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Intervention of breeding and agronomy to enhance grain yield, fodder yield and income in barnyard millet in Karnataka, India

Nagappa Govankoppa, Modali Laxmi Prasanna, Anilkumar H, Kiran KM and Abinandan Wajantri

Abstract
Barnyard millet newly developed genotypes *viz*., DHBM-36-6, DHBM-56-6 along with check, RAU-11 was evaluated at ARS, Hanumanamatti and MARS, Dharwad in zone-8 of Karnataka. The highest grain yield and fodder yield produced by DHBM-36-6 (Grain: 43.05q/ha and Fodder: 63.80 q/ha) and followed by DHBM-56-6 (Grain: 39.54 q/ha and Fodder: 61.90 q/ha) and RAU-11 (Grain: 3744 kg/ha and Fodder:59.00 q/ha). Same genotypes were produced highest grain and fodder yield found in spacing of 22.5 x 10 cm (70.90 q / ha) as compared to 30 x 7.5-10 cm spacing (52.30 q/ha). When look into returns, DHBM-56-6 (Rs 39544 and Rs 28861) and RAU-11 (Rs 37438 and Rs 26754), the DHBM-36-6 (Rupees 43052 and Rupees 32369) produced the greatest gross and net returns. Out of three genotypes, DHBM-36-6 (4.02:1) exhibited statistically more B:C ratio as compared to DHBM-56-6 (3.69:1) and RAU-11 (3.5:1).

Keywords: Intervention, agronomy, enhance, barnyard, millet

Introduction
Barnyard millet (*Echinochloa frumentacea* (Roxb) is a hexaploid (2n=6x=36) and it belongs to family *poaceae. Echinochloa frumentacea* is an ancient crop species known as 'Oodalu' in Kannada and is grown for two purposes: fodder and food grains in certain pockets (mountain ranges) of numerous Indian states. It has been grown across Asia, including China, Korea, Japan, the former Soviet Union, and India. The area, it covered the United States and some Central African countries. The crop was first documented by archaeologists in China, where it was planted as early as 4150 BC. Different species of this crop are being domesticated in various parts of the world, such as *E. Frumentacea* (L.) in India and China. *E. colona* (L.) in India and *E. Crusgalli* (L.) in Japan. *E. Crusgalli* was domesticated in Japan 4000 years ago, and E. Colona was domesticated in India. Because of its prompt maturity, this crop can avoid drought and is the quickest growing of all millets. It has a high adaptability and can reach a height of 2000 meters above mean sea level. Increase productivity of barnyard millet depends upon varieties which were respond to optimum fertilizer doses (100% (20: 20: 0), 150% (30:30:0) and 200% (40:40:0) RDF and optimum spacing row to row was 22.5 cm and plant to plant was 7.5-10.0 cm. Outstanding genotypes, DHBM-56-6 and DHBM-36-3 along with check, RAU-11 were utilized for this factorial experiment.

Materials and Methods
A field experiment was carried out on red sandy loamy soil and black soil during Kharif 2017 and 2018 at ARS Hanumanamatti and Kharif 2018 at MARS, UAS Dharwad in Karnataka, India. The soil texture of the trial location was red sandy loam, which is deep and has good drainage at ARS Hanumanamatti. The Dharwad region featured black shallow soil with adequate drainage. The field experiment was designed using a Randomized Complete Block Design (RCBD) in a factorial format with 18 treatment combinations of three fertilizer amounts (100%, 150%, and 200% RDF). The land was prepared by repeated ploughing and harrowing. All treatments were given 7.5 t/ha FYM 15 days before planting. The barnyard millet genotypes DHBM-36-6, DHBM-56-6, and RAU-11 were sown at 22.5 X 7.5 - 10 cm and 30 X 7.5 - 10 cm spacing with a seed rate of 5 kg/ha. The entire NPK dosage (100% (20:20:0) to 150% (30:30:0) and 200% (40:40:0) RDF was applied.

All agronomic activities, as well as other suggestions were carried out in accordance with the UAS Dharwad package of practices. The experimental data was analysed using Fischer's method of analysis of variance (ANOVA) as stated by Gomez and Gomez (1984) [11], and the findings are given and discussed at a probability level of 0.05 percent.

