COMPARATIVE ASSESSMENT OF PHYSICAL AND CHEMICAL PROPERTIES OF SOIL OF INDUSTRIAL AND NON- INDUSTRIAL AREA'S FARMERS FIELD OF NALAGARH TEHSIL, DISTRICT SOLAN, HIMANCHAL PRADESH, INDIA

ABSTRACT

The experiment was carried out to assess the physical and chemical properties of industrial and non-industrial area's soil of Solan District, Himanchal Pradesh" during 2023. The soil sample were collected from the industrial area of Nalagarh block of the Solan district *viz.*, Guru Majra (V_1), Kaundi (V_2), Theda (V_3), Krishanpura (V_4), Makhnu Majra (V_5) and non-industrial area of Nalagarh block in the Solan district *viz.*, Gurukund (V_1), Ramsar (V_2), Khanpur (V_3), Serri (V_4) and Dattowal (V_5) at 0-15 and 15-30 cm depth with the help of khurpi and following standard procedure. The analysis of physical and chemical properties of soil was carried out in the laboratory of Department of Soil Science, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-211 007 (U.P.). The physical parameters of soil were analyzed and the texture of soil was found Sandy Loam in both industrial and non-industrial area. The color of the soil sample of industrial area in a dry condition varied at different depths from dark greyish brown to yellowish brown and in wet conditions; it varied at different depths from very dark greyish brown to dark greyish brown. The color of the soil sample of non-industrial area in a dry condition varied at different depths from Dark greyish brown to yellowish brown and in wet condition; it varied at different depths from dark greyish brown to dark greyish brown. The bulk density of the industrial and non- industrial soils varied at 0-15 and 15-30 cm between 1.50 to 1.70 Mg m^{-3} and 1.79 to 1.68 Mg m^{-3} respectively, while the particle density ranged from 2.324 to 2.505 Mg m^{-3} and 2.487 to 2. 326 Mg m^{-3} respectively. The percentage of pore space of soils ranged from 27 to 40 % and 24.33 to 33.09 % respectively and water holding capacity ranged from 20.23 to 33.10 % and 17.32 to 26.29 % respectively in non-industrial respectively. Soil pH varied from 7.38 to 7.66 in industrial and 7.06 to 7.35 in non-industrial soil, which was neutral to slightly saline. Moreover, the Electrical conductivity of industrial area and non-industrial area soil at different depth was recorded as 0.47-0.64 dS m^{-1} and 0.33-0.48 dS m^{-1} respectively. In the case of the organic carbon, Available Nitrogen, phosphorus, potassium 0.25-0.39%, 0.39-0.67% and 217.86-243.12, 243.19-265.27 kg ha^{-1} and 25.44-38.25, 33.61-48.36 kg ha^{-1} and 131.54-264.54, 258.43-287.59 kg ha^{-1} was recorded at different depth in industrial and non-industrial area soil respectively. The concentration levels of certain micronutrients and heavy metals were analyzed and the results indicate that the Zinc concentration was found 17.08-27.22 and 24.44-33.43 mg kg^{-1} and Iron was recorded as 51.19-73.43 mg kg^{-1} and 16.69-24.38 mg kg^{-1} and manganese was found 8.5-18.70 mg kg^{-1} and 9.17-19.68 mg kg^{-1} along with high Cadmium 0.23-0.34 and 0.27-0.39 mg kg^{-1} and lead 8.67-12.55 and 7.1-11.9 mg kg^{-1} at different depth in industrial and non-industrial area respectively.

