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Influence of different organics on soil physical and chemical properties by Finger millet (*Eleusine coracana* L.)

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Abstract
A field trial was conducted at KVK, Rajendrapur Farm, NAU, Waghai to study the "Effect of organics on soil properties, yield and quality of finger millet during *kharif* season of 2018 to 2019 under rainfed condition of south Gujarat. Soil of the experimental field was clayey in texture, medium in organic carbon (0.60% and 0.58%), available nitrogen (270.80 and 274.50 kg/ha), available phosphorus (28.75 and 30.39 kg/ha) whereas, high in available k (365.25 and 360.55 kg/ha) and neutral in response (pH 6.85 and 6.95) with normal EC (0.15 and 0.20 dSm^{-1}) during the year 2018 to 2019, respectively. The chemical properties of soil (O.C., N, P_2O_5 and Ca) were recorded higher value under the treatment of application of 100 percent RDN through biocompost (S_1) during both the years, respectively. While other chemical properties of soil (EC, pH, K_2O, Zn, Mn, Fe and Cu) were failed to respond significantly with different application of solid organics. Effect of liquid organics did not influence considerably on physical as well as chemical properties of soil after harvest of finger millet during the both years. Although, significant result obtained in case of biological properties of soil.

Keywords: Finger millet, rainfed, *Eleusine coracana*

Introduction
Providing wholesome nutrition to plants is the essence of good plant growth leading to better productivity. An integration of inorganic and organic nutrient sources holds the key to good soil health leading to flourishing agriculture. The Finger millet is most important millet crop belongs to Poaceae family and subfamily Chloridoidae. Finger millet is also known as ragi. In India is one of the imperative cereals occupies highest area under farming among the small millets. It is cultivated on area of 890.9 thousands ha with production of 1238.7 thousands tones with a productivity of 1390 kg/ha. In Gujarat, finger millet occupies an area about 2.7 thousands ha with production of 3.96 thousands tones with a yield of 1344 kg/ha (Anon., 2020) [2]. The main finger millet rising states are Karnataka, Uttarakhand, Maharashtra, Tamil Nadu and Odisha. In Gujarat finger millet cultivated mainly in dry land and tribal area of Panchmahal, Dang and some parts of Surat, Navsari and Valsad districts.
Organic farming is a holistic crop making and managing system which can be practiced in any situation from lowest rainfall areas to highest rainfall areas to achieve sustainable effectiveness without the use of external inputs such as chemical fertilizers and pesticides and has many environmental advantages like encouraging conservation and development of on farm natural resources and their most favourable use in maintaining the soil fertility status for a long time with improved microbial activity. The organically formed food grains, fruits, vegetables, spices & condiments, medicinal & aromatic plant products have showed high-quality keeping quality than products grown with chemical fertilizers. Organic agriculture is adopted with a blend of ecologically safe modern technologies which are acceptable to the farmers (Sreenivasa *et al.*, 2009, Pathak and Ram, 2007 and Natarajan, 2002) [4, 5, 9]. In Gujarat, finger millet is the most staple food of the tribal in Agroclimatic Zone I, II and III. It is grown under *kharif* rainfed crop in the least fruitful soil of South Gujarat.

Materials and Methods
"Effect of organics on soil properties, yield and quality of finger millet was carried out by laying out a field experiment on finger millet with combined application of solid organic with foliar application of liquid organics in *kharif* season experiment during 2018 to 2019.

Treatments were lay out in an RBD with factorial concept along with three replications. Treatments were compared with control suggested practice consisting of 40-20-0 NPK kg/ha. In *kharif* season, treatments were allotted to different experimental units of finger millet during solid organics (S-Factor *viz.,* 100% RDN through biocompost: S_1, 75% RDN through biocompost: S_2 and 50% RDN through biocompost: S_3) and foliar application of liquid organics (L- Factor *viz.*, Enriched Banana Psuedostem sap @ 1% that is L_1, *Jeevamrut* @ 1% that is L_2, *Vermiwash* @ 1% that is L_3 and Cow Urine @ 1% that is L_4).

