Effect of Nitrogen on the Performance of Finger Millet in Eastern Ghat High Land Zone of Odisha

ABSTRACT

An experiment was conducted to find out performance of finger millet varieties to different levels of nitrogen under rainfed condition in *kharif* season of 2019 to 2021 at Regional Research and Technology Transfer Station (OUAT), Semiliguda-763002, Koraput, Odisha, India. Four varieties of finger millet (Kalua, OEB 602, Bhairabi and Arjun) and three different nitrogen levels (40, 60 and 80 kg/ha)along with 30 kg/ha each of phosphorus and potassium,were laid out in split-plot design with three replications. The varieties were taken in the main plots and different nitrogen levels were assigned to the sub plots. The results revealed that highest number of tillers (6.1/plant), fingers (8.3/ear head), finger length (8.8 cm) along with maximum yield (2491 kg/ha), net return (Rs. 39464per ha) and B: C ratio (1.94) were obtained with finger millet variety Arjun followed by Bhairabi. The ~~application of nitrogen fertilizer significantly affected the different studied characters and~~ application of 80 kg N/ha gave highest number of tillers (5.7/plant), fingers (7.7/ear head), finger length (8.4 cm) and yield (2399 kg/ha) with highest net return (Rs. 36237per ha) and B: C ratio (1.86).From the present investigation, it can be concluded that finger millet variety Arjuncan be grown with application of 80 kg N/ha along with 30 kg/ha each of phosphorus and potassium~~as ithas resulted in~~formaximum yield and economic return.

Keywords:Finger millet, net return, nitrogen, variety, yield

1. INTRODUCTION

Finger millet (*Eleusinecoracana* (L.)Gaertn) commonly known as ragi and it is a cereal grass grown generally for its grain. It plays a major role for socio-economic condition of the small and marginal farmers. One of the important features of this millet is its ability to adjust itself in different agro-climatic conditions which reflects it having highest productivity among the millets.Finger millet is well adapted to extreme weather situation and can act as an alternative food supply for ensuring food and nutritional security in changing climate condition [1,2].Grain of finger millet contains carbohydrate of 66.82 g, protein of 7.16 g, total fat of 1.92 g, total dietary fibre of 11.18 g per 100 g of grain which is equivalent to 1342 KJ energy [3]. Ragicontains higher amount of Calcium i.e. 364 mg/g (7.49 g/mg in milled rice) which helps in making strong bones [3]. An amino acid called Tryptophan which is reducing appetite and helps in controlling body weight. Other~~s~~ amino acids namely Lecithin, Methionine and Threonine help~~s~~ in lowering cholesterol by removing extra fat from Liver or hampers fat formation in liver. It is a good source of Iron (4.62 mg/g) [3] and improves anemia and malnutrition where it is consumed [4]. Ragi grains are reported to have anti-ulcerative properties. The total area under finger millet in India is about 1004 thousand ha with production of 1755 thousand tonnes during 2019-20 which was mainly contributed by the states of Karnataka, Maharashtra, Uttar Pradesh, Tamil Nadu, Uttarakhand and Odisha. In Odisha, finger millet is cultivated in an area of 43 thousand ha with production and productivity of 33 thousand tonnes and 767 kg/ha, respectively. Productivity of finger millet is quite less in Odishaas compared to national average i.e. 1747 kg/ha [5]. There is huge scope to improve the productivity of crops in different ways. Nitrogen is one of the important yield controlling nutrients for crop production [6-8] and optimization of nitrogenous fertilizer ~~is important~~ to increase crop yields [9].There is a lack of information on nitrogenrequirement of transplantedfinger milletforunderstanding optimum yield.Thus, present study was conducted toinvestigate the yield and economic profitability oftransplanted finger millet cultivars under different levels of nitrogen in Eastern Ghat High Land zone of Odisha.

2.MATERIALS AND METHODS

The experiment was carried out at the Regional Research and Technology Transfer Station (O.U.A.T.), Semiliguda, Odisha($18^0$42' N latitude, $82^0$30' E longitudeand at an elevation of 884 m above mean sea level)during rainy season of 2019, 2020 and 2021. Initial basic chemicalproperties of the surface soil (0-15 cm) were pH of 5.8,available N, P and K as 185.21, 16.30 and 138.51 kg/ha,