Keywords: Industrial, non-industrial, physical and chemical properties, texture, *etc.*

1. Introduction

"Soil is a dynamic natural body formed by pedogenic processes such as rock weathering, and it is made up of mineral and organic ingredients with specific chemical, physical, and biological properties" **(Bindu *et al.*, 2022). "**The physical and chemical characteristics of soil plays a big role in the plants ability to extract water and nutrients. High quality soils not only produce better food and fiber, but also help to establish natural ecosystem and enhance air and water quality" (**Brady and Weil, 2016).** "The physical and chemical properties are soil texture, bulk density, water holding capacity, soil structure, soil colour, pH, electrical conductivity, cation exchange capacity, organic carbon and soil nutrients (macro and micro)" **(Griffiths *et al.*, 2010).** The Soil Science Society of America defines soil health 'as the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation' **(Paul and Putman, 2008).** Soil quality is simply defined as "the capacity of a specific kind of soil "(**Karlen *et al.*, 1997**), *i.e.*, mainly to provide nutrition to plants and absorb and drain water. The different properties of soil are – texture, moisture, fertility (level of nitrogen, phosphorus, and potassium) and pH level, where the pH is the measure of a soil's acidity or alkalinity. "Physical properties analysis generally includes simple, fast and low-cost methodologies. The physical properties of soil commonly assessed include bulk density, particle density, porosity, water holding capacity, soil color, texture, and specific gravity" **(Brady and Weil, 2016)**. Soil organic carbon is also an important key attribute in assessing the soil health, generally correlating positively with the crop yield. Nitrogen is the most required plant nutrient, which is found in several chemical forms in the soil, resulting in a very dynamic behavior. Phosphorus is the main nutrient that limit Agricultural yield and is essential for assessment of soil quality. "While Potassium increases the crop yield and improves the quality. it is required for numerous plant growth processes" **(Prajapati *et al.*, 2012). "**The other Nutrient elements (iron, manganese, copper, zinc, boron, molybdenum, chlorine, cobalt) obtained from soil are utilized in very small amounts by higher plants, hence are called as micronutrients, they are mostly present in most soils with low availability; however, the deficiency problems concerning micronutrients are not widespread as that of macronutrients" **(Shelton, 1976).**

Heavy metals are those elements which have specific weight of more than 5 g cm^3 **(Leonard *et al.*, 2004).** Heavy metals are either essential (Mo, Mn Cu, Ni, Fe, Zn) or non-essential metals (Cd, Ni, As, Hg, Pb). Heavy metals are also essential for plants as they act as a cofactor, activate the enzyme reaction and show ductility, conductivity and provide cation stability **(Stohs and Bagchi, 1995).**

2. METHODOLOGY

Soil samples were collected from five different sites of industrial i.e.,Guru majra, Kaundi, Theda, Krishanpura, Makhanu majra and non- industrial *i.e.,* Gurukund, Ramsar, Khanpur, Serri, Dattowal. Nalagarh Tehsil, district Solan at two respective depths of 0-15, 15-30 cm for the analysis of physical and chemical properties of soil. Soil samples were collected from the highland, middle land and lowland fields that are used for crop production and also from industrial areas. Taking soil samples from the areas such as waterlogged area, areas near main bund, trees, manure heaps and irrigation channels were avoided. These samples were air dried in shade for one week to obtain constant weight then crushed with wooden hammer, after that it was sieved with 0.2mm sieve to obtain composite samples of each site and each depth. The physical properties of soils, soil colour, texture, bulk density (Mg m^{-3}), particle density (Mg m^{-3}), percent pore space and percent water holding capacity, specific gravity were analysed with the following standard procedures: Munsell (1971), Bouyoucos (1927), Muthuvel *et al.*,(1992) and chemical properties, pH, EC (dS m^{-1}) at 25˚C, percent organic carbon, available nitrogen, phosphorus and potassium (kg ha^{-1}), Available copper, zinc, manganese, iron, lead and cadmium mg kg^{-1} were analyzed by following Jackson (1958), Wilcox (1950), Walkley and Black (1947), Subbiah and Asija (1956), Olsen *et al.*,(1954) Toth and Prince (1949), and Lindsay and Norvell (1978) at 0-15 and 15-30 cm depths. The data recorded during the course of investigation was subjected to statistical analysis by the method of analysis of Completely Randomized Design (CRD) as per the method of "Analysis of Variance technique" (ANOVA).

