International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Quantitative Estimation of Nitrogen, Phosphorus, Potassium and Omnicides in Bawal Block of Haryana

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ABSTRACT

In growing democratic nations such as India, the rapid increase in population has greatly boosted agri-agro activity. In order to meet public demand for grain and feed, increasing amounts of fertilizers and omnicides are being employed. Only a portion of these fertilizers are absorbed by plants, and the remainder has negative impacts on other living things. The use of fertilizers, insecticides, herbicides, and biocides, among other modern agricultural techniques, is done to boost crop yields and soil fertility. Fertilizers are so essential to human agriculture that it is hard to imagine farming without them. Overuse of these fertilizers by humans is one of the main causes of pollution in the environment. The soil in the area being studied has been physicochemical characterized.

Keywords: physicochemical, Dichloro-diphenyl-trichloroethane, Benzene hexachloride, High-performance liquid chromatography

1. INTRODUCTION

Various fertilizers and omnicides are given to the soil to improve its fertility and crop yield. Many pesticides, fungicides, bactericides, insecticides, biocides, fertilizers, and manures are added to land through modern agricultural practices, severely contaminating it chemically and biologically [1]. In addition to all of these, direct soil contamination by lethal pathogenic organisms is also very significant. A major issue is soil degradation and contamination, particularly in a nation with as many people as India [2]. Since independence, civilization has advanced astronomically, but the threat of soil degradation has also increased with fast industrialization. Nearly everything in our environment today is seriously contaminated, including the land on which we grow food, the water we drink, and the air we breathe [3]. The destruction of grazing grounds for human habitation, indiscriminate deforestation, and mining have caused irreversible harm to the environment and have even resulted in drastic changes in climate [4]. Poisonous effluents from industrial facilities, locomotives, cars, and aircraft that are in the air exacerbate the situation. A portion of the risks associated with soil pollution stem from the fact that, although the world's population is growing, its natural resources are largely finite. As a result, dangerous chemicals extensively contaminate the soil every day, allowing microorganisms to infiltrate the air, water, and food chain, which humans then consume [5].

2. TOOLS AND MATERIALS

Five distinct villages were chosen for the collection of soil samples: Karnawas, Suthana, Banipur, Khatiwas, and Rasiawas. Using standard sampling procedures, the soil samples were analyzed for their physico-chemical characterization. Kjeldahl's approach [6], which was also used by others [7], was used to estimate the soil's nitrogen pool. Olsen's approach was used to estimate the phosphorus concentration quantitatively [8].
The "Flame photometry" approach [9], which was previously used by other researchers [10], was used to determine the amount of exchangeable or accessible potassium in the soil. Among the pesticides, the organo-chlorine compounds viz. DDT, BHC, dieldrin, aldrin, endrin, heptachlor, chlordane, toxaphene etc. have widely been employed and these persist in the environment and are not easily biodegradable. Gas chromatography [11] and high-performance liquid chromatography [12] have been used to quantify these pesticides/omnicides (HPLG).
Several techniques have previously been used to assess the organic matter content, particularly the organic carbon and organic phosphorus content [13. 14].
1. Various tools were utilized for soil sampling, including kassi & khurpi, screw type auger, post-hole auger, and soil tube auger.
2. The tube auger, khurpi, can be utilized nicely for sampling soft, wet soil. Dust and other foreign objects that could contaminate the samples should not be present in the tools used to collect the samples.

3. A pail intended for gathering and combining the combined specimen.

Sampling for Fertility Evaluation

1. The field was split up into sections such that each sample corresponds to a about 1.0 hectare region. Samples from sites with different soil colors or post-manuring, fertilizer, cropping patterns, etc. was taken individually.
2. To a plow depth, the surface and any auger or sampling tubes inserted were scraped away. A clean bucket was filled with ten to fifteen randomly distributed samples from each area.
3. A bucket was filled with fully mixed soil samples that were gathered from various locations within each area. By quartering, the composite sample's bulk was decreased, leaving roughly 500g behind.

