Plant Archives Vol. 26, Supplement 2, 2026 pp. 2745-2750 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.347

RESPONSE OF INTEGRATED NUTRIENT MANAGEMENT ON SOIL PROPERTIES AND GROWTH OF CHINA ASTER (*Callistephus chinensis* L. Nees) CV. ARKA ARCHANA

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(Date of Receiving : 03-05-2026; Date of Revision : 21-06-2026; Date of Acceptance : 08-07-2026)

ABSTRACT

A field experiment was conducted at the Flower and Ornamental Nursery, College of Horticulture, Anand Agricultural University, Anand, during the *Rabi* season of 2025 to evaluate the response of integrated nutrient management on soil properties and growth of china Aster (*Callistephus chinensis* L. Nees) cv. Arka Archana. The experiment was laid out in a Randomized Block Design (RBD) with ten treatments and three replications. The treatments comprised varying combinations of chemical fertilizers, organic manures and the Bio NPK consortium. The results revealed that the integrated application of 75% RDF + 25% Vermicompost + Bio NPK consortium (T_6) recorded significantly increase in terms of all vegetative growth parameters, including plant height (15.52, 28.64 and 39.28 cm at 30, 60 and 90 DAT, respectively), number of branches per plant and plant spread (E-W), plant spread (N-S) across all growth stages. Furthermore, post-harvest soil tracking indicated that treatment T_6 significantly enhanced soil fertility status, recording the highest residual available nitrogen (284.37 kg/ha), available phosphorus (48.46 kg/ha) and available potassium (332.86 kg/ha), along with a massive proliferation in the microbial count (3.3×10^{10} CFU/g). These findings demonstrate that integrated nutrient management strategy can successfully optimize crop growth while simultaneously sustaining post-harvest soil health.
Keywords **:** *Callistephus chinensis*, Integrated nutrient management, Vermicompost, Bio NPK consortium, Available nutrients.

Introduction

China aster (*Callistephus chinensis* L. Nees) is a highly valued commercial annual flower crop belonging to the family Asteraceae. The botanical name is derived from Greek words: *'kallos,'* meaning beauty and *'stephos,'* meaning crown, alluding to the beautiful and showy inflorescence (Jayaweera, 1981). Valued for its diverse color spectrum, sturdy stems and long post-harvest life, it is widely grown as a commercial crop for loose and cut flowers across India. China aster is a short-duration and heavy-feeder crop. Synthetic mineral fertilizers facilitate rapid vegetative growth and early blooming, their continuous, unbalanced and exclusive use degrades soil health. It causes structural soil compaction, decreases organic carbon levels and severely suppresses beneficial biological activity within the rhizosphere. Integrated Nutrient Management (INM) offers a sustainable alternative by combining chemical fertilizer, organic manures and Bio NPK consortium. This balanced approach maintains high crop productivity without degrading the soil health. Consequently, this study was designed to evaluate the impact of various bio-organic treatment combinations on the growth and post-harvest soil properties of china aster.

