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Effect of Integrated Nutrient Management on Growth Parameters of Okra [*Abelmoschus esculentus* (L.) Moench.] Variety Parbhani Kranti under South Eastern Plain Zone V of Rajasthan

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The zero hunger target, poverty elimination and depletion of soil fertility are now becoming major threat to the food security of ever increasing population across the world however, in sustainable agriculture these points are to be considered as significant challenge faced by agriculture scientist and planners. The vegetables can play a major source of minerals, vitamins beside carbohydrates and protein to meet out the malnutrition among mankind. Looking to such a difficult situation a field trial was conducted during kharif 2019 and 2020 on okra at Research Farm of Career Point University, Kota (Rajasthan). The experiment was laid out in Randomized Block Design with twenty treatments and their combination with three replications.

The application of 140% RDF + 25 t FYM /ha was found to be the best followed by 80% RDF +3t neem cake/ha and 120% RDF + 3t neem cake/ha with a mean yield of 154.33q/ha, 146.22q/ha and 142.97q/ha along with net return of Rs.202374.43, Rs. 184118.24 and Rs. 176637.37/ha respectively when compared with recommended control (RDF) where only 104.66q/ha yield was recorded with net return of Rs. 150475.31 /ha where NPK @120: 60:60 kg/ha respectively was

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applied as per their recommendation in which 50% nitrogen with full phosphorus and potash were applied at sowing as basal and remaining 50% nitrogen was applied with two equal split dose at 40 days and 75 days.

Keywords: Farmyard manure (FYM); neem cake; recommended dose of fertilizer (RDF) i.e.; NPK @120:60:60kg/ha respectively.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L) is commonly known as Bhindi or lady's finger belongs to family Malvaceae with 2n=130. It is one of the important crops among the vegetable and grown in many countries and distributed from Africa to Asia, Southern Europe and America. It is considered to be an important vegetable crop cultivated almost across the country under various agro climatic conditions. It is cultivated in loamy soil with heavy clay along with proper drainage and intermittent moisture with soil pH between5.8 to 7.0The 7.0 pH is ideal being a tropical and sub-tropical plant. It is a good source of vitamin A, B, C and also rich in protein, carbohydrates, fats, minerals, iron and iodine. (Aykroyed, 1963). The soils of Rajasthan varied from light to heavy in texture with high pH and low nitrogen content. The application of nitrogen is quite essential for proper growth and development of plants. Among the manures, vermin-compost is one of the most suitable and stable organic matter, when added in to the soil, it loosens the soil and improves the passage to the entry of air. The organic carbon in vermin-compost releases the nutrients slowly and steadily into the soil system which enables the plant to absorb the nutrients and soil get enriched with vermin-compost which provides additional useful substances that are not found in chemical fertilizers [1]. It also produces antifungal metabolizes that certain vitamin and growth promoting substances which increased seed germination and initial vigor in inoculated sorghum plants [2] use of organic manure in combination with chemical fertilizers that helps in improving physical and chemical properties of soil structure, water holding capacity and soil aeration, chemical properties and supply of essential nutrients in balanced ratio, However, much information is not available on use of inorganic fertilizers in combination with organic manures. Therefore, there is a need to work on the requirement of inorganic fertilizers in combination with organic manures and bio-fertilizers for sustainable increased in yield and quality of okra [3].

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at the Instructional farm, School of Agricultural Sciences, CPU Kota during Kharif season of 2019 and 2020. The site is situated in humid south eastern plain zone V *of* Rajasthan and covers geographical area of 26.43 lakh hectare that represents 7.71 per cent of the total geographical area of the state. The Rajasthan state lies between $23^0 3'$ and $36^0 12'$ N latitude, $78^0 17'$ E longitude in which Kota falls between $25^0 11'$N latitude and $75^0 54'$E longitude at 273-meter altitude from mean sea level (MSL) with an average rain fall ranging from 650 mm to 1000 mm annually. The area under cultivation is about 18.0 lakh hectares, out of which approximately 26% is under irrigated and remaining area is under rain fed and dry land conditions. It includes all tehsils of Kota, Bundi, Baran, Jhalawar and part of Sawai Modhopur districts.

