Indian Journal of Agricultural Sciences **96** (1): 135–138, January 2026/Short Communication
https://doi.org/10.56093/ijas.v96i1.148278

Effect of integrated nutrient management on growth and yield of spring onion (*Allium fistulosum* var. Chiru Maroi)

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Received: 08 February 2024; Accepted: 18 December 2025

Keywords: FYM, Rice husk, Soil physical properties, Vermicompost

Spring onion (*Allium fistulosum* var. Chiru Maroi) is a perennial herb belonging to genus *Allium* under family Alliaceae originated in the Far East and is recorded in Chinese history from 2000 BC. In China, it is called 'Cong' and in Japan it is called 'Negi'. It has elongated food storage leaves which are hollow and rounded. Additionally, it features a short bulb stem and a fibrous root system at the bulb stem's base (Tindall 1986). Spring onion are available throughout the year. As per the version of local farmers of Manipur, local spring onion is called "*Chiru Maroi*" which was growing wild in the forest and domesticated later by the tribal group called *Chiru* since time immemorial. Since 1940's, it has been sold to local market and has become important vegetable crop in the state. Among the various plant nutrients, nitrogen, phosphorous and potash are the major elements absorbed by plants in large quantities. Continuous use of only chemical fertilisers intensive cropping system will lead to imbalance of nutrients in the soil. The use of organic manures like FYM, vermicompost and rice husk will be beneficial towards improving yield attributes of spring onion with the maximum profit. Thus, the concept of using integrated nutrient management (both inorganic fertilisers and organic manures) has received more attention as it helps in improving soil fertility, crop productivity, checking nutrient deficiency other than NPK.

The field experiment were conducted during rainy (*kharif*) season (July-November) of 2022 at College of Agriculture, Central Agricultural University, Imphal (24º82'N, 93º90'E; at an elevation of 790 m amsl), Manipur. The soil was clay in texture [*p*H- 5.7, organic carbon (0.98), available N (285.23 kg/ha), P (28.56 kg/ha) and K (246.00 kg/ha)]. The experiment consisted of eleven treatments, viz. T_1, 100% RDF (Recommended dose of fertiliser) 100:50:50 NPK kg/ha; T_2, 100% RDF + 10 t/ha FYM; T_3, 75% RDF + 10 t/ha FYM; T_4, 50% RDF + 10 t/ha FYM; T_5, 100% RDF + 5 t/ha FYM; T_6, 75% RDF + 5 t/ha FYM; T_7, 50% RDF + 5 t/ha FYM; T_8, 100% RDF + 2.5 t/ha VC (vermicompost); T_9, 75% RDF + 2.5 t/ha VC; T_{10}, 50% RDF + 2.5 t/ha VC; T_{11} (Control), Rice husk @10 t/ha with three replications. All the treatments were applied at the time of planting. Local spring onion var. Chiru Maroi was planted in spacing of 15 cm × 10 cm apart on 20th July 2022. Soil *p*H, organic carbon, and available N, P, K of soil were estimated by standards methods. The data obtained from different observations were analysed statistically as per standard procedure suggested by Gomez and Gomez (2010).

Integrated use of fertiliser with vermicompost increased plant height (cm), leaf length (cm) and number of leaves/plant. The data (Table 1) showed that maximum plant height (31.53, 35.59 and 37.00 cm) at 30, 60 and 90 days after planting (DAP) was recorded in Treatment T_8 (100% RDF + 2.5 t/ha vermicompost), respectively which was statistically at par with T_2 (100% RDF + 10 t/ha FYM) but significantly superior to the other treatments. This enhanced plant height might be attributed to the adequate and balanced application of major and minor nutrients, which likely stimulated photosynthetic activity, chlorophyll synthesis, nitrogen metabolism, and auxin production all of which play a crucial role in promoting vegetative growth. These findings are in agreement with the results reported by Abbey and Kanton (2003), Jayathilake *et al.* (2003) and Prabhakar *et al.* (2012). The maximum leaf length of 27.80, 31.13 and 34.09 cm at 30, 60, and 90 DAP were also recorded with treatment T_8, respectively. These results are in agreement with the findings of Jawadagi *et al.* (2012) who reported similar improvements in leaf development under integrated nutrient management practices. Likewise, the highest number of leaves/plant recorded as 14.37, 34.87, and 44.72 at 30, 60, and 90 DAP, respectively was also observed in T_8. The increase in the number of leaves can be attributed to the availability of both macro- and micronutrients, which promote vigorous vegetative growth, leading to enhanced photosynthetic activity and overall biomass accumulation. These results are consistent with the findings of Jayathilake

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Table 1 Effect of integrated nutrient management on growth of spring onion

