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RESEARCH ARTICLE :

Integrated nutrient management's effect on nutrients content and nutrients uptake of okra (*Abelmoschus esculentus* (L.) Moench)

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SUMMARY : A field experiment on nutrient content and nutrient uptake attributes of okra (*Abelmoschus esculentus* (L.) Moench) under integrated nutrient management was carried out in College Orchard of Agricultural College and Research Institute, Madurai, Tamil Nadu. The experiments were laid out in Randomized Block Design (RBD) with fifteen treatments in three replications. The study revealed that the increased nutrient content and nutrient uptake attributes was obtained in T_{15} (75% recommended dose of N + 75% recommended dose of P + 100% K + *Azospirillum* + Phosphobacteria + GA_3-100 ppm). Application of T_{15} significantly highest leaf nitrogen (2.91 %), leaf phosphorus (0.36 %), leaf potassium (3.95 %), uptake of nitrogen (170.9 kg ha $^{-1}$), phosphorus (9.12 kg ha^{-1}) and potassium (214.81 kg ha^{-1}) of okra (*Abelmoschus esculentus* (L.) Moench).

KEY WORDS :
Nutrient, Okra, Management, Nutrient uptake

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BACKGROUND AND OBJECTIVES

Okra one of the important summer vegetable crops of India. Organic manure alone may not be enough to meet the nutritional requirement of crop in intensive cropping system, thus, a suitable organic matter with chemical fertilizers, biofertilizers and growth regulators may help in improving the fertility, productivity and physical condition of soil. Nutrient accumulation in plant varies with the soil type, soil fertility, varieties and agro-climatic conditions.

RESOURCES AND METHODS

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 in Table A.

Table A : Details of the treatment are furnished below

T_0	-	Recommended level NPK (40:50:30 kg / ha)
T_1	-	Recommended dose of NPK + *Azospirillum*
T_2	-	Recommended dose of NPK + *Azospirillum* + NAA – 50 ppm
T_3	-	Recommended dose of NPK + *Azospirillum* + GA_3 –100 ppm
T_4	-	Recommended dose of NPK + Phosphobacteria
T_5	-	Recommended dose of NPK + Phosphobacteria + NAA – 50 ppm
T_6	-	Recommended dose of NPK + Phosphobacteria + GA_3 – 100 ppm
T_7	-	75% recommended dose of N + 100% P and K + *Azospirillum*
T_8	-	75% recommended dose of N + 100% P and K + *Azospirillum* + NAA – 50 ppm
T_9	-	75% recommended dose of N + 100% P and K + *Azospirillum* + GA_3 –100 ppm
T_{10}	-	75% recommended dose of P + 100% N and K + Phosphobacteria
T_{11}	-	75% recommended dose of P + 100% N and K + Phosphobacteria + NAA- 50 ppm
T_{12}	-	75% recommended dose of P + 100% N and K + Phosphobacteria + GA_3- 100 ppm
T_{13}	-	75% recommended dose of N + 75% recommended dose of P + 100% K + *Azospirillum* + Phosphobacteria
T_{14}	-	75% recommended dose of N + 75% recommended dose of P + 100% K + *Azospirillum* + Phosphobacteria +NAA 50 ppm
T_{15}	-	75% recommended dose of N + 75% recommended dose of P + 100% K + *Azospirillum* + Phosphobacteria + GA_3-100 ppm

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads :

Nutrient status in leaves :

The present study indicated a definite increase in the leaf nitrogen, phosphorus and potassium content due to application of (T_{15}) 75% recommended dose of N + 75% recommended dose of P + 100% K + *Azospirillum* + Phosphobacteria + GA_3-100 ppm registered highest leaf nitrogen (2.91 %), leaf phosphorus (0.36 %) and leaf potassium (3.95 %) at final harvesting stage (Table 1). Higher level of nutrients resulted in higher leaf N concentration. The combined effect of *Azospirillum*, Phosphobacteria help in improving K, Ca, Mg content in plants at peak flowering, such an increase in the leaf nutrient content was also observed by Subbiah (1986). Leaf N concentration was also positively influenced by GA_3 spray which might have been mainly by the activity of absorption of nitrogen and production of photoassimilates and protein synthesis.

Leaf P concentration at both the growth stages was positively influenced by organic manures, higher nutrient levels, biofertilizers and growth regulators. Inoculation of *Azosopirillum* and Phosphobacteria mediate the fixation of atmospheric nitrogen and solubilise the phosphorus with simultaneous uptake of nitrogen and phosphorus. The enzyme complexes released by *Azospirillum* and Phosphobacterium inoculation has been reported to be responsible for solubilising the unavailable form of P and rendering them available P to plants (Pacovsky *et al.*, 1985).

