Plant Archives Vol. 24, No. 2, 2024 pp. 1643-1648 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.233

EFFECT OF ESTABLISHMENT TECHNIQUES AND NUTRIENT SOURCES ON GROWTH, YIELD AND ECONOMIC RETURN OF FOXTAIL MILLET VARIETIES (*SETARIA ITALICA* L.) IN MID HILLS OF MEGHALAYA, INDIA

Upasana Bordoloi*, Aditya Kumar Singh, Lala I.P. Ray, Vishram Ram, Sanjay Swami and Rahul Saikia

School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam - 793 103, Meghalaya, India.
*Corresponding author E-mail : upasanajrt17@gmail.com
(Date of Receiving-19-06-2024; Date of Acceptance-06-09-2024)

ABSTRACT

A field experiment was conducted at the experimental farm of College of Post Graduate Studies in Agricultural Sciences, Umiam, Meghalaya during *kharif* seasons of 2023 to study the response foxtail millet (*Setaria italica* L.) varieties to crop establishment techniques and nutrient sources. The study comprised of two method of establishment (direct sowing and transplanting), two foxtail millet varieties (SiA 3156 and Rajendra Kauni 1) and four nutrient sources (Control, inorganic (RDF @ 40:20:20), organic (FYM @5 t ha^{-1}) and natural farming nutrient solutions (*Beejamrutha* + *Jeevamrutha*) laid out in factorial randomized block design with three replications. Experimental results revealed no significant differences on the performance of the two varieties in terms of crop growth, yield, nutrient content, and economic outcomes. However, transplanted method of establishment significantly improved growth parameters, yield attributes and nutrient uptake of foxtail millet as compared direct sowing. Transplanted foxtail millet significantly increased grain yield, straw yield, and net return by 29.67%, 27.50% and 70.69% over direct sowing method. Though the application of inorganic nutrient sources (RDF) recorded the maximum growth yield attributes and yield, it was closely followed by organic nutrient sources with at par differences for most of the parameters. The organic nutrient sources, which outperformed both the natural source and the control treatments. Net return and B: C ratio recorded in both inorganic (` 21323 ha$^{-1}$, 1.88) and organic source (` 18216 ha^{-1}, 1.85) was statistically at par. Both varieties demonstrated equal suitability for the Northeastern Hill (NEH) region. The transplanting method of establishment, combined with the use of organic nutrient sources, is recommended for enhancing economic benefits and promoting sustainable production.

Key words : Foxtail millet, Fertilizer, FYM, *Beejamrutha*, *Jeevamrutha*, Transplanting, Direct sowing.

Introduction

Millets are small, nutritious, environmentally friendly and warm weather cereals belong to family 'Poaceae' consumed for generations in India. Because of their high nutritional value, millets are categorized as nutri-cereals. They can be grown in diverse adverse climates and arid regions with minimal external inputs. Foxtail millet is one of the earliest millets grown for food and fodder. This millet is a good source of minerals including calcium, zinc, magnesium, phosphorus and potassium as well as proteins, fiber, and essential fats (Prajapati *et al.*, 2023). The millets are high in dietary fiber; contain 7–12% protein, 2-5% fat and 6–75% carbohydrates with a better amino acid composition than other cereal like corn (Ghose *et al.*, 2023). It has 60.9 g of carbohydrates, 12.3 g of protein, 8.0 g of fiber, 3.3 g of minerals, 2.8 mg of iron, 31 mg of calcium and 331 kcal of energy per 100 g (Banerjee and Maitra, 2020; Singh *et al.*, 2023).

