Effect of integrated nutrient management on growth, yield and quality of green onion

Abstract

A field experiment was conducted during *rabi* season of 2021-22 at College of Horticulture, S. D. Agricultural University, Jagudan, Dist. Mehsana, Gujarat to study the effect of integrated nutrient management (INM) on the growth, yield and quality of green onion. The experiment was laid out in Randomized Block Design (RBD) replicated thrice with 16 nutrient management treatments of different organic, bio-enhancer sources and inorganic sources. The maximum plant height (45.39 cm) at 30 days after planting (DAP) and at harvest (60.60 cm); number of leaves plant^{-1} at 30 DAP (9.10) and at harvest (11.00) and neck thickness (1.65 cm) was observed with application of 100 % recommended dose of nitrogen (RDN) through vermicompost containing 1.12, 0.35 and 0.56 % of N, P_2O_5 and K_2O, respectively, applied at planting (4.46 t ha^{-1}) with NPK consortia (2.5 Lha^{-1}) i.e. T_6, while, the effect of different integrated nutrient management practices on days taken for harvesting was found non-significant. Treatment T_6 was also as good as the highest yield producing treatment. The maximum yield plant^{-1} (58.72 g), yield plot^{-1} (3.20 kg) and yield ha^{-1} (66.67 t) were obtained with application of 100 % RDN through vermicompost + NPK consortia (T_6). In case of quality parameters, the maximum chlorophyll content a, b and total chlorophyll, 0.92, 0.70 and 1.59 mg g^{-1}, respectively and phosphorus uptake by plant (7.50 kg ha^{-1}) were recorded with application of 100 % RDN through vermicompost (4.46 t ha^{-1}) with VAM (2.5 kgha^{-1}) i.e. T_5. Combined application of organic sources of nutrients along-with NPK consortia improved the nutrient uptake by the crop. The maximum nitrogen uptake (16.75 kg ha^{-1}) and potassium uptake (11.74 kg ha^{-1}) were recorded with application of 100% RDN through vermicompost + NPK consortia (T_6).

***Key Words*:** Green onion, Growth, INM, Nutrient uptake, Yield

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Introduction

Green onion belongs to family Alliaceae having other vegetables including garlic, leek, shallots and chives. The bulbs of many *Allium* species are used as food, but the green onion species is that they lack a fully developed bulb. Green onions have

hollow, tubular green leaves growing directly from the bulb. The leaves at the base are overlapped forming as a stem. The plants are harvested when the bulbs are 1 to 2 cm in diameter and the leaves are tender, green and standing. Onion is one of the most important vegetable bulbous crop grown in India from ancient time. Onion is the "Queen of the kitchen". Onion is preferred mainly because of its green leaves, immature and mature bulbs are either eaten raw or cooked as vegetables. It is popular as salad crop and mature onion bulbs are widely used as a cooked vegetable in soups stews and casseroles in addition to a flavouring agent in many additional dishes.

Onion also possesses nutritional and medicinal importance. Onion bulb is rich in minerals like phosphorus and calcium, and carbohydrates. It also contains proteins and vitamin C. The bulbs are acrid, sweet, aromatic, thermogenic, antiperiodic, antibacterial, stimulant, appetite, diuretic and tonic. Besides these, it has several medicinal properties such as useful against malarial fever, jaundice, asthma, vomiting, wounds, paralysis, skin disease, disorders of lever and respiratory tract. The outstanding characteristic of onion is pungency which is due to volatile oil known as Allyl-propyl-disulphide. It acts as a gastric stimulant and promotes digestion. It contains 87.5 percent water and provides energy to the extent of 4 g calories, 20 I.U. vitamin A, 0.12 mg riboflavin, 0.1 mg niacin, 1.2 mg albuminoides and 0.4 mg ash 100 g^{-1} of fresh edible portion (Thompson and Kelley, 1957). The growth and yield of vegetable crops are mainly depending on the quality and quantity of fertilizers used. So, to increase the soil fertility and yield, inorganic fertilizers are often used. Frequent and high rate uses of inorganic fertilizer have been associated with some environmental pollution, alteration in soil textures and physical property of the soil. Moreover, the nutritional value of the crops will be affected seriously by the continuous use of synthetic fertilizer also inorganic fertilizers will increase the cost of crop production. Now, throughout the world, the demand for organic foods is increased among the consumers that are good for health and the environment. Furthermore, consumers often look upon the taste of organic products and it should be healthier one than the conventional one. Apart from the release of nutrient is slow manner, the application of organic fertilizers, which are made from animal excreta or other agricultural wastes is usually used to improve the structure and stability of the soil and in addition to enhancing the yield and quality of the crop plants. India is the second leading onion producing country having an area, production, productivity of 1.62 million hectares, 26.64 million tonnes, 16.40 t ha^{-1}, respectively (Sable *et al.*, 2024). Organic manures