Materials and Methods

The field trial was carried out from September 2025 to March 2026 at the Flower and Ornamental Nursery, College of Horticulture, Anand Agricultural University, Anand, Gujarat, India (22.35° N, 72.56° E, 45.1 m above MSL). The experimental soil belongs to the alluvial 'Goradu' sandy loam class (Entisol) with an initial baseline pH (8.14), EC (0.26 dS/m), organic carbon (0.325%), available nitrogen (226.89 kg/ha), available phosphorous (39.42 kg/ha) and available potash (278.75 kg/ha). The experiment was laid out in a Randomized Block Design (RBD) featuring ten treatments replicated three times with a uniform plant spacing of 30 cm x 30 cm. The detailed treatments are: T_1: Control (Absolute); T_2: 100% RDF (180:120:60 kg NPK/ha); T_3: 75% RDF + 25% Castor cake; T_4: 75% RDF + 25% Vermicompost; T_5: 75% RDF + 25% Castor cake + Bio NPK consortium (1 L/ha); T_6: 75% RDF + 25% Vermicompost + Bio NPK consortium (1 L/ha); T_7: 50% RDF + 50% Castor cake; T_8: 50% RDF + 50% Vermicompost; T_9: 50% RDF + 50% Castor cake + Bio NPK consortium (1 L/ha); T_{10}: 50% RDF + 50% Vermicompost + Bio NPK consortium (1 L/ha). Healthy 45 day old seedlings of cv. Arka Archana were transplanted into plots measuring 2.1 m x 1.8 m. Full doses of organic manures, phosphorus, potassium and half the nitrogen were applied at planting, while the remaining nitrogen was given at 30 DAT. All growth parameters were recorded at 30, 60 and 90 days after transplanting (DAT) from five randomly selected and tagged plants per treatment, with values averaged to determine the mean. Plant height (cm) was measured from ground level to the apical growing tip using a standard meter scale. Number of branches per plant were calculated by counting the total number of branches emerging from the main stem. Plant spread (E-W) (cm) was measured as the maximum canopy width along the East-West axis. Plant spread (N-S) (cm) was measured as the maximum canopy width along the North-South axis. In soil analysis, soil samples were collected from the experimental field at a depth of 0–15 cm both prior to the experiment's initiation and immediately following its conclusion. The collected samples were air-dried, gently ground using a wooden mortar and pestle, passed through a 2-mm sieve and preserved in sealed polythene bags for subsequent chemical analysis. Soil EC (dS/m) was measured in a 1:2.5 soil-water ratio using the conductometry method (Jackson, 1973). Soil pH was determined in a 1:2.5 soil-water ratio using the potentiometric method (Jackson, 1973). Organic Carbon (%) was determined via Walkley and Black's rapid titration method (Jackson, 1973). Available Nitrogen (kg/ha) was quantified utilizing the alkaline $KMnO_4$ method (Subbiah and Asija, 1956). Available Phosphorus (kg/ha) was extracted with 0.5 M sodium bicarbonate and quantified via spectrophotometry using Olsen's method (Jackson, 1973). Available Potassium (kg/ha) was extracted utilizing a neutral normal ammonium acetate solution and determined via flame photometry (Jackson, 1973). Microbial Count (CFU/g)- To quantify the rhizospheric microbial population, soil samples collected before the experiment and after the final harvest were analyzed using standard serial dilution and spread plate techniques. A 1 g soil sample was thoroughly dispersed in 10 ml of sterile distilled water and sequentially diluted to prepare a series up to 10^7. A 0.1 ml aliquot from the 10^5 and 10^7 dilutions was spread onto specific agar media. Following the required incubation period, the developed colonies were tallied using a digital colony counter and the microbial population was expressed as colony-forming units (CFU) per gram of soil.

$$\text{CFU g}^{-1}\text{ of moist soil} = \frac{\text{(Number of colonies with zone)(Dilution factor)}}{\text{(Volume of sample plated)}}$$

Data were analysed using Analysis of Variance (ANOVA) at a 5% level of significance.

Results and Discussion

Growth parameters

Integrated nutrient management treatments significantly increased all vegetative features of china aster (Table 1).

Plant height (cm): Treatment T_6 (75% RDF + 25% Vermicompost + Bio NPK consortium) recorded the maximum plant height at 30 DAT (15.52 cm), 60 DAT (28.64 cm) and 90 DAT (39.28 cm), while T_1 remained the lowest (8.65, 18.95 and 28.97 cm). Immediate mineral supply combined with steady organic nutrient release optimized metabolic growth, while vermicompost-derived auxins accelerated cellular division and elongation. These findings match results reported by Giri *et al.* (2020) in gerbera, Dhanumjaya *et al*. (2015) in tuberose, Kirar *et al*. (2014) and Jogi *et al*. (2022) in china aster and Pandey *et al.* (2010) in chrysanthemum.

Number of branches per plant: Number of branches per plant was found maximum under T_6 at 30 DAT (5.00), 60 DAT (16.13) and 90 DAT (28.67), while T_1 recorded minimum (3.80, 9.93 and 21.40) at 30, 60 and 90 DAT respectively. Enhanced macro- and micro nutrient mobility along with cytokinins synthesized by the Bio NPK consortium broke apical dominance, encouraging lateral bud development. These results conform with Patanwar *et al*. (2014) in chrysanthemum, Sharma *et al*. (2017) and Kumura *et al*. (2019) in marigold.

