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A Study on Pesticide Residue impacts on Groundwater Quality near Agricultural Activity Areas

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KEYWORDS

Groundwater, Agriculture, Pesticide, Toxicity.

ABSTRACT:

Agricultural runoff contaminates the groundwater sources. The widespread use of pesticides and fertilizers for agricultural and non-agricultural purposes has resulted in the presence of their residues in groundwater sources. The present study aims to provide a better understanding of the impacts of pesticide residue on groundwater quality in some selected agro based rural habitations in Konaseema region of East Godavari District, Andhra Pradesh state, India. pH is measured using a portable pH meter, Total dissolved solids (TDS) is measured by portable TDS sensor, Total hardness(TH) and Chloride (Cl^-) is measured by titrimetry, Sulphate (SO_4^{2-}) and Phosphate (PO_4^{3-}) are measured by spectrophotometer, Nitrate (NO_3^-) by using ion selective electrode. In waters near agricultural areas TH and PO_4^{3-} were observed to be higher than the guideline values of IS. The present work is mainly focused on characterizing ground waters for pesticide residues. The analytical results obtained indicated the presence of pesticide residues. The maximum concentration of pesticides were found particularly Trifluralin (1.28 mg/l), Terbutyl azine (1.29 mg/l), Dimethachlor (1.30 mg/l), Metribuzin (1.14 mg/l), Dimethrimol (1.26 mg/l), Ethion (1.08 mg/l), Bifenithrin (1.22 mg/l), Atrazine (1.28 mg/l), Beta HCH (1.18 mg/l), Lindane (1.25 mg/l), Diazinon (1.15 mg/l) and Butachlor (1.28 mg/l) respectively were indicate the contamination of waters with their residues.

1. Introduction:

Water is essential to life and it plays a crucial role in the development of any country. Rise in population and rapid urbanization along with climate change can reduce water supply at global level during the 21st century [1, 2]. The groundwater resources are at higher risk as its recharge is very difficult [3]. Polluted waters affect water quality and it becomes a threat to human health, economic development and social prosperity [4]. Application of fertilizers and pesticides enhance the agriculture production but result in direct and harmful impact on water quality [5, 6, 7]. The contamination of environment by hazardous substances such as persistent Organochlorine pesticides and other persistent Organic pollutants is a worldwide public health concern [8, 9]. Agricultural practices resulted in serious impacts on the environment, causing an increase in the level of residues in natural water, soil, river sediments and foodstuffs [10, 11]. Both herbicides and pesticides reach natural water bodies through run off. These residues when reach to natural water bodies they disturb flora and fauna. Pesticides which do not mortify easily or take time to mortify are more harmful [12]. HCHs isomers are found to be wide-ranging toxicants which accumulate in food chain with high risk to the environment [13]. Pesticides like DDT and HCH were used extensively in India for agricultural purposes. It is estimated that about 25000 MT of chlorinated pesticides were used annually in India [14]. Poor maintenance of agricultural operations can lead to contamination of surface and ground waters by pesticides [15,16]. Wastes discharged into drainage systems enter natural waters,

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polluting them and resulting in number of health hazards like cholera and diarrhea [17].The high toxicity of pesticides may cause skin irritation, respiratory problems, dizziness and nausea. The low toxicity of pesticides is associated with various chronic diseases such as effect on the nervous system, parkinson's disease and abnormal immune system [18]. The objective of the study is to characterize waters for pesticide residues to evaluate toxicity of waters near agricultural areas. It is further proposed to provide the data to the concerned agencies to initiate remedial measures to protect the quality of waters for safe guarding the health of the public residing in the habitations nearer to agricultural areas.

2. Materials & Methods

Study Area

The study areas of interest for the present study were Nedunuru village of Ainavilli mandal, Palagummi village of Amalapuram mandal and K.Pedapudi village of Ambhajipeta mandal in East Godavari district of Andhra Pradesh state, India which has agricultural climatic zone characteristics. The sample code and GPS coordinates of the study area are presented in table-1. The study area maps and sampling locations are shown in Fig 1(a).

Sample collection

The study area locations were selected in the vicinities of hectic agricultural activity areas. And 10 Groundwater samples were collected from each village of the three study areas in pre and post monsoon seasons during the months of April-May and November-December. Three representative samples were prepared from these ten samples for the analysis of pesticide residue. The samples were collected as per the standard procedures [21,22]. The details of sample code, sampling locations along with their GPS Coordinates are presented in the table-1. The representative sample codes for samples of pesticide residue analysis are shown in table-2.