However, foxtail millet productivity is low in India due to use of low yielding local cultivars and faulty management methods, the yield potential of foxtail millet in India is lower than the potentially achievable yield

(Ramesh *et al.*, 2019). Varieties differ in their yield potential and nutritional quality. So, use of an improved high yielding variety with superior nutritional quality is one of the important factors to increase productivity per unit area. Further, increasing population pressure, demand for food, fuel, fibre etc. increases day by day. To meet the future demand better resource management is necessary. One of the ways to increase production is increase productivity by adoption of ecofriendly nutrient management practices. Moreover, in most of the crops including some millet, it was experimentally proved that yield is more in transplanted crop than direct sowing due to better weed management and maintenance of desired plant population at harvest. However, performance of foxtail millet under transplanted condition is not yet evaluated experimentally. Although the green revolution helped in achieving self-sufficiency in food grain production, but the intensive use of cropping practices and inorganic inputs has negatively affected natural resources. Therefore, to sustain the fertility and productivity of the soils, there is urgent need to encourage farmers to adopt organic and natural eco-friendly farming practices with larger dependence on natural, renewal sources of crop nutrition *viz.*, FYM, traditional crop nutrient solutions like *beejamrutha* and *Jeevamrutha*, giving an alternate way to reduce the doses of harmful chemicals like fertilizers and poisonous pesticides for saving the soil and environment and to get food and feed free from toxic residues. As raw material requirement for preparation of organic manure is very high, there is large scope for promotion of natural farming in NEH region through introduction and application of cow based natural nutrient solutions along with the mulching because of very less requirements for dung and urine, for preparing organic nutrient sources like FYM, vermicompost and others.

By considering all these points, a field study was conducted with an objective to assess the response of different foxtail millet varieties under different nutrient sources in direct sowing and transplanting condition.

Materials and Methods

The field experiment was conducted at experimental farm (25°41' N latitude, 91°54' E longitude and altitude of 950m above the mean sea level) of College of Post Graduate Studies in Agricultural Sciences, Umiam, Meghalaya during *kharif* season of 2023. The weekly average of maximum and minimum temperature during the cropping period was ranged from 26.1°C to 30.5°C and 14.5°C to 21.7°C. The soil of the experimental site was sandy clay loam texture with pH 5.62, high in organic carbon (1.62%), low in available nitrogen (150.42 kg ha^{-1}), low in available phosphorus (13.22 kg ha^{-1}) and high in available potassium (309.6 kg ha^{-1}) recorded at the beginning of experiment.

The treatments comprised of two varieties *viz.*, SiA 3156 (V1) and Rajendra Kauni 1 (V2), two method of establishment *viz.*, direct sowing (E1) and transplanting (E2) and four nutrient sources *viz.*, Control (N0), RDF @ 40:20:20 (N1), FYM @5 tha^{-1} (N2) and Beejamrutha + jeevamrutha @ 500 L ha^{-1} at 20 days interval (N3) laid out in factorial randomized block design with three replications. Seeds in the direct sown plots were sown on 18th July 2023 and nursery sowing for transplanting was also done on the same date. In nursery only FYM was applied @ 5 t ha^{-1}. In direct sown plot after two weeks of sowing thinning was done to maintain plant population at spacing of 25cm × 10cm. As per the treatment in inorganic plots recommended dose of fertilizers @ 40-20-20 kg N, P_2O_5 and K_2O ha^{-1} were supplied through urea, single super phosphate and muriate of potash. The entire quantity of phosphorus and potassium and half of the nitrogen were applied as basal at the time of sowing and transplanting. The remaining quantity of nitrogen was applied at 30 days after sowing and transplanting. In organic plots FYM was applied one week before sowing and transplanting of the crop. In natural nutrient treated plot *beejamrutha* treated seeds were sown and *jeevamrutha* were applied to soil by uniformly covering the total area of the plots at every twenty days interval until fifteen days before harvest. In transplanted plot transplanting of seedlings was done on 9th August 2023 by maintaining two seedlings/hill at spacing of 25cm × 10cm.

