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Influence of sowing date and variety on Growth and Yield of finger millet grown on Mid Himalayan region of Uttarakhand

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ABSTRACT: *The present study was conducted during kharif season of the year 2012 to quantify the performance and variability for yield and yield contributing characters of finger millet against different dates of sowing (23rd May, 30th May and 10th June) under rainfed conditions at Ranichauri Campus, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Bharsar. Experiment was carried out for two finger millet varieties against three dates of sowing. Results revealed that finger millet yield and its attributes were significantly affected by different dates of sowing and different varieties during the study period. Crop growth, yield and yield attributing characters in terms of number of effective tillers/m², number of grains/plant, number of grains/m², test weight, straw yield, biological yield and grain yields of finger millet crop were recorded significantly. After comparative study of different sowing dates of finger millet it was found that variety PRM-1 sown on 23rd May provided best results. Among the variety results showed that PRM-1 recorded a highest grain weight of 1,204.5 kg ha^{-1} while the lowest was 1,091.00 kg ha^{-1} recorded by local variety. Results also revealed that 23rd May was the suitable planting date of finger millet followed by 30th May. PRM-1 variety of finger millet had the best growth and yield components therefore is recommended for further studies in mid hill region.*

Key words: *Sowing dates, Varieties, Weather variations, Growth and Yield Components.*

INTRODUCTION

Finger millet (*Eleusine coracana*) locally called ragi, mandika, nagli, kapai, mandua etc. is the most widely cultivated cereals in hilly region of Uttarakhand. Chapatti made of mandua flour is a simple and nutritious. Mandua chapatti is staple food in many parts of north India especially from the Kumauni cuisine which is the food of the Kumaon region of Uttarakhand, India. Small millets are highly nutritious food and even superior to rice and wheat in certain constituents. Finger millet is the richest source of calcium (300-350mg/100 gm grain) and other small millets like phosphorous and iron too. It is sown during May/June and harvested during October/ November. Medium duration varieties having 150-160 days growth cycle are mostly used in hilly regions of Uttarakhand because of optimum temperature during physiological and harvest maturity and availability of optimum amount of available moisture in monsoon period at the time of active growth stage of crop. Finger millet is grown under rainfed conditions on undulating hilly terrains of Ranichauri, Tehri Garhwal because of less availability of moisture in the form of irrigation water. Most of the areas (mid hill) of finger millet are confined to rainfed conditions but with the development of high yielding input responsive varieties, the crop can be cultivated under irrigated conditions also. The late sowing leads to reduction in the yield; however, this variation can be minimized by sowing a variety which has relatively less reduction under both conditions. The reduction in yield under delayed sowing conditions has also been reported by Siag (2003) and Sheoran *et al.* (2008).

Among the factors influencing finger millet productivity the sowing date is of particular importance. This in turn is closely correlated with soil preparation, which has a critical effect on seed germination, moisture and nutrient availability. Interaction between the sowing dates and finger millet varieties remains unexplored and there is a need to

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investigate the influence of this interaction on the yield attributes of finger millet. Therefore, the experiment was conducted with the objectives to investigate the relative performance of different varieties of finger millet at varying sowing dates and to estimate the maximum profitability with least input investment in mid hills of Uttarakhand under varied environment.

MATERIALS AND METHODS

Experimental details: Present study was conducted during *kharif* season of the year 2012 at "B block", College of Forestry, Ranichauri Campus, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Bharsar to evaluate the crop characteristics of finger millet varieties under rainfed conditions. Hill campus Ranichauri located in the mid hills of Himalayas falls under cool temperate climate with an annual rainfall about 1,273 mm. Ranicahuri is located between 30° 18′ N latitudes and 78° 24′ E longitude with an altitude varying from 1600 to 2200 m amsl. Soil organic matter content of the experimental plot is 0.75-0.80% with a soil pH of 5.5-6.8. The experiment was laid out in randomized block design replicated four times with recommended dose of fertilizers NPK @ 60: 30: 20 kg/ ha. Depth of fertilizer application was 2-3cm. Finger millet crop was sown at the seed rate of 20 kg/ha with a row to row spacing of 20 cm. The soil of the experimental plots is silty clay loam in texture having brownish black colour. Twenty lines per plot of seed was sown using single row hand drill at 20 cm spacing.

