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EVALUATION OF FOXTAIL MILLET (*Setaria italica* L.) GENOTYPES FOR GRAIN YIELD AND ADAPTATION UNDER IRRIGATED AND RAINFED CONDITION

Rosalind Rajkhowa¹, Rinjumoni Dutta², Soibam H. Devi¹, Sumita Acharjee³ and Sangita Das^{1*}

¹Department of Plant Physiology, Assam Agricultural University, Jorhat, 785013, Assam, India

²Department of Agronomy, Assam Agricultural University, Jorhat, 785013, Assam, India

³Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat, 785013, Assam, India

*Corresponding author E-Mail: sangita.das@aaau.ac.in

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ABSTRACT

A field study was conducted to study the performance of foxtail millets under two situations viz. irrigated and rainfed conditions to identify the performance of yield in ten foxtail genotypes. The study was conducted at the ICR farm, Assam Agricultural University, Jorhat, Assam during February to June, 2024. Ten numbers of *Setaria italica* (L.) genotypes were selected viz. SiA-3159, SiA-4213, SiA-4200, SiA-3156, SiA-4210, TNSi-379, GPUF-4, IIMR FxM-7, Local Gossaigaon, and DHFT-109. The genotypes were collected from AAU-Zonal Research Station, Gossaigaon, Assam. Two numbers of conditions were created for the growth and yield of foxtail genotypes. The current experiment was laid out in (Two Factorial Randomized Block Design) that were replicated three times. In this study, plants under irrigated condition recorded maximum yield in terms of length of the panicles, number of effective panicles, weight of the panicle per plants, grain weight per panicle, economic yield and biological yield. Yield performance was found to be better under irrigated condition when compared to the rainfed condition. Maximum yield was recorded in DHFT-109 followed by TNSi-379 and Local Gossaigaon under both irrigated and rainfed situations, due to their genetic variability and better adaptivity under Assam condition.

Key words: *Setaria italica* (L.), rainfed, irrigated, length of panicle, effective panicle, grain weight/ panicle, economic yield, biological yield

Introduction

The word “millet” comes from the French word “mille”, which means thousand. This suggests that a tiny quantity of millets contains thousands of grains. That means thousand, which infers that a small number of millets contains thousands of grains. Millets are cultivated in semi-arid regions where less rainfall is observed, and are grown mainly in marginal soil and degraded soils that consisted of very low nutrient levels. Especially, the yield of millets is more steady than other crops in low-rainfall areas. Being a C4 plants they possess very high photosynthetic efficiencies with short life spans, and more amount of dry matter production. Millets have strong tolerance to heat and drought and are considered as

climate resilient crops. It is also referred to as ‘Miracle Grains’ as it can have adaptivity to different ecological condition. Millets thrive under regions, with high temperature and requires only 350–400 mm of annual rainfall. (Chivenge *et al.*, 2015). The seeds of this C4 cereal mature in a short span and completes its life cycle within 7-8 weeks due to their effective photosynthetic system. Often these grains are called as “poor man’s food,” especially by people who reside in hot, dry regions (Amadou *et al.*, 2014).

Millets are high in nutrient and have been grown especially in Africa and Asia. In India, millets are extensively grown viz. pearl millet, foxtail millets, finger millet, barnyard millet, kodo millet, proso millet and little

millet (Chauhan *et al.*, 2023). The nutrigenomic role has contributed to human health due to hypoglycaemic, antioxidant and anti-inflammatory properties. Polyunsaturated Fatty Acids (PUFA) is found in millet oil that are useful in heart diseases and a gluten-free diet (Saleem *et al.*, 2023). Protein composition of millets is mainly 7 to 12%, fat is 1–5 % content, high fibre content, good protein quality and improved mineral composition (Singh *et al.*, 2020).

Yield of any crop is measured as production of each unit of land. Crop yield determines the quantity of agricultural production and are measured in units. It is often expressed in quintals, or tonnes per acre. Yield management is a method used acquire optimum revenue with maximization of available resources, while minimizing the cost of inputs

Miller *et al.*, (2016) have reported the millets as low-investment rain-fed summer crop, possessing short-growing season to lower the risk in agriculture. Assam soil is fertile and cultivable area is 78,43,800 hectare which are suitable for cultivation of different crops (Economic survey, 2021). In Assam small millets produces 3230 tons with an average yield of 0.59 tonnes/hectare in 5210 hectares of land that are under minor millets cultivation in 2019-20 (Agricultural statistics at a glance, 2021). According to Tiwari *et al.*, (2022) drought imposes a significant impact on the vegetative and reproductive phases of plants. Under Assam condition, foxtail millets are sown during Jan-Mar, and the best time of sowing is last week of Jan (POP –Rabi, AAU, Jorhat). The early vegetative stage of foxtail millets receives very scanty rainfall with a water deficit condition. Crop yield prediction aims at improving the accuracy and reliability of its yield forecasting.

