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Effect of integrated nutrient management on growth, yield, and economics of grain amaranth (*Amaranthus hypochondriacus* L.) and its residual impact on successive greengram (*Vigna radiata* L.)

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Abstract
A field experiment was carried out during two consecutive *Rabi* and summer seasons of 2021-22 and 2022-23 on loamy sand soil of Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study Effect of Integrated Nutrient Management on production potential of Grain Amaranth (*Amaranthus hypochondriacus* L.) and Its Residual Impact on Successive Green gram crop (*Vigna radiata* L.). The application of 75% RDN through urea + 25% through castor cake to *rabi* grain amaranth reported the significant effect on growth, yield attributes, seed and straw yields of grain amaranth while, application of 100% RDF *i.e.* 20 kg nitrogen and 40 kg P2O5 reported promising effect on growth, yield and yield attributing characters of green gram in grain amaranth-green gram cropping sequence under North Gujarat condition.

Keywords: FYM, grain amaranth, green gram, fertilizer, vermicompost, castor cake, economics

Introduction
Amaranth or pigweed belongs to the family Amaranthaceae. It is believed to have originated from Central and South America. The genus *Amaranthus* consists of up to 70 species (in the form of cosmopolitan weed or cultivated plant) and are widely spread in all tropical and subtropical regions of the world and they are cultivated as leaf vegetables, grains or ornamental plants, while, others are weeds. Grain amaranth produce significant edible cereals grain but known as "pseudocereals" to distinguish it from other cereal producing crops. In India, presently amaranth is commonly grown in Himachal Pradesh and on hills of Uttar Pradesh and Uttaranchal for both grain and leafy vegetable purpose, however, the Himalayan region is mainly known as the amaranth 'centre for diversity' for the number of varieties that are been cultivated. While, it is mainly grown for grain especially in Uttarakhand, Maharashtra and in some parts of Gujarat. Grain amaranth commonly called as *Chaulai*, *Batu*, *Bhabhri*, *Ganhar*, *Harave*, *Keere*, *Maarsu*, *Marsha*, *Pung-keerai*, *Rajakeera*, *Sawal*, *Sil* or *Ram Dana*. However, in parts of Maharashtra and Gujarat, it is known as *Rajgirah* "King seed" (Patel *at el*., 2022) [18].
Amaranthus is a promising food crop for its resistance to heat, drought, diseases and pests, as well as high nutritional value. The main virtue of the seed lies in the high protein content coupled with easily digestible carbohydrate component. It is the richest source of protein (16%) and amino acids like lysine (5%), cystine (2.9%), methionine (4.4%) and tryptophan (1.4%) in comparison to the cereal crops *viz.*, barley, maize, rice and wheat. It is also a rich source of fat (7.1 g), moisture (9.3%), calcium (0.49 g), phosphorus (0.45 g), iron (22.4 g) and total food energy (391 calories) per 100 grams in comparison to common cereals (Patel *et al*. 2024) [19]. Recently, an increased interest in amaranth appeared in the 1980s, when the United States National Academy of Science performed research on the grain and described its high nutritional value and agronomic potential (Jangir 2019) [6].
At present, India is the largest exported of amaranth seeds. India has the most conducive climate for the growth of amaranth as the crop responds well to high sunlight & warm temperatures.

In the year 2015-16 India exported amaranth seeds worth USD 1,138,974. India export near to 70% of amaranth every year of the total exports made out of India (Anon 2023) [1].

In Gujarat, it is mainly grown in Mehsana, Banaskantha, Sabarkantha, Gandhinagar and Kheda districts as sole or as mixed crop during *Rabi* season with mustard. It is also grown on borders of the field of lucerne or cumin crops or taken as a mixed crop with mustard. Area under grain amaranth in Gujarat is about 9000 ha (Anon 2024) [2] and in India experimental productivity of grain amaranth up to 38 q/ha have been reported in hilly region and 25 q/ha in plains (Solanki *et al*., 2024) [22].

