Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 3426-3429
Received: 12-05-2020
Accepted: 14-06-2020

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Growth, yield attributes and yield of foxtail millet as influenced by varieties and integrated nutrient management

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Abstract
A field experiment was conducted during *kharif*, 2019 at College farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The soil of the experimental plot was sandy loam in texture, neutral in soil reaction, low in available nitrogen and organic carbon, low in available phosphorus and high in available potassium. The experiment was laid out in Factorial Randomized Block Design with 14 treatments and each treatment replicated thrice. Among the two varieties tested *viz.,* SiA 3085 and SiA 3156, there were no significant difference in growth and yield of foxtail millet, both the varieties performed equally and found to be equally effective and remunerative with respect to different organic and inorganic sources of nutrients. Among integrated nutrient management practices, 25% RDN through Vermicompost + 75% RDF recorded significantly higher growth, yield attributes, grain yield and straw yield over other combinations of organic and inorganic treatments and 100% RDF.

Keywords: Growth, yield attributes, yield and integrated nutrient management.

Introduction
Foxtail millet (*Setaria italica* L.) is known as Italian millet, German millet and korralu, Kangu, Kangani, Koni and Kaon in different parts of India. It is one of the oldest crops cultivated for food, grain, hay and pasture. It ranks second in the total world production of millets and it continues to have an important place in world agriculture providing food for millions of people in arid and semiarid regions.

India is the largest producer of foxtail millet. In India it is largely grown in Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Uttar Pradesh and Southern Rajasthan. Andhra Pradesh, Karnataka and Tamil Nadu are the major foxtail millet growing states in India contributing about 79 per cent of the total area (Munirathnam *et al.*, 2006) [10].

It is generally grown as a rainfed crop in India. It has an erect leafy stem that grow 60-75 cm tall and bend quite a bit at maturity due to heavy weight of ear head. In 100 g of foxtail millet grain contains excellent source of good fibre 8 g, protein 12.3 g, carbohydrates 60.9 g, fat 4.3 g, calcium 31 mg, Iron 2.8 mg, phosphorus 290 mg, vitamins 3.3 g, amino acids, minerals 3.3 g and food energy 323-350 K Cal (Vanithasri *et al.*, 2012) [17]. It has low glycemic index, so it is used for preparation of low glycemic index biscuits and burfi, a sweet product and it is an ideal food for people suffering from diabetes.

The soils in arid and semiarid regions are mainly deficient in nitrogen and inherently low in organic carbon because of rapid turnover rates of organic material due to higher soil temperature. With harsh climatic conditions and low soil fertility, effective nutrient management is of considerable importance to overcome the situations of limited yields in these areas. Thus low productivity in farmers' field in foxtail millet can be increased by adopting improved production technologies like integrated nutrient management.

Now a days, use of chemical fertilizer is increasing to boost up crop production. Simultaneously, cost of chemical fertilizer is increased constantly, besides these, only use of inorganic fertilizer is injurious to soil health and soil productivity. Integration of inorganic and organic fertilizers play a vital role for enhancing crop productivity and sustaining soil fertility, this proves great promise for farmers. Organic manure like vermicompost is a rich mixture of macro and micro plant nutrients. It also increases availability of nitrogen and phosphorus and improves microbial action in soil (Choudhary *et al.*, 2014) [2].

Hence integrated nutrient supply system involving sheep manure, organic manures like vermicompost, FYM in conjunction with chemical fertilizer is necessary to meet the nutrient

Demand besides improving physicochemical properties of soil. Since information pertaining to above aspects is meager, the present investigation was carried out to study the effect of integrated nutrient management on growth, productivity and nutrient uptake of foxtail millet.

Materials and Methods

The field experiment was conducted in College farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, which is geographically situated at 17°19' N latitude and 78°23' E longitude at an altitude of 542.6 m above mean sea level. The soil of the experimental site was sandy loam in texture, neutral in soil reaction (7.56) and E.C. was 0.26. It was low in available nitrogen (166.8 kg ha^{-1}), available phosphorus (22.1 kg ha^{-1}) and organic carbon (0.87%) and high in available potassium 376.5 kg ha^{-1}). The treatment consisted of two varieties *viz.*, SiA 3085 (C_1) and SiA 3156 (C_2) as first factor and seven integrated nutrient management practices *viz.*, Control (100% RDF -40-20-20 kg NPK ha^{-1}) (T_1), 25% RDN through Vermicompost + 75% RDF (T_2), 25% RDN through Farm Yard Manure + 75% RDF (T_3), 25% RDN through Sheep Manure + 75% RDF (T_4), 50% RDN through Vermicompost + 50% RDF (T_5), 50% RDN through FYM + 50% RDF (T_6), 50% RDN through Sheep Manure + 50% RDF (T_7) as second factor comprising fourteen treatment combinations, laid out in randomized block design with factorial concept, replicated thrice. Foxtail millet was sown during 16 July 2019 and harvested during 15 October 2019. Foxtail millet was planted at a spacing of 30 cm x 10 cm using seed rate of 5 kg ha^{-1}. The required quantities of (25% N and 50% N through) farm yard manure, vermicompost and sheep manure were applied in respective plots as per the treatments and incorporated into soil two weeks before sowing of the crop. Nitrogen as per N levels (100%, 75% and 50% RD N) was applied through urea in three equal splits *viz*., 1/3 as basal, 1/3 at tillering stage (30 DAS) and the remaining 1/3 at spike initiation stage (55 DAS). The entire dose of phosphorous @ 20 kg ha^{-1} as single super phosphate (SSP) and potassium @ 20 kg ha^{-1} as muriate of potash (MOP) were applied as basal dose at the time of sowing.