3. RESULT AND DISSCUSSION:

The data presented in tables 1 depicted the soil color of the farmer’s field of village in dry and wet conditions at two depths 0-15 and 15-30 cm of non-industrial and industrial area respectively. The color of non-industrial area’s soil sample in a dry condition varies at different depths from dark greyish brown to yellowish brown and in wet conditions; it also varies at different depths from very dark greyish brown to dark greyish brown for non-industrial area. The color of non-industrial area's soil sample in a dry condition varies at different depths from olive yellow to olive grey and in wet conditions; it also varies at different depths from olive brown to dark greyish brown for industrial area. The similar finding is also seen in Kumar *et al.* (2018). The table 2 described the soil texture of farmer's fields of different villages at 0-15, and 15-30 cm soil depths. The soil texture was found sandy loam in both respective depths. The sand, silt, and clay percent range from 67 - 68.64%, 13.30 - 18.83%, and 13.36-19.70 % for industrial soil respectively. Similarly sand, silt and clay percent range from 66.50 - 67.20 %, 14.10 - 19.20% and 12.80 - 18.70 % for non-industrial soil respectively. A similar result analysis was reported by Patel *et al.* (2017). The table 3 depicted the statistical analysis of the bulk density and particle density (Mg m^{-3}) of the farmer's field and depths which was found significant at 5% critical difference. The maximum bulk density 1.68 & 1.70 Mg m^{-3} and 1.76 & 1.79 Mg m^{-3} of soil were recorded at 0-15 and 15-30 cm depths with V5. The minimum bulk density 1.50 & 1.55 Mg m^{-3} and 1.66 & 1.68 Mg m^{-3} of soil were recorded at with V3 for industrial and non-industrial soil respectively. The maximum particle density 2.500 & 2.505 Mg m^{-3} and 2.481 and 2.487 Mg m^{-3} of soil were recorded at 0-15 and 15-30 cm depths with V3 and the minimum 2.324 & 2.329 Mg m^{-3} and 2.323 and 2.326 Mg m^{-3} of soil were recorded with V5 for industrial soil and V1 for non-industrial soil respectively. The bulk density and particle density of soil increases with an increase in soil depth and decreased due to high organic matter content or vice versa. The different levels of erosion of soil depending upon the slope and management practices are also responsible for higher bulk- density which might be due to greater compaction that might have occurred in the lower horizons of the soil profiles with time. The increase in the particle density is due to soil depth, water quality, and their interaction. A similar finding was reported by Bhuyan *et al.* (2013) and Kumar *et al.* (2018). Table 4 depicted the statistical analysis of the percent pore space of farmer's field which was found significant at 5% critical difference. The maximum percent pore space 40.00 and 38.12% and 33.09 and 32.36% of soil was recorded at 0-15 and 15-30 cm depths at V3 and the minimum 27.71 and 27.00% and 25.09 and 24.33% of soil was recorded at V5 for industrial and non-industrial soil respectively. Soil containing high organic matter possesses high porosity. The percent pore space decreases with an increase in the soil depth. The same analysis result was reported by Choudhary *et al.