2.2 Climate and Weather Conditions

This zone possesses typically sub-tropical climatic conditions characterized by mild winters and moderate summers associated with high relative humidity during the months of July to September. The annual rainfall of the region is 650 – 1000 mm, most of which is contributed by south west monsoon from July to September.

2.3 Detailed Methodology

The details information about experiment is given as under.

2.4 Fertilizer Application

1. In RDF: The 50% nitrogen and full dose of phosphorus and potash was applied as a basal and remaining 50% dose of nitrogen was given in two equal split doses at 45 &70 days after sowing.

2. Organic manure was applied about 15 days prior to sowing.
3. Organic and inorganic fertilizer was applied as per given standard procedure.

Table 1. Detailed methodology

Location	Agriculture Research Farm, CPU Kota	**Year**	Kharif 2019 & Kharif 2020
Gross plot size (m^2)	3.6m x2.1m =7.56m^2 12Rows of 14 plant each (168 plant/plot)	**Total number of plots**	20 x 3 =60
Net plot size (m^2)	3.0mx1.8m=5.40m^2 10Rows of 12 plant each. (120plant/plot)	**Area required (m^2)**	7.5 m^2 x60=453.60 m^2
Spacing (cm.)	30 cm x 15 cm	**30% Extra area required (m^2)**	453.6m^2 x0.3=136.08 m^2
Treatment	Twenty (20)	**Total area(m^2)**	589.68 m^2
Replication & Statistical design	Three (3) & RBD	**Crop**	Okra
Date of sowing	20July in kharif 2019 And 25July in Kharif 2020	**Variety**	**Parbhani Kranti**
Seed rate (kg/ha)	12 -15 kg/ha.	**Vermin-compost(t/ha)**	2.0
Date of picking	As and when required	**FYM (t/ha)**	25.0
Fertilizers NPKkg/ha	120:60:60 kg/ha respectively.	**Neem cake (t/ha)**	3.0

Table 2. Details of treatment and their combination

S.N.	Treatment	Quantity required (Kg or t /ha)
T1	Absolute Control	No fertilizer & No manure
T2	RDF	NPK @120:60:60kg/ha
T3	FYM	@25 t/ha
T4	Vermin-compost	@2 t/ha
T5	Neem Cake	@3t/ha
T6	60%RDF+FYM	NPK @72:36:36kg/ha+25t/ha
T7	80%RDF+FYM	NPK @96:48:48kg/ha+25t/ha
T8	100%RDF+FYM	NPK @120:60:60kg/ha+25t/ha
T9	120%RDF+FYM	NPK @144:72:72kg/ha+25t/ha
T10	140%RDF+FYM	NPK @168:84:84kg/ha+25t/ha
T11	60%RDF+ Vermin-compost	NPK @72:36:36kg/ha+2 t/ha
T12	80%RDF+ Vermin-compost	NPK @96:48:48kg/ha +2 t/ha
T13	100%RDF+ Vermin-compost	NPK @120:60:60kg/ha+2 t/ha
T14	120%RDF+ Vermin-compost	NPK @144:72:72kg/ha+2 t/ha
T15	140%RDF+ Vermin-compost	NPK @168:84:84kg/ha+2 t/ha
T16	60%RDF+ Neem Cake	NPK @72:36:36kg/ha+ 3t//ha
T17	80%RDF+ Neem Cake	NPK @96:48:48kg/ha+ 3t//ha
T18	100%RDF+ Neem Cake	NPK @120:60:60kg/ha+ 3t//ha
T19	120%RDF+ Neem Cake	NPK @144:72:72kg/ha+ 3t//ha
T20	140%RDF+ Neem Cake	NPK @168:84:84kg/ha+ 3t//ha

Note:

