5.10

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

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Weight of individual pod of okra showed statistically significant differences due to different fertilizer amendment (Table 12 and Appendix X). The highest weight of individual pod (21.00 g) was recorded from F_3 which was followed (20.25 g and 19.95 g) by F_2 and F_1, respectively and they were statistically similar, while the lowest weight (15.83 g) was found from F_0 treatment.

Combined effect of different sowing date and fertilizer amendment showed statistically significant variation in terms of weight of individual pod (Table 13 and Appendix X). The highest weight of individual pod (22.41 g) was recorded from S_2F_3 treatment combination and the lowest weight (15.41 g) was found from S_3F_0 treatment combination.

4.15. Pod yield

Different sowing date showed statistically significant differences in terms of pod yield of okra (Table 12 and Appendix X). The highest pod yield (15.24 t ha^{-1}) was recorded from S_2 treatment which was statistically similar (14.70 t ha^{-1}) by S_1 treatment, while the lowest pod yield (12.88 t ha^{-1}) was found from S_3 treatment. Talukder *et al*. (2003) reported that green pod yield was significantly higher when crop was sown on April (18.92 t ha^{-1}) than March sown crop (16.24 t ha^{-1}). Moniruzzaman *et al*. (2007) also reported the highest seed yield (2.97 t/ha) was recorded from 15 April sowing closely followed by 15 March sowing (2.77 t/ha). Dash *et al*. (2013) recorded significantly higher yield was obtained (9.11 t/ha) from Annie Oakley variety when shown on 15 February, compared to other dates and the higher pod yield with 15 February sowing was mainly due to increased number of pods/plant, pod size and pod weight.

Pod yield of okra showed statistically significant differences due to different fertilizer amendment (Table 12 and Appendix X). The highest pod yield (16.42 t ha^{-1}) was found from F_3 treatment which was followed (15.15 t ha^{-1} and 14.92 t ha^{-1}) by F_2 and F_1 treatment, respectively and they were statistically similar, whereas the lowest pod yield (10.60 t ha^{-1}) was recorded from F_0 treatment. Yadav *et al.* (2004) reported that the treatment involving 50% N as urea + 50%

N as farm yard manure, poultry manure or vermicompost recorded the highest yield (90.61 q/ha). Sharma *et al*. (2009) reported the highest yield of okra in the treatment comprising 100% recommended NPK + vermicompost @ 10 t ha^{-1}, 11.10 and 11.63 t ha^{-1}. Also revealed that yield of okra obtained at 5 t vermicompost ha^{-1} plus 100% NPK (9.73 and 10.83 t ha^{-1}) was at par with that under 10 t farmyard manure plus 100% NPK (10.03 and 10.46 t ha^{-1}).

Statistically significant variation was observed due to the combined effect of different sowing date and fertilizer amendment in terms of pod yield (Table 13 and Appendix X). The highest pod yield (17.90 t ha^{-1}) was recorded from S_2F_3 treatment combination, while the lowest pod yield (10.15 t ha^{-1}) was observed from S_3F_0 treatment combination.

4.16 Economic analysis

Costs for land preparation, vermicompost, fertilizer, seeds, manpower and all operational cost from seeds sowing to harvesting of okra were recorded as per plot and converted into hectare. Price of okra was considered as per present market price and benefit cost of okra cultivation presented in Table 14 and Appendix XI. The economic analysis presented under the following headings-

4.16.1 Gross return

The combination of different sowing date and fertilizer amendment showed different value in terms of gross return under the trial of okra production (Table 14). The highest gross return (Tk. 501,200/ha) was obtained from the treatment combination S_2F_3 and the second highest gross return (Tk. 468,440/ha) was found in S_1F_3, whereas the lowest gross return (Tk. 284,200/ha) was obtained from S_3F_0.