Therefore, the current study has been planned with the following objective:

To study the variation in yield performances of some foxtail millet genotypes under rainfed and irrigated situation during Rabi season.

Materials and Methods

The current studies investigated the yield performance of *Setaria italica* (L.) P. Beauv. genotypes under both the irrigated and rainfed situation. The experiment was carried out at the Instructional Cum Research (ICR) Farm, Assam Agricultural University, Jorhat during February to June, 2024.

Site of the Experiment

The experiment was conducted at 26°47' N latitude,

and 94°19' E longitude with an elevation of 86.6 m above mean sea level. The experimental field was located at the Upper Brahmaputra Valley (UBVZ) in Assam. This region has a subtropical climate, with summer that are hot and humid and comparatively dry, cold winter. The average rainfall in Jorhat ranges between 1875 mm to 2146 mm. Intensity of rainfall reach maximum during the monsoon season. During the winter, the lowest temperature drops to 9°C, while in the summer, it rises to 36° to 38°C Meteorological data are presented below

The weekly meteorological data during experimentation including minimum and maximum temperature, average rainfall data, relative humidity that were obtained from the Department of Agricultural Meteorology, Assam Agricultural University, Jorhat-13 (Fig. 1.).

Parameters recorded: Yield and yield attributing parameters:

1. **Length of panicle (cm):** Length of the panicle was calculated by using a meter scale from the base of the plant to the tip, at the time of harvesting. It was expressed in (cm) for each variety
2. **Number of effective tillers:** The number of effective tillers were counted randomly for each variety
3. **Weight of panicle (g):** Weight of the panicles were recorded at the time of harvesting by using an electronic weighing machine and it was expressed in g per plant for each variety.
4. **Grain weight per plant (g):** Weight of the grain per panicle were recorded by using an electronic weighing machine and were expressed in g for each variety
5. **Economic yield (kg/ha):** The economic yield of the crop was the total grain yield of the crop and it was expressed in kg ha⁻¹.
6. **Biological yield (kg/ha):** The biological yield of the crop was determined by adding total grain yield with total straw yield and it was expressed in kg ha⁻¹

Statistical analysis

Statistical analysis of the data was done by following the procedure of analysis of variance (ANOVA) for two factorial randomized block design. The critical difference (CD) values were calculated at 5% probability level. The standard error of the means (S.Ed.) was determined by using the following formula.

$$S. Ed. (\pm) = \sqrt{\frac{2 \times \text{error mean square}}{\text{Pooled number of replication}}}$$

Results and Discussion

Yield and yield attributing traits

Length of the panicle and number of effective tillers:

A significant difference was recorded by the *Seteria italica* (L.) P. Beauv. genotypes under irrigated and rainfed situations. Plants grown under irrigated situation recorded the maximum length of panicle, whereas plants grown under rainfed situation recorded the minimum. The genotypes TNSi-379 recorded the maximum length of the panicle followed by DHFT 109 and SiA-4200 recorded the minimum. The study in length of panicle and number of effective tillers has been recorded in foxtail millet genotypes as reported by Vardhan *et al.*, (2024).

A significant interaction effect was recorded between the genotypes and the situations. TNSi-379 recorded the maximum length of the panicle under irrigated situation, followed by DHFT-109 and SiA-3156, which were at par, whereas SiA-4200 recorded the minimum under rainfed situation which was at par with SiA-3159 and SiA-4213.

Peng *et al.*, (2008) reported that enhancing light energy use efficiency, enhanced transport of electrons, and greater carbon assimilation capacity, collectively facilitated dry matter accumulation. This enhancement strengthened the source capacity of foxtail millet plants and promoted the efficiency of the “source–sink–translocation” system. The abundant availability of photosynthates supplies the necessary driving force for phloem loading and assimilate translocation, which improved post-flowering dry matter transport Chang *et al.*, (2023). In addition, the sufficient supply of photosynthetic products likely stimulated panicle sink growth through signalling mechanisms and direct nutrient provision, resulting in significant increases in panicle length,

