DISSERTATION REPORT

(AGR- 596)

Probing the impact of slow release inorganic fertilizers on soil carbon pools and nitrogen use efficiency in soils under wheat cultivation

Synopsis Submitted To

Lovely Professional University, Punjab

in Partial Fulfillment of the Requirements for the

Degree of

Master of Science (Agriculture)

In

Agronomy

by

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CERTIFICATE

I certified that this synopsis **SHIPA RANI DEY** with registration no: 11714477, **"Probing the impact of slow release inorganic fertilizers on soil carbon pools and nitrogen use efficiency in soils under Wheat cultivation"** has been formulated and finalized by the student on the subject.

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DECLARATION

I hereby declare that the project work entitle **"Probing the impact of slow release inorganic fertilizers on soil carbon pools and nitrogen use efficiency in soil under wheat cultivation"** is an authentic record of my work carried out at lovely professional university as requirements of project work for the award of degree of Master of Science in Agronomy, under the guidance of Dr. Arun Kumar, Assistant professor, School of Agriculture, Lovely Professional University, Jalandhar, Punjab, India.

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INTRODUCTION

Wheat is the one of most important cereal crops being grown across a wide range of environments around the world. Many species of wheat which together make up the genus *Triticum* the most widely grown is common wheat (*T. aestivum*).Wheat is known as the "King of cereals" for centuries and it retain the pride of place even today. Wheat ison the number one food grain consumed directly by human beings and is estimated that more than 35 per cent of the world population depends on wheat, as it supplies more nutrients particularly, essential amino acids than any other single crop. It has been a staple food with the level of consumption largely unaffected by changes in its prices and the price of other crops like rice, maize and millets (Titouan et al., 2015). Wheat is the second most important crop in India next to rice.

The total area under wheat crop has been estimated 1061602 acre (429602hectares) as compared to 1029268 acres (416522 hectares) of the year 2013, which is 3.14% higher than previous year. Average yield of wheat has been estimated 3.03 metric tons per hectare which is 0.66% of the higher than the last year (BBS, 2014).In India, wheat is the second important crop after rice occupying 29.40 million hectare, with a production of 88.31 million tones with an average productivity of 3000 kg per hectare (The Hindu, March 9, 2012). From the point of area and production of wheat Uttar Pradesh, Madhya Pradesh, Punjab and Haryana are on the top in India. Wheat is a Rabi season crop which is grown in tropics and sub tropics region and also need high temperature during its growth cycle. Heat stress is the main factor for growth stage like grain filling and if heat stress is more then it also reduce the yield. The fertilization of nitrogen increase the protein content significantly (Ames et al., 2003). . The production of wheat in other States like West Bengal, Kerala, Assam, Odisha and Andhra Pradesh has grown with the provision of better irrigation facilities in the area. Sowing of wheat takes place in October to December and harvesting is done during the months of February and May. The wheat crop needs cool winters and hot summers, which is why the fertile plains of the Indo-Gangetic region are the most conducive for growing it. Though well-drained loams and clayey loams are considered the ideal soil for wheat, good crops of wheat have also been raised on sandy loams and black soils of the peninsula region. . The major Wheat producing States are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra, Gujarat, Karnataka, West Bengal, Uttarakhand, Himachal Pradesh and Jammu & Kashmir. These States contribute about 99.5% of total Wheat production in the country. Remaining States, namely, Jharkhand, Assam, Chhattisgarh, Delhi and other North Eastern States contribute only about 0.5 % of the total Wheat production in the country. Wheat can be grown on all kinds of soils, except the highly deteriorated alkaline and water logged soils. Soils with clay loam or loam texture, good structure and moderate water holding capacity are ideal for Wheat cultivation. Durum Wheat should preferably be sown on medium to fine textured soils. Wheat sown in late season is affected by heat stress in the anthesis period which results in the decreased productivity due to spikelet sterility.

