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Sayali Biradar
Ph.D. Scholar, Department of Soil Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Dr. VG Salvi
Department of Soil Science, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

Corresponding Author:
Sayali Biradar
Ph.D. Scholar, Department of Soil Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Nutrient content, quality and yield of yam bean as affected by different levels of inorganic and organic manure in coastal region of Maharashtra

Sayali Biradar and Dr. VG Salvi

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Abstract
The effect of combine application of inorganic fertilizers and FYM on nutrient content i.e., Nitrogen, phosphorous and potassium as well as quality parameters such as reducing sugars, non-reducing sugars, starch, crude fiber, protein, moisture content and shelf life of yam bean (*Pachyrhizus erosus* L.) tuber was investigated in Alfisols of Konkan region. The field experiment was conducted during *Kharif 2020* at research farm of Central Experiment Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri. The experiment comprised of different levels of nitrogen (80,100,120 kg ha^{-1}), phosphorous (40, 60, 80 kg ha^{-1}), a constant dose of potassium (100 kg ha^{-1}) alone and in combination with different levels of farm yard manure (10, 15, 20 t ha^{-1}), was laid out in thirteen treatment combinations consisting one absolute control which was replicated thrice in randomized block design. The nutrient content of yam bean leaves and yam bean tubers were observed to be highest in treatments receiving higher dose of nitrogen, phosphorus and FYM as compared to sole application of inorganic sources and absolute control. The highest NPK content of tuber recorded was 0.61 percent, 0.24 percent and 0.24 percent, respectively. The various quality parameters were significantly improved due to various treatments receiving combined application of inorganic fertilizers and organic manures over control treatment. The total yam bean tuber yield (23.02 t ha^{-1}) recorded was significantly highest under treatment consisting 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 20 t FYM ha^{-1}. The study further concluded that integrated nutrient application significantly improves quality as well as quantity of yam bean in lateritic soils of Konkan region of Maharashtra.

Keywords: Alfisols, inorganic-organic manures, nutrient content, quality parameters, Yam bean

Introduction
The yam bean crop belongs to genus *Pachyrhizus* and is close relative of *Phaseolus bean* and *soyabean* (Bhat and Karim, 2009) [2]. It belongs to the Leguminosae family and mostly cultivated for its edible tuberous root. It is adapted to a wide range of environmental conditions especially in the tropics and has high yields. It mostly goes by local names or indigenous names as Shankalu, Mishrikand, Sankeshalu or Kesaru. The plants have rambling vines that can be let run along the ground or up on trellis. It is widely grown for its large, spherical or elongated taproot which after removal of thick, fibrous brown skin, the white flesh is eaten cooked in vegetables or raw as in salad. Tubers of yam bean contain 49-58 percent moisture, 1-3 percent crude fibre, 8-14 mg 100 g^{-1} ascorbic acid, 1-3 percent protein, 8-16 percent starch and 1-4 percent sugars (Biradar, 2021) [3-4]. The matured seeds have high content of alkaloids and high level of rotenone which have insecticidal properties (Mukhopadhaya *et al.*, 2008) [18]. The crop has good stress resistant capacity for both biotic and abiotic stresses. It comes up well in comparatively marginal land and does not require great care (Nath *et al.*,2008) [20].
Agro-climatic conditions of Konkan region i.e., hot and humid climate is ideal for yam bean cultivation. It can be grown during both *Kharif* as well as in *Rabi* season. Due to the great taste of yam bean and acceptability as salad, it is having tremendous potential for commercial cultivation in Konkan. Its tubers may be well marketed as an attractive product to be used in various dishes, and also as a snack (Mudahar and Jen, 1991) [17]. The lateritic soils of Konkan region are generally sandy clay loam in texture, moderately acidic in nature having pH between 5.0-6.0, highly base leached and sesqui-oxide rich soils due to high

rainfall, having organic carbon content from 1 to 2 percent, favours production of tuber crops.

