



International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

© Agronomy

www.agronomyjournals.com

2024; SP-7(11): 594-598

Received: 03-09-2024

Accepted: 05-10-2024

Ritu M Patel

Ph.D. (Scholar), Department of
agronomy, C.P. College of
Agriculture, Sardarkrushinagar
Dantiwada Agricultural
University, Sardarkrushinagar,
Gujarat, India

PP Chaudhari

Research Scientist, Agroforestry
Research Station, S.D.
Agricultural University,
Sardarkrushinagar, Gujarat, India

KJ Chauhan,

Ph.D. (Scholar), Department of
Agricultural Chemistry and Soil
Science, C. P. College of
Agriculture, S.D. Agricultural
University Sardarkrushinagar,
Gujarat, India

TV Joshi,

Ph.D. (Scholar), Department of
agronomy, C.P. College of
Agriculture, Sardarkrushinagar
Dantiwada Agricultural
University, Sardarkrushinagar,
Gujarat, India

KK Patel

Ph.D. (Scholar), Department of
Agricultural Chemistry and Soil
Science, C. P. College of
Agriculture, S.D. Agricultural
University Sardarkrushinagar,
Gujarat, India

DM Patel

Assistant Professor, Rai School of
Agriculture, Rai University,
Gujarat, India

Corresponding Author:

Ritu M Patel

Ph.D. (Scholar), Department of
agronomy, C.P. College of
Agriculture, Sardarkrushinagar
Dantiwada Agricultural
University, Sardarkrushinagar,
Gujarat, India

Response of integrated nitrogen management on nutrient content-uptake and economics in *kharif* sorghum

Ritu M Patel, PP Chaudhari, KJ Chauhan, TV Joshi, KK Patel and DM Patel

DOI: <https://doi.org/10.33545/2618060X.2024.v7.i11Sh.2149>

Abstract

The field experiments were conducted during *kharif* 2022 and 2023 on loamy sand soil at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha, Gujarat to study the "Response of integrated nitrogen management on nutrient content-uptake and economics in *kharif* sorghum". The experiment was laid out in a randomized block design with four replications and ten treatments viz., T₁: absolute control, T₂: RDF (80:40:00 kg N:P₂O₅:K₂O/ha), T₃: 25% RDN through FYM + 75% RDN through urea, T₄: 50% RDN through FYM + 50% RDN through urea, T₅: 25% RDN through castor shell compost + 75% RDN through urea, T₆: 50% RDN through castor shell compost + 50% RDN through urea, T₇: 25% RDN through FYM + 50% RDN through urea + *Azotobacter*, T₈: 25% RDN through castor shell compost + 50% RDN through urea + *Azotobacter*, T₉: 25% RDN through FYM + 25% RDN through castor shell compost + 50% RDN through urea, T₁₀: 50% RDN through FYM + 50% RDN through castor shell compost + *Azotobacter*. Results revealed that significantly higher nutrient content - uptake by grain and fodder of sorghum were found with the application of 50% RDN through castor shell compost + 50% RDN through urea, which also gave the highest net return (₹101472/ha). While application of RDF (80:40:00 kg N:P₂O₅:K₂O/ha) to sorghum recorded higher BCR (4.79) during course of study.

Keywords: Sorghum, nutrient content, castor shell compost, fym, *azotobacter*

Introduction

Amongst cereals, sorghum is the fourth most important crop after rice, wheat and maize. Sorghum [*Sorghum bicolor* (L.) Moench], the king of millets holds promise for food, feed, fodder and ration for human, cattle and poultry. In India, it is popularly known as "*Jowar*". Its grains have about 10-12% protein, 3% fat and 70% carbohydrate.

