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Feasibilities of Intensification System in Finger Millet (*Eleusine coracana* L. Gaertn)

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A B S T R A C T

A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand with a view to study the Feasibilities of intensification system in finger millet (*Eleusine coracana* L. Gaertn) during *kharif* season of the year 2019. The experiment consisted of twelve treatment combination comprised of three age of seedling and four different spacing tested under Randomized Block Design (Factorial) with four replications. The results revealed that periodical plant height, grain and straw yield of finger millet was achieved significantly higher with transplanting of 21 day old seedling at 30 cm x 10 cm but it was at par with 21 day old seedling transplanted either at 20 cm x 20 cm or 30 cm x 15 cm or 20 cm x 15 cm. Among all the treatments, maximum net realization of Rs. 39768 /ha with maximum benefit cost ratio of 2.3 was achieved with transplanting of 21 day old seedling at 30 cm x 10 cm.

Introduction

Finger millet is the most important small millet grown in India and it serves as a subsistence and food security. It is important for its nutritive and cultural value in low input cereal-based farming systems on upland crop. In India, finger millet is commonly known as '*Ragi*' and as '*Nagali*' and '*Bavato'* in Gujarat state. Finger millet is the richest source of calcium, iron, Vit-B_1 and B_2 among all the cereals. It possesses hypoglycemic, hypocholestrolemic and anti-ulcerative activities. Finger millet is the most important of the small millets grown for food and among the course cereals in India and it accounts 7 per cent of the area with 11 per cent of production. In India, it is cultivated over an area of 1.2 million ha with an annual production of 2.06 million tones with the productivity of 1700 kg/ha. In Gujarat, it is cultivated in an area of 0.2 lakh ha producing 0.16 lakh tones with average productivity of 800 kg/ha (Anonymous, 2015). The demand of finger millet is in increasing trend due to its nutritional value. To satisfy the increasing demand, there is urgent need to increase productivity of fingermillet through modification of agronomic practices. Spacing and age of seedlings have great impact on growth and yield parameters of fingermillet. Spacing is an important factor to achieve higher production by better utilization of moisture and nutrients from the soil (root spread) and above ground (plant canopy) by harvesting maximum possible solar radiation and in turn better photosynthates formation (Uphoff *et al.,* 2011). Wider spacing was superior to narrow spacing in terms of enhanced grain and straw yield. The age of seedlings is an important factor as it has a tremendous influence on the tiller dynamics, tiller production, grain formation and other yield contributing characteristics (Pasuquin *et al.,* 2008). Young seedlings are transplanted to preserve the potential for high tillering and extensive rooting ability than the aged seedlings. The information related to the productivity of finger millet under different geometries and age of seedlings in Gujarat is lacking. Hence, present investigation was planned.

Materials and Methods

A field experiment was conducted during *kharif* season of the year 2019 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand on loamy sand soil to study the "Feasibilities of intensification system in finger millet (*Eleusine coracana* L. Gaertn)". The soil is alluvial in origin, having 7.46 pH, 0.38 organic carbon, 150.48 kg/ha available N, 30.28 kg/ha available P_2O_5 and 350.30 kg/ha available K_2O. Twelve treatment combination comprising three age of seedling (A_1: 14 days, A_2: 21 days and A_3: 28 days) and four spacing (S_1: 20 cm x 15 cm, S_2: 20 cm x 20 cm, S_3: 30 cm x 10 cm and S_4: 30 cm x 15 cm) were tested in Randomized Block Design (factorial) with four replications. The plot was kept ready through tractor drawn cultivator for preparing nursery beds for raising the seedling. The seeds of finger miller (Variety : GN 8) was sown in the nursery in three different seed bed keeping the seed rate of 5.0 kg/ha on the date 17th June, 24th June and 1st July to get the 28, 21, 14 days old seedling, respectively. The seedling of finger millet of different age was used for transplanting as per the treatments. The first light irrigation was given to the crop before transplanting for better establishment. The crop was fertilized with recommended dose of fertilizer (40-20-00 kg N, P_2O_5 and K_2O/ha) wherein, 50 per cent nitrogen and entire quantity of phosphorus through urea and DAP, respectively as a basal application before transplanting and remaining quantity of nitrogen was applied 30 days after transplanting. In general, different weather parameters were congenial for better growth of the crop during experimental period. The other package of practices was adopted to raise the crop as per the recommendations. In order to represent the plot five plants from each plot selected and labelled and all biometric observations was taken from selected plants. Data on various observations recorded during the course of investigation was statistically analyzed as per the standard procedure developed by Cochran and Cox (1957).

