Effectofestablishmentmethodsandorganicnutrientmanagementpracticesonproductivity and profitability of finger millet (*Eleusine coracana* L.) in lateriticsoilsofOdisha

Abstract

A field experiment was carried out during *kharif* seasons in 2020 and 2021 atAgronomyMainResearchFarm,DepartmentofAgronomy,CollegeofAgriculture, Odisha University of Agriculture and Technology, Bhubaneswar tostudyeffectofcropestablishmentmethodandorganicnutrientmanagementonfingermillet.(VarietyArjuna).Theexperimentwaslaidoutinasplitplotdesignandreplicated thrice.The treatmentscomprised of2 methods of cropestablishment*viz*.conventionalmethodoflinetransplanting(20cmx10cm)andsystem of finger millet intensification (25 cm X 25 cm) in main plot withapplicationof4organicnutrientsources*viz*.FYM@100%RDN,FYM@50%RDN (basal)+Vermicompost @50%RDN (basal), FYM@50%RDN(basal) +Vermicompost@50%RDN(topdressing)andFYM@25%RDN(basal)+*toria*oil cake@25%RDN(basal)+Vermicompost@50%RDN(topdressing)allotted to sub plot in finger millet during *Kharif* season. SFMI method ofestablishment resulted in superior yield attributes, grain yield (2051 kg ha^{-1}),straw yield (2901 kg ha^{-1}) and harvest index (41.42%) in finger millet thanline transplanting. Yield attributes, grain yield (2092 kg ha^{-1}), straw yield(2889 kg ha^{-1}) and harvest index (42.00 %)were higher with the applicationof FYM @ 50% RDN (basal) + Vermicompost @ 50 % RDN (top dressing)in finger millet and was statistically similar with application of FYM @ 25%RDN (basal) + *toria*oil cake @ 25% RDN (basal) + Vermicompost @ 50 %RDN (top dressing).The benefit cost ratio was higher in SFMI and with theapplicationofFYM@50%RDN(basal)+Vermicompost@50%RDN(topdressing)to finger millet.

Keywords:SFMI,organicnutrient, yieldattributes,grainyield,economics

Introduction

Millets have been accorded a prominent position as super food in the presentera. Under the changing scenario of global warming and climate change, cultivation ofecologically suitable hardy millets may be a wise alternative for optimum food andnutritional security. Finger millet (*Eleusine coracana* L.) is an important small milletrankingthirdinIndiainareaandproductionhavinghighestproductivity.Outofthetotal minor millets produced, finger millet accounts for about 85% of production in India(Sakamma*et al.*2018) [12]. In Odisha, the area, production and productivity is 116.8th.ha, 128.73 th.tonnes and 1102 kg/ha, respectively (5 Decades of Odisha AgricultureStatistics,2020)[1].Itisaversatileclimateresilientcropwithwideadaptabilitytoadverseweather conditions with low input requirement, easy cultivation, free from major pestsand diseases and drought tolerance which have made this crop an automatic choice indryfarmingsystem. Itisnutritionallysuperior withhighnutrientprofileandisidealforpatients suffering from diabetes and digestive problems as the grains contain essentialamino acid methionine having low glycemic index and no gluten. SRI principle havebeen followed in finger millet which mainly emphasizes on utilizing early growth andvigour of seedlings, less competition for light and nutrients, enhancing resource useefficiency (seeds, water, fertilizer and pesticide) and bring down over dependence onchemical fertilizers, breaking soil anoxia condition and promoting healthy root growthandincreasingsoilmicrobialactivity;andtherebyenhancingsoilorganicmattercontent.Conversion of modern chemically intensive agriculture to a more sustainable form ofagriculture like organic farming appears to be an option for maintaining the desirableagricultural production in future. Further, growing finger millet organically may insurenutritionalfood and farmingsecurityat thejunctureof climatechange.

Comment [SS1]: Need to add some statement the relationship of research interest

Materialsandmethod

The field experiment was conducted at the Agronomy Main Research Farm,DepartmentofAgronomy, CollegeofAgriculture,OrissaUniversityofAgricultureandTechnology (OUAT), Bhubaneswar, Odisha with finger millet grown during *kharif*season *of* 2020 and 2021. The experimental site is situated between 20°15' N latitude,85°52' E longitude and at an altitude of 25.9 m above the mean sea-level and about 64km away of the Bay of Bengal, Odisha. The soil was sandy loam in texture, acidic inreaction(pH4.64),lowinorganiccarbon(4.24gkg),mediuminavailablenitrogen(298.1kgha^{-}