Nitrogen is a major nutrient for living organisms on earth and plays a central role in regulating the composition, structure and functions of ecosystems (Fang *et al.*, 2009) [8]. It plays an important role in plant nutrition, being an essential constituent of many metabolic functions, active compounds like amino acids, proteins, nucleic acids, enzymes and co-enzymes. Phosphorous stimulates early root formation and growth, gives a rapid and vigorous growth to plants, while potassium acts as quality nutrient improving quality of produce. The high fiber as well as ascorbic acid content, moderate protein content and no fat of yam bean tubers helps in weight loss as well as improvement of digestion process. It is a good source of antioxidants like vitamin C that lowers the risk of certain chronic diseases. The better shelf life and versatility for yam bean consumption can help this tuber crop make place in market. With aim to improve quality characters and yield of yam bean, the present study was carried out to examine various treatment combinations of inorganic and organic manures.

Materials and Methods

The experimental plot was laid out at the Central Experiment Station Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri**.** A field trial was conducted from 19th May 2020 to 28th December 2020. The soil of experimental plot was sandy loam in texture, moderately acidic in reaction (5.34) with low electrical conductivity (0.03 dS m^{-1}) having very high content of organic carbon (10.97 g kg^{-1}). It was medium in available nitrogen (420.57 kg ha^{-1}), very low in available phosphorous (11.74 kg ha^{-1}) and high in available potassium (297.38 kg ha^{-1}) content in its initial physio-chemical analysis. These Results are in line with the results reported by Shinde *et al.*, (2010) [33], Salvi *et al.*,(2014) [30] and Rathod *et al.*,(2018) [26-28]. In general, it can be concluded that soil of experimental site indicated typical lateritic soil of Konkan region**.** Salvi *et al.*, (2015) [31] similarly indicated soil fertility parameters of lateritic soil of coastal region of Maharashtra and reported that the soils were medium in available nitrogen and phosphorous content and very high in available potassium content. The above results also corroborate the findings of Biradar *et al.*, (2021) [3-4] regarding lateritic soils of Coastal region of Maharashtra. The test crop used was yam bean (*Pachyrhizus erosus* L.), a tuber crop var. *Rajendra Mishrikand* -1 (RM-1). As depicted in Table 1, thirteen treatment combinations comprising different levels of nitrogen (80,100,120 kg ha^{-1}), phosphorous (40, 60, 80 kg ha^{-1}), FYM (10, 15, 20 t ha^{-1}), a constant dose of potassium (100 kg ha^{-1}) and an absolute control were replicated thrice in randomized block design.

The oven dried plant and tuber samples (0.5g each) were digested by using concentrated H_2SO_4 (15mL) and H_2O_2 (5mL). A suitable aliquot was taken for distillation and nitrogen was determined by Kjelplus apparatus as described by Tandon (1993) [34]. The diacid digestion of dried sample was carried out for estimation of phosphorus and potassium of plant and tuber sample. The phosphorous was estimated by vanado-molybdate method colorimetrically at 420 nm wavelength as suggested by Chopra and Kanwar (1978) [5].

The determination of reducing sugars was undertaken by the method of Lane and Eynon (1923) [13] as described by Ranganna (1977) [25] while, the total sugars were estimated by the same method in an aliquot of the extract after hydrolyzing with HCL and neutralizing the excess acid with Na_2CO_3. Non reducing sugars were calculated considering the difference between total and reducing sugars. The determination of ascorbic acid was carried out by 2, 6 dichlorophenol indophenol dye method of Johanson (1948). Sample preparation for starch was done as explained by Ranganna (1977) [25] and calculated using formula,

% Starch = % Reducing sugars × 0.90 Crude fibre content was estimated by washing of fat free dried tuber sample first with sulphuric acid and then with sodium hydroxide and percent fibre content was calculated by estimating loss in weight after ignition of sample in muffle furnace.

$$\text{Crude fibre content (\%)} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100 \quad (1)$$

The protein content of tuber sample was calculated by multiplying the estimated total nitrogen content of tuber by 6.25, as it is considered that in most proteins nitrogen constitutes about 16 percent of the total composition. A known quantity of tuber sample was oven dried at 105^0C to estimated the moisture content by calculating difference in initial and final weight on percent basis. To evaluate tuber shelf-life, one tuber was randomly taken from each plot and were stored. The shelf life of tubers was judged by weighing the tubers every alternate day until 15 percent loss in weight was found (Mali, 2017) [15]. The percent physiological loss in weight was calculated by using the following formula,

$$\text{\% PLW} = \frac{\text{(Initial weight – Final weight)}}{\text{Initial weight}} \times 100 \quad (2)$$

The total tuber yield was obtained by harvesting the complete plot and weighing yield separately in kg for each plot and then converted into ton per hector. The experimental data was analyzed statistically by the technique of analysis of variance as applicable to randomized block design. (Gomez and Gomez, 1984) [9].