Five plants were selected at random from net plot area and labeled with tags for recording growth attributes throughout the crop growing period. At harvesting, those 5 plants were sampled from the net plot of each plot to observe the yield attributes like number of panicles m^{-2}, number of grains panicle^{-1}, number of filled grains panicle^{-1}, length of the panicle and test weight. The grains and straw obtained from the net plot area including the sampled plants were thoroughly sun dried, weighed and expressed as kg ha^{-1}.

The data were statistically analyzed with standard method outlined for randomized block design factorial concept as described by Gomez and Gomez (1984) [5]. Statistically significance was tested by F-value at 0.05 % level of probability and critical difference was worked out where ever the effect were significant.

Results and Discussion

Growth

All the growth attributes (Table. 1) *viz.*, plant height, dry matter accumulation and total number of tillers m^{-2} were significantly influenced by integrated nutrient management at all growth stages, however these were found to be non-significant with the choice of varieties. Among the varieties, at all the stages of observation, SiA 3085 (C_1) produced significantly higher LAI compared to the other cultivar *viz.*, SiA 3156 (C_2). This might be due to higher plant height, varietal difference in leaf area and delayed senescence of leaves. These results are in agreement with the findings of Hanumantha Rao *et al*. (1987) [7] and Saini and Negi (1996) [11]. With respect to integrated nutrient management, 25% RDN through Vermicompost + 75% RDF (T_2) had shown significantly higher plant height, leaf area index, number of tillers m^{-2} and dry matter production compared to all other combinations of organic and inorganic treatments and control (100% RDF), however, it was statistically at par with 50% RDN through Vermicompost + 50% RDF (T_5). This might be due to the gradual release and maintained a high level of availability of nutrients throughout the crop growth period by vermicompost. The growth of plant is greatly influenced by soil environment. Here the treatment with integration of chemical and organic sources provided enough amounts of nutrients and organic matter which ultimately influenced the soil environment in positive ways for plant growth. The favourable soil condition finally resulted into higher values of almost all growth parameters under this treatment. Nitrogen being a constituent of the plant cell influenced different physiological processes such as a cell division, cell elongation and chlorophyll production which ultimately resulted in better growth attributes. These findings are in close agreement with those reported by Thesiya *et al.* (2019) [14], Umesh *et al*. (2006) [16], Thimmaiah *et al*. (2016) [15] and Shubhashree *et al.* (2017) [12].

Table 1: Growth attributes of foxtail millet at different growth stages as influenced by varieties and INM.

Treatments	Plant height (cm)	Leaf area index	Dry matter production (kg ha^{-1})	Number of tillers m^{-2}
Varieties				
C_1: SiA 3085	133.5	1.36	3876	55.0
C_2: SiA 3156	134.5	1.28	3776	52.2
SEm±	1.01	0.02	63.50	1.18
CD (P=0.05)	NS	0.06	NS	NS
Integrated nutrient management				
T_1 Control(100% RDF)	127.1	1.23	3333	48.1
T_2 25% RDN Vermicompost + 75% RDF	142.6	1.47	4442	60.9
T_3 25% RDN FYM + 75% RDF	135.0	1.36	3884	53.7
T_4 25% RDN Sheep manure + 75% RDF	134.0	1.33	3843	52.9
T_5 50% RDN Vermicompost + 50% RDF	138.8	1.37	4190	57.9
T_6 50% RDN FYM + 50% RDF	131.6	1.26	3610	51.2
T_7 50% RDN Sheep manure + 50% RDF	129.0	1.25	3484	50.6
SEm±	1.90	0.04	118.79	2.20
CD (P=0.05)	5.54	0.10	347.2	6.4
Interaction				
SEm±	2.68	0.05	168.00	3.11
CD (P=0.05)	NS	NS	NS	NS
C.V.	5.3	11.91	10.83	13.48