respectively. The soil texture of the experimentalsite was sandy loam. Different weather data during experimentation are presented in Table 1.Experiment was conducted in a split-plot design with three replications. Four different finger millet cultivars namely Kalua, OEB 602, Bhairabi and Arjunwere accommodated in mainplots. Sub-plots were fitted with three different dosses of nitrogen i.e. 40, 60 and 80 kg/ha. Before sowing in seed bad, seeds of different varieties were treated with Carboxin 37.5%+Thiram37.5% DS @ 2 g/kg of seeds. Seed rate of 6 kg/ha used for this experiment and 28 days old seedlings transplanted in main field with a spacing of 22.5 cm x 10 cm. A uniform dose of FYM @ 5 t/ha incorporated well into the soil before sowing. Nitrogen was applied as per treatments (50% basal and 50% at 21 days after transplanting) and a uniform dose of 30 kg/ha each of phosphorus and potassium were applied as basal. All other cultural operations upto the harvest of finger millet was followed uniformlyas per recommended package of practices to get a healthy crop.

Table 1. Monthly weather data during experimentation

	Max. Temperature(˚C)			Min. Temperature(˚C)		
Months	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**
May	35.9	33.7	32.6	16.7	19.7	20.6
June	33.0	29.2	28.1	18.2	20.9	20.9
July	26.6	28.7	27.2	16.2	20.6	20.8
August	27.0	25.8	27.7	16.4	20.7	20.6
September	27.0	29.0	27.5	16.2	20.5	20.2
October	28.7	27.9	28.6	14.2	18.1	18.5
Mean	29.7	29.1	28.6	16.3	20.1	20.3
	PercentRelative Humidity (morning)			**PercentRelative Humidity (after noon)**		
May	87	84	83	46	68	65
June	89	91	91	65	86	82
July	93	93	93	87	88	86
August	92	95	94	83	93	83
September	93	94	94	92	87	84
October	90	93	93	88	85	78
Mean	91	92	91	77	85	80
	Total Rainfall (mm)			**No. of rainy days**		
May	51.4	129.3	68.9	5	7	6
June	185.0	238.0	224.0	9	10	18
July	468.2	196.5	155.5	21	15	13
August	429.0	390.7	291.4	16	22	15
September	306.6	208.8	267.7	12	11	11
October	204.4	193.3	65.2	9	14	6
Total	1644.6	1356.6	1072.7	72	79	69

Observations on plant height, number of tillers/hill, number of fingers/ear head, finger length and yield were recorded at harvest. The plant height was measured from the base of the plant to the tip of the upper leaf and expressed in centimeters (cm). Ten plants and ten ear heads were picked at random from each plot for estimation of number of tillers/hill and number of fingers/ear head, respectively. Finger length was measured from the base of the finger to the tip of the finger of ear head and expressed in centimeters (cm).The crop was harvested plotwiseand grain yield obtained fromnet plot was converted into kg/ha.Economicparameters such as cost of production, gross return, netreturn and benefit cost ratio were calculated byconsidering all inputs and outputs as per local situation. Data were statisticallyanalyzed using analysis of variance (ANOVA) as split-plotdesign [10]. Further significantdifferences between the treatments were compared withthe critical difference at ±5% probability level.

3.RESULTS AND DISCUSSION

3.1 Growth Attributes

Plant height and number of tillers/hill of finger millet varied significantly in respect to different cultivars and nitrogen levels during all three years of experimentation (Table 2). Plant height was significantly superior with variety Kalua (144.53, 125.20 and 130.33 cm during 2019, 2020 and 2021, respectively) as compared to OEB 602 and Bhairabi but statistically atpar with finger millet variety Arjun (144.22, 117.78 and 125.04 cm during 2019, 2020 and 2021, respectively). Based on pooled analysis, significantly highest plant height recorded with Kalua (133.25 cm) followed by Arjun (129.12 cm), Bharabi (125.87 cm) and OEB 602 ~~recorded least values~~ (120.21 cm).~~Among the finger millet cultivars~~, The significantly highest number of tillers/hill recorded with Arjun (6.11, 6.06 and 6.09 in 2019, 2020 and 2021, respectively) followed by Bhairabi. Pooled data showed a variation of 4.26 (Kalua) to 6.09 (Arjun) innumbers of tillers/plant.The differences in growth attributes among the various varieties are general, due to their different genetic potential. Significant differences for plant height and number oftillers among the varieties was also reported in other studies[11,12].Application of 80 kg N/ha resulted in significantly higher plant height of 146.38, 120.38 and 127.65 cm during 2019, 2020 and 2021, respectively as compared to 40 and 60 kg N/ha. Moreover, statistically similar plant height recorded with 40 and 60 kg N/ha (Table 2).On the other hand, increase in nitrogen level significantly increased number of tillers/hill (Table 2) and it was found highest with the application of 80 kg N/ha during all three years of experimentation (5.73, 5.67 and 5.69 during 1st, 2nd and 3rd year, respectively) as well as for pooled analysis (5.70). Nitrogen helps in increasing internodes number and sizes which resulted in more plant height with higher dose [13]. Availability of nitrogen isincreased with higher level and nitrogen is one of the major parts of proteins and influences cell division and resulted in more plant height [14]. The increased tiller number with more nitrogen might due to be greater translocation of nutrients [14].

