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Effect of Crop Geometry and Nutrient Management Practices on Growth Attributes and Yield of Transplanted Finger Millet in Krishna Agro-climatic Conditions of Andhra Pradesh

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ABSTRACT: Finger millet being a low fertilizer input and staple food crop for tribal and lower income class, it suffers from low yields. The present investigation deals with agro-management practices that are imperative for boosting the growth and production of finger millet. Field experiment was conducted at Agricultural college farm, Bapatla during the *kharif* seasons of 2018 and 2019 to evaluate the effect of crop geometry and nutrient management practices on growth and yield performance of finger millet. The trial comprised of three crop geometries with different age of seedlings (30 × 10 cm with 30 days old seedlings, 30 × 30 cm with 15 days old seedlings and 45 × 45 cm with 15 days old seedlings) in main plots and seven nutrient management practices (S_0: absolute control, S_1: FYM @ 10 tonnes ha^{-1} + application of *dravajeevamrutham*, S_2: FYM @ 10 tonnes ha^{-1} + application of *dravajeevamrutham* along with wooden log treatment, S_3: FYM @ 10 tonnes ha^{-1} + 100% RDF, S_4: FYM @ 10 tonnes ha^{-1} + 100% RDF along with wooden log treatment, S_5: FYM @ 10 tonnes ha^{-1} + 125% RDF, S_6: FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment) in subplots. The experimental design was split plot with three replications. The spacing of 30 × 10 cm produced the tallest plants, highest dry matter production and yield, while 45 × 45 cm spacing recorded highest no. of tillers hill^{-1} and SPAD values. Significantly higher growth attributes and grain yield were recorded with the application of FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment.

Keywords: Yield, growth attributes, crop geometry, nutrient management practice and finger millet.

INTRODUCTION

Millets are the imperative food and fodder crops in semi-arid regions that are predominantly gaining more relevance in the world. They are mostly grown in marginal areas where the other major cereals fail to give sustainable yields. Millets which are mainly cultivated as rainfed crops are potential in their contribution to food production, both in developing and developed countries (Bhagat *et al*., 2019). Among different millets, finger millet (*Eleusine coracana* L. Gaertn.), is a major staple crop among tribal farming communities in developing countries like India, which has manifold nutritional benefits, has thirty times more calcium than rice. Finger millet grains have an excellent property of long storability even under normal conditions which made them "famine reserves" (Sakamma *et al*., 2018). Being a low fertilizer input (NRC, 1996) and staple food crop for tribal and lower income class, it suffers from low yields (Rurinda *et al*., 2014). Productivity limit in finger millet is attributed to resource-poor soils of rainfed areas deficient in macro and micronutrients, besides continuous cropping, poor recycling of crop residues and low rates of organic matter application (Rao *et al*., 2012). Delayed transplanting, coupled with faulty methods of cultivation, lower fertilizer use efficiency and higher seed rate are the other reasons for it's poor yields.

Among the modern agro-management practices, suitable planting method and fertilizer application are imperative for boosting the growth and production of finger millet. Plant geometry plays an important role on growth, development and yield of crops. Improper spacing reduces the yield but optimum spacing ensures plants to grow properly making better utilization of sunlight and nutrients. Hence, maintenance of an optimum level of finger millet plant population in the field is necessary to maximize the grain yields. In Karnataka, the average yield of finger millet is higher under square planting with young single seedling hill^{-1} (Kalaraju *et al*., 2011). Whereas wider spacing was found superior to narrow spacing in terms of enhanced grain and straw yield. The increased spacing means increased number of tillers and with better girth than those plants cultivated under traditional method (Anitha, 2015). Further wider spacing facilitates inter row and intra row weed control, enabling farmers to use simple weeding tools to incorporate the weeds to increase the soil fertility (Kumar, 2018). Fertilizer application not only influences the economic return of the investment through optimized yield and quality, but also causes minimum level of environmental hazard (Pallavi *et al*., 2016). However, conjunctive use of chemical fertilizers and organic manures is important to maintain and sustain soil fertility and crop productivity (Hebbal, 2017). Since integrated Nutrient Management system is gaining importance among the farmers in rainfed agro ecosystem, it is advisable to optimize the use of inorganic fertilizers along with organic manures such as FYM, for getting high yields of better quality besides keeping the production cost at sustainable level (Nevse *et al*., 2013). When other growing conditions are favorable the dragging of *koradu* stimulates profused tillering and adventitious root system enabling panicles to be larger with better grain filling and improved size coupled with quality of the ear heads due to better availability of nutrients and moisture facilitating harvesting of 18 to 20 quintals of produce acre^{-1} (Prakasha, 2015). An experiment was conducted to explore the impact of these factors on growth attributes and yield of finger millet.