Results and Discussions

Nutrient content of yam bean leaves

As per the observations recorded in Table 1, the nitrogen content in yam bean leaves varied from 1.33 to 2.25 percent at 30 DAS, 0.76 to 1.38 percent at 60 DAS and 0.69 to 1.27 percent at harvest, phosphorous content ranged from 0.31 to 0.60 percent at 30 DAS, 0.25 to 0.55 percent at 60 DAS and 0.12 to 0.45 percent at harvest and potassium content varied from 0.74 to 1.51 percent, 0.67 to 1.36 percent and 0.60 to 1.25 percent at 30 DAS, 60 DAS and at harvest, respectively. A gradual increase in nitrogen, phosphorous and potassium content of leaves was observed with increasing levels of nitrogen and phosphorous fertilizers in all growth stages of yam bean crop. These results are in close conformity with results reported by Salvi *et al.*, (2014) [30] and Rathod *et al.*, (2018) [26-28] who reported significantly highest nitrogen, phosphorous and potassium content due to integration of inorganic fertilizers, poultry manure and Azotobacter. The treatment receiving 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 20t FYM ha^{-1} noted significantly highest levels of nutrients in leaves at all growth stages. It was further studied from the data that the nitrogen, phosphorous and potassium content in leaves at 30 DAS was comparatively higher than at 60 DAS and again it was lower at harvest stage which could be attributed to translocation of nutrients to tuber formation. All the nutrients absorbed by plants are mostly directed toward reproductive growth after certain stage that resulting from the reduced nutrients in vegetative parts. While, phosphorous content may have decreased during growth period due to translocation of nutrient to reproductive parts indicating the common behavior of tuber and root crops. The stage wise decrease in potassium content may be because it may have used for sugar translocation and quality improvement of tuber by plant.

Pandya *et al.* (2007) [23] who revealed that the application of 15 percent NPK along with 25 t ha^{-1} FYM proved to be the best for getting the highest nitrogen, phosphorus and potassium content as well as uptake in cowpea. Kasawala *et al.* (2013) [11] reported higher nutrient content in vines of greater yam with integrated nutrient management treatment.

Nutrient content of yam bean tuber

The values of nutrient content of yam bean tubers after harvest showed significant difference in nitrogen, phosphorous and potassium content over absolute control (Table 1). The nitrogen content in yam bean tuber varied from 0.28 percent to 0.61 percent, phosphorous content varied from 0.09 percent to 0.24 percent while potassium content varied from 0.11 percent to 0.24 percent in tubers. The nitrogen content of tuber under treatments T_9 and T_{10} was significantly superior over all other treatments, whereas highest phosphorus and potassium content was reported where, FYM was applied @ 15 t ha^{-1} with highest nitrogen and phosphorous levels i.e., 120 kg ha^{-1} and 80 kg ha^{-1}, respectively. It was observed from the data that integrated effect of organic and inorganic inputs resulted in improved nutrient content over absolute control and even over sole chemical dose. The nitrogen and phosphorous content increased potassium was applied equally in all treatments except absolute control significant differences were observed in potassium content of yam bean tuber. Kasawala *et al.* (2013) [11] and Koodi *et al.* (2017) [12] reported maximum nutrient content of N, P, K in tubers of greater yam and sweet potato, respectively under integrated nutrient supply. The lowest values of NPK content were noted in absolute control treatment (T_1).

Quality parameters and yield of tuber

The quality characters such as, reducing sugars, non-reducing sugars, starch, crude fiber, ascorbic acid, protein, moisture content and shelf life of yam bean showed significant improvement over absolute control across the treatment variations (Table 2). The higher levels of reducing and non-reducing sugars were observed in treatment receiving highest levels of nitrogen, phosphorus and FYM which was statistically at par with treatments containing FYM @ 15-20 t ha^{-1} and reduced level of nitrogen and phosphorus (T_8, T_9, T_{10}, T_{11}, T_{12}). Similar findings of increased TSS, reducing sugars and total sugars content of ridge gourd with combined application of inorganic and organic manure have been reported by Rathod *et al.,* (2018) [26-28].