The basic concept of integrated nutrient management (INM) is maintenance or adjustment of soil fertility and supply plant nutrients to an optimum level for sustaining the desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner (Patel *et al.*, 2022) [16]. Experiences from long term fertilizer experiments revealed that integrated use of farm yard manures, vermicompost, biocompost, cakes *etc.*, with graded levels of chemical fertilizers is promising not only in maintaining higher productivity but also in providing maximum stability in crop production. The response of N as chemical fertilizer generally increases when it is used in combination with FYM, vermicompost, cakes *etc.* and saves N fertilizer (Jangir *et al.*, 2021) [7]. Although increased level of production can be achieved by increasing use of inorganic fertilizers alone but it may lead to pollution problem and deterioration of soil. This can only be maintained at sustainable level by nutrients via integrated approach. The organic manures is now becoming very popular and the use of organic manure has become an important input in the integrated nutrient management.

Greengram is one of the most ancient and extensively grown pulse crops of India. The agronomical importance of greengram is linked to its high protein content and other essential minerals, especially micronutrients. The productivity of greengram in India is very low and far below the other greengram growing countries. Development of short duration as well as photo and thermo insensitive as well as yellow vein mosaic resistant varieties provided excellent opportunity for greengram cultivation. The adoption of modern farming practices and integrated nutrient management is essential to produce crops in line with the observed global standards of quantity and quality. (Joshi, 2020) [8].

Therefore, to maintain soil productivity on a sustainable basis, blending of organic and inorganic sources of nutrient needs to be adopted. Continuous use of crop residues and organics help to build up soil humus and beneficial microbes besides, improvement in soil physical properties. Whereas, chemical fertilizers provide one or more essential plant nutrient which the soil cannot supply in adequate quantities. Thus, judicious combination of organics and chemical fertilizers help to maintain soil productivity. The present study was therefore undertaken to assess the effects of organic manures and fertilizers applied to preceding crop grain amaranth and its residual effect on succeeding crop greengram in the grain amaranth-greengram crop sequence.

Material and Methods

The present investigation was conducted during the *Rabi* seasons of 2021-22 and 2022-23 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha (Gujarat). It is situated in the North Gujarat Agro-climatic Zone. The soil of instructional farm was loamy sand in texture, low in organic carbon (0.22%) and available nitrogen (146.5 kg/ha), medium in available phosphorus (32.05 kg/ha) and medium in available potassium (253.1 kg/ha). The soil was found slightly alkaline (pH 7.55) with normal electric conductivity (0.14 dS/m). The experiment comprising of total nine integrated nutrient management treatments applied to grain amaranth during *Rabi* season in randomized block design *viz.,*N_1: 100% RDN through urea, N_2: 75% RDN through urea + 25% through FYM, N_3: 75% RDN through urea + 25% through vermicompost, N_4: 50% RDN through urea + 50% through FYM, N_5: 50% RDN through urea + 50% through vermicompost, N_6: 50% RDN through FYM + 50% through vermicompost, N_7: 75% RDN through urea + 25% through castor cake, N_8: 50% RDN through urea + 50% through castor cake and N_9: 33% RDN through FYM + 33% through vermicompost + 33% through castor cake and during summer season each main plot treatment was spited in to four sub-plot treatments with four levels of fertilizer *viz.*, F_1: Control, F_2: 50% RDF, F_3: 75% RDF and F_4: 100% RDF to green gram resulting in thirty-six treatment combinations replicated four times in Split Plot Design. Recommended dose of fertilizer (RDF) for *Rabi* grain amaranth and green gram are 60 N + 40 P_2O_5 + 00 K_2O kg/ha and 20 N + 40 P_2O_5 + 00 K_2O kg/ha, respectively.