Measurement of soil moisture: Before sowing of the crop, soil samples were collected at a depth of 0-15 cm, 15-30 cm and 30-45 cm with the help of soil auger at periodic intervals. Different weather variables (*viz*., Rainfall, maximum and minimum temperatures) were also recorded on the same day to analyze the variability of moisture status.

Observation of crop growth parameters: Experiments were conducted with two varieties *viz*., PRM-1 (V1) and Local (V2) as influenced by three sowing dates *viz*. 23rd May (D1), 30th May (D2) and 10th June (D3). The recommended standard package and practices were followed. Periodic measurements of dry matter production (tiller, finger, no. of plant etc.) and plant height are to be taken throughout the crop season. Measurements should be started at 15 DAS (Days after Sowing) and must be taken at 15 days interval up to physiological maturity. Five randomly selected quadrate sites were chosen per plot to record yield contributing characters.

Biological yield refers to total above ground dry matter produced by a plant in a unit land area weighed in kg/plot and finally expressed in kg/ha and Harvest Index is the ratio of economic yield to total biological yield in terms of dry matter. The dry weight was determined after drying of plant parts in an oven until constant weight. After that their dry weight was measured with the help of electric balance. At the time of maturity, yield related characters like grains per plant, thousand grain weight and productive tillers were recorded. Number of effective tillers was counted at maximum vegetative stage of the crop, while, ear bearing tillers per plot was counted at harvest stage and expressed in number of tillers/m^2. The plots were harvested at maturity period and manually threshed separately to calculate the grain yield. Grain yield was recorded in kg/plot and finally expressed in kg/ha at optimum moisture content of 12-15%. Total numbers of grains from randomly selected plant were counted after threshing and averaged to single plant. Test weight denotes the weight of 1,000 grains of field crops. The samples were collected randomly from the cleaned grains of each plot and 1,000 grains were taken using electronic balance. Weight of grains was measured in grams and expressed as test weight.

Statistical analysis: The experimental data were analyzed by using analysis of variance (ANOVA) technique for every character as prescribed for a Randomized Block Design (RBD) having with four replications. Analysis of the data was carried out by using Fisher's analysis of variance technique and critical differences (CD) at 5% level of probability were calculated for testing the significance of difference among various treatments means (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

***Effects of soil moisture*:** Finger millet is predominantly grown as a rainfed crop on undulating fields therefore it is essential to adopt soil and moisture conservation practices to achieve stability in yield. Periodic measurements of soil moisture have been portrayed in table 1. The results revealed that soil moisture is highly dependent on the total amount of rainfall received for the period. However, high negative correlation was observed between soil moisture and temperature. It could also be seen that in the three soil layer (0-15 cm, 15-30cm and 30-45cm), the availability of soil moisture varied from 3.1-30.3%, 6.1-30.4% and 8.2-30.7% respectively. Soil water decreases slowly with the growth of plant especially

during the later stages of the crop leading to soil moisture stress.

Yield contributing characters of finger millet: The effect of sowing dates on different yield attributes in terms of number of effective tillers/m^2, number of grains/m^2, test weight etc. of two finger millet varieties selected in this study have been presented in table 2. In this experiment, dates of sowing showed significant effects on growth and yield attributing characters during crop duration. The effect of sowing dates on all yield contributing characters was found to be significant except number of effective tillers/m^2, grain yield and harvest index during the *kharif* season 2012. It is evident from the results that the effective numbers of tillers were significantly superior for the crop sown on 23rd May followed by 30th May sowing, whereas number of tillers was significantly lowest for the crop sown on 10th June. Effective number of tillers decreased with delayed sowings. Delayed emergence of seedlings caused by low temperature and early maturity due to high temperature during reproductive stage particularly the grain filling process leads to reduced number of effective tillers in case of late sown crop (Tripathi, 2003). Crop grown on 23rd May recorded significantly more number of effective tiller/m^2 (160.37), number of grains/plant (863.62), number of grains/m^2 (138882.2) and harvest index (39.52) followed by 30th May and June sowing. Total numbers of grains per ear head was also highest in early sown crop as compared with late sown crops. Cumulative effect of reduced LAI, photosynthetic rate and period of grain filling might have reduced assimilate availability to developing grains in late sown crop resulting in lower harvest index as compared to early sown crop. The delayed sowing caused poor vegetative growth probably due to low temperature during early vegetative stage and high temperature during reproductive stage resulting in improper grain development (Patil *et al.,* 2003). The early sown crop also performed better in terms of yield attributes over the late sown crop. The least numbers of all yield attributing characters were accounted with June sowing *i.e.* late sown crop.