1. FYM@18.9kg/plot (For 7.56m^2 area) for all FYM treatment.

2. Vermin-compost@1.519kg/plot (For 7.56m^2 area) for all Vermin-compost treatment.

3. Neem Cake@ 2.268kg/plot (For 7.56m^2 area) for all Neem Cake treatment.

Treatments

4. RESULTS

4.1 Average Days to 50% Germination

The minimum number of days from the date of sowing that must pass for germination to reach 50% was noted. However, among treatments, treatment (T-15), which is 140 percent RDF+ Vermicompost @2t/ha, was found statistically superior than any of the treatments or its combination, including absolute control (T-1), where nothing was applied during both the season and year. Treatments RDF, FYM, Vermicompost, and Neemcake alone were statistically similar to each other but were found superior to absolute control (T-1). The minimum amount of time (5.15 days), (4.95 days), and (4.76 days) needed for 50 percent of the seed to germinate were followed by treatments T-14 (5.54 days) and T-12 (5.60 days), but these two treatments were statistically equal throughout the season and the year. However, a similar result and trend was also seen in the pooled mean treatment T-15 (Table 3 and Fig. 2).

4.2 Days to 100% Germination

The minimum days required to take 100% germination was observed from the date of sowing. Among treatment, treatment (T-15) i.e. 140% RDF+ Vermicompost @2t/ha was statistically superior than any of the treatment or its combination including absolute control (T-1) where nothing was applied .The minimum (9.30 days & 9.10days) required to germinate 100% seed with treatment (T-15) followed by treatment T-14 (10.07days, 10.30days and 10.18 days) and T-12 (11.50 days, 11.70days & 12.10 days) but were statistically at par during both the season The similar result and trend was however, also observed in pooled mean treatment T-15 (Table 3 and Fig. 1).

4.3 Plant Height (cm.)

The initially five plants were selected and tagged randomly in each treatment and replication for observation at 90 days after sowing. The average height was then measured and calculated with the help of measuring scale on the tagged five plants in each treatment and replication for further computation.

The maximum plant height (100.23 cm, 100.90 cm and 100.57cm) was recorded at 90 DAS with the treatment (T-15) i.e., 140% RDF+ Vermicompost @ 2t/ha was applied which was found superior to any of the treatment or its combination including RDF and absolute control (T-1) where nothing was applied. On the other hand, minimum plant height (78.13cm, 78.47cm, and 78.30cm.) was however, recorded where nothing was applied (absolute control T-1) during both the season and year, however, plant height was statistically non-significant during both the season and year.

4.4 Stem Diameter (cm)

Stem diameter was recorded with the help of virneer calipers on five tagged plants in each treatment and replication at three portions of plant i.e., top, mid and lower part of stem. The average stem diameters were then calculated in five tagged plants at each portion (Table 3 and Fig. 1). Significantly maximum stem girth (2.75cm, 2.82cmand 2.78cm) was recorded with treatment (T-15) i.e., 140% RDF+ Vermicompost @2t/ha which was statistically superior to rest of the treatment or its combination including RDF and absolute control (T-1) where nothing was given to the plot during both the season and year. However, on the other hand, minimum stem girth (1.69 cm, 1.65 cm. and 1.67 cm.) was observed in absolute control (T-1). The similar result and trend were also with the pooled mean of the same treatment (T-15).

4.5 Number of Branches per Plant

The significantly maximum pooled (5.66) number of branches per plant was recorded with the same treatment i.e., treatment (T-15) where 140% RDF+ Vermicompost was applied when compared with any of the treatment or its combinations including RDF and absolute control (T-1) during both the season and years (Table 4 and Fig. 2) however, minimum number of branches (3.81) per plant was recorded with the control (T-1). The pooled mean also represents the same trend as it was reported in both the consecutive season and year.

4.5.1 Number of leaves per plant at 90 DAS

The significant variation was observed due to treatments (Table 4 and Fig. 2). The number of leaves per plant was recorded significantly maximum (50.23 leaves, 51.23 leaves & 50.73leaves) were recorded with the treatment (T-15) where 140% RDF+ Vermicompost @2t/ha was applied and when compared with any of the

treatment including its combinations along with RDF and absolute control (T-1) during both the season and years followed by treatment T-11 where (47.33 leaves, 47.67 and 47.50 leaves) and treatment T-10 (46.65 leaves, 46.98 leaves and 46.81leaves) were observed but were both the treatment ie.T-11 and T-12 were statistically at par however, absolute control (T-1) had significantly minimum leaves (32.10 leaves, 32.43 leaves and 32.27 leaves) per plant.