The Grain amaranth crop was fertilized as per treatment. The nitrogen was applied through urea (46% N) whereas phosphorus was applied through SSP (18% N & 16% P_2O_5).The total quantity of phosphorus and half dose of nitrogen were applied in furrows just before sowing of amaranth as per treatments. The remaining half dose of nitrogen was applied as top dressing at 30 days after sowing. Vermicompost, castor cake and FYM as per treatments were applied as basal dose in ploughed furrows before 15 days of sowing. The required quantity of clean seeds of grain amaranth variety GA 6 was mixed with soil for uniform sowing of seeds with spacing of 45 x 10 cm. The sowing was done manually in previously opened furrows at a depth of 2 cm in November month. Seed rate @ 2 kg/ha was used and treated with Thirum @ 3.0 g/kg of seeds to protect the crop against fungal diseases and with *Azotobactor* and PSB biofertilizers @ 10 ml/kg seed during both the years was used for this experiment in *Rabi* season in both the years before sowing. The crop was raised as per the recommended package of practices. The crop was harvested at physiological maturity in March and February month in both the years, respectively. The growth parameters and yield attributes were recorded from the five tagged plants in each plot. Grain and straw yield were recorded from the net plot area and converted into kilogram per hectare base. The data were subjected to statistical analysis by adopting appropriate analysis of variance as described by Gomez and Gomez (1984). Wherever the F values found significant at 5% level of probability, the critical difference (CD) values were computed for making comparison among the treatment means.

Results and Discussion

Growth parameters

An inquisition of the data in Table 1 revealed that application of 75% RDN through urea + 25% through castor cake (N_7) showed significantly higher plant height (22.45 and 107.0 cm) at 30 DAS and 60 DAS. Treatment N_7 remained statistically at par with N_1 (100% RDN through urea), N_3 (75% RDN through urea + 25% through vermicompost) and N_2 (75% RDN through urea + 25% through FYM) at 30 and 60 DAS. Plant height was found significantly lower with the application of 33% RDN through FYM + 33% through vermicompost + 33% through castor cake (N_9) at 30 and 60 DAS during the pooled analysis.

Significantly higher plant height was observed by combined application of organic and inorganic sources of nitrogen, it might be due to application of nitrogen and phosphorus through chemical fertilizer, which enhanced its availability, which resulted in increased photosynthetic activity, and translocation of photosynthates from source to sink which help to achieve higher plant height. At the same time effect of organic sources like FYM, castor cake and vermicompost as source of the plant nutrient and humus improved the soil physiological condition by increasing its capacity to absorb and store water, improving aeration and favoring the beneficial microbial activity, which helps in improving the plant height. The increase in plant height is also a function of cell division and cell enlargement, which depends upon availability of nutrients in balanced form especially N and P. Similar results were reported by Neeraja and Patel (2015) [12], Keraliya *et al*. (2017) [10], Jangir *et al*. (2021) [7] and Solanki *et al*. (2024) [22] in grain amaranth.

A reference to data revealed (Table 1) that the dry matter production increased with the advancement in the age of the crop. The rate of increase was more pronounced during 60 DAS. Application of 75% RDN through urea + 25% through castor cake (N_7) was produced significantly higher dry matter accumulation per plant at 30 DAS and 60 DAS (2.60 and 53.23 g, respectively) and which was remained at par with N_3; 75% RDN through urea + 25% through vermicompost (2.55 and 50.20 g, respectively) and N_1; 100% RDN through urea (2.53 and 52.76 g, respectively) during pooled study. The increase in dry matter accumulation/plant might be due to integrated application of organic and inorganic fertilizer in adequate amount leads to improve the root growth and development and thereby higher uptake of nutrients provided better condition for cell division and cell enlargement resulting in increases in the photosynthetic efficiency and thus increased the production of photosynthates reflected in better growth and ultimately in higher dry matter accumulation. Such improvement in dry matter accumulation was also reported by Verma *et al*. (2018) [25], Jangir *et al*. (2021) [7], Radwan *et al*. (2021) [21], Srujan *et al*. (2021) [23] and Patel *et al*. (2022) [16] in grain amaranth.

Yield attributes and yield

The various yield attributes *viz.*, Spike length, number of lateral spikelets/spike, grain and straw yield of *Rabi* grain amaranth were significantly influenced by integrated nutrient management on pooled basis (Table 1 & 2). Significantly higher spike length (77.94 cm), number of spikelets/spike (75.63), grain yield (2170 kg/ha) and straw yield (4436 kg/ha) recorded with the application of 75% RDN through urea + 25% through castor cake (N_7) and remained at par with treatment N_3; 75% RDN through urea + 25% through vermicompost and recorded 2052 kg/ha grain yield of grain amaranth.