Yield attributes

Among the varieties, yield attributes *viz.*, higher length of the panicle, number of grains/ panicle, number of filled grains panicle^{-1} were obtained with the variety SiA 3085 (C_1), which was superior over the other variety *viz.*, SiA 3156 (C_2), whereas for yield attributes *viz.*, number of panicles m^{-2} and test weight both the varieties performed equally effective. This might be due to the genetic potential of the variety in deciding the length of the panicle, efficient translocation of photosynthates from source to the sink and also the genetic potential of variety. This is in the accordance with the results reported by Gurunadha Rao *et al.* (1990) [6], Divya and Maurya (2013) [4], Jyothi *et al.* (2014) [9].

Among the integrated nutrient management treatments, 25% RDN through Vermicompost + 75% RDF (T_2) had resulted in significantly highest number of panicles m^{-2}, length of the panicle, number of grains panicle^{-1}, number of filled grains/panicle, test weight over other combinations of organic and inorganic treatments and 100% RDF, except 50% RDN through Vermicompost + 50% RDF (T_5) which was at par with it. This might be due to more vigorous and luxuriant vegetative growth due to application of vermicompost along with inorganic fertilizer, which in turn favoured a better partitioning of assimilates from source to sink. The present results were in accordance with the findings of Subramanian and Ganesaraja (1992) [13], Hasan *et al.* (2013) [8] and Divya *et al*. (2017) [3].

Yield

The significantly higher grain and straw yields were produced by the application of 25% RDN through Vermicompost + 75% RDF (T_2) compared to all other combinations of integrated nutrient management and control (100% RDF) whereas the choice of varieties had no significant effect on grain and straw yields. Grain and straw yield were directly related with the growth and yield attributes. All the growth and yield attributes were higher with application of 25% RDN through Vermicompost + 75% RDF (T_2) compare to all other combinations of organic and inorganic treatments, however it was statistically at par with 50% RDN through Vermicompost + 50% RDF (T_5). The increased grain yield can be ascribed to the effect of adequate availability of NPK in soil solution by addition of vermicompost, that might cause increase in root growth, thereby increasing uptake of nutrients. The easy availability of nitrogen due to mineralization of organics influences the shoot and root growth favouring absorption of other nutrients. Similar results were obtained by Yakadri and Reddy (2009) [18], Umesh *et al*. (2006) [16] and Basavaraju and Purushotham (2009) [1], Thesiya *et al*. (2019) [14].

Table 2: Yield attributes and yield of foxtail millet as influenced by varieties and INM.

Treatments	Number Of panicles m^{-2}	Length of the panicle (cm)	Number Of grains panicle^{-1}	Number of filled grains panicle^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Varieties							
C_1: SiA 3085	40	23.5	2155	2029	3.10	2048	3929
C_2: SiA 3156	39	21.5	2022	1905	3.08	2011	3820
SEm±	0.77	0.50	41.80	37.42	0.02	43.37	46.54
CD (P=0.05)	NS	1.5	122.2	109.4	NS	NS	NS
Integrated nutrient management							
T_1 Control(100% RDF)	36	20.1	1928	1812	2.90	1725	3353
T_2 25% RDN Vermicompost + 75% RDF	45	25.4	2327	2200	3.26	2324	4353
T_3 25% RDN FYM + 75% RDF	41	22.7	2098	1971	3.11	2089	3987
T_4 25% RDN Sheep manure + 75% RDF	40	22.3	2096	1950	3.09	2058	3917
T_5 50% RDN Vermicompost + 50% RDF	42	23.7	2182	2058	3.15	2187	4144
T_6 50% RDN FYM + 50% RDF	38	21.7	2019	1895	3.06	1923	3720
T_7 50% RDN Sheep manure + 50% RDF	37	21.8	1969	1886	3.03	1903	3651
SEm±	1.43	0.93	78.20	70.01	0.04	81.08	87.07
CD (P=0.05)	4.2	2.7	228.6	204.6	0.1	237.0	254.5
Interaction							
SEm±	2.03	1.32	110.60	99.11	0.05	114.70	123.13
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
C.V.	9.1	5.1	5.1	5.1	7.2	10.9	7.5

Conclusion

On the basis of experimental results, foxtail millet should be nourished with 25% RDN through Vermicompost + 75% RDF or with 50% RDN through Vermicompost + 50% RDF as these two treatments reported promising effect on growth, yield attributing characters and yield of foxtail millet and any of the two varieties *viz.*, SiA 3085 and SiA 3156 could be taken, as both the varieties performed equally with response to integrated nutrient management.

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