^{1}),mediuminavailablephosphorus(17.6kgha^{-1})andlowinavailablepotassium(95 kg ha^{-1}). Total rainfall amounting to 989.1 mm (44 rainy days) and 1317.9 mm (59rainy days) was received during *Kharif* season of 2020 and 2021, respectively. Theexperiment was laid out in split plot design with three replications.The treatmentscomprised of2 methods of plant establishment *viz*. M_1:conventional method of linetransplanting(20cmx10cm)andM_2:systemoffingermilletintensification(25cmX25cm)inmainplotwith4organicnutrientsources*viz*.N_1:FYM@100%RDN(basal),N_2:FYM@50%RDN(basal)+Vermicompost @50%RDN(basal), N_3:FYM@50%RDN(basal)+Vermicompost@50%RDN(topdressing),N_4:FYM@25%RDN(basal)+*toria*oil cake @ 25% RDN (basal) + Vermicompost @ 50 % RDN (top dressing) allotted to subplotinfingermillet.Therecommendeddoseofnitrogen(RDN)appliedtofingermilletwas60kgha^{-1}.InSFMI,squareplantingof12daysoldseedlingwasdone@oneseedlinghill^{-1}.Theorganicformulation'*Jibamruta*'wassprayeduniformlytoallthetreatmentsat21DAT for controlling insect pests and diseases. Weeding operation was done in SFMI byusingacycleweeder.

Observationsonyieldattributes,grainyieldandstrawyieldoffingermilletwererecorded at harvest. The collected data were analyzed statistically by standard analysisofvariancetechniqueforsplitplotdesignassuggestedbyGomezand Gomez(1984)[4]andsignificantdifferentbetweenthetreatmentswerecomparedwiththecriticaldifference at ±5%probabilitybyleast significantdifference.

Resultanddiscussion

The pooled data of two years of *Kharif* season of 2020 and 2021 for yieldattributes,yieldandeconomicsof fingermillet arepresentedin Table1to3.

Effect of establishment methods on yield attributes, yield and economics of fingermillet

Yieldattributing charactersi.e.earheadhill^{-1},fingerear^{-1},spikeletsfinger^{-1},grains spikelet^{-1}, finger length, 1000 grain weight of finger millet were higher in SFMI(7.9, 6.4, 88.6, 5.98, 7.90 cm and 3.37 g, respectively) than line transplanting. Lesscompetition between plants due to wider space allowed the individual plants to developmassive root system and ultimately higher nutrient uptake. Better aeration at widerspacingresultedinhealthyplantgrowthwithmoretillers(SomashekharandLoganandhan.,2020)[13].Theseresultswereinconformitywiththefindingsof Prakasha *et al*. (2018)[8].

Thegrainyield,strawyieldandharvestindexoffingermilletwerehigher(2051kg ha^{-1}, 2901 kg ha^{-1} and 41.42%, respectively) in SFMI than line transplanting. Grainyield and straw yield is the final outcome of a crop which generally relies on thedevelopmentofyieldattributes.Increaseingrowthattributesduetoincreaseduptakeofnitrogen and translocation of photosynthates from source to sink increased most of theyield attributing characters in SFMI. Similar findings were also reported by Naidu andRao(1958)[5];NarasimhaRao*etal*.(1963)[7];DivaKaran(1967)[3];NarasimhaMurthy and Hegde (1981) [6]; PSI (2009) [10] and Rajesh (2011) [11] in finger millet. The grossreturn(Rs.110721ha^{-1}andRs.118080ha^{-1}),netreturn(Rs.53121ha^{-1}andRs.60480ha^{-1}) and B: C ratio (1.92 and 2.05) was higher in SFMI method of establishment in 2020-21and 2021-22, respectively.

Effect of organic nutrient management on yield attributes, yield and economics offingermillet