Comment [YB1]: Rewrite the sentence

Comment [YB2]: What is the need for these lines which is emphasizing on organic foods. The study is on INM which is not a organic practice. So, it is not necessary to highlight the importance of organic practice which is not the best practice according to your study.

act as sources of not only for macro nutrients but also micronutrients, but the quantity varies depending upon the its nature, sources and extent of decomposition. Generation of the information regarding the effect of different sources of organic manures, bio-enhancers, NPK consortia and inorganic fertilizers on the growth, yield, quality of green onion and nutrient uptake is an important to the farmers. In view of this, an investigation was planned to study the effect of integrated nutrient management (INM) on growth, yield and quality of green onion.

Comment [YB3]: Delete it

Materials and Methods

A field experiment was conducted during *rabi* season of 2021-22 at College of Horticulture, S. D. Agricultural University, Jagudan, Dist. Mehsana, Gujarat to study the effect of integrated nutrient management (INM) on the growth, yield and quality of green onion. The experiment was laid out in Randomized Block Design (RBD) replicated thrice with 16 nutrient management treatments of different organic, bio-enhancer sources and inorganic sources viz. T_1: Control 100 % RDF (50:25:25 kg NPK ha^{-1}), T_2 : 50 % RDF + 50 % RDN through vermicompost, T_3 : 50 % RDF + 50 % RDN through neem cake, T_4 : 50 % RDF + 50 % RDN through FYM, T_5 : 100 % RDN through vermicompost + VAM, T_6 : 100 % RDN through vermicompost + NPK consortia, T_7 : 100 % RDN through vermicompost + *Jeevamrut*, T_8 : 100 % RDN through vermicompost + Novel culture, T_9 : 100 % RDN through neem cake + VAM, T_{10} : 100 % RDN through neem cake + NPK consortia, T_{11} : 100 % RDN through neem cake + *Jeevamrut*, T_{12} : 100 % RDN through neem cake + Novel culture, T_{13} : 100 % RDN through FYM + VAM, T_{14}: 100 % RDN through FYM + NPK consortia, T_{15} : 100 % RDN through FYM + *Jeevamrut*, T_{16} : 100 % RDN through FYM + Novel culture. Planting of healthy, uniform and medium size onion (variety Agrifound Light Red) bulbsets at 10 cm x 7.5 cm was done on 3rd week of October 2021 at evening hours. In this experiment combinations of organic manures (FYM, neem cake and vermicompost) with bio-enhancers (NPK consortia, VAM, *jeevamrut*and novel culture) and chemical fertilizers embedded under the study along with control. The organic manures and its quantity were applied according to the treatments and their nitrogen content, respectively. All the organic manures were analyzed for available NPK analysis at Soil Science Laboratory, Department of Natural Resource Management, College of Horticulture, SardarkrushinagarDantiwada Agricultural University, Jagudan (Table 1). Organic manures (FYM, vermicompost and neem cake) were applied according to the treatments at the time of planting as a basal

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dose. After organic manures application, according to the chemical fertilizers treatments, full dose of P, K and half dose of N were applied at planting, while, remaining half dose of N was applied at 30 DAP. Common full dose of P and K (25 kg ha^{-1}) were applied at planting. Urea, single super phosphate (SSP) and muriate of potash (MOP) were the source of NPK of chemical fertilizers. The bio-fertilizers like VAM (2.5 kg ha^{-1}) and NPK consortia (2.5 L ha^{-1}) were given through organic manures, whereas, *jeevamrut* and novel organic liquid nutrient were sprayed at @ 5 % and 3%, respectively at 30 DAP.

Table 1: Chemical properties of organic manures used in experiment

Sr. No.	Organic manures	N (%)	P_2O_5 (%)	K_2O (%)
1.	FYM	0.51	0.26	0.54
2.	Neem cake	5.17	1.16	1.45
3.	Vermicompost	1.12	0.35	0.56

Recommended dose of fertilizer (RDF): 50:25:25 kg NPK ha^{-1}.

