E-ISSN: 2618-0618
P-ISSN: 2618-060X
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www.agronomyjournals.com
2024; 7(3): 29-31
Received: 05-01-2024
Accepted: 11-02-2024

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Assessing the impact of pigeonpea [*Cajanus cajan* (L.) Millsp] genotypes under varied fertilization rates: A comprehensive analysis of energy dynamics

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i3a.377

Abstract
During the *kharif* season of 2018-19, an agricultural field trial was conducted at G.B. Pant University of Agriculture and Technology in Pantnagar, Uttarakhand. The primary focus of this study was to investigate the performance of promising pigeonpea [*Cajanus cajan* (L.) Millsp] genotypes when subjected to different fertilization rates in the Tarai region of Uttarakhand. The main objective was to assess how pigeonpea genotypes respond to varied fertilization rates, aligning with the broader goal of conducting a comprehensive analysis of energy dynamics in the crop. The results obtained during course of investigation revealed that genotypes significantly influenced various energy parameters. Genotype PA 421 was significantly superior over PA 291 and UPAS 120 in terms of energy output, energy efficiency, net energy and energy productivity. Among the fertility levels, 125% RDF recorded significant response to energy input, energy output, net energy and energy intensity of pigeonpea compared to other fertility levels, 125% RDF was at par with 100% RDF, but I was non-significant different in initial and final population and mortality.

Keywords: Genotype, energy, efficiency, fertility, pigeonpea variety, input-output

Introduction

Pigeonpea, recognized in India as Red gram, Arhar, or Tur, is a tropical crop with predominant cultivation during the *Kharif* season. It serves both as a standalone crop and an intercrop across diverse agro-ecological settings in India. Renowned for its deep-rooting capabilities and drought tolerance, pigeonpea thrives in regions characterized by low and uncertain rainfall. Its popularity is underscored by its nitrogen-restorative properties and the substantial organic matter it contributes to the soil, making it a promising candidate for inclusion in crop rotation and mixtures. As a leguminous crop, pigeonpea plays a crucial role in fixing atmospheric nitrogen, enriching the soil with this essential element. The plant's deep-rooting system facilitates nutrient and moisture extraction from deeper soil layers, rendering it well-suited for rainfed conditions. This deep-rooting characteristic also aids in breaking plough pans and enhancing soil structure, earning it the designation of a 'Biological plough.' Originating from Africa, pigeonpea found its way to India through early traders and has since become a staple in semi-arid areas of the tropics and subtropics. Noteworthy for its ability to yield economically viable harvests in moisture-deficient soils, pigeonpea holds significance in dryland agriculture. Pigeonpea grains boast nutritional value, containing 23.3% protein, 35% minerals, and 57.6% carbohydrates, providing 335 kJ of energy per 100 grams (Alse *et al*., 2017) [10]. Despite its importance, the production and productivity of pigeonpea have seen limited growth, primarily focusing on meeting grain surpluses. India holds a prominent position in pigeon pea production, recording 4.34 million tonnes from an acreage of 5.05 million hectares and achieving a productivity of 859 kg/ha (MoAF&W, 2022) [5]. India also leads in global pigeon pea imports, constituting 92.65% of the share in 2021, amounting to 674.44 million kg. In 2020, India contributed significantly to the global pigeon pea production, accounting for 77.61% (MoAF&W, 2022) [5].

Within India, Uttar Pradesh emerges as the leading producer, contributing 34.87% to the national production with 0.47 million tonnes from 0.49 million hectares, boasting a productivity of 944 kg/ha (MoAF&W, 2022) [5]. Following Uttar Pradesh, Madhya Pradesh contributes 34.55% (0.44 million tonnes) to the national production, with West Bengal, Bihar, and Jharkhand contributing 10.53%, 8.84%, and 4.53%, respectively, to the overall national production of pigeon pea.

2. Material and Methods

In 2018-19, a field experiment took place in the Pulse Agronomy Block at G. B. Pant University, Pantnagar. The *kharif* season experienced temperatures ranging from 20.3-37.2 °C and received 1316.9 mm rainfall. The randomized block design included three genotypes (PA 421, PA 291, and UPAS 120) and four fertility levels (control, 75% RDF, 100% RDF, and 125% RDF). Fertilizer, applied as basal, utilized RDF (18:48:24 kg/ha N: P_2O_5: K_2O) through 150 kg/ha NPK mixture (12:32:16). The sandy loam soil had 0.83% organic carbon, low available nitrogen (270.9 kg/ha), high available phosphorus (26.1 kg/ha), and medium available potassium (230 kg/ha), with a slightly alkaline pH of 7.3. The energy requirement for the different field operations was calculated by using the energy conversion factors. Energy equivalents for all the inputs were summed up to provide an estimate for total energy input. The farm produce (grain yield) was also converted into energy in terms of energy output (MJ). Output energy from the produce (grain) was calculated by multiplying the amount of production and its corresponding equivalents. Energy use efficiency, energy productivity, energy intensity, specific energy and net energy gain for production of pigeonpea was calculated using the standard formulae (Canakci *et al.*, 2005) [1].

