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Effect of Crop Geometry and Nutrient Management Approaches on Yield and Quality of Transplanted Finger Millet

A. Aliveni[1], B. Venkateswarlu[1], M. Sree Rekha[1], P.R.K. Prasad[1], K. Jayalalitha[1]

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ABSTRACT

Background: An ideal crop geometry is essential for obtaining optimum plant stand in the field as the yield of a crop depends on the final plant density with effective utilization of growth resources. Conjunctive use of chemical fertilizers and organic manures is important to maintain and sustain soil fertility and crop productivity. Nutrient Management system is gaining importance among the farmers and it is advisable to optimize the use of inorganic fertilizers along with organic manures for getting high yields of better quality besides keeping the production cost at sustainable level. The current field study was aimed to evaluate the impact of various crop geometries and nutrient management treatments on yield and quality of transplanted finger millet.

Methods: A Field experiment was conducted at Agricultural college farm, Bapatla during the *kharif* seasons of 2018 and 2019 and the experimental design was split plot with three replications. The main-plot factor comprised of three crop geometries with different age of seedlings and seven nutrient management practices in subplots.

Result: The experimental results indicated that significantly higher grain and straw yields with good quality grain of finger millet were recorded in the spacing of 30 × 10 cm fb 30 × 30 cm spacing and among the nutrient management approaches application of FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment (S_6) recorded the highest yield and however was statistically comparable with 125% of RDF + FYM (S_5).

Key words: Crop geometry, Finger millet, Nutrient management approach, Quality, Yield.

INTRODUCTION

Millets are the imperative food and fodder crops, gaining more relevance in the world. The attention towards millet-based farming systems were increasing as a challenge to food production posed by climate aberrations. They are climate-resilient and nutritionally equivalent or superior to most other cereals, making them a favourable crop to address the prevalence of malnutrition. Among different millets, finger millet [*Eleusine coracana* (L.) Gaertn.], also known as ragi is a major staple crop among tribal farming communities and low socio-economic groups in developing countries like India, which has manifold nutritional benefits, has thirty times more calcium than rice. It is a good source of carbohydrate, protein, dietary fibre and minerals. Andhra Pradesh occupies an area of 0.32 lakh ha with both production and productivity of 0.35 lakh tones and 1.09 tones ha^{-1}, respectively (www.Indiastat.com, 2017-18). In spite of these admirable qualities and its importance in food and nutrition security the crop is neglected and there has been decline both in area and production of the crop. Productivity limit in finger millet is, attributed to resource-poor soils of rainfed areas deficient in macro and micronutrients, 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. To sustain the soil health and to attain the production potential of crops, a complementary usage of organic manures and chemical fertilizers is important. An experiment was conducted to explore the impact of these factors on yield and quality 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

[1]Department of Agronomy, Agricultural College, Bapatla-522 101, Andhra Pradesh, India.

Corresponding Author: A. Aliveni, Department of Agronomy, Agricultural College, Bapatla-522 101, Andhra Pradesh, India. Email: aliveni165@gmail.com

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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: 45x45 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. *Dravajeevamrutham* is prepared by mixing 10 kg local cow dung with 10 litres cow urine and 2 kg local jaggery, 2 kg pulse flour and handful of garden soil was added and then the volume was made to 200 litres. A wooden log known as *Koradu* (7 feet long and 18 inches wide) was worked twice between 15 and 30 DAT on the transplanted seedlings as per treatment under favorable soil conditions to bent over the stems to ground level so as to stimulate profused tillering for realizing higher yield. RDF: 60-40-30 kg, N, P_2O_5 and K_2O ha^{-1} (P and K as basal, N in two splits as basal and 35-40 DAT). Grain and straw yields of finger millet was calculated to kg ha^{-1}. Nitrogen content in the grains of finger millet was estimated by Kjeldhal's method (Jackson, 1967). The protein per cent in the grain was calculated by multiplying the nitrogen content by a factor of 6.25 (Bandyopadhyay and Roy, 1992).

Protein content (%)= Nitrogen content in grain (%) × 6.25

RESULTS AND DISCUSSION

Productive tillers

Data in Table 1 show that **s**ignificantly the highest number of productive tillers hill^{-1} (10.28) was observed with the wider spacing of M_3, which was significantly superior to the other geometries and was followed by M_2. The lowest number of productive tillers (2.52) were recorded with M_1.