MATERIALS AND METHODS

The experiment was conducted at Agricultural college farm, Bapatla during the *kharif* seasons of 2018 and 2019. The soil of experimental site was sandy clay loam in texture with slightly alkaline reaction, low organic carbon content, low available nitrogen and medium in available phosphorous and potassium. The experiment was laid in split plot design having 21 treatments replicated thrice. The treatments comprised of two factors, *viz*., crop geometries with different age of seedlings (M_1: 30 × 10 cm with 30 days old seedlings, M_2: 30 × 30 cm with 15 days old seedlings and M_3: 45 × 45 cm with 15 days old seedlings) and seven nutrient management practices (S_0: absolute control, S_1: FYM @ 10 tonnes ha^{-1} + application of *dravajeevamrutham*, S_2: FYM @ 10 tonnes ha^{-1} + application of *dravajeevamrutham* along with wooden log treatment, S_3: FYM @ 10 tonnes ha^{-1} + 100% RDF, S_4: FYM @ 10 tonnes ha^{-1} + 100% RDF along with wooden log treatment, S_5: FYM @ 10 tonnes ha^{-1} + 125% RDF, S_6: FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment. The growth parameters were recorded at periodical intervals of 30, 60 DAT and at harvest from the randomly selected five plants in each treatment. Pooled data of the growth parameters was given here for comprehensive understanding. Grain and straw yields of finger millet was calculated to kg ha^{-1}.

RESULTS AND DISCUSSION

The results of the present investigation revealed that transplanting of 30 days old seedlings at a spacing of 30 × 10 cm significantly increased the plant height (54, 108 and 115 cm at 30, 60 DAT and at harvest, respectively) at 60 DAT and at harvest only and dry matter production (5125.0, 8326.2 and 9849.2 kg ha^{-1}) at 30, 60 DAT and at harvest respectively. As the mutual shading increases at greater plant densities, the plant tends to grow taller. The current findings are in line with the earlier findings of Rajesh, (2011); Anitha (2015). Significantly the highest dry matter production in closer spacing may be because of higher plant population as compared to the wider spacing and vice versa. Taller plants and increased number of tillers per unit area in this treatment might have also resulted in higher dry matter accumulation. The results are in accordance with the earlier findings of Damodaran *et al*., (2012); Anitha, (2015); Praveen *et al.*, (2019).

Significantly higher number of tillers hill^{-1} (3.48, 7.80 and 10.52 at 30, 60 DAT and at harvest respectively) and higher SPAD values (34.04, 42.37 and 29.16 at 30, 60 DAT and at harvest respectively) though not significant were recorded with transplanting of 15 days old seedlings at a spacing of 45 × 45 cm. This could be due to the fact that the individual plants could have effectively utilized the available resources such as space, foraging area for root system, light utilization etc and thus enhanced the tiller production. Similar increased number of tillers hill^{-1} under wider spacing was well documented by Kalaraju *et al*., (2011); Dahal and Khadka (2012); Anitha (2015). Green colour retention in leaves in wider spacing might have resulted in higher value of SPAD than lower spacing. The findings are in line with earlier findings of Prakasha, (2015); Hebbal, (2017). The chlorophyll content increased due to transplanting of 15 days old seedlings and this can be associated to prolific root growth resulting from non destruction of the root system during uprooting and transplanting. The results are in line with Pramanik and Bera (2013).

There was a marked increase in plant height (60, 118 and 124 cm at 30, 60 DAT and at harvest respectively) at all stages of the plant growth with application of FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment (S_6). Increased per cent of RDF provides sufficient nutrition to plant which lead to anatomical changes such as increase in size of cells, intercellular spaces, thinner cell walls and lower development of epidermal tissue resulting in increased plant height. Similar finding were also reported by Sunitha *et al*., (2004); Deshmukh (2007); Pradhan *et al*., (2011); Raundal and Vidya, (2017). The lowest plant height was obviously recorded with control as no fertilizer was supplied through this treatment. Similar reduced plant height in absolute control was also reported by Sahare, (2015); Mahapatra, (2017). Significantly the highest dry matter production at 30, 60 DAT and at harvest (5856.8, 9576.1 and 11417.0 kg ha^{-1}) was observed with S_6 treatment. The results are in accordance with the findings of Duryodhana *et al*., (2004); Giribabu, (2006); Kadalli *et al*., (2006) who observed that adequate supply of nutrients through RDF and addition of FYM might have created favourable conditions for better availability and uptake of plant nutrients throughout the crop growth period and resulted in increased growth parameters. Addition of FYM might have reduced the losses of added fertilizers and the availability of the nutrients might have regulated in tune with the crop uptake. Similarly the wooden log treatment might have enhanced the tiller number leading to production of increased dry matter as reported by Uphoff (2006); Kalaraju, (2007); Prakasha, (2015); Patil, (2017).