The well-combined dirt sample was split into two equal portions and thrown away in the other two quarters. After remixing, dividing into four sections once more, and rejecting two, the final two quarters were used. This process was continued until roughly 500g of soil remained. After the dirt had air dried in the shade at room temperature, it was put into a fresh, numbered cloth bag.

Sampling for Soil Reclamation

In order to obtain the sample for reclamation, a 90-cm excavation was conducted using a soil auger. A sample of dirt was taken as follows:
1. The pit's vertical side was marked at 15, 30, 60, and 90 centimeters below the surface.
2. A appropriate container was held at the 15-cm mark, and 500g of soil sample was obtained by scraping off a consistent slice of soil from the surface down to this mark. After being moved to a cloth bag, the sample was labeled as 0–15 cm.
3. After drying in the shade, a 500g sample of soil was taken from each layer, or 15–30, 30–60, and 60–90 cm, and placed individually in three cotton bags.
4. A different sample of the crust's surface was also obtained.
5. Each sample had two labels made that indicated the depth at which it was taken.
6. The sample was sent for analytical processing along with an information leaflet.

3. QUANTITATIVE ESTIMATION OF NITROGEN, PHOSPHORUS, POTASSIUM AND OMNICIDES

3.1 Quantitative Estimation of Nitrogen

The Kjeldahl method [319] was used to estimate the nitrogen.

Materials:

a. Cone. H_2SO_4
b. 40% NaOH
c. Zn granules
d. H_3BO_3
e. 0.1 N HCl
f. Catalyst mixture ($CuSO_4$+HgO+Selenium powder+Na_2SO_4)

Method:

A circular-bottom flask containing 10.0 g of air-dried soil sample, 20 g of catalyst mixture, and roughly 35 mL of cone were added. It was mixed with H2SO4. For around two hours, the content was heated. Approximately 100 mL of distilled water was added after the content had cooled. The supernatant was transferred into a one-liter distillation flask of the Kjeldahl distillation assembly after a five-minute pause. The residue was repeatedly cleaned with a little amount of distilled water, and the supernatant was always transferred to the same distillation flask. A few Zn grains and 100 mL of NaOH solution were added to this. The bottom open end of the distillation assembly's condenser was dipped in solution by placing an Erlenmeyer flask holding 25 mL of boric acid cum indicator solution underneath it. About 150 mL of distillate were collected in the flask after the distillation flask was gently heated on a hot griddle. After removing the flask containing the distillate, it was titrated against 0.1N HCl. The finish point was indicated by the blue tint changing to a light brown-pink hue.

Calculation:

Kjeldahl Nitrogen % = $((V_1-V_2) * N * 1.4)/ x$

Where, V_1 = Volume of titrant which is used against sample (mL)

V_2 = Volume of titrant which is used against distilled water blank (mL)

N Normality of titrant (0.1)

x =Weight of soil (g)

3.2 Quantitative Estimation of Phosphorus

Olsen's approach [321] has been used to estimate phosphorus.
Reagents
1. Perchloric acid (70%)
2. Phenolphthalein indicator
3. NaOH solution (IN)
4. Ammonium molybdate solution [$(NH_4)_2MoO_4$]
5. $SnCl_2$
6. Standard phosphate solution
7. Cone. H_2SO_4

Method:

After being air dried, the soil sample was ground into a fine powder. It was put into a flask with a circular bottom. Two milliliters (mL) each of HNO_3 and $HClO_3$, as well as a few drops of pure water, were added.