Table 1: Response of Barnyard Millet genotypes to different spacing and fertilizer levels (Hanumanamatti2015-16)

Treatments	Grain yield (q/ha)	Straw (Fodder) yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
Genotypes (G)					
G1 RAU-11	37.44	59.00	37438	26754	3.5
G2 DHBM-56-6	39.54	61.90	39544	28861	3.69
G3 DHBM-36-6	43.05	63.80	43052	32369	4.02
S.Em±	.70	0.0034	699.98	699.98	0.06
CD at 5%	2.0118	0.0098	2011.76	2011.76	0.18
Spacing (S)					
S1 (22.5 cm)	44.14	70.90	44141	33457	4.13
S2 (30 cm)	35.88	52.30	35882	25198	3.35
S.Em±	0.5715	0.0028	571.53	571.53	0.05
CD at 5%	1.6426	0.008	1642.59	1642.59	0.15
Fertilizer levels (F)					
F1 (100% RDF) (20:20:00)	35.55	52.80	35545	25445	3.52
F2 (150% RDF) (33:30:00)	39.81	62.10	39810	29110	3.72
F3 (200% RDF) (40:40:00)	44.68	69.80	44679	33429	3.97
S.Em±	0.70	0.0034	699.98	699.98	0.06
CD at 5%	2.0118	0.0098	2011.76	2011.76	0.18

Table 2: Response of Barnyard Millet genotypes to different spacing and fertilizer levels.

Treatments	Grain yield (kg/ha)	Straw (Fodder) yield (kg/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
G1S1F1 RAU-11	37.59	42.10	37587	27486	3.72
G1S1F2	41.59	47.90	41587	30886	3.89
G1S1F3	45.60	59.40	45597	34346	4.05
G1S2F1	29.60	64.90	29597	19496	2.93
G1S2F2	31.52	68.90	31520	20820	2.95
G1S2F3	38.74	70.90	38740	27490	3.44
G2S1F1 DHBM-56-6	39.94	39.50	39937	29836	3.95
G2S1F2	43.52	56.30	43523	32823	4.07
G2S1F3	45.85	59.70	46316	35062	4.2
G2S2F1	30.70	66.40	30697	20596	3.04
G2S2F2	35.67	72.30	35670	24970	3.33
G2S2F3	39.63	76.30	39633	28383	3.52
G3S1F1 DHBM-36-6	42.93	37.60	42933	32833	4.21
G3S1F2	45.86	55.80	46316	35063	3.98
G3S1F3	50.59	81.00	50590	39340	4.5
G3S2F1	32.52	65.90	32520	22420	3.22
G3S2F2	38.85	71.30	38850	28150	3.63
G3S2F3	45.71	71.40	45710	34460	4.06
S.Em±	1.8546	0.0084	1425.59	1425.59	0.09
CD at 5%	4.7178	0.256	4273.78	4273.78	0.28

Table 3: Response of Barnyard Millet genotypes to different spacing and fertilizer levels (Hanumanamatti2016-17)

Treatments	Grain yield (q/ha)	Straw (Fodder) yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
Genotypes (G)					
G1 RAU-11	36.99	59.50	36985	25351	3.17
G2 DHBM-56-6	39.01	62.20	39011	27377	3.35
G3 DHBM-36-6	42.21	64.30	42206	30572	3.62
S.Em±	1.0578	0.0032	1057.79	1057.79	0.09
CD at 5%	3.0401	0.0092	3040.13	3040.13	0.26
Spacing (S)					
S1 (22.5 cm)	43.27	71.40	43266	31632	3.72
S2 (30 cm)	35.53	52.70	35535	23901	3.04
S.Em±	86.37	0.0026	863.68	863.68	0.07
CD at 5%	2.4823	0.0075	2482.25	2482.25	0.21
Fertilizer levels (F)					
F1 (100% RDF) (20:20:00)	34.81	53.20	34812	23762	3.15
F2 (150% RDF) (33:30:00)	39.65	62.60	39653	28003	3.36
F3 (200% RDF) (40:40:00)	43.74	70.30	43736	31535	3.58
S.Em±	1.0578	0.0032	1057.79	1057.79	0.09
CD at 5%	3.0401	0.0092	3040.13	3040.13	0.21

Table 4: Response of Barnyard Millet genotypes to different spacing and fertilizer levels.

Treatments	Grain yield (q/ha)	Straw (Fodder) yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
G1S1F1 RAU-11	39.67	42.60	39670	28620	3.59
G1S1F2	41.71	48.40	41710	30060	3.58
G1S1F3	43.49	59.90	43487	31286	3.56
G1S2F1	26.55	65.40	26553	15503	2.4
G1S2F2	31.60	69.40	31597	19946	2.71
G1S2F3	38.89	71.40	38893	26693	3.19
G2S1F1 DHBM-56-6	40.71	40.00	40710	29660	3.68
G2S1F2	42.35	56.80	42350	30700	3.64
G2S1F3	43.60	60.20	43590	31223	3.57
G2S2F1	26.83	66.90	26827	15776	2.43
G2S2F2	39.52	72.80	39517	27866	3.39
G2S2F3	41.06	76.80	41063	28863	3.37
G3S1F1 DHBM-36-6	42.52	38.10	42517	31223	3.85
G3S1F2	44.25	56.30	43488	31224	3.86
G3S1F3	50.10	81.50	50096	37896	4.11
G3S2F1	32.60	66.40	32597	21546	2.95
G3S2F2	37.49	71.60	37491	25841	3.22
G3S2F3	44.26	71.90	43489	31223	3.71
S.Em±	1.9411	0.0078	2202.05	2202.05	0.08
CD at 5%	5.8268	0.0312	6606.76	6606.76	0.24