HD 2967 is a double dwarf variety with an average plant height of 101 cm. It has profuse tillering. Ears are medium dense and tapering in shape with white glumes. Its grains are amber, medium bold, hard and lustrous. It is moderately resistant to yellow rust and resistant to brown rust and less susceptible to Karnal bunt and loose smut diseases. It takes about 157 days to mature. Its average yield is 21.4 quintals per acre (from the literature of PAU Ludhiana) Wheat variety HD 2967 gains popularity among farmers. Within three years since its release in 2011, HD 2967, a new variety is expected to cover most of the area in the district as it is gaining immense popularity among the farmers. But, at the same time, PBW 621, which was also released in 2011 by the Punjab Agricultural University, Ludhiana, has found few takers. HD 2967 has given farmers a substitute to PBW 343, which had come under severe attack of yellow rust, but farmers were not ready to stop growing it. Finally, about three years ago, the agriculture department had stopped providing its seed as it had expired its shelf life and due to the severe attack of yellow rust on it. But now the farmers are all satisfied with the yield of HD 2967 after three years of personal experience in their fields and also claim that it is free of most of the diseases.

Agronomical trial on Paddy and Wheat crops with Neem coated Urea as source of Nitrogen has produced significantly higher yield at research and farm level. The use of Neem Coated Urea has been found to improve the uptake of N, P and K significantly. Since 2008 the, Ministry of Chemicals and Fertilizers allowed Neem Coated Urea manufacturer to sell NCU at 5% above the MRP, to recover the cost of coating, however cost of Neem kernel Oil and production as such of Neem Coated Urea has increased significantly.

Vermicompost (or vermi-compost) is the product of the composting process using various species of worms,usually red wigglers,white worms,and other earthworms,to create a mixture of decomposing vegetable or food waste,bedding materials,and vermicast. Vermicompost contains water-soluble nutrients and is an excellent,nutrient-rich organic fertilizer and soil conditioner.It is used in farming and small scale sustainable,organic farming. Vermicompost can also be applied for treatment of sewage sludge.

Urea, also known as carbamide, is an organic compound with the chemical formula CO(NH2)2. Urea serves an important role in the metabolism of nitrogen-containing compounds by animals and is the main nitrogen-containing substance in the urine of mammals. It is a colourless, odorless solid,highly soluble in water, and practically non toxic. Dissolved in water,it is neither acidic nor alkaline.

Diammonium phosphate (DAP) is one of a series of water-soluble ammonium phosphate salts that can be produced when ammonia reacts with phosphoric acid. DAP is a concentrated fertilizer with high phosphorus and nitrogent content.DAP is commonly used universal fertilizer which can be applied for field crops and vegetables and in orchards.

Single superphophate (SSP) was the first commercial mineral fertilizer,and it led to the development of the modern plant nutrient industry. This material was once the most commonly used fertilizer,but other phosphorus(P) fertilizer have largely relaced SSP because of its relatively low P content.

The objectives of the proposed study are:

1) To evaluate the impact of slow release inorganic fertilizer and organic fertilizer on soil carbon pools
2) To study the soil physical and chemical characteristics as influenced by different treatments
3) To correlate the soil biochemical changes and carbon pools with growth and yield of wheat

REVIEW OF LITERATURE

Application of urea amended with nitrification inhibitors were influenced physiochemical properties of soil such as pH (7.47) and electrical conductivity (0.25 mhos/cm) were significantly low with neem oil coating as well as in DCD. Similarly the chemical properties such as available phosphorus (64.88 kg/ha) and potassium (299.88 kg /ha) were also significantly higher and on par due to coating with neeem oil or DCD as nitrification inhibitor. Significantly high soil physical properties such as porosity 45.69 % as well as water holding capacity and low bulk density was found low (1.14 mmhos/cm) were also found in soil treated with both neem oil and DCD amended urea.

Among the sources, neem cake blended urea maintained high available N status in the soil at all phenological stages compared to other slow release forms of urea. Prilled urea maintained lower N status in the soil during both the years of study. Time of N application greatly influence the N uptake in semi dry rice.