The increase in the non-reducing sugars content can be attributed to the fact that nitrogen significantly increases sucrose contents, recoverable sugar yield adding to the highest level of nitrogen and association exists between uptake and accumulation of nutrient in tuber and also between their combined role in enhancing the synthesis of sucrose content and accumulation in tubers (Pushpalatha *et al.*, 2017) [24]. Deshmukh (2019) [7] and Mane (2020) [16] reported the highest reducing sugar content (1.24% to 1.39%) and (1.34 to 1.45%), respectively and non-reducing sugar content (4.39%) and (4.26%), respectively with higher dose of inorganic and FYM application. In case of starch content in tuber it showed significantly highest value as noted under treatment T_8 consisting 80:40:100 N, P_2O_5, K_2O kg ha^{-1}+ 15 t FYM ha^{-1} which was at par with treatments receiving combine application of nutrients. Sheth (2017) also recorded higher starch content (14.43%) and higher sugar content (2.97%) with the treatment receiving 50 percent RDN + 50 percent N from vermicompost. Navya (2017) similarly noted higher starch content (16.57%) under treatment 50 percent FDN + 50 percent nitrogen from FYM. The data regarding crude fiber content of yam bean tuber showed significant differences in values over graded nutrient levels and FYM application. The maximum crude fiber content recorded was 3.04% which was at par with treatments containing low level of FYM with inorganic fertilizers and higher levels of FYM resulted in low crude fiber content in tuber which may be due to, improved moisture content of soils caused by higher water holding capacity of FYM application which was taken up by tubers during underground growth and resulting into comparatively less crude fiber formation. Nersekar (2016) [22] observed the highest fiber content (0.66%) with application of 80:40:100 NPK kg ha^{-1} application. The lowest content of reducing sugar, non-reducing sugar and starch was recorded under control treatment (T_1).

As far as ascorbic acid content was considered, the highest value recorded was 16.33 mg 100 g^{-1} in treatment receiving 80: 40:100 N, P_2O_5, K_2O kg ha^{-1} + 15 t FYM ha^{-1} which was statistically at par with combination treatments indicating improved results over only inorganic fertilizers treatments and absolute control. Reported the ascorbic acid content of 12.13 mg 100 g^{-1} in Rajendra Mishrikand (RM-1) variety of yam bean in lateritic soils of Konkan region. The protein content which was calculated by multiplication factor showed similar behaviors as nitrogen content of tuber, indicating highest value due to treatments T_9 and T_{10} (3.81%). Tuber or root crops are generally low in protein content as compared to pulses however higher dose of nitrogen along with FYM may help in improving protein content significantly which can be an additional nutrient benefit during yam bean consumption. Coursey (1995) [6] noted that yam bean tubers contain 1-3 percent protein on dry weight basis.

A gradual increase in moisture content was observed over increasing FYM application. The maximum moisture content of tuber was observed under treatments receiving FYM @ 15-20 t ha^{-1}. The highest moisture content noted was 58.42 percent, while lowest was 48.69 percent in absolute control. The improved moisture in soil due to application of FYM, may have resulted in increased absorbance of water by tubers during growth. Babatunde (2018) [1] observed 15 percent moisture content after oven drying of yam tuber samples. The shelf life of tuber was varied from 7.67 days to 25.00 days. A significant difference throughout the treatment variations was noted. The tubers of treatment consisting 100:60:100 N, P_2O_5, K_2O

kg ha^{-1} + 10 t FYM ha^{-1} showed highest shelf life (25 days). Increasing nutrient doses and FYM content improves the moisture content of tubers which increases the deterioration rate of tubers with time, reducing its shelf life period which may be the reason that inorganic NPK with lower FYM level recorded significantly higher shelf life period over other treatments. Hailu *et al.* (2008) [10] mentioned that increasing inorganic-N fertilizer application combined with organic-P resulted in Physiological weight loss of carrot stored under ambient conditions. The lowest value of ascorbic acid, protein, moisture content and shelf life were due to control treatment.