Table 5: Response of Barnyard Millet genotypes to different spacing and fertilizer levels (Dharwad 2016-17)

Treatments	Grain yield (q/ha)	Straw (Fodder) yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
Genotypes (G)					
G1 RAU-11	40.33	70.90	40326	28693	3.46
G2 DHBM-56-6	41.85	73.80	41850	30217	3.58
G3 DHBM-36-6	44.89	74.00	44895	33262	3.85
S.Em±	1.04	0.0021	1040.8	1040.8	0.09
CD at 5%	2.99	NS	2991.3	2991.3	0.26
Spacing (S)					
S1 (22.5 cm)	46.42	82.90	46424	34791	3.98
S2 (30 cm)	38.29	62.90	38290	26657	3.27
S.Em±	0.85	0.0017	849.81	849.81	0.07
CD at 5%	2.44	0.005	2442.39	2442.39	0.21
Fertilizer levels (F)					
F1 (100% RDF) (20:20:00)	35.89	65.00	35895	24845	3.25
F2 (150% RDF) (33:30:00)	42.70	72.20	42704	31054	3.67
F3 (200% RDF) (40:40:00)	48.47	81.50	48473	36273	3.97
S.Em±	1.04	0.0021	1040.8	1040.8	0.09
CD at 5%	2.99	0.0062	2991.3	2991.3	0.26

Table 6: Response of Barnyard Millet genotypes to different spacing and fertilizer levels.

Treatments	Grain yield (q/ha)	Straw (Fodder) yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
G1S1F1 RAU-11	40.68	54.00	40677	29627	3.68
G1S1F2	42.49	57.40	42493	30843	3.65
G1S1F3	47.81	69.00	47812	35934	4
G1S2F1	27.81	78.40	27810	16760	2.52
G1S2F2	38.81	81.80	38810	27160	3.33
G1S2F3	43.42	84.60	43417	31217	3.56
G2S1F1 DHBM-56-6	40.70	53.00	40703	29653	3.68
G2S1F2	45.64	65.90	45637	33987	3.92
G2S1F3	47.81	69.40	47811	35934	4.15
G2S2F1	28.78	79.10	28780	17730	2.6
G2S2F2	39.64	82.60	39643	27993	3.4
G2S2F3	45.66	91.10	45665	33465	3.74
G3S1F1 DHBM-36-6	46.59	47.10	46586	35536	4.21
G3S1F2	47.71	69.30	47717	35934	4.1
G3S1F3	54.58	93.70	54581	42381	4.47
G3S2F1	30.81	78.60	30813	19763	2.79
G3S2F2	41.92	75.90	41923	30273	3.6
G3S2F3	47.68	81.00	47687	35550	3.91
S.Em±	2.10	0.0052	2149.44	2149.44	0.08
CD at 5%	6.30	0.208	6447.16	6447.16	0.25

Table 7: Response of Barnyard Millet genotypes to different spacing and fertilizer levels (Pooled for three years)

Treatments	Grain yield (q/ha)	Straw (Fodder) yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
Genotypes (G)					
G1 RAU-11	38.25	63.20	38250	26933	3.37
G2 DHBM-56-6	40.14	66.00	40135	28818	3.54
G3 DHBM-36-6	43.38	67.30	43384	32067	3.83
S.Em±	0.714	0.00268	714.03	714.03	0.06
CD at 5%	2.0521	7.71	2052.15	2052.15	0.18
Spacing (S)					
S1 (22.5 cm)	44.61	75.10	44610	33293	3.94
S2 (30 cm)	36.57	56.00	36569	25252	3.22
S.Em±	0.523	0.00219	583.01	583.01	0.05
CD at 5%	1.6756	0.00629	1675.57	1675.57	0.14
Fertilizer levels (F)					
F1 (100% RDF) (20:20:00)	35.42	57.00	35417	24684	3.31
F2 (150% RDF) (33:30:00)	40.72	65.60	40722	29389	3.6
F3 (200% RDF) (40:40:00)	45.63	73.80	45629	33746	3.84
S.Em±	0.714	0.268	714.03	714.03	0.06
CD at 5%	2.0521	0.00771	2052.15	2052.15	0.18

Table 8: Response of Barnyard Millet genotypes to different spacing and fertilizer levels (Pooled).