Significantly higher number of tillers hill^{-1} (4.25, 7.40 and 8.84 at 30, 60 DAT and at harvest respectively) were recorded in S_6 treatment. The results were in accordance with the findings of Thesiya *et al*., (2019) who stated that integration of chemical and organic sources provided enough nutrients coupled with organic matter. The increased tiller number with FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment could be due the wooden log treatment, which might have resulted in greater availability of auxins to lateral buds, which otherwise would have remained dormant (Hosapalya, 2005; Kalaraju, 2007). The young plants bend over without breaking, causing a mild trauma in plants so as to initiate increased tillers and greater root proliferation (Patil, 2017). Passing the wooden implement known as *Koradu* thrice, at weekly interval between 30 to 35 DAT on the seedlings under favorable soil conditions enhances tillering in finger millet (Uphoff, 2006; Prakasha, 2015). Higher SPAD values (37.32, 50.83 and 31.66 at 30, 60 DAT and at harvest respectively) were observed in S_6 treatment. The chlorophyll content that directly involved in photosynthesis, was significantly higher at 60 DAT with conjunctive use of FYM along with recommended NPK. The findings are in line with Goudar, (2014). The gradual decrease in SPAD value might be due to decrease in applied soil nitrogen due to leaching or by volatilization loss. The findings were in accordance with Sekharkumar, (2004); Pallavi, (2014).

Table 1: Growth parameters of finger millet as influenced by crop geometry and nutrient management practices during *kharif* in pooled data.

Treatments	Plant height (cm)			Dry matter production (kg ha^{-1})			Number of tillers hill^{-1}			SPAD readings		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest
Crop geometry												
M_1- 30 × 10 cm with 30 days old seedlings	54	108	115	5125.0	8326.2	9849.2	1.81	2.31	2.66	28.67	37.68	26.14
M_2- 30 × 30 cm with 15 days old seedlings	49	96	108	4630.3	7534.4	8687.3	2.91	5.50	6.69	33.13	40.31	27.45
M_3- 45 × 45 cm with 15 days old seedlings	47	91	106	3711.1	6030.6	7071.1	3.48	7.80	10.52	34.04	42.37	29.16
S.Em±	1.72	1.52	1.76	141.4	209.5	330.5	0.11	0.16	0.19	1.39	1.26	0.79
CD (p = 0.05)	NS	6	7	555.4	822.5	1297.8	0.43	0.64	0.76	NS	NS	NS
CV(%)	15.7	7.1	7.4	14.44	13.16	17.74	18.15	14.24	13.32	19.99	14.40	13.12
Nutrient management												
S_0-Absolute control	41	79	91	2390.4	3932.1	4417.0	1.59	2.68	4.04	23.86	30.29	22.50
S_1- FYM @ 10 tonnes ha^{-1} +*dravajeevamrutham*	44	83	98	3113.3	5100.1	5801.8	1.88	3.23	5.02	27.14	32.09	24.51
S_2- S_1+ passing wooden log	46	86	101	4060.7	6623.5	7598.8	2.11	4.41	5.56	29.38	34.50	26.28
S_3- FYM @ 10 tonnes ha^{-1} + 100% RDF	51	103	116	4888.2	7900.8	9279.8	2.71	5.49	6.92	34.15	41.43	27.80
S_4- S_3+ passing wooden log	54	107	117	5297.8	8555.6	10063.2	3.10	6.51	7.81	35.23	44.41	29.59
S_5 - FYM @ 10 tonnes ha^{-1} + 125% RDF	56	112	120	5814.1	9391.2	11173.5	3.51	6.72	8.17	36.53	47.28	30.74
S_6- S_5 + passing wooden log	60	118	124	5856.8	9576.1	11417.0	4.25	7.40	8.84	37.32	50.83	31.66
S.Em±	1.80	3.08	2.80	235.7	406.4	440.7	0.14	0.33	0.43	1.41	1.71	0.86
CD (p = 0.05)	5	9	8	675.9	1165.6	1263.9	0.41	0.94	1.22	4.04	4.90	2.47
CV (%)	10.8	9.4	7.7	15.75	14.49	15.49	15.62	18.88	19.29	13.22	12.76	9.37
Interaction												
M × S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S × M	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The current results are in accordance with Salem *et al*., (2011); Munirathnam and Ashok Kumar (2015). The grain (2668 and 2773 and 2721 kg ha^{-1}) and straw yields (6538, 6722, 6630 kg ha^{-1}) of finger millet during 2018-19, 2019-20 and in pooled data were significantly higher at the closer spacing of 30 × 10 cm. Since the number of plants per unit area are higher in closer spacing, compared to wider spacing, this reflected in realizing greater grain yield ha^{-1}. Though higher number of tillers hill^{-1} were recorded at wider spacing, this could not compensate for more number of plants per unit area. Shinggu and Gani, (2012) recorded higher grain yield at 10 and 15 cm spacing and this could be attributed to higher plant population per unit area and reduced competition from weeds due to closer spacing. Similar higher straw yields at closer spacing was also reported by Rajesh, (2011); Kalaraju *et al*., (2011); Anitha, (2015).