Grain yield, the ultimate result of various interacting growth factors (*i.e.* plant height, and dry matter weight interdependence of growth, development and yield attributing characters (*i.e.* main infloresence (spike) length, number of spikelets/spike and test weight), increased consistently and significantly with combined application of nitrogen through organic and inorganic fertilizer. It may also be due to adequate availability of major nutrients, which are required in larger quantity, thus directly help the plants to register higher yield. An increase in the grain yield with vermicompost, castor cake and FYM served as reserves of macro and micronutrients, which are released during process of mineralization. Among the treatments, conjunctive use of organics with inorganics and inorganic fertilizer recorded higher grain yield compared to treatment which receiving nutrient through organic manures probably because of optimum supply of nutrients at right time of crop requirement and grain amaranth responds well to fertilizer application as a results of more root growth in sampled area which has resulted in better absorption of moisture and nutrients from soil for effective dry matter production and translocation of photosynthates from leaves to sink for better development of grains in spikelets. The results were in agreement with the findings of Neeraja and Patel (2015) [12], Keraliya *et al*. (2017) [10] and Jangir *et al*. (2019) [6], Parewa *et al.* (2021) [15], Radwan *et al*. (2021) [21] and Solanki *et al*. (2024) [22] in grain amaranth.

Agronomic efficiency (kg/kg)

An examination of data in Table 2 indicated that the treatment N_7; recorded highest agronomic efficiency (13.91 kg/kg) in respect to the treatment N_9. Numerically followed by treatment N_3; 75% RDN through urea + 25% through vermicompost (11.94 kg/kg), N_1; 100% RDN through urea (10.14 kg/kg) and N_2; 75% RDN through urea + 25% through FYM (9.12 kg/kg) after the treatment N_7 in pooled study.

Effect on economics

Among the different integrated nutrient management treatments, 75% RDN through urea + 25% through castor cake (N_7) recorded the maximum net (₹149734/ha) return, which was closely followed by the treatment N_1; 100% RDN through urea (₹137443/ha) and treatment N_3; 75% RDN through urea + 25% through vermicompost (₹136741/ha). While in view of BCR, maximum BCR observed with treatment N_1 (4.19) followed by N_7 (4.05) and N_3 (3.71). The minimum net realization (₹62077/ha) and BCR (1.96) was fetched with the treatment N_9 (33% RDN through FYM + 33% through vermicompost + 33% through castor cake). This indicated that use of organic manure (vermicompost or castor cake) along inorganic fertilizer was found more remunerative with respect to net return and BCR as compared to rest of the treatments. This could be attributed due to higher grain and straw yield of grain amaranth received in these treatments. These findings are in accordance with those reported by Chaudhari *et al*. (2009) [20] and Patel *et al*. (2022) [16] in grain amaranth.

Effect of fertilizer levels in greengram and Residual effect of integrated nutrient management of grain amaranth

Growth parameters

It was evident from the Table 3 that plant height measured at 30 and 60 DAS and number of branches were found non-significant due to integrated nutrient management treatments to preceding grain amaranth crop during experimentation. Numerically higher plant height at 30 DAS (16.11 cm) and 60 DAS (32.18 cm) and no. of branches per plant (5.18) found with the application of 50% RDN through FYM + 50% through vermicompost (N_6) to preceding grain amaranth crop in pooled study.

While different level of recommended dose of fertilizer significantly influenced on the plant height at 30 and 60 DAS and number of branches per plant. Plant height at 30 DAS (16.17 cm), 60 DAS (32.27 cm) and number of branches per plant (5.56) were recorded significantly the higher with the treatment F_4 (100% RDF), and found at par with treatment F_3 (75% RDF) at 30 DAS (15.74 cm), 60 DAS (31.46 cm) during pooled study. The lower plant height at 30 DAS (14.60 cm), 60 DAS (30.18 cm) and no. of branches per plant (4.48) were observed in treatment F_1 (control).