After being slowly heated until it was dry, it was chilled. A few drops of cone H2SO_4 were added to this, and it was cooked for roughly fifteen minutes. Distilled water was added to the flask to bring its volume to 250 mL. The following formula was used to find the solution's phosphate content:

Calculation:

Total phosphorus per gram = (Pd * V) / (1000 * X)
Where, Pd = PO_4-^{3}-P indigest (mg/l)
V = Total volume of solution (mL)
X = Weight of air-dry soil (g)

3.3 Qualitative estimation of available or exchangeable Potassium

Reagents:
1. 1.0 N CH_3COONH_4 solution having pH 7.0.
2. Standard KCl solution

Method:

An air-dried soil sample weighing about 5g was put in a 50 ml centrifuge tube. After adding 25 milliliters of neutral ammonium acetate solution, it was thoroughly shaken. The supernatant liquid was centrifuged for 10 minutes at 200 rpm in the tube. It was diluted with 100 mL of ammonium acetate solution after being decanted into a 1.000 mL volumetric flask. The flame photometery method was used to quantify the amount of potassium in the extract [322].

Calculation:

Available K (kg/ha) = ((C * Volume of extractant)/ (Weight of Soil taken)) * 2.24
Where C = ppm or ugmL^{-1} of K.

3.4 Quantitative Analysis for Omnicides

Organochlorine pesticides: gas chromatographic technique. Repetitively, the material was extracted using 15% ethyl ether in hexane. On a steam bath, the ether extract was evaporated to a small volume (3–4 mL), and it was then diluted to around 5 mL with hexane. Using a microsyringe and argon-methane as the carrier gas at a rate of 60 mL/min, an aliquot (5 mL) of this extract was injected into the gas chromatographic column at 180°C. The extract's insecticides evaporated and passed through the chromatographic column at various speeds. An electron capture detector was used to find them [324]. Organophosphorus and carbamate pesticides were quantitatively estimated using the HPLC technique [325].

Table 3.1: Percent consumption of Nitrogen in different crops and its Residual Value

Villages & Crops	**Sample No.**	**Pre-sowing Concentration (kgha^{-1})**	**Post-harvesting Concentration (kg ha^{-1})**	**Consumed Nitrogen (kg ha^{-1})**	**Percent consumption**
Karnawas					
(a) Bajra	**30**	**138 8**	**62.46**	**76.34**	**55**

(b) Moong	**30**	**135.2**	**54.08**	**81.12**	**60**
Suthana					
(a) Bajra	**35**	**140.5**	**63.23**	**77.27**	**55**
(b) Moong	**35**	**132.6**	**53.04**	**79.56**	**60**
Banipur					
(a) Bajra	**25**	**142 8**	**64.26**	**78.54**	**55**
(b) Moong	**25**	**135.4**	**54.16**	**81.24**	**60**
Khatiwas					
(a) Bajra	**40**	**145 5**	**65.50**	**80.00**	**55**
(b) Moong	**40**	**136.2**	**54.48**	**81.72**	**60**
Rasiawas					
(a) Bajra	**25**	**148.6**	**66.87**	**81.73**	**55**
(b) Moong	**25**	**140.5**	**56.20**	**84.30**	**60**

Table 3.2: Percent consumption of Phosphorus in different Crops and its Residual Value

Villages & crops	**Sample No.**	**Pre-sowing Concentration (kg ha^{-1})**	**Post-harvesting Concentration (kg ha^{-1})**	**Consumed phosphorus (kg ha^{-1})**	**Percent consumption**
Karnawas					
(a) Bajra	**30**	**80.25**	**36.12**	**44.13**	**55**
(b) Moong	**30**	**85.72**	**25.72**	**60.00**	**0**
Suthana					
(a) Bajra	**35**	**82.45**	**37.11**	**45.34**	**55**

(b) Moong	**35**	**87.20**	**26.16**	**61.04**	**70**
Banipur					
(a) Bajra	**25**	**85.75**	**38.59**	**47.16**	**55**
(b) Moong	**25**	**88.90**	**26.67**	**62.33**	**70**
Khatiwas					
(a) Bajra	**40**	**84 62**	**38.08**	**4d.54**	**55**
(b) Moong	**40**	**86.54**	**25.97**	**60.57**	**70**
Rasiawas					
(a) Bajra	**25**	**81.35**	**36.95**	**44.74**	**55**
(b) Moong	**25**	**84.65**	**25.40**	**59.25**	**70**