The required cultural practices and plant protection measures were followed as per recommended package of practices. Observations on growth parameters *viz.* plant height (cm), number of leaves $plant^{-1}$(30 DAP and harvest); yield parameters *viz*. yield per $plot^{-1}$ (kg) and yield (t ha^{-1}) at harvest and quality parameters *viz.* total soluble solids (^{o}Brix), chlorophyll content a, b and total chlorophyll (mg g^{-1}) and nitrogen, phosphorus and potassium uptake by plant (kg ha^{-1}) were recorded, data was statistically analysed by adopting the standard procedures described by Panse and Sukhatme (1985). Least significant difference at 5 % level was used for finding the significant differences among the treatment means.

Results and discussion

Growth parameters

Plant height

Plant height (cm) (45.39 cm and 60.60 cm, respectively) of green onion was higher in the treatment 100 % RDN through vermicompost + NPK consortia (T_6) which was at par with treatments T_5, T_{10} and T_9 at 30 DAP and T_{10}, T_5, T_9, T_{14}, T_{13} and T_8 at harvest (Table 2). While, the minimum plant height (35.13 cm and 46.70 cm) was recorded in the treatment 50 % RDF + 50 % RDN through FYM (T_4)at 30 DAP and at harvest, respectively. This increase in plant height may be due to the nutrient management through vermicompost along with bio-fertilizers, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant height. These results also corroborate the findings of Prabhakar *et al.* (2012) and Dhaker *et al.* (2017) in onion.

Comment [YB4]: Rectify the grammatical mistake in the sentence.

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Number of leaves plant^{-1}, the maximum number of leaves plant^{-1} at 30 DAP (9.10) and at harvest (11.00) were recorded in the treatment 100% RDN through vermicompost + NPK consortia (T_6) which was on par with treatments T_5, T_{10} and T_9 at 30 DAP and T_{10}, T_5, T_9, T_{14}, T_{13} and T_8 at harvest respectively (Table 2). While, the minimum number of leaves plant^{-1} at 30 DAP (7.23) and at harvest (9.00) was recorded with treatment 50 % RDF + 50 % RDN through FYM (T_4). The increase in number of leaves plant^{-1} under supply of organic fertilizer and bio-fertilizers may be attributed to increased soil tilth and aeration ability as well as availability of essential macro and micro nutrients. The superiority of vermicompost over other organic manures may also be attributed to its more mineral elements contents and also their available forms. Also biofertilizers might have helped in production of growth regulating substances, also supplemented by favourable micro climate which proved for increasing number of leaves plant^{-1} and other growth parameters. Similar findings were earlier reported by Meena *et al.* (2017), Atal *et al.* (2019) in broccoli and Kaur *et al.* (2019) in onion.

Comment [YB5]: Provide reference to support the statement

Comment [YB6]: Provide reference to support the statement

Comment [YB7]: Correct the sentence to clearly present your idea.

Neck thickness (cm), the maximum neck thickness at harvest (1.65 cm) was recorded in the treatment 100 % RDN through vermicompost + NPK consortia (T_6) which was at par with treatment T_{10}, T_5 and T_9, while, the minimum neck thickness (1.31 cm) was recorded in the treatment 50 % RDF + 50 % RDN through FYM i.e. T_4 (Table 2). This might be due to the increase in nitrogen levels cause more vegetative growth resulting enhancement in cell multiplication and cell elongation, and also increase number of leaves and leads to increase neck thickness of the bulb. Similar results have also been reported by Mandal *et al.* (2013) and Kaur *et al.* (2019) in onion.

Comment [YB8]: Insert the reference to support the statement. Hewitt EJ, Smith JA (1974). Plant mineral nutrition. The English Universities Press, London; p. 298.

Days taken for harvesting, table 2 proved that the effect of different integrated nutrient management treatments on days taken for harvesting of green onion was found non-significant.

