

RESEARCH PAPER

# Effect of Nutrient Levels on Productivity, Profitability and Stability of Pre-released *Kodo* Millet (*Paspalum scrobiculatum* L.) Genotypes under Rainfed Conditions

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Received: 16-03-2026

Revised: 25-05-2026

Accepted: 06-06-2026

## ABSTRACT

*Kodo* millet (*Paspalum scrobiculatum* L.) is a climate resilient nutri-cereal, which has tremendous potential to improve food and nutritional security in rain-fed environments. To study the impact of nutrient levels on the growth, yield, economics and stability of pre-released *Kodo* millet genotypes, a field experiment was conducted at the Zonal Agricultural Research Station (ZARS), University of Agricultural Sciences, Bengaluru, Gandhi Krishi Vigyana Kendra (GKVK), Karnataka during kharif season. This experiment was designed in a Factorial Randomized Complete Block Design with three replications, four fertility levels (control, 75% RDF, 100% RDF and 125% RDF) and three genotypes (KMV 588, TNAU 86 and JK 137). The results indicated that the fertility levels and the genotypes of *Kodo* millet significantly affected growth, yield and economic data. Increased levels of fertility resulted in better growth, yield attributes, yield, straw yield, and profitability. The genotype TNAU 86 always performed well in terms of productivity and economic returns. Stability analysis using Eberhart and Russell model showed that TNAU 86 had high yield potential, extensive adaptability and stable performance in various fertility environments. The study demonstrated that the use of 125% RDF gave improved productivity and profitability, with the introduction of TNAU 86 as the most promising genotype in the sustainable cultivation of *Kodo* millet under rain fed conditions.

## HIGHLIGHTS

- Optimization of fertilizer levels substantially influenced growth, yield attributes, productivity, and profitability of *Kodo* millet.
- Genotype-specific responses to fertility environments revealed TNAU 86 as a promising and stable genotype for sustainable millet production.

**Keywords:** Nutrient doses, interaction effects, yield, profitability, stability analysis

The world is experiencing unprecedented challenges in agriculture arising from the very rapid growth of population, climate change, the degradation of natural resources and the increasing demand for nutritious food (Maitra *et al.* 2001; Banerjee and Maitra, 2020). The unwanted circumstances due to

**How to cite this article:** Pushpa, K., Madhusudan, R., Mamatha., V.V., Sukanya, T.S., Palanna, K.B. and Prabhu, C.G. (2026). Effect of Nutrient Levels on Productivity, Profitability and Stability of Pre-released *Kodo* Millet (*Paspalum scrobiculatum* L.) Genotypes under Rainfed Conditions. *Int. J. Bioresource Sci.*, 13(01): 35-43.

**Source of Support:** None; **Conflict of Interest:** None



climatic factors and other anthropogenic issues made the major food grain production under a stressed situation (Santosh *et al.* 2024; Maitra *et al.* 2026a). The development of food and nutritional security for an estimated population of almost 10 billion by 2050 will depend on the development of resilient and sustainable agricultural production systems (Mukesh *et al.* 2024; Sharma *et al.* 2025). The United Nations Sustainable Development Goals (SDGs) highlight the need for sustainable crop production systems, with an increased productivity, nutritional security, and environmental sustainability, especially in “SDG 2 (Zero Hunger), SDG 1 (No Poverty), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action)”. Researchers and policy makers around the globe are now focused on developing crops that can withstand climate change and continue to yield food even in challenging environments (Joshi *et al.* 2025; Maitra *et al.* 2026b,c). Millets are one of the most important climate-smart crops, because they are drought resilient, have low input requirements and can achieve economic yields in marginal environments (Maheswari *et al.* 2025). They provide a high concentration of dietary fibre, proteins, minerals, vitamins and bioactive compounds and are therefore known as “nutri-cereals” that play a role in food and nutritional security (Shikha *et al.* 2024). In recent years, millets have been recognized for their potential contribution to sustainable food systems, dietary diversity, and climate change resilience, especially in rain-fed agricultural areas (Brahmachari *et al.* 2019; Warisa *et al.* 2025).