Higher number of productive tillers were observed with wider spacing. Similar results were also supported by Rajbhandari (2007), who reported higher effective tillers with wider spacing. The different responses for hill spacing might be due to the fact that the wider spacing allowed more light, space for producing higher number of effective tillers (Sohel *et al*., 2009).

With respect to the nutrient management practices S_6 treatment recorded the highest number of productive tillers hill^{-1} (8.47), which was however comparable with S_5 and S_4. The least number of productive tillers hill^{-1} (3.84) was recorded with the absolute control, which maintained parity with S_1.

The increase in productive tillers might be due to the INM application of fertilizers, which make more availability of nutrients to the plant, while FYM improves the soil physical properties, hydraulic conductivity of the soil and also the

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

Treatments	Productive tillers hill^{-1}	Ear head weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Protein content (%)
Crop geometry					
M_1- 30 × 10 cm with 30 days old seedlings	2.52	2.49	2721	6630	13.53
M_2- 30 × 30 cm with 15 days old seedlings	6.33	3.76	2310	5827	12.62
M_3- 45 × 45 cm with 15 days old seedlings	10.28	4.22	2126	4427	12.35
S.Em±	0.22	0.10	61.18	177.42	0.09
CD (p= 0.05)	0.87	0.39	240	697	0.36
CV (%)	15.84	12.94	11.75	14.45	3.29
Nutrient management					
S_0-Absolute control	3.84	2.54	1268	2502	11.51
S_1- FYM @ 10 tonnes ha^{-1}+*dravajeevamrutham*	4.82	2.91	1801	3671	11.62
S_2- S+passing wooden log	5.31	3.17	2076	4914	12.03
S_3- FYM @ 10 tonnes ha^{-1}+100% RDF	6.71	3.50	2595	6234	13.45
S_4- S+passing wooden log	7.54	3.79	2822	6547	13.64
S_5- FYM @ 10 tonnes ha^{-1}+125% RDF	7.94	4.13	3000	7711	13.73
S_6- S_5 +passing wooden log	8.47	4.38	3135	7816	13.85
S.Em±	0.42	0.18	98.73	320.07	0.29
CD (p= 0.05)	1.21	0.52	283	918	0.83
CV (%)	19.90	15.51	12.42	17.06	6.73
Interaction					
M × S	NS	NS	NS	NS	NS
S × M	NS	NS	NS	NS	NS

availability of NPK along with all other essential plant nutrients, which promoted plant growth and development, resulting in increased yield attributes. The present findings are in close conformity with the earlier findings of Divya *et al*. (2017).

Ear head weight

Data pertaining to ear head weight (Table 1) of finger millet revealed that with regard to different crop geometries, M_3 recorded significantly the highest ear head weight (4.22g) and was statistically on a par with M_2 treatment. M_1 treatment registered the lowest value (2.49 g).

These results are in conformity with the findings of Mishra *et al*. (1973) and Kalaraju *et al.* (2009) who reported that spacing of 30 × 30 cm prolonged the growth duration and increased the yield attributes.

The findings of Kipgen *et al*., 2018 in rice is in close confirmation with the present findings who observed significantly higher panicle weight with wider spacing of 20 × 20 cm and least weight in close spacing of 15 × 15 cm which might be due to competition of plants for light within the dense plants at closer hill spacing resulting in reduced panicle weight due to reduction in the rate of photosynthesis (Yadav, 2007). Planting of early age seedlings in main field have more opportunity to harness solar radiation for photosynthesis and established better source and sink relationship which resulted in increased weight of ear head. The results are in accordance with the findings of Amin and Haque (2009) and Balasaheb (2017).

The nutrient management practices significantly influenced the ear head weight of finger millet. The integrated nutrient management practice with high fertilizer dose with wooden log treatment (125% of RDF + FYM @ 10 tonnes ha^{-1}) recorded significantly the highest ear head weight (4.38 g) and was comparable with S_5. The absolute control recorded the lowest weight of ear head (2.54 g). However statistically on a par with farmers practice without wooden log treatment (S_1).