Total tuber yield of yam bean

The total tuber yield increased significantly by the application of inorganic fertilizers over control. The lowest value of tuber (9.01 t ha^{-1}) yield was reported in absolute control (T_1). The inorganic fertilizers along with organic manures still produced higher yield as compared to control as well as application of chemical fertilizers alone. Among the various treatments, treatment T_{13} comprising 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 20 t FYM ha^{-1} produced significantly higher (23.02 t ha^{-1}) total tuber yield as compared to all other treatments, except T_{12} (22.08 t ha^{-1}), T_8 (21.92 t ha^{-1}) and T_{11} (21.88 t ha^{-1}) which were at par with treatment T_{13} indicating that FYM application at 20 t ha^{-1} can be substituted with 15 t ha^{-1} application.

The combine effect of organic and inorganic fertilizers may be responsible for improving yield of the crop which may be due to enhanced physical, chemical and biological properties of soil. FYM application may have helped in betterment of physical properties such as reduced bulk density, better water holding capacity, improved porosity which are favorable for good tuber growth and increased tuber size thereby increasing yield. It may also improve biological population in soils resulting into better mineralization process and soil fertility. Salvi *et al.*, (2021) [32] similarly observed significant increase in microbial population as well as CO2 evolution in soil due to integration of inorganic fertilizers and organic manure application @ 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 20 t FYM ha^{-1}. The application of inorganic fertilizers made the immediate nutrient availability to crop in early growth stages and the integrated effect on improved soil properties may have resulted into increased yield over absolute control and even sole application of chemical fertilizers. In this context, Laxminarayana (2017) explained that yam bean is a heavy feeder of nutrients and the yields were increased considerably due to application of excess doses of NPK fertilizers in low and marginal soils as it has shown significant response to higher doses of NPK rather than the optimum doses of NPK, where it is being cultivated extensively. Roy *et al.* (1974) [29] reported that the applications of N, P and K at the rates of 40 kg of each recorded the maximum yield of yam bean tubers (16.0, 15.2, 16.2 m. tones ha^{-1}, respectively) which were much higher than the control treatment (12.1 m. tones ha^{-1}). Biradar *et al.*, (2021) [3-4] also observed significant and positive correlation of available nitrogen, phosphorus and potassium with total tuber yield of yam bean indicating its highest contribution in total tuber yield.

Table 1: Nutrient content in yam bean leaves and tuber as influenced by inorganic and organic manures.

Tr. no.	Nutrient content of yam bean leaves									Nutrient content of yam bean tuber at harvest		
	Nitrogen content (%)			Phosphorous content (%)			Potassium content (%)					
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	N (%)	P (%)	K (%)
T_1	1.33	0.76	0.69	0.31	0.25	0.12	0.74	0.67	0.60	0.28	0.09	0.11
T_2	1.49	0.96	0.84	0.35	0.31	0.16	0.81	0.77	0.69	0.31	0.11	0.16
T_3	1.55	1.04	0.89	0.42	0.34	0.20	0.87	0.83	0.77	0.42	0.12	0.17
T_4	1.64	1.11	0.96	0.46	0.38	0.25	0.92	0.99	0.83	0.45	0.12	0.18
T_5	1.74	1.03	0.99	0.50	0.42	0.24	0.97	1.08	0.90	0.32	0.11	0.16
T_6	1.55	1.11	1.06	0.44	0.46	0.28	1.09	1.12	0.96	0.37	0.12	0.17
T_7	1.84	1.17	1.09	0.49	0.49	0.30	1.18	1.17	1.05	0.41	0.14	0.18
T_8	1.96	1.25	1.13	0.55	0.51	0.34	1.35	1.25	1.13	0.48	0.15	0.18
T_9	1.87	1.23	1.08	0.51	0.46	0.31	1.24	1.24	1.10	0.61	0.15	0.19
T_{10}	2.13	1.29	1.17	0.58	0.52	0.37	1.44	1.29	1.17	0.61	0.20	0.20
T_{11}	2.04	1.26	1.16	0.52	0.50	0.35	1.33	1.27	1.14	0.48	0.19	0.21
T_{12}	2.18	1.33	1.21	0.57	0.52	0.41	1.47	1.32	1.20	0.54	0.22	0.22
T_{13}	2.25	1.38	1.27	0.60	0.55	0.45	1.51	1.36	1.25	0.56	0.24	0.24
S.E. (±)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD (P=0.05)	0.06	0.04	0.04	0.03	0.03	0.03	0.03	0.05	0.04	0.04	0.04	0.05