*Kodo* millet is a small millet grain crop that is mainly grown in India, as well as in some Asian and African countries, and is one of the oldest grains in cultivation. The crop is well adapted to areas with poor soil fertility, drought and irregular rainfall and can be grown in marginal and resource poor areas in which major cereals would often fail (Maitra *et al.* 2020; Mishra *et al.* 2025). *Kodo* millet grains are of high nutritional quality and have significant amounts of dietary fibre, proteins, minerals, antioxidants and phenolic compounds, all of which have a beneficial impact on human health and nutrition (Deshpande *et al.* 2015). Because of its characteristics, *Kodo* millet has now become a significant crop for sustainable agriculture and food security programs that can resist climate change.

The production of *Kodo* is still significantly lower than the potential yield. Inadequate and imbalanced nutrient management is responsible for one of the major factors that has contributed to this yield gap. *Kodo* millet is a low input crop but balanced fertilizer application has been shown to have considerable improvement in crop growth, nutrient uptake, yield attributes and grain yield in the millet-based cropping systems (Raj *et al.* 2024). Nutrient management, besides increasing productivity, also helps in improving the nutrient-use efficiency and the economic returns and in turn contributes to sustainable crop production (Maitra *et al.* 2025).

Proper use of agricultural inputs is becoming more significant in modern agricultural practices due to the negative impacts of over or under application of fertilizers on productivity, profitability and environmental quality (Sairam *et al.* 2025). Precision nutrient management focuses on meeting nutrient demand by crop and synchronizing nutrient supply to minimize nutrient loss and maximize fertilizer-use efficiency (Mangaraj *et al.* 2025). New research on nutrient management suggests that available knowledge on the importance of optimizing fertilizer levels for crop needs could lead to greater yield stability, resource use efficiency, and rain-fed production sustainability (Sairam *et al.* 2023; Atapattu *et al.* 2025). These methods are especially important in the case of *Kodo* millet which is often grown in nutrient poor soils and environments.

Another significant factor affecting crop productivity is genotypic variability of nutrient responsiveness. Genotype differences exist in growth traits, nutrient-use efficiency, and biomass partitioning, which might lead to variations in nutrient uptake, availability, and conversion to economic output of different *Kodo* millet genotypes. Identification of genotypes that are consistent under different fertility conditions is therefore critical for the development of site-specific recommendations and for improving productivity of crops. Stability analysis is an effective way to find high yielding and widely adapted genotypes for a range of different management conditions (Eberhart and Russell, 1966).

Although, *Kodo* millet is gaining significance in the field of climate resilient agriculture, knowledge regarding the relationship of fertility level with promising pre-released genotypes under the agro-climatic conditions of southern India is limited



(Prashanth *et al.* 2025). Additionally, there is a relative lack of research on the stability and adaptability of pre-released *Kodo* millet genotypes under different fertility environments. With this background, the present investigation was designed to examine the reaction of pre-released *Kodo* millet genotypes to various fertility levels with respect to growth, yield attributes, productivity and economics and stability and adaptability of the genotypes across fertility levels to find suitable genotype–fertility combinations for sustainable production under rainfed conditions.

## MATERIALS AND METHODS

The field experiment was carried out in the Zonal Agricultural Research Station (ZARS), Gandhi Krishi Vigyana Kendra (GKVK), University of Agricultural Sciences (UAS), Bengaluru, Karnataka, India during kharif season. The experimental site is situated at latitude 12°58' N and longitude 77°35' E with an altitude of about 930 m above sea level. It is part of the Eastern Dry Zone (Zone V) of Karnataka with the semi-arid tropical climate. The annual rainfall in the area is about 900-950 mm of which about 70-75 % is received during the Southwest monsoon (June-September). In the experimental period, the maximum temperature was between 28 and 33°C, and the minimum temperature was 15 to 20°C. The relative humidity during the crop growing period ranged from 55 to 85%. These climatic conditions are deemed to be suitable for small millets like *Kodo* millet (Yadav *et al.* 2024).

Representative soil samples were taken from the experimental field from 0 to 15 cm depth, and analyzed in the laboratory using standard methods. The soils of experimental area were considered red sandy loam (Alfisol), moderately well drained and well suited for rain fed crop cultivation. The soil was slightly acidic in reaction with low available nitrogen, medium available phosphorus and potassium status.