Table 14. Cost and return of okra cultivation as influenced by sowing date and fertilizer amendment

Treatments	Cost of production (Tk./ha)	Yield of okra (t/ha)	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
S_1F_0	222,600	10.39	290,920	68,320	1.31
S_1F_1	230,725	15.54	435,120	204,395	1.89
S_1F_2	253,764	16.15	452,200	198,436	1.78
S_1F_3	242,244	16.73	468,440	226,196	1.93
S_2F_0	222,600	11.25	315,000	92,400	1.42
S_2F_1	230,725	15.56	435,680	204,955	1.89
S_2F_2	253,764	16.24	454,720	200,956	1.79
S_2F_3	242,244	17.90	501,200	258,956	2.07
S_3F_0	222,600	10.15	284,200	61,600	1.28
S_3F_1	230,725	13.66	382,480	151,755	1.66
S_3F_2	253,764	13.06	365,680	111,916	1.44
S_3F_3	242,244	14.63	409,640	167,396	1.69

Price of okra @ Tk. 28/kg

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

4.16.2 Net return

In case of net return, different sowing date and fertilizer amendment showed different levels of net return under the present trial (Table 14). The highest net return (Tk. 258,956/ha) was found from the treatment combination S_2F_3 and the second highest net return (Tk. 226,196/ha) was obtained from the combination S_1F_3. The lowest (Tk. 61,600/ha) net return was obtained S_3F_0.

4.16.3 Benefit cost ratio

In the different sowing date and fertilizer amendment, the highest benefit cost ratio (2.07) was noted from the combination of S_2F_3 and the second highest benefit cost ratio (1.93) was estimated from the combination of S_1F_3. The lowest benefit cost ratio (1.28) was obtained from S_3F_0 (Table 14). From economic point of view, it is apparent from the above results that the combination of S_2F_3 was best than rest of the combination in okra cultivation.

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out in the Horticulture farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka from February to July 2018 to find the growth and yield of okra as influenced by sowing date and fertilizer amendment. BARI Dherosh-2 was used as planting materials for this experiment. The experiment consisted of two factors: Factor A: Sowing dates (3 levels) as- S_1: Sowing at 1st March, 2018, S_2: Sowing at 15th March, 2018 and S_3: Sowing at 30th March, 2018; Factor B: Fertilizer amendment (4 levels) as- F_0: No nutrients (control), F_1: RFD of NPK fertilizer, F_2: Vermicompost @ 4 t ha^{-1} and F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer. The two-factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data were recorded on different growth, yield contributing characters and yield of okra and significant variation was recorded for different treatments.

For different sowing date, at 30, 45, 60 and 75 DAS, the tallest plant (32.42, 67.99, 91.08 and 123.39 cm, respectively) was recorded from S_2 treatment, whereas the shortest plant (26.98, 60.02, 79.98 and 113.14 cm, respectively) was observed from S_3 treatment. At 30, 45, 60 and 75 DAS, the maximum number of leaves plant^{-1} (14.62, 24.97, 34.78 and 42.92, respectively) was observed from S_2, while the minimum number (12.63, 22.48, 29.32 and 34.70, respectively) was recorded from S_3 treatment. At 30, 45, 60 and 75 DAS, the longest leaf (12.97, 15.10, 18.01 and 20.79 cm, respectively) was observed from S_2 treatment, while the shortest leaf (12.35, 14.31, 17.21 and 19.92 cm, respectively) was recorded from S_3 treatment. At 30, 45, 60 and 75 DAS, the longest petiole (8.32, 12.16, 13.68 and 14.84 cm, respectively) was found from S_2 treatment, while the shortest petiole (7.55, 10.28, 11.72 and 12.67 cm, respectively) was observed from S_3 treatment. At 30, 45, 60 and 75 DAS, the maximum number of branches plant^{-1} (2.22, 3.47, 4.62 and 5.73, respectively)