Yield attributing characters i.e. earhead hill^{-1}, finger ear^{-1}, spikelets finger $^{-1}$,grainsspikelet-1,fingerlength,1000grainweightoffingermilletwerehigher(6.5,6.5,71.5,5.84,7.86and3.36g,respectively)whenFYM@50%RDN(basal)+Vermicompost @ 50 % RDN (top dressing) was applied to finger millet but wasstatisticallyatparwithapplicationofFYM@25%RDN(basal)+toriaoilcake@25%RDN(basal)+Vermicompost@50%RDN(topdressing).Thegrainyield,strawyieldandharvestindex(%)offingermilletwerealsohigher(2092kgha^{-1},2889kgha^{-1}and 42.00 %,respectively)whenFYM@50%RDN(basal)+Vermicompost@50%RDN(topdressing)wasappliedtofingermilletbutwasstatisticallyatparwithapplicationofFYM@25%RDN(basal)+*toria*oilcake@25%RDN(basal)+Vermicompost@50 % RDN (top dressing). The higher yield attributes might be due to higher macro andmicronutrientcontentofvermicompostwhichenabledcontinuousandsteadyreleaseofnutrients. FYM application also increased the nutrient uptake which might have helpedinbettertillering,earlength,grainfilling,numberofgrainsearhead^{-1} (PriyaandSathyamoorthi, 2019) [9]. Balanced combination of organic sources is indispensable tosupplement nutrients in accordance with the demand of plants for ensuring higherproductionandproductivitywithouthavingdeleteriouseffectonsoilhealth.Topdressingofvermicompostensuredcontinuousavailabilityofnutrientsthroughoutthecropgrowthstages due to steady transformation, mineralization, solubilisation, decomposition ofmineralsandnutrientsthatmighthelpedinensuringsuperioryieldattributingcharactersandyield.Supplyofnitrogenandothernutrientsatrighttimeandquantityenabletheplantstoassimilatesufficientphotosyntheticproductsandthusincreasedyieldattributesandyieldofthecropand alsobringanimprovementtowardsphysicalpropertiesofsoil andthereby improvingnutrientandwaterholdingcapacity(BhardwajandGaur,1985)[2].Highestgrossreturn (Rs.112573and121595ha^{-1}),netreturn(Rs.51873andRs60474ha^{-1})andB:Cratio(1.85and2.00)wererecordedwiththetreatmentreceivingFYM@50%RDN(basal)+Vermicompost@50%RDN(top dressing) during 2020-21and 2021-22, respectively.

Interaction

Comment [SS2]: Need to add more discussion (interaction) about what is the impact of treatments to the environment

ItisobservedthatinteractionofSFMIwithnutrientmanagementbyapplicationofFYM@ 50% RDN (basal) + Vermicompost @ 50% RDN (top dressing) produced maximumnumbers of yield attributes and ultimately resulted in higher yield. However, it was atpar withapplicationofFYM @25% RDN(basal)+ *toria*oilcake @25%RDN (basal) + Vermicompost @ 50 % RDN (top dressing).Wider spacing with organic nutrientmanagement resulted in less competition between plants for solar radiation, space andincreased supply of nutrients and efficient utilization helps in better growth and yield(Somashekhar andLoganandhan., 2020)[13].

Table1. Yieldattributing characters offingermilletasinfluenced byorganicnutrientmanagement practices

Treatment	Yieldattributes																	
	Earheadhill^{-1}			Fingersear^{-1}			Spikeletsfinger^{-1}			Grainspikelet^{-1}			Fingerlength			1000grainweight (g)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Establishmentmethod(M)infingermillet																		
M1:Linetransplanting	2.9	3.2	3.1	4.9	5.1	5.0	39.2	41.4	40.2	4.40	4.41	4.41	7.03	7.08	7.06	3.14	3.15	3.15
M2: SFMI	7.8	8.0	7.9	6.4	6.3	6.4	92.6	91.8	88.6	5.90	6.05	5.98	7.96	7.83	7.90	3.37	3.36	3.37
S.E.m(±)	1.4	1.4	1.0	0.27	0.2	0.16	1.18	1.7	1.01	0.40	0.43	0.29	0.23	0.24	0.17	0.06	0.06	0.04
CD(0.05)	4.1	4.3	2.8	1	1.1	0.5	3.6	3.2	2.9	1.2	1.3	0.8	0.7	0.7	0.5	0.2	0.2	0.1
Nutrientmanagement(N)infingermillet																		
N1: FYM@100%RDN(basal)	4.3	4.5	4.4	5.0	5.1	5.1	61.8	62.0	61.9	4.67	4.675	4.67	7.11	6.98	7.05	3.11	3.13	3.12
N2: FYM@50%RDN(basal) + Vermicompost @50%RDN(basal)	4.9	5.0	5.0	5.3	5.4	5.4	62.9	63.5	63.2	4.97	4.94	4.95	7.4	7.32	7.36	3.25	3.24	3.25
N3: FYM@50%RDN(basal) + Vermicompost @ 50% RDN (topdressing)	6.3	6.6	6.5	6.4	6.5	6.5	71.0	71.9	71.5	5.74	5.93	5.84	7.84	7.88	7.86	3.36	3.35	3.36
N4: FYM @ 25% (basal) + *toria*oilcake@ 25% RDN (basal) +Vermicompost@50% RDN(top dressing)	5.9	6.3	6.1	5.9	5.8	5.9	67.9	69.1	68.5	5.38	5.38	5.38	7.64	7.66	7.65	3.30	3.29	3.29
S.Em(±)	0.46	0.42	0.31	0.39	0.26	0.22	2.24	2.41	1.64	0.24	0.3	0.19	0.13	0.14	0.09	0.03	0.03	0.02
CD(0.05)	1.4	1.3	0.9	0.9	0.8	0.7	6.8	7.3	4.8	0.7	0.9	0.5	0.4	0.4	0.3	0.1	0.1	0.06
M x N																		
S.Em(±)	1.98	1.94	1.38	0.78	0.58	0.48	3.51	4.21	2.72	0.76	0.84	0.56	0.47	0.48	0.33	0.16	0.16	0.11
CD(0.05)	5.9	5.8	4.0	2.36	1.75	1.38	10.7	12.7	7.86	2.3	2.5	1.6	1.42	1.45	0.96	0.48	0.48	0.32