4.5.2 Number of nodes per plant at 90 DAS

The data on number of nodes per plant as influenced by the application of organic, inorganic and their combinations are presented (Table 4 and Fig. 2). It is evident from the table that node/plant were found significantly maximum per plant (19.90, 20.57 and 20.23) with the treatment (T-15) where 140% RDF+Vermicompost@2t/ha was applied, followed by treatment T-14, T-16, T-17, T-18, T-19 and T-20 but these treatments were at par to each other during both successive seasons and year. The minimum number of node/plants was however, recorded (12.70, 12.03 and 12.36) in treatment (T-1) i.e., absolute control.

4.5.3 Days to first flowering

The minimum days required to first flowering was recorded from the date of sowing. The data showed (Table 4 and Fig. 2) that minimum number of day taken to first flower appearance was observed in the treatment, (T-15) where 140% RDF+Vermicompost@2t/ha was applied followed by treatment (T-14) but these treatments were similar to each other in the year Kharif 2019 however, it differs in the Kharif 2020. Among treatment, Treatment (T-15) was the best which took the minimum days to first flower (39.67 days and 39.33 days) when compared with any other treatment or their combination including RDF and absolute control (T-1) which took maximum days (46.73 days) to first flower appearance during both the season and year. However, days to first flower appearance was found statistically non-significant in both the season and year. However, days to first flower appearance was found statistically non-significant. kharif 2019 and kharif 2020.

5. DISCUSSION

To obtain better growth and yield of a crop, optimum fertilizer should be used in suitable combinations with optimum dose. Overuse of fertilizers might be harmful for a crop. Different organic fertilizers provide different nutrients for a crop [4]. This study was conducted to know the effects of organic fertilizers (either alone or in combination) on growth and growth parameters of okra.