3. Result and discussion

3.1 Energy input (MJ)

The data presented in Table 1. The study revealed that energy input was equal for three genotypes but vary with fertility levels. In case of fertility levels, maximum energy input was recorded in 125% RDF followed by 100% RDF and then 75% RDF. The lowest energy input was found under control. The highest energy input in 125% RDF was due to higher rate of application of fertilizer. This is might to be nutrient content is increasing the energy input is increasing similar result was reported by Singh *et al*. (2016) [8].

3.2 Energy output (MJ) and Net energy (MJ)

The results of the study indicate notable variations in energy output and net energy among different genotypes and fertility levels in the context of the pigeon pea cultivation experiment. The data presented in Table 1, the findings reveal that PA 421 exhibited significantly higher energy output and net energy compared to PA 291 and UPAS 120. However, PA 291 and UPAS 120 were found to be statistically similar in terms of energy output and net energy. In terms of fertility levels, the study found that 125% RDF resulted in significantly higher energy output and net energy when compared to 75% RDF and the control group. Interestingly, the energy output at 125% RDF was found to be statistically equivalent to that of 100% RDF. This implies that providing a higher dose of fertilizers, specifically at 125% RDF, led to a substantial increase in energy output and net energy, primarily attributed to the maximum yield recorded at this fertility level. Additionally, the parity observed between 125% RDF and 100% RDF suggests that there might be an optimal fertilization point beyond which additional fertilizers do not contribute significantly to energy output. PA 421 emerges as a promising genotype for maximizing energy production, while the application of 125% RDF appears to be an effective strategy for enhancing energy output in this context (Tripathi *et al*., 2015 and Mishra *et al*., 2017) [9, 6].

3.3 Energy efficiency

It is clear from the Table 1, among all the genotypes, PA 421 recorded significantly higher energy efficiency than PA 291 and UPAS 120. But PA 291 was at par with UPAS 120 in terms of energy efficiency. More ever, all the fertility levels, energy efficiency was significantly higher in control as compared to 75% RDF, 100% RDF and 125% RDF. This is due to higher energy output and lower energy input in control (Koocheki *et al*., 2011 and Mandal *et al*., 2002) [3, 4].

Table 1: Effect of genotype and fertility level on energy studies in pigeonpea

Treatment	Energy study					
	Energy input (MJ)	**Energy output (MJ)**	**Energy efficiency**	**Net energy (MJ/kg)**	**Energy intensity (MJ/kg)**	**Energy productivity (kg/MJ)**
Genotype						
PA 421	3924	36405	9.8	32481	1.57	0.67
PA 291	3924	30244	8.2	26320	1.88	0.55
UPAS 120	3924	29756	8.0	25832	1.91	0.54
SEm±	-	603	0.2	603	0.03	0.01
C.D. at 5%	-	1779	0.5	1779	0.10	0.03
Fertility level						
Control (No fertilizer)	2380	28424	11.9	26044	1.25	0.81
75% RDF*	3924	31494	8.0	27570	1.86	0.54
100% RDF	4438	33929	7.6	29491	1.93	0.52
125% RDF	4955	34693	7.0	29738	2.13	0.47
SEm±	-	696	0.2	696	0.0	0.0
C.D. at 5%	-	2054	0.5	2054	0.11	0.04

3.4 Energy intensity (MJ/kg)

The findings revealed that UPAS 120 exhibited a significantly higher energy intensity compared to both PA 421 and PA 291. Interestingly, UPAS 120 and PA 291 demonstrated similar energy intensity levels, indicating that despite inherent genotypic differences, the two varieties performed comparably in terms of energy utilization. This suggests that there might be specific traits or mechanisms within UPAS 120 and PA 291 that contribute to their comparable energy intensity levels. The energy intensity was found to be significantly higher when the crop was subjected to 125% RDF compared to 100% RDF, 75% RDF, and the control group. This implies that an increase in the amount of fertilizer applied positively correlates with higher energy intensity, underscoring the importance of nutrient availability in influencing the energy dynamics of plant growth. Moreover, the parity observed between the energy intensity of 100% RDF and 75% RDF suggests that there might be a threshold beyond which additional fertilization does not significantly contribute to increased energy utilization (Tripathi *et al.*, 2013 and Patil *et al*., 2014) [2].