The data on interaction effect due to integrated nutrient management treatments to preceding grain amaranth crop and fertilizer levels to greengram crop (N × F) were found non-significant with respect to plant height at 30, 60 DAS.

It is well known that addition of FYM, castor cake and vermicompost could increase the macronutrients concentration in the soil and increased the adsorption power of soil for cations and anions, particularly, phosphates and nitrates and they were released slowly for the benefit of the crop during entire growth period. On the other hand, favourable influence of nitrogen to produce larger cells with thinner cell walls and its contribution in cell division and cell elongation, which promoted vegetative growth and ultimately increased plant height and number of branches. These results are in close proximity with those of Thesiya *et al*. (2019[a]) [24], Joshi (2020) [8], Jangir *et al*. (2021) [7], Patel and Thanki (2022) [16], Khadadiya *et al*. (2023) [11] and Niranjan *et al*. (2023) [14].

Direct application of inorganic fertilizers as recommended dose supply nutrients at early stages of crop reflected in increases growth parameters as resulted in higher plant height and number of branches per plant and findings are tune with results reported by Patel *et al*. (2018) [20].

Effect on yield attributes and yield

An examination of data presented in Table 3 revealed that effect of integrated nutrient management treatments applied to grain amaranth was found to be non-significant on number of pods per plant at harvest, test weight, seed and stover yiled of greengram crop. However, numerically higher number of pods per plant at harvest (25.00) and seed yield (1021 kg/ha) observed with the application of 50% RDN through FYM + 50% through vermicompost (N_6) followed by treatment N_4; 50% RDN through urea + 50% through FYM to preceding grain amaranth crop.

The mean data presented in Table 3 indicated that, application of 100% RDF (F_4) significantly achieved more number of pods per plant at harvest (26.06), 100 seed weight (35.53 g), seed yield (1110 kg/ha) and stover yield (2145 kg/ha) of greengram during investigation. Which recorded statistically at par with treatment F_3 (75% RDF) during pooled study.

The increased seed and stover yield of greengram might be due to integration of inorganics and organics applied to preceding *Rabi* amaranth which might have positive correlation with yield of greengram. This might be ascribed to the fact that there is a residual effect of the organics applied in previous crop season which increased availability of nutrients in soil from native pool as well as their residual effect through mineralization and improvement of physico-chemical properties of soil, which imparted more growth of crop and resulted in adequate food supply to sink and ultimately reflected in better yield attributes *viz*., higher number of pod per plant, and higher seed weight under the particular treatment. This cumulatively might have resulted in higher yield of greengram. Second reason may be vigorous growth of the crop with increased fertility levels which is closely associated with sink capacity, which might be responsible for increased yield of greengram crop due to high level of nutrition. Thus, the overall better growth performance and higher values of the yield attributes reflected in higher yield of greengram. These results of the beneficial residual effect of addition of organic manure along with inorganic fertilizers under copping system on seed are in agreement with the findings of Thesiya *et al*. (2019[b]) [24] in little millet-greengram cropping sequence, Kantwa *et al*., (2021) [9] in rustica tobacco and succeeding summer green gram and Niranjan *et al*. (2023) [14] maize-green gram cropping sequence.

Application of inorganic fertilizers as recommended dose increases yield attributing parameters as resulted in higher seed and Stover yield and results in conformity with the finds of Ghule *et al*. (2020) [3] and Jagtap *et al*. (2022) [5].

