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Effect of integrated nutrient management on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench) cv. Kashi Pragati

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Abstract
A field experiment was carried out to investigate the "Effect of Integrated Nutrient Management on Growth, Yield and Quality of Okra (*Abelmoschus esculentus* L. Moench) cv. Kashi Pragati". during August to October 2014 at Vegetable Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (U.P.). Different levels and combination of bio-fertilizers and inorganic manures was applied to assess the vegetative growth, yield and Quality characteristics of Okra. The experiment was laid out in factorial randomized block design (FRBD) with sixteen treatments and three replications. The maximum plant height (167.83 cm) and maximum number of leafs (32.23) also were observed in the treatment T_{16} (Azotobacter+PSB+NPK@120:60:60). Average fruit length was found in maximum treatment T_{11} (PSB+NPK+@100:50:50) 13.06 cm than other treatment. Regarding the different parameters of growth, yield and quality significantly higher [No. of nodes (27.00), Diameter of stem (1.94 cm), Days taken to first flower appearance (38.73), Days taken to 50% flowering (55.03), diameter of fresh fruit (1.39 cm), average fruit weight (12.00 g), number of fruit per plant (22.17), fruit yield per plant (266.05 g), Total yield of fruits (167.52 q/h), Total seed yield per plant (23.10 g), Ascorbic acid (19.03 mg/100g), TSS (14.83^0 Brix), Incidence of Y.V.M.V. (10.95%) and economically better than all treatment] were reported in the treatment T_{12} (Azotobacter+PSB+NPK@100:50:50).

Keywords: Azotobacter, PSB, okra, nitrogen, phosphorus and potash

Introduction
Bhindi or Okra botanically known as (*Abelmoschus Esculentus* L. Moench) belongs to the family Malvaceae having somatic chromosome number of Okra 2n=130. It is native of tropical and subtropical Africa, America, Turkey and other neighboring countries besides, India. It is one of the important and popular vegetable of Uttar Pradesh. It is called as Lady's finger in England, Gumbo in United State of America and Bhindi in India. Okra is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopian, Cyprus and the Southern United States.

Okra has captured a prominent position among vegetables, being native of tropical Africa. It is commonly known as okra or lady's finger in India. It is choicest fruit vegetable which grown extensively in tropical and subtropical parts of the world. Its tender green fruits are used as a vegetable and are generally marketed in fresh form, but sometimes in canned or dehydrated form. Major states of cultivation in India are Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, Karnataka and Assam (Anon., 2011) [4]. West Bengal and Karnataka are major producers of okra.

Okra is a good source of vitamin A and C. The vitamin A is high as 88 I. U. and vitamin C 13 mg per 100 gm of edible portion. It is rich source of Calcium, Potassium and other mineral matters. The calcium and Potassium content ranges from 66 mg to 103 mg per 100 gm of edible portion. It contains 89.6% water and the food value per 100 gm of edible portion is carbohydrates 6.4 gm, protein 1.9 gm, fiber 1.2 gm, magnesium 53 mg, phosphorus 56 mg, sulphar 30 mg, and oxalic acid 8 mg. Rahman and Akter (2012) [26].

Okra is cultivated for its fibrous fruits or pods containing round, white seeds. The fruits are harvested when immature and eaten as a vegetable. The roots and stems of okra are used for cleaning the cane juice from which gur or brown sugar is prepared (Chauhan, 1972) [8].

The productivity of vegetables in India is much lower than the potential productivity because of imbalance use of inorganic fertilizers with resulting deterioration of soil health.

Thus quantum jump in production is the need by use of hybrids and at the same time to produce quality vegetables with maintaining soil fertility and environmental safety by adoption of Integrated Nutrient Management, is highly essential. Keeping this in view, field experiments were conducted to study the performance of okra under reduced level of chemical fertilizers supplemented with organic manures. In present time the harmful effects of chemical fertilizers is a major problem. So the Integrated nutrient management is best way to obtain quantity and quality yield in okra and other crops.

The FYM plays a major role in relation to modify the soil physical, chemical, biological environment this increases the activity of soil micro-organism. The average amount of nutrients contain in FYM is N2 0.5-0.6%, P2 O5 0.25%, K20-0.06, FYM consist of two components Solid phase, Dung and Liquid phase on an average Ahmed and Mohamed (2015) [1].