Results and Discussion

Effect of age of seedling

Results (Table 1) indicated that periodical plant height of fingermillet was linearly increased with increasing age of seedling from 14 to 28 days old seedling only at 30 DATP. Data given in Table 1 show that significantly the tallest plant (48.67 cm) was observed under treatment A_3 (transplanting of 28 days old seedling) while the smallest plant (39.94 cm) was noticed under treatment A_1 (transplanting of 14 days old seeding) at 30 DATP due to variation in age of seedling at the time of transplanting. Moreover, treatment A_2 (transplanting of 21 days old seedling) recorded significantly the highest plant height of 96.94 and 107.86 cm at 60 DATP and at harvest, respectively. These results are in close accordance with the results of Rajesh (2011).The highest dry plant biomass of 3.56 g/plant and 13.93 g/plant were recorded under transplanting of 21 day old seedling (A_2) at 30 DATP and 60 DATP than transplanting of 28 day old seedling (A_3) and 14 day old seedling (A_1). The lowest value of 1.65 g/plant and 9.68 g/plant of dry plant biomass were observed under transplanting of 14 days old seedling (A_1) at both the intervals, respectively. Similar trend was noticed for dry root biomass (g/plant) and root length (cm) measured at 30 and 60 DATP. The higher and lower dry plant and root biomass as well as root length were observed under treatment A_2 and A_1, respectively could be attributed to variation in age of seedling at the time of transplanting as evident from the plant height at 60 DATP. Higher values of dry plant biomass dry root biomass and root length measured at 30 and 60 DATP forming larger sink size coupled with efficient translocation of photosynthates to the sink and thereby increasing yield. Dhananivetha *et al.,* (2019) also recorded higher dry matter production with transplanting of 21 days old seedling in barnyard millet under irrigated condition at Madurai. Grain yield and straw yield was found to be significant due to different age of seedling. Significantly the highest grain and straw yield of 2748 kg/ha and 6335 kg/ha were recorded under transplanting of 21 day old seedling (A_2), respectively. While significantly the lowest grain and straw yield was registered under transplanting of 14 day old seedling (A_1).The present findings are in close accordance with the findings of Dhananivetha *et al.*, (2019) in banyard millet.

Effect of spacings

Data presented in Table 1 indicated that periodical plant height was observed higher under spacing of 20 cm x 15 cm (47.44 cm) and 30 cm x 10 cm (46.24 cm) and remained at par with each other at 30 DATP. Similar trend was found at 60 DATP in plant height. At harvest, 20 cm x 15 cm (S_1), 20 cm x 20 cm (S_2) and 30 cm x 10 cm spacing (S_3) treatments recorded significantly higher plant of 104.41 cm, 99.82 cm and 99.56 cm, respectively and remained at par with each other. Significantly lower plant height was registered under treatment of 30 cm x 15 cm spacing (S_4) at 30 DATP, 60 DATP and harvest. Nandini and Sridhara (2019) observed that transplanting of foxtail millet seedling at 20 cm x 10 cm recorded significantly higher plant height as compared to other spacing. Further, it was observed that significantly the highest dry plant biomass of 2.99 and 12.93 g/plant as well as dry root biomass of 2.03 and 3.38 g/plant were recorded with 30 cm x 15 cm spacing (S_4) at 30 DATP and 60 DATP, respectively. As far as root length is concern, significantly the higher root length of 13.35 cm and 20.17 cm were observed with 30 cm x 15 cm spacing (S_4) and was remained at par with 20 cm x 20 cm spacing (S_2) at 30 DATP and 60 DATP, respectively. While spacing of 20 cm x 15 cm spacing (S_1) recorded significantly the lowest values for said parameters. The increase in plant dry biomass, dry root biomass and root length under treatment S_4 (30 cm x 15 cm) could be attributed to enough space available to the plants which leads to less competition for space, light, nutrients and moisture which helps in better utilization of available resources where each individual plant may be able to obtain adequate supply of plant nutrients from relatively large volume of soil. Roy *et al.*, (2002) reported that total dry matter production (287.3 g/m^2) was higher at a wider spacing of 25 cm x 10 cm over closer spacing of 25 cm x 6 cm in finger millet.