Well perished solid organic manures (biocompost) is applied based on gross plot size and calculated quantities of these pure manures were applied well mixed with soil homogenously in the respective plots one day prior to sowing that particular bed. While, different liquid organics *viz.* enriched banana pseudostem sap, vermiwash, Jeevamrut and cow urine were applied through foliar submission at 15, 30 and 45 DAT of finger millet. The finger millet variety GNN 6 was sown in June 2018 to 2019. Standard agronomic practices were adopted for raising fit crop. The experimental field was having undulating geography. A representative soil samples were drawn from 0-22.5 cm depth before and after sowing of the finger millet crop. The samples were miscellaneous thoroughly and a composite sample was obtained. These samples were analysed for various physico-chemical properties.

Results and Discussion

Physical properties of the soil

The information in respect of soil physical properties like water stable aggregate and BD as prejudiced by different treatments after harvest of finger millet are presented in Table 1. The end product exposed that percent of both the fractions (*i.e.* 0.5^{-1} mm and more than 1 mm) of the water stable aggregate as influenced by different treatments of solid organics after harvest of finger millet were non-significant. However, numerically the maximum water stable aggregates of both the type (0.5-1.0 mm and more than 1.0 mm) were found in the treatment of 100 percent RDN through biocompost (S_1) (23.10, 23.67 and 46.43, 47.59) in order that throughout 2018, 2019 and pooled data analysis. While smallest amount was observed in S_3 treatment under the application of 50 percent RDN through biocompost as exposed in Table 1.

The facts regarding BD as influenced by different treatments of solid organics after yield of finger millet were non-significant during both years. The higher BD of 1.41 and 1.43 g/cc was observed in the treatment under S_3: the application of 50% RDN through biocompost during 2018 to 2019, respectively. The effect exposed that percent of both the fractions (*i.e.* 0.5-1.0 mm and more than 1.0 mm) of the water stable aggregate as influenced by different treatments of liquid organics after harvest of finger millet were non-significant. The other hand, numerically the highest water stable aggregates of both the type (*i.e.* 0.5-1.0 mm and more than 1.0 mm) were found in the appliance of enriched banana pseudostem sap @ 1% (L_1) (23.22, 23.69 and 46.69, 47.61) correspondingly during 2018 to 2019. Though, minimum were observed in the treatment under application of cow urine @ 1% (L_4). The Data regarding BD as influenced by different treatments of liquid organics after harvest of finger millet were non-significant during mutually the year (Table 1).

Table 1: Water stable aggregate and BD of soil as influenced by different treatments after harvest of finger millet

Treatment	WSA (0.5-1.0 mm)		WSA (>1.0 mm)		BD (g/cc)	
	2018	2019	2018	2019	2018	2019
S_1	23.10	23.67	46.43	47.59	1.39	1.39
S_2	22.77	23.46	45.78	47.15	1.40	1.42
S_3	22.34	22.86	44.91	45.95	1.41	1.43
S.Em. (±)	0.37	0.38	0.77	0.75	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
L_1	23.22	23.69	46.69	47.61	1.41	1.42
L_2	22.92	23.50	46.09	47.23	1.37	1.40
L_3	22.66	23.25	45.56	46.72	1.39	1.41
L_4	22.13	22.90	44.49	46.03	1.43	1.42
S.Em. (±)	0.42	0.44	0.89	0.87	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
Interaction (S X L)						
S.Em. (±)	0.73	0.77	1.55	1.50	0.02	0.02
CD at 5%	NS	NS	NS	NS	NS	NS
Treat Mean	22.74	23.33	45.70	46.90	1.40	1.41
Control	21.85	22.72	43.92	45.67	1.45	1.41
Control V/S Rest						
S.Em. (±)	0.58	0.61	1.22	1.19	0.02	0.02
CD at 5%	NS	NS	NS	NS	NS	NS
CV (%)	5.59	5.71	5.88	5.56	3.05	2.80
Pooled	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%
Y x T	0.75	NS	1.52	NS	0.02	NS
Y x S	1.13	NS	2.29	NS	0.04	NS
Y x L	1.30	NS	2.64	NS	0.04	NS
Y x S x L	1.01	NS	2.04	NS	0.03	NS
Y x Con V/S Rest	0.55	NS	1.12	NS	0.02	NS
Initial	21.6	20.8	48.7	46.7	1.49	1.53

Soil chemical properties (pH, EC and Organic carbon)

The figures in admiration of chemical properties of soil *viz*., EC, pH and O.C. as influenced by altered treatments after harvest of finger millet are shown in Table 2.