* (2020). The maximum water holding capacity 33.10 & 30.22% and 26.29 & 24.26 % of the soil were recorded at 0-15 and 15- 30 cm depths at V3 and the minimum 21.55 & 20.23% and 19.19 & 17.32 % of soil were recorded at V1 for industrial and non-industrial soil respectively. These variations were due to clay, silt, and organic carbon content and low water holding capacity in sandy soils due to high sand and less clay content. The water holding capacity increased with an increase in the clay content at the sites. The water holding capacity decreases with an increase in the depth of soil. The same analysis result were reported by Sahu *et al.* (2014) and Sharma *et al.* (2010). The maximum pH 7.64 & 7.66 and 7.33 and 7.35 of soil were recorded at 0-15 and 15-30 cm depths at V5 and the minimum 7.38 & 7.40 and 7.06 and 7.10 of soil were recorded at V3 for industrial soil and non-industrial soil respectively. The soil pH increased with an increase in depth. The low pH value is due to the presence of organic matter and the reduction in the pH value is due to the production of acids by bacterial action in nitrification processes in the soil and the decomposition of the organic matter. Similar results were reported by Kiran *et al.* (2012). The maximum EC 0.64 & 0.60 dS m^{-1} and 0.48 & 0.45 dS m^{-1} of soil were recorded at 0-15 and 15-30 cm depths at V5 and the minimum 0.52 & 0.47 dS m^{-1} and 0.37 & 0.33 dS m^{-1} of soil were recorded at V4 for industrial soil and V3 for non-industrial soil respectively. The surface soil was found to have maximum salt concentration and decreasing trend with an increase in depth of the soil profile. The low EC may be due to good drainage conditions which favored the removal of released bases by percolating. A similar analysis was recorded by Rathi *et al.* (2018) and Singaravel *et al.* (2000). The maximum organic carbon and organic Matter 0.39 & 0.36 and 0.67 & 0.62 % of the soil were recorded at 0-15 and 15-30 cm depths at V5 and the minimum 0.29 & 0. 25% and 0.50 & 0.43 % of soil were recorded at V2 for industrial soil respectively. Similarly, the maximum organic carbon 0.67 & 0.61 and 1.16 & 1.05 % of the soil was recorded at 0-15 and 15-30 cm depths at V3 and the minimum 0.44 & 0.39 and 0.76 & 0.67 % of soil was recorded at V1 for non-industrial soil respectively. The soil organic carbon content decreased with an increase in soil depth and this is due to the addition of plant residues and FYM to surface soil than in the sub-surface soil. Similar results were reported by Rana *et al.*, (2020) and Gautam *et al.* (2018). Table 5 depicted the statistical analysis of the NPK (kg ha^{-1}) of the farmer's field and depths which was found significant at 5% critical difference. The maximum NPK 243.12 & 239.57, 38.45 & 36.14 and 264.54 & 259.18 kg ha^{-1} of soil were recorded at 0-15 and 15-30 cm depths at V5, V4 & V1 respectively. The minimum NPK 221.33 & 217.86, 28.36 & 25.44 and 137.56 & 131.54 kg ha^{-1} of soil were recorded at V1, V5 & V5 for industrial soil respectively. Similarly, the maximum NPK 265.27 & 258.36, 48.36 & 44.21 and 287.59 & 281.48 kg ha^{-1} of soil were recorded at 0-15 and 15-30 cm depths at V3 and the minimum NPK 247.17 & 243.19, 37.54 & 33.61 and 264.87 & 258.43 kg ha^{-1} of soil were recorded at V1 for non-industrial soil respectively. The available nitrogen decreased with the increase in soil depth. However, the highest phosphorus and available K content was noticed on the surface horizon and decreased with soil depth. A similar result analysis was noticed by Bhavya *et al.*, (2018), Khanday *et al.*, (2018) and Kumar *et al.*, (2013).