Treatments	Grain yield (q/ha)	Fodder yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
G1S1F1 RAU-11	39.31	46.20	39311	28578	3.66
G1S1F2	41.93	51.30	41930	30596	3.7
G1S1F3	45.94	62.80	45944	34061	3.87
G1S2F1	27.99	69.60	27987	17253	2.62
G1S2F2	33.98	73.40	33976	22642	3
G1S2F3	40.35	75.70	40350	28466	3.4
G2S1F1 DHBM-56-6	40.45	44.30	40450	29716	3.77
G2S1F2	43.84	59.70	43837	32503	3.87
G2S1F3	47.33	63.10	47359	35475	3.99
G2S2F1	28.77	70.80	28768	18034	2.69
G2S2F2	38.28	75.90	38277	26943	3.38
G2S2F3	42.12	82.20	42120	30237	3.54
G3S1F1 DHBM-36-6	44.01	40.90	44012	33278	4.01
G3S1F2	46.89	60.50	46894	35560	4.03
G3S1F3	51.76	84.50	51756	39872	4.36
G3S2F1	31.98	70.30	37977	21243	2.99
G3S2F2	39.42	73.00	39421	28088	3.48
G3S2F3	46.25	74.70	46246	34362	3.9
S.Em±	1.479	0.0657	1435.02	1435.02	0.1
CD at 5%	4.4267	0.01888	4305.72	4305.72	0.31

Grain yield

The barnyard millet newly developed genotypes, DHBM-56-6, and DHBM-36-6 along with check RAU-11 which were evaluated in various levels of nitrogen and phosphorus at varied spacing *viz*., 22.50 x 7.5- 10 and 30 x 7.5- 10 cm at ARS Hanumanamatti during 2017-18 and results were depicted in tables 1 and 2. Among these, DHBM-36-6 produced highest grain yield (4305 kg/ha) which was significantly superior over DHBM-56-6 (39.54 q/ha) and RAU-11 (37.44q/ha). These genotypes were recorded substantially more grain yield in22.50 x 7.5- 10 cm spacing (44.14q/ha) as compared to30 x 7.5- 10 cm spacing (35.88 kg/ha) as well as these were maximum response to two hundred percent of RDF(44.68 kg/ha) as compared 150% RDF (39.81 q/ha) and 100% RDF (35.55q/ha).

With respect to the various factorial combinations, DHBM-36-6, DHBM-56-6and RAU-11 produced higher grain yield of 50.59 q/ha, 45.85q/ha and 45.60q/ha, respectively at 22.50 x 7.5- 10 cm spacing and 200% RDF (40:40: 00:N: P: K).

There were three barnyard millet genotypes *viz*., RAU-11, DHBM-56-6and DHBM-36-6evaluatedin various levels of Nitrogenand phosphorus and different spacing 22.50 x 7.5-10 and 30 x 7.5-10 cm during 2018-19 at ARS Hanumanamatti. TheDHBM-36-6 produced highest grain yield of 42.21q/ha and it was significantly superior over DHBM-56-6(39.01 kg/ha) and RAU-11 (36.99q/ha). These genotypes produced significantly more grain yield in 22.50 x 7.5- 10 cm spacing (43.27q/ha) as compared to 30 x 7.5- 10 cm spacing (35.53q/ha).These genotypes maximum responded to 200% RDF (43.74 q/ha)and this dose produced statistically superior over 150% RDF (39.65 q/ha) and 100% RDF (34.81q/ha).

Look into the different factorial combinations,DHBM-36-6, DHBM-56-6and RAU-11recorded maximum grain yield of 50.10 q/ha, 43.60 q/ha and 43.49q/ha

respectively, at 22.50 x10 cm spacing and 200percent RDF(40:40: 00:N:P:K).

Same experiment was conducted at MARS, Dharwad (black soil) and results were presented in table 5 and 6. Among all, DHBM-36-6 produced highest grain yield (44.89 q /ha) and it recorded significantly superior over DHBM-56-6(41.85 q/ha) and RAU-11 (40.33q/ha). These genotypes produced considerably larger grain yield at 22.5 x 7.5- 10 cm spacing (46.42 q/ha) than 30 x 7.5-10 cm spacing (38.29 q/ha). Two hundred percent RDF (48.47 q/ha) outperformed over 150% RDF (42.70 q/ha) and 100% RDF (20:20:0) (35.89 q/ha). Looking at the factorial combinations, DHBM-36-6, DHBM-56-6, and RAU-11 generated the maximum grain yields of 54.58 q/ha, 47.81 q/ha, and 47.81 q/ha, respectively, at spacing of 22.50 x 7.5-10 cm and 200%RDF (40:40: 00: N: P: K).