The information exposed that solid organics were unsuccessful to exert any significant effect on soil pH after harvest of finger millet during both the year and pooled analysis. The values of soil pH varied from 6.93 to 7.15, and 6.91 to 7.07 in 2018 to 2019, respectively. While, EC significant effect of solid organics was obtained varied from 0.20 to 0.24 & 0.19 to 0.23 ds/m in 2018 to 2019, respectively.

In casing of soil organic carbon, significant effect of solid organics was obtained. Extensively superior organic carbon content of (0.62% and 0.63%) was renowned under treatment S_1: Application of 100% RDN all the way through biocompost during the years 2018 as well as 2019, respectively which was statistically at par with the function of 75% RDN through biocompost (S_2) in both the years. However, lowest value of soil organic carbon (0.59% and 0.58%) was recorded with the treatment S_3: the appliance of 50% RDN through biocompost during both the years 2018 to 2019, respectively.

Denial significant impacts of liquid organics were found on pH, EC and OC content of the experimental soil subsequent to harvest of the finger millet. The values of soil pH, EC and organic carbon content varied from (6.91 to 7.16, 6.76 to 7.14) (0.21 to 0.22, 0.22 -0.23 dSm^{-1}), and (0.59 to 0.62, 0.59 to 0.63%) in that order throughout the year 2018 to 2019.

Table 2: pH, EC and O.C. of soil as influenced by different treatments after harvest of finger millet

Treatment	pH		EC (dsm^{-1})		Organic carbon (%)	
	2018	2019	2018	2019	2018	2019
S_1	7.02	6.99	0.22	0.20	0.62	0.63
S_2	7.05	7.01	0.23	0.22	0.60	0.62
S_3	7.15	7.04	0.24	0.23	0.59	0.58
S.Em. (±)	0.08	0.12	0.008	0.009	0.01	0.01
CD at 5%	NS	NS	NS	NS	0.02	0.02
L_1	7.01	7.09	0.25	0.23	0.62	0.63
L_2	7.19	7.07	0.23	0.21	0.61	0.62
L_3	7.08	7.07	0.22	0.21	0.59	0.60
L_4	7.00	6.82	0.22	0.21	0.59	0.59
S.Em. (±)	0.10	0.14	0.01	0.01	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
Interaction (S X L)						
S.Em. (±)	0.17	0.24	0.02	0.02	0.02	0.02
CD at 5%	NS	NS	NS	NS	NS	NS
Treat Mean	7.07	7.01	0.23	0.22	0.60	0.61
Control	6.72	6.93	0.23	0.23	0.60	0.59
Control V/S Rest						
S.Em. (±)	0.13	0.19	0.01	0.01	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS
CV (%)	4.18	5.86	14.81	13.57	4.39	4.84
Pooled	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%
Y x T	0.21	NS	0.02	NS	0.02	NS
Y x S	0.31	NS	0.03	NS	0.02	NS
Y x L	0.36	NS	0.03	NS	0.03	NS
Y x S x L	0.29	NS	0.01	NS	0.02	NS
Y x Con V/S Rest	0.15	NS	0.01	NS	0.01	NS
Initial	6.85	6.95	0.15	0.20	0.60	0.58

Solid and liquid organics of Nutrient status

The numbers in respect of available primary nutrients of soil *viz*., N, P_2O_5 and K_2O content of experimental soil after harvest of finger millet as prejudiced by different treatments are cited in Table 3.