Measurement of Physico-chemical parameters of groundwater samples

The groundwater samples were characterized for physicochemical parameters viz., pH, temp, Total Dissolved solids (TDS), Total hardness (TH), Chloride, Sulphate, Nirtate and Phosphate. pH is determined by portable pH Meter (Model-PCS Tester35, Eutech, UK) and TDS is determined by portable TDS Sensor (Electrode based), Total hardness and Chloride are estimated by titrimetry. Total hardness was determined by EDTA titration using Erichrome black-T indicator. Chloride was determined by titrimetric method by standard Silver nitrate solution. Sulphate and Phosphate by spectrophotometer (Model-106, Systronics), Nitrate by using Ion selective electrode (Model-HI 3222 pH/ORP/ISE Meter, HANNA) and GPS Coordinates measured with Garmine (Germany) make-etrex30x-Model in WGS 84 decimal system. To establish the data quality strict quality assurance and quality control programme has been followed for all the parametric values.

Chromatography parameter condition

Gas chromatography-mass spectrometry was used to detect the pesticide residues in groundwater samples. GC-MS analysis was carried out on a GC CLARUS 550 PerkinElmer system comprising a gas chromatograph interfaced to a mass spectrometer (GC-MS) instrument [23,24].

3. Results & Discussion

Physico-chemical parameters

All the representative groundwater samples were characterized for physicochemical parameters viz., pH, Temp, TDS, TH, Cl^-, SO_4^{2-}, PO_4^{3-} and NO_3^-. The physicochemical parametric values of groundwater near agricultural areas are presented in table-3.

The pH of the groundwater samples ranges from 6.97 – 7.64. They are within the permissible limits. Temperature ranges from 31.23 ^{0}C to 33.43^{0}C. TDS of groundwater near agricultural activity areas ranges from 240.3–363.6 mg/l. All the samples are within the guideline value. TH in groundwater samples ranges from 251.6-351.6 mg/l. In samples NAg-1, NAg-2, NAg-3 and KAg-2 it crossed the guideline value. Chloride and sulphate ranges from 23.49-47.26 mg/l and 8.53-50.59 mg/l. They are within the permissible limits. Phosphate in water samples ranges from 0.05-8.90 mg/l. In samples NAg-1 and PAg-1 it crossed the guideline value. Nitrate in groundwater near agricultural

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areas ranges from 3.47-5.51 mg/l. All the samples are within the guideline value [21].

Pesticide residue

The water samples collected from the nearby areas of agricultural activities in the study areas of Nedunuru, Palagummi and K. Pedapudi villages in konaseema region of East Godavari District; Andhra pradesh were analyzed by GC-MS for assessing the levels of Pesticide residue contamination. 57 pesticides which were employed for agricultural activity in 3 study areas by the farmer community are categorized as Herbicides, Fungicides and Insecticides and the details are presented in Table-4. Out of 57 pesticides, 15 pesticides which were categorized as Herbicides, Fungicides and Insecticides were employed by the farmers in Nedunuru village, 28 pesticides which were categorized as Herbicides, Fungicides and Insecticides were found to be used in Palagummi village and 22 pesticides which were categorized as Herbicides, Fungicides and Insecticides were used by the farmers in K.Pedapudi village.

Herbicide concentrations identified in ground water of study areas

Nedunuru Village

The mean concentration of propachlor in samples NAg-1 and NAg-3 were observed as 0.02 mg/l, while in sample NAg-2 it was 0.01 mg/l. The higher concentration of Trifluralin was 1.28 mg/l in samples NAg-1, NAg-2 and NAg-3 respectively. The mean concentration of Simazine was found in NAg-1 and NAg-2 as 0.13 mg/l and 0.65 mg/l respectively. The higher concentration of Terbuthyl azine in samples NAg-1 and NAg-3 was 1.29 mg/l. In sample NAg-2 it was 1.30 mg/l. The concentration of Pirimicarb was observed as 0.18 mg/l and 0.01 mg/l in samples NAg-1 and NAg-2 respectively. In all the three samples, the concentration of Dimethachlor remained as 1.30 mg/l. The concentration of metribuzin in samples NAg-1, NAg-2 and NAg-3 was 0.07 mg/l, 0.14 mg/l and 1.14 mg/l respectively. Pendimethalin was observed in NAg-1 sample only with a concentration of 0.01 mg/l. Acetochlor concentration in two samples NAg-1 and NAg-2 was observed as 0.33 mg/l and 0.165 mg/l respectively.