The sorghum crop exhausts more nutrients than other forage crops and being cereal crop, requires higher amount of nutrients for higher productivity. Among the various agronomic factors determining crop productivity, adequate and prudent use of fertilizer is considered the most important to achieve potential and targeted crop production. However, ill effects of chemical fertilizers on soil health, energy crisis, and prohibitive cost of chemical fertilizers and poor purchasing power of small and marginal farmers restrict the use of this vital input. Therefore, it is time to develop a strategy for integrated use of organic manures in conjunction with chemical fertilizer to the maximum possible extent with proper technology to boost crop production. Among the essential nutrients, nitrogen is universally deficient in Indian soils. Nitrogen is essential constituent of chlorophyll and implies dark green colour to the plants and an integral part of amino acids. It contributes to the building units of protein and growth of plants. It promotes shoot elongation, tillering and regeneration after defoliation and governs to considerable degree, the utilization of phosphorus, potassium and other elements in the plant. In plant nutrition, organic matter level of a soil is the key property that decides the availability status of essential nutrients. The role of organic materials in maintaining and increasing soil fertility is well established. Maintenance of optimal level of organic matter in soil is essential to

sustain productivity. Although increase level of production can be achieved by increase the use of inorganic fertilizers alone but it may lead to pollution problem and deterioration in soil characteristics *i.e.* organic carbon and soil fertility. This can only be maintained at sustainable level by the application of organic manures. There is an increasing interest in the use of organic manures as a source of nutrient supply to crop production for sustainable soil productivity, ecological stability and to minimize the requirement of chemical fertilizers. Indian soils are poor in organic carbon due to its tropical climate. With the increasing soil degradation and cost of chemical fertilizers, there is a need to integrate them with organic sources, which are good for soil health besides supplying nutrients for longer period. The organic manures like FYM and castor shell compost are natural sources of slow release nutrients and inclusion in nutrient management has become necessity to improve the soil fertility and to sustain the productivity. Addition to these, it increases soil microbiological activities and plays key role in transformation, recycling and availability of nutrients to the crop. It also improves the physical properties like soil structure, porosity, reduces compaction and crusting and increases water holding capacity of the soil.

Farmyard manure refers to the decomposed mixture of dung and urine of farm animals, litter and leftover material from roughages or fodder fed to the cattle. On average well decomposed farmyard manure contains 0.5% N, 0.2% P₂O₅ and 0.5% K₂O. FYM increases the N-use efficiency of the crop and the status of organic carbon, available N, P and trace elements in the soil. FYM also improves the physical condition of the soil. The well decomposed castor shell compost contains 2.24% N, 0.82% P₂O₅, 1.74% K₂O with pH 7.33 and EC 0.16 dS/m (Annual Report, 2020) [1].

Bio-fertilizers are cheaper, pollution free and renewable source of nutrients supply. Introduction of beneficial microorganisms into soil in a capacity of biofertilization could increase plant growth by providing nutrients in available forms. *Azotobacter* bacteria are free living non-photosynthetic aerobic N₂-fixing bacteria which activate nitrogen cycle in the rhizosphere, and produce vitamins as thiamine and riboflavin and hormones as indole acetic acid, gibberellic acids and cytokinin's.

Materials and Methods

A field experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the *kharif* seasons of 2022 and 2023, entitled with "Response of integrated nitrogen management on nutrient content-uptake and economics in *kharif* sorghum".

The experiment was laid out in a randomized block design comprising of 10 treatments viz., T₁: absolute control, T₂: RDF (80:40:00 kg N:P₂O₅:K₂O/ha), T₃: 25% RDN through FYM + 75% RDN through urea, T₄: 50% RDN through FYM + 50% RDN through urea, T₅: 25% RDN through castor shell compost + 75% RDN through urea, T₆: 50% RDN through castor shell compost + 50% RDN through urea, T₇: 25% RDN through FYM + 50% RDN through urea + *Azotobacter*, T₈: 25% RDN through castor shell compost + 50% RDN through urea + *Azotobacter*, T₉: 25% RDN through FYM + 25% RDN through castor shell compost + 50% RDN through urea, T₁₀: 50% RDN through FYM + 50% RDN through castor shell compost + *Azotobacter* to sorghum replicated four times in a gross plot size of 6.0 m × 9.0 m. Sorghum crop variety 'GJ 43' was sown in June with recommended package of practices during both the years. Sowing of sorghum was done with recommended seed rate of 12

kg/ha by maintaining 45 cm distance between the rows. The application of fertilizer for sorghum was applied as per fertilizer treatment. According to content of nutrient, FYM and castor shell compost were applied to sorghum crop as per treatments at least 13 days before sowing and incorporated into the soil. Recommended dose of fertilizers (80: 40: 00: kg N: P₂O₅: K₂O ha⁻¹) were applied through urea and SSP as per the treatments. 25% inorganic N was applied at basal and remaining 75% as three equal splits at 20, 40 and 60 DAS. Seeds of sorghum were treated 10 ml *Azotobacter* per kg seed in specific treatments at the time of sowing. The 1st irrigation was given immediately after sowing and remaining irrigations were given as per requirement of the crop. During the entire crop season experimental area was kept weed free and clean. Sorghum was harvested in the 1st week of October during both the years.