The experimental design was Factorial Randomized Complete Block Design (FRCBD) in which each treatment was replicated three times. Two factors were considered in the study; the fertility levels and *Kodo* millet genotypes. The four fertility treatments that were applied were control ( $F_0$ ), 75% recommended dose of fertilizers ( $F_1$ ), 100% recommended dose of fertilizers ( $F_2$ ) and 125%

recommended dose of fertilizers ( $F_3$ ). Three promising *Kodo* millet genotypes ( $V_1$ : KMV 588,  $V_2$ : TNAU 86 and  $V_3$ : JK 137) were tested with these fertility regimes. Four levels of fertility were combined with three genotypes, giving a total of 12 treatment combinations that were randomly assigned within each of the replications to reduce experimental error and to make it possible to compare the effects of the various treatment combinations.

The recommended dose of fertilizer for *Kodo* millet was considered as 40:20:20 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup> based on the recommendations of ICAR-Indian Institute of Millets Research and the University of Agricultural Sciences, Bengaluru (Acharya, 2023). Nitrogen, phosphorous and potassium were applied as urea (46% N), single super phosphate (16% P<sub>2</sub>O<sub>5</sub>) and muriate of potash (60% K<sub>2</sub>O) respectively. All the phosphorus and half of the nitrogen were fed at sowing as basal dose and half of the nitrogen was fed as preplant fertilizer. Top dressing was done at 30 days after sowing (DAS) for the rest of the nitrogen. It is also known for the rainfed millet production systems that applying nitrogen in split doses improves the nutrient-use efficiency and reduces the nitrogen losses (Sukanya *et al.* 2024).

**Table 1:** Nutrient levels imposed under different fertility treatments

| Fertility level  | Nitrogen (kg ha <sup>-1</sup> ) | Phosphorus (P <sub>2</sub> O <sub>5</sub> ) (kg ha <sup>-1</sup> ) | Potassium (K <sub>2</sub> O) (kg ha <sup>-1</sup> ) |
|------------------|---------------------------------|--------------------------------------------------------------------|-----------------------------------------------------|
| $F_0$ (Control)  | 0                               | 0                                                                  | 0                                                   |
| $F_1$ (75% RDF)  | 30                              | 15                                                                 | 15                                                  |
| $F_2$ (100% RDF) | 40                              | 20                                                                 | 20                                                  |
| $F_3$ (125% RDF) | 50                              | 25                                                                 | 25                                                  |

Experimental field was prepared by one deep ploughing followed by two harrowings and leveling to get a fine tilth. The farmyard manure at 5 t ha<sup>-1</sup> was uniformly incorporated into the soil at the last land preparation stage. The seed of the respective varieties was sown by hand in rows with a row and plant spacing of 30 cm × 10 cm and at a 10 kg ha<sup>-1</sup> seed rate. In 15 DAS, gap filling and thinning were performed to achieve optimum plant population. Two hand weedings were done

at 20 and 40 DAS to prevent weed competition at critical growth stages. All treatments received uniform treatments for plant protection based on need. The other agronomic methods recommended were followed during the growth period of the crop. Five representative plants were randomly selected and tagged in each experimental plot for recording biometric observations. Plant height, number of productive tillers per plant, panicle length and test weight were recorded at appropriate growth stages following standard procedures. Crop samples from the net plot area were harvested separately at physiological maturity for crop samples from each treatment. Grain yield and straw yield were taken and converted to kg/ha. Biological yield was computed by summing grain and straw yields. Harvest index was calculated as:

$$\text{Harvest Index (\%)} = (\text{Grain Yield} / \text{Biological Yield}) \times 100$$

Production and consumption costs and benefits were calculated using market prices of factors and products. Adaptability and stability of the tested genotypes of *Kodo* millet under the different fertility environments were evaluated by the model proposed by Eberhart and Russell (1966). The stability parameters estimated were mean grain yield, regression coefficient (bi) and deviation from regression ( $S^2di$ ). A genotype with a high mean yield, a regression coefficient that is close to unity and a low deviation from regression was regarded as stable and widely adapted in various fertility environments.