Application of FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment (S_6) registered significantly higher grain (3079, 3191, 3135 kg ha^{-1}) and straw yields (7729, 7903, 7816 kg ha^{-1}) during both years and in pooled data which were statistically comparable with S_5 treatment and the absolute control recorded the lowest yield. Sustained release of available nutrients during crop growth period was found to increase yield substantially (Raniperumal *et al*., 1991, Goudar, 2014; Senthilkumar *et al*., 2018). The lowest grain and straw yields observed with control might be attributed to the poor performance of the crop due to low supply of nutrients (Mahapatra, 2017).

Table 2: Yield of finger millet as influenced by crop geometry and nutrient management practices during *kharif*, 2018-19 and 2019-20 and in pooled data.

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
	2018-19	2019-20	Pooled data	2018-19	2019-20	Pooled data
Crop geometry						
M_1 - 30 × 10cm with 30 days old seedlings	2668	2773	2721	6538	6722	6630
M_2 - 30 × 30cm with 15 days old seedlings	2258	2363	2310	5757	5896	5827
M_3 - 45 × 45cm with 15 days old seedlings	2079	2172	2126	4350	4504	4427
S.Em ±	91.61	48.79	61.18	147.14	200.83	177.42
CD (p = 0.05)	360	192	240	578	789	697
CV (%)	17.98	9.18	11.75	12.15	16.13	14.45
Nutrient management						
S_0-Absolute control	1213	1324	1268	2483	2520	2502
S_1- FYM @ 10 tonnes ha^{-1} + *dravajeevamrutham*	1765	1837	1801	3603	3738	3671
S_2- S_1 + passing wooden log	2051	2102	2076	4884	4944	4914
S_3- FYM @ 10 tonnes ha^{-1} + 100% RDF	2521	2668	2595	6131	6338	6234
S_4- S_3 + passing wooden log	2761	2884	2822	6358	6737	6547
S_5- FYM @ 10 tonnes ha^{-1} + 125% RDF	2955	3046	3000	7652	7770	7711
S_6- S_5 + passing wooden log	3079	3191	3135	7729	7903	7816
S.Em±	136.30	128.22	98.73	325.33	388.27	320.07
CD (p = 0.05)	391	368	283	933	1114	918
CV (%)	17.51	15.79	12.42	17.59	20.41	17.06
Interaction						
M x S	NS	NS	NS	NS	NS	NS
S x M	NS	NS	NS	NS	NS	NS

CONCLUSION

In conclusion from the study, it was inferred that transplanting of 30 days old seedlings at a spacing of 30 × 10 cm and integrated application of FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment resulted in better growth and yield of finger millet per unit area.

FUTURE SCOPE

1. Inclusion of other planting geometry in pit method may be suggested.
2. Elaborate and systemic studies are required for development of strategies to sustain high nutrient use efficiency on long term basis in different intensive cropping systems in various agro climatic regions.
3. Research trials have to be conducted in farmers fields also for more significance and on farm comparison.

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Conflict of Interest: None.

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