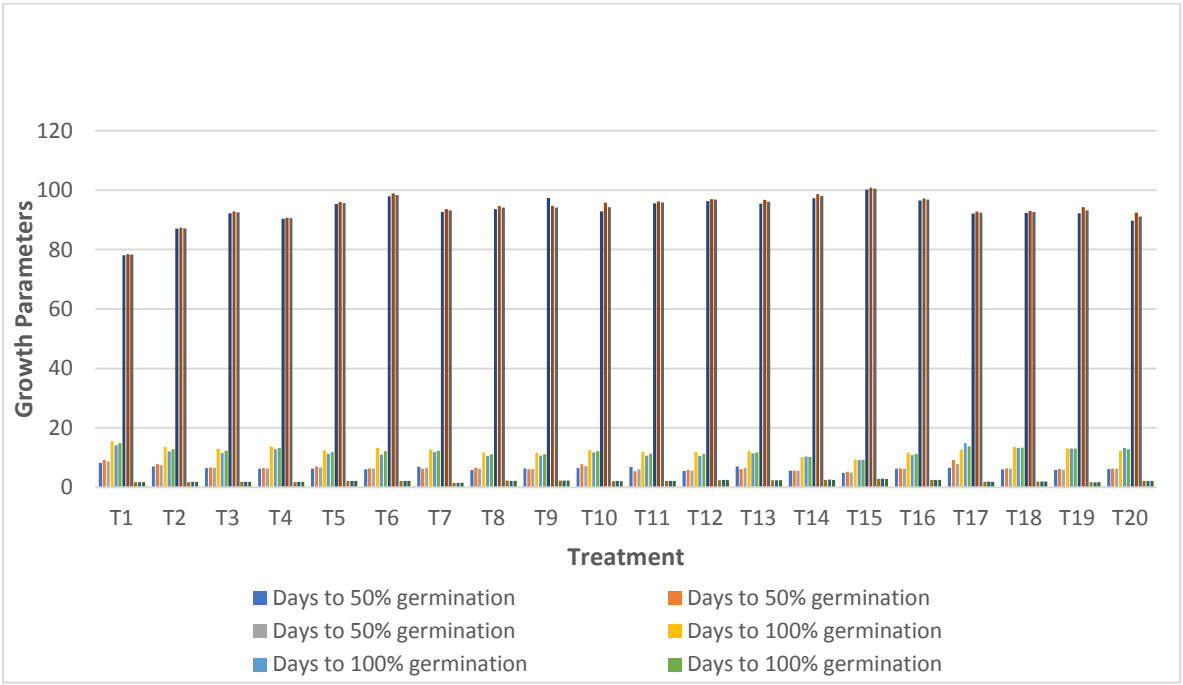

Fig. 1. Effects of different fertilizers on growth and growth parameters in Okra

Table 3. Effects of different fertilizers on growth parameters in Okra

Treatment	Days to 50% germination			Days to 100% germination			Plant height (cm)			Stem diameter (cm)		
	2019	2020	Mean	2019	2020	Mean	2019	2020	Mean	2019	2020	Mean
T1	8.11	9.16	8.64	15.50	14.10	14.80	78.13	78.47	78.30	1.69	1.65	1.67
T2	6.96	7.76	7.36	13.50	12.00	12.75	87.00	87.33	87.17	1.74	1.81	1.77
T3	6.41	6.67	6.54	12.90	11.50	12.20	92.23	92.90	92.57	1.80	1.83	1.82
T4	6.21	6.42	6.32	13.70	12.80	13.25	90.43	90.77	90.60	1.74	1.77	1.76
T5	6.22	7.01	6.62	12.40	11.30	11.85	95.33	96.00	95.67	2.11	2.14	2.13
T6	6.03	6.33	6.18	13.20	11.00	12.10	97.90	98.90	98.40	2.12	2.15	2.14
T7	6.90	6.25	6.58	12.70	11.80	12.25	92.67	93.67	93.17	1.42	1.45	1.44
T8	5.75	6.59	6.17	11.70	10.50	11.10	93.67	94.67	94.17	2.19	2.12	2.16
T9	6.31	6.01	6.16	11.50	10.60	11.05	97.37	94.67	94.17	2.24	2.27	2.26
T10	6.43	7.77	7.10	12.50	11.70	12.10	92.82	95.82	94.32	2.00	2.07	2.03
T11	6.73	5.31	6.02	11.90	10.60	11.25	95.57	96.23	95.90	2.17	2.14	2.15
T12	5.46	5.73	5.60	11.80	10.50	11.15	96.33	97.00	96.87	2.38	2.41	2.40
T13	6.98	6.07	6.52	12.10	11.40	11.75	95.43	96.77	96.10	2.34	2.31	2.32
T14	5.54	5.54	5.54	10.07	10.30	10.18	97.33	98.67	98.00	2.47	2.50	2.49
T15	4.76	5.15	4.95	9.30	9.10	9.20	100.23	100.90	100.57	2.75	2.82	2.78
T16	6.18	6.30	6.24	11.60	10.80	11.20	96.53	97.20	96.87	2.40	2.40	2.40
T17	6.55	9.16	7.86	12.70	14.81	13.75	92.12	92.80	92.47	1.80	1.87	1.83
T18	6.05	6.28	6.17	13.50	13.24	13.37	92.33	93.00	92.67	1.90	1.93	1.92
T19	5.75	6.11	5.93	13.00	12.97	12.99	92.23	94.23	93.23	1.70	1.63	1.67
T20	6.15	6.21	6.18	12.30	13.25	12.77	89.77	92.43	91.10	2.10	2.07	2.08
CD (P= 0.05)	1.049	1.003	1.265	1.793	1.685	1.43	NS	NS	NS	0.3	0.303	0.069
SEm	0.365	0.349	0.424	0.624	0.586	0.48	1.44	1.538	0.367	0.104	0.105	0.023
SED	0.516	0.494	0.600	0.882	0.829	0.678	2.037	2.175	0.519	0.148	0.149	0.033

Table 4. Effects of different fertilizers on growth and growth parameters in Okra

