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Barnyard Millet (*Echinochloa frumentacea*) Varieties Performance under Different Fertility Levels in Rainfed Conditions of Garhwal Himalaya, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author AK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AP and Shikha managed the literature searches. Authors RS and SBS contributed to the final version of manuscript. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Kharif* season of 2017-18 at the College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India to study the effect of fertility levels on different high yielding cultivars of barnyard millet under rainfed conditions of hills of Uttarakhand. The experiment consisted of two factors *viz.* variety and fertilizer. The experiment had three fertility levels *viz.* 75% RDF (Recommended Dose of Fertilizer), 100% RDF and 125% RDF and four varieties *viz.* VL249, DHBMV23-3, VL172 and VL207. Total experiment has twelve treatment combinations. The three fertility levels were laid out in main plots and four varieties were in sub-plots of split plot design along with three replications.

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The results indicated that VL249 was the most economical high yielding cultivar of barnyard millet at 100% of the recommended dose of fertilizer with higher B:C ratio of 1.92 for rainfed conditions of Garhwal hills.

Keywords: Barnyard millet; nutri-cereals; minor millet; small millet; nutrient management.

1. INTRODUCTION

Barnyard millet is locally known as '*jhangora'* and '*sawan'* in Uttarakhand that is one among the small millet/ minor millets. It is the important *kharif* season crop of the state. It is mainly grown for fodder purpose during the lean period but its grains are also been used for consumption purpose. India is the biggest producer of barnyard millet, both in terms of area (0.146 m ha) and production (0.147 mt) with average productivity of 1034 kg/ha during the last 3 years [1]. Uttarakhand state average production of barnyard millet was 78,477 metric tons from 55,437 hectare area during 2016-17 [2]. Uttarakhand has highest productivity of 1174 kg/ha followed by Tamil Nadu (1067 kg/ha) and Gujarat (1056 kg/ha) [3]. It was grown in *Garhwal* region on a sizable acreage of more than 37,758 hectare with production of 55,337 metric tons [2]. The millet production is shrinking over the last many decades. The 44% of millet cultivation were occupied by other crops between 1966 to 2006 indicated loss to India's food and farming system diversity [4]. In recent year consumer are very conscious about what they are consuming especially sugar and obesity people. They are moving towards barnyard millet as it contains low calories, low glycemic index, high dietary fiber as high as 14.7% in comparison to wheat (1.2) and rice (0.2) and gluten free. Some of its varieties have high amount of iron (18.6 mg in 100g of raw millet) which is the richest amongst all millets and cereal grains. The protein content of barnyard millet (11.6%) is comparable with wheat (11.8%) and much higher than rice (6.8%) [3]. Therefore, millets are now being pronounced as "Miracle grains/ *Adbhut Anaj* and nutri-cereals".

Being a traditional crop of Uttarakhand, barnyard millet secures the food and fodder security of small and marginal farmers of hill districts of Uttarakhand. Adoption of improved varieties and management practices such as fertilizer use could improve barnyard millet yields of rainfed *Garhwal* region of Uttarakhand hills. The varieties producing higher amount of dry matter, use greater quantities of nutrients from soil. The various root characteristics might vary with the varieties which may affect nutrient uptake. Hence there is need to evaluate different varieties under rainfed *Garhwal* conditions for its suitability along with optimum fertilization schedules for achieving its potential yield.

2. MATERIALS AND METHODS

A field experiment was conducted at the Research and Extension Centre, Gaja, College of Forestry of VCSG Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India during *Kharif* season of 2017-18 to evaluate the effect of different fertility levels on high yield varieties of barnyard millet under rainfed condition of hilly *Garhwal* region. The soil was silty clay loam of medium depth with acidic pH (5.7) having 0.73% organic carbon, 216 kg/ha available N, 14.16 kg/ha available P and 412 kg/ha available K.

The climate of experimental site is humid and temperate type with chilled winter. The total precipitation during the crop season was recorded 1186.9 mm in 2017, whereas the maximum temperature varied between 22.2 to 24.6°C during cropping season. Similarly minimum temperature varied between 11.2 and 16.8° C during *Kharif* season of 2017-18.

The experiment was having twelve treatment combinations consisting of three fertility levels *viz.* 75% recommended dose of fertilizer (RDF), 100% RDF and 125% RDF in main plot and four varieties namely VL249, DHBMV23-3, VL172 and VL207 in sub plots arranged in split plot design along with three replications. The crop was sown in lines of 25 cm apart with plant to plant distance of 7.5 cm on 23.06.2017 and harvested as per maturity. The crop was raised using standard package and practices recommended for the region. The crop was fertilized with RDF NPK @ 40:20:0 kg/ha using Urea and DAP. Data on yield performance and economics were recorded using standard procedure. The data was statistically analyzed using STPR-1 designed by Department of Mathematics and Statistics of GBPUA&T, Pantnagar.

3. RESULTS AND DISCUSSION

The results obtained are all given in Table 1. The plant height of barnyard millet was significantly affected by the fertility levels and different varieties. The plant height was recorded significantly higher in VL249 in comparison to other varieties. Plant height of barnyard millet was increased with the rise in fertility level. Maximum plant height was recorded in 100% recommended dose of fertilizer which was significantly higher than the 75% recommended dose of fertilizer and statistically at par with the 125% recommended dose of fertilizer. The interaction of fertilizer dose and variety was recorded significant in case of plant height of barnyard millet. VL249 with 100% RDF recorded significantly higher plant height than the other treatment combinations except VL249 with 75% RDF.