Palagummi village

The concentration of Atrazine in sample PAg-1 was 0.64 mg/l while in samples PAg-2 and PAg-3 were detected as 1.28 mg/l. In all the three samples the concentration of Molinate and Azinphos ethyl were identified as 0.01 mg/l and 0.005 mg/l respectively. The concentration of Propanil was identified in samples PAg-2 and PAg-3 as 0.035 mg/l and 0.07 mg/l respectively. Metalachlor was detected in sample PAg-3 whose concentration was 0.285 mg/l.

K. Pedapudi village

The concentration of Atrazine in samples KAg-1 and KAg-2 were observed as 0.87 mg/l. The concentration of Alachlor was found in sample KAg-1 as 0.04 mg/l. In samples KAg-2 and KAg-3, the concentration of Butachlor was observed as 1.25 mg/l and 1.28 mg/l respectively.

Fungicide concentrations identified in ground waters of study areas

Nedunuru Village

Dimethrimol concentration in sample NAg-1 was 0.63 mg/l while in samples NAg-2 and NAg-3 higher concentrations were observed as 1.26 mg/l. The concentration of Iprodione in samples NAg-1 and NAg-2 were noted as 0.24 mg/l whereas in sample NAg-3 it was 0.12 mg/l.

Palagummi village

The concentration of Procymidone in sample PAg-1 was 0.32 mg/l while in the case of samples PAg-2 and PAg-3 it was observed as 0.23 mg/l. The concentration of Captan in all the three samples PAg-1, PAg-2 and PAg-3 were 0.02 mg/l. The concentration of Cyproconazole in sample PAg-1 was 0.01 mg/l. The concentration of Hexachloro benzene in sample PAg-3 was 0.105 mg/l.

K. Pedapudi village

In study area K.Pedapudi village the fungicide residues were absent. Hence the waters are free from fungicide residue contamination.

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Insecticide concentrations identified in ground water of study areas

Nedunuru Village

The concentration of Heptachlor Epoxide was observed as 0.57 mg/l and 0.98 mg/l in samples NAg-1 and NAg-3 respectively. The concentration of Ethion was perceived as 0.65 mg/l, 0.98 mg/l and 1.08 mg/l in samples NAg-1, NAg-2 and NAg-3 respectively. The concentration of Bifenithrin in samples NAg-1 and NAg-2 were 1.08 mg/l whereas in sample NAg-3 it was noticed as 1.22 mg/l. The phosmet concentration in samples NAg-1, NAg-2 and NAg-3 were observed as 0.09 mg/l, 0.045 mg/l and 0.03 mg/l respectively.

Palagummi village

The mean concentrations of Dimethoate and Prothiofos in samples PAg-1, PAg-2 and PAg-3 were 0.06 mg/l and 0.03 mg/l respectively. Triazophos in sample PAg-1 was noticed as 0.02 mg/l whereas in samples PAg-2 and PAg-3 it was 0.04 mg/l. The concentration of Ethion in sample PAg-1 was 0.97 mg/l while in samples PAg-2 and PAg-3 it was 0.32 mg/l. The higher concentration of Bifenithrin in sample PAg-1 was observed as1.26 mg/l while in samples PAg-2 and PAg-3 it was noted as 0.97 mg/l. Heptachlor epoxide was observed in only one sample PAg-1 whose concentration was noted as 0.98 mg/l. The concentration of Cypermethrin in sample PAg-1 was 0.12 mg/l while in samples PAg-2 and PAg-3 it was 0.655 mg/l. The pesticide residue, Aldrin in sampling location of PAg-1 was observed as 0.54 mg/l. The concentration of Deltamethrin in sample PAg-1 was 0.01 mg/l while in samples PAg-2 and PAg-3 it was observed as 0.75 mg/l. The concentration of Dieldrin in sample PAg-1 was 0.01 mg/l. The concentration of Phosmet in sample PAg-1 was observed as 0.03 mg/l while in samples PAg-2 and PAg-3 it was noted as 0.005 mg/l. The concentrations of Phosalone, Fluvalinate, Chloropyrifos methyl, P,P – DDT were detected in samples PAg-2 and PAg-3 and their concentrations were 0.01 mg/l, 0.04 mg/l, 0.03 mg/l and 0.02 mg/l respectively. The concentration of Fenvalerate and Methamidophos in samples PAg-2 and PAg-3 were 0.645 mg/l and 0.09 mg/l respectively. Fipronil and Permethrin were detected in sample PAg-3 of concentrations 0.27 mg/l and 0.01 mg/l respectively.