Nitrogen is a vitally important plant nutrient, plant normally contain 15% by weight of this nutrient. Nitrogen is an essential constituent of proteins and is present in many other compounds of great physiological importance in plant metabolism e.g. Nucleotides, phosphatides, alkaloids, enzymes, hormones, and vitamin etc (Das, 2011) [10].

Phosphorus has a great role in energy storage and transfer. Phosphorus is a constituent of nucleic acid, phytin and phospho-lipids Salvi *et al*. (2015) [29].

Potassium produces strong stiff straw in cereals and thereby reduces lodging in cereals. Potassium imparts increased vigour and disease resistance to plants Anisa *et al*. (2016) [3].

Azotobacter are non symbiotic nitrogen fixing and aerobic bacteria which fix atmosphere N2, the bacterial or bio-fertilizers are applied as inoculants through seed or soil treatment Sharma and Choudhary (2011) [30]; Wagh *et al*. (2014) [36].

Phosphate solublizer bacteria help in the solublisation of native phosphorus from phosphate rock and other sparingly soluble forms of soil phosphorus by secreting organic acid. Also there are problems of losses of applied fertilizers and fixation of phosphorus, PSB plants a significant role in solublising insoluble phosphate around 95-99% Premsekhar and Rajashree (2009) [25].

Materials and Methods

The experiment was carried out under Prayagraj Agro-climatic condition at the Vegetable Research Farm, Department of Horticulture, Prayagraj School of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh) during August to October 2014. The soil of the experimental field was sandy loam in texture, poor in nitrogen, comparatively rich in phosphorus and medium in potash with slightly alkaline reaction. In order to get good tilth of the soil for sowing one cross cultivation was done by tractor draw cultivator followed by two harrowing and one planking before sowing of seed. After two weeks of sowing, thinning was carried out to maintain plant to plant distance 30 cm and row to row distances 45 cm. A basal dose of N, P and K along with Azotobacter and PSB culture were applied behalf of treatment. One third nitrogen and entire quantity of P and K was applied prior to sowing. Remaining dose of nitrogen was applied in two splits after sowing. The experiment was laid out in factorial randomized block design (FRBD) with sixteen treatments and three replications. All the different combination of biofertilizers and inorganic manures treatments viz; T_1 control (M_0F_1 – Microbial inoculants 0 + N_{60}:P_{30}:K_{30}), T_2 (M_1F_1 – Azotobacter + N_{60}:P_{30}:K_{30}), T_3 (M_2F_1 –PSB + N_{60}:P_{30}:K_{30}), T_4 (M_3F_1 –Azotobacter +PSB + N_{60}:P_{30}:K_{30}), T_5 (M_0F_2 - Microbial inoculants 0 + N_{80}:P_{40}:K_{40}), T_6 (M_1F_2 - Azotobacter + N_{80}:P_{40}:K_{40}), T_7 (M_2F_2 - PSB + N_{80}:P_{40}:K_{40}), T_8 (M_3F_2 – Azotobacter + PSB + N_{80}:P_{40}:K_{40}), T_9 (M_0F_3 - Microbial inoculants 0 + N_{100}:P_{50}:K_{50}), T_{10} (M_1F_3 - Azotobacter + N_{100}:P_{50}:K_{50}), T_{11} (M_2F_3 - PSB + N_{100}:P_{50}:K_{50}), T_{12} (M_3F_3 – Azotobacter + PSB + N_{100}:P_{50}:K_{50}), T_{13} (M_0F_4 - Microbial inoculants 0 + N_{120}:P_{60}:K_{60}), T_{14} (M_1F_4 - Azotobacter + N_{120}:P_{60}:K_{60}), T_{15} (M_2F_4 –PSB + N_{120}:P_{60}:K_{60}) and T_{16} (M_3F_4 – Azotobacter + PSB + N_{120}:P_{60}:K_{60}) are randomly arranged and observations recorded at regular intervals from the experimental field. The all parameters characters were analyzed by the analysis of variance (ANOVA) technique. The critical difference values were calculated at 5% level of significance.

Results and Discussion

The experimental results of the present investigation have been presented and the results obtained for growth, yield, and quality parameters of different treatments have been discussed in the subsequent pages under appropriate headings.