Plant spread (E-W) (cm): Maximum E-W plant spread (12.35, 22.64 and 30.55 cm) were recorded in T_6 at 30, 60 and 90 DAT respectively. Whereas minimum plant spread was recorded in T_1 (8.81, 15.45 and 21.82 cm) at 30, 60 and 90 DAT respectively. The higher rate of cell division and growth that occurs through the use of Bio-NPK consortium and vermicompost. Maximum spreading of the plants takes place due to meristematic growth through cell production and expansion. This is supported by Geeta *et al*. (2016) and Marak *et al*. (2020) in china aster.

Plant spread (N-S) (cm): Maximum N-S plant spread (12.67, 23.31 and 30.96 cm) was captured in T_6 at 30, 60 and 90 DAT, respectively. Whereas minimum plant spread was recorded in T_1 (9.95, 12.60 and 21.73 cm) at 30, 60 and 90 DAT, respectively. Biological mineralization converted nutrients into highly absorbable forms, fueling meristematic cell production and expansion to expand the canopy. This is supported by Arha *et al*. (2021) in gaillardia, Patanwar *et al*. (2014) in chrysanthemum and Singh *et al*. (2015) in marigold

Table 1: Response of china aster growth parameters to INM

Treatment No.	Plant height (cm)			Number of branches/plants			Plant spread (E-W) (cm)			Plant spread (N-S) (cm)		
	30 DAT	**60 DAT**	**90 DAT**	**30 DAT**	**60 DAT**	**90 DAT**	**30 DAT**	**60 DAT**	**90 DAT**	**30 DAT**	**60 DAT**	**90 DAT**
T_1	8.65	18.95	28.97	3.80	9.93	21.40	8.81	15.45	21.82	9.95	12.60	21.73
T_2	11.70	23.19	34.15	4.20	12.93	24.13	10.32	17.46	24.74	10.18	16.56	24.26
T_3	12.05	23.22	34.30	4.27	13.07	24.27	10.41	17.60	25.57	10.98	17.03	27.07
T_4	12.39	24.29	34.59	4.33	13.27	24.40	10.51	18.06	26.07	10.53	17.93	27.15
T_5	13.49	27.09	36.30	4.93	15.60	27.73	11.99	21.19	28.79	11.99	21.68	29.07
T_6	15.52	28.64	39.28	5.00	16.13	28.67	12.35	22.64	30.55	12.67	23.31	30.96
T_7	10.07	21.92	32.08	4.07	12.47	23.20	9.78	16.53	23.39	10.03	15.12	23.49
T_8	10.72	22.77	34.10	4.13	12.60	23.27	10.22	17.13	23.75	10.05	15.90	23.65
T_9	13.02	25.92	34.93	4.33	14.07	26.27	11.25	20.22	28.22	10.99	18.29	28.01
T_{10}	13.31	26.13	35.74	4.53	14.73	26.93	11.67	20.25	28.57	11.57	20.32	28.41
S.Em. ±	**0.75**	**1.41**	**1.52**	**0.21**	**0.84**	**1.16**	**0.59**	**0.84**	**1.21**	**0.54**	**1.04**	**1.26**
C.D. (P=0.05)	**2.24**	**4.18**	**4.52**	**0.62**	**2.51**	**3.46**	**1.74**	**2.50**	**3.60**	**1.62**	**3.09**	**3.73**