Yield parameters

Yield plant^{-1} (g)

Table 3 showed that different integrated nutrient management practices significantly influence green onion yield parameters viz. yield plant^{-1} (g), yield plot^{-1} (kg) and yield (t ha^{-1}) at harvest. The maximum yield plant^{-1} (58.72 g) was obtained in the treatment 100 % RDN through vermicompost + NPK consortia (T_6), whereas, the minimum yield plant^{-1} (45.20 g) was obtained in the treatment 50 % RDF + 50 % RDN through FYM (T_4). This might be due to application of biofertilizer which improve nitrogen status of the soil and also it is free nitrogen fixer, thereby increasing the

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nitrogen level, major nutrient avaibility is supplied by inorganic fertilizer will be utilized quickly and other essential secondary nutrient slowly released by organic substances and also vermicompost increase physical and biological condition of soil which helps to increase vegetative growth of plant and due to high rate of photosynthesis, chlorophyll synthesis and translocation of more photosynthates to the storage organ resulting good bulb yield. Similar findings have been reported by Rabari *et al.* (2016) and Vaghela *et al.* (2019).

Comment [YB9]: Spelling. Should be availability

Yield (kg plot $^{-1}$) and yield (t ha $^{-1}$)

The significantly highest yield plot^{-1} (3.20 kg) and yield hectare^{-1} (66.67 t) was recorded with treatment 100 % RDN through vermicompost + NPK consortia (T_6). The increasing yield in green onion might be due to better nutrient supply by specific combination of integrated nutrient management treatments. Use of vermicompost improves the soil aeration, nutrient status and biological properties. The results confirm findings of Thriveni *et al.* (2017), Kaur *et al.* (2019) and Vani *et al.* (2019).

Table 2: Influence of integrated nutrient management on growth parameters

Treatments	Plant height (cm)		No. of leaves plant^{-1}		Neck thickness (cm)	Days taken for harvesting
	At 30 DAP	At harvest	At 30 DAP	At harvest		
T_1	36.47	49.20	7.57	9.27	1.35	50.57
T_2	36.20	48.76	7.40	9.20	1.33	50.77
T_3	35.51	48.60	7.33	9.10	1.32	51.10
T_4	35.13	46.70	7.23	9.00	1.31	51.30
T_5	43.57	59.36	8.40	10.87	1.55	46.20
T_6	45.39	60.60	9.10	11.00	1.65	45.03
T_7	38.93	51.35	8.00	9.60	1.39	49.23
T_8	39.11	53.55	8.03	9.77	1.43	48.10
T_9	42.37	57.81	8.34	10.77	1.52	46.50
T_{10}	44.16	59.72	8.57	10.93	1.60	45.23
T_{11}	38.65	50.64	7.94	9.53	1.39	49.43
T_{12}	38.46	51.70	7.97	9.70	1.42	48.53
T_{13}	39.42	54.13	8.03	10.37	1.44	47.40
T_{14}	39.55	54.40	8.10	10.50	1.45	47.07
T_{15}	37.36	50.11	7.60	9.40	1.36	49.53
T_{16}	37.41	51.37	7.62	9.70	1.40	48.67
S.Em. ±	1.68	2.51	0.34	0.43	0.07	2.01
C.D. (P=0.05)	4.85	7.26	0.98	1.24	0.19	NS
C.V. (%)	7.42	8.21	7.41	7.50	8.07	7.18

Table 3: Influence of integrated nutrient management on yield parameters

Treatments	Yield plant^{-1} (g)	Yield plot^{-1} (kg)	Yield hectare^{-1} (t)

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T_1	46.39	2.20	45.83
T_2	45.78	2.07	43.06
T_3	45.70	2.06	42.85
T_4	45.20	1.93	40.14
T_5	51.37	2.83	58.89
T_6	58.72	3.20	66.67
T_7	47.08	2.39	49.79
T_8	49.80	2.61	54.31
T_9	50.98	2.82	58.75
T_{10}	52.25	2.84	59.10
T_{11}	46.91	2.28	47.50
T_{12}	49.32	2.54	52.99
T_{13}	49.95	2.64	55.07
T_{14}	50.27	2.80	58.33
T_{15}	46.90	2.27	47.22
T_{16}	47.09	2.40	50.00
S.Em. ±	2.12	0.12	2.44
C.D. (P=0.05)	6.11	0.34	7.04
C.V. (%)	7.48	8.13	8.13

Quality parameters

Chlorophyll content a, b and total (mg g^{-1})

Significantly maximum chlorophyll (a, b and total) content of ~~a, b and total~~ 0.92, 0.70 and 1.59 mg g^{-1}, respectively were observed in the treatment 100 % RDN through vermicompost (4.46 t ha^{-1}) + VAM (2.5 $kgha^{-1}$) (T_5) which was on par with treatment T_9 and T_{13}. Whereas, minimum chlorophyll (a, b and total) content of ~~a, b and total~~ 0.79, 0.47 and 1.26 mg g^{-1}, respectively were recorded in the treatment Control i.e. T_1 (100 % RDF= 50:25:25 kg NPK ha^{-1}). This might be due to the VAMfungi found to be most efficient in colonizing the roots and showed high content of chlorophyll (Haripriya and Shekharan, 2002). It helps in absorption of mineral nutrients from the soil and provide to the growing plant due to which there is an increase in growth parameters and photosynthetic pigments. Darade, (2014) also reported similar results.