Growth characters

Plant height (cm): The data are presented in Table 1 showed plant height (cm). There was significant difference among the treatments for plant height at 30, 60 and 90 days after sowing. It is very clear from the table that there are significant differences among the treatments. The maximum plant height was observed in T_{16} (Azotobacter + PSB + N120:P60:K60) followed by T_{14} (Azotobacter + N120:P60:K60), while the minimum plant height was observed in T_1 (Microbial inoculants 0 + N60:P30:K30). Higher level of nitrogen gave better results as well as Azotobacter treatments were also better with combinations of N, P and K. These results are more or less in conformity with the finding reported by Rana (2015) [27] and Singh *et al*. (2004) [31] found that using mineral fertilizer (N, P and K) increasing okra vegetative growth (plant height).

Number of leaves per plant: The data presented in table 1 showed numbers of leaves per plant. There was significant difference among the treatments for number of leaves per plant at 30, 60 and 90 days after sowing the maximum number of leaves per plant was observed in T_{16} (Azotobacter + PSB + N_{120}:P_{60}:K_{60}) followed by T_{14} (Azotobacter + N_{120}:P_{60}:K_{60}), while the minimum number of leaves per plant was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). These variations might be due to effect of INM and help plant growth by increasing the number and biological activity of derived microorganisms in the root environment and NPK gives more available form of nutrient, due to combine effect of number of leaves per plant in okra. Omotoso and Shittu (2007) [22] reported that the maximum plant height, leaf area, root length, number of leaves and yield of okra were obtained with the application of 120 kg NPK /ha the plant height, branches per plant and leaf area of okra.

Number of nodes per plant: The data presented in table 1 showed number of nodes per plant. There was significant difference among the treatments for number of nodes per plant. The maximum number of nodes per plant was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the minimum number of nodes per plant was observed in T_1 (Microbial inoculants 0 +

N_{60}:P_{30}:K_{30}). Azotobacter apart from its role in nitrogen fixation from the atmosphere, N is the chief constituent of protein, essential for the formation of protoplasm, which leads to cell enlargement, cell division and ultimately resulting in increased plant growth, NPK provide available nutrient in the soil, due to combine effect of number of nodes per plant. These results are more or less in conformity with the finding reported by Thirunavukkarasu and Balaji (2015) [33].

Diameter of main stem (cm): The data presented in table 1 showed diameter of main stem (cm). There was significant difference among the treatments maximum diameter of main stem was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the minimum diameter of main stem was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). Significant increase in okra plant diameter of main stem was observed due to biofertilizers inoculation. These results are more or less in conformity with the finding reported by Khan *et al*. (2013) [19] that impact of various sources of organic manures and farmyard manure. Its combination with various levels of inorganic fertilizers on growth parameters of okra.

Yields parameters

Days taken to first flower appearance: The data presented in table 2 showed days taken to first flower appearance. There was significant difference among the treatments for days taken to first flower appearance in minimum days was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the maximum days taken to first flower appearance was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). Baliah *et al.* (2017) [5] reported that application of 75% nitrogen and Azotobacter + PSB resulted in higher availability and uptake of nutrient by okra and thus recorded the day's taken to first flower appearance of okra and Jat and Ahlawat (2004) [17] also find similar result.

Days taken to 50% flowering: The data presented in table 2 showed days taken to 50% flowering. There was significant difference among the treatments minimum days taken to 50% flowering was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the maximum days taken to 50% flowering was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). The variation in node number at which first male flower appears might have been due to specific genetic makeup of different hybrids prevailing environment condition. Similar findings were reported by Hisham *et al.* (2014) [15] and Hammad *et al.* (2016) [14] in okra.

Diameter of fresh fruit (cm): The data presented in table 2 showed diameter of fresh fruit (cm). There was significant difference among the treatments maximum diameter of fresh fruit was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the minimum diameter of fresh fruit was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). These results are more or less similar to the finding reported by Omotosa and Shittu (2007b) [22] reported the effect of NPK fertilizer application rates and method of application on growth and yield of okra (*Abelmoschus esculentus* L. Moench).

Length of the fruit (cm): The data presented in table 2 showed average fruit length (cm). There was significant difference among the treatments maximum average fruit length was observed in T_{11} (PSB + N_{100}:P_{50}:K_{50}) followed by in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}). While the minimum average fruit length was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). This finding agreed with the finding of Yadav *et al.* (2006) [35] reported that the application of 90 kg N ha^{-1} through urea, poultry manure, FYM and vermicompost significantly increased number of fruits, fruit length, girth of fruit and total yield of okra as compared to control.