The pooled results of Hanumanamatti during kharif 2017-18 and 2018-19 and Dharwad 2018-19 were summarized in table7 and 8. Out of three genotypes, DHBM-36-3 (4338 kg/ha) produced highest grain yield and it noticed significantly superior over DHBM-56-6 (4041 kg/ha) and RAU-11 (3825 kg/ha). These genotypes were recorded maximum yield at 22.5 x 10 cm spacing (4461 kg/ha). These barnyard millet genotypes gave highest grain yield when applied two hundred percent RDF (4563 kg/ha) as compare to 150 percent RDF (4072 kg/ha) and 100 percent RDF (3542 kg/ha).

When look in to factorial combinations, DHBM-36-3, DHBM-56-6, and RAU-11 produced maximum grain yield of 5176 kg/ha, 4733 kg/ha, and 4594 kg/ha, respectively, at 22.50 x10 cm spacing with 200% RDF (40:40: 00:N: P: K).

Found that applying a greater dose of fertilizer N30P24K15 to little millet yielded larger grain production (1.77 / ha) than using a lower dose (0.86 / ha). Charate *et al*. (2017) [4] discovered that little millet yielded greater grain at 40:20:20 than at 20:00:00 N: P: K. Andrew Kipkurui Korir (2019) [5] and John W. Mc Arthur *et al*. (2017) [10] found similar results. Charles F. Yanoah *et al*. (2002) [6] found that applying 30 kg/ha increased pearl millet grain output by 1.2 t/ha. Danish Ahmed Siddiqui *et al*. (2020) [3] found that varying fertilizer amounts and row spacing effect brown top millet production. Nandini and Sridhar (2019) [7] in foxtail millet, 20 X 10 cm spacing produced considerably greater grain yield than 30 X 10 cm, 20 X5 cm, and 10 X5 cm spacing. M. Roja *et al*. (2020) found that finger millet reacted to fertilizer treatment in the range of 90:40:25 to 100:50:50 kg/ha N2 P2 O5 and K2O, whereas foxtail millet responded in the range of 30:15:15 to 50:30:20 kg/ha N2 P2 O5 and K2O.

Fodder

During 2017-18, the barnyard millet genotypes RAU-11 (Check), DHBM-56-6, and DHBM-36-6 were used to investigate the influence of varying levels of nitrogen and phosphorusas well as spacing, at ARS Hanumanamatti and the findings are shown in tables 1 and 2. DHBM-36-6 provided the maximum fodder output (6380 kg/ha) and superior over DHBM-56-6 (6190 kg/ha) and RAU-11 (5900 kg/ha). The same genotypes produced more fodder yield at 22.5 × 10 cmspacing (7090 kg/ha) as compared to 30 x 7.5-10 cmspacing (5230 kg/ha). For fodder yield, these genotypes highest response to200% RDF (6980 kg/ha), which was cstatistically superior over 100% RDF (5280 kg/ha) but numerically superior over 150% RDF (6210 kg/ha).

In factorial combinations, DHBM-36-6, DHBM-56-6, and RAU-11 produced highest fodder yields of 8100 kg/ha, 7630 kg/ha, and 7090 kg/ha, respectively under the condition of 22.50 x 7.5-10 cmspacing with 200% RDF (40:40: 00:: N:P:K).

There were three barnyard millet genotypes *viz*., RAU-11(Check), DHBM-56-6and DHBM-36-6 evaluated in different level of Nitrogen and phosphorus as well as different spacing *viz*., 22.50 x 10 cm and 30 x 10 cm during 2017-18 at ARS Hanumanamatti. Out of these, DHBM-36-6(6430 kg/ha) produced highest fodder yield followed by DHBM-56-6(6220 kg/ha) and RAU-11 (5950 kg/ha). Same genotypes were recorded maximum fodderat 22.5 x 10 cm spacing (7140 kg/ha) which was statistically superior over 30 x 10 cm spacing (5270 kg/ha). These genotypes maximum responded to 200% RDF (7030 kg/ha) and it was significantly superior over to 150% RDF (6260 kg/ha) and 100% RDF (5320 kg/ha).

Look into the different factorial combinations,DHBM-36-6(8150 kg/ha) produced highest fodder yield at 22.50 x10 cm spacing and 200% RDF. Other genotypes DHBM-56-6and RAU-11(C) recorded highest fodder yield of 7680 kg/ha and 7140 kg/ha, respectively with spacing 30 x 10 cm and 200% RDF (40:40:00:: N: P: K).