The growth attributes *viz.*, plant height, number of tillers per plant, dry matter accumulation was recorded from 30 days after sowing at an interval of 15 days till harvesting in the respective plots. All the observations on growth, yield attributes and yield were recorded by following standard procedure. For dry matter accumulation, fresh plant samples were kept in hot air oven at 70°C until a constant weight was achieved. Economics (gross return, net return and B:C ratio) were calculated as per common cost of cultivation for foxtail millet and prevailing selling price of foxtail grain (` 35/kg) and organic and natural nutrient sources were considered to be recycled in the farm itself.

The data obtained from various observations recorded from the field and analytical studies from the laboratories were statistically analyzed by using the technique of analysis of variance for factorial randomized block design.

The difference between the treatment means was tested for their statistical significance with an appropriate critical difference (C.D) value at 5% level of significance as suggested by Gomez and Gomez (1984).

Results and Discussion

Growth parameters

Both the varieties remained statistically at par in case of plant height, number of tillers per plant and dry matter accumulation at all the stages of observation. However, at harvest relatively higher plant height recorded by variety SiA 3156 (87.74 cm) over Rajendra Kauni 1 (87.09 cm). Rajendra Kauni 1 variety recorded relatively higher number of tillers and dry matter accumulation per plant at all the stages under observation.

Transplanted foxtail millet recorded significantly higher number of tillers (2.77, 3.96, 4.07, 3.98) and dry matter accumulation per plant (2.80, 5.42, 9.35, 11.05 g) over direct sowing at 45, 60, 75 DAS and harvest stage, respectively. At 30 DAS, significantly highest plant height (28.90 cm) and dry matter accumulation (0.57 g/plant) was recorded in direct sown millet over transplanted millet because seedlings in transplanted plots were just recovered from transplanting shock at that time. More tillering in transplanting might be due to better root proliferation which has positive impact on tillering (Girisha *et al.*, 2021). After proper establishment more roots might develop and higher number of tillers were produced which resulted in more accumulation of dry matter in transplanted crop over direct sown crop (Hebbal *et al.*, 2018).

Inorganic source recorded significantly highest plant height, number of tillers and dry matter accumulation at 30, 45, 60, 75 DAS and at harvest, respectively closely followed by organic source over natural source and control. This might be due to quick release of nutrient from inorganic sources, particularly nitrogen, which promoted quick growth by enhancing cell division, elongation and meristematic activity (Jyothi *et al.*, 2016). Continuous nitrogen supply enabled longer leaf area duration, improving photosynthates accumulation and translocation, which resulted in more dry matter accumulation in the plant (Shagun *et al.*, 2022; Mahapatra *et*

Table 1 : Effect of varieties, establishment techniques and nutrient sources on plant height, number of tillers and dry matter accumulation of foxtail millet.