The (grain and fodder) samples of sorghum were subjected to analysis of N through Micro-Kjeldahl's method, P through calorimetrically Vanadomolybdic phosphoric acid yellow colour method, K through Flame photometric method (Jackson, 1973). The concentration of nutrients in grain and fodder were used to calculate the uptake of nutrients by sorghum crop. The uptake of nutrients by sorghum were worked out by using following formula.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)}}{100} \times \text{Yield (kg ha}^{-1}\text{)}$$

Economics was worked out on the basis of prevailing market prices of inputs and output obtained from each treatment. The data collected from chemical study were subjected to statistical analysis and interpretation of data of various characters studied in present investigation as suggested by Panse and Sukhatme (1967). The critical difference (CD) at 5% was calculated where differences among the treatments were found significant in 'F' test. The co-efficient of variation percentage (C.V.%), illustration based on the data are given at appropriate places in respective table.

Results and Discussion

Effect on nutrient content

Effect of applying different integrated nitrogen management treatments are shown in Table 2. A critical examination of data (Table 2) indicated that application of 50% RDN through castor shell compost + 50% RDN through urea (T₆) to sorghum gave significantly higher nitrogen content in grain (1.679%) and fodder (0.855%) during pooled study, which was remained at par with treatments T₉ (1.635%), T₄ (1.630%), T₅ (1.619%), T₃ (1.605%) and T₂ (1.604%) in pooled study of N content in grain. Higher content of nitrogen in castor shell compost promoted increase in available nitrogen in soil and improved soil structure due to increased organic matter that increased nutrients availability. The favorable conditions for microbial as well as chemical activities resulted in increased N content of grain and fodder. Incorporating organic sources along with chemical fertilizers resulted in the formation of clay-humus complexes in the soil which in turn promotes higher and prolonged availability of nitrogen to the crop Kumar *et al.* (2005) [5], Singh *et al.* (2013) [8], Yadav and Singh (2016) [11], Rakesh (2017) [7] and Khushbu (2021) [4].

The mean data presented in Table 2 indicated that different treatments tried in the experiment showed that application of 50% RDN through castor shell compost + 50% RDN through urea (T₆) to sorghum registered significantly higher phosphorus

content in grain (0.341%) and fodder (0.218%) in pooled study. Treatment T₆ was remained at par with T₉ (0.333%) and T₄ (0.326%) in pooled study of P content in grain. In case of phosphorus content in fodder T₆ was remained at par with only T₉ (0.209%). This could be attributed to the fact that added castor shell compost increased the phosphorus concentration in grain and fodder due to better root establishment into rhizosphere, resulting in higher absorption of phosphorus due to supply more plant available P as well mobilizes native soil P and converted into plant available form and sustain in increased growth led to higher content of P. Increased accumulation of nutrients especially N and P in vegetative plant parts concomitant with improved metabolism led to greater translocation of N and P in reproductive structure led to higher concentration. These results are in close proximity with the findings Kumar *et al.* (2005) [5], Singh *et al.* (2013) [8], Yadav and Singh (2016) [11], Rakesh (2017) [7] and Khushbu (2021) [4].

An examination of data (Table 2) indicated that the different treatments tried in the experiment did not exert any significant effect on the potassium content in fodder in pooled study. A perusal of data indicated that the application of 50% RDN through castor shell compost + 50% RDN through urea (T₆) to sorghum registered significantly higher potassium content in grain (0.614%) in pooled study. Treatment T₆ was remained at par with T₄ (0.610%), T₅ (0.610%), T₉ (0.608%), T₂ (0.605%), T₃ (0.596) and T₁₀ (0.585%) in pooled study of potassium content in grain.