Data further indicated that grain yield and straw yield was found to be significant due to different spacing. Spacing of 30 cm x 10 cm (S_3) recorded significantly higher grain yield (2575 kg/ha) and it was at par with 20 cm x 20 cm (S_2) and 30 cm x 15 cm spacing (S_4) treatment. Crop spacing of 30 cm x 10 cm (S_3) and 20 cm x 20 cm (S_2) remained at par with each other but recorded significantly higher straw yield (5786 kg/ha)as compared to 20 cm x 15 cm (S_1) and 30 cm x 15 cm (S_4) treatment. Grain and straw yield was recorded lower under 20 cm x 15 cm spacing (S_1) treatment.

Table.1 Growth attributes and yield of finger millet as influenced by age of seedling and spacing

Treatment	Plant height (cm)			Dry plant biomass (g/plant)		**Dry root biomass (g/plant)**		Root length (cm)		Grain yield (kg/ha)	Straw yield (kg/ha)
	At 30 DATP	AT 60 DATP	At Harvest	At 30 DATP	AT 60 DATP	At 30 DATP	AT 60 DATP	At 30 DATP	AT 60 DATP		
Age of seedling (A)											
A_1: 14 days	39.94	**75.94**	**88.98**	1.65	9.68	1.56	2.60	11.09	17.66	1961	4484
A_2: 21 days	46.28	**96.94**	**107.86**	3.56	13.93	2.14	3.57	14.13	20.92	2748	6335
A_3: 28 days	48.67	**88.92**	**99.67**	2.49	12.49	1.80	3.06	12.11	18.72	2451	5116
S.Em.±	**0.76**	**1.58**	**1.98**	0.05	0.26	0.04	0.06	0.22	0.31	65	137
C.D. at 5%	**2.18**	**4.53**	**5.70**	0.16	0.74	0.11	0.19	0.65	0.90	186	394
Spacing (S)											
S_1: 20 cm x 15 cm	**47.44**	**92.99**	**104.41**	2.12	11.39	1.68	2.82	11.71	18.15	2102	4613
S_2: 20 cm x 20 cm	**43.77**	**84.53**	**99.82**	2.70	12.06	1.84	3.08	12.70	19.40	2484	5614
S_3: 30 cm x 10 cm	**46.24**	**90.50**	**99.56**	2.46	11.76	1.78	3.02	12.01	18.68	2575	5786
S_4: 30 cm x 15 cm	**42.41**	**81.03**	**91.55**	2.99	12.93	2.03	3.38	13.35	20.17	2385	5187
S.Em.±	**0.88**	**1.82**	**2.29**	0.06	0.30	0.04	0.07	0.26	0.36	75	158
C.D. at 5%	**2.52**	**5.24**	**6.58**	0.18	0.85	0.13	0.13	0.75	1.04	215	455
A x S interaction	**Sig.**	**Sig.**	**Sig.**	NS	NS	NS	NS	NS	NS	Sig.	Sig.
C.V. (%)	**6.75**	**7.22**	**8.02**	8.52	8.53	8.28	8.44	7.21	6.56	10.82	10.33

Table.2 Periodical plant height of finger millet as influenced by interaction effect of age of seedling and spacing

Treatment	**Plant height (cm) at 30 DATP**				**Plant height (cm) at 60 DATP**				**Plant height (cm) at harvest**			
	S_1	**S_2**	**S_3**	**S_4**	**S_1**	**S_2**	**S_3**	**S_4**	**S_1**	**S_2**	**S_3**	**S_4**
A_1	45.14	37.27	43.11	34.23	86.11	69.33	84.83	63.48	98.30	93.94	92.42	71.28
A_2	47.30	45.82	46.53	45.48	102.03	96.19	97.51	92.02	114.02	106.36	106.25	104.82
A_3	49.87	48.22	49.08	47.52	90.83	88.09	89.17	87.60	100.92	99.17	100.02	98.55
S.Em.±	1.52				3.15				3.96			
C.D. at 5%	4.36				9.07				11.4			
C.V. (%)	6.75				7.22				8.02			

Table.3 Grain and straw yield of finger millet as influenced by interaction effect of age of seedling and spacing