Table 1: Plant height, dry matter accumulation per plant at 30 and 60 DAS, main inflorescence length and number of lateral spikelets per plant of grain amaranth as influenced by integrated nutrient management (Two year pooled results)

Treatments		Plant height (cm)		Dry matter accumulation per plant (g)		Spike length (cm)	No of lateral spikelets/spike
		At 30 DAS	At 60 DAS	At 30 DAS	At 60 DAS		
N_1:	100% RDN through urea	21.71	101.65	2.53	52.76	73.64	69.93
N_2:	75% RDN through urea + 25% through FYM	21.06	96.99	1.87	35.24	71.27	65.85
N_3:	75% RDN through urea + 25% through vermicompost	21.59	100.55	2.55	50.20	75.69	72.65
N_4:	50% RDN through urea + 50% through FYM	19.58	76.78	1.45	25.85	63.26	57.30
N_5:	50% RDN through urea + 50% through vermicompost	19.00	79.95	1.73	24.78	62.35	58.45
N_6:	50% RDN through FYM + 50% through vermicompost	19.11	79.73	1.49	23.18	67.25	52.70
N_7:	75% RDN through urea + 25% through castor cake	22.45	107.00	2.60	53.23	77.94	75.63
N_8:	50% RDN through urea + 50% through castor cake	18.63	80.43	1.64	25.51	59.92	61.12
N_9:	33% RDN through FYM + 33% through vermicompost + 33% through castor cake	16.51	73.20	1.21	19.18	57.01	47.35
S.Em. (±)		0.57	3.88	0.035	0.751	2.35	2.61
C. D. (P = 0.05)		1.63	11.04	0.10	2.14	6.69	7.42
C. V. (%)		8.12	12.41	5.25	6.17	9.84	14.51

Table 2: Plant height, dry matter accumulation per plant at 30 and 60 DAS, main inflorescence length and number of lateral spikelets per plant of grain amaranth as influenced by integrated nutrient management (Two year pooled results)

Treatments		Grain yield (kg/ha)	Straw yield (kg/ha)	Agronomic efficiency (kg/kg)	Net returns (₹/ha)	BCR
N_1:	100% RDN through urea	1943	4121	10.14	137443	4.19
N_2:	75% RDN through urea + 25% through FYM	1882	3976	9.12	125487	3.63
N_3:	75% RDN through urea + 25% through vermicompost	2052	4254	11.94	136741	3.71
N_4:	50% RDN through urea + 50% through FYM	1630	3476	4.92	98229	2.91
N_5:	50% RDN through urea + 50% through vermicompost	1732	3582	6.62	103589	2.81
N_6:	50% RDN through FYM + 50% through vermicompost	1558	3271	3.71	76259	2.18
N_7:	75% RDN through urea + 25% through castor cake	2170	4436	13.91	149734	4.05

N_8:	50% RDN through urea + 50% through castor cake	1828	3833	8.22	114099	3.10
N_9:	33% RDN through FYM + 33% through vermicompost + 33% through castor cake	1335	2996	-	62077	1.96
S.Em. (±)		76.25	174.07	-	-	-
C. D. (P = 0.05)		217	495	-	-	-
C. V. (%)		12.03	13.05	-	-	-

Table 3: Growth parameters, yield attributes and yield of greengram as influenced by different treatments (Two years pooled results)

Treatments	**Plant height (cm)**						
	30 DAS	**60 DAS**	**No of branches per plant**	**No of pods per plant**	**100 seed weight (g)**	**Seed yield (kg/ha)**	**Stover yield (kg/ha)**
Main plot: Residual effect of integrated nutrient management of grain amaranth							
N_1	14.45	29.62	4.91	23.50	34.37	901	1728
N_2	14.73	29.84	5.02	23.60	34.71	975	1896
N_3	14.93	30.24	4.99	23.79	34.73	938	1834
N_4	16.05	32.11	5.14	24.87	35.28	1013	1988
N_5	15.69	31.37	5.09	24.32	35.07	993	1901
N_6	16.11	32.18	5.18	25.00	35.35	1021	1980
N_7	15.27	30.62	5.04	23.95	34.66	955	1850
N_8	15.83	31.84	5.07	24.55	35.00	987	1906
N_9	16.02	32.06	5.13	24.77	35.27	1007	1979
S. Em.(±)	0.30	0.52	0.12	0.63	0.60	22.56	44.23
C. D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS
C. V. (%)	11.09	9.45	13.26	14.77	9.65	13.07	13.20
Sub plot: Fertilizer levels in greengram							
F_1 : Control	14.60	30.18	4.48	21.83	34.51	716	1435
F_2 : 50% RDF	15.30	30.49	4.96	23.83	34.63	997	1905
F_3 : 75% RDF	15.74	31.46	5.26	25.33	35.08	1084	2097
F_4 : 100% RDF	16.17	32.27	5.56	26.06	35.53	1110	2145
S. Em. (±)	0.14	0.26	0.04	0.27	0.38	11.60	20.39
C. D. (P = 0.05)	0.39	0.73	0.12	0.76	NS	32.38	56.95
Interactions	NS	NS	NS	NS	NS	NS	NS
C. V. (%)	7.76	7.11	7.03	9.49	9.13	10.07	9.13