The information publicized that the nitrogen pleased of soil was significantly higher available N content of (266.08 and 269.34 kg/ha) were recorded under the treatment of appliance of 100% RDN through biocompost (S_1) during both the years respectively in soil, which was found statistically at par with the application of 75% RDN through biocompost (S_2) (254.2 and 257.5 kg/ha) during 2018 to 2019. Surrounded by the whole treatment's lowest straw yield of finger millet was recorded during both the years were experiential under S_3: the application of 50% RDN through biocompost.

The records exposed that the available nitrogen content in soil was observed to be non-significant consequence as prejudiced by different application of fluid organics. The application of enriched banana pseudostem sap @ 1% (L_1) showed higher value of available N content in soil (264.08 and 263.59 kg/ha) were recorded throughout both the years, respectively. Among the all treatments smallest amount of available nitrogen content was recorded during both the years observed under L_3: appliance of vermiwash @ 1%.

The facts shown that the phosphorus content of soil was observed to be significant effect as influenced due to application of solid organics. Drastically higher values of available P_2O_5 content in soil (32.73 and 34.63 kg/ha) were recorded under the treatment of application of 100% RDN through biocompost (S_1) throughout the years 2018 to 2019 in soil. Which was found statistically at par with the application of 75% RDN through biocompost (S_2) (30 and 32 kg/ha) in that order during 2018 to 2019. Amongst the entire treatments least available phosphorus relaxed of soil was record under

S_3: the function of 50% RDN through biocompost in that order during the years 2018 to 2019.

The records publicized that the available phosphorus content in soil was observed to be not to be significant effect as prejudiced by different application of liquid organics. The appliance of enriched banana pseudostem sap @ 1% (L_1) showed superior value of available P_2O_5 content in soil (31.22 and 33.21 kg/ha) were recorded during both the years correspondingly. Along with the whole treatments least available phosphorus content was recorded under the application of cow urine @ 1% (L_4) for the duration of 2018 while in 2019 recorded below application of vermiwash @ 1% (L_3).

The figures publicized that the available k content in soil was observed to be not to be significant effect as influenced by different application of solid organics. The function of 100% RDN through biocompost (S_1) showed superior value of available K_2O content of (359.98 and 362.20 kg/ha) in that order during both the years. Amongst the entire treatment lowest available k content of soil was recorded under the application of 50% RDN through biocompost throughout 2018 to 2019 (S_3).

The statistics shown that the available k content in soil was observed to be not to be significant effect as influenced by different application of liquid organics. The relevance of enriched banana pseudostem sap @ 1% (L_1) showed higher value of available K_2O content of (358.24 and 361.21 kg/ha) were recorded in that order during both the years. Among the whole treatments least available k content was recorded under claim of vermiwash @ 1% (L_3) during the years in 2018.

The facts in respect of secondary nutrient of soil *viz*., exchangeable calcium as inclined by different treatments after produce of finger millet are paraded in Table 3.

The information shown that the exchangeable calcium content of soil was observed to be significant effect as influenced due to application of solid organics. Significantly higher exchangeable Ca content of (25.37 and 24.71 me/100g) were recorded under the treatment of appliance of 100% RDN through biocompost that is S_1 in that order during both the years, which was found statistically at par with the appliance of 75% RDN through biocompost (S_2) (24.30 and 23.43 me/100g) throughout 2018 to 2019. Among the entire treatments, least exchangeable calcium content of finger millet was recorded during both the years under the application of 50% RDN in the course of biocompost (S_3).

The numbers exposed that the exchangeable calcium in soil was observed not to be significant effect as prejudiced by different application of liquid organics. The request of enriched banana pseudostem sap @ 1% (L_1) showed higher values of calcium content in soil (24.11 and 23.98 me/100g) were recorded in that order during both the years. Among the complete treatment's tiniest available calcium content of (22.46 and 21.20 me/100g) was recorded during together the years observed under application of cow urine @ 1% (L_4).

To be acquainted with the effect of solid and liquid organics on DTPA extractable Fe, Zn, Mn and Cu content of experimental soil after harvest of finger millet were analyzed and grades accordingly obtained are specified in Table 4.

