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INFLUENCE OF MULTIPLE CROPPING ON THE WATER STABLE AGGREGATES OF UPLAND RICE SOILS

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The efficient uptake of available nutrients by crops depends not only on their proper supply, but also on the soil–air–water relationships. If sufficient water is not available to plants, growth is retarded and nutrient uptake is hindered· But if excessive amount of water is present, air is excluded from the soil pores and roots are unable to carry on respiration and growth functions. The air water relationship of soil depends to a large extent on the soil structure.

Cropping patterns influence the soil structure in many ways. Grain and root crops were found to be the least effective in maintaining an adequate state of soil aggregation (Harris *et al*, 1966). Continuous cropping of corn and grain crops was found to have a detrimental effect on water stable aggregates. (Page and Willard, 1946; Strickling, 1957; and Mohant and Singh, 1969). Continuous cultivation of rice or rice in rotation with othei crops has a deteriorating effect on soil structure (Padmaraju and Deb, 1969). On the other hand cultivation of groundnut has been reported to bring about a slight increase in water stable aggregates (Dvoraesek *et al*, 1965 and Mohant and Singh, 1969).

However, very little information is available on the influence of multiple cropping with rice as major crop on soil structure. Hence a study was conducted to find out the change in soil structure due to multiple cropping with rice as the main crop.

Materials and Methods

The soil samples for the study of water stable aggregates were collected from the multiple cropping experiment in progress at the Central Rice Research Institute, Cuttack, Orissa State. The experiment was started in November 1967. Soil samples were taken before starting of the experiment as well as after every crop The cropping patterns followed were (1) Potato-rice-rice (2) Maize–rice–rice (3) Groundnut–jute–rice (4) Rice–juter–rice (5) Rice-rice. The

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experimental site was not under cultivation *till 1965. It* was lying infested *with* weeds and other vegetation and in 1965 it was reclaimed. During the year 1966-67, it was used for raising rice seedlings.

Plotwise undisturbed soil cores were taken up to a depth of 15 cm. These samples were broken by hand into small crumbs and fractionated by sieveing through a set of 5mm and 2mm sieves. The material retained in the 2mm sieve was used in the analysis of water stable aggregates according to procedure described by Yoder (1936).

Results and Discussion

The data on the percentage of water stable aggregates of the original soil and after each crop during the years 1967-68 and 1968-69 are presented in Table 1. It is evident that before starting of the experiment there was a very high percentage of water stable aggregates larger than 0.5 mm, 0.25 mm and 0.1 mm. After every crop there was a decrease in large sized aggregates due to cultivation. The area under the experiment was not under cultivation till 1965 and from January 1967 to November 1967 it was lying fallow infested with grassy weeds which had a deep root system. This may be the reason for the high percentages of aggregates in the beginning.

In treatment potato–rice–rice, during the first year after potato, there was a slight decrease in aggregates of all sizes, but after *dalua* and *kharif* rice, the decrease was very heavy. However, during the second year, after the potato crop there was an increase in water stable aggregates of all sizes but after the next t\\o crops of rice there was again deterioration in soil structure. A similar trend in change of water stable aggregates was noticed in treatment maize–rice–rice.

In treatment groundnut–jute–rice, there was a decrease in water stable aggregates after every crop during the first year, but during the second year there was an increase in water stable aggregates of all sizes after the groundnut crop. In treatments rice-jute-rice and rice-rice, there was a break down in water stable aggregates of all sizes after each crop during both the years. The maximum break down was in aggregates of the size > 0.5 mm.

After one complete cycle, the maximum decrease in soil structure took piace in maize-rice-rice and rice-rice treatments. This shows that pure cereal rotation does not have a favourable effect on formation of aggregates. This unfavourable effect of cereals on soil structure may be due to the shallow root system of the cereals. The slight increase in water stable aggregates during the second year may

Table 1

Water stable aggregates (percentages) after each crop

Treatment	Size of aggregates in mm	Initial stage	1967-68			1968-69		
			after potato	after *dalua* rice	after *kharif* rice	after potato	after *dalua* rice	after *kharif* rice
1. Potato-rice—rice	> 0.50	47.25	39.07	28.16	11.88	31.24	24.99	22.59
	> 0.25	59.19	48.70	34.97	18.74	39.37	39.01	3[illegible].71
	> 0.10	85.20	80.60	70.27	54.18	69.55	72.06	7[illegible].30
			after maize			after maize		
2. Maize—rice—rice	> 0.50	47.25	28.04	26.50	10.52	21.93	22.43	20.48
	> 0.25	59.19	39.14	34.29	16.49	30.89	32.83	29.07
	> 0.10	85.20	73.10	68.79	52.49	66.63	61.23	65.72
			after groundnut	after jute		after groundnut	after jute	
3. Groun[illegible]-jute—[illegible]	> 0.50	47.25	[illegible].48	18.89	11.02	15.16	28.51	14.09
	> 0.25	59.19	35.20	26.10	18.09	43.94	34.1[illegible]	19.63
	> 0.10	85.20	63.51	57.84	56.19	74.49	65.17	60.14
			after *dalua* rice			after *dalua* rice		
4. Rice—jute—rice	> 0.50	47.25	15.62	13.09	14.69	17.48	21.00	18.40
	> 0.25	59.19	22.16	22.13	29.43	25.43	35.67	25.62
	> 0.10	85.20	54.03	60.82	66.71	67.12	67.28	63.65
				after *dalua* rice			after *dalua* rice	
5. Rice—rice	> 0.50	47.25		22.11	13.02		17.31	14.14
	> 0.25	59.19		27.48	21.13		24.13	20.96
	> 0.10	85.20		58.80	52.45		60.01	63.13