Treatment	Plant height (cm)			Leaf length (cm)			Number of leaves/plant		
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP*	60 DAP*	90 DAP*
T_1	28.70	31.98	34.43	24.50	27.57	28.90	11.60 (3.41)	30.57 (5.53)	40.27 (6.34)
T_2	30.83	34.63	36.13	27.20	29.97	32.97	13.50 (3.67)	34.13 (5.84)	44.31 (6.66)
T_3	27.84	31.90	34.30	24.48	27.48	28.87	11.50 (3.39)	29.93 (5.47)	40.03 (6.32)
T_4	27.06	30.34	32.40	22.43	26.70	27.45	10.27 (3.20)	25.23 (5.02)	31.33 (5.60)
T_5	29.00	32.67	34.67	25.67	28.33	30.11	12.27 (3.50)	31.10 (5.58)	41.46 (6.44)
T_6	27.23	31.11	33.45	22.78	26.87	27.84	10.40 (3.22)	25.75 (5.07)	37.06 (6.09)
T_7	26.89	30.25	31.77	22.27	26.50	27.13	9.80 (3.13)	23.67 (4.87)	34.33 (5.86)
T_8	31.53	35.59	37.00	27.80	31.13	34.19	14.37 (3.79)	34.87 (5.90)	44.72 (6.69)
T_9	28.71	32.61	34.49	24.80	28.00	29.90	11.93 (3.45)	30.80 (5.55)	40.45 (6.36)
T_{10}	27.20	30.97	32.97	22.57	26.80	27.75	10.30 (3.21)	25.73 (5.07)	34.44 (5.87)
T_{11}	24.20	27.62	29.70	20.80	23.53	24.83	8.60 (2.93)	20.50 (4.53)	31.17 (5.58)
SEM±	0.50	0.48	0.46	0.42	0.43	0.42	0.05	0.07	0.08
CD (p=0.05)	1.47	1.43	1.36	1.23	1.27	1.24	0.15	0.20	0.23

DAP, Days after planting. Refer to methodology for treatment details. *Figures in parenthesis are square root transformed value.

et al. (2002) and Reddy and Reddy (2005) who also reported increased leaf production in crops supplied with a balanced nutrient regime.

The data further (Table 2 and 3) revealed that among the various nutrient management treatments evaluated, T_8 (100% RDF + 2.5 t/ha vermicompost) consistently outperformed other treatments across multiple growth and yield parameters of spring onion. Specifically, T_8 recorded the highest fresh plant weight (45.61 g) and dry plant weight (6.81 g), indicating a significant accumulation of vegetative biomass. It also produced the maximum number of bulbs/hill (10.77), longer bulbs (6.16 cm), greater bulb diameter (1.13 cm), and highest number of bulbs/kg (50.37 bulbs/kg). These favourable characteristics collectively translated into the maximum bulb yield of 70.39 q/ha, which was statistically at par with T_2 (100% RDF + 10 t/ha FYM). This statistical equivalence suggests that both treatments were highly effective in enhancing crop growth and productivity through balanced and sustained nutrient delivery. The superior performance of T_8 and T_2 may be attributed to the synergistic effects of integrated nutrient management, where the combination of organic and inorganic nutrient sources facilitated improved soil fertility, enhanced nutrient-use efficiency, and optimised plant physiological processes. RDF ensured an immediate and steady supply of essential nutrients such as nitrogen, phosphorus, and potassium, crucial for early growth and metabolic activity. In parallel, vermicompost and FYM contributed to the slow and continuous release of nutrients, thereby minimising leaching losses and ensuring availability during critical crop growth stages. Additionally, the organic amendments likely improved soil physical properties such as porosity, water-holding capacity, and aeration, while also stimulated microbial activity and enzyme production in the rhizosphere. These factors collectively enhanced root proliferation, nutrient solubilisation, and uptake, contributing to better shoot-root balance and ultimately improved bulb development. The increased number of bulbs/hill and higher bulb weight under integrated treatments reflect the cumulative impact of these benefits on reproductive success and marketable yield. These results are strongly supported by earlier studies in onion, where integrated nutrient application improved crop performance significantly. For instance, Yoldas *et al.* (2011) reported enhanced growth and yield attributes with the use of compost and chemical fertilisers. Shinde *et al.* (2013) and Sitapara *et al.* (2024) further demonstrated that combining vermicompost or FYM with RDF resulted in higher yields compared to sole application

Table 2 Effect of integrated nutrient management on yield parameters of spring onion