T_1 = Absolute control; T_2 = 80:40:100 N, P_2O_5, K_2O kg ha^{-1}; T_3 = 100:60:100 N, P_2O_5, K_2O kg ha^{-1}; T_4 = 120:80:100 N, P_2O_5, K_2O kg ha^{-1}; T_5 = 80:40:100 N, P_2O_5, K_2O kg ha^{-1} +10t FYM ha^{-1}; T_6 = 100:60:100 N, P_2O_5, K_2O kg ha^{-1} + 10t FYM ha^{-1}; T_7 = 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 10 t FYM ha^{-1}; T_8 = 80:40:100 N, P_2O_5, K_2O kg ha^{-1}+ 15 t FYM ha^{-1}; T_9 = 100:60:100 N, P_2O_5, K_2O kg ha^{-1} + 15t FYM ha^{-1}; T_{10} = 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 15 t FYM ha^{-1}; T_{11} = 80:40:100 N, P_2O_5, K_2O kg ha^{-1} + 20t FYM ha^{-1}; T_{12} = 100:60:100 N, P_2O_5, K_2O kg ha^{-1} + 20t FYM ha^{-1}; T_{13} = 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 20t FYM ha^{-1}

Observation tables

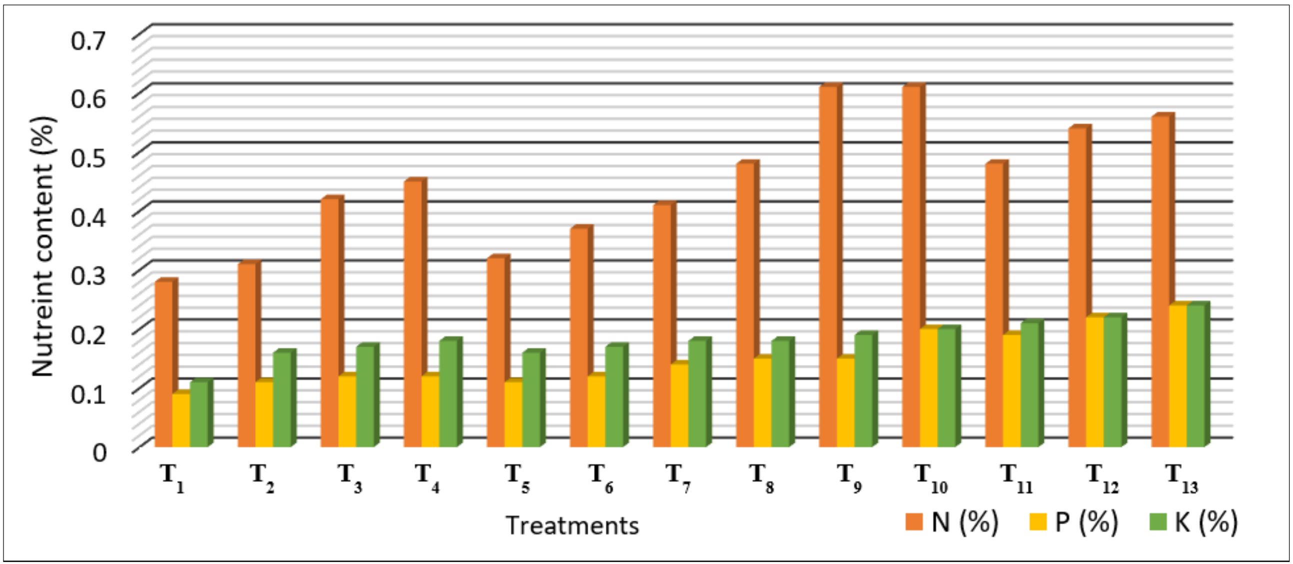

Fig 1: NPK content of tuber as influenced by inorganic and organic manures.