K. Pedapudi village

The mean concentrations of Dichlorvos and Monocrotophos in samples KAg-1, KAg-2 and KAg-3 were noticed as 0.03 mg/l and 0.04 mg/l. In all the three samples, Phorate and Fenitrothion concentrations were observed as 0.02 mg/l each. The concentration of Lambda cyhalothrin in samples KAg-1 and KAg-2 were observed as 0.12 mg/l. The concentrations of Beta HCH, Lindane, Diazinon, Methyl parathion, Alachlor and Heptachlor were found in one sample KAg-1 as 1.18 mg/l, 1.25 mg/l, 1.15 mg/l, 0.09 mg/l, 0.04 mg/l and 0.01 mg/l respectively. The concentration of Delta HCH in samples KAg-1, KAg-2 and KAg-3 were observed as 0.62 mg/l, 0.05 mg/l and 0.02 mg/l respectively. The concentration of Chloropyrifos in samples KAg-1, KAg-2 and KAg-3 were 0.34 mg/l, 0.06 mg/l and 0.03 mg/l respectively. The Aldrin concentration in samples KAg-2 and KAg-3 were 0.92 mg/l. Phosphomidon concentration in sample KAg-2 was observed as 0.72 mg/l. The concentration of Parathion in samples KAg-2 and KAg-3 were 0.02 mg/l and 0.03 mg/l respectively. The concentrations of Profenophos, Quinalphos, Fipronil and Dieldrin in sample KAg-3 were observed as 0.12 mg/l, 0.86 mg/l, 0.94 mg/l and 0.92 mg/l respectively.

Correlation:

The concentration of Physico-chemical parameters viz., pH, Temp, TDS, TH, Cl^-, SO_4^{2-}, PO_4^{3-} and NO_3^- will correlate with the pesticide residues which dissolved in water sources. These parameters will have co-relation with pesticide residues (Lower concentrations are not considered in the matrix) present in waters. Hence the correlation matrix has been proposed to find the co-relation and inter dependence of the parameters and the concentration of pesticide residues.

The correlation matrix of selected Physico-chemical parameters and Pesticide residues near agricultural areas of Nedunuru, palagummi and K.pedapudi villages are shown in tables – 8, 9 & 10 respectively.

Study area - Nedunuru village:

pH strongly correlated with temperature, TH and PO_4^{3-}. Temperature is strongly correlated with TH, Cl^- and PO_4^{3-}. TDS strongly correlated with Terbuthyl azine and Dimethirimol. TH strongly correlated with Cl^-, PO_4^{3-} and NO_3^-. Cl^- strongly correlated with PO_4^{3-} and NO_3^-. SO_4^{2-} strongly correlated with Terbuthyl azine. PO_4^{3-}

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strongly correlated with NO_3^-. Dimethirimol strongly correlated with Ethion.

Study area - Palagummi village:

pH strongly correlated with SO_4^{2-}, NO_3^- and Atrazine. TDS strongly correlated with TH. Cl^- strongly correlated with PO_4^{3-} and Bifenithrin. SO_4^{2-} strongly correlated with NO_3^- and Atrazine. PO_4^{3-} strongly correlated with Bifenithrin. NO_3^- strongly correlated with Atrazine.

Study area - K. Pedapudi village:

pH strongly correlated Beta HCH, Lindane, Diazinon. TDS strongly correlated with TH, Cl^- and PO_4^{3-}. TH strongly correlated with Cl^-.

4. Conclusion

The research results revealed that ground waters were contaminated due to discharge of pesticide residues from the sources of agricultural run-off. Higher TH in waters near agricultural activity areas confirmed the encrustative nature of water. Higher phosphate concentration in water near some areas showed the discharge of agricultural runoff into groundwater sources. Higher concentration of pesticides found in water sources of study areas include Trifluralin, Terbuthyl azine, Dimethachlor, Metribuzin, Dimethrimol, Ethion, Bifenithrin, Atrazine, Beta HCH, Lindane, Diazinon and Butachlor. The study results revealed that the ground waters in the study areas are contaminated by pesticidal residues and can cause concern on the health of public residing in the nearby study areas who consume these waters for drinking or domestic purposes.