Table2. Grainyield,strawyieldandharvestindexoffingermilletasinfluencedbyestablishmentmethodandorganicnutrientmanagement

Treatment	Grain yield(kgha^{-1})			Straw yield(kg ha^{-1})			Harvestindex(%)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Establishmentmethod(M)infingermillet									
M1:Linetransplanting	1642	1714	1678	2483	2579	2531	39.81	39.93	39.87
M2: SFMI	2007	2095	2051	2844	2958	2901	41.37	41.46	41.42
SEm±	46.60	53.30	35.32	57.10	58.89	41.01	0.46	0.46	0.33
CD(0.05)	141.2	161.5	102.3	173.1	178.4	118.8	1.4	1.4	0.9
Nutrientmanagement(N)infingermillet									
N1: FYM@100%RDN(basal)	1510	1610	1560	2504	2562	2533	37.62	38.59	38.10
N2:FYM@50%RDN(basal)+Vermicompost@50% RDN(basal)	1800	1840	1820	2565	2712	2638.5	41.24	40.42	40.83
N3:FYM@50%RDN(basal)+Vermicompost@50% RDN(topdressing)	2028	2157	2092	2812	2967	2889.5	41.90	42.10	42.00
N4:FYM@25%(basal)+*toria*oilcake@25%RDN (basal)Vermicompost@50%RDN(topdressing)	1961	2011	1986	2773	2833	2803	41.42	41.52	41.47
S.Em(±)	65.90	75.37	49.95	80.73	82.57	57.74	0.20	0.20	0.14
CD(0.05)	199.7	228.4	144.6	244.8	252.2	167.2	0.6	0.6	0.4
M x N									
S.Em(±)	126.10	139.60	93.95	148.30	152.20	106.25	0.78	0.78	0.55
CD(0.05)	382.0	422.9	270.6	449.3	461.1	306.0	2.4	2.4	1.6

Table3.Economicsoffingermilletasinfluencedby establishmentmethodandorganicnutrientmanagementpractices

Treatment	Gross return(Rs. ha^{-1})		Net return(Rs .ha^{-1})		B-Cratio	
	2020	2021	2020	2021	2020	2021
Establishmentmethod(M)infingermillet						
M1:Linetransplanting	97158	103051	34433	40326	1.55	1.64
M2: SFMI	110721	118080	53121	60480	1.92	2.05
Nutrientmanagement(N)infingermillet						
N1: FYM@100% RDN(basal)	90088	96954	32138	39004	1.55	1.67
N2: FYM@50%RDN(basal) +Vermicompost@50%RDN(basal)	103175	107917	42475	47217	1.70	1.78
N3: FYM@50%RDN(basal)+Vermicompost @50%RDN(topdressing)	112573	121594	51873	60474	1.85	2.00
N4:FYM@25%(basal)+*toria*oilcake@25%RDN(basal)+Vermicompost@50%RDN(topdressing)	109947	115796	48047	54316	1.78	1.88

Conclusion

ThestudyindicatesthatSFMImethodofcropestablishmentresultedinsuperioryield attributesandyieldoffingermilletovertheconventionalmethodoflinetransplanting. Application of FYM @ 50% RDN as basal + Vermicompost @ 50%RDN as top dressing to finger millet resulted in higher yield attributing characters andyield in finger millet and this was statistically similar with the application ofFYM @25%RDN(basal)+*toria*oilcake@25%RDN(basal)+Vermicompost@50%RDN(topdressing)tofingermillet.Thegrossreturn,net returnandB:CratiowashigherinFYM@50%RDN as basal +Vermicompost@ 50% RDN as top dressing. Soconsideringtheproductivityandprofitability,farmerscanadoptSFMIwiththeapplication of FYM @ 50% RDN as basal (6.55 t/ha) + Vermicompost @ 50% RDNastopdressing(1.62t/ha)infingermilletinlateriticsoilsofOdisha.

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