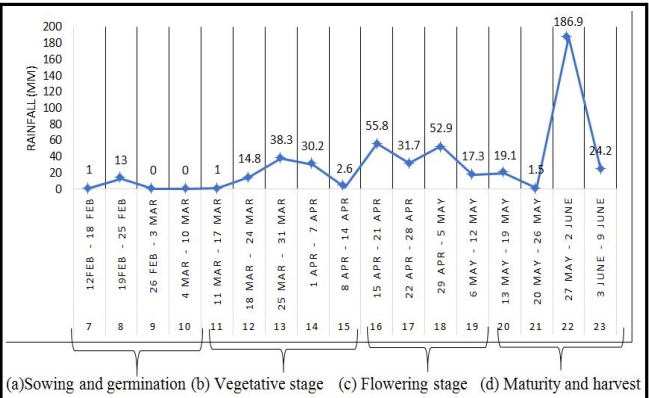


Fig. 2: Weekly rainfall pattern of the crop growing season.

Table 1: Length of panicle and number of effective tillers under rainfed and irrigated condition.

Genotypes	LP			NET		
	IG	RF	Mean	I	R	Mean
SiA-3159	17.97	13.00	15.48	2.67	2.33	2.50
SiA-4213	18.37	13.67	16.02	1.67	1.67	1.67
SiA-4200	16.60	12.37	14.48	2.33	2.00	2.17
SiA-3156	20.97	17.33	19.15	2.00	1.67	1.83
SiA-4210	20.17	16.87	18.52	1.67	1.33	1.50
TNSi-379	23.07	22.07	22.57	3.33	2.00	2.67
GPUF-4	19.87	16.40	18.13	2.00	2.00	2.00
IIMR FxM-7	18.57	14.57	16.57	2.00	1.33	1.67
Local Gossaigaon	19.20	15.63	17.42	3.33	2.33	2.83
DHFT 109	21.20	20.40	20.80	3.67	2.67	3.17
Mean	19.60	16.23		2.47	1.93	
	C.D (0.05)	S.Ed (±)		C.D(±) (0.05)	S.Ed (±)	
V	0.70	0.34		0.35	0.17	
C	1.55	0.76		0.79	0.39	
V × C	2.19	1.08		NS	0.55	
IG: Irrigated; RF: Rainfed						
LP: Length of panicle (cm); NET: Number of effective tillers						

panicle weight, and grain weight per panicle Okamura *et al.*, (2018).

Similarly, there was a significant difference in the number of effective tillers under both irrigated and rainfed situations. Under irrigated situation, a higher number of effective tillers were found as compared to rainfed situation. DHFT 109 recorded the maximum number of effective tillers whereas SiA- 4210 recorded the minimum. A non-significant interaction effect was recorded between the genotypes and the situations. The development of shoot from buds at the base of main stem aids in tiller production (Thomason *et al.*, 2009). (Patil *et al.*, 2018) identified as a selection index to obtain parental lines during pearl millet breeding program.

Weight of the panicle and grain weight per plant:

A significant difference in weight of panicles was recorded by the genotypes under the two situations, viz. irrigated and rainfed situations. Plants grown under irrigated situation recorded the maximum weight of panicle and plants grown under rainfed situation recorded minimum. DHFT 109 recorded maximum weight of panicle followed by TNSi-379 and SiA-4210 recorded the minimum weight of panicle (Table 2).

A significant interaction effect was recorded between the genotypes and the situations. DHFT-109 and TNSi-379 showed the maximum weight of panicle under irrigated situation, which were at par with Local Gossaigaon and SiA-4210 recorded the minimum.

Table 2: Weight of the panicle and grain weight/panicle of *Setaria italica* (L.) P. Beauv. genotypes under irrigated and rainfed situations.

Genotypes	WP			GWP		
	IG	RF	Mean	I	R	Mean
SiA-3159	3.12	2.87	3.00	3.12	2.59	2.85
SiA-4213	2.17	1.49	1.83	1.79	1.52	1.66
SiA-4200	2.98	2.79	2.89	2.81	2.54	2.67
SiA-3156	2.85	1.95	2.40	2.29	1.89	2.09
SiA-4210	1.97	1.47	1.72	1.67	1.38	1.53
TNSi-379	3.34	3.05	3.20	3.40	2.90	3.15
GPUF-4	2.53	1.73	2.13	2.06	1.66	1.86
IIMR FxM-7	2.87	2.20	2.53	2.53	2.09	2.31
Local Gossaigaon	3.20	2.94	3.07	3.33	2.82	3.08
DHFT 109	3.34	3.16	3.25	3.74	3.07	3.40
Mean	2.84	2.37		2.67	2.25	
	C.D (0.05)	S.Ed (±)		C.D(±) (0.05)	S.Ed (±)	
V	0.12	0.06		0.21	0.10	
C	0.27	0.13		0.47	0.23	
V × C	0.38	0.19		NS	0.33	
IG: Irrigated; RF: Rainfed WP: Weight of panicle (g); GWP: Grain weight/plant (g)						

Similarly, there was a significant difference in the grain weight/plant of the genotypes under irrigated and rainfed situation individually. Plants under irrigated situation recorded significantly higher grain weight/plant. The genotype DHFT 109 recorded the maximum grain weight/plant followed by TNSi-379 and SiA-4210

Table 3: Economic yield and biological yield of *Setaria italica* (L.) P. Beauv. genotypes under irrigated and rainfed situations.