Treatments	Plant height (cm)					Number of tillers/ plant					Dry matter accumulation (g/ plant)				
	30 DAS	45 DAS	60 DAS	75 DAS	Harvest	30 DAS	45 DAS	60 DAS	75 DAS	Harvest	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Varieties															
V1: SiA 3156	26.22	44.21	67.05	78.24	87.74	1.33	2.59	3.49	3.59	3.52	0.51	2.51	5.07	8.68	10.14
V2: Rajendra Kauni 1	25.78	44.41	66.56	77.54	87.09	1.34	2.61	3.58	3.68	3.60	0.52	2.67	5.21	9.06	10.61
S.E(m) (±)	0.64	1.26	1.83	2.27	2.67	0.03	0.06	0.09	0.08	0.09	0.01	0.06	0.13	0.22	0.25
C.D (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Method of establishment															
E1: Direct sowing	28.90	43.32	65.64	76.52	85.10	1.38	2.43	3.11	3.20	3.13	0.57	2.39	4.86	8.40	9.71
E2: Transplanting	23.10	45.31	67.97	79.26	89.73	1.30	2.77	3.96	4.07	3.98	0.45	2.80	5.42	9.35	11.05
S.E(m) (±)	0.64	1.26	1.83	2.27	2.67	0.03	0.06	0.09	0.08	0.09	0.01	0.06	0.13	0.22	0.25
C.D (p=0.05)	1.851	NS	NS	NS	NS	NS	0.17	0.25	0.25	0.25	0.04	0.18	0.37	0.62	0.72
Nutrient sources															
N0: Control	20.02	31.11	49.70	61.50	69.55	1.05	2.17	3.03	3.17	3.08	0.45	1.67	3.82	7.12	8.09
N1: RDF	34.62	63.06	88.97	95.79	106.05	1.63	3.05	4.22	4.31	4.25	0.58	3.48	6.60	10.70	12.61
N2: FYM	26.19	45.15	69.96	82.90	90.18	1.42	2.73	3.62	3.72	3.65	0.52	2.81	5.53	9.37	11.07
N3: Natural	23.18	37.93	58.58	70.98	83.88	1.25	2.45	3.27	3.35	3.24	0.50	2.41	4.62	8.31	9.74
S.E(m) (±)	0.91	1.78	2.59	3.21	3.78	0.05	0.08	0.12	0.12	0.12	0.02	0.09	0.18	0.31	0.35
C.D (p=0.05)	2.62	5.13	7.49	9.26	10.91	0.14	0.24	0.36	0.35	0.36	0.05	0.25	0.52	0.88	1.01

Table 2 : Effect of varieties, establishment techniques and nutrient sources on yield attributes and yield of foxtail millet.

Treatments	Number of panicles/ plant	Panicle length (cm)	Number of grains/ panicle	Test weight (g)	Grain weight (g/plant)	Biological yield (t ha^{-1})	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Varieties									
V1: SiA 3156	2.55	13.91	721.42	2.30	3.38	4.11	1.02	3.09	24.74
V2: Rajendra Kauni 1	2.70	14.86	749.81	2.31	3.62	4.34	1.07	3.27	24.68
S.E(m) (±)	0.06	0.39	16.59	0.05	0.09	0.10	0.02	0.08	0.39
C.D (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Method of establishment									
E1: Direct sowing	2.44	12.98	691.92	2.29	3.28	3.71	0.91	2.80	24.60
E2: Transplanting	2.81	15.79	779.30	2.32	3.71	4.74	1.18	3.57	24.83
S.E(m) (±)	0.06	0.39	16.59	0.05	0.09	0.10	0.02	0.08	0.39
C.D (p=0.05)	0.19	1.14	47.92	NS	0.26	0.28	0.07	0.23	NS
Nutrient sources									
N0: Control	2.34	11.72	549.69	2.21	2.67	3.21	0.78	2.44	24.36
N1: RDF	3.13	16.39	997.86	2.43	4.22	5.18	1.30	3.89	25.02
N2: FYM	2.66	14.86	746.28	2.32	3.76	4.52	1.12	3.39	24.86
N3: Natural	2.37	14.56	648.61	2.27	3.34	3.98	0.97	3.01	24.61
S.E(m) (±)	0.09	0.56	23.46	0.07	0.13	0.14	0.03	0.11	0.55
C.D (p=0.05)	0.26	1.61	67.76	NS	0.36	0.39	0.10	0.32	NS

al., 2017).

Yield attributes and yields

Both the varieties remained statistically at par for yield attributes (number of panicles per plant, panicle length, number of grains per panicle, test weight and grain weight per plant) and yield (biological, grain and straw yield). However, Rajendra Kauni 1 recorded slightly higher yield attributes and yield over SiA 3156.

Transplanted foxtail millet recorded significantly highest values of all the yield attributes and yield over direct sown crop except test weight and harvest index. The improvement in yield attributes and yield of transplanted crop might be due to better establishment of crop and better accumulation of photosynthates during vegetative stage and their proper translocation occurred from source to sink during reproductive stage (Jan *et al.*, 2015 and Ahiwale *et al.*, 2013).