The current results are supported by Ahiwale *et al*. (2011) who obtained highest ear head weight with integration of organic and inorganic sources of nutrients (FYM @ 5 t ha^{-1} plus RDF) indicating that the role of FYM is multi dimensional ranging from building up of soil organic matter, maintaining favourable soil physical and chemical properties and balanced supply of nutrients. Further, Balasaheb (2017) stated that application of recommended dose in main field get opportunity to carry out photosynthesis and established better source and sink relationship which in turn resulted in the highest weight of $panicle^{-1}$.

Yield

The data recorded and analysed for yield (Table 1) manifested that crop geometries and nutrient management practices significantly influenced the yield. However the interaction effect between the treatments was statistically not significant during both years of study.

The grain (2721 kg ha^{-1}) and straw yields (6630 kg ha^{-1}) of finger millet 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 $hill^{-1}$ (10.28) were recorded at wider spacing, this could not compensate for more number of plants per unit area. The current findings are also supported by the study conducted by Borkar *et al*. (2008). Optimum planting pattern is the prerequisite for proper utilization of growth resources and ultimately to exploit the potential productivity of any crop. This is in agreement with the findings of Rafey and Srivastava (1988). Similar higher straw yield at closer spacing was also reported by (Rajesh, 2011), Kalaraju *et al*. (2011) and Anitha (2015). This also agrees with the report by Shinggu *et al*. (2009) who felt that closer spacing resulted in reduced weed competition rendering higher yield. 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.

Application of FYM @ 10 tonnes ha^{-1} + 125% RDF along with wooden log treatment (S_6) registered significantly higher grain (3135 kg ha^{-1}) and straw yields (7816 kg ha^{-1}) which were statistically comparable with S_5 treatment and the absolute control recorded the lowest yield. This may be due to sufficient and continous supply of all essential nutrients in integrated approach (Prakash *et al*., 2018). Vidya *et al*. (2018) reported that 125 and 150% RDF might have resulted in better root activity, good source to sink relationship. Sustained release of available nutrients during crop growth period was found to increase yield substantially (Raniperumal *et al*., 1991, Goudar, 2014 and 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).

Quality

The data analyzed for protein content was tabulated in (Table 1). The protein content was significantly influenced by crop geometry and nutrient management practices. However their interaction was found to be non-significant. Finger millet transplantation at 30 × 10 cm with 30 days old seedlings (M_1) recorded significantly the highest protein content in grain (13.53%) followed by M_2. The lowest protein content (12.35%) was recorded with M_3 (45 × 45 cm spacing with 15 days old seedlings) but statistically comparable with M_2 treatment. Higher grain protein content in closer spacing was also observed by Nandini and Sridhara (2019) in foxtail millet. The results were also in compliance with Zhang *et al*. (2018) who observed maximum protein content and protein fractions at the planting density of 260 plants m^{-2} in wheat. It may be due to the reason that at high plant population tillers group were reduced whereas nitrogen metabolism is higher in the early stage of grain filling.

The results were also in compliance with Joginaidu *et al*. (2013), who observed significantly higher protein content in a planting pattern of 25x25 cm, over 35x35 cm in rice crop and stated that planting pattern of 25 x 25 cm, might have created better growth environment with proper root development due to prevailing of optimum moisture and better availability of nutrients resulting in higher protein content.

With respect to nutrient management practices the highest protein content in grain was recorded in S_6 (13.85%) and was significantly superior to S_0, S_1 and S_2 treatments and however on a par with rest of the nutrient management practices with and without wooden log treatment *i.e*., S_3, S_4 and S_5 treatments. The absolute control (S_0) recorded significantly the lowest grain protein content (11.51%). The protein content in grain is infact a manifestation of nitrogen concentration. Nitrogen is a major structural constituent of cell wall thus increasing the quality by improving the protein content. The increased grain nitrogen resulted in higher protein content recorded with combined use of fertilizers and manures. The findings of present investigation are in agreement with those of Jat *et al*. (2003) and Rampratap (2006). The findings are also supported by Nandini *et al*. (2018) who observed higher protein content with 150% N ha^{-1} and least with control.

CONCLUSION

Keeping in view of the above options, it can be concluded that for realizing higher production with good quality grain, the finger millet has to be transplanted at a spacing of 30 × 10 cm and supplied with FYM @ 10 tonnes ha^{-1} + 125% RDF.

Conflict of interest: None.

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