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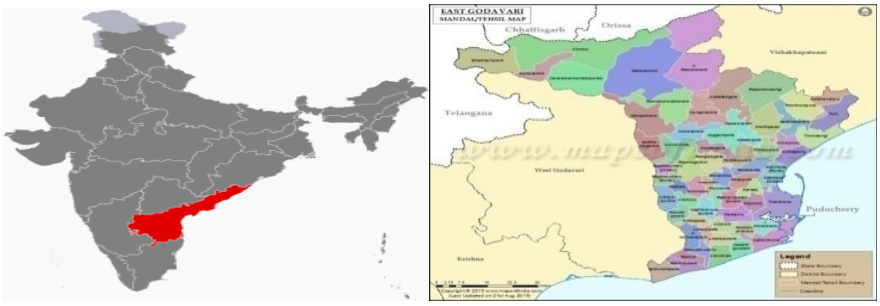

Figure – 1(a): Location map of the study area
Source: Google maps [19]

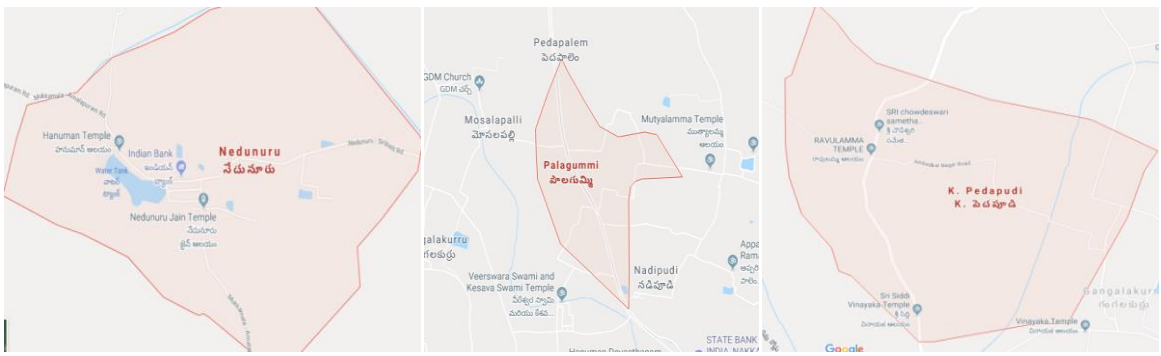

Figure – 1(b): Study area maps Source: Google Maps [19]

Table-1: Sample code and Sampling locations

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Sample Code	Sampling Location	Source	Coordinates(GPS) Latitude	Longitude
N-1/Ag	Nedunuru village	BW	16.62984	81.97655
N-2/Ag	Nedunuru village	OW	16.64014	81.97617
N-3/Ag	Nedunuru village	OW	16.63931	81.97591
N-4/Ag	Nedunuru village	OW	16.63845	81.97662
N-5/Ag	Nedunuru village	BW	16.64005	81.97117
N-6/Ag	Nedunuru village	BW	16.63553	81.97507
N-7/Ag	Nedunuru village	BW	16.63346	81.97472
N-8/Ag	Nedunuru village	BW	16.63609	81.97311
N-9/Ag	Nedunuru village	BW	16.63173	81.97702
N-10/Ag	Nedunuru village	BW	16.63133	81.97369
P-1/Ag	Palagummi Village	BW	16.61628	81.97182
P-2/Ag	Palagummi Village	OW	16.61583	81.97249
P-3/Ag	Palagummi Village	OW	16.61509	81.97388
P-4/Ag	Palagummi Village	OW	16.61476	81.97459
P-5/Ag	Palagummi Village	BW	16.61399	81.97556
P-6/Ag	Palagummi Village	OW	16.61350	81.97524
P-7/Ag	Palagummi Village	BW	16.60961	81.97675
P-8/Ag	Palagummi Village	OW	16.61053	81.97701
P-9/Ag	Palagummi Village	BW	16.60749	81.97666
P-10/Ag	Palagummi Village	OW	16.60741	81.97755
KP-1	K. Pedapudi Village	OW	16.61208	81.93954
KP-2	K. Pedapudi Village	BW	16.61596	81.93118
KP-3	K. Pedapudi Village	BW	16.62358	81.93096
KP-4	K. Pedapudi Village	OW	16.62151	81.93349
KP-5	K. Pedapudi Village	OW	16.60934	81.94070
KP-6	K. Pedapudi Village	OW	16.61361	81.93905
KP-7	K. Pedapudi Village	BW	16.62376	81.93885
KP-8	K. Pedapudi Village	OW	16.62426	81.93943
KP-9	K. Pedapudi Village	BW	16.62413	81.93980
KP-10	K. Pedapudi Village	OW	16.62394	81.94124