No considerable effect of solid organics was experiential on DTPA extractable Cu. The data revealed that the DTPA extractable Fe, Zn, Mn and Cu content of investigational soil after produce of finger millet was observed to be non-significant effect as influenced by different application of solid organics. Though, the function of 100% RDN through biocompost (S_1) showed higher value of DTPA extractable Fe, Mn, Zn and Cu in soil (15.35 and 15.81 ppm, 12.25 and 13.27 ppm, 0.36 and 0.38 ppm, 1.53 and 1.58 ppm) were recorded throughout in order that both the years. Amongst the whole treatments least DTPA extractable Fe, Zn, Mn and Cu in soil was recorded under the request of 50% RDN through biocompost throughout 2018 to 2019 (S_3).

The information given away that the DTPA extractable Mn, Fe, Zn and Cu in soil were observed not to be significant effect as influenced by different application of liquid organics. The function of enriched banana pseudostem sap @ 1% (L_1) showed higher value of DTPA extractable Fe, Mn, Zn and Cu in soil (15.40 and 15.91 ppm, 12.42 and 13.44 ppm, 0.36 and 0.38 ppm, 1.54 and 1.59 ppm) were recorded in that order during both the years. Among the entire treatments most minuscule DTPA extractable Fe, Mn and Cu in soil was recorded under application of cow urine @ 1% (L_4) during both the years while DTPA extractable Zn in soil was recorded under application of vermiwash @ 1% (L_3).

Marks accessible in tables (Table 2 to 4) of soil properties after produce of finger millet showed noticeable influence of different treatments of solid fertilizer on the availability of nutrients in soil. Significant differences were found for available soil nutrients *viz.* nitrogen, phosphorus and calcium. This may be due to application of superior quantity of value-added organic sources in form of biocompost and their complementary effects. The build-up of available nutrient in earth due to integration of organics sources has also been observed by Varalakshmi *et al.* (2005) [11], Sushma *et al.* (2007) [10], Senapati *et al.* (2008) [8], Chaudhary *et al.* (2011) [3], Sandhya Rani *et al.* (2017) [6] and Saraswathi *et al.* (2018) [7].

Dissimilar liquid organics did not power availability of nutrient in soil after yield of finger millet crop (Table 2 to 4). This capacity be happened because of none of the liquid organics was functional on soil. Comparable results have also been reported by Ananda *et al.* (2018) [1].

Table 3: Nutrients status of soil as influenced by different treatments after harvest of finger millet

Treatment	Available N (kg/ha)		Available P_2O_5 (kg/ha)		Available K_2O (kg/ha)		Exch. Ca (me/100 g)	
	2018	2019	2018	2019	2018	2019	2018	2019
S_1	266.08	269.34	32.73	34.63	359.98	362.20	25.37	24.71
S_2	254.20	257.51	30.31	32.00	350.40	354.46	24.30	23.43
S_3	251.52	253.08	28.01	30.20	347.42	349.00	20.24	19.60
S.Em. (±)	4.16	4.29	1.10	1.14	7.35	7.47	0.88	0.99
CD at 5%	12.15	12.51	3.21	3.33	NS	NS	2.56	2.88
L_1	264.08	263.59	31.22	33.21	358.24	361.21	24.11	23.98
L_2	263.78	265.55	30.93	33.15	358.48	363.49	23.98	23.14
L_3	247.98	253.81	29.81	31.36	344.68	349.68	22.67	21.99
L_4	253.23	256.95	29.43	31.38	349.00	346.49	22.46	21.20