Effect on nutrient uptake (kg/ha)

A scrutiny of data (Table 3) revealed that application of 50% RDN through castor shell compost + 50% RDN through urea (T₆) show significantly higher N uptake by grain (36.36 kg/ha) and fodder (120.14 kg/ha) of sorghum crop during pooled analysis and remained statistically at par with treatment T₉ (34.04 kg/ha) and T₄ (33.32 kg/ha) during pooled study in nitrogen uptake by grain. While treatment T₆ remained statistically at par with treatment T₉ (110.39 kg/ha) in nitrogen uptake by fodder. It can be inferred from the data that significantly higher P uptake (7.40 and 30.60 kg/ha in grain and fodder, respectively) by sorghum crop recorded under the application of 50% RDN through castor shell compost + 50% RDN through urea in pooled study and it was remained at par with treatments T₉ (6.96 kg/ha) and T₄ (6.67 kg/ha) in phosphorus uptake by grain. In case of P uptake by fodder treatment T₆ remained statistically at par with only treatment T₉

(28.42 kg/ha). A perusal of data indicated that significantly higher K uptake by grain (13.26 kg/ha) and fodder (188.15 kg/ha) of sorghum were registered under the treatment of (T₆) 50% RDN through castor shell compost + 50% RDN through urea in pooled study, which remained at par with treatments T₉ (12.68 kg/ha), T₄ (12.47 kg/ha) and T₅ (12.33 kg/ha) in K uptake by grain. In case of K uptake by fodder treatment T₆ remained statistically at par with T₉ (179.57 kg/ha), T₄ (177.89kg/ha), T₅ (175.57kg/ha), T₃ (172.90 kg/ha) and T₂ (169.75kg/ha). The maximum N, P and K uptake by grain and fodder of sorghum might be due to fact that castor shell compost release nutrients easily and furthermore, because of prolonged availability of moisture due to castor shell compost might be resulted into increased uptake of nutrients and also dry matter accumulation and higher yield recorded with application of castor shell compost which directly related with the higher uptake of nutrients observed by sorghum. This was in concomitant with the findings of Kumar *et al.* (2005) [5], Vidyavathi *et al.* (2012) [10], Singh *et al.* (2013) [8], Yadav and Singh (2016) [11] and Khushbu (2021) [4]. The organic acids produced from decomposition of organic matter might be responsible for quick release of nutrients from native pool, result in greater availability on nutrients to growing plants and increase nutrient uptake by crop. The results are in line with those reported in the Castor Annual Report, 2020 [1].

Economics

Among the different integrated nitrogen management treatments in Table 4, 50% RDN through castor shell compost + 50% RDN through urea (T₆) recorded the maximum net (₹101472/ha) realizations but BCR (4.79) was fetched under treatment T₂ RDF (80:40:00 kg N:P₂O₅:K₂O/ha), which was closely followed by the treatment T₂ for net (₹96848/ha) realizations and treatment T₆ for BCR (4.00) and the minimum net realization (52947₹/ha) was procured with the treatment T₁ (absolute control) and the lower BCR (2.39) recorded under treatment T₁₀ (50% RDN through FYM + 50% RDN through castor shell compost + *Azotobacter*).

This indicated that use of 50% RDN through castor shell compost + 50% RDN through urea 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 fodder yield of sorghum received in these treatments. These findings are in accordance with those reported by Tudu *et al.* (2023) [9] and Javiya (2019) [3].

Table 1: Grain and fodder yield of sorghum as influenced by integrated nitrogen management (Pooled of 2 year)

Treatments	Grain yield (kg/ha)	Fodder yield (kg/ha)
T ₁ : Absolute control	1181	8340
T ₂ : RDF (80:40:00 kg N:P ₂ O ₅ :K ₂ O/ha)	1978	12613
T ₃ : 25% RDN through FYM + 75% RDN through urea	1997	13008
T ₄ : 50% RDN through FYM + 50% RDN through urea	2042	13334
T ₅ : 25% RDN through castor shell compost + 75% RDN through urea	2022	13223
T ₆ : 50% RDN through castor shell compost + 50% RDN through urea	2166	14059
T ₇ : 25% RDN through FYM + 50% RDN through urea + <i>Azotobacter</i>	1702	11065
T ₈ : 25% RDN through castor shell compost + 50% RDN through urea + <i>Azotobacter</i>	1723	11183
T ₉ : 25% RDN through FYM + 25% RDN through castor shell compost + 50% RDN through urea	2086	13599
T ₁₀ : 50% RDN through FYM + 50% RDN through castor shell compost + <i>Azotobacter</i>	1594	11023
S. Em. ±	71.22	486.38
C. D. (P = 0.05)	201.25	1374.32
Interaction (Y × T)	NS	NS
C. V. %	11.63	12.12