3.5 Energy productivity

The observed differences in energy productivity among genotypes PA 421, PA 291, and UPAS 120 provide valuable insights into the genetic variability within the studied population. Notably, PA 421 exhibited a significantly higher energy productivity compared to both PA 291 and UPAS 120. This outcome underscores the genetic superiority of PA 421 in harnessing and utilizing resources for energy production, suggesting potential advantages in terms of overall crop performance and yield. Conversely, the comparable energy productivity levels between PA 291 and UPAS 120 indicate a similar capacity for energy conversion within these two genotypes. This finding suggests a degree of genetic similarity or adaptation to the prevailing environmental conditions, as reflected in their comparable energy productivity. The observation that the control group exhibited significantly higher energy productivity in comparison to treatments with 75%, 100%, and 125% RDF indicates a pronounced influence of fertility management on energy conversion processes within the studied crops. The reduced energy productivity under varying RDF levels suggests that an optimal or balanced nutrient supply, as represented by the control group, is conducive to maximizing energy output. The diminishing trend in energy productivity with increasing RDF levels could be indicative of nutrient imbalances, possibly leading to inefficiencies in energy assimilation and utilization. This might to be shed light on the intricate interplay between genotype variability and fertility management in determining energy productivity. The superior performance of PA 421 highlights its potential as a promising genotype for energy-efficient crop production (Yadav *et al*., 2013) [11].

Conclusion

In conclusion, our study provides valuable insights for pigeonpea cultivation, guiding informed decisions in agricultural practices. Genotype analysis revealed PA 421's significant superiority in energy parameters over PA 291 and UPAS 120. Additionally, 125% RDF demonstrated a significant response in energy-related aspects, emphasizing the importance of precise fertilization strategies. These findings pave the way for sustainable approaches to enhance crop productivity and contribute to global food security.

Reference

1. Canakci M, Topakci, Akinci I, Ozmerzi A. Energy pattern of some field crops and vegetable production: Case study for Antalya Region, Turkey. Energy Conversion and Management. 2005;46:655-666.
2. Tripathi HNS, Chandel A, Tripathi P, Mishra. Energy Use and Economical Analysis for Pea Production. Madras Agricultural Journal. 2015;102(4-6):196-200.
3. Koocheki A, Ghorbani R, Mondani M, Moradi AR. Pulses production systems in terms of energy use efficiency and economical analysis in Iran. International Journal of Energy Economics and Policy. 2011;1(4):95-106.
4. Mandal KG, Saha KP, Ghosh PK, Hati KM, Bandyopadhyay KK. Bioenergy and economic analysis of soybean-based crop production systems in central India. Biomass and Bioenergy. 2002;23(5):337-345.
5. Ministry of Agriculture and Farmers Welfare; c2022.
6. Mishra PK, Tripathi A, Tripathi Sheen H, Moses C. Energy Inputs in Production of Lentil Crop under Different Types of Farming Systems. International Journal of Current Microbiology and Applied Sciences. 2017;6(10):971-977.
7. Patil SL, Mishra PK, Loganandhan N, Ramesha MN, Math SKN. Energy, economics, and water use efficiency of chickpea (*Cicer arietinum* L.) cultivars in Vertisols of semi-arid tropics, India. Current Science. 2014;107(4):656-664.
8. Singh R, B, Subhash RK, Avasthe GS, Yadav DJ, Rajkhowa. Productivity, profitability and energy dynamics of rice (*Oryza sativa*) under tillage and organic nitrogen management practices in rice–vegetable pea (*Pisum sativum*) cropping system of Sikkim Himalayas. Indian Journal of Agricultural Sciences. 2016; 86(3):326–330.
9. Tripathi H, Chandel NS, Tripathi A, Mishra P. Energy use and economical analysis for green gram production under different farming systems in northern India. Agricultural Engineering Today. 2013;37(3):27-32.
10. UN Alse SK, Nayak SG, Jadhav SU, Vidhate. Effect of plant spacing on different genotypes of pigeonpea [*Cajanus cajan* (L.) millisp]. Agriculture Update. 2017;(12):731-736.
11. Yadav SK, Babu, Subhash, Singh Y, Yadav GS, Singh K, *et al*. Effect of organic nitrogen sources and biofertilizers on production potential and energy budgeting of rice (*Oryza sativa*)-based cropping systems. Indian Journal of Agronomy. 2013;58(4):9-14.