S.Em. (±)	4.81	4.95	1.27	1.32	8.49	8.62	1.01	1.14
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (S X L)								
S.Em. (±)	8.32	8.57	2.20	2.28	14.71	14.93	1.76	1.97
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
Treat Mean	257.27	259.97	30.35	32.28	352.60	355.22	23.30	22.58
Control	272.25	277.24	32.08	31.85	368.64	373.64	22.01	21.34
Control V/S Rest								
S.Em. (±)	6.58	6.78	1.74	1.80	11.63	11.81	1.39	1.56
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.58	5.68	12.51	12.25	7.20	7.25	13.11	15.20
Pooled	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%
Y x T	8.45	NS	2.24	NS	14.82	NS	1.87	NS
Y x S	12.67	NS	3.36	NS	22.23	NS	2.80	NS
Y x L	14.63	NS	3.88	NS	25.67	NS	3.23	NS
Y x S x L	21.91	NS	0.89	NS	23.41	NS	1.72	NS
Y x Con V/S Rest	6.22	NS	1.65	NS	10.91	NS	1.37	NS
Initial	270.80	274.50	28.75	30.39	365.25	360.55	28.5	25.4

Table 4: Nutrients status (Fe, Mn, Zn and Cu) of soil as influenced by different treatments after harvest of finger millet

Treatment	Fe (ppm)		Mn (ppm)		Zn (ppm)		Cu (ppm)	
	2018	2019	2018	2019	2018	2019	2018	2019
S_1	15.35	15.81	12.25	13.27	0.36	0.38	1.53	1.58
S_2	15.06	15.62	12.10	13.12	0.35	0.37	1.50	1.56
S_3	14.39	14.96	11.47	12.49	0.35	0.37	1.44	1.50
S.Em. (±)	0.31	0.32	0.24	0.25	0.01	0.01	0.03	0.03
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
L_1	15.40	15.91	12.42	13.44	0.36	0.38	1.54	1.59
L_2	15.17	15.73	12.21	13.23	0.35	0.37	1.52	1.57
L_3	14.76	15.30	11.77	12.80	0.34	0.36	1.47	1.53
L_4	14.39	14.91	11.35	12.38	0.35	0.37	1.44	1.49
S.Em. (±)	0.36	0.37	0.28	0.28	0.01	0.01	0.03	0.03
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (S X L)								
S.Em. (±)	0.62	0.64	0.48	0.49	0.01	0.01	0.05	0.06
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
Treat Mean	14.93	15.46	11.94	12.96	0.35	0.37	1.49	1.55
Control	14.32	15.04	11.56	12.58	0.37	0.39	1.46	1.53
Control V/S Rest								
S.Em. (±)	0.49	0.51	0.38	0.39	0.01	0.01	0.04	0.04
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	7.25	7.23	6.93	6.58	5.28	5.06	6.12	6.20
Pooled	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%	S.Em. (±)	CD at 5%
Y x T	0.63	NS	0.48	NS	0.01	NS	0.05	NS
Y x S	0.95	NS	0.73	NS	0.02	NS	0.08	NS
Y x L	1.10	NS	0.84	NS	0.02	NS	0.09	NS
Y x S x L	0.70	NS	0.52	NS	0.02	NS	0.03	NS
Y x Con V/S Rest	0.47	NS	0.36	NS	0.01	NS	0.04	NS
Initial	13.46	14.25	12.41	12.75	0.30	0.33	1.55	1.57

Interaction effect

An examination of information exposed that the interface effects of solid and liquid organics on water stable aggregate and BD of the finger millet as prejudiced by different treatments were found not to be significant during being years and in pooled data analysis.

The interface effects of solid & liquid organics on pH, EC and OC content of the finger millet during entity both the years and in pooled analysis were observed not to be significant.

Control V/s Rest

The rest of the treatments compare with control that was found not to be significant on water stable aggregate and BD during investigational period of both the years and pooled data analysis in finger millet.

The respite of the treatments evaluates with control that was found not to be significant on pH, EC and organic carbon content of the finger millet during together the years and pooled analysis.

Conclusion

Based on beyond research soil properties (O.C., N, P_2O_5 and Ca) after harvest of finger millet were recorded significantly superior value under the behaviour of application of 100% RDN through biocompost (S_1) during in cooperation the years and in pooled analysis. At the same time as other chemical properties of soil (EC, pH, K_2O, Fe, Mn, Zn and Cu) were failed to respond significantly with different request of solid organics levels during in cooperation the years and in pooled analysis. Though effect of liquid organics did not influence

significantly on chemical properties of soil after produce of finger millet crop during the both years.

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