was found from S_2 treatment, whereas the minimum number (1.82, 3.07, 3.65 and 4.52, respectively) was recorded from S_3 treatment. At 30, 45, 60 and 75 DAS, the highest stem diameter (0.84, 1.36, 1.52 and 1.66 cm, respectively) was found from S_2 treatment, while the lowest stem diameter (0.72, 1.13, 1.39 and 1.52 cm, respectively) was observed from S_3 treatment. The maximum days to starting of flowering (45.83) was observed from S_1 treatment, whereas the minimum days to starting of flowering (40.17) was recorded from S_3 treatment. The highest fresh weight plant^{-1} (258.76 g) was found from S_2 treatment and the lowest fresh weight (215.83 g) was recorded from S_3 treatment. The highest dry matter content of plant (12.57%) was observed from S_2 treatment, while the lowest (11.55%) was recorded from S_3 treatment. The maximum number of flower buds plant^{-1} (33.62) was found from S_2 treatment, whereas the minimum number (25.88) was recorded from S_3 treatment. The maximum number of pods plant^{-1} (24.07) was recorded from S_2 treatment, while the minimum number (21.35) was found from S_3 treatment. The longest pod (15.18 cm) was observed from S_2 treatment, whereas the shortest pod (11.89 cm) was found from S_3 treatment. The highest pod diameter (2.02 cm) was observed from S_2 treatment, whereas the lowest pod diameter (1.83 cm) was recorded from S_3 treatment. The highest weight of individual pod (20.25 g) was observed from S_2 treatment, whereas the lowest weight (17.67 g) was found from S_3 treatment. The highest pod yield (15.24 t ha^{-1}) was recorded from S_2 treatment, while the lowest pod yield (12.88 t ha^{-1}) was found from S_3 treatment.

In case of different fertilizer amendment, at 30, 45, 60 and 75 DAS, the tallest plant (33.63, 69.53, 93.27 and 127.10 cm, respectively) was found from F_3, while the shortest plant (25.29, 56.91, 76.04 and 106.91 cm, respectively) from recorded from F_0 treatment. At 30, 45, 60 and 75 DAS, the maximum number of leaves plant^{-1} (15.49, 26.33, 34.53 and 42.33, respectively) was found from F_3 treatment, while the minimum number (11.11, 20.04, 27.67 and 33.91, respectively) was observed from F_0 treatment. At 30, 45, 60 and 75 DAS, the longest leaf (13.69, 16.08, 19.15 and 22.20 cm, respectively) was recorded from

F_3 treatment, while the shortest leaf (10.38, 12.26, 13.72 and 15.10 cm, respectively) was found from F_0 treatment. At 30, 45, 60 and 75 DAS, the longest petiole (9.07, 12.45, 14.10 and 15.40 cm, respectively) was found from F_3 treatment, while the shortest petiole (6.60, 9.31, 10.73 and 11.36 cm, respectively) was recorded from F_0 treatment. At 30, 45, 60 and 75 DAS, the maximum number of branches plant^{-1} (2.33, 3.64, 4.53 and 5.69, respectively) was found from F_3 treatment, while the minimum number (1.69, 2.67, 3.56 and 4.33, respectively) was observed from F_0 treatment. At 30, 45, 60 and 75 DAS, the highest diameter of stem (0.89, 1.40, 1.62 and 1.73 cm, respectively) was recorded from F_3 treatment, whereas the lowest stem diameter (0.64, 1.08, 1.21 and 1.32, respectively) was observed from F_0 treatment. The maximum days to starting of flowering (45.11) was found from F_0 treatment and the minimum days (41.11) was observed from F_3 treatment. The highest fresh weight plant^{-1} (254.82 g) was recorded from F_3 treatment, while the lowest fresh weight (204.33 g) was observed from F_0 treatment. The highest dry matter content of plant (13.14%) was found from F_3 treatment, while the lowest (10.56%) was observed from F_0 treatment. The maximum number of flower buds plant^{-1} (35.31) was observed from F_3 treatment and the minimum number (22.76) was recorded from F_0 treatment. The maximum number of pods plant^{-1} (25.16) was recorded from F_3 treatment, while the minimum number (18.27) was found from F_0 treatment. The longest pod (15.27 cm) was recorded from F_3 treatment, while the shortest pod (11.86 cm) was found from F_0 treatment. The highest pod diameter (2.08 cm) was found from F_3 treatment, while the lowest pod diameter (1.75 cm) was observed from F_0 treatment. The highest weight of individual pod (21.00 g) was recorded from F_3 treatment, while the lowest weight (15.83 g) was found from F_0 treatment. The highest pod yield (16.42 t ha^{-1}) was found from F_3, whereas the lowest pod yield (10.60 t ha^{-1}) was recorded from F_0 treatment.