The effect due to varieties was found to be significant for all yield components of the crop, except for the number of effective tillers/m^2 which was non-significant. Data revealed that effective number of tillers was found maximum with the variety PRM-1 which was significantly at par over local variety. The variety PRM-1 also recorded significantly more number of grains/m^2 than the local variety while, significantly maximum test weight were accounted in PRM-1. In addition, selection of optimum dates of sowing and varieties with maximum productivity is the principal aim of finger millet cultivation in this region. The total number of effective tillers recorded under different treatments revealed that treatment D1V1 recorded maximum tillers as compared to other treatments. The treatment combinations D1V2 and D2V1 were also in subsequent orders.

Yields of finger millet crop: Grain yield, straw yield and biological yield were measured carefully. The yields of finger millet were significantly affected due to different dates of sowing during *kharif* season of the year 2012, whereas, the effect due to varieties on yield was also found to be significant (Table 3). The significant effects of different sowing dates and varieties might be due to the changes in weather and soil moisture conditions, especially, in temperature at the time of inflorescence and pollination that are enough to cause adverse effect on the development of spikelets due to direct affect of intense solar radiation on sloppy experimental field. The interaction between sowing dates and varieties was found to be significant and the highest grain yield (1,187.5 kg/ha) was recorded in 1st date of sowing thereafter second (1,172.87 kg/ha) and third (1,082.87 kg/ha) date sown crop. The highest straw yield was recorded in second date sown crop (1,807.87 kg/ha) and also second date sown finger millet crop witnessed the highest biological yield (3,007.82 kg/ha). Grain yield, straw yield and biological yield decreased as sowing was delayed by approximately 2-3 weeks. Delay in sowings reduced number of tillers as a result of exposure to high temperature during reproductive stage, which reduces the length of growing season thereby reducing the finger millet yields. Maximum yield can be obtained when crop is sown on 23rd May rather than on 30th May or 10th June. In the present experiment, finger millet yield decreased by 1 and 9% due to delayed sowing and 10% due to varietal variation respectively. The delayed sowing caused poor vegetative growth probably due to high temperature variation during early vegetative stage and reduced number of tillers as a result of high temperature exposure during reproductive stage; thereby reducing growing season length and causing reduction in finger millet yields. Environmental conditions during this time favour proper seed germination and thus lead to healthy crop stand that reduces the chances of insect pests attack (Mushtaq and Saleem, 2012). Productivity of the crop is directly influenced by many growth as well as yield

components. Similarly, highest straw yield (1807.87 kg/ha) was recorded in 30th May sown and least in June sown crop (1740 kg/ha). The maximum biological yield (3007.82 kg/ha) was recorded in crop sown on 30th May, which was significantly higher followed by 23rd May and 10th June sowing. The lowest grain yield, straw yield and minimum harvest index were reported from the crop sown on 10th June for both the varieties. However, a value of dry matter partitioning was gradually increased from first observation till the end of physiological maturity of the crop.

