Jour. Agric. Physics, Vol. 3, No. 1 & 2, pp. 31-34 (2003)

Effect of Mixing Dunal Sand in a Heavy Soil on Soil Properties and Crop Productivity

R.S. MALIK[1], B.S. JHORAR[2] AND Y.S. SAHRAWAT[3]
Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar

ABSTRACT

Dunal sand @ 1000 tones per ha was spread evenly by the tractor drawn leveler and mixed in the surface soil by a single run of cultivator up to a depth of 12 cm. Yields of paddy, wheat and cotton were observed at seven different sites at farmer's field (Sirsa District, India) 2 and 8 years after sand mixing under stress and non stressed conditions. Mixing dunal sand decreased the soil strength of surface (3-8 cm) and subsurface (12-17 cm) by 75% and 0%, respectively, and decreased the bulk density of surface and subsurface soil by 9% and 11%, respectively, after 2 years of mixing as compared to the control. It increased the paddy grain and straw yield by 50% and 39%, respectively, and of wheat grain and straw yield by 58% and 64%, respectively, and of seed cotton by 25% as compared to those of the control. Under water stress condition, it increased the grain and straw yield of paddy by 100% and 110%. Under crusting condition, it increased grain and straw yield of wheat by 175% and 173% and that of seed cotton by 400%. It saved two irrigations in the paddy and one each in wheat and cotton. Sand mixing saved energy by saving two passes of cultivator and two passes of planking in paddy and wheat and saved one each of these in cotton as compared to the control. The effect of sand mixing was studied up to 8 years and it was found that there was no difference in the soil properties, yield parameters, energy giving between 2 and 8 years after sand mixing. The cost of sand mixing was Rs.15000 per ha. This cost was recovered from the increased yield and from decreased cost of cultivation in one year. It showed that sand mixing is a practically feasible and economically viable technique for increasing biomass and grain production of important crops i.e. paddy, wheat and cotton grown in heavy soils of arid and semi-arid regions.

Introduction

Sand mixing in surface layers of hard soils is increasingly being practised extensively in Ghaggar belt of Sirsa district of Haryana in about 1000 ha of land area for making the soils more easily tillable for sustainable crop production. To the best of our knowledge, there is no systematic report to account for the reasons of its wide adaptability in spite of the large initial cost involved. Sand mixing in surface of heavy soils, creates surface stratification, is likely to have profound influence on water movement and tilth preparation (Brady, 1995). Sand layers are reported to act as barrier to salt and water movement (Felitsiant, 1961; Melnikova *et al.*, 1968 and Malik *et al.*, 1978). In order to create a scientific data base of the technology, this study was undertaken with the following objective: to quantify the direct and residual effects of sand mixing on soil and its productivity under normal and stress conditions.

[1]Chief Scientist (Water Management), Deptt. of Soil Science, CCSHAU, Hisar, Haryana, India. e-mail : cswm@hau.nic.in and malikrs1@rediffmail.com

[2]Soil Scientist, Deptt. of Forestry, CCS HAU, Hisar, Haryana, India

[3]Ph.D. Scholar, Deptt. of Soil Sciences CCS HAU, Hisar, Haryana, India. e-mail : sehrawatyash111 @rediffmail.com

Materials and Methods

Seven farmers site were selected for collecting technology details and yield data of different crops under normal and stress conditions (water and crusting) in Sirsa district of Haryana where this technology is widely used in approximately 1000 acres. List of farmers and their addresses are given in Table 1.

This farmer's innovative practice consisted of mixing dunal sand @ 100 trolleys (1000 tons) per ha, by putting the sand in a fallow strips at any time preferably during the winter season when he

Table 1. List of farmer's field from where data was collected

Sr. No.	Name	Address	Size of farm (acre)
1	Harish Mehta	S/o Ramdial, V&PO Mangala Distt. Sirsa	50
2	Sarmitter	S/o, Harikishan, V&PO Mangala Distt. Sirsa	40
3	Makhan lal	S/o Jameet Ram, V&PO Ferozpur Distt. Sirsa	12
4	Dayal Singh	S/o Harman Singh, V&PO Habli Distt. Sirsa	25
5	Lalchand	V&PO Ragulpur Distt. Sirsa	40
6.	Champa lal Jain	S/o Ramji lal V&PO Nagrana Kher Distt. Sirsa	40
7	Karnail Singh	V&PO Dhani Guruber Distt. Sirsa	10

is relatively free, and then spread it evenly over the entire field by a tractor drawn leveler. It is then followed by a single pass of a cultivator to mix it in the surface soil. These operations are completed before field preparation of paddy in summer season. Yield data, no of irrigations and cultivation passes and the horse power of the tractor owned were averaged over the 7 farms. Site 1 was selected for measuring soil properties in detail. Soil strength was measured using the cone penetrometer at 15 points in one field for one meaningful observation at 3-8 and 12-17 cm depths. Saturated hydraulic conductivity was measured in undisturbed cores by maintaining constant head of 1m. Moisture content was measured gravimetrically. Bulk density was measured in undisturbed soil cores. EC and pH were determined in 1:2 soil water extracts. Mechanical analysis was done by hydrometer method. Field capacity and wilting point were determined in pressure plate apparatus at 1/3 and 15 bar pressures.