Due to the combined effect of different sowing date and fertilizer amendment, at 30, 45, 60 and 75 DAS, the tallest plant (37.00, 75.75, 99.25 and 136.88 cm, respectively) was found from S_2F_3 treatment combination, whereas the shortest

plant (23.21, 56.12, 74.76 and 105.30 cm, respectively) was recorded from S_3F_0. At 30, 45, 60 and 75 DAS, the maximum number of leaves plant^{-1} (16.60, 28.80, 39.07 and 47.53, respectively) was recorded from S_2F_3 treatment combination and the minimum number (10.80, 19.80, 24.07 and 28.40, respectively) was found from S_3F_0 treatment combination. At 30, 45, 60 and 75 DAS, the longest leaf (14.72, 17.60, 20.38 and 23.52 cm, respectively) was observed from S_2F_3 treatment combination and the shortest leaf (10.09, 12.02, 13.31 and 14.39 cm, respectively) was recorded from S_3F_0 treatment combination. At 30, 45, 60 and 75 DAS, the longest petiole (9.53, 13.94, 15.66 and 17.14 cm, respectively) was found from S_2F_3 treatment combination and the shortest petiole (6.08, 8.23, 10.10 and 10.38 cm, respectively) was observed from S_3F_0 treatment combination. At 30, 45, 60 and 75 DAS, the maximum number branches plant^{-1} (2.60, 3.80, 4.73 and 6.40, respectively) was recorded from S_2F_3 treatment combination, whereas the minimum number (1.40, 2.33, 3.07 and 3.73, respectively) was observed from S_3F_0 treatment combination. At 30, 45, 60 and 75 DAS, the highest stem diameter (0.98, 1.52, 1.69 and 1.86 cm, respectively) was recorded from S_2F_3 treatment combination and the lowest diameter (0.60, 1.03, 1.18 and 1.25, respectively) was observed from S_3F_0 treatment combination. The maximum days to starting of flowering (49.00) was recorded from S_1F_3 treatment combination, while the minimum days (36.33) was found from S_2F_3 treatment combination. The highest fresh weight plant^{-1} (288.10 g) was recorded from S_2F_3 treatment combination, whereas the lowest fresh weight (191.91 g) was observed from S_3F_0 treatment combination. The highest dry matter content of plant (14.30%) was recorded from S_2F_3 treatment combination and the lowest (10.40%) was found from S_3F_0 treatment combination. The maximum number of flower buds plant^{-1} (39.40) was found from S_2F_3 treatment combination, while the minimum number (20.33) was observed from S_3F_0 treatment combination. The maximum number of pods plant^{-1} (27.07) was recorded from S_2F_3 treatment combination and the minimum number (17.60) was found from S_3F_0 treatment combination. The longest pod (17.45 cm) was

observed from S_2F_3 treatment combination and the shortest pod (11.15 cm) was recorded from S_3F_0 treatment combination. The highest pod diameter (2.20 cm) was recorded from S_2F_3 treatment combination, whereas the lowest pod diameter (1.74 cm) was found from S_3F_0 treatment combination. The highest weight of individual pod (22.41 g) was recorded from S_2F_3 treatment combination and the lowest weight (15.41 g) was found from S_3F_0 treatment combination. The highest pod yield (17.90 t ha^{-1}) was recorded from S_2F_3 treatment combination, while the lowest pod yield (10.15 t ha^{-1}) was observed from S_3F_0 treatment combination. In the different sowing date and fertilizer amendment, the highest benefit cost ratio (2.07) was noted from the combination of S_2F_3 and the lowest benefit cost ratio (1.28) was obtained from S_3F_0.

Recorded information revealed that sowing at 15th March, 2018 and Vermicompost @ 2 t + 50% RFD of NPK fertilizer was the superior among the other treatments in consideration of yield attributes and yield of okra.

Considering the results of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed to be repeated in different agro-ecological zones (AEZ) of Bangladesh for the evaluation of regional adaptability,
2. Other management practices may be used for further study, and
3. Other combination of organic manures and chemicals fertilizer may be used for further study to specify the specific combination.