N: Nedunuru village P: Palagummi village KP: K. Pedapudi village Ag: Agriculture BW: Bore Well OW: Open Well

Table-2: Sample codes and Representative sample codes

Sample code	Representative sample code	Sample code	Representative sample code	Sample code	Representative sample code
N-1/Ag		P-1/Ag		KP-1	
N-2/Ag		P-2/Ag		KP-2	
N-3/Ag	**NAg-1**	P-3/Ag	**PAg-1**	KP-3	**KAg-1**
N-4/Ag		P-4/Ag		KP-4	
N-5/Ag		P-5/Ag		KP-5	
N-6/Ag	**NAg-2**	P-6/Ag	**PAg-2**	KP-6	**KAg-2**

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N-7/Ag		P-7/Ag		KP-7	
N-8/Ag		P-8/Ag		KP-8	
N-9/Ag		P-9/Ag		KP-9	
N-10/Ag	**NAg-3**	P-10/Ag	**PAg-3**	KP-10	**KAg-3**

N: Nedunuru Village P: Palagummi village KP:K. Pedapudi village Ag: Agriculture

Table-3: Physicochemical parameters of representative groundwater samples near agricultural areas

Sample Code	pH	Temp ^{0}C	TDS (mg/l)	TH (mg/l)	Cl^- (mg/l)	SO_4^{2-} (mg/l)	PO_4^{3-} (mg/l)	NO_3^- (mg/l)
NAg-1	7.64	33.41	346	351.6	30.13	18.04	8.90	5.31
NAg-2	7.50	32.93	363.6	328.3	28.36	19.33	3.64	4.93
NAg-3	7.40	32.95	353.6	302.5	23.49	17.12	0.59	4.36
PAg-1	6.97	33.43	308	293.3	47.26	10.26	7.63	3.60
PAg-2	7.42	32.93	304.3	283.3	28.94	11.59	2.31	4.72
PAg-3	7.57	33.36	240.3	257.5	30.13	12.35	2.23	4.89
KAg-1	7.58	31.23	246	251.6	24.82	41.36	0.05	3.47
KAg-2	7.33	32.63	357.8	306.6	37.82	50.59	0.14	3.69
KAg-3	7.45	32.56	261.3	245	28.81	8.53	0.06	5.59

N: Nedunuru Village P: Palagummi village K: K. Pedapudi village Ag: Agriculture

Table 4: Details of pesticides employed by farmers for agriculture in study areas

S.No	**Herbicides**	**S.No**	**Fungicides**	**S.No**	**Insecticides**				
1	Propachlor	1	Dimethirimol	1	Pirimicarb	15	Azinphos ethyl	29	Diazinon
2	Trifluralin	2	Iprodione	2	Heptachlor Epoxide	16	Phosalone	30	Delta HCH
3	Simazine	3	Procymidone	3	Ethion	17	Fluvalinate	31	Chlorpyrifos
4	Terbuthylazine	4	Captan	4	Bifenithrin	18	Chloropyrifos methyl	32	Methyl parathion
5	Dimethachlor	5	Cyproconazole	5	Phosmet	19	P,P - DDT	33	Heptachlor
6	Metribuzin	6	Hexachloro benzene	6	Dimethoate	20	Fenvalerate	34	Phosphomidon
7	Pendimethalin			7	Triazophos	21	Dieldrin	35	Parathion
8	Acetochlor			8	Prothiofos	22	Dichlorvos	36	Profenophos
9	Atrazine			9	Cypermethrin	23	Monocrotophos	37	Quinalphos
10	Molinate			10	Methamidophos	24	Phorate		
11	Propanil			11	Fipronil	25	Fenitrothion		
12	Metolachlor			12	Permethrin	26	Lambda cyhalothrin		
13	Alachlor			13	Aldrin	27	Beta HCH		
14	Butachlor			14	Deltamethrin	28	Lindane		