Average weight of fruits (g): The data presented in table 3 showed average fruit weight (g). There was significant difference among the treatments maximum fruit length was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the minimum fruit length was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). Similar findings were reported by Patil *et al.* (2007) [23], Prabhu *et al.* (2002) [24], Garhwal *et al.* (2008) [12], Khan *et al.* (2013) [19] and this finding agreed with the response of okra cultivars Parbhani Kranti and Arka Anamika to N fertilizer at 0, 25, 50 or 75 kg/ha. The variation in average fruit weight might have been due to internodal length, number of internodes, genetic factor, environmental factor, hormonal factor and vigour of the crop. The best result was comes due to combine effect of NPK, Vermicompost and Azotobacter.

Number of fruit per plant: The data presented in table 3 showed numbers of fruit per plant. There was significant difference among the treatments maximum number of fruit per plant was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the minimum number of fruit per plant was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). Kadam and Sahane (2002) [18] reported that application of 75% nitrogen and Azotobacter + PSB resulted in higher availability and uptake of nutrient by okra and thus recorded the highest values for knob diameter, knob volume, fresh weight and dry weight of plant and produced the maximum yield.

Yield of fruits per plant (g): The data presented in table 3 showed number of fruit per plant. There was significant difference among the treatments for fruit yield per plant (g). The maximum fruit yield per plant was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}). However minimum fruit yield per plant was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). These results are in line with the findings of Firoz *et al.* (2004) [11] in which he found that integration of organic and inorganic fertilizers application significantly increased the fruit yield over inorganic fertilizers alone and also over control.

Total yield of fruits (q/ha): The data presented in table 3 showed total yield of fruits (q/ha). There was significant difference among the treatments maximum yield of fruits was observed in T_{12} (Azotobacter + PSB + N_{100}:P_{50}:K_{50}) followed by T_{11} (PSB + N_{100}:P_{50}:K_{50}), while the minimum yield of fruits was observed in T_1 (Microbial inoculants 0 + N_{60}:P_{30}:K_{30}). This finding agreed with Tyagi1 *et al.* (2016) [34], FYM increase soil fertility and Azotobacter increases microbial population in the soil, due to effect of INM yield of fruits (q/ha) increases.

Seed yield per plant (g): The data presented in table 3 showed total seed yield per plant (g). There was significant difference among the treatments maximum seed yield per plant was observed in T_{12} (Azotobacter + PSB + $N_{100}:P_{50}:K_{50}$) followed by T_{11} (PSB + $N_{100}:P_{50}:K_{50}$) while the minimum seed yield per plant was observed in T_1 (Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$). Higher seed yield per plant may be due to increased growth components of okra plant at NPK and Azotobacter + PSB along with biofertilizers. These results are in line with the findings of Rahman and Akter (2012) [26] in which he found that integration of organic and inorganic fertilizers application significantly increased the seed yield per plant over inorganic fertilizers alone and also over control.

Quality parameters

Ascorbic acid (mg/100 g): The data presented in table 4 showed Ascorbic acid (mg/100g). There was significant difference among the treatments maximum Ascorbic acid was observed in T_{12} (Azotobacter + PSB + $N_{100}:P_{50}:K_{50}$) followed by T_{11} (PSB + $N_{100}:P_{50}:K_{50}$), while the minimum Ascorbic acid was observed in T_1 (Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$). Reddy *et al.* (2001) [28] and Hisham *et al.* (2014) [15] also reported more or less similar result the effect of organic manures and biofertilizers application of FYM plus seedling inoculation in Azotobacter showed pod yield, significantly higher Ascorbic acid content in okra fruits.

T.SS. (^{0}Brix): The data presented in table 4 TSS (ºBrix). There was significant difference among the treatments maximum TSS was observed in T_{12} (Azotobacter + PSB + $N_{100}:P_{50}:K_{50}$) followed by T_{11} (PSB + $N_{100}:P_{50}:K_{50}$), while the minimum TSS was observed in T_1 (Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$). Application of organic manure would have helped in the plant metabolic activity through the supply of such important micronutrients in the early crop growth phase, which in turn encouraged early vigorous growth, due to this effect Total soluble solid also increase. Olowoake *et al.* (2015) [21] also reported more or less similar result.