Results and discussion

The surface (3-5 cm) and subsurface (12 to 18 cm) soils at site 1 was compacted clay loam with bulk densities of 1.63 and 1.91 Mg m^{-3} (Table 2).

Brady (1995) had also reported very high bulk density up to 2.0 Mg m^{-3} of compacted silt loam and clay loams. Two after years sand mixing (SM) decreased bulk density by 9 and 11% of surface and subsurface layers as compared to those of control. It thus opened up the compacted surface as well as subsurface of the soil. It is also seen in decreased soil strength by 75 and 0% and increased hydraulic conductivities by 767 and 112 times. There was no corresponding decrease in soil strength of subsurface which may be attributed to its lower soil moisture contents (see column 5 and 7^{th}, 5^{th} row in Table 2). Sand mixing changed the texture of surface soil to sandy loam and there by decreased its the field capacity and wilting point by 50%. Sand mixing reduced the energy consumption for tillage and seed bed preparation. there was saving of at least 2 cultivator and 2 planking passes (Table 3). The power requirement of tractor was reduced from 50 hp to light tractors of 35 hp at each farm. One irrigation in wheat and cotton and 2 in paddy were saved by mulch action and non formation of cracks by the sand mixing technology.

Sand mixing increased the paddy grain and straw yield by 50% and 39%, respectively, and of wheat grain and straw yield by 58% and 64%, respectively, and of seed cotton by 25% as compared to those of the control (Table 4). Under water stress condition, it increased the grain and straw yield of paddy by 100% and 110%. Sand mixing reduced the formation of crusts under crusting condition where it increased grain and straw yield of wheat by 175% and 173% and that of seed cotton by 400%. The effect of sand mixing was studied up to 8 years and it was found that there was no difference in the soil properties, yield parameters, energy saving between 2 and 8 years after sand mixing.

Table 2. Soil properties as affected by sand mixing

	NSM		2 years ASM		8 years ASM	
Depth (cm)	3-8	12-17	3-8	12-17	3-8	12-17
Soil Strength (N m^{-2})	120	160	30	160	31	160
Ks (mm d^{-1})	1.0	0.5	768	57	752	58
Moisture content (g 100 g^{-1})	12.7	12.3	9.9	10.7	9.5	11.1
Bulk density (Mg m^{-3})	1.63	1.91	1.49	1.70	1.49	1.71
Field capacity (g 100 g^{-1})	21.96	22.64	15.25	19.87	16.94	19.61
Wilting point (g 100 g^{-1})	10.99	11.74	7.98	9.8	8.36	9.72
Silt (%)	35.8	32.7	18.3	30.3	19.1	28.5
Clay (%)	3.17	33.7	16.5	32.2	16.2	29.9
EC (dS m^{-1})	.57	.48	.73	.40	.42	.38
pH	9.2	8.8	8.2	9.0	9.3	8.9

NSM=No sand mixing; ASM=after sand mixing; Ks=saturated hydraulic conductivity

Table 3. Savings in tillage operations irrigations as affected by sand mixing

Parameter	2 years ASM		8 years ASM	
	No. of irrigations	No. of passes	No. of irrigations	No. of passes
Paddy	2	2 cultivator + 2 planking	2	2 cultivator + 2 planking 2cul
Wheat	1	2 cultivator + 2 planking 2cul	1	2 cultivator + 2 planking
Cotton	1	1 cultivator + 1 planking	1	1 cultivator + 1 planking

Table 4. Crop yields (t ha^{-1}) as affected by sand mixing.

Parameter	ASM		2 year ASM		8 year ASM	
	Straw	Grain	Straw	Grain	Straw	Grain
Normal (paddy)	6.5	4.0	9.0	6.0	8.8	5.9
Water stress (paddy)	3.1	2.0	6.5	4.0	6.6	4.0
Normal (wheat)	5.0	3.5	8.2	5.5	8.2	5.5
Crusting (wheat)	3.0	2.0	8.2	5.5	8.2	5.5
Normal (seed cotton)	2.0		2.5		2.5	
Crusting (seed cotton)	0.5		2.5		2.5	

C.D. for grain at 5% = 0.28 t/ha.

The cost of sand mixing was Rs.15000 per ha. It was recovered from the increased yield and from decreased cost of cultivation in one year. It showed that sand mixing is a practically feasible and economically viable technique for increasing biomass and grain production of important crops i.e. paddy, wheat and cotton, grown in heavy soils of arid and semi-arid regions.

References

Brady, N.C. (1995). The Nature and Properties of Soils. Tenth Edition. Prentice-Hall of India Private Limited, New Delhi-110 001. p. 621.

Felitsiant, I.N. 1961. Regularity of capillary movement of water and salt solutions in stratified soils. An experimental study. Translated from Russian. Israel Programmed for Scientifidc Translation, Jerusalem (1966). Editor : Heimann, Printed by Monsoon Jerusalem.

Malik, R.S., Jagan Nath and Oswal, M.C. 1978. Evaporation and salinization in layered soils in the presence of a water table. *J. Indian Society of Soil Science*, **26** : 1-6.

Melnikova, M.K., Zamanurod, K.H. and Frial, A.S. 1968. *Sov. Soil Science*, **3** : 340.