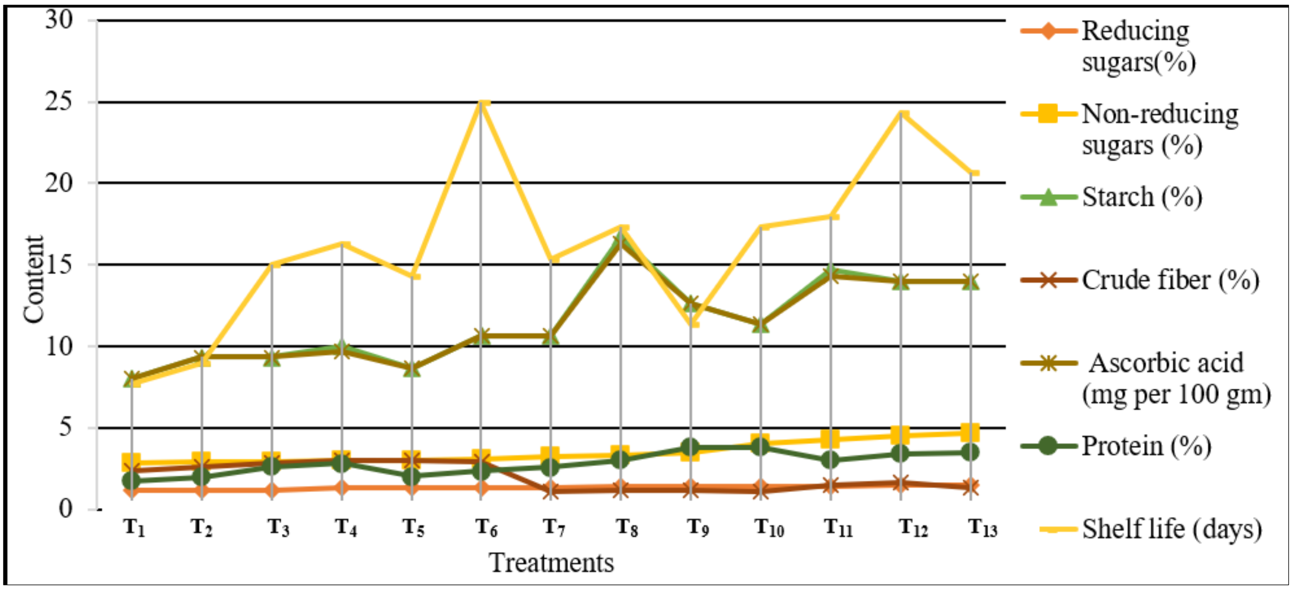

Fig 2: Quality parameters of tuber as influenced by inorganic and organic treatments.