Table 3.3: Percent consumption of Potash in different Crops and its Residual Value

Villages & crops	**Sample No.**	**Pre-sowing Concentration (kg ha^{-1})**	**Post-harvesting Concentration (kg ha^{-1})**	**Consumed potash (kg ha^{-1})**	**Percent consumption**
Karnawas					
(a) Bajra	**30**	**60.75**	**33.42**	**27.33**	**45**
(b) Moong	**30**	**62.23**	**21.79**	**40.44**	**65**
Suthana					
(a) Bajra	**35**	**58.20**	**33.76**	**24.44**	**42**
(b) Moong	**35**	**65.20**	**24.78**	**40.42**	**62**
Banipur					
(a) Bajra	**25**	**65.69**	**39.42**	**26.27**	**40**

(b) Moong	**25**	**67.35**	**26.94**	**40.41**	**60**
Khatiwas					
(a) Bajra	**40**	**68.94**	**36.11**	**32.83**	**47**
(b) Moong	**40**	**69.20**	**22.84**	**46.36**	**67**
Rasiawas					
(a) Bajra	**25**	**70.45**	**40.16**	**30.29**	**41**
(b) Moong	**25**	**71.32**	**26.39**	**44.93**	**63**

Table 3.4: Residual Values of Omnicides in different crops

Investigated Area	**Crops**	**Omnicides**	**Omnicide concentration**		**% Residual Values**
			Pre-harvesting concentration ($kg\ ha^{-1}$)	**Post-harvesting concentration ($kg\ ha^{-1}$)**	
Karnawas	**Bajra**	**Rodenticide Zinc dust. (Zinc phosphide)**	**0.0158**	**0.0106**	**33**
Suthana	**Bajra**	**Insecticide Malathion 5%**	**25.40**	**11.43**	**55**
Banipur	**Oilseeds**	**Insecticide Phoret**	**12.5**	**1.40**	**90**
Khatiwas	**Guwar**	**Fungicide Thiram 75%**	**2.5**	**1.25**	**50**
Rasiawas	**Moong**	**Insecticide Methyl parathion 2%**	**25.80**	**9.03**	**65**

4 RESULTS AND DISCUSSION

4.1 Assessment of percent consumption of nitrogen, phosphorus and potash in different crops and their residual values

From several researched sites namely Karnawas, Suthana, Banipur, Khatiwas and Rasiawas 30, 35, 25, 40 and 25 soil samples were submitted to analysis for the estimate of residual nitrogen, phosphorus and potash content. Owing to the frequent application of nitrogenous fertilizers, the current study found that 40% of the nitrogen supplied to the crop in Moong and 45% of the crop in Bajra remains unutilized. 5% more nitrogen is used by the Bajra crop than by the Moong crop. The required fertilizer dose is typically administered to crops without the laborious process of soil analysis, resulting in a buildup of excessive concentrations of nitrogen in the soil. Some of it dissolves into other compounds and travels via drains, contaminating bodies of water including rivers, lakes, and ponds. The uneven soil gradients alter the soil's composition, texture, and chemical and physical characteristics. Thus, it is recommended that the soil analysis of the plots should be duly done and fertilizers added in requisite amounts.

Overapplication speeds up the ripening process, but it also shorten the growth season and lowers yield. Besides the good effect of fertilizers usage, the negative elements which are often disregarded must be addressed with specific attention to the environmental challenges.

