Int.J.Curr.Microbiol.App.Sci (2017) *6*(11): 3321-3325

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 11 (2017) pp. 3321-3325**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.611.389

Study on Integrated Nutrient Management on Physiological and Biochemical Attributes of Okra (*Abelmoschus esculentus*)

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Keywords

Physiological - biochemical characteristics, INM, Okra.

Article Info

Accepted:
24 September 2017
Available Online:
10 November 2017

A B S T R A C T

Field experiment was conducted to study the effect of graded doses of N, P and different biofertilizers *viz.*, *Azospirillum* and phosphobacteria along with growth regulators *viz.*, Naphalene Acetic Acid -50 ppm and Gibberellic Acid -100 ppm on growth and yield of okra (*Abelmoschus esculentus*) at Agricultural College & Research Institute, Madurai. The highest physiological and biochemical parameters *viz.*, dry matter production (2680.8 kg/ha at 125th DAS), crop growth rate (17.9 g m^{-2} day^{-1} 85 - 125th DAS), relatively growth rate (0.0164 mg g^{-1} day^{-1} at 85 - 125th DAS), ascorbic acid (13.7 mg/100 g of fruits) crude fibre (6.1 %), calcium (0.073 %) and magnesium (0.042 %) was recorded in the treatment (T_{15}) 75 per cent recommended dose of N, P + 100 % K + *Azospirillum* + Phosphobacteria + GA_3 –100 ppm.

Introduction

Okra is one of the most important vegetables crops grown throughout the tropics of the world. It is used as vegetable and has some industrial importance like extraction of mucilage used in the preparation of jaggery. The integrated nutrient management approach is indispensable for sustaining high quality vegetable production without causing detrimental effects on soil caused by inorganic fertilizers can be minimized. The ultimate aim of sustainable agriculture is to develop farming system that would be productive and profitable, simultaneously conserve the natural resource base, protect the environment and to enhance the health and safety of the soil as well as human life over a long period. This is possible to a certain extent by proper input management. Low input farming system seeks to minimize the use of external inputs like fertilizers.

Wherever and whenever feasible and practicable, to lower the production cost, to avoid pollution of surface and ground water and to increase both short-term and long-term farm profitability. The organic farming concept, not only supply the macro and micro nutrients required for crop growth, but also improves the soil physical properties thereby improves aeration, to root zone.

The other aspect of the soil health is its microbial activity. Soil micro-organisms play a pivotal role in the evolution of agriculturally useful soil conditions as well as stimulating plant growth. Artificial inoculation of soil with micro-organisms might temporarily or permanently change the balance of rhizosphere physically, biologically and nutritionally which will eventually enhance the plant growth and yield. Beneficial effects due to seed application with nitrogen fixing and phosphate solubilising bacteria on plant growth, nutrient uptake and yield has been reported by a number of workers in many agricultural and horticultural crops. The third aspect is the use of plant growth regulators in improving crop yield. As native biochemicals, they trigger all the physiological activities in the plant system for efficient crop production. This treatment was associated with increased crop growth rate (CGR), relative growth rate (RGR**),** dry matter production (DMP), ascorbic acid, crude fibre, calcium and magnesium of okra.

Materials and Methods

Field experiment was laid out in College Orchard of Agricultural College and Research Institute, Madurai, to study the effect of integrated nutrient management in okra. The experiment was laid out in a Randomized Block Design with three replications. The field was ploughed to fine tilth and a general dose of farmyard manure was incorporated at the time of last ploughing. Then ridges and furrows of 60 cm apart were formed. The hybrid seeds of okra (no.152) was obtained from Syngenta Seed Company and treated with *Azospirillum* and phosphobacteria biofertilizers each at 200 g and sown at different treatment combination with plant to plant spacing of 30 cm row to row 60 cm by simple hand dibbling. Rest of the *Azospirillum* and Phosphobacteria @ 1.8 kg each was applied in the soil along with the FYM before sowing the seed. According to treatment structure NAA (50 ppm) and GA_3 (100 ppm) were sprayed during two stages *viz.*, Initial flowering stage (DAS) and peak flowering stage (DAS) in different treatment combinations. The treatment details are furnished below. Each treatment plot constituted twenty seven plants, of which five plants were identified and labeled for stage wise morphological observations.