Conclusion

The present study highlights about comparative Assessment Of Physical And Chemical Properties Of Soil Of Industrial And Non- Industrial Area's Farmers Field Of Nalagarh Tehsil, District Solan, Himanchal Pradesh, India. Heavy metals are either essential (Mo, Mn Cu, Ni, Fe, Zn) or non-essential metals (Cd, Ni, As, Hg, Pb). Heavy metals are also essential for plants as they act as a cofactor, activate the enzyme reaction and show ductility, conductivity and provide cation stability

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1.

2.

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Table 1: Soil color of different fields of village in dry and wet condition of the soil for non-industrial and industrial area

Samp. Sites	Non-industrial Area				Industrial Area			
	Dry Condition		Wet Condition		Dry Condition		Wet Condition	
	Depth (0-15cm)	Depth (15-30cm)	Depth (0-15cm)	Depth (15-30cm)	Depth (0-15cm)	Depth (15-30cm)	Depth (0-15cm)	Depth (15-30cm)
V_1	10YR 5/3	10YR 4/2	2.5YR 3/2	2.5YR 3/2	5Y 6/6	5Y 5/2	2.5Y 4/4	2.5Y 4/2
	Brown	Dark greyish Brown	Very dark Greyish Brown	Very Dark greyish Brown	Olive Yellow	Olive Grey	Olive Brown	Dark greyish Brown
V_2	10YR 4/2	4 R 5/2	2.5YR 4/2	2.5YR 5/4	5Y 6/6	5Y 5/2	2.5Y 4/4	2.5Y 4/2
	Dark greyish Brown	Greyish Brown	Very Dark grayish Brown	Very Dark greyish Brown	Olive Yellow	Olive Grey	Olive Brown	Dark greyish Brown
V_3	10YR 6/3	10 YR 7/3	2.5YR 4/4	2.5YR 5/4	5Y 6/6	5Y 5/2	2.5Y 4/4	2.5Y 4/2
	Pale Brown	Very Pale Brown	Light olive Brown	olive Brown	Olive Yellow	Olive Grey	Olive Brown	Dark greyish Brown
V_4	10YR 5/3	10 YR 5/4	2.5YR 3/2	2.5YR 3/3	5Y 6/6	5Y 5/2	2.5Y 4/4	2.5Y 4/2
	Brown	Yellowish Brown	Very Greyish Brown	Very Greyish	Olive Yellow	Olive Grey	Olive Brown	Dark greyish Brown

V5	10YR 6/4	10YR 7/6	2.5YR 3/7	2.5YR ¾	5Y 6/6	5Y 5/2	2.5Y 4/4	2.5Y 4/2
	Light Brown Yellow	Yellow	Very Dark greyish Brown	Greyish Brown	Olive Yellow	Olive Grey	Olive Brown	Dark greyish Brown

Table 2: Soil texture of different fields of village in dry and wet condition of the soil for non-industrial and industrial area

Samp. Sites	Non-industrial Area				Industrial Area			
	Soil Texture				Soil Texture			
	Sand (%)	Silt (%)	Clay (%)	Texture	Sand (%)	Silt (%)	Clay (%)	Texture
V1	66.50	19.20	14.30	Sandy Loam	67.00	13.30	19.70	Sandy Loam
	67.38	19.82	12.80	Sandy Loam	68.00	18.64	13.36	Sandy Loam
V2	68.00	16.30	15.70	Sandy Loam	68.20	16.00	15.80	Sandy Loam
	67.20	14.10	18.70	Sandy Loam	68.64	18.00	13.36	Sandy Loam
V3	67.10	14.70	18.20	Sandy Loam	68.00	18.83	13.90	Sandy Loam
	66.50	19.20	14.30	Sandy Loam	67.00	13.30	19.70	Sandy Loam
V4	67.38	19.82	12.80	Sandy Loam	68.00	18.64	13.36	Sandy Loam
	68.00	16.30	15.70	Sandy	68.20	16.00	15.80	Sandy

				Loam				Loam
V_5	67.20	14.10	18.70	Sandy Loam	68.64	18.00	13.36	Sandy Loam
	67.10	14.70	18.20	Sandy Loam	68.00	18.83	13.90	Sandy Loam

Table 3: BD, PD, Pore Space, Water holding Capacity and soil pH of different fields of village in soil for non-industrial and industrial area

Soil Samples	**Bulk density (Mg/m^3)**		**Particle density (Mg/m^3)**		**Percent Pore Space**		**Water Holding Capacity (%)**		**Soil pH**	
	Industrial									
	Depth (0-15 cm)	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth 15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**
V1	1.68	1.69	2.352	2.356	28.57	28.26	21.55	20.23	7.52	7.55
V2	1.56	1.59	2.483	2.488	37.17	36.09	32.27	30.19	7.61	7.62
V3	1.5	1.55	2.500	2.505	40.00	38.12	33.10	30.22	7.41	7.43
V4	1.63	1.67	2.422	2.425	32.70	31.13	25.60	23.23	7.38	7.4
V5	1.68	1.7	2.324	2.329	27.71	27.00	22.60	21.36	7.64	7.66
Non-Industrial										
V1	1.74	1.76	2.323	2.326	25.09	24.33	19.19	17.32	7.33	7.35

V2	1.73	1.77	2.453	2.487	29.47	27.96	23.27	22.76	7.13	7.15
V3	1.66	1.68	2.481	2.484	33.09	32.36	26.29	24.26	7.06	7.1
V4	1.68	1.7	2.424	2.428	30.69	29.98	22.79	20.66	7.12	7.16
V5	1.76	1.79	2.452	2.456	28.22	27.11	23.32	20.91	7.09	7.13