Same barnyard millet genotypes *viz*., RAU-11, DHBM-56-6and DHBM-36-6 were evaluated to know effect of different level of Nitrogenandphosphorus with different spacing during 2018-19 at MARS Dharwad (black soil). Out of these, DHBM-36-6 produced highest fodder yield (7400kg/ha) followed by DHBM-56-6(7380q/ha) and RAU-11 (7090kg/ha). When look in to spacing, 22.50 x 7.5-10 cm (8290 kg/ha)statistically more fodder yield than 30 x 7.5-10 cm (6290kg/ha) while, maximum fodder yield found in 200% of RDF (8150 kg /ha) which was statistically superior over 150% RDF (7220 kg/ha) and 100% RDF (6500kg/ha).

Look into the factorial combinations, barnyard millet genotypes *viz*.,DHBM-36-6 produced highest fodder yield of 9370 kg/ha at 22.50 x 7.5-10 cm spacing with 200% RDF. Other genotypes exhibited maximum fodder yield of 9110kg/ha and 8460 kg/ha, respectively at 30 x 7.5-10 cm spacing with 200% RDF (40:40:00::

N:P:K).

The pooled results of Hanumanamatti (during 2017-8 and 2018-19) and Dharwad 2018-19 were summarized in table7 and 8. DHBM-36-6 (6730 kg /ha) produced maximum fodder yield followed by DHBM-56-6 (6600 kg/ha) and RAU-11 (6320 kg/ha). These genotypes produced highest fodder yield at 22.5 x 7.5-10 cm spacing (7510 kg/ha) which was statistically superior over 30 x 7.5-10 cm spacing (5600kg/ha). These barnyard millet genotypes gave highest grain yield when applied two hundred percent RDF (7380kg/ha) as compared to 150 percent RDF (6560 kg/ha) and 100 percent RDF (5700kg/ha).

Look into factorial combinations, DHBM-56-6 and RAU-11 produced higher fodder yield of 8220kg/ha and 7570kg/ha, respectively at 30 x 7.5-10 cm spacing with 200% RDF (60:30:30:: N:P:K) while, DHBM-36-3 recorded maximum fodder yield (8450kg/ha) in the situation of 22.50 x 7.5-10 cm spacing with200 percent RDF (40:40:0).

Found that applying a greater dose of fertilizer $N_{30}P_{24}K_{15}$ to tiny millet yielded larger grain production (1.77 / ha) than using a lower dose (0.86 / ha). Charate *et al.* (2017) [4] discovered that tiny millet yielded greater grain at 40:20:20 than at 20:00:00 N: P: K. Andrew Kipkurui Korir (2019) [5] and John W. Mc Arthur *et al* (2017) [10] found similar results. Charles F. Yanoah and colleagues (2002) [6] In pearl millet, applying 30 kg/ha increases grain production by 1.2 t/ha. Danish Ahmed Siddiqui *et al* (2020) [3] found that varying fertilizer amounts and row spacing effect brown top millet output. According to Nandini and Sridhar (2019) [7], 20 X 10 cm yielded much more grain than 30 X 10 cm and 20 X5 cm.

Gross and net returns

The trial was conduct at Hanumanamatti during 2017-18 and results were presented table 1 and 2. The DHBM-36-6 recorded highest gross and net returns (Rs.43052 and Rs.32369) which were statistically superior over DHBM-56-6(Rs.39544 and Rs.28861) and RAU-11 (Rs.37438 and Rs.26754). The spacing, 30 X 7.5-10 cm (Rs. 44679 Rs. 33429) exhibited significantly superior over22.5 X 7.5-10 (Rs. 44141 and Rs. 26754). Two hundred percent RDF (Rs.44679 and Rs.33429) recorded statistically more gross and net returns over 150% RDF (Rs.39810 and Rs. 29110) and 100% RDF (Rs.35545 Rs. 25445).

Look into different factorial combination DHBM-36-6 (Rs.50590 and Rs. 39340) DHBM-56-6 (Rs. 46316 and Rs. 35062 and RAU-11(Rs. 45597 and Rs. 34346) recorded maximum gross and net returns, at 22.50 x 7.5-10 cm spacing with 200% RDF (40:40: 00:: N:P:K)

Same experiment repeated at Hanumanamatti during 2018-19 and results were depicted in table 3 and 4. DHBM-36-6 (Rs.42206 and Rs.30572) recorded statistically more gross and net returns than DHBM-56-6 (Rs.39011 and Rs.27377) and RAU-11 (Rs.36985 and Rs.25351). The spacing 22.5 X 7.5-10 (43266 and 31632) also expressed significantly more gross and net returns when compared to 30 X 7.5-10 cm spacing (Rs.35535 and Rs.25351). Two hundred percent RDF (Rs.43736 and Rs. 31535) recorded statistically superior over 150% RDF (Rs.39653 and Rs. 28003) and 100% RDF (Rs.34812 and Rs.23762) for gross and net returns. Out of eighteen different combinations, DHBM-36-6 (Rs.50096 and Rs.37896) exhibited maximum gross and net returns at22.5 X 7.5-10 cm with two hundred percent RDF.