Higher level of nutrients resulted in highest leaf K concentration. Increase in leaf K content is due to K application in bhendi was reported by Singh (1979). Inoculation of biofertilizers also resulted in higher leaf K concentration than uninoculated control. Increased leaf N, P, K content by *Azospirillum* was observed in bhendi by Balasubramani (1988). It can be inferred that increased nutrient content in leaves could have been due to the formation of cytokinin, GA and IAA activities in the roots by *Azospirillum* leading to high absorption of nutrients. Higher rate of assimilation in plants under organic nutrition due to better absorption of nitrogen and phosphorus nutrients and further assimilation into chlorophyll would have encouraged better photosynthesis. Enhanced activity of applied GA_3 would have been the cause for better absorption of K. Since the translocation of metabolites were also triggered by the phytohormones like GA_3 and the portion transport essentially involves the chemical combination of source and K^+ ion to reach the sink namely the developing fruits from source (leaves). The plants were essentially forced to absorb more K^+ ions from the soil especially during flowering stage. On the contrary, a decrease in all leaf nutrients concentration at harvesting stage observed might be due to rapid translocation of nutrients to the developing fruits.

Uptake of major nutrients :

In present study, increased uptake of nitrogen (170.9

kg ha $^{-1}$), phosphorus (9.12 kg ha $^{-1}$) and potassium (214.81 kg ha $^{-1}$) due to application of (T_{15}) 75% recommended dose of N + 75% recommended dose of P + 100% K + *Azospirillum* + Phosphobacteria + GA_3-100 ppm registered highest was observed (Table 2). The increase in N uptake at higher levels of K may be due to higher available N which was released by the higher levels of K. Enhanced uptake of nitrogen due to *Azospirillum*

Table 1 : Effect of integrated nutrient management on leaf nitrogen, phosphorus and potassium (%) in okra

Treatments	Leaf nitrogen content (%)		Leaf phosphorus content (%)		Leaf potassium content (%)	
	Peak flowering stage	Final harvesting stage	Peak flowering stage	Final harvesting stage	Peak flowering stage	Final harvesting stage
T_0	2.01	1.89	0.21	0.19	2.70	2.34
T_1	2.05	1.95	0.21	0.19	2.77	2.47
T_2	2.07	2.01	0.22	0.20	2.83	2.47
T_3	2.07	2.05	0.23	0.21	2.86	2.51
T_4	2.10	2.08	0.24	0.22	2.92	2.62
T_5	2.09	2.09	0.25	0.22	2.95	2.64
T_6	2.27	2.18	0.25	0.24	2.99	2.65
T_7	2.35	2.33	0.24	0.24	3.24	2.72
T_8	2.40	2.38	0.27	0.25	3.33	2.76
T_9	2.48	2.40	0.28	0.26	3.39	2.80
T_{10}	2.50	2.42	0.28	0.27	3.57	2.84
T_{11}	2.69	2.54	0.29	0.27	3.62	2.91
T_{12}	2.72	2.55	0.31	0.27	3.66	2.93
T_{13}	2.78	2.57	0.33	0.29	3.82	3.01
T_{14}	2.86	2.60	0.34	0.31	3.86	3.06
T_{15}	2.91	2.63	0.36	0.34	3.95	3.36
S.E. ±	0.015	0.011	0.009	0.008	0.04	0.03
CD (P=0.05)	0.031	0.023	0.018	0.017	0.09	0.06

Table 2 : Effect of integrated nutrient management on uptake nitrogen, phosphorus and potassium (kg ha $^{-1}$) in okra

Treatments	Uptake N (kg ha^{-1})	Uptake P (kg ha^{-1})	Uptake K (kg ha^{-1})
T_0	98.4	5.34	167.58
T_1	101.6	5.60	167.92
T_2	104.2	5.67	170.09
T_3	100.6	5.89	182.62
T_4	112.5	5.95	184.71
T_5	120.5	6.03	190.06
T_6	127.5	7.01	192.24
T_7	131.1	7.46	185.82
T_8	131.8	7.48	184.99
T_9	134.1	7.71	194.40
T_{10}	140.3	7.73	197.12
T_{11}	141.2	7.85	193.76
T_{12}	152.0	8.11	204.00
T_{13}	159.1	8.43	204.59
T_{14}	167.8	8.89	208.07
T_{15}	170.9	9.12	214.81
S.E. ±	2.03	0.14	3.51
C.D. (P=0.05)	4.15	0.29	7.18

treatment was also reported in bhendi (Balasubramani, 1988 and Parvatham and Vijan (1989). Improved N availability in the Rhizosphere facilitates better uptake of nitrogen.

The uptake of phosphorus was high under organic manures and higher level of nutrients. The significant influence of N and P uptake was reported earlier by (Pandey and Dubey, 1997) in bhendi. The possible reason for better uptake of P due to biofertilizers inoculation can be due to the production of enzymatic complex by Phosphobacteria (Rokade and Patil, 1993) and *Azospirillum* (Abbott and Robson, 1984) which solubilise the unavailable phosphorus resulting them into forms easily available to roots. The increased absorbing root surface also might have resulted in higher nutrient uptake (Venkateswarlu and Rao, 1983).

The uptake of potassium was positively influenced by higher level of nutrients. Positive effect of N application on uptake of K was reported by Hammond *et al*. (1951) in soybean. The synergistic effect between N and K existed leading to production of more photo assimilates and conversion into glycosides. For any plant to put forth better growth, the assimilates should consistently be transported from leaves to the growing region or storage region. This essential transport function takes place in the highly specialized phloem tissues (*i.e.*,) the network of interconnecting sieve tubes. The loading of sugars into the sieve elements is generally considered to be an active process operating at high flux rate (Geiger, 1975).

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