(This data for review only)

Table 2: Nitrogen, phosphorus and potassium content in grain and fodder of sorghum as influenced by integrated nitrogen management (Pooled of 2 year)

Treatments	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	Grain	Fodder	Grain	Fodder	Grain	Fodder
T ₁ : Absolute control	1.430	0.685	0.233	0.159	0.574	1.291
T ₂ : RDF (80:40:00 kg N:P ₂ O ₅ :K ₂ O/ha)	1.604	0.776	0.319	0.201	0.605	1.341
T ₃ : 25% RDN through FYM + 75% RDN through urea	1.605	0.791	0.309	0.200	0.596	1.325
T ₄ : 50% RDN through FYM + 50% RDN through urea	1.630	0.800	0.326	0.201	0.610	1.334
T ₅ : 25% RDN through castor shell compost + 75% RDN through urea	1.619	0.795	0.315	0.205	0.610	1.329
T ₆ : 50% RDN through castor shell compost + 50% RDN through urea	1.679	0.855	0.341	0.218	0.614	1.336
T ₇ : 25% RDN through FYM + 50% RDN through urea + <i>Azotobacter</i>	1.526	0.745	0.314	0.205	0.576	1.313
T ₈ : 25% RDN through castor shell compost + 50% RDN through urea + <i>Azotobacter</i>	1.538	0.755	0.310	0.205	0.576	1.313
T ₉ : 25% RDN through FYM + 25% RDN through castor shell compost + 50% RDN through urea	1.635	0.813	0.333	0.209	0.608	1.321
T ₁₀ : 50% RDN through FYM + 50% RDN through castor shell compost + <i>Azotobacter</i>	1.510	0.734	0.308	0.196	0.585	1.319
S. Em. ±	0.027	0.013	0.006	0.003	0.010	0.025
C. D. (P = 0.05)	0.082	0.036	0.017	0.010	0.029	NS
Interaction (Y × T)	NS	NS	NS	NS	NS	NS
C. V. %	5.22	4.57	5.47	4.92	4.83	5.45

Table 3: Nitrogen, phosphorus and potassium uptake by grain and fodder of sorghum as influenced by integrated nitrogen management (Pooled of 2 year)

Treatments	Nitrogen uptake (kg/ha)		Phosphorus uptake (kg/ha)		Potassium uptake (kg/ha)	
	Grain	Fodder	Grain	Fodder	Grain	Fodder
T ₁ : Absolute control	16.91	57.25	2.74	13.21	6.74	107.41
T ₂ : RDF (80:40:00 kg N:P ₂ O ₅ :K ₂ O/ha)	31.76	98.05	6.31	25.45	11.97	169.75
T ₃ : 25% RDN through FYM + 75% RDN through urea	32.03	102.95	6.16	26.02	11.89	172.90
T ₄ : 50% RDN through FYM + 50% RDN through urea	33.32	106.61	6.67	26.81	12.47	177.89
T ₅ : 25% RDN through castor shell compost + 75% RDN through urea	32.77	105.12	6.36	27.09	12.33	175.57
T ₆ : 50% RDN through castor shell compost + 50% RDN through urea	36.36	120.14	7.40	30.60	13.26	188.15
T ₇ : 25% RDN through FYM + 50% RDN through urea + <i>Azotobacter</i>	25.95	82.57	5.34	22.66	9.80	145.26
T ₈ : 25% RDN through castor shell compost + 50% RDN through urea + <i>Azotobacter</i>	26.46	84.49	5.34	22.88	9.94	146.89
T ₉ : 25% RDN through FYM + 25% RDN through castor shell compost + 50% RDN through urea	34.04	110.39	6.96	28.42	12.68	179.57
T ₁₀ : 50% RDN through FYM + 50% RDN through castor shell compost + <i>Azotobacter</i>	24.11	81.11	4.91	21.67	9.32	145.52
S. Em. ±	1.22	4.06	0.26	1.09	0.43	7.47
C. D. (P = 0.05)	3.45	11.48	0.73	3.08	1.21	21.12
Interaction (Y × T)	NS	NS	NS	NS	NS	NS
C. V. %	12.62	12.98	13.17	13.36	11.67	14.10