Performance of Varieties: It was found that there is a significant relationship between different varieties among various sowing environments except number of effective tillers/m^2 which is insignificant. Varietal variation in the yield attributes were also recorded during the study. Finger millet variety PRM-1 recorded significantly higher grain yield as compared to local variety during first sown conditions but it was found statistically at par under second and late sown conditions (Table 3). Due to high variability of weather and soil conditions PRM-1 produced statistically higher grain yield during May sown, whereas local variety produced significantly lower grain yield during this period. The lower grain yield of local variety during June sowing was due to deficient to moisture stress as compared to PRM-1. Even though 1000 grain weight of timely sown local variety indicating the bolder seed size was significantly higher, it failed to compensate the grain losses as the number of ears per plant was less. The yield loss of local variety may be due to seed shattering during the adverse weather conditions. 30th May sown finger millet variety PRM-1 produced the highest straw yield and June sown produces lower straw yield. 30th May sown PRM-1 produce also the highest biological yield followed by early and late sown. PRM-1 also produced the larger size of grains as compared to local variety. Hence, PRM-1 produced significantly bolder seeds compared to local as is evident from significantly higher 1000 grain weight. For both the variety, 30th May sown PRM-1 could accumulate highest total biological yield 3007.82 kg/ha, followed by late sown. 23rd May sown variety PRM-1 produced highest biological yield than 30th May and late sown. The rate of biomass production was also highest in variety PRM-1 as compared with local variety.

CONCLUSION

Finger millet crop was found as a subsistence crop at higher hilly regions. Suitable time for sowing of finger millet crop results in higher economic yield without involving additional input as it helps varieties to express their full growth potential. Due to the huge variations in the climate; delayed sown finger millet decreases yield by 9%. The response of finger millet crop with different growth and yield characteristics under the varied agro-climatic conditions of Uttarakhand (mid hills of Western Himalayas) proved to be beneficial under crop sown on 23rd May with the variety PRM-1 as the farmers can keep good harvest. Date of sowing plays a crucial role in the mid hills of Uttarakhand in response to selection of varieties also therefore, in the present experiment, sowing of finger millet variety PRM-1 in the month of May yields promising results in terms of enhanced productivity of finger millet.

Table 1
Soil moisture (%) measured at fortnightly interval during different growth stages

Date	*Depth (cm)*		
	0 – 15	*15 – 30*	*30 – 45*
23.05.12	3.5	7.6	13.1
30.05.12	3.5	9.5	11.1
10.06.12	3.1	6.1	8.2
25.06.12	16.8	11.6	11.4
10.07.12	28.3	25.3	16.3
25.07.12	30.2	30.4	30.7
10.08.12	28.9	28.0	27.9
25.08.12	30.3	28.2	27.6
10.09.12	30.2	27.6	27.6
25.09.12	28.2	27.6	27.4

Table 2
Yield contributing characters of finger millet as influenced by various treatments

Treatments	*No. of effective tillers/m^2*	*No. of grains/ plant*	*No. of grains/m^2*	*Test weight (g)*
Dates of sowing				
23 May	160.37	863.62	138882.50	0.007
30 May	153.87	844.12	129936.75	0.007
10 June	141.87	733.12	103892.25	0.008
SEm ±	4.09	8.03	9.73	0.0001
CD at 5%	12.35	24.22	29.34	0.003
Varieties				
PRM-1	152.58	858.58	131520.67	0.008
Local	151.5	768.66	116953.66	0.007
SEm ±	3.34	6.56	7.94	0.0001
CD at 5%	ns	19.77	23.95	0.002

Table 3
Effect of different sowing environments and varieties on grain yield, straw yield, biological yield and harvest index of finger millet

Treatments	*Grain yield (kg/ha)*	*Straw yield (kg/ha)*	*Biological yield (kg/ha)*	*Harvest Index (%)*
Dates of sowing				
23 May	1187.50	1802.75	2997.62	39.52
30 May	1172.87	1807.87	3007.87	38.98
10 June	1082.70	1740.00	2895.87	37.44
SEm ±	15.23	7.43	8.14	0.46
CD at 5%	45.93	22.42	24.56	1.39
Varieties				
PRM-1	1204.50	2984.83	1186.16	40.30
Local	1091.00	2949.14	1172.83	36.99
SEm ±	12.49	6.65	37.43	0.37
CD at 5%	37.50	20.05	ns	1.13

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