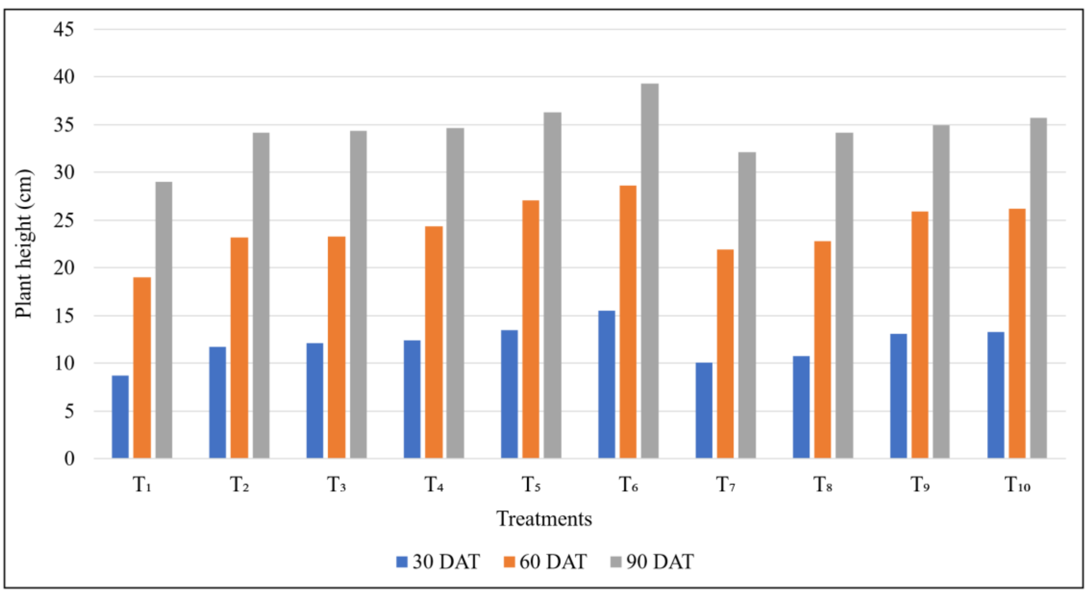

Fig. 4.1 Effect of integrated nutrient management on plant height (cm) of china aster at 30, 60 and 90 days after transplanting

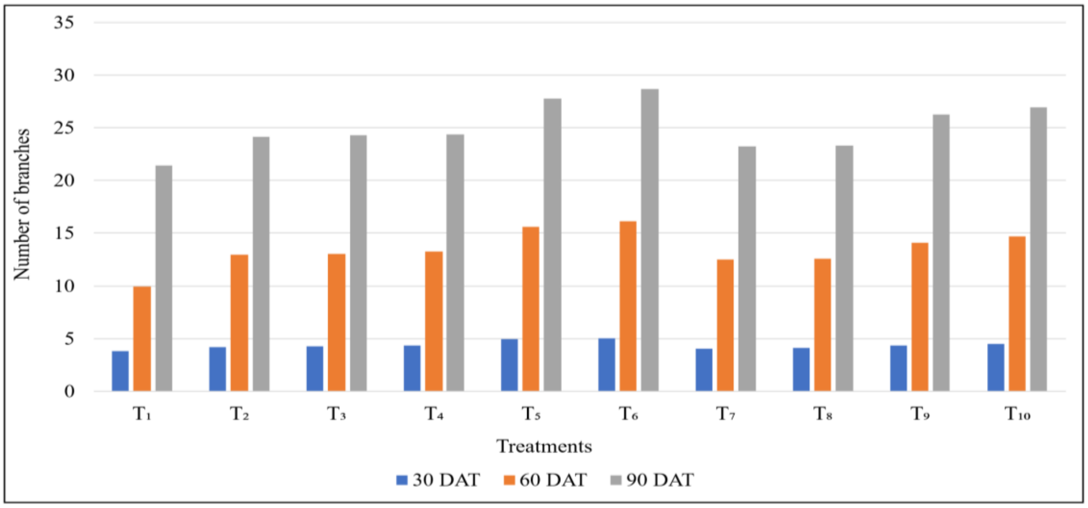

Fig. 4.2 Effect of integrated nutrient management on no. of branches of china aster at 30, 60 and 90 days after transplanting

Post-harvest soil chemical properties

Soil pH, EC and organic carbon: The applied INM treatments exerted a non-significant (NS) influence on post-harvest soil pH, electrical conductivity and organic carbon percentages (Table 2).

Available nitrogen: The available nitrogen rose significantly to 284.37 kg/ha under treatment T_6, while T_1 decreased to 210.34 kg/ha. Organic matrix nitrogen retention combined with atmospheric nitrogen fixation by *Azotobacter* strains inside the consortium left high residual soil nitrogen. These findings align with Sharma *et al*. (2025) in African marigold, Kuchanwar *et al*. (2018) in jasmine and Indhumathi *et al*. (2023) in gaillardia.