Out of 30 samples of soil pertaining to Bajra and Moong on an average 45% and 30% of phosphorus residues have been observed in Karnawas. In Suthana 35 soil samples were taken for Bajra and Moong in which unconsumed phosphorus has been observed to the same extent as in Karnawas. The same extent of unconsumed phosphorus left has been observed in Banipur, Khatiwas and Rasiawas. Nearly 15% more phosphorus has been consumed by Moong as compared to Bajra. The gradual increase of residual phosphorus in these zones will naturally affect the plant metabolism significant effect of phosphorus may be observed on the root system of plants. Phosphorus in ample quantity may promote the lateral and fibrous root development which in turn will increase the absorbing surface for the nutrients. Of course, the ripening period of plant will be reduced and the seed quality will be improved.

For the analysis of potash in different crops in Karnawas 30, Suthana 35, Banipur 25, Khatiwas 40 and Rasiawas 25 soil samples were selected. In Bajra crop on an average nearly 43.4% potash was consumed leaving behind about 56.6% unconsumed. Thus, repeated Bajra crop will elevate the potash content in soil. Also, Moong consumes nearly 63.5% of potash with a residual value of about 36.5% in the soil. Thus, in both the crops there will be surplus potash which according to the plant metabolism will increase the starch and sugar content in the crops. No doubt, the yield, size, and the quality of the cereals due to residual potash will increase gradually.

4.2 Chemical analysis of nitrogen and determination of nutritive index (N_I) and fertility index (F_I)

The fertility index is related with nutritive index (N_I). If N_I is less than 1.75 then F_I is regarded very low. If N_I ranges between 1.75-2.50 then F_I is regarded as low. If N_I becomes in between 2.51-3.25 then F_I will be medium and if N_I exceeds 3.25 the F_I is considered high. The N_I is calculated based on following formula.

Nutritive Index (N_I) = (V_L*1+L*2+M*3+H*4)/(V_L*L*M*H)

From Karnawas area 30 soil samples were put to analysis. All of them were almost neutral inclining towards acidity. Only 1 soil sample was found to have very low content of nitrogen while 21 with low, 7 medium and 1 high content of it. The N, of the area was found to be 2.26 and Ft was regarded low. From Suthana zone 85 soil samples have been analyzed. The pH value ranges between 4.9-6.5. Among all the soil samples, 12 soil samples were found to have very low content of nitrogen while 57 low and 16 medium contents of it. In Banipur 12 soil samples have been subjected to analysis. Out of all, 8 have low and 4 have medium content of nitrogen. None was found to have very low or high values. The N_I of the area being 2.33 has F_I of low order. Twenty-six (26) soil samples from Khatiwas area were subjected to Ph meter indicating almost neutral (pH 7.0-7.5) nature of the soil.

The statistical analysis of the soil leads to the N_I numerically equal to 2.03 showing a low F_I from Rasiawas under investigation 4 soil samples were collected and processed for pH measurement. The pH of the soil ranges between 6.5-7.0 indicating towards neutrality. The quantitative calculations derived the N_I equal to 2.00 indicating that the soil under investigation has a low fertility index. The overall scenario of the entire area has an outcome of 157 soil samples, the average pH was found in between 5.6-6.5 showing the acidic character of soil and the average N_I being 2.14 characterizes the zone in a low F_I cadre. The findings are in accordance with the other soil properties of the area.