be due to the addition of organic matter to potato, maize and groundnut. Addition of organic matter increases the activity of bacteria and other micro-organisms. Some bacteria produce pure mucous which binds soil particles (Peele, 1940). Similarly legumes have a structure improving effect when introduced in rotation. In the case of groundnut, it may also be due to the formation of nuts in the soil which exerts a pressure around them when they grow and the micro water stable aggregates of more than 0.5 mm in size are broken up into smaller portions to increase the micro (> 0.25 mm) and total water stable aggregates. Similar observations were reported by Dvoraesek *et al*, (1956); Sankaranarayana und Mehta (1967) and Mohant and Singh (1969).

In rice-rice treatment after four crops of rice, water stable aggregateg of size > 0.5 mm decreased from 47 to 14 percent. By continued puddling operation in rice cultivation the water stable aggregates are broken up. The lowest percentage of organic carbon was also noticed in this treatment. These factors were responsible for the lowest percentages of water stable aggregates in rice-rice treatment Islam and Islam (1961) also reported similar results.

Summary

A field experiment at the Central Rice Research Institute, Cuttack, Orissa State on multiple cropping conducted during the years 1967-68 and 1968-69 showed that continuous cropping of rice (rice-rice rotation) and rice-jute-rice rotation had deteriorating effect on soil structure. However, the inclusion of. groundnut in a cropping pattern, the structure of the soil was found to improve slightly. It was also found that in soils where organic manures have been applied, developed a good soil structure as indicated by higher percentages of water stable aggregates.

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സംഗ്രഹം

കട്ടക്കിലുള്ള കേന്ദ്രനെല്ലുഗവേഷണകേന്ദ്രത്തിൽ 1967–68, 1968–69 എന്നീ വർഷങ്ങളിൽ നടത്തിയ പരീക്ഷണത്തിൽ, തുടർച്ചയായ നെൽകൃഷിയും നെല്ല്—നെല്ല് പരിക്രമവും നെല്ല്—ചണം—നെല്ല് എന്ന പരിക്രമവും മണ്ണിന്റെ ഘടന മോശപ്പെടുത്തുന്നതായി കണ്ടു. എന്നാൽ, നിലക്കടല ഉൾപ്പെടുത്തിയിട്ടുള്ള പരിക്രമംകൊണ്ട് മണ്ണിന്റെ ഘടന അല്പം മെച്ചപ്പെട്ടതായി അനുഭവപ്പെട്ടു. ജൈവവളങ്ങൾ ചേർക്കപ്പെട്ടിട്ടുള്ള മണ്ണിൽ വാട്ടർ സ്റ്റേബിൾ അഗ്രിഗേറ്റുകളുടെ ശതമാനം കൂടിയതായും അങ്ങനെ നല്ല ഘടന ഉണ്ടായതായും കാണുകയുണ്ടായി.

REFERENCES

Dvoracsek, M. I. and Dvoracsek, M. 1956. The structure of cultivated and virgin soils. *Soils and Fert.* **19** (6) : 488.

Harris, R. F. Chesters, G. and Allen, O. N. 1966. Dynamics of soil aggregation. *Adv. Agron.* **18**: 107-160

Islam, M. A. and Islam, W. 1961. Influence of sugarcane, paddy and jute on soil aggregation. *Soil. Sci.* **91**: 19-21

Mohant. and Singh, R. A. 1969. Effect of cropping on aggregation and some other physical properties of soils of Kanka. *Jour. Soil Water Cons. India.* **17**: 67-73.

Padmaraju, A. and Deb, A. R. 1969. Influence of crop rotation in the structure of paddy soils. *Ind. Jour. Agric. Sci.* **39:** 81-87.

Sankaranaraya, H. S. and Mahta, B. V. 1967. Soil structure studies in Chambal commanded area of Rajastan. *Jour. Ind. Soc. Soil Sci.* **15**: 77-78,

Strickling, E. 1957. Effect of cropping systems and Voma on soil aggregation, organic matter and yields. *Soil. Sci.* **84:** 489-498.

Yoder, R. E. 1936. A direct method of aggregate analysis and a study of the physical nature of erosion losses. *Jour. Amer. Soc. Agron.* **28:** 337-351.

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