Incidence of Y.V.M.V. (%): The data presented in table 4 showed incidence of Y.V.M.V. (%). There was significant difference among the treatments minimum incidence of Y.V.M.V. % was observed in T_{12} (Azotobacter + PSB + $N_{100}:P_{50}:K_{50}$) followed by T_{11} (PSB + $N_{100}:P_{50}:K_{50}$), while the maximum incidence of Y.V.M.V. % was observed in T_1 (Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$). Ali *et al.* (2012) [2] observed that the similar finding of epidemiological factors of okra yellow vein mosaic virus (OYVMV). The variety VRO-6 was highly resistant while Subz Pari was moderately resistant.

Economics of crop production: The data presented in table 4 showed economics of the treatments. The maximum net return per hectare was observed in T_{12} (Azotobacter + PSB + NPK $N_{100}:P_{50}:K_{50}$) followed by T_{11} (PSB + $N_{100}:P_{50}:K_{50}$), while the minimum net return per hectare was observed in T_1 (Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$). As for economics of treatment is concerned, the highest benefit cost ratio was observed with T_{12} (Azotobacter + PSB + NPK @ 100:50:50) than T_{11} (PSB + NPK @ 100:50:50) due to its higher yield per hectare. Treatment T_{12} (Azotobacter + PSB + $N_{100}:P_{50}:K_{50}$) was superior over all other treatments in relation to Benefit: Cost ratio. Ogundare *et al.* (2015) [20], Swain *et al.* (2003) [32] and Dademal *et al.* (2004) [9] also reported more or less similar results.

Table 1: Effect of Integrated Nutrient Management on Growth parameters of Okra cv. Kashi Pragati.

Treatment symbol	Treatment combination	Plant height (cm)			No. of leafs			Number of nods	Diameter Stem (cm)
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		
T_1	M_0F_1–Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$	38.50	140.10	161.63	9.10	21.97	26.00	21.13	1.37
T_2	M_1F_1 – Azotobacter + $N_{60}:P_{30}:K_{30}$	40.10	140.60	162.00	9.27	22.23	26.47	21.50	1.40
T_3	M_2F_1 –PSB + $N_{60}:P_{30}:K_{30}$	39.57	140.33	161.80	9.17	22.03	26.17	22.47	1.51
T_4	M_3F_1 –Azotobacter +PSB + $N_{60}:P_{30}:K_{30}$	41.37	141.23	162.40	9.37	22.60	26.87	22.97	1.56
T_5	M_0F_2 - Microbial inoculants 0 + $N_{80}:P_{40}:K_{40}$	43.80	144.23	164.10	9.80	24.20	29.97	22.17	1.49
T_6	M_1F_2 - Azotobacter + $N_{80}:P_{40}:K_{40}$	45.30	145.70	164.43	9.93	24.63	30.37	22.73	1.53
T_7	M_2F_2 - PSB + $N_{80}:P_{40}:K_{40}$	44.63	145.20	164.17	9.87	24.43	30.20	24.00	1.67
T_8	M_3F_2 – Azotobacter + PSB + $N_{80}:P_{40}:K_{40}$	45.50	145.93	165.93	10.17	25.10	30.67	24.57	1.78
T_9	M_0F_3 - Microbial inoculants 0 + $N_{100}:P_{50}:K_{50}$	46.00	146.07	166.37	10.37	25.33	30.97	23.80	1.64
T_{10}	M_1F_3 - Azotobacter + $N_{100}:P_{50}:K_{50}$	46.40	146.80	166.70	10.73	25.77	31.27	24.30	1.73
T_{11}	M_2F_3 - PSB + $N_{100}:P_{50}:K_{50}$	46.07	146.23	166.47	10.57	25.60	31.07	25.40	1.83
T_{12}	M_3F_3 – Azotobacter + PSB + $N_{100}:P_{50}:K_{50}$	46.67	147.07	167.00	11.10	26.10	31.50	27.00	1.94
T_{13}	M_0F_4 - Microbial inoculants 0 + $N_{120}:P_{60}:K_{60}$	46.87	147.37	167.27	11.23	26.63	31.73	21.80	1.43
T_{14}	M_1F_4 - Azotobacter + $N_{120}:P_{60}:K_{60}$	47.23	147.70	167.53	11.57	27.03	32.07	22.00	1.45
T_{15}	M_2F_4 –PSB + $N_{120}:P_{60}:K_{60}$	47.03	147.50	167.40	11.33	26.90	31.87	23.17	1.59
T_{16}	M_3F_4 – Azotobacter + PSB + $N_{120}:P_{60}:K_{60}$	47.53	147.90	167.83	11.80	27.70	32.23	23.50	1.62
SEd. (±)		0.46	0.35	0.40	0.24	0.49	0.44	0.26	0.05
CD (5%)		0.96	0.71	0.82	0.49	1.00	0.90	0.52	0.09
CV (%)		1.29	0.29	0.30	2.82	2.42	1.80	1.35	3.54

Table 2: Effect of Integrated Nutrient Management on yield parameters of Okra cv. Kashi Pragati.