Table 4: Effect of integrated nitrogen management on economics of sorghum (Average of 2022 and 2023)

Treatments	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	BCR
T ₁ : Absolute control	24185	77132	52947	3.19
T ₂ : RDF (80:40:00 kg N:P ₂ O ₅ :K ₂ O/ha)	25569	122417	96848	4.79
T ₃ : 25% RDN through FYM + 75% RDN through urea	34126	124959	90833	3.66
T ₄ : 50% RDN through FYM + 50% RDN through urea	38759	127943	89184	3.30
T ₅ : 25% RDN through castor shell compost + 75% RDN through urea	31823	126768	94945	3.98
T ₆ : 50% RDN through castor shell compost + 50% RDN through urea	33811	135283	101472	4.00
T ₇ : 25% RDN through FYM + 50% RDN through urea + <i>Azotobacter</i>	33870	106388	72518	3.14
T ₈ : 25% RDN through castor shell compost + 50% RDN through urea + <i>Azotobacter</i>	31227	107594	76367	3.45
T ₉ : 25% RDN through FYM + 25% RDN through castor shell compost + 50% RDN through urea	36456	130571	94115	3.58
T ₁₀ : 50% RDN through FYM + 50% RDN through castor shell compost + <i>Azotobacter</i>	43073	102944	59871	2.39

Conclusion

Based on the findings of two years of experimentation, it is concluded that for securing higher grain and fodder yield,

nutrient content-uptake and net profit from *kharif* sorghum crop under integrated nitrogen management, apply 50% RDN through castor shell compost + 50% RDN through urea to sorghum,

while higher BCR of sorghum recorded under application of RDF (80:40:00 kg N:P₂O₅:K₂O/ha) to sorghum.

References

1. Castor-Mustard Research Station. Annual Report 2020. S. D. Agricultural University, Sardarkrushinagar, Gujarat; 2020.
2. Jackson ML. Soil chemical analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; c1973.
3. Javiya K. Effect of sulphur and potassium with and without castor shell compost on yield and quality of groundnut (*Arachis hypogaea* L.) in loamy sand. M.Sc. (Agri.) Thesis (Unpublished). S.D. Agricultural University, Sardarkrushinagar; c2019.
4. Khushbu K. Effect of castor transplanting and different organic manures on growth, yield and quality of castor (*Ricinus communis* L.) under North Gujarat agro climatic conditions. M.Sc. (Agri.) Thesis (Unpublished). S. D. Agricultural University, Sardarkrushinagar; c2021.
5. Kumar S, Rawat CR, Dhar S, Rai S. Dry-matter accumulation, nutrient uptake and changes in soil-fertility status as influenced by different organic and inorganic sources of nutrients to forage sorghum (*Sorghum bicolor*). Indian J Agric Sci. 2005;75(6):340-342.
6. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: ICAR Publication; c1967.
7. Rakesh. Integrated nitrogen management in sorghum [*Sorghum bicolor* (L.) Moench] and its residual effect on chickpea. M.Sc. (Agri.) Thesis (Unpublished). MPUAT, Rajasthan College of Agriculture, Udaipur; c2017.
8. Singh R, Ram T, Choudhary GL, Gupta AK. Effect of integrated nitrogen management on nutrient uptake, quality, economics and soil fertility of pearl millet under rainfed conditions. Elixir Agric. 2013;54:12373-12375.
9. Tudu AK, Palai JB, Shankar T, Adhikary R, Mondal T, Nath S. Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of rabi sorghum (*Sorghum bicolor* (L.) Moench). Int J Environ Clim Change. 2023;13(10):4239-4247.
10. Vidyavathi GS, Dasog HB, Babalad NS, Hebsur SK, Gali SG, Patil, Alagawadi AR. Nutrient status of soil under different nutrient and crop management practices. Karnataka J Agric Sci. 2012;25(2):193-198.
11. Yadav AK, Singh P. Effect of integrated nutrient management on yield, protein content, nutrient content and uptake of sorghum [*Sorghum bicolor* (L.) Moench]. Innov Farming. 2016;1(2):30-34.