Barnyard millet genotypes evaluated at Dharwad during 2018-19 and results were summarised in table 5 and 6. The DHBM-36-6 (Rs.44895 and Rs33262) showed statistically more gross and net returns than DHBM-56-6 (Rs. 41850 and Rs. 30217) as well asRAU-11 (Rs.40326 and Rs.28693). Row spacing, 22.5 X 10 (Rs.46424 and Rs. 34791) exhibited significantly superior over 30 X 10 cm (Rs.38290 and Rs.26657). Two hundred percent RDF (Rs.48473 and Rs.36273) expressed significantly superior over 150% RDF (Rs.42704, and Rs.31054) and 100% RDF(Rs.35895 and Rs.24845). Among eighteen different combinations, DHBM-78-3 (Rs.54581 and Rs. 42381) exhibited maximum gross and net returns at 22.5 X 10 cm spacing and two hundred percent RDF.

Pooled analysis of Hanumanamatti (during 2017-18 and 2018-19)and Dharwad (during 2018-19) and results were presented in table 7 and 8. The DHBM-36-3 (Rs.43384 and Rs.32067) recorded highest gross and net returns and it showed significantly superior over DHBM-56-6 (Rs.40135 and Rs.28818) and RAU-11 (Rs.38250 and Rs.26933). The spacing 22.5 X 7.5-10 recorded statistically more gross (Rs.44610) and net returns (Rs. 33293) than 30 X 7.5-10 cm (Gross returns:Rs.36569and Net returns:Rs.25252). Two hundred percent RDF (Rs.45629 and Rs.33746) exhibited statistically superior over 150% RDF (Rs.40722 and Rs. 29389) and 100% RDF (Rs.35417 and Rs.24684) for gross and net returns,respectively. Look into different factorial combinations, DHBM-36-6 (Rs.51756 and Rs.39872) exhibited maximum gross and net returns at 22.5 X 10 cm spacing with two hundred percent RDF.

B:C ratio

The trial was conducted during 2017-18 at ARS, Hanumanamatti and results were presented in table 1 and 2. Out of three genotypes, DHBM-36-6exhibited statistically more B:C (4.02:1) ratio as compared to DHBM-56-6(3.69:1) and RAU-11 (3.5:1).Look into different spacing, 22.50 x 10 cm spacing(4.13:1) recorded significantly more B:C than 30 x 10 cm (3.35:1). The 200 percent RDF expressed significantly more B:C (3.97:1) ratio than 150% RDF (3.72:1) and 100% RDF (3.52:1).

Among eighteen different factorial combinations, DHBM-36-6(4.5:1) recorded maximum B:C ratio at 200% RDF with 22.50 x 7.5-10 cm spacing.

Same experiment was repeated during 2018-19 and results were depicted in table 3 and 4. The B:C ratio ofDHBM-36-6 was 3.62:1 which was statistically superior over DHBM-56-6 (3.35:1)and RAU-11(3.17:1).These barnyard millet genotypes produced significantly more B:C ratio at22.50 x 7.5-10 cm spacing (3.72:1)as compared to 30 x 7.5-10 cmspacing (3.04:1) and 200% RDF (3.58:1) recorded more B:C ratio than 150% RDF (3.36:1) and 100% RDF (3.15:1).

Look into different genotypes, spacing and fertilizer combinations,DHBM-36-6recorded maximum B:C ratioof 4.11:1at22.50 x 7.5-10 cm spacing with 200 percent recommended dose of fertilizer (40:40:00).

The same experiment was conducted at main agricultural research station Dharwad during 2018-19 and results were presented in table 5 and 6.

The B: C ratio of DHBM-36-6(3.85:1) was statistically superior over DHBM-56-6(3.58:1) and RAU-11 (3.46:1). These genotypes recorded maximum B:C ratioat22.50 x 7.5-10 cm spacing(3.98:1) which was significantly superior over 30 x 7.5-10 cm spacing (3.27:1). Out of these different fertilizer levels 200% fertilizer level (4.21:1) recorded highest B: C ratio and it was statistically superior over 150% RDF (3.67:1) and 100% RDF (3.25:1).

Among eighteen different factorial combinations, DHBM-36-3, DHBM-56-6 and RAU-11exhibited maximum B:C ratio of 4.47:1, 4.15:1 and 4.0:1, respectively at 200% RDF with 22.50 x 10 cm spacing.