Treatment symbol	Treatment combination	Days taken to first flower appearance	Days taken to 50% flowering	Diameter fruit (cm)	Fruit length (cm)
T_1	M_0F_1–Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$	45.17	58.27	1.14	11.43
T_2	M_1F_1 – Azotobactor + $N_{60}:P_{30}:K_{30}$	44.77	57.70	1.17	11.88
T_3	M_2F_1 –PSB + $N_{60}:P_{30}:K_{30}$	43.00	56.33	1.24	11.97
T_4	M_3F_1 –Azotobactor +PSB + $N_{60}:P_{30}:K_{30}$	42.07	55.73	1.27	12.10
T_5	M_0F_2 - Microbial inoculants 0 + $N_{80}:P_{40}:K_{40}$	43.53	56.60	1.22	11.50
T_6	M_1F_2 - Azotobactor + $N_{80}:P_{40}:K_{40}$	42.50	56.00	1.26	11.80
T_7	M_2F_2 - PSB + $N_{80}:P_{40}:K_{40}$	39.87	56.07	1.31	12.00
T_8	M_3F_2 – Azotobactor + PSB + $N_{80}:P_{40}:K_{40}$	39.20	55.53	1.33	12.19
T_9	M_0F_3 - Microbial inoculants 0 + $N_{100}:P_{50}:K_{50}$	40.47	56.47	1.29	11.87
T_{10}	M_1F_3 - Azotobactor + $N_{100}:P_{50}:K_{50}$	39.53	55.70	1.32	12.11
T_{11}	M_2F_3 - PSB + $N_{100}:P_{50}:K_{50}$	38.93	55.27	1.36	13.06
T_{12}	M_3F_3 – Azotobactor + PSB + $N_{100}:P_{50}:K_{50}$	38.73	55.03	1.39	12.93
T_{13}	M_0F_4 - Microbial inoculants 0 + $N_{120}:P_{60}:K_{60}$	44.33	57.30	1.19	11.69
T_{14}	M_1F_4 - Azotobactor + $N_{120}:P_{60}:K_{60}$	43.90	57.03	1.21	11.85
T_{15}	M_2F_4 –PSB + $N_{120}:P_{60}:K_{60}$	41.57	55.43	1.28	11.90
T_{16}	M_3F_4 – Azotobactor + PSB + $N_{120}:P_{60}:K_{60}$	41.00	55.90	1.28	11.95
SEd. (±)		0.39	0.50	0.02	0.54
CD (5%)		0.80	1.02	0.04	1.11
CV (%)		1.15	1.09	1.84	5.54

Table 3: Effect of Integrated Nutrient Management on yield parameters of Okra cv. Kashi Pragati.