Table 2. **Growth attributes of finger millet varieties to different levels of Nitrogen**

	Plant height (cm)				No. of tillers/hill			
Treatments	**2019**	**2020**	**2021**	**Pooled**	**2019**	**2020**	**2021**	**Pooled**
Different varieties								
Kalua	144.53	125.20	130.33	133.36	4.38	4.13	4.26	4.26
OEB 602	132.40	110.82	117.41	120.21	4.20	4.27	4.34	4.27
Bhairabi	139.71	115.16	122.74	125.87	4.69	4.49	4.57	4.58
Arjun	144.22	117.78	125.04	129.01	6.11	6.06	6.09	6.09
SEm (±)	**2.36**	**2.36**	**1.70**	**1.93**	**0.17**	**0.06**	**0.09**	**0.09**
CD (5%)	**8.16**	**8.15**	**5.89**	**6.67**	**0.57**	**0.19**	**0.32**	**0.32**
Nitrogen levels								
40 kg N/ha	135.87	114.38	120.36	123.54	4.03	4.03	4.05	4.04
60 kg N/ha	138.40	116.95	123.64	126.33	4.77	4.52	4.70	4.66
80 kg N/ha	146.38	120.38	127.65	131.47	5.73	5.67	5.69	5.70
SEm (±)	**1.93**	**1.32**	**1.41**	**1.23**	**0.16**	**0.12**	**0.10**	**0.11**
CD (5%)	**5.80**	**3.96**	**4.24**	**3.68**	**0.48**	**0.37**	**0.31**	**0.33**

3.2 Yield Attributes

Yield attributes of finger millet like number of fingers/ear head and length of finger was significantly varied in relation to different varieties and nitrogen levels (Table 3). Number of fingers/ear head was found to vary between7.02 (OEB 602) and 9.27 (Arjun) during 2019, 6.16 (Kalua) and 7.31 (Arjun) during 2020 and 6.80 (Kalua) and 8.38 (Arjun)during 2021. Based on pooled analysis, significantly highest numbers of finger/hill was recorded with finger millet variety Arjun (8.32) followed by Bhairabi (7.45), OEB 602 (7.13) and Kalua (6.79).Same trends were also followed for finger length (Table 3) and highest finger length of 8.84 cm was recorded with finger millet variety Arjun followed by Bhairabi (8.08 cm), OEB 602 (7.83 cm) and Kalua (7.31 cm).The variation in agronomic traits like number of

fingers/ear head and finger length were observed could be attributed to genotypic variation within different varieties [15].Both number offingers and finger length were significantly increased with increase in N levels. Application of 80 kg N/ha recorded higher number of fingers/ear head (8.27, 7.08 and 7.88 during 2019, 2020 and 2021, respectively) and finger length (8.73, 8.03 and 8.38 cm during 2019, 2020 and 2021, respectively) as compared to 40 and 60 kg N/ha.Increased in number of fingers/ear head and finger length with increase in nitrogen levels was also reported in others studies[16, 17].

3.3 Yield

Irrespective of years and pooled analysis, grain yield of finger millet was significantly influenced by cultivars and different doses of nitrogen (Table 3). Highest grain production of 2706, 2206 and 2560 kg/ha obtained with finger millet variety Arjun as compared to 2375, 1992 and 2460 kg/ha by Bhairabi; 2097, 2057 and 2089 kg/ha by OEB 602; and 2192, 1759 and 1989 kg/ha by Kalua during 2019, 2020 and 2021, respectively. Based on pooled analysis, significantly highest grain yield obtained with Arjun (2491 kg/ha) followed by Bhairabi (2276 kg/ha) and OEB 602 (2081 kg/ha). Finger millet variety Kalua recorded lowest grain yield (1980 kg/ha). As of growth and yield attributes, grain yield of finger millet was also increased by increase in nitrogen levels from 40 to 80 kg/ha (Table 3). High grain yields observed in Arjun can be directly associated with high number of tillers, fingers and finger length[15]. Kandelet al. [2] also observed an increased finger millet yield with good yield attributing characters.Significantly highest grain yield of 2589, 2147 and 2462 kg/ha obtained with the application of 80 kg N/ha during 2019, 2020 and 2021, respectively as compared to 40 and 60 kg N/ha. Based on pooled data, 9.24-18.47% more yield obtained with the application of 80 kg N/ha as compared to lower two doses. Higher grain yield obtained with more nitrogen level owing to better yieldattributing characters like number of finger/ear head and finger length and that ultimately gave higher yield. This is confirming the findings ofPradhanet al. [16], Krishna et al. [17] and Niharikaet al. [18].

