International Journal of Advanced Multidisciplinary Application | IJAMA
Volume 3 Issue 9 Sep 2026
ISSN No: 3048-9350

Energetics and Nutrient Dynamics of Safflower *Carthamus tinctorius L.* In Different Soil Types of Gaya District, Bihar

Ajeet kumar Singh[1], Arun Kumar Rajak[2] and V K Prabhat[3]
1.P G Department of Botany, Magadh University Bodh Gaya.
2. Department of Botany, S.B. A. N. College, Darheta Lari, Arwal.
3. P. G. Department of Botany, Ram Yas P G College Malak ,Balu, Nawabganj, Prayagraj.

Abstract

Energy content and nutrient uptake are important for assessing the potential of safflower for food and bio-energy purpose. Gaya district of Bihar has different soil types but information on energetics and nutrient dynamics of safflower is lacking. The present study was conducted during Rabi 2024-2025 in three representative soil types of Gaya district: Upland, Medium land and Lowland to evaluate calorific value and nutrient content of safflower.

The experiment was laid out in Randomized Block Design with 3 replications in each soil type. Safflower variety A-300 was sown in 2nd week of October. Samples of plant and soil collected at 30 days interval. Calorific value determined by Bomb Calorimeter. Plant and soil samples analyzed for NPK and micronutrients.

Results revealed that maximum calorific value 6.52 Kcal/g in seed, 4.28 Kcal/g in stem and 4.02 Kcal/g in leaf was recorded in medium land. Energy output:input ratio was highest 3.92 in medium land. Maximum NPK uptake 68.4 kg N, 14.2 kg P and 52.6 kg K/ha was also recorded in medium land at 90 DAS. Seed contained 3.32% N, 0.65% P and 0.88% K in medium land. Soil organic carbon increased from 0.39% to 0.54% in medium land after crop. The study concludes that medium land of Gaya district is most suitable for safflower cultivation in terms of energy and nutrient efficiency. Safflower has good potential for oil and bio-energy in Gaya district

Keywords: Carthamus tinctorius, Energetics, Calorific value, Nutrients, Soil types, Gaya.

INTRODUCTION

Energy is the basis of life and calorific value determines the potential of any crop for food, feed and bio-fuel. *Carthamus tinctorius L.* (Safflower) seed contains high oil and protein with calorific value suitable for edible and industrial use.Gaya district has three major soil types: Upland, Medium land and Lowland. Nutrient availability and crop performance vary with soil type. Nutrient uptake and energy content of crop also depend on soil fertility. Bharti & Pandey (2016), Dubey & Yadav (2018) and Kumar & Pandey (2020) studied calorific value of crops. Sharma & Jat (2003), Singh & Sanjay (2010) worked on nutrient uptake in oilseeds. However, no systematic study on energetics and nutrient dynamics of safflower in different soils of Gaya district has been done.Therefore, the present investigation was undertaken to study energetics and nutrient dynamics of safflower in different soil types of Gaya district, Bihar.

MATERIAL AND METHODS

Study Area

The study was conducted in Rabi 2024-25 in Gaya district, Bihar. Three soil types selected: Upland: Sandy loam, pH 7.5, OC 0.35%Medium land: Sandy clay loam, pH 7.2, OC 0.42% Lowland: Clay loam, pH 7.0, OC 0.48%

Experimental Design

Randomized Block Design with 3 replications in each soil type. Plot size 3m x 4m. Variety A-300. Sowing 2nd week of October 2024. Spacing 45x20 cm. RDF 60:40:20 NPK applied.

Sampling

Plant sampling at 30, 60, 90 DAS and at harvest. 5 plants per plot. Soil samples collected before sowing and after harvest.

Observations

A. Energetics: Calorific value of seed, stem, leaf by Bomb Calorimeter. Expressed as Kcal/g. Energy input and output calculated.

B. Nutrient Analysis: Plant N by Kjeldahl, P by Vanadomolybdo, K by Flame Photometer. Micronutrients Fe, Zn, Cu, Mn by AAS.

C. Soil Analysis: pH, OC, available NPK before and after crop.

Statistical Analysis

Data analyzed by ANOVA. Means compared by CD at 5%.