Table 4: Soil EC, Organic Carbon, Organic matter, Available N and Available P of different fields of village in soil of the soil for non-industrial and industrial area

Soil Samples	Soil EC (dS m^{-1})		Soil Organic Carbon (%)		Soil Organic matter (%)		Available Nitrogen (kg ha^{-1})		Available Phosphorus (kg ha^{-1})	
	Industrial									
	Depth (0-15 cm)	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**
V1	0.54	0.52	0.36	0.32	0.62	0.55	238.94	235.61	32.18	30.55
V2	0.59	0.55	0.29	0.25	0.50	0.43	221.33	217.86	30.51	28.43
V3	0.58	0.55	0.34	0.31	0.59	0.53	232.33	230.19	35.66	32.18
V4	0.52	0.47	0.32	0.28	0.55	0.48	228.47	225.37	38.45	36.14
V5	0.64	0.60	0.39	0.36	0.67	0.62	243.12	239.57	28.36	25.44
Non-Industrial										
V1	0.48	0.45	0.44	0.39	0.76	0.67	247.17	243.19	37.54	33.61

V2	0.44	0.41	0.56	0.52	0.97	0.90	258.11	254.83	42.02	39.49
V3	0.37	0.33	0.67	0.61	1.16	1.05	265.27	258.36	48.36	44.21
V4	0.43	0.39	0.52	0.49	0.90	0.84	256.43	251.72	41.88	38.44
V5	0.41	0.38	0.58	0.54	1.00	0.93	261.32	256.66	45.89	42.84

Table 5: Available K, Cd, Pb, Fe, and Zn of different fields of village in the soil for non-industrial and industrial area

Soil Samples	**Available Potassium (kg ha^{-1})**		**Cadmium (mg kg^{-1})**		**Lead (mg kg^{-1})**		**Iron (mg kg^{-1})**		**Zinc (mg kg^{-1})**	
	Industrial									
	Depth (0-15 cm)	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**
V1	264.54	259.18	0.23	0.25	9.68	9.69	52.08	51.19	18.32	18.11
V2	210.78	204.72	0.24	0.25	10.56	10.59	57.83	56.63	21.95	21.62
V3	157.65	152.76	0.31	0.34	12.5	12.55	73.43	71.92	27.22	26.91
V4	142.87	139.45	0.23	0.25	8.63	8.67	62.17	60.56	18.27	17.08
V5	137.56	131.54	0.29	0.31	9.68	9.7	69.53	68.24	19.81	19.71
Non-Industrial										
V1	264.87	258.43	0.27	0.29	8.6	8.8	18.58	16.69	24.46	24.44

V2	278.31	272.83	0.29	0.31	9.6	9.9	22.84	21.88	27.71	26.53
V3	287.59	281.48	0.37	0.39	11.7	11.9	24.38	23.30	33.43	32.18
V4	274.54	271.44	0.28	0.3	7.8	7.1	23.60	22.10	24.44	23.77
V5	280.47	275.34	0.34	0.36	8.9	9	21.15	20.00	25.71	24.49

Table 6: Manganese and Copper of different fields of village in soil for non-industrial and industrial area

Soil Samples	**Manganese (mg kg^{-1})**		**Copper (mg kg^{-1})**	
	Industrial			
	Depth (0-15 cm)	**Depth (15-30 cm)**	**Depth (0-15 cm)**	**Depth (15-30 cm)**
V1	11.42	10.32	4.3	3.83
V2	8.63	8.5	4.1	3.91
V3	12.64	11.98	3.7	3.43
V4	11.53	11.03	2.9	2.63
V5	18.70	17.85	3.2	2.97
Non-Industrial				
V1	11.68	10.69	4.89	4.37
V2	9.56	9.17	4.58	4.36

V3	13.51	12.55	4.15	4.23
V4	12.63	11.67	3.48	3.12
V5	19.68	18.73	3.67	3.45