N_1: 100% RDN through urea, N_2: 75% RDN through urea + 25% through FYM, N_3: 75% RDN through urea + 25% through vermicompost, N_4: 50% RDN through urea + 50% through FYM, N_5: 50% RDN through urea + 50% through vermicompost, N_6: 50% RDN through FYM + 50% through vermicompost, N_7: 75% RDN through urea + 25% through castor cake, N_8: 50% RDN through urea + 50% through castor cake, N_9: 33% RDN through FYM + 33% through vermicompost + 33% through castor cake

Conclusion
Based on two years of experimentation, it can be concluded that for optimal yield of grain Amaranth apply 75% of the recommended nitrogen dose (45 kg N/ha) through urea, combined with 25% (15 kg N/ha) from either castor cake or vermicompost, along with the recommended dose of 40 kg P_2O_5 and for greengram apply 75% of the recommended fertilizer dose (20:40:00 kg/ha) in the grain amaranth–greengram cropping sequence under North Gujarat conditions.

Conflict of Interest
The author declares no potential conflict of interest.

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References
1. Anonymous. Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi, 2023.
2. Anonymous. Directorate of Horticulture, Gandhinagar, Gujarat, 2024.
3. Ghule NS, Bhosale AS, Shende SM, Gedam VB. Effect of fertilizer levels on yield, nutrient content and uptake of summer greengram (*Vigna radiata* L.). Int J Chem Stud. 2020;8(6):1670-1673.
4. Gomez K, Gomez A. Statistical Procedures for Agricultural Research. 2nd Ed. New York: John Wiley and Sons, 1984.
5. Jagtap M, Ghilotia YK, Singh A. Response of different fertility levels and bio-fertilizers on yield and yield attributes of green gram [*Vigna radiata* (L.)]. Int J Res Trends Innov. 2022;7(8):2456-3315.
6. Jangir R. Integrated nutrient management in grain amaranth (*Amaranthus hypochondriacus* L.)-cowpea [*Vigna unguiculata* (L.) Walp] cropping sequence under South Gujarat condition. Ph.D. Thesis (Unpublished). Navsari Agricultural University, Navsari (Gujarat), 2019, p. 265.
7. Jangir R, Thanki JD, Kranti B, Patil, Saini L. Residual and direct effect of integrated nutrient management on growth, yield, monetary efficiency, nutrient uptake of cowpea and soil properties under grain amaranth (*Amaranthus hypochondriacus* L.)-cowpea [*Vigna unguiculata* (L.) Walp] cropping sequence in Inceptisols of Western India. J Plant Nutr. 2021;44(19):2928-2932.
8. Joshi. Effect of integrated nutrient management in rabi green gram (*Vigna radiata* L.) pearl millet (*Pennisetum glaucum* L.) cropping sequence under South Gujarat condition. Ph.D. Thesis (Unpublished). Navsari Agricultural University, Navsari (Gujarat), 2020.
9. Kantwa CR, Vyas KG, Patel SA, Patel BJ. Residual effect of wheat varieties and integrated nutrient management on productivity and profitability of green gram under North Gujarat agro-climatic condition. Legume Res, 2021; DOI: 10.18805/LR-4629.
10. Keraliya SJ, Desai LJ, Patel SJ, Kanara DA. Effect of integrated nitrogen management on yield, quality and