Treatment	Grain yield (kg/ha)				Straw yield (kg/ha)			
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
A_1	1346	2178	2236	2084	3384	4940	4999	4472
A_2	2595	2831	2946	2622	5392	6777	7160	6010
A_3	2365	2442	2545	2450	5064	5124	5197	5079
S.Em.±	129				274			
C.D. at 5%	372				788			
C.V. (%)	10.82				10.33			

Table.4 Economics of finger millet as influenced by age of seedling and spacing

Treatment	Total cost of cultivation (□ /ha)	Yield (kg/ha)		Gross income (□ /ha)	Net realization (□ /ha)	BCR
		Grain	Straw			
A_1S_1	29886	1346	3384	31998	2112	1.1
A_1S_2	29695	2178	4940	50966	21271	1.7
A_1S_3	29886	2236	5000	52210	22324	1.7
A_1S_4	29504	2084	4472	48382	18879	1.6
A_2S_1	29886	2595	5392	59994	30109	2.0
A_2S_2	29695	2831	6777	66778	37083	2.2
A_2S_3	29886	2946	7161	69654	39768	2.3
A_2S_4	29504	2622	6010	61450	31946	2.1
A_3S_1	29886	2365	5064	54904	25018	1.8
A3S_2	29695	2442	5124	56532	26837	1.9
A_3S_3	29886	2545	5197	58695	28809	2.0
A_3S_4	29504	2450	5079	56617	27113	1.9

Selling price of produce: Grain 20 □ /kg and Straw 1.5 □ /kg

The increase in grain and straw yield was probably due to increase in total plant population upto optimum level and adoption of planting geometry with optimum spacing and medium aged seedling for better and uniform plant stand which enhanced higher dry matter accumulation which might have enhanced yield of finger millet. Similar kind of results are also observed by Pradhan *et al.*, (2014), they reported that the highest yield was recorded under transplanting of 25 days old seedling at 30 cm x 8 cm spacing.

Interaction effect

Result presented in Table 2 revealed treatment combination A_3S_1(transplanting of 28 days old seedling with spacing of 20 cm x 15 cm) recorded significantly higher plant height of 49.87cm while A_1S_4(14 days old seedling with spacing of 30 cm x 15 cm) recorded significantly lower plant height of 34.23 cm at 30 DATP. At 60 DATP and harvest, treatment combination A_2S_1 (transplanting of 21 days old seedling with spacing of 20 cm x 15 cm) recorded significantly higher plant height of 102.03and 114.02 cm, respectively. While treatment combination A_1S_4 (14 days old seedling with spacing of 30 cm x 15 cm) produced smallest plant at 60 DATP and harvest. Similar line of results was also reported by Anitha *et al.*, (2017).

Grain and straw yield was recorded higher under treatment combination A_2S_3 (transplanting of 21 day old seedling at 30 cm x 10 cm) but it was at par with treatment combination A_2S_2 (transplanting of 21 day old seedling at 20 cm x 20 cm), A_2S_4 (transplanting of 21 day old seedling at 30 cm x 15 cm) and A_2S_1 (transplanting of 21 day old seedling at 20 cm x 15 cm) while it was lower in case of treatment combination A_1S_1 (transplanting of 14 day old seedling at 20 cm x 15 cm) (Table 3). Kumar *et al.,* (2019) observed that transplanting of 20 days old seedling at 25 cm x 25 cm spacing registered superior performance in expression of yield of finger millet as compared to other treatments.

Economics

Treatment combination A_2S_3 (transplanting of 21 day old seedling at 30 cm x 10 cm) was found superior by recording maximum net realization of Rs. 39768 /ha with maximum benefit cost ratio of 2.3 (Table 4) while treatment combination A_1S_1 (transplanting of 14 day old seedling at 20 cm x 15 cm) recorded minimum net realization of Rs. 2112/ha with benefit cost ratio of 1.1 due to higher grain and straw yield. This result are in accordance with the results of Pradhan *et al.*, (2014), they observed gross returns, net return and B: C ratio (1.29) under transplanting of 25 days old seedling at 30 cm x 8 cm spacing.

In the light of the present investigation, it is concluded that transplanting of 21 days old seedling at 30cm × 10 cm spacing produced higher grain yield, straw yield, net realization and benefit cost ratio of *kharif* finger millet.

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