The maximum number of productive tillers per meter square was recorded in VL249 which was statistically superior to the all other varieties. VL207 had the lowest productive tiller per meter square which was statistically at par with VL172.The interaction of fertilizer dose and variety of barnyard was found significant in case of number of tillers per meter square. VL249 with 125% RDF recorded significantly higher productive tiller per meter square than the other treatment combinations except VL249 with 100% RDF and DHBMV23-3 with 100% RDF.

The grain weight per plant was significantly higher in 100% RDF than 75% RDF and statistically on par with 125% RDF. VL249 recorded significantly higher grain weight per plant than other varieties.

The test weight of barnyard millet was also significantly influenced by the fertilizer application and varieties. The test weight increased significantly when fertilizer level increased from 75% to 100% RDF but there was not significant increase when fertilizer increased from 100% to 125% RDF. The maximum test weight was recorded in VL249 which was statistically on par with DHBMV23-3. The application of 100% RDF resulted better growth parameters such as plant height, number of tillers per meter square and grain weight per plant because higher applications of fertilizers had a positive consequence on growth pattern with betterment of physiological process such as cell division, cell elongation along with timely metabolic processes [5]. The similar result was also reported by Divyashree et al. 2018 [6] in little millet.

Among the tested varieties of barnyard millet, maximum grain yield (1781 kg/ha) was recorded with VL249 which was significantly superior over the other tested varieties (Table 1). The grain yield of VL249 was 20.3% higher than VL207. The lowest grain yield (1480 kg/ha) was obtained from VL207. The maximum straw yield was also get from variety VL249 as compare to other tested varieties and minimum straw yield was recorded in VL207. Fertilizer level influence grain and straw yield significantly. Application of 100% recommended dose gave higher grain yield (1768 kg/ha) and straw yield (4266 kg/ha) than the 75% RDF. The further increase of fertilizer level *i.e.* from 100% to 125% RDF cause reduction of grain and straw yield due to lodging of plants. The significant increase in seed yield in VL249 variety at 100% fertility levels was due to higher plant growth *i.e.* plant height and yield attributing characters like number of productive tiller per meter square, grain weight per plant, test weight and harvest index.

The balance application of nitrogen, phosphorus and potassium lead to better growth of barnyard millet. This may be due to increased vegetative growth and capacity to produce more number of tillers under higher nitrogen levels [7]. Sankar *et al.* 2011 [8] also reported application of $N:P_2O_5:K_2O$ at 50:50:25 kg/ha increased finger millet yield compare to non-fertilized crop under rainfed conditions of Bangalore, India. Anandha Krishnaveni, 2018 [9] also reported that application of 125% RDF in transplanting of barnyard millet at 35 x 10 cm under sodic condition gave higher yield.

The maximum net return (Rs. 27955/ha) was recorded in VL249 and lowest net return was recorded in case of VL207 (Rs. 20807/ha). It is only because of higher grain and straw yield of the variety as cost of cultivation was same with the all varieties. It also resulted in higher B:C ratio (1.69) with the cultivation of VL249. Among the fertility level maximum B:C ratio was observed at 100% RDF (1.67) due to higher gross and net return. The B:C ratio in case of application of 125% recommended dose of fertilizer was reduced due to increase of cost of fertilizer and reduction in the grain and straw yield of the barnyard millet.

Table 1. Effect of different levels of fertilizer on yield of barnyard millet varieties

Treatments	Plant Height (cm)	Number productive of tiller per m^2	Grain weight per plant (g)	1000 grain weight (gm)	Yield		Harvest Index	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
					Grain (kg/ha)	Straw (kg/ha					
Fertilizer level											
75 % RDF	102	133.3	4.48	2.79	1367	3835	26.28	15799	35010	19211	1.22
100% RDF	109	152.7	4.71	3.04	1768	4435	28.50	16583	44230	27647	1.67
125% RDF	107	149.1	4.69	2.99	1670	4266	28.13	17367	41932	24565	1.41
SEm±	0.7	2.55	0.01	0.02	19	104	0.73				
CD (5%)	2.8	9.98	0.04	0.06	76	419	NS				
Verities											
VL 249	120	155.6	4.86	3.05	1781	4459	28.54	16583	44538	27955	1.69
DHBMV 23-3	106	146.3	4.72	2.93	1629	4311	27.42	16583	41202	24619	1.48
VL 172	100	139.9	4.54	2.91	1517	4049	27.25	16583	38438	21855	1.32
VL 207	97	138.2	4.39	2.87	1480	3895	27.53	16583	37390	20807	1.25
SEm±	1.7	1.96	0.02	0.02	30	137	0.73				
CD (5%)	5.1	5.83	0.08	0.07	88	410	NS				
Interaction (F x V)											
CD (5%)	9	10.1	NS	0.12	NS	NS	NS				

4. CONCLUSION

It may be concluded that VL249 cultivar is the most economical high yielding cultivar of barnyard millet and may be recommended for rainfed conditions of *Garhwa*l hills of Uttarakhand under timely sown conditions at 100% of the existing recommended dose of fertilizers (40:20:0 kg/ha N:P:K).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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