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APPENDICES

APPENDICES

Appendix I. Characteristics of the soil of experimental field

A. Morphological characteristics of the soil of experimental field

Morphological features	Characteristics
Location	Horticulture Farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% Clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Appendix II. Monthly record of air temperature, relative humidity, rainfall and sunshine hour of the experimental site during the period from February to July 2018

Month (2018)	Air temperature (^{0}C)		Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
February	27.1	16.7	67	30	6.8
March	28.1	19.5	68	00	6.8
April	33.4	23.2	67	78	6.9
May	34.7	25.9	70	185	7.8
June	32.4	25.5	81	228	5.7
July	35.1	22.4	67	298	5.9

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka–1207

Appendix III. Analysis of variance of the data on plant height at different days after sowing (DAS) of okra as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square			
		Plant height (cm) at			
		30 DAS	45 DAS	60 DAS	75 DAS
Replication	2	0.894	3.724	7.365	10.802
Sowing date (A)	2	101.060**	206.685**	449.429**	335.084**
Fertilizer amendment (B)	3	112.624**	264.902**	513.787**	665.038**
Interaction (A×B)	6	9.691*	29.144*	38.083*	164.148*
Error	22	3.620	11.052	13.846	35.880

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix IV. Analysis of variance of the data on number of leaves plant^{-1} at different days after sowing (DAS) of okra as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square			
		Number of leaves plant^{-1} at			
		30 DAS	45 DAS	60 DAS	75 DAS
Replication	2	0.223	0.701	0.948	3.408
Sowing date (A)	2	13.363**	19.281**	90.191**	208.874**
Fertilizer amendment (B)	3	32.327**	65.169**	79.909**	122.635**
Interaction (A×B)	6	0.904*	4.320*	9.077*	21.980*
Error	22	0.312	1.654	3.547	7.599

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix V. Analysis of variance of the data on leaf length at different days after sowing (DAS) of okra as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square			
		Leaf length (cm) at			
		30 DAS	45 DAS	60 DAS	75 DAS
Replication	2	0.075	0.137	0.149	0.334
Sowing date (A)	2	2.872**	4.091**	5.476**	10.907**
Fertilizer amendment (B)	3	19.030**	23.540**	53.195**	93.691**
Interaction (A×B)	6	0.834*	1.139*	1.111*	2.614*
Error	22	0.320	0.538	0.421	0.499

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VI. Analysis of variance of the data on petiole length at different days after sowing (DAS) of okra as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square			
		Petiole length (cm) at			
		30 DAS	45 DAS	60 DAS	75 DAS
Replication	2	0.007	0.102	0.033	0.384
Sowing date (A)	2	1.800**	10.718**	11.566**	14.194**
Fertilizer amendment (B)	3	9.422**	15.982**	18.000**	26.904**
Interaction (A×B)	6	1.837**	1.728*	1.448**	1.926*
Error	22	0.170	0.602	0.366	0.687

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VII. Analysis of variance of the data on number of branches plant^{-1} at different days after sowing (DAS) of okra as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square			
		Number of branches plant^{-1} at			
		30 DAS	45 DAS	60 DAS	75 DAS
Replication	2	0.008	0.021	0.004	0.034
Sowing date (A)	2	0.484**	0.484**	2.804**	4.588**
Fertilizer amendment (B)	3	0.629**	1.640**	1.560**	3.261**
Interaction (A×B)	6	0.059*	0.084*	0.167*	0.293*
Error	22	0.021	0.032	0.060	0.106

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix VIII. Analysis of variance of the data on stem diameter at different days after sowing (DAS) of okra as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square			
		Stem diameter (cm) at			
		30 DAS	45 DAS	60 DAS	75 DAS
Replication	2	0.000	0.001	0.003	0.000
Sowing date (A)	2	0.048**	0.156**	0.046**	0.067**
Fertilizer amendment (B)	3	0.109**	0.168**	0.274**	0.293**
Interaction (A×B)	6	0.003*	0.011*	0.009*	0.011**
Error	22	0.001	0.004	0.003	0.003

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix IX. Analysis of variance of the data on yield contributing characters as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square				
		Days to starting of flowering	Fresh weight plant^{-1} (g)	Dry matter content of plant (%)	Number of flower buds plant^{-1}	Number of pods plant^{-1}
Replication	2	0.694	32.329	0.109	1.121	0.658
Sowing date (A)	2	101.0**	5529.1**	3.161**	206.80**	22.48**
Fertilizer amendment (B)	3	26.84*	4518.5**	10.67**	270.49**	86.36**
Interaction (A×B)	6	39.29**	494.20*	1.032**	9.613**	2.339*
Error	22	7.210	190.021	0.280	1.736	0.858