Details of the treatment are furnished below

T0 - Recommended level NPK (40:50:30 kg / ha)

T1 - Recommended dose of NPK + Azospirillum

T2 - Recommended dose of NPK + Azospirillum + NAA – 50 ppm

T3 - Recommended dose of NPK + Azospirillum + GA3 –100 ppm

T4 - Recommended dose of NPK + Phosphobacteria

T5 - Recommended dose of NPK + Phosphobacteria + NAA – 50 ppm

T6 - Recommended dose of NPK + Phosphobacteria + GA3 – 100 ppm

T7 - 75% recommended dose of N + 100% P and K + Azospirillum

T8 - 75% recommended dose of N + 100% P and K + Azospirillum + NAA – 50 ppm

T9 - 75% recommended dose of N + 100% P and K + Azospirillum + GA3 –100 ppm

T10 - 75% recommended dose of P + 100% N and K + Phosphobacteria

T11 - 75% recommended dose of P + 100% N and K + Phosphobacteria + NAA-50 ppm

T12 - 75% recommended dose of P + 100% N and K + Phosphobacteria + GA3-100 ppm

T13 - 75% recommended dose of N + 75% recommended dose of P + 100% K + Azospirillum + Phosphobacteria

T14 - 75% recommended dose of N + 75% recommended dose of P + 100% K + Azospirillum + Phosphobacteria +NAA 50 ppm

T15 - 75% recommended dose of N + 75% recommended dose of P + 100% K + Azospirillum + Phosphobacteria + GA3-100 ppm

Results and Discussion

The application of T_{15} (75 per cent recommended dose of N + 75 per cent recommended dose of P + 100 per cent K + *Azospirillum* + Phosphobacteria + GA_3-100 ppm) significantly influenced the physiological and biochemical attributes of okra. T_{15} registered highest dry matter production (2680.8 kg/ha at 125th DAS), crop growth rate (17.9 g m^{-2} day^{-1} at 85 - 125 th DAS), relative growth rate (0.0164 mg g^{-1} day^{-1} at 85 - 125 th DAS), ascorbic acid (13.7 mg/ 100 g of fruits), crude fibre (6.1 %) calcium (0.073 %) and magnesium (0.042 %).

The increased dry matter production was the result of better plant growth as reflected by plant height and leaf number.

Organic manures and higher level of nutrients enhanced the dry matter production (Table 1).

Table.1 Effect of integrated nutrient management on dry matter production (kg/ha) in okra

Treatment	Dry Matter Production (kg/ha)		
	45th DAS	85 th DAS	125 th DAS
T_0	247.5	879.9	1509.9
T_1	286.5	926.4	1589.7
T_2	277.5	976.5	1619.1
T_3	326.1	1056.6	1630.8
T_4	329.7	1119.9	1719.0
T_5	338.1	1176.6	1807.5
T_6	377.4	1206.6	1907.4
T_7	407.4	1229.1	1949.1
T_8	430.5	1247.4	2020.8
T_9	461.7	1257.6	2110.8
T_{10}	487.5	1279.8	2210.7
T_{11}	520.5	1307.4	2260.8
T_{12}	550.8	1289.1	2380.8
T_{13}	526.5	1319.1	2560.8
T_{14}	550.8	1307.1	2536.5
T_{15}	596.4	1390.8	2680.8
SEd	**41.62**	**75.25**	**156.83**
CD (P=0.05)	**85.01**	**153.68**	**320.29**

DAS – Days After Sowing

Table.2 Effect of integrated nutrient management on Crop Growth Rate (g m^{-2} day^{-1}) and Relative growth rate (mg g^{-1} day^{-1}) in okra

Treatment	Crop Growth Rate (g m^{-2} day^{-1})		Relative growth rate (mg g^{-1} day^{-1})	
	First stage (45 th -85 th DAS)	Second stage (85 th -125 th DAS)	First stage (45 th -85 th DAS)	Second stage (85 th -125 th DAS)
T_0	8.78	8.75	0.02117	0.01350
T_1	8.89	9.21	0.02126	0.01350
T_2	9.71	8.93	0.02160	0.01264
T_3	10.15	7.98	0.02296	0.01085
T_4	10.98	8.32	0.02303	0.01071
T_5	10.50	8.76	0.02505	0.01073
T_6	11.01	9.73	0.02413	0.01145
T_7	10.93	10.00	0.02660	0.01153
T_8	10.25	10.74	0.02906	0.01206
T_9	11.03	11.85	0.02939	0.01295
T_{10}	11.00	12.93	0.02761	0.01367
T_{11}	11.05	13.24	0.02934	0.01369
T_{12}	11.35	15.16	0.03057	0.01534
T_{13}	11.41	17.25	0.03118	0.01658
T_{14}	11.52	17.08	0.03145	0.01657
T_{15}	11.65	17.92	0.03171	0.01641
SEd	**0.668**	**1.633**	**0.0015**	**0.0009**
CD (P=0.05)	**1.364**	**3.336**	**0.0030**	**0.0018**