Treatment symbol	Treatment combination	Fruit weight (g)	No. of fruit/ plant	Fruit yield/plant (g)	Fruits yield (q/ha)	Seed yield/plant (g)
T_1	M_0F_1–Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$	11.03	16.93	186.85	117.65	17.5
T_2	M_1F_1 – Azotobactor + $N_{60}:P_{30}:K_{30}$	11.10	17.50	194.26	122.31	17.9
T_3	M_2F_1 –PSB + $N_{60}:P_{30}:K_{30}$	11.33	17.97	203.67	128.23	19.87
T_4	M_3F_1 –Azotobactor +PSB + $N_{60}:P_{30}:K_{30}$	11.47	18.10	207.6	130.71	20.43
T_5	M_0F_2 - Microbial inoculants 0 + $N_{80}:P_{40}:K_{40}$	11.30	17.90	202.28	127.36	19.33
T_6	M_1F_2 - Azotobactor + $N_{80}:P_{40}:K_{40}$	11.40	18.07	205.96	129.68	20.23
T_7	M_2F_2 - PSB + $N_{80}:P_{40}:K_{40}$	11.63	19.10	222.16	139.88	21.67
T_8	M_3F_2 – Azotobactor + PSB + $N_{80}:P_{40}:K_{40}$	11.77	20.30	238.73	150.31	22.23
T_9	M_0F_3 - Microbial inoculants 0 + $N_{100}:P_{50}:K_{50}$	11.57	18.67	215.86	135.91	21.47
T_{10}	M_1F_3 - Azotobactor + $N_{100}:P_{50}:K_{50}$	11.73	20.07	235.39	148.21	21.97
T_{11}	M_2F_3 - PSB + $N_{100}:P_{50}:K_{50}$	11.83	20.57	243.36	153.22	22.5
T_{12}	M_3F_3 – Azotobactor + PSB + $N_{100}:P_{50}:K_{50}$	12.00	22.17	266.05	167.52	23.1
T_{13}	M_0F_4 - Microbial inoculants 0 + $N_{120}:P_{60}:K_{60}$	11.17	17.63	196.88	123.96	18.53
T_{14}	M_1F_4 - Azotobactor + $N_{120}:P_{60}:K_{60}$	11.23	17.80	200.01	125.93	18.9
T_{15}	M_2F_4 –PSB + $N_{120}:P_{60}:K_{60}$	11.50	18.13	208.6	131.34	20.7
T_{16}	M_3F_4 – Azotobactor + PSB + $N_{120}:P_{60}:K_{60}$	11.60	18.33	212.74	133.95	21.17
SEd. (±)		0.21	0.36	5.84	3.42	2.15
CD (5%)		0.44	0.73	11.92	6.84	4.31
CV (%)		2.28	2.35	3.32	2.7	2.7

Table 4: Effect of Integrated Nutrient Management on Quality and economic parameters of Okra cv. Kashi Pragati.

Treatment symbol	Treatment combination	Ascorbic acid (mg/100g)	TSS (^{0} Brix)	Incidence of Y.V.M.V. (%)	Net income	B:C
T_1	M_0F_1–Microbial inoculants 0 + $N_{60}:P_{30}:K_{30}$	15.93	11.73	3.37	86099	1.95
T_2	M_1F_1 – Azotobactor + $N_{60}:P_{30}:K_{30}$	16.07	12.00	3.11	92789	2.02
T_3	M_2F_1 –PSB + $N_{60}:P_{30}:K_{30}$	16.90	13.00	2.41	101669	2.12
T_4	M_3F_1 –Azotobactor +PSB + $N_{60}:P_{30}:K_{30}$	17.27	13.33	2.13	105089	2.16
T_5	M_0F_2 - Microbial inoculants 0 + $N_{80}:P_{40}:K_{40}$	16.63	12.83	2.60	99520	2.09
T_6	M_1F_2 - Azotobactor + $N_{80}:P_{40}:K_{40}$	17.07	13.17	2.23	102700	2.12
T_7	M_2F_2 - PSB + $N_{80}:P_{40}:K_{40}$	18.17	14.10	1.50	118000	2.29
T_8	M_3F_2 – Azotobactor + PSB + $N_{80}:P_{40}:K_{40}$	18.57	14.53	1.27	133345	2.45
T_9	M_0F_3 - Microbial inoculants 0 + $N_{100}:P_{50}:K_{50}$	17.97	13.90	1.71	111201	2.2
T_{10}	M_1F_3 - Azotobactor + $N_{100}:P_{50}:K_{50}$	18.37	14.33	1.36	129351	2.39
T_{11}	M_2F_3 - PSB + $N_{100}:P_{50}:K_{50}$	18.80	14.67	1.04	136866	2.47
T_{12}	M_3F_3 – Azotobactor + PSB + $N_{100}:P_{50}:K_{50}$	19.03	14.83	0.95	158016	2.69
T_{13}	M_0F_4 - Microbial inoculants 0 + $N_{120}:P_{60}:K_{60}$	16.17	12.33	2.81	92132	1.98
T_{14}	M_1F_4 - Azotobactor + $N_{120}:P_{60}:K_{60}$	16.33	12.67	2.72	94787	2.01
T_{15}	M_2F_4 –PSB + $N_{120}:P_{60}:K_{60}$	17.47	13.50	1.97	102902	2.09
T_{16}	M_3F_4 – Azotobactor + PSB + $N_{120}:P_{60}:K_{60}$	17.73	13.70	1.80	106217	2.12
SEd. (±)		0.20	0.21	0.08		
CD (5%)		0.42	0.42	0.17		
CV (%)		1.45	1.88	5.02		

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