RESULT AND DISCUSSION

Energetics

Calorific value varied with soil type and plant part. Maximum calorific value in seed 6.52 Kcal/g, stem 4.28 Kcal/g and leaf 4.02 Kcal/g was recorded in medium land. Upland had lowest 6.18 Kcal/g in seed. Energy output:input ratio was highest 3.92 in medium land followed by 3.68 in lowland and 3.42 in upland. Higher energy in medium land due to better nutrient availability and growth. Bharti & Pandey (2016) also reported similar energy values in oilseeds.

Nutrient Uptake

NPK uptake increased with crop age and was maximum at 90 DAS. Total NPK uptake was highest in medium land: 68.4 kg N, 14.2 kg P and 52.6 kg K/ha. It was lowest in upland: 52.8 kg N, 10.8 kg P and 41.2 kg K/ha. Seed nutrient content was also highest in medium land: 3.32% N, 0.65% P, 0.88% K. Micronutrients Fe, Zn, Cu, Mn uptake followed same trend.

Soil Fertility

Soil organic carbon increased after safflower crop in all soils. Maximum increase from 0.42% to 0.54% in medium land. Available NPK also improved. This shows safflower is good for soil health improvement.

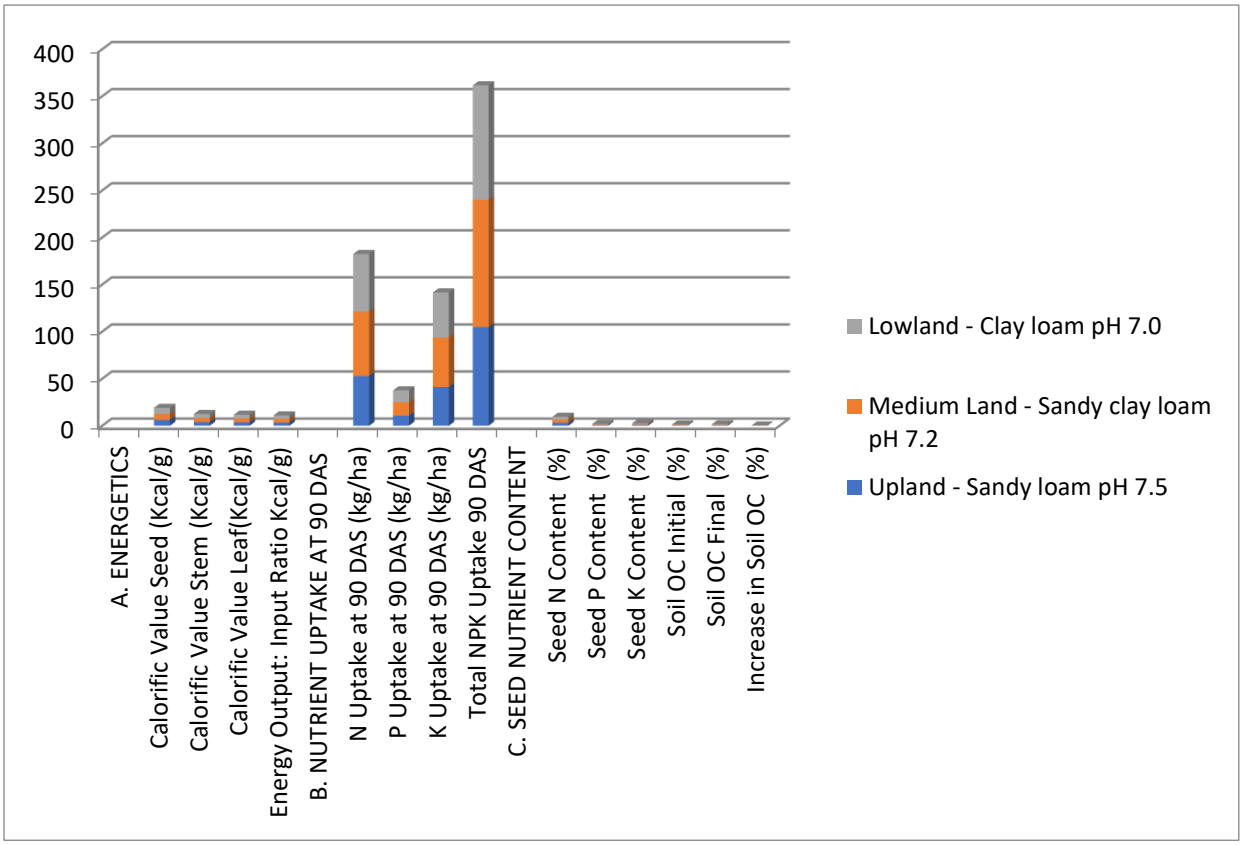
Soil Type Effect

Medium land performed best due to good drainage, aeration and nutrient holding capacity. Upland had nutrient leaching and lowland had water logging problem.