Treatment	Number of branches/plants			Number of leaves/plants			Number of nodes/plants			Days to first flowering		
	2019	2020	Mean	2019	2020	Mean	2019	2020	Mean	2019	2020	Mean
T1	3.78	3.85	3.81	32.10	32.43	32.27	12.70	12.03	12.36	45.90	47.57	46.73
T2	4.06	4.09	4.08	37.21	37.54	37.38	13.60	13.93	13.77	45.73	45.40	45.56
T3	4.08	4.11	4.10	38.00	38.67	38.33	13.20	13.53	13.37	45.67	46.00	45.84
T4	4.01	3.98	3.99	35.10	35.43	35.27	12.41	12.74	12.58	45.85	46.18	46.02
T5	4.08	4.15	4.11	42.00	42.33	42.17	15.44	15.77	15.61	45.20	46.20	45.70
T6	4.03	3.96	4.00	40.90	41.23	41.07	16.23	16.56	16.40	44.90	45.23	45.07
T7	4.02	4.05	4.04	38.30	38.63	38.47	14.30	14.63	14.47	45.42	45.75	45.59
T8	4.01	4.08	4.04	41.03	42.03	41.53	18.40	18.73	18.57	43.50	43.83	43.67
T9	4.14	4.21	4.17	46.00	46.33	46.17	18.31	18.98	18.64	43.00	43.67	43.33
T10	4.14	4.24	4.19	46.65	46.98	46.81	14.35	15.35	14.85	45.08	46.41	45.75
T11	4.70	4.73	4.72	47.33	47.67	47.50	17.12	17.45	17.29	44.20	44.87	44.53
T12	4.76	4.66	4.71	44.10	44.43	44.27	17.31	17.64	17.48	44.07	44.74	44.40
T13	4.54	4.51	4.52	43.75	44.42	44.09	16.29	16.96	16.62	44.67	45.34	45.00
T14	4.94	4.91	4.92	46.10	46.43	46.27	19.13	19.46	19.30	41.43	42.10	41.77
T15	5.61	5.71	5.66	50.23	51.23	50.73	19.90	20.57	20.23	39.67	39.33	39.50
T16	4.84	4.87	4.86	43.90	44.23	44.07	18.67	19.00	18.84	43.10	43.86	43.52
T17	4.20	4.27	4.23	45.93	46.27	46.10	18.21	18.88	18.54	44.90	45.90	45.40
T18	4.00	4.03	4.02	42.70	43.03	42.87	18.00	18.67	18.33	44.35	45.02	44.68
T19	4.10	4.13	4.12	42.10	42.77	42.43	18.60	18.93	18.77	45.23	45.90	45.56
T20	4.30	4.33	4.32	43.20	43.53	43.37	18.80	19.47	19.13	44.65	44.98	44.82
CD (P= 0.05)	0.622	0.601	0.08	3.652	3.689	0.324	2.358	2.312	0.297	NS	NS	NS
SEm	0.216	0.209	0.027	1.271	1.284	0.109	0.82	0.804	0.1	2.302	2.21	0.236
SED	0.306	0.296	0.038	1.797	1.815	0.154	1.16	1.137	0.141	3.255	3.125	0.333