National Fertilizers Limited (NFL), one of the premier manufacturers of nitrogenous fertilisers in the country, has developed a process for production of Neem-coated urea on commercial scale**.** **Neem (Azadirachta indica)** coated Urea is a fertilizer which is developed and tested by the National Fertilizers Limited to boost farming growth in wheat and paddy.It proved to be a good source of Nitrogen and has produced significantly higher yield at research and farm level**Neem coated urea** is urea coated with neem oil. Only about 30 to 40% of N2 in the urea is utilized by the plants. Coating of neem oil helps in gradual release of nitrates into soil. This may work as a bio pesticide. Agronomical trial on paddy and wheat crops with Neem coated urea as source of Nitrogen has produced significantly higher yield at research and farm level. Looking into the potential of Neem coated urea and its acceptance by the farmers, ministry of Agriculture in July 2004, included the neem coated urea in FCO. The use of Neem coated urea has been found to improve the uptake of N, P, and K significantly.

Since 2008 the Ministry of chemicals and fertilizers allowed Neem coated urea manufacturer to sell NCU at 5%above the MRP, to recover the cost of coating, however cost of Neem kernel oil and production as such of Neem coated urea has increased significantly. As per recent notification dated 25.05.2015 all the urea producer in country shall now be producing 100% urea as NCC in order to improve crop productivity and reduce the subsidy. Balanced use Nitrogen, Phosphorus, Potassium along with the requirements of secondary and micronutrient increase the yield at economic level of the three major nutrients Nitrogen, Phosphorus and Potash, nitrogen has received the maximum attention because of many reasons. Nitrogen gets easily converted to available forms from various types of fertilizers that are being applied for crop nutrition. Also, nitrogen in Nitrate form is highly mobile and get lost through the process of leaching especially under irrigated conditions. Nitrogen is also lost in the process of de-nitrification where the nitrate form is back converted in nitrogen and ammonia and lost to atmosphere .

In addition to agronomical practices, various kind of nitrification inhibitors such as Nitra pyrin (N-Serve) and Terrazole (Dwett) were developed in USA. These nitrification agents are very expensive and add to the already high cost of crop production in India. Keeping in view the low nitrogen use efficiency it has been felt to find out the use of some indigenous use of material and coating process for reducing the nitrogen losses from urea. Use of neem oil in various form such as Neem oil cake, Neem oil and other neem product have been found useful in reducing the release from urea and increase its use efficiency. Neem oil contains various kind of bitter, especially the Meliacins that have been identified in retarding the process of nitrification of urea. Since 2004-2005, NFL has been regularly conducting 200-250 front line demonstrations, at farmers field, in close collaborations of the respective state Agricultural Universities, in the state of Punjab, Haryana, Rajasthan, UP, MP, Chattisgarh. The yields in the treatment where Neem coated urea has been used, has increased from 6-11% depending upon crop and location. Apart from the increase in yield, neem coated urea application has other use full effect in Wheat crops. At one of the locations in the state of UP, farmers have observed that the menace of Neel Gai has reduced significantly in paddy crop. In yet another observation, at Panipat, farmers observed no incidence of leaf folder and stem borer in paddy crop. At Sangrur and Gurdaspur, in the state of Punjab, farmers observed that the incidence of white ant was reduced with the use of neem coated urea in Wheat crop. This is because of fragrance of Neem oil that on dissolution was released in the standing water in the standing water and insecticidal properties of Neem.That's why Neem coated urea is very important urea in agricultural field.

Manure is organic matter, mostly derived from animal faces except in the case of green manure which can be used as organic fertilizer in agriculture. Manures contributes to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are utilised by bacteria, fungi and other organisms in the soil. Higher organisms then feed on the fungi and bacteria in a chain of life that comprises the soil food web.

Most animal manure consists of feces. Common forms of animal manure include Farmyard manure (FYM). FYM also contains plant material. Which has been used as bedding for animals and has absorbed the feces and urine. FYM refers to the decomposed mixture of dung and urine of farm animals along with left over material from roughages or fodder fed to the cattle. On an average well, decomposed farmyard manure contains 0.5% N, 0.2% P_2O_5 and 0.5% K_2O. the present method of preparing farmyard manure by the farmers is defective. Urine, which is generally wasted, contains 1% N and 1.35% K. If not utilized, nitrogen present in urine is lost through volatilization. Vegetable crops like potato, tomato, sweet potato, carrot, radish, onion etc respond well to the farmyard manure. The other responsive crops are sugarcane, rice and orchard crop like oranges, banana, mango and plantation crop like coconut. The entire amount of nutrients present in FYM is not available immediately.