Table.3 Effect of integrated nutrient management on fruit quality attributes in okra

Treatments	Crude fibre (per cent)	Vitamin C (mg/ 100 g of fruits)	Ca (per cent)	Mg (per cent)
T_0	9.08	6.30	0.054	0.027
T_1	8.94	9.63	0.056	0.029
T_2	8.96	10.05	0.063	0.030
T_3	8.59	9.88	0.058	0.029
T_4	8.38	9.84	0.056	0.030
T_5	8.04	10.30	0.058	0.031
T_6	7.86	10.31	0.063	0.035
T_7	7.56	10.85	0.063	0.034
T_8	7.64	11.47	0.067	0.033
T_9	7.60	12.28	0.066	0.034
T_{10}	7.47	12.88	0.066	0.035
T_{11}	7.42	12.88	0.068	0.035
T_{12}	7.26	12.87	0.068	0.038
T_{13}	7.22	13.14	0.069	0.038
T_{14}	7.03	12.66	0.070	0.041
T_{15}	6.06	13.66	0.073	0.042
SEd	**0.15**	**0.16**	**0.0012**	**0.0010**
CD (P=0.05)	**0.30**	**0.33**	**0.0024**	**0.0020**

Nitrogen nutrition enhanced the vegetative growth with more number of leaves, number of nodes and phosphorus increased root production. This would have resulted in increased accumulation of dry matter and also efficient partitioning of photosynthates towards sink. Better absorption of potassium would have helped in the translocation of photosynthates to the reproductive part, the sink namely the fruits. Increased dry matter production in biofertilizer applied plants was an indirect effect of the biofertilizer through plant and root growth. This effect mediated through auxin and cytokinin like substances found in higher level of mycorrhizal plants (Lewis, 1975) and the effect of growth regulators on photosynthesis and translocation of assimilates might be the cause for the enhanced biomass (Herold, 1980). The plants inoculated with biofertilizers recorded high dry matter production in sweet potato (Palanisamy, 1985). The early growth of the leaf is supported by photosynthates derived from the cotyledon leaf and other source. As the lamina expands the rate of photosynthesis increases. But most carbon for structural carbohydrates comes from photosynthesis when the entire growing period is analyzed and the timing of transition from source to sink coincides with positive accumulation of carbon in the leaf. Computation of CGR and RGR were done to quantify these transitions. Similar effect of fertilizers on CGR and RGR were observed by Parvatham *et al.,* (1989) in bhendi (Table 2).

High content of vitamins like ascorbic acid coupled with low fibre would be an ideal vegetable (Table 3). Promotive effect of nutrients on ascorbic acid content has been reported earlier in chilli (Niranjana and Devi, 1990). Increase in ascorbic acid content was reported due to biofertilizers in brinjal (Nanthakumar and Veeraragavathatham, 2001). The lowest crude fibre content the desirable quality of okra was observed due to application of organic manures, inorganic fertilizers, biofertilizers and growth regulator which led to an improvement in the fruit quality. Increase in the fruit length crude fibre content is an additional requirement for consumer preference in this perishable vegetable. The quality and suitability of a vegetable for consumption, in a crop like okra is judged based on the crude fibre content of fruits. Low crude fibre content is considered to be the most desirable character. Nitrogen had a negative influence on the crude fibre content in the present study. Organic manures, higher level of nutrients and biofertilizers decreased the crude fibre content. Decreased crude fibre content due to increased N application has been observed earlier in bhendi (Mani and Ramanthan, 1981).

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How to cite this article:

Ciba C. and Syamala M. 2017. Study on Integrated Nutrient Management on Physiological and Biochemical Attributes of Okra (*Abelmoschus esculentus*). *Int.J.Curr.Microbiol.App.Sci.* 6(11): 3321-3325. doi: https://doi.org/10.20546/ijcmas.2017.611.389