Genotypes	EY			BY		
	IG	RF	Mean	I	R	Mean
SiA-3159	1246.67	1034.67	1140.67	2745.33	1908.00	2326.67
SiA-4213	717.33	609.33	663.33	1657.33	1177.33	1417.33
SiA-4200	1122.67	1014.67	1068.67	2705.33	1756.00	2230.67
SiA-3156	914.67	757.33	836.00	1922.67	1314.67	1618.67
SiA-4210	669.33	552.00	610.67	1329.33	1046.67	1188.00
TNSi-379	1358.67	1161.33	1260.00	3185.33	2064.00	2624.67
GPUF-4	822.67	665.33	744.00	1785.33	1257.33	1521.33
IIMR F×M-7	1012.00	836.00	924.00	2548.00	1698.67	2123.33
Local Gossaigaon	1330.67	1129.33	1230.00	3108.00	1969.33	2538.67
DHFT 109-3	1496.00	1226.67	1361.33	3276.00	2186.67	2731.33
Mean	1069.07	898.67		2426.27	1637.87	
	C.D (0.05)	S.Ed(±)		C.D(0.05)	S.Ed(±)	
V	83.79	41.23		76.14	37.47	
C	187.35	92.19		170.26	83.78	
V × C	NS	130.38		240.78	118.48	
IG: Irrigated; RF: Rainfed EY: Economic yield (kg/ha); BY: Biological yield (kg/ha)						

recorded the minimum grain weight/plant.

A non-significant interaction effect was observed between the genotypes and the situations. Yadav *et al.*, (2014) recorded an increase in soil moisture under irrigated condition, which could be due to higher moisture content and resulting in higher yield performance of foxtail millet genotypes. Irrigation enhances the plant's growth and internal water status. Under irrigated situation, higher rate of water movement from soil to the plant resulted in improved stomatal conductance and increase leaf area, by sustaining better transpiration and enhancing the number of ear heads ear length and average grain yield. Vapour Pressure Deficit is often under plant control. This results in partial stomatal closure during the midday for conserving soil water (Sinclair T.R., 2018).

Economic yield and biological yield:

Economic yield of the *Setaria italica* (L.) P. Beauv. genotypes were recorded (Table 3). There was a significant difference in the economic yield of the genotypes under irrigated and rainfed situation individually. Plants under irrigated situation recorded significantly higher economic yield as compared to the plants under rainfed situation.

Amongst the genotypes DHFT 109 recorded the maximum economic yield followed by TNSi-379 and SiA-4210 recorded the minimum economic yield.

A non-significant interaction effect was observed between the genotypes and the situations. DHFT 109 recorded maximum economic yield under irrigated situation and SiA-4210 recorded minimum economic yield under rainfed situation.

Similarly, there is a significant difference in the biological yield of the *Setaria italica* (L.) P. Beauv. genotypes under irrigated and rainfed situations. Plants grown under irrigated situation recorded maximum biological yield and the plants under rainfed situation recorded minimum.

A significant interaction effect was also recorded between the genotypes and the situations. Highest biological yield was recorded by DHFT- 109 under irrigated situation, followed by TNSi-379 and Local Gossaigaon, which were at par. The lowest was recorded by SiA-4210 under rainfed situation, which was at par with SiA-4213 and GPUF-4.

Irrigated situation enhanced moisture availability, which result in longes root system that enabling the plant to extract water and nutrients from the soil. Which ultimately enhances the physiological aspects and increases net

assimilate production from source to sink. Improved crop growth and dry matter production under irrigated situation leads to more flower heads with more seeds. It directly improves the crop's yield and yield characteristics (Singh, 2016).

Conclusion

There were two situations in the experiment viz., irrigated and rainfed. Plants grown under irrigated situation performed better results in terms of yield attributing characters. Amongst the varieties DHFT-109 performed better in all the yield attributing parameters followed by TNSi-379 and Local Gossaigaon. Therefore, these three genotypes can be grown under Assam condition in both irrigated and rainfed situation, though the performance was better under irrigated situation.