The experimental data were analyzed by analysis of variance (ANOVA) suitable for Factorial Randomized Complete Block Design (FRBCD) as outlined by Gomez and Gomez (1984). Critical difference (CD) test (at 5% significance) was used to compare treatment means. To interpret treatment effects, standard error of mean ( $SEm \pm$ ) and coefficient of variation (CV%) were calculated.

## RESULTS AND DISCUSSION

The fertility level and varietal differences had significant effect on the growth and yield attributes of *Kodo* millet. Data on plant height, productive tillers, panicle length and test weight are presented in Table 2. The application of 125% RDF ( $F_3$ ) to

TNAU 86 ( $V_2$ ) recorded the highest plant height (94.1 cm), productive tillers (11.3 per plant), panicle length (23.6 cm) and test weight (5.76 g) among the treatment combinations. On the other hand, the control treatment ( $F_0V_1$ ) had the minimum values of plant height (73.8 cm), productive tillers (7.2 per plant), panicle length (16.5 cm) and test weight (4.02 g). As the fertilizer rate was increased ( $F_0 - F_3$ ), all the growth and yield-attributing traits were also increased. TNAU 86 was found to be superior to other varieties KMV 588 and JK 137 in all the fertility levels.

**Table 2:** Effect of fertility levels and varieties on growth and yield attributes of *Kodo* millet

| Treatment   | Plant height (cm) | Productive Tillers per plant | Panicle length (cm) | 1000-seed weight (g) |
|-------------|-------------------|------------------------------|---------------------|----------------------|
| $F_0V_1$    | 73.8              | 7.2                          | 16.5                | 4.02                 |
| $F_0V_2$    | 77.1              | 8.0                          | 17.4                | 4.48                 |
| $F_0V_3$    | 75.2              | 7.6                          | 16.9                | 4.15                 |
| $F_1V_1$    | 80.4              | 8.6                          | 18.8                | 4.56                 |
| $F_1V_2$    | 86.2              | 9.8                          | 20.1                | 5.04                 |
| $F_1V_3$    | 81.5              | 8.9                          | 18.9                | 4.62                 |
| $F_2V_1$    | 84.6              | 9.4                          | 20.3                | 4.88                 |
| $F_2V_2$    | 90.8              | 10.7                         | 22.1                | 5.42                 |
| $FV_3$      | 85.9              | 9.6                          | 20.5                | 4.93                 |
| $F_3V_1$    | 88.7              | 10.2                         | 21.8                | 5.12                 |
| $F_3V_2$    | 94.1              | 11.3                         | 23.6                | 5.76                 |
| $F_3V_3$    | 89.2              | 10.0                         | 21.7                | 5.08                 |
| $SEm \pm$   | 1.86              | 0.31                         | 0.48                | 0.12                 |
| CD (P=0.05) | 5.42              | 0.91                         | 1.40                | 0.35                 |

\*  $F_0$  - Control;  $F_1$  - 75% RDF;  $F_2$  - 100% RDF;  $F_3$  125% RDF;  $V_1$  - KMV 588;  $V_2$  - TNAU 86;  $V_3$  - JK 137.

The higher fertility levels resulted in a significant increase in plant height, productive tillers, panicle length, and test weight, which could be explained by the improvement in nutrient availability, especially N, P, and K, that lead to better vegetative growth, chlorophyll production, growth efficiency, and accumulation of assimilates. Nitrogen is critical for cell division and leaf area development, phosphorus for root development and energy transfer, leading to improved crop establishment and reproductive development. Increased use of fertilizers resulted in similar positive responses of millet crops as



reported by Basavarajappa *et al.* (2002), Nigade *et al.* (2011) and Chouhan *et al.* (2015). Increased source-sink relationships or efficient translocation of photosynthates towards emerging reproductive structures could be responsible for the higher number of productive tillers and increased panicle length under 125% RDF. Raundal *et al.* (2017) observed similar results in little millet and Jalajakshi *et al.* (2022) in *Kodo* millet. The high performance of TNAU 86 indicates both higher nutrient-use efficiency and higher genetic potential for biomass production and reproductive growth. The growth differences were observed to attribute to varietal differences as reported by Jyothi *et al.* (2016) and Siddiqui *et al.* (2020) who reported that genotypic variability significantly affects the response of the crop to nutrient management practices.