Treatment	Bulb diameter (cm)			Bulb length (cm)			Number of bulbs/kg	Yield of bulb (q/ha)
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP		
T_1	0.33	0.54	0.90	2.64	3.91	4.72	45.66	50.26
T_2	0.35	0.64	1.09	3.02	5.02	5.72	48.77	66.21
T_3	0.30	0.53	0.85	2.55	3.89	4.61	45.50	49.88
T_4	0.23	0.49	0.74	2.40	3.64	4.38	36.73	40.89
T_5	0.34	0.60	0.92	2.81	4.29	5.03	45.14	54.59
T_6	0.28	0.50	0.77	2.44	3.87	4.50	39.80	41.33
T_7	0.20	0.46	0.72	2.38	3.59	4.22	35.33	40.20
T_8	0.42	0.72	1.13	3.16	5.13	6.16	50.37	70.39
T_9	0.35	0.60	0.91	2.72	4.00	4.84	44.96	51.88
T_{10}	0.24	0.49	0.76	2.42	3.78	4.44	39.23	41.11
T_{11}	0.18	0.34	0.51	2.27	3.03	3.66	30.55	28.62
SEM±	0.05	0.03	0.04	0.20	0.14	0.17	0.94	1.75
CD (p=0.05)	NS	0.09	0.11	NS	0.40	0.51	2.79	5.17

DAP, Days after planting. Refer to methodology for treatment details.

Table 3 Effect of integrated nutrient management on fresh and dry weight of plant and number of bulbs/hill of spring onion

Treatment	Fresh weight of plant (g)			Dry weight of plant (g)			Number of bulbs/hill		
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP*	60 DAP*	90 DAP*
T_1	18.17	33.53	36.40	2.23	4.06	5.53	3.33 (1.96)	4.55 (2.25)	8.77 (3.05)
T_2	22.02	38.57	44.18	2.87	5.20	6.25	4.44 (2.22)	5.88 (2.52)	10.55 (3.32)
T_3	17.91	32.33	36.18	2.14	3.85	5.49	3.22 (1.93)	4.44 (2.22)	8.77 (3.05)
T_4	15.25	27.83	29.38	1.63	3.54	4.39	2.66 (1.78)	3.66 (2.04)	7.11 (2.76)
T_5	19.30	34.30	38.38	2.46	4.12	5.50	3.55 (2.01)	4.89 (2.32)	9.44 (3.16)
T_6	15.77	27.76	30.30	1.77	3.62	4.71	2.89 (1.84)	4.00 (2.12)	7.55 (2.84)
T_7	15.22	26.63	28.64	1.46	3.41	3.80	2.44 (1.71)	3.55 (2.01)	6.88 (2.72)
T_8	23.32	37.13	45.61	2.91	5.11	6.81	4.66 (2.27)	6.55 (2.65)	10.77 (3.36)
T_9	18.96	34.23	37.23	2.26	4.11	5.28	3.44 (1.99)	4.66 (2.27)	9.11 (3.10)
T_{10}	15.53	27.47	28.38	1.70	3.57	4.65	2.77 (1.81)	3.89 (2.09)	7.22 (2.78)
T_{11}	13.24	21.10	22.42	1.13	2.37	3.25	1.89 (1.54)	2.78 (1.81)	5.66 (2.48)
SEM±	0.58	0.79	0.76	0.11	0.14	0.18	0.04	0.05	0.04
CD (p=0.05)	1.72	2.34	2.23	0.32	0.41	0.54	0.12	0.16	0.12

*Figures in parenthesis are square root transformed value. DAP, Days after planting. Refer to methodology for treatment details.

of inorganic or organic sources. In garlic, Santhi *et al.* (2021) observed similar benefits, attributing them to better nutrient synchronisation and soil health. Likewise, in carrot, Shanu *et al.* (2019) noted that INM improved root weight, length, and overall marketable yield. The physiological basis for these improvements can be further explained by the findings of Jayathilake *et al.* (2003), who highlighted that enhanced nutrient availability facilitates greater photosynthetic activity, leading to increased assimilation and translocation of photosynthates from source organs (leaves) to sink organs (bulbs). This contributes directly to bulb enlargement, weight gain, and higher yield efficiency. Moreover, integrated nutrient management plays a crucial role in sustainable agriculture, as it helps reduce dependence on chemical fertilisers, minimises nutrient losses, and supports long-term soil organic matter build-up, carbon sequestration, and biological diversity in the soil ecosystem.

SUMMARY

The experiment, conducted during rainy (*kharif*) season (July–November) of 2022 at College of Agriculture, Central Agricultural University, Imphal, Manipur, concluded that the application of 100% recommended dose of fertilisers (RDF) combined with 2.5 t/ha vermicompost (T_8), as well as 100% RDF + 10 t/ha FYM (T_2), proved to be the most effective treatments for achieving optimum growth and yield of local spring onion. These integrated nutrient management practices enhanced vegetative growth, yield attributes, and overall productivity. For future research, studies may be undertaken to evaluate the effects of different doses and combinations of organic manures such as bio-fertilisers, vermicompost, poultry manure, and others alongside chemical fertilisers on the growth, yield, and quality of spring onion. Additionally, further investigations into optimum spacing and planting dates may provide valuable insights into maximising yield potential and improving bulb quality under varying agro-climatic conditions.

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