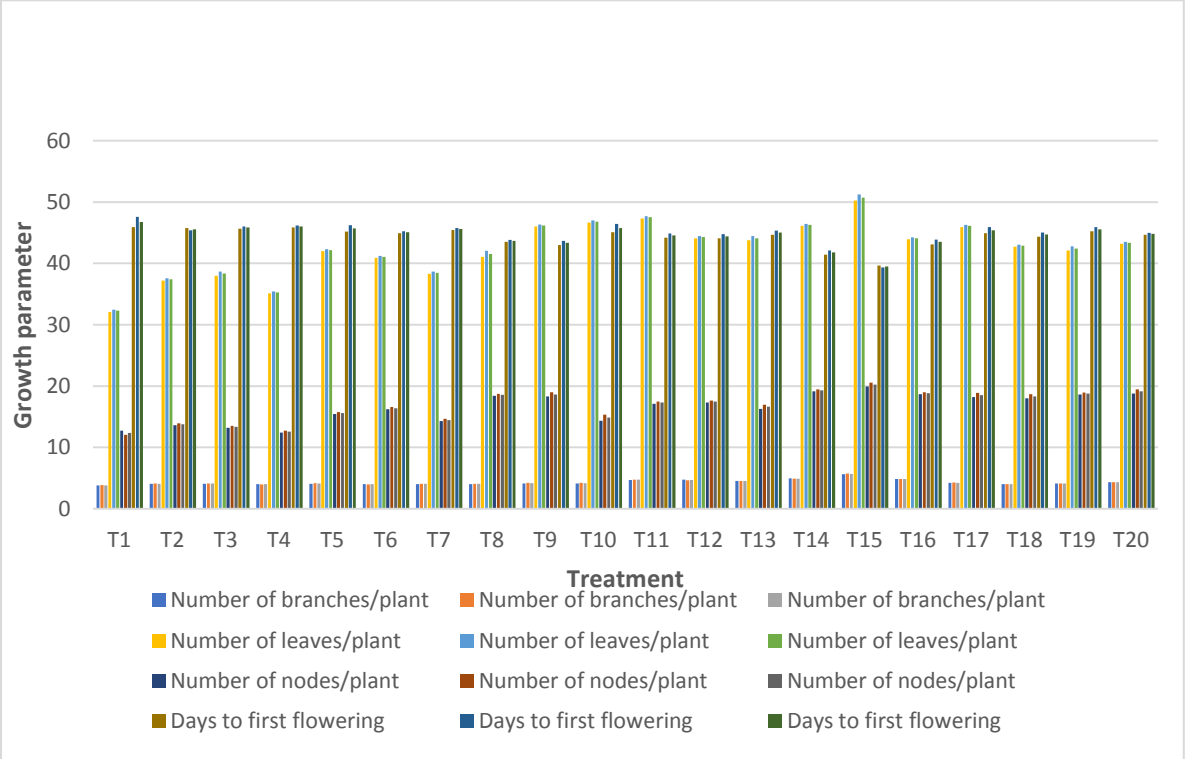

Fig. 2. Effects of different fertilizers on growth and growth parameters in Okra

In our study, lowest days to seed germination, highest plant height and stem diameter, maximum number of branches, leaves, nodes per plant and the lowest days to first flowering were found when 140% RDF and vermicompost@2t/ha were used together. Our findings are in accordance with results of studies by Mohammadi G, et al. [5-9].

Singh, N.P. [10] also reported that application of nitrogen @ 0.0, 75.0 and 150.0 kg/ha, phosphorous and potash @ 0.0, 60.0 and 120.0 kg/ha in okra variety Pusa Sawani at IIVR Varanasi (UP). He noticed that application of nitrogen and phosphorous @ 75.0 kg/ha and 60.0 kg/ha respectively gave maximum value in number of branches, plant height, fruit and size of fruit with minimum number days taken to first flowering. However, Potassium alone could not show any significant effect. His finding also confirmed this experimental finding.

Result obtained in this experiment had close conformity with the findings of Miglani, A. et al. [11] when he applied bioagents in combination with nitrogen that showed and confirms the application of Azospirillum to seed +30.0kg nitrogen/ha gave highest growth and yield in okra variety Pusa Sawani. It is now clear that application of organic, inorganic and bio agent have synergetic effect on physiological parameter including yields as well. Bhushan et al. [12] also confirms the results of present research finding and they also reported that the effect of Azotobactor and inorganic fertilizers on growth, development and yields of okra var. Hissar Unnut.

Results revealed that days to 50% germination, days to 100% germination, plant height, stem diameter, number of leaves per plant, number of branches per plant, number of nodes per plant, days to first flowering were better with combination of 140% RDF+Vermicompost@2t/ha which was significantly higher than control and other plants which were treated with single fertilizer. Results of the current study strongly suggest that growth and development of okra can be enhanced by combined use of organic fertilizers in their optimum ration. Similar kinds of results were also shown by Akter et al. [13]. They also found that combination of different manures and fertilizers significantly enhance growth and yield parameters in comparison to using fertilizer/manure alone. It has also been cleared by other scientists also that the combined application of organic manures and inorganic

fertilizers is highly beneficial for sustainability in crop production [14,15]. Supplying different fertilizers together increases the quantity the quality of a variety of nutrients simultaneously and can reduce the amount of N loss [16].

Myint et al. [17] suggested that the main advantage of using organic manures was to provide plants with nutrients that are released slowly throughout the growing season. Uses of waste as manure cut the investment cost for a crop.

6. CONCLUSION

Based on the findings of the experiment, it can be said that utilising vermicompost and RDF at a ratio of 140 % can improve okra's growth and development while also providing farmers with a greater financial return.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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