economics of grain amaranth (*Amaranthus hypochondriacus* L.). Int J Pure Appl Biosci. 2017;5(6):531-534.
11. Khadadiya MB, Desai LJ, Desai SS. Effect of integrated nitrogen management on wheat-greengram crop sequence. Pharma Innovation. 2023;12(12):2061-2066.
12. Neeraja CR, Patel MV. Integrated nutrient management in grain amaranth (*Amaranthus hypochondriacus* L.) under middle Gujarat conditions. J Pure Appl Microbiol. 2015;9(1):823-826.
13. Ninama SD, Gediya KM, Rathwa MK, Vaghela GM. Effect of integrated nutrient management on growth and yield parameters of rustica tobacco (Nicotiana rustica L.) and its residual impact on succeeding summer greengram (*Vigna radiata* L.). Pharma Innovation. 2022;11(9):2520-2528.
14. Niranjan BN, Kishor N, Prakash SS, Kumaraswamy S. Residual effect of INM on mungbean (*Vigna radiata*) growth, yield uptake and nutrient balance. Indian J Agric Sci. 2023;93(11):1248-1253.
15. Parewa HP, Yadav J, Meena VS, Rakshit A. Effects of chemical fertilizer, FYM and bio-inoculants on nutrient content, uptake and quality of wheat (*Triticum aestivum* L.). Bangladesh J Bot. 2021;50(4):1109-17.
16. Patel HA, Thanki JD. Productivity, profitability and nutrient status of soil as influenced by integrated nutrient management in chickpea-fodder maize cropping sequence. Legume Res. 2022;45(3):1-6.
17. Patel KH, Shah KA, Patel HB. Response of summer greengram [*Vigna radiata* (L.) Wilczek] varieties to different nutrient management under South Gujarat condition. Int J Curr Microbiol Appl Sci. 2020;9(5):1043-1050.
18. Patel RS, Pankhaniya RM, Bartwal D, Katara AR. Effect of nutrient management on growth, yield and economics of grain amaranth (*Amaranthus hypochondriacus* L.) under South Gujarat conditions. The Pharma Innovation J. 2022;11(6):1307-1310.
19. Patel R, Pankhaniya RM, Bartwal D, Patel A. Residual, direct and interaction effect of nutrient management on growth, yield, quality and economics of fodder maize and soil nutrient balance under grain amaranth (*Amaranthus hypochondriacus* L.) fodder maize [*Zea mays* (L.)] sequence in Inceptisols of western India. Cereal Res Commun, 2024; Published online: 09 June 2024:1-18.
20. Patel SA, Chaudhari PP, Chaudhary N. Integrated nutrient management in greengram [*Vigna radiata* (L.) Wilczek] cultivars. Int J Chem Stud. 2018;6(2):943-945.
21. Radwan T, Ewais M, Ahmed M. The combined effect of mineral, organic and bio-fertilizers on wheat productivity. Fayoum J Agric Res Dev. 2021;35(2):220-244.
22. Solanki DH, Bhalu VB, Chhodavadia SK, Bhedela SJ, Zalavadiya RK, Usadadiya BR. Influence of integrated nutrient management on growth, yield attributes and yield of grain amaranth (*Amaranthus hypochondriacus* L.) under South Saurashtra condition. Int J Res Agron. 2024;7(7):429-432.
23. Srujan SC, Patel HH, Madagoudra YB, Lokesh R, Terin P. The effect of irrigation and nitrogen levels on growth, yield and economics of grain amaranth (*Amaranthus hypochondriacus* L.). Pharma Innovation. 2021;10(9):1146-1149.
24. Thesiya NM, Dobariya JB, Patel JG. Effect of integrated management on growth and yield parameters of kharif little millet under little millet-greengram cropping sequence. Int J Pure Appl Biosci. 2019;7(3):294-298.
25. Verma HP, Sharma OP, Kumar R, Shivran AC, Sammauria R, Dudwal BL. Quality and yield of wheat (*Triticum aestivum* L.) as influenced by irrigation scheduling and organic manures. Indian J Agron. 2018;63(2):181-185.