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Table 5: The correlation matrix of selected Physico-chemical parameters and Pesticide residues near agricultural areas of Nedunuru village

	pH	*Temp*	*TDS*	*TH*	Cl^-	SO_4^{2-}	PO_4^{3-}	NO_3^-	*Triflu ralin*	*Terb uthyl azine*	*Dimeth achlor*	*Metri buzin*	*Dimethi rimol*	*Eth ion*	*Bifeni thrin*
pH	1														
Temp	0.894	1													
TDS	-0.515	-0.844	1												
TH	0.992	0.831	-0.404	1											
Cl^-	0.936	0.679	-0.181	0.973	1										
SO_4^{2-}	0.325	-0.133	0.643	0.441	0.637	1									
PO_4^{3-}	0.998	0.918	-0.562	0.984	0.915	0.271	1								
NO_3^-	0.977	0.781	-0.324	0.996	0.989	0.516	0.964	1							
Triflura lin	0	0	0	0	0	0	0	0	1						
Terbuth yl azine	-0.096	-0.532	0.903	0.029	0.26	0.91	-0.15	0.115	0	1					
Dimeth achlor	0	0	0	0	0	0	0	0	0	0	1				
Metribu zin	-0.814	-0.468	-0.078	-0.88	-0.97	-0.814	-0.78	-0.92	0	-0.5	0	1			
Dimethi rimol	-0.91	-0.999	0.824	-0.85	-0.71	0.096	-0.93	-0.8	0	0.5	0	0.5	1		
Ethion	-0.979	-0.967	0.68	-0.95	-0.84	-0.125	-0.99	-0.91	0	0.297	0	0.677	0.976	1	
Bifenith rin	-0.814	-0.468	-0.078	-0.88	-0.97	-0.814	-0.78	-0.92	0	-0.5	0	1	0.5	0.678	1

Table 6: The correlation matrix of selected Physico-chemical parameters and Pesticide residues near agricultural areas of Palagummi village

	pH	Temp	TDS	TH	Cl^-	SO_4^{2-}	PO_4^{3-}	NO_3^-	Bifenithrin
pH	1								
Temp	-0.3992	1							
TDS	-0.7276	-	1						

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		0.3385							
TH	-0.8625	-0.1196	0.97469	1					
Cl^{-}	-0.9551	0.6528	0.49179	0.674	1				
SO_4^{2-}	0.99222	-0.2819	-0.8073	-0.919	-0.91	1			
PO_4^{3-}	-0.9737	0.5974	0.55232	0.7247	0.997	-0.938	1		
NO_3^{-}	0.99269	-0.507	-0.6395	-0.795	-0.98	0.97	-0.99	1	
Bifenithrin	-0.9707	0.6078	0.5415	0.7158	0.998	-0.933	1	-0.993	1
Atrazine	0.97073	-0.6078	-0.5415	-0.716	-1	0.933	-1	0.993	-1

Table 7: The correlation matrix of selected Physico-chemical parameters and Pesticide residues near agricultural areas of K. Pedapudi village

	pH	*Temp*	*TDS*	*TH*	Cl^{-}	SO_4^{2-}	PO_4^{3-}	NO_3^{-}	*Beta HCH*	*Lindane*	*Diazinon*	*Butachlor*
pH	1											
Temp	-0.898	1										
TDS	-0.913	0.64	1									
TH	-0.799	0.453	0.975	1								
Cl^{-}	-0.971	0.766	0.984	0.92	1							
SO_4^{2-}	-0.186	-0.266	0.571	0.739	0.417	1						
PO_4^{3-}	-0.893	0.604	0.999	0.984	0.975	0.608	1					
NO_3^{-}	-0.117	0.543	-0.3	-0.5	-0.12	-0.954	-0.34	1				
Beta HCH	0.877	-0.999	-0.61	-0.41	-0.74	0.308	-0.57	-0.579	1			
Lindane	0.877	-0.999	-0.61	-0.41	-0.74	0.308	-0.57	-0.579	1	1		
Diazinon	0.877	-0.999	-0.61	-0.41	-0.74	0.308	-0.57	-0.579	1	1	1	
Butachlor	-0.867	0.998	0.589	0.394	0.722	-0.328	0.551	0.596	-0.999	-1	-0.999	1