3.4 Economics

Total cost of cultivation increased with increase in nitrogen level due toadditional cost involved in additional dose of nitrogen (Table 3). Based on pooled data, among the different cultivars of finger millet highest gross return (Rs. 81460 per ha), net return (Rs. 39464 per ha) and B: C ratio (1.94) was obtained with finger millet variety Arjun followed by Bhairabi and OEB 602. Finger millet variety Kalua recorded least economic return.This might be due tohigher total grain yield recorded with Arjunfollowedby Bhairabi, OEB 602 and Kalua, but there was no difference for cost ofproduction among the different varieties.In case of nitrogen levels, maximum gross return (Rs. 78748 per ha) and net returns (Rs. 36237 per ha) were obtained with the application of 80 kg N/ha as compared to low nitrogen levels. Highest B: C (1.86) ratio was also obtained with the application of 80 kg N/ha. Though the cost of cultivation was more with 80 kg N/ha but higher economic returns obtained with this treatment because of increased grain yield by 9.24-18.47% whereas, increase in cost of cultivation was very less i.e. 0.58-1.77% as compare to reduced two doses.

Table 3. Yield attributes, yield and economics (mean of three years) of finger millet varieties to different levels of Nitrogen

Treatments	No of fingers/ear head				Finger length (cm)				Grain yield (kg/ha)				Cost of Cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	B: C ratio
	2019	2020	2021	Pooled	2019	2020	2021	Pooled	2019	2020	2021	Pooled				
Different varieties																
Kalua	7.40	6.16	6.80	6.79	7.87	6.78	7.30	7.31	2192	1759	1989	1980	41996	64718	22722	1.54
OEB 602	7.02	6.98	7.39	7.13	7.78	7.78	7.94	7.83	2097	2057	2089	2081	41996	68132	26135	1.62
Bhairabi	7.98	6.87	7.51	7.45	8.58	7.53	8.12	8.08	2375	1992	2460	2276	41996	74514	32517	1.77
Arjun	9.27	7.31	8.38	8.32	9.33	8.44	8.73	8.84	2706	2206	2560	2491	41996	81460	39464	1.94
SEm (±)	**0.16**	**0.09**	**0.10**	**0.08**	**0.21**	**0.15**	**0.13**	**0.12**	**70.0**	**58.6**	**36.2**	**40.5**	**-**	**-**	**-**	**-**
CD (5%)	**0.55**	**0.33**	**0.36**	**0.27**	**0.72**	**0.52**	**0.46**	**0.42**	**242.0**	**202.7**	**125.3**	**140.1**	**-**	**-**	**-**	**-**
Nitrogen levels																
40 kg N/ha	7.53	6.62	7.19	7.11	8.08	7.28	7.56	7.64	2115	1862	2099	2025	41751	66288	24537	1.59
60 kg N/ha	7.96	6.78	7.49	7.41	8.37	7.58	8.14	8.03	2323	2002	2262	2196	41996	71852	29855	1.71
80 kg N/ha	8.27	7.08	7.88	7.74	8.73	8.03	8.38	8.38	2589	2147	2462	2399	42241	78478	36237	1.86
SEm (±)	**0.15**	**0.06**	**0.05**	**0.07**	**0.13**	**0.07**	**0.10**	**0.07**	**37.9**	**19.8**	**22.4**	**22.1**	**-**	**-**	**-**	**-**
CD (5%)	**0.43**	**0.18**	**0.15**	**0.22**	**0.38**	**0.20**	**0.30**	**0.20**	**113.7**	**59.2**	**67.1**	**66.3**	**-**	**-**	**-**	**-**

4.CONCLUSION

Farmers of the Eastern Ghat High Land Zone and adjoining areas of Odishacan be advised to cultivate finger millet variety Arjun with 80 kg N/ha along with 30 kg/ha each of phosphorus and potassium for higher yield and economic return.

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