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Reference

- Amadou, I., Gounga M.E., Shi Y.H. and Le G.W. (2014). Fermentation and heat-moisture treatment induced changes on the physicochemical properties of foxtail millet (*Setaria italica*) flour. *Food and Bioprocess Technology*, **92**(1), 38-45.
- Anonymous (2022). Agricultural Statistics at a glance 2021, <https://eands.dacnet.nic.in/> retrieved on June 2022.
- Anonymous (2022). Economic Survey 2020-21, <https://www.indiabudget.gov.in/economicsurvey/> retrieved on July 2022.
- Chang, T.G., Wei Z.W., Shi Z., Xiao Y., Zhao H., Chang S.Q., Qu M., Song Q., Chen F., Miao F. and Zhu X.G. (2023). Bridging photosynthesis and crop yield formation with a mechanistic model of whole-plant carbon-nitrogen interaction. *Silico Plants*, **5**(2), 1-19. <https://doi.org/10.1093/insilicoplants/diad011>.
- Chauhan, D., Sethi L., Tyagi M. and Sharma S. (2023). Millets: The sustainable ancient superfood for the modern world. *J. Drug Res. Ayurvedic Sci.*, **8**, S34-41. DOI: 10.4103/jdras.jdras_248_23
- Chivenge, P., Mabhaudhi T., Modi A.T. and Mafongoya P. (2015). The potential role of neglected and underutilised crop species as future crops under water scarce conditions in Sub-Saharan Africa. *International journal of environmental research and public health*, **12**(6), 5685-5711.
- Miller, N.F., Spengler R.N. and Frachetti M. (2016). Millet cultivation across Eurasia: Origins, spread, and the influence of seasonal climate. *The Holocene*, **26**(10), 1566-1575.
- Okamura, M., Arai-Sanoh Y., Yoshida H., Mukouyama T., Adachi S., Yabe S., Nakagawa H., Tsutsumi K., Taniguchi Y., Kobayashi N. and Kondo M. (2018). Characterization of high-yielding rice cultivars with different grain-filling properties to clarify limiting factors for improving grain yield. *Field Crops Res.* **219**, 139-147. <https://doi.org/10.1016/j.fcr.2018.01.035>
- Patil, H.E., Patel B.K., Vavdiya P. and Pali V. (2018). Breeding for quality improvement in small millets: a review. *International Journal of Genetics*, ISSN, 0975-2862.
- Peng, S.B., Khush G.S., Virk P., Tang Q.Y. and Zou Y.B. (2008). Progress in ideotype breeding to increase rice yield potential. *Field Crops Res.* **108**, 32-38. <https://doi.org/10.1016/j.fcr.2008.04.001>
- Saleem, S., Mushtaq N.U., Shah W.H., Rasool A., Hakeem K.R. Seth C.S., Tahir I. and Rehman R.U (2023). Millets as smart future food with essential phytonutrients for promoting health. *Journal of Food Composition and Analysis*, **124**, December 2023, 105669. <https://doi.org/10.1016/j.jfca.2023.105669>
- Ray, J.D. and Sinclair T.R. (1997) Stomatal Closure of Maize Hybrids in Response to Soil Drying. *Crop Science*, **37**, 803-807. <https://doi.org/10.2135/cropsci1997.0011183X003700030018x>
- Singh, B. (2016). Nutrient's uptake and oil content in different cultivars of safflower (*Carthamus tinctorius* L.) as influenced by time of sowing. Thesis M. Sc. (Agri.), Indira Gandhi Krishiuniversity, Raipur, India. 24-60.
- Singh, A., Kumar M. and Shamim M. (2020). Importance of minor millets (*Nutri Cereals*) for nutrition purpose in present scenario. *International Journal of Chemical Studies*, **8**(1), 3109-3113.
- Thomason, W.E., Brooks W.S., Griffey C.A. and Vaughn M.E. (2009). Hulled barley seedling rate effects on grain yield and yield component. *Crop Sci.*, **49**, 342-346 (2009). doi: 10.2135/cropsci2008.03.0174
- Tiwari, A., Kesarwani K., Sharma A., Ghosh T., Bisht N. and Punetha S. (2022). Drought stress in millets and its response mechanism. In *Advances in plant defense mechanisms*. IntechOpen
- Yadav, A.K., Kumar A., Singh J., Jat R.D., Jat H.S., Datta A. and Chaudhary R. (2014). Performance of pearl millet genotypes under irrigated and rainfed conditions at Hisar, India. *Journal of Applied and Natural Science*, **6**(2), 377-382.