Available phosphorus: The available phosphorus reached a maximum of 48.46 kg/ha in T_6, whereas T_1 fell to 37.44 kg/ha compared to the initial status of 39.42 kg/ha. Phosphate Solubilizing Bacteria (PSB) secreted organic acids that unlocked fixed native phosphates, while vermicompost humic elements coated fixation sites to reduce phosphorus locking. This is backed by Sharma *et al*. (2025) in marigold, Kuchanwar *et al*. (2018) in jasmine and Indhumathi *et al*. (2023) in gaillardia.

Available potassium: The available potassium rose to a maximum of 332.86 kg/ha under T_6, while T_1 recorded the minimum (267.49 kg/ha). Vermicompost decomposition increased the soil's Cation Exchange Capacity (CEC) for better potassium retention, while potassium-solubilizing microbes mobilized non-available mineral fractions. These findings align with Sharma *et al*. (2025), Kuchanwar *et al*. (2018) and Indhumathi *et al*. (2023).

Table 2: Response of post-harvest soil chemical parameters to INM packages

Treat. No.	Soil pH	Soil EC (dS/m)	Soil O.C. (%)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Initial	8.14	0.26	0.325	226.89	39.42	278.75
T_1	8.12	0.28	0.33	210.34	37.44	267.49
T_2	8.07	0.27	0.35	239.17	42.74	286.75
T_3	8.15	0.25	0.36	243.41	43.13	288.19
T_4	8.29	0.27	0.36	246.99	43.53	295.69
T_5	8.10	0.29	0.37	275.13	48.08	331.90
T_6	8.24	0.26	0.38	284.37	48.46	332.86
T_7	8.19	0.28	0.37	231.35	42.27	282.02
T_8	8.16	0.27	0.35	235.66	42.56	283.11
T_9	8.17	0.27	0.39	272.88	47.69	327.04
T_{10}	8.09	0.29	0.37	280.49	47.75	323.88
S.Em. ±	0.20	0.02	0.02	8.39	1.59	11.17
C D (P=0.05)	NS	NS	NS	24.94	4.73	33.19

Soil microbial count

Microbial count (CFU/g): The microbial count increased from a pre-planting baseline of 6.8 x 10^6 CFU/g to a maximum count of 3.3 x 10^{10} CFU/g under T_6, whereas the T_1 remained unchanged at 7.2 x 10^6 CFU/g (Table 3). Vermicompost supplied an abundant organic carbon substrate that served as an energy source, fueling quick microbial replication and sustaining the added bio-inoculant populations. These trends match the biological responses recorded by Sharma *et al*. (2025) in African marigold and Kuchanwar *et al*. (2018) in jasmine.

Table 3 : Rhizospheric total bacterial viable counts post-harvest

Treatment number	Treatment details	Soil microbial count (CFU/g of soil)
Initial		6.8 x 10^6
T_1	Control (Absolute)	7.2 x 10^6
T_2	100% RDF	9.1 x 10^7
T_3	75% RDF + 25% Castor cake	5.6 x 10^8
T_4	75% RDF + 25% Vermicompost	7.5 x 10^8
T_5	75% RDF + 25% Castor cake + Bio NPK	2.1 x 10^{10}
T_6	75% RDF + 25% Vermicompost + Bio NPK	3.3 x 10^{10}
T_7	50% RDF + 50% Castor cake	4.9 x 10^8
T_8	50% RDF + 50% Vermicompost	4.3 x 10^8
T_9	50% RDF + 50% Castor cake + Bio NPK	2.8 x 10^{10}
T_{10}	50% RDF + 50% Vermicompost + Bio NPK	1.6 x 10^{10}

Conclusion

Based on the results obtained, it can be concluded that the application of 75% RDF + 25% Vermicompost + Bio NPK consortium (1 L/ha) recorded the highest increase in vegetative growth. Furthermore, this combined treatment significantly enhanced post-harvest soil nutrient status and soil microbial activity.

References

Arha, A., Kaushik, R. A., Lakhawat, S. S., Bairwa, H. L. and Verma, A. (2021). Effect of integrated nutrient management on growth, flowering and yield of gaillardia. *International Journal of Current Microbiology and Applied Sciences*, **10**, 3461.

Dhanumjaya Rao, K., Lalitha Kameswari, P. and Baby Rani, T. (2015). Impact of integrated nutrient management on growth, flowering, yield and economics of tuberose. *Agricultural Science Digest*, **35**(1), 66–69.