Total soluble solids (^oBrix), effect of different INM practices on TSSwas found non-significant (Table 4).

Nutrient uptake by plant (kg ha^{-1})

Nitrogen uptake

The maximum uptake of N (16.75 kg ha^{-1}) was recorded under treatment i.e. 100 % RDN through vermicompost + NPK consortia (T_6) which was at par with treatment T_{10}, T_5 and T_9, whereas, the minimum N uptake (12.02 kg ha^{-1}) was recorded in the

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treatment T_4 i.e. 50 % RDF + 50 % RDN through FYM (Table 4). This might be due the beneficial effect of combined use of organic manure with biosource which enhanced the nutrient availability. Enhanced microbial activities in the root zone, decomposes organic manures and also fixed unavailable form of mineral nutrients into available forms in soil, which might have resulted in larger NPK uptake by plant (Edwards *et al.* 2011).

Phosphorus uptake

The maximum uptake of phosphorus (7.50 kg ha^{-1}) was recorded with treatment100 % RDN through vermicompost + VAM (T_5) which was at par with treatment T_9 and T_{13}, whereas, minimum uptake of phosphorus (4.02 kg ha^{-1}) was found under treatment 50 % RDF + 50 % RDN through FYM i.e. T_4 (Table 4) (Mengel and Kirby, 2001). Mycorrhiza helps plants with such ~~as~~ shallow sparse root system to increase phosphorus uptake (Deressa and Schenk, 2008).

Potassium uptake

The maximum uptake of potassium (11.74 kg ha^{-1}) was recorded with treatment 100% RDN through vermicompost + NPK consortia (T_6) which was at par with treatment T_{10}, T_5, T_9, T_{14} and T_{13}, whereas, minimum uptake of potassium (8.44 kg ha^{-1}) was found with treatment 50 % RDF + 50 % RDN through FYM i.e. T_4 (Table 4).

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Table 4: Influence of integrated nutrient management on quality parameters

Treatments	Chlorophyll content (mg g^{-1})			NPK uptake by plant (kg ha^{-1})			TSS (^{o}Brix)
	'a'	'b'	Total chlorophyll	N uptake	P_2O_5 uptake	K_2O uptake	
T_1	0.79	0.47	1.26	13.08	5.31	9.51	7.36
T_2	0.82	0.50	1.31	12.76	5.12	9.18	7.45
T_3	0.80	0.50	1.30	12.54	5.09	8.46	7.42
T_4	0.80	0.49	1.28	12.02	4.02	8.44	7.37
T_5	0.92	0.70	1.59	15.67	7.50	11.18	8.18
T_6	0.85	0.60	1.44	16.75	6.40	11.74	8.30
T_7	0.83	0.58	1.40	14.12	5.60	9.84	7.55
T_8	0.84	0.59	1.43	15.07	6.02	10.49	7.84
T_9	0.90	0.66	1.56	15.62	6.92	11.00	8.08
T_{10}	0.84	0.60	1.44	16.56	6.51	11.49	8.22
T_{11}	0.82	0.55	1.37	13.91	5.58	9.63	7.50
T_{12}	0.83	0.59	1.42	14.73	5.97	10.37	7.63
T_{13}	0.90	0.65	1.54	15.25	6.91	10.73	8.01
T_{14}	0.84	0.59	1.43	15.29	6.18	10.87	8.04
T_{15}	0.82	0.51	1.33	13.69	5.57	9.60	7.46
T_{16}	0.83	0.58	1.41	14.38	5.72	10.13	7.62
S.Em. ±	0.02	0.02	0.03	0.47	0.20	0.38	0.48
C.D. (P=0.05)	0.06	0.05	0.07	1.36	0.59	1.10	NS
C.V. (%)	4.00	5.64	3.12	5.64	5.97	6.49	5.48

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