Among different nutrient sources inorganic source recorded significantly highest values of yield attributes (panicles per plant-3.13, grains per panicle-997.86 and grain weight per plant-4.22g) and yield (grain yield- 1.30 t ha^{-1} and straw- 3.89 t ha^{-1}) closely followed by organic source over natural source and control. However, panicle length in both inorganic source and organic source were statistically at par. Test weight did not differ significantly due to different nutrient sources. Higher yield attributes and yield in inorganic source might be due to optimal use of growth resources which led to production of a greater number of productive tillers and more accumulation of photosynthates during vegetative stage and better partitioning of photosynthates from source to the sink might occur during the panicle initiation and grain filling stages (Govindappa *et al.*, 2009).

Economic returns

Both the varieties remained statistically at par for gross return, net return and B: C ratio. Transplanted foxtail millet recorded significantly highest gross return (` 41145 ha$^{-1}$), net return (` 18493 ha^{-1}) and B: C ratio (1.81) over direct sown foxtail millet. This might be due to higher grain yield and straw yield because of improvement in growth and yield parameters. Higher B: C ratio in transplanting over direct sowing might be due to higher gross return regardless of higher cost of cultivation. Similar findings are also reported by Hebbal *et al.* (2018).

Under different nutrient sources significantly highest net return and B: C ratio recorded from inorganic source which was at par with organic source. This might be due to higher growth and yield attributing characters in inorganic which resulted in higher yield and higher gross return. Higher net return and B: C ratio in organic is due to less cost of cultivation in organic, if farmer's recycled materials in the farm itself. Similar findings also reported by Veerendra *et al.* (2021) and Ramesh *et al.* (2020).

Table 3 : Effect of varieties, establishment techniques and nutrient sources on economics of foxtail millet.

Treatments	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	Economic efficiency
Varieties				
V1: SiA 3156	21871	35560	13688	1.61
V2: Rajendra Kauni 1	21871	37510	15639	1.70
S.E(m) (±)	-	811	811	0.04
C.D (p=0.05)	-	NS	NS	NS
Method of establishment				
E1: Direct sowing	21091	31925	10834	1.50
E2: Transplanting	22652	41145	18493	1.81
S.E(m) (±)	-	811	811	0.04
C.D (p=0.05)	-	2344	2344	0.11
Nutrient sources				
N0: Control	21119	27274	6155	1.29
N1: RDF	24128	45451	21323	1.88
N2: FYM	21119	39335	18216	1.85
N3: Natural	21119	34080	12961	1.61
S.E(m) (±)	-	1147	1148	0.05
C.D (p=0.05)	-	3314	3314	0.15

Conclusion

From the experiment, it was found that both the varieties were statistically at par in growth, yield attributes, yield and economics. So, both the foxtail millet varieties (Rajendra Kauni 1 and SiA 3156) have equal potential to grow through transplanted method for promotion of foxtail millet cultivation in NEH region as both the varieties recorded significantly high growth and yield attributes, yield, net return and B: C ratio over the direct sown condition. Among the nutrient sources evaluated, inorganic fertilizers resulted in the highest growth, yield, and economic returns. Since organic nutrient source (FYM) demonstrated significant growth and yield attributes, ranking just below inorganic fertilizers but significantly more over the natural nutrient sources and control. Additionally, both the net return and B:C ratio were statistically at par between organic and inorganic sources. So, this research revealed that use of organic manure (FYM) as nutrient source in foxtail millet will be most effective and economically viable practice which not only improve yield and economic returns of foxtail millet but also ensures its sustainable productivity.

Acknowledgements

The authors extends their sincere gratitude to the authorities of CPGS-AS, CAU-I, Umiam for providing all types of support for field and laboratory study and other facilities for successfully conducting this experiment.

Conflict of interests

Authors have declared that no conflict of interests exist related to the research.