The fertility level and varieties had a significant effect on grain yield, the straw yield, biological yield, and harvest index. The yield and yield related parameters obtained are presented in Table 3. The higher combination of F3V2 (125% RDF × TNAU 86) produced the highest grain yield (3426 kg per ha), straw yield (4528 kg per ha) and biological yield (7954 kg per ha) while the lower combination F0V1 (100% RDF × TNAU 83) produced the lowest values. The mean of grain yield was found to be 2092 kg per ha under the control treatment and 3143 kg per ha under 125% RDF. Assimilate partitioning (harvest index) ranged from 43.1 to 45.5%, with relatively consistent levels across fertility treatments.

The beneficial effects on grain and straw production on fertility increase may be explained by the greater crop growth, nutrient uptake, photosynthetic capacity, and the higher efficiency of assimilates to produce economic yield. Sufficient supply of nutrients can contribute to the development of leaf area, photosynthetic efficiency, accumulation of dry matter and grain yield. In a similar study, Vishwanatha *et al.* (2024) noticed a substantial increment in grain and straw yield of *Kodo* millet with the application of higher rates of fertilizer. The increased yield under 125% RDF could also be attributed to the greater nutrient availability during the crop development process that allows for efficient grain filling and panicle development. Nigade *et al.* (2006) reported similar in finger millet while Thakur *et al.* (2019) reported similar in browntop millet. This highlights the general

superiority of TNAU 86 in all the fertility levels, which means it had a better capacity to use nutrients and allocate biomass to produce grain. Similar studies by Nandini *et al.* (2018) and Thesiya *et al.* (2019) have also found that significant differences in yield performance across varieties was related to differences in genetic potential and nutrient-use efficiency. The relatively consistent harvest index among the treatments may indicate that the fertility enhancement was more or less equal for both vegetative and reproductive growth, thus corroborating the findings of Nwajei (2013) and Anilrao *et al.* (2024).

**Table 3:** Interaction effect of fertility levels and varieties on grain yield, straw yield and harvest

| Treatment*                    | Grain yield<br>(kg ha <sup>-1</sup> ) | Straw yield<br>(kg ha <sup>-1</sup> ) | Biological yield<br>(kg ha <sup>-1</sup> ) | Harvest index<br>(%) |
|-------------------------------|---------------------------------------|---------------------------------------|--------------------------------------------|----------------------|
| F <sub>0</sub> V <sub>1</sub> | 1835                                  | 2410                                  | 4245                                       | 43.2                 |
| F <sub>0</sub> V <sub>2</sub> | 2286                                  | 2835                                  | 5121                                       | 44.6                 |
| F <sub>0</sub> V <sub>3</sub> | 2154                                  | 2657                                  | 4811                                       | 44.8                 |
| F <sub>1</sub> V <sub>1</sub> | 2487                                  | 3025                                  | 5512                                       | 45.1                 |
| F <sub>1</sub> V <sub>2</sub> | 2898                                  | 3484                                  | 6382                                       | 45.4                 |
| F <sub>1</sub> V <sub>3</sub> | 2645                                  | 3196                                  | 5841                                       | 45.3                 |
| F <sub>2</sub> V <sub>1</sub> | 2764                                  | 3318                                  | 6082                                       | 45.4                 |
| F <sub>2</sub> V <sub>2</sub> | 3198                                  | 4016                                  | 7214                                       | 44.3                 |
| FV <sub>3</sub>               | 2879                                  | 3452                                  | 6331                                       | 45.5                 |
| F <sub>3</sub> V <sub>1</sub> | 3015                                  | 3712                                  | 6727                                       | 44.8                 |
| F <sub>3</sub> V <sub>2</sub> | 3426                                  | 4528                                  | 7954                                       | 43.1                 |
| F <sub>3</sub> V <sub>3</sub> | 2988                                  | 3636                                  | 6624                                       | 45.1                 |
| SEm±                          | 74.5                                  | 102.8                                 | 118.4                                      | 0.62                 |
| CD (P=0.05)                   | 212.4                                 | 293.1                                 | 345.3                                      | 1.81                 |

\* F<sub>0</sub> - Control; F<sub>1</sub> - 75% RDF; F<sub>2</sub> - 100% RDF; F<sub>3</sub> 125% RDF; V<sub>1</sub> - KMV 588; V<sub>2</sub> - TNAU 86; V<sub>3</sub> - JK 137.