4.3 Chemical analysis of phosphorus and determination of nutritive index (N_I) and fertility index (F_I)

For Karnawas area for all 30 soil samples the pH was found to be almost neutral. Twenty-seven (27) soil samples were found to have very low, 2 low and 1 medium phosphorus content while none had high value. It is nutritive index (N_I) was found to be 1.13 and fertility index (F_I) very low. In Suthana zone 85 soil samples were put to analysis. All of them were also almost neutral indicating an inadequate acidity having a pH range of 4.9-6.5. Out of all 69 soil samples were found to contain very low content of phosphorus while 14 have low and only 2 have medium content of it. The nutritive index of the area has been calculated to be 1.21 and its fertility index was found to be very low. Twelve (12) soil samples from Banipur village have been subjected to analysis. They were having a pH range of 5.0-6.5 indicating the acidic nature of soil. Among all 8 soil samples have very low nutrient content while 4 have low content of the same. The N_I of the area being 1.33 has F_I of very low order: From Khatiwas area 26 soil was subjected to pH meter indicating almost neutral nature of the soil (pH = 7.0-7.5). The quantitative analysis leads to the N_I numerically equal to 1.50 showing very low F_I from Rasiawas 4 soil samples were collected and processed for PH. measurement. The pH of the soil ranges between 6.5-7.0. The statistical calculations derived the N_I equal to 1.75 indicating that the soil of this zone has very low F_I The overall scanning of the entire area has an outcome of 157 soil samples, the average pH was found in between 5.6-6.5 showing the acidic character of soil and the average N_I being 1.38 characterizes the zone in a very low fertility index cadre

4.4 Chemical analysis of potassium and determination of nutritive index (N_I) and fertility index (F_I)

From Karnawas area 30 soil samples have been analyzed. The pH range was 4.6-6.2. Six (6) soil samples were found to have medium potassium content while 24 samples had high content of it. It is nutritive index (N_I) was found to be 3.80 and fertility index (F_I) was high. In Suthana zone 85 soil samples were put to analysis. All of them were almost acidic having pH in the range of 4.9-6.5. Only one soil sample was found to contain low content of potassium while 26 have medium and 58 have high content of it. The N_I of this area has been calculated to be 3.67 and it is F_I was found to be high. Twelve (12) soil samples from Banipur village have been subjected to analysis. They were moderately acidic having a pH range of 5.0-

6.5. The N_I of this area is found 3.66 having F_I of high order. From Khatiwas area 26 soil samples were subjected to pH meter indicating almost neutral (7.0-7.5) nature of the soil. The statistical analysis leads to the N_I numerically equal to 3.53 showing a high F_I from Rasiawas under investigation 4 soil samples were collected and processed for pH measurement. The pH of the soil ranges between 6.5-7.0. The statistical calculations derived the N_I equal to 3.0 indicating that the soil of this zone has a medium fertility index. The overall scanning of the entire area has an outcome of 157 soil samples, the pH may be considered as acidic and the average N_I, being 3.53 characterizes the zone in a high fertility index cadre. It has already been observed that soil management and potassium fertilizer application affect soil-K pools. The N_I and F_I of the entire investigated areas based on N, P and K.

The whole area on an average is quite rich for potassium, lacking in phosphorus but have a normal value as regards nitrogen. The crop rotation, application of fertilizers and organic matter should be recommended accordingly. Based on nutrients concentration, nutritive and fertility values, the areas may be economically evaluated and categorized establishing relation the biodiversity of the ecosystem.

Remarkable divergence between the scientific approach and visual valuation of lands has been encountered which needs attention for a developing nation.

4.5 Quantitative assessment of residual values of omnicides by different crops

The consumption of omnicide has increased in emerging nations like India due to the fierce competition to produce more and more grain and the rising demand for food. As a plant protector, omnicides have a unique ability to degrade soil and increase resistance. The region under investigation is well-known for growing oilseeds, bajra, guwar, and moong, and it frequently uses fungicides, insecticides, and rodenticides. Table 3.19 provides a clear understanding of the use and consumption of omnicide by location. According to data, 55% of the pesticide residue remains after the rodenticide—applied to Bajra in the form of zinc dust—is devoured, leaving 33% unconsumed. 90% of the phoret used as an insecticide in oilseeds is left unconsumed. When methyl parathion is given to moong as an insecticide, it barely eats 65% of it, leaving behind around 35%. In Guwar, thiram, which is used as a fungicide, left over 50% unused. These omnicides have the ability to spread through the air, water, and soil when they are exposed to the atmosphere. Therefore, omnicides that are not eaten directly damage the ecology, but those that are breathed by living things have a greater detrimental effect.

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