Geeta, B. L., Siddappa, M. M., Raj, L. and Totad, M. (2016). Influence of NPK and biofertilizers on growth, yield and quality of china aster (*Callistephus chinensis* L. Nees) for cut flower production. *Research in Environment and Life Sciences*, **9**(10), 1236-1238.

Giri, B. and Beura, S. (2020). Impact of INM Practices on Vegetative Growth and Flowering of Hybrid Gerbera (*Gerbera jamesonii* B.) cv. Shimmer in Open Condition. *International Journal of Current Microbiology and Applied Sciences*, **9**(6), 1680-1688.

Indhumathi, M., Chandrashekar, S. Y., Srinivasa, V., Shivaprasad, M. and Girish, R. (2023). Effect of Integrated Nutrient Management on Flowering, Flower Quality and Flower Yield of Gaillardia (*Gaillardia pulchella* Foug.) under Hill Zone of Karnataka. *Biological Forum-An International Journal*, **15**(1), 119-123.

Jackson, M. L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 183-192.

Jayaweera, D. M. A. (1981). *Medicinal Plants (Indigenous and Exotic) Used in Ceylon*. Colombo: National Science Council of Sri Lanka.

Jogi, P., Tirkey, T. and Tamrakar, S. K. (2022). Effect of different doses of chemical fertilizer and different formulations of bio-fertilizer on growth parameters of China aster (*Callistephus chinensis* (L.) Nees) var. Arka Archana. *The Pharma Innovation*, **11**(2), 3006-3010.

Kirar, K. P. S., Lekhi, R., Sharma, S. and Sharma, R. (2014). Effect of integrated nutrient management practices on growth and flower yield of China aster (*Callistephus chinensis* (L.) Nees) cv Princess. *Agriculture: Towards a New Paradigm of Sustainability*, **64**, 234-237.

Kuchanwar, O. D., Patil, S. B., Chopde, N., Patil, R. S. and Dongare, T. V. (2018). Impact of INM on yield of jasmine, physic-chemical properties and fertility status of soil after harvest of flowers. *International Journal of Current Microbiology and Applied Sciences*, **6**(12), 2968-2975.

Kumura, A., Pandey, G., Mishra, P. P. and Kumar, R. (2019). Effect of integrated nutrient management on growth and flowering of African marigold (*Tagetes erecta*) cv. Pusa Narangi Gainda. *International Journal of Current Microbiology and Applied Sciences*, **8**(11), 1271-1278.

Marak, B. S., Kumar, S. and Momin, K. C. (2020). Effects of organic manures and bio-fertilizers on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees var. Kamini). *Bangladesh Journal of Botany*, **49**(4), 1111-1117.

Pandey, G., Kumar, S. and Kumar, A. (2010). Effect of integrated nutrient management on growth and flowering of chrysanthemum (*Dendranthema grandiflora* Tzvelev.). *Journal of Ornamental Horticulture*, **13**(2), 112-116.

Patanwar, M., Sharma, G., Banjare, C., Chandravanshi, D. and Sahu, E. (2014). Growth and development of chrysanthemum (*Dendranthema grandiflora* Tzvelev) as influenced by integrated nutrient management. *Ecoscan*, **6**, 459-462.

Sharma, A., Sharma, K., Gaur, D., Dhakad, H., Banafer, R. N. S. and Lekhi, R. (2017). Effect of integrated nutrient management on growth, flower yield and vase life of marigold (Var. Pusa Narangi). *Journal of Pharmacognosy and Phytochemistry*, **6**(6), 319-323.

Sharma, S. K., Tewari, S. K. and Upadhyay, R. K. (2025). Effect of integrated nutrient management on quality production of African marigold (*Tagetes erecta* L.). *International Journal of Agriculture and Plant Science*, **7**(1), 56-58.

Singh, P., Prakash, S., Kumar, M., Malik, S., Singh, M. K. and Kumar, A. (2015). Effect of integrated nutrient management (INM) on growth, flowering and yield in marigold (*Tagetes erecta* L.) cv. 'Pusa basanti'. *Annals of Horticulture*, **8**(1), 73-80.

Subbiah, B. V. & Asija, G. L. (1956). A rapid procedure for the estimation of available nitrogen in soil. *Current Science*, **25**, 259-260.