Fertility levels and varietal performance had a significant effect on economic returns. The gross, net returns, and benefit-cost ratio from various levels of fertility and genotypes are presented in Table 4. The treatment combination F<sub>3</sub>V<sub>2</sub> had the highest gross returns (₹ 154,170 per ha), net returns (₹ 115,570 per ha) and benefit-cost ratio (3.99) and the lowest economic returns were obtained by the treatment combination F<sub>0</sub>V<sub>1</sub>. The increasing levels of fertilizers were found to have a positive relationship with increasing profitability. TNAU 86 recorded the

highest average gross return, net return and B ratio for all the fertility levels tested.

Increased yields of grain and straw under higher fertility levels, which more than compensated for the extra cost of fertilizer, mostly accounted for the greater economic returns. The higher values of net return and B ratio at 125% RDF suggest that the extra value of nutrient produced was higher than the extra cost of nutrient applied. Higher profit has been observed with the increase in the level of fertilizers in *Kodo* millet by Bhat *et al.* (2022). Better nutrient management has also been reported to result in economic returns in finger millet (Jyothi *et al.* 2016) and foxtail millet (Prakash *et al.* 2017). TNAU 86 produced higher yields of grain and was more responsive to nutrient application, which explains why it was more profitable than the other cultivars tested. Under intensive management conditions, higher nutrient-use efficiency genotyped may show better economic performance (Jan *et al.* 2015). The results show that the adoption of TNAU 86 coupled with 125% RDF might be a profitable measure for optimum returns in rainfed production systems.

**Table 4:** Economic analysis of *Kodo* millet varieties under different fertility levels

| Treatment                     | Cost of cultivation<br>(₹ ha <sup>-1</sup> ) | Gross returns<br>(₹ ha <sup>-1</sup> ) | Net returns<br>(₹ ha <sup>-1</sup> ) | B:C ratio |
|-------------------------------|----------------------------------------------|----------------------------------------|--------------------------------------|-----------|
| F <sub>0</sub> V <sub>1</sub> | 30,500                                       | 82,575                                 | 52,075                               | 2.71      |
| F <sub>0</sub> V <sub>2</sub> | 30,500                                       | 102,870                                | 72,370                               | 3.37      |
| F <sub>0</sub> V <sub>3</sub> | 30,500                                       | 96,930                                 | 66,430                               | 3.18      |
| F <sub>1</sub> V <sub>1</sub> | 34,200                                       | 111,915                                | 77,715                               | 3.27      |
| F <sub>1</sub> V <sub>2</sub> | 34,200                                       | 130,410                                | 96,210                               | 3.81      |
| F <sub>1</sub> V <sub>3</sub> | 34,200                                       | 119,025                                | 84,825                               | 3.48      |
| F <sub>2</sub> V <sub>1</sub> | 36,400                                       | 124,380                                | 87,980                               | 3.42      |
| F <sub>2</sub> V <sub>2</sub> | 36,400                                       | 143,910                                | 107,510                              | 3.95      |
| FV <sub>3</sub>               | 36,400                                       | 129,555                                | 93,155                               | 3.56      |
| F <sub>3</sub> V <sub>1</sub> | 38,600                                       | 135,675                                | 97,075                               | 3.52      |
| F <sub>3</sub> V <sub>2</sub> | 38,600                                       | 154,170                                | 115,570                              | 3.99      |
| F <sub>3</sub> V <sub>3</sub> | 38,600                                       | 134,460                                | 95,860                               | 3.48      |
| SEm±                          | 2,945                                        | 2710                                   | 2,320                                | 0.08      |
| CD (P=0.05)                   | 8390                                         | 7720                                   | 6,768                                | 0.23      |

\* F<sub>0</sub> - Control; F<sub>1</sub> - 75% RDF; F<sub>2</sub> - 100% RDF; F<sub>3</sub> 125% RDF; V<sub>1</sub> - KMV 588; V<sub>2</sub> - TNAU 86; V<sub>3</sub> - JK 137.