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix X. Analysis of variance of the data on yield contributing characters and yield as influenced by different sowing date and fertilizer amendment

Source of variation	Degrees of freedom	Mean square			
		Pod length (cm)	Pod diameter (cm)	Weight of individual pod (g)	Pod yield (t ha^{-1})
Replication	2	0.235	0.002	0.019	0.219
Sowing date (A)	2	35.583**	0.079**	23.232**	18.402**
Fertilizer amendment (B)	3	19.112**	0.139**	48.838**	57.978**
Interaction (A×B)	6	2.388*	0.011*	1.577*	1.414*
Error	22	0.744	0.004	0.566	0.530

**: Significant at 0.01 level of significance; *: Significant at 0.05 level of significance

Appendix XI. Per hectare production cost of okra

A. Input cost

Treatment Combination	Labour cost	Ploughing cost	Seed Cost	Water for plant Establishment	Manure and fertilizer				Insecticide/ pesticides	Sub total (A)
					Vermicompost	Urea	TSP	MP		
S_1F_0	48,000	32,000	8,000	20,000	0	0	0	0	12,000	120,000
S_1F_1	48,000	32,000	8,000	20,000	0	1,600	3,000	2,700	12,000	127,300
S_1F_2	48,000	32,000	8,000	20,000	28,000	0	0	0	12,000	148,000
S_1F_3	48,000	32,000	8,000	20,000	14,000	800	1,500	1,350	12,000	137,650
S_2F_0	48,000	32,000	8,000	20,000	0	0	0	0	12,000	120,000
S_2F_1	48,000	32,000	8,000	20,000	0	1,600	3,000	2,700	12,000	127,300
S_2F_2	48,000	32,000	8,000	20,000	28,000	0	0	0	12,000	148,000
S_2F_3	48,000	32,000	8,000	20,000	14,000	800	1,500	1,350	12,000	137,650
S_3F_0	48,000	32,000	8,000	20,000	0	0	0	0	12,000	120,000
S_3F_1	48,000	32,000	8,000	20,000	0	1,600	3,000	2,700	12,000	127,300
S_3F_2	48,000	32,000	8,000	20,000	28,000	0	0	0	12,000	148,000
S_3F_3	48,000	32,000	8,000	20,000	14,000	800	1,500	1,350	12,000	137,650

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)

Appendix XI. Per hectare production cost of okra (cont'd)

B. Overhead cost (Tk./ha)

Treatment Combination	Cost of lease of land (12% of value of land Tk. 14,00000/year	Miscellaneous cost (Tk. 5% of the input cost)	Interest on running capital for 6 months (Tk. 12% of cost/year)	Sub total (Tk) (B)	Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)]
S_1F_0	84,000	6,000	12,600	102,600	222,600
S_1F_1	84,000	6,365	13,060	103,425	230,725
S_1F_2	84,000	7,400	14,364	105,764	253,764
S_1F_3	84,000	6,883	13,712	104,594	242,244
S_2F_0	84,000	6,000	12,600	102,600	222,600
S_2F_1	84,000	6,365	13,060	103,425	230,725
S_2F_2	84,000	7,400	14,364	105,764	253,764
S_2F_3	84,000	6,883	13,712	104,594	242,244
S_3F_0	84,000	6,000	12,600	102,600	222,600
S_3F_1	84,000	6,365	13,060	103,425	230,725
S_3F_2	84,000	7,400	14,364	105,764	253,764
S_3F_3	84,000	6,883	13,712	104,594	242,244

S_1: Sowing at 1st March, 2018

S_2: Sowing at 15th March, 2018

S_3: Sowing at 30th March, 2018

F_0: No nutrients (control)

F_1: RFD of NPK fertilizer

F_2: Vermicompost @ 4 t ha^{-1}

F_3: Vermicompost @ 2 t + 50% RFD of NPK fertilizer

RFD-Recommended NPK Fertilizer Doses (150, 150 and 100 kg ha^{-1} of N, P and K, respectively)