References

Ahiwale, P.H., Chavan L.S., Jagtap D.N., Mahadkar U.V. and Gawade M.B. (2013). Effect of establishment methods and nutrient management on yield attributes and yield of finger millet (*Eleusine coracana* G.). *Crop Res.*, **45(1-3)**, 6-12.

Banerjee, P. and Maitra S. (2020). The role of small millets as functional food to combat malnutrition in developing countries. *IJONS*, **10(60)**, 20412-20417.

Ghose, R., Mishra S. and Jati H. (2023). Millet: The Food for Millennium. *Indian J. Nutr. Diet.*, **60(3)**, 460-469.

Girisha, K., Singh S., Swathi P. and Moharana S.K. (2021). Response of establishment methods on growth, yield and economics of finger millet (*Eleusine coracana* L.) Varieties. *J. Pharm. Innov.*, **10(10)**, 1117-1121.

Govindappa, M., Vishwanath A.P., Harsha K.N., Thimmegowda P. and Jnanesh A.C. (2009). Response of finger millet (*Eluesine coracana*.L.) to organic and inorganic sources of nutrients under rainfed condition. *J. Crop Weed.*, **5(1)**, 291-293.

Hebbal, N., Ramachandrappa B.K. and Thimmegouda M.N. (2018). Yield and economics of finger millet with establishment methods under different planting geometry and nutrient source. *Indian J. Dryland Agric. Res. Dev.*, **33(1)**, 54-58.

Jan, A., Khan I. and Sohail A. (2015). Sowing dates and sowing methods influenced on growth yiled and yield components of pearl millet under rainfied conditions. *J.*

Environ. Earth Sci., **5(1)**, 105-109.

Jyothi, K.N., Sumathi V. and Sunitha N. (2016). Productivity, nutrient balance and profitability of foxtail millet (*Setaria italica* L.) varieties as influenced by levels of nitrogen. *IOSR-JAVS*, **9(4)**, 18-22.

Mahapatra, S.S., Sunitha N., Ramu Y.R. and Prasanthi A. (2017). Efficacy of different organic nutrient management practices on growth and yield of fingermillet. *Andhra Pradesh J Agril. Sci.*, **3(3)**, 165-170.

Prajapati, B.K., Kumar M., Rawat D.K., Prajapati S.K. and Kumar Y. (2023). Minor millet: distribution, health benefit and strategies for enhancing the productivity of millets. *Curr. Agri.Tren.:e-Newsletter,* **2(9)**, 1-5.

Ramesh, G., Rao C.P., Prasad P.V.N. and Prasad P.R.K. (2019). Effect of integrated nutrient management on growth, yield and economics of foxtail millet. *J. Pharmacogn. Phytochem.*, **8(4)**, 3115-3117.

Ramesh, G., Rao C.P., Prasad P.V.N. and Prasad P.R.K. (2020). Influence of Integrated Nutrient Management on Growth, Yield and Economics of Foxtail Millet. *The Andhra Agric. J.*, **67(1)**, 7-9.

Shagun, Rawat P.K., Kumar S. and Jhala V.S. (2022). Yield performance of finger millet (*Eleusine coracana* L.) as influenced by integrated nutrient management in rainfed condition of Uttarakhand. *IJONS,* **13(73)**, 45481-45485.

Singh, S., Yadav R.N., Tripathi A.K., Kumar M., Kumar M., Yadav S., Kumar D., Kumar S. and Yadav R. (2023). Current status and promotional strategies of millets: a review. *Int. J. Environ. Clim. Change*, **13(9)**, 3088-3095.

Veerendra, M., Padmaja B., Reddy M.M. and Triveni S. (2021). Yield, nutrient uptake, quality and economics of Foxtail millet cultivation as influenced by integrated nutrient management with bacterial consortia and liquid manures. *Int. J. Curr. Microbiol. App. Sci.*, **10(03)**, 1703-1711.