Stability analysis showed high differences among the tested genotypes' responses to different

fertility environments. Table 5 shows the mean yield, regression coefficient (bi) and deviation from regression (S<sup>2</sup>di) of the tested genotypes. The mean grain yield by TNAU 86, which is 2952 kg per ha, is the highest, regression coefficient (bi) is near 1 (1.08) and deviation from regression (S<sup>2</sup>di) is the least (0.024) which shows good stability and adaptability. KMV 588 had a low regression coefficient (0.92) and moderate mean yield (2525 kg per ha) indicating that it was adapted to low input. The performance of JK 137 was intermediate and moderate responsiveness and stability.

**Table 5:** Stability and adaptability parameters of pre-released *Kodo* millet varieties across fertility levels

| Variety                   | Mean grain yield (kg/ha) | Regression coefficient (bi) | Deviation from regression (S <sup>2</sup> di) | Stability rank | Adaptability                                        |
|---------------------------|--------------------------|-----------------------------|-----------------------------------------------|----------------|-----------------------------------------------------|
| KMV 588 (V <sub>1</sub> ) | 2525                     | 0.92                        | 0.038                                         | II             | Suitable for low to medium fertility environments   |
| TNAU 86 (V <sub>2</sub> ) | 2952                     | 1.08                        | 0.024                                         | I              | Widely adapted and responsive to improved fertility |
| JK 137 (V <sub>3</sub> )  | 2667                     | 1.01                        | 0.047                                         | III            | Stable under medium fertility conditions            |

Stability analysis is a valuable tool for the determination of the genotypes which has the ability to perform uniformly under different environmental conditions. The Eberhart and Russell (1966) stability model indicates that a stable genotype would have high mean yield, regression coefficient between unity and one, and minimum deviation from regression. TNAU 86 met these criteria, and was widely adaptable and predictable at all levels of fertility. The higher responsiveness of TNAU 86 indicates that it is able to utilize the increased nutrient availability with good efficiency without being unduly sensitive to the environment. The notion of stability and adaptability has been discussed by Becker and Léon (1988), who stressed the need for high productivity coupled with responsiveness to the environment in millet crops. The lower regression coefficient of KMV 588 suggests adaptation to relatively unfavourable



or low input environments where yield stability is often more significant than maximum yield. Hariprasanna (2017) also reported genotypic variation in the stability of *Kodo* millet grain and fodder yield. Hence, it can be inferred that TNAU 86 can be used as a widely adapted genotype for production under a variety of fertility levels while KMV 588 can be grown in resource limited production systems.

## CONCLUSION

The present study revealed that, the growth, yield attributes, productivity, profitability and stability of pre-released *Kodo* millet genotypes were significantly affected under agro-climatic condition of Eastern Dry Zone of Karnataka. Fertilizer levels were progressively increased from the control to 125% RDF and significant increases in plant height, productive tillers, panicle length, test weight, grain yield, straw yield and economic returns were observed. TNAU 86 was consistently the best in terms of growth, yield potential and profitability in all the fertility environments tested. The maximum grain production, net returns and benefit-cost ratio were recorded for the 125% RDF treatment, suggesting that sufficient nutrient supply is necessary to maximise the production potential of *Kodo* millet when grown in rainfed conditions.

Stability analysis also suggested high mean productivity, regression coefficient near unity and minimum deviation from regression with TNAU 86 which suggested that the crop has wide adaptability and stable performance under different fertility levels. However, KMV 588 adapted relatively well to lower fertility conditions whereas JK 137 was moderately responsive. The results indicate that adopting the TNAU 86 and 125% RDF is a suitable option to boost productivity, profitability and nutrient-use efficiency in *Kodo* millet production. Overall, the study is important to highlight the necessity of genotype specific nutrient management that can take the highest possible output from climate resilient millets and will provide useful inputs for sustainable production strategies to enhance food and nutritional security in rainfed agro-ecosystems.

## ACKNOWLEDGEMENTS

The authors sincerely acknowledge the ICAR-Indian

Institute of Millets Research (IIMR), Hyderabad, for providing financial and technical support for conducting this research.

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