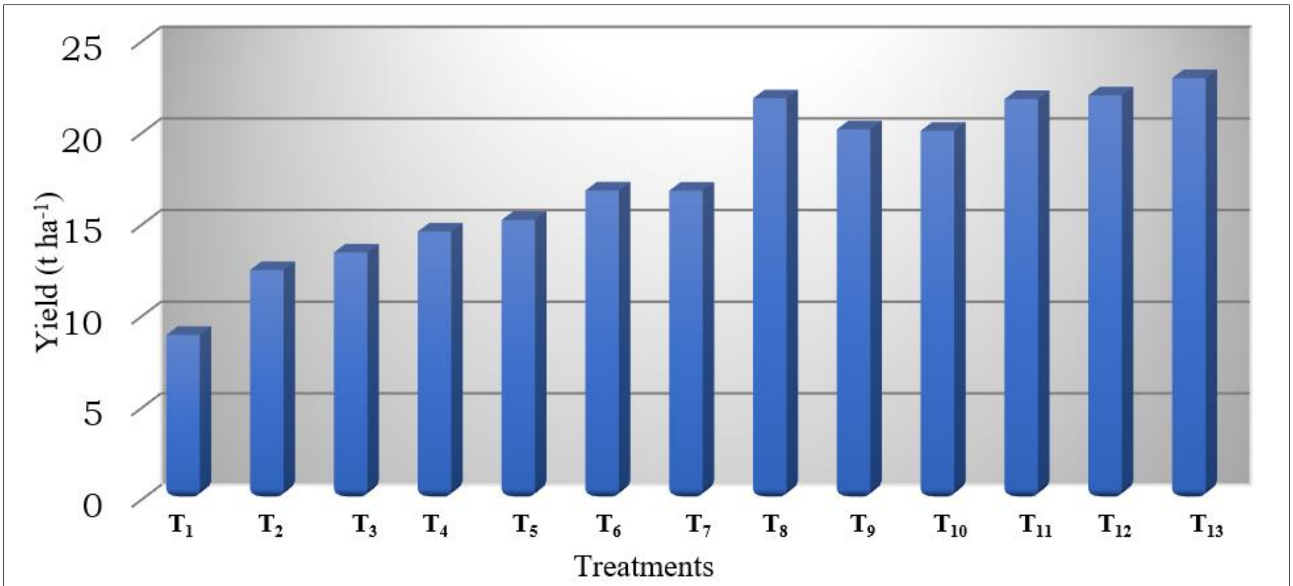

Fig 3: Total tuber yield of yam bean as influenced by inorganic and organic manures.

Table 2: Quality parameters and total yield of tuber as influenced by inorganic and organic manures.

Tr. no.	Quality parameters of tuber								Total tuber yield (t ha^{-1})
	Reducing sugar (%)	Non-reducing sugar (%)	Starch (%)	Crude fibre (%)	Ascorbic Acid (mg 100 g^{-1})	Protein (%)	Moisture content (%)	Shelf life (Days)	
T_1	1.13	2.88	8.00	2.35	8.00	1.75	48.69	7.67	9.01
T_2	1.17	2.92	9.33	2.58	9.33	1.94	56.25	9.00	12.55
T_3	1.18	2.94	9.33	2.87	9.33	2.63	57.63	15.00	13.51
T_4	1.32	3.02	10.00	3.04	9.67	2.80	55.04	16.33	14.65
T_5	1.32	2.97	8.67	3.00	8.67	2.00	54.53	14.33	15.28
T_6	1.34	3.08	10.67	2.89	10.67	2.32	55.11	25.00	16.89
T_7	1.34	3.21	10.67	1.06	10.67	2.56	55.86	15.33	16.88
T_8	1.40	3.30	16.67	1.16	16.33	3.00	53.07	17.33	21.92
T_9	1.40	3.50	12.67	1.14	12.67	3.81	58.42	11.33	20.23
T_{10}	1.42	4.00	11.33	1.09	11.33	3.81	56.43	17.33	20.15
T_{11}	1.43	4.24	14.67	1.48	14.33	3.00	57.15	18.00	21.88
T_{12}	1.46	4.48	14.00	1.65	14.00	3.38	57.68	24.33	22.08
T_{13}	1.46	4.68	14.00	1.32	14.00	3.50	58.11	20.67	23.02
S.E. (±)	0.01	0.08	1.33	0.03	1.31	0.05	0.06	0.70	0.51
CD (P=0.05)	0.08	0.43	7.06	0.18	6.92	0.24	0.32	3.73	2.70

T_1 = Absolute control; T_2 = 80:40:100 N, P_2O_5, K_2O kg ha^{-1}; T_3 = 100:60:100 N, P_2O_5, K_2O kg ha^{-1}; T_4 = 120:80:100 N, P_2O_5, K_2O kg ha^{-1}; T_5 = 80:40:100 N, P_2O_5, K_2O kg ha^{-1} +10t FYM ha^{-1}; T_6 = 100:60:100 N, P_2O_5, K_2O kg ha^{-1} +10t FYM ha^{-1}; T_7 = 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 10 t FYM ha^{-1}; T_8 = 80:40:100 N, P_2O_5, K_2O kg ha^{-1}+ 15 t FYM ha^{-1}; T_9 = 100:60:100 N, P_2O_5, K_2O kg ha^{-1} + 15t FYM ha^{-1}; T_{10} = 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 15 t FYM ha^{-1}; T_{11} = 80:40:100 N, P_2O_5, K_2O kg ha^{-1} + 20t FYM ha^{-1}; T_{12} = 100:60:100 N, P_2O_5, K_2O kg ha^{-1} + 20t FYM ha^{-1}; T_{13} = 120:80:100 N, P_2O_5, K_2O kg ha^{-1} + 20t FYM ha^{-1}

Conclusion

Based on the findings of above experiment it could be concluded that combined application of inorganic fertilizers and organic manures in optimum level successfully helps in improving the nutrient content of yam bean plant and tubers, quality parameters such as sugars, starch, ascorbic acid, fiber, protein, moisture content and shelf life of tuber. It also results in successful improvement in total tuber yield of yam bean.

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