The pooled results of ARS, Hanumanamatti (during 2017-18 and 2018-19)and MARS, Dharwad (during 2018-19) and results were presented in table 7 and 8. Out of three genotypes, DHBM-36-6(3.83:1) produced maximum B: C ratio which was significantly superior over DHBM-56-6(3.54:1) and RAU-11 (3.37:1). These genotypes exhibited highest B:C ratio at 22.50 x 7.5-10 cm spacing (3.94:1) which was statistically superior over 30 x 7.5-10 cm (3.22:1).Two hundred percent RDF (3.84:1) exhibited significantly more B:C ratio than 150% RDF (3.6:1) as well as 100% RDF (3.31:1). Among eighteen different factorial combinations, DHBM-36-6, recorded maximum B:C ratio (4.36:1) at RDF 22.50 x 7.5-10 cm spacing. With 200% B.H. reported that RDF along with urea spray 2%, spray 2% DAP + spray 2% (CaNO3) + spray 2% (19:19:19) increase B:C (1.54:1)

Conclusion

Out of three genotypes, DHBM-36-3 (4338 kg/ha) produced highest grain yield and it noticed significantly superior over DHBM-56-6 (4041 kg/ha) and RAU-11 (3825 kg/ha). These genotypes were recorded maximum yield at 22.5 x 10 cm spacing (4461 kg/ha).

Two hundred percent RDF (4563 kg/ha) as compare to 150 percent RDF (4072 kg/ha) and 100 percent RDF (3542 kg/ha).When look in to factorial combinations, DHBM-36-3, DHBM-56-6, and RAU-11 produced maximum grain yield of 5176 kg/ha, 4733 kg/ha, and 4594 kg/ha, respectively, at 22.50 x10 cm spacing with 200% RDF (40:40: 00: N: P: K).

DHBM-36-6 (6730 kg /ha) produced maximum fodder yield followed by DHBM-56-6 (6600 kg/ha) and RAU-11 (6320 kg/ha). These genotypes produced highest fodder yield at 22.5 x 7.5-10 cm spacing (7510 kg/ha) which was statistically superior over 30 x 7.5-10 cm spacing (5600 kg/ha). These barnyard millet genotypes gave highest grain yield when applied two hundred percent RDF (7380 kg/ha) as compared to 150 percent RDF (6560 kg/ha) and 100 percent RDF (5700 kg/ha).

Look into factorial combinations, DHBM-56-6 and RAU-11 produced higher fodder yield of 8220 kg/ha and 7570 kg/ha, respectively at 30 x 7.5-10 cm spacing with 200% RDF (60:30:30:: N:P:K) while, DHBM-36-3 recorded maximum fodder yield (8450 kg/ha) in the situation of 22.50 x 7.5-10 cm spacing with 200 percent RDF (40:40:0).

The DHBM-36-3 (Rs 43384 and Rs 32067) recorded highest gross and net returns and it showed significantly superior over DHBM-56-6 (Rs 40135 and Rs 28818) and RAU-11 (Rs 38250 and Rs 26933). The spacing 22.5 X 7.5-10 recorded statistically more gross (Rs 44610) and net returns (Rs 33293) than 30 X 7.5-10 cm (Gross returns: Rs 36569 and Net returns: Rs 25252). Two hundred percent RDF (Rs 45629 and Rs 33746) exhibited statistically superior over 150% RDF (Rs 40722 and Rs 29389) and 100% RDF (Rs 35417 and Rs 24684) for gross and net returns, respectively. Look into different factorial combinations, DHBM-36-6 (Rs 51756 and Rs 39872) exhibited maximum gross and net returns at 22.5 X 10 cm spacing with two hundred percent RDF.

Out of three genotypes, DHBM-36-6 (3.83:1) produced maximum B: C ratio which was significantly superior over DHBM-56-6 (3.54:1) and RAU-11 (3.37:1). These genotypes exhibited highest B:C ratio at 22.50 x 7.5-10 cm spacing (3.94:1) which was statistically superior over 30 x 7.5-10 cm (3.22:1). Two hundred percent RDF (3.84:1) exhibited significantly more B:C ratio than 150% RDF (3.6:1) as well as 100% RDF (3.31:1). Among eighteen different factorial combinations, DHBM-36-6, recorded maximum B:C ratio (4.36:1) at RDF 22.50 x 7.5-10 cm spacing.

Overall DHBM-36-6 was best genotype it produced highest grain yield (4338 kg/ha), fodder yield (6730 kg /ha), B:C ratio DHBM-36-6 (3.83:1) and gross and net return (Rs 43384 and Rs 32067)and these barnyard millet genotypes respond to 200 percent RDF and 22.5 X 7.5-10 cm spacing.

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