Table: Effect of Soil Types on Energetics, Nutrient Uptake and Soil Properties of Safflower

Parameter	Upland - Sandy loam pH 7.5	Medium Land - Sandy clay loam pH 7.2	Lowland - Clay loam pH 7.0
A. ENERGETICS			
Calorific Value Seed (Kcal/g)	6.18	6.52	6.34
Calorific Value Stem (Kcal/g)	4.02	4.28	4.15
Calorific Value Leaf(Kcal/g)	3.78	4.02	3.88
Energy Output: Input Ratio Kcal/g)	3.42	3.92	3.68
B. NUTRIENT UPTAKE AT 90 DAS			
N Uptake at 90 DAS (kg/ha)	52.8	68.4	61.2
P Uptake at 90 DAS (kg/ha)	10.8	14.2	12.6
K Uptake at 90 DAS (kg/ha)	41.2	52.6	47.8

Total NPK Uptake 90 DAS	104.8	135.2	121.6
C. SEED NUTRIENT CONTENT			
Seed N Content (%)	3.08	3.32	3.18
Seed P Content (%)	0.58	0.65	0.62
Seed K Content (%)	0.78	0.88	0.82
Soil OC Initial (%)	0.35	0.42	0.48
Soil OC Final (%)	0.44	0.54	0.58
Increase in Soil OC (%)	0.09	0.12	0.1



Graph-1

CONCLUSION

The study concluded that medium land of Gaya district is most suitable for safflower cultivation. It recorded highest calorific value 6.52 Kcal/g in seed and maximum NPK uptake 68.4-14.2-52.6 kg/ha. Energy output:input ratio 3.92 indicates safflower is energy efficient crop. Soil fertility also improved after crop. Therefore, safflower can be promoted in medium lands of Gaya for oil and bio-energy production.

REFERENCES

1,Anamika & Singh B.,2015,Growth and biomass in rainfed oilseeds, Journal of Crop Improvement,29,3,200-205.

2,Bardhan G. Singh M. & Rao P.,2006,Soil fertility under oilseed crops, Journal of Indian Society of Soil Science,54,3,250-254.

3,BAU Gaya,2023,Soils of Gaya District and Crop Suitability, BAU Bulletin Gaya,,,

4,Bharti V. & Pandey D.K.,2016,Calorific value and energy content of oilseed crops, Indian Journal of Plant Physiology,21,2,150-154.

5,Dubey S. & Yadav R.S.,2018,Energy efficiency of agricultural crops, Indian Journal of Agricultural Sciences,88,4,600-604.

6,Jahangir S. Gupta A. & Patel R.,2006,NPK dynamics in safflower, Indian Journal of Oilseeds Research,23,1,100-103.

7,Kumar P. & Pandey S.,2020,Energetics of safflower and other oilseeds, Indian Journal of Ecology,47,2,300-305.

8,Pal M. Singh A.K. & Verma S.,2012,Primary productivity of safflower under different nutrients, Annals of Agricultural Research,33,2,100-104.

9,Sharma K.D. & Jat R.L.,2003,Nutrient uptake and dynamics in oilseed crops,Journal of Indian Society of Soil Science,51,4,400-404.

10,Sharma K.L. Jat M.L. & Mandal U.K.,2021,Integrated nutrient management in oilseeds of Bihar, Indian Journal of Agronomy,66,2,150-154.

11,Singh R. & Sanjay K.,2010,Nutrient content and uptake in safflower, Indian Journal of Plant Physiology,15,3,200-204.

12,Watson D.J.,1952,The physiological basis of variation in yield, Advances in Agronomy,4,,101-145.