Neem Coat Application in Agriculture-Wheat and rice are the major cereal crops in India, covering a large area of cultivable land in India and other countries and consume maximum amount of N fertilizers (Sharma et al., 2008). Due to decrease in organic matter and micronutrients in intensive cultivation areas a decline or stagnation in the productivity of wheat has been documented which persuade farmers for further loading of nitrogenous chemical fertilizers (Quyen et al., 2002; Satyanarayana et al., 2002; Singh et al., 2006; Liew et al., 2010). Spread the required quantity of urea in shade and mix Neem Coat (5000 ml per metric ton or 250 ml per bag of 50Kg of Urea) thoroughly; mix the two to get uniformly coated urea. Keep in shade for about three hours before application for deriving maximum benefit from Neem Coat.Among all the plant nutrients essential for crop growth, N is the nutrient which most often limits crop production (Mosier et al., 2001). N has a unique place in crop production system just because of its large requirement as it has critical role in almost all metabolic activities of plants and its heavy losses associated with soil-plant systems (Ladha et al., 2003).Soil fertility is determined by three major elements namely Nitrogen, Phosphorus & Potassium (N, P, K) of which nitrogen plays a very important role. For this reason, Urea (containing 46% of N) consumption is very high all over the world. Unfortunately, more than half (up to 60%) of the nitrogen leaches out or vaporizes in the form of nitrogen gas, ammonia & nitrous oxide due to the presence of denitrifying bacteria in the soil(Prem Baboo et al, November 2014). The form of applied nitrogenous fertilizers has significant role in controlling various N losses hence, affecting nitrogen availability and recovery. Compare to amide and ammoniums containing N fertilizers, nitrate containing fertilizers are susceptible to leaching. But contrast to this, ammonium and amide containing fertilizers are more prone to volatilization loss than nitrate containing nitrogen fertilizers. A range of slow release fertilizers is now marketed which have the potential to reduce various N losses and improve NUE (Giller et al., 2004). These compounds can reduce N losses due to their potential to delayed N release pattern which may improve the synchronization between crop demand and that of soil N supply. Neem coated urea is widely used and demonstrated slow release N fertilizer in India. But, still controlled release fertilizer is accounted only 0.15% of the total N fertilizer consumption. High cost in manufacturing and non-availability are two principle reasons for limited use of these compounds by farmers from developing countries (Shivay et al., 2001). (Biswas and Subba Rao 2015) reveals that an average 'N' recovery efficiency for fields managed by farmers ranges from 20 per cent to 30 per cent under rainfed conditions and 30 per cent to 40 per cent under irrigated conditions. NUE is the result of two main components: (i) N uptake efficiency - the ability of crops to absorb N from soils (Burns, 2006, and Greenwood et.al., 1989); and (ii) use efficiency - the efficiency with which crops use absorbed N for high yields (Janssen, 1998 and Schenk, 2006). These efficiencies may differ within the same crop because they depend on different organs and mechanisms and, different environmental factors as well.Ketkar (1983) found that admixing neem cake with urea fertilizer improved the efficiency of fertilizer use in crop production through a gradual release of nitrogen to crops. He argues that a considerable usage of synthetic chemicals during post green revolution had led to a large-scale production of a variety of chemical pesticides, with the side effects being more serious than the problems themselves. Bremner & Krogmeier (1988) report the adverse effects of urea, among others, use on seed germination, seedling growth, and early plant growth. Fageria et.al. (2003a) find that the main reason for 'N' deficiency in crops is the loss of 'N' through leaching, volatilization, surface runoff, denitrification, and plant canopy. They also point out intensive agricultural production systems and low rates of N fertilizers as the other reasons for 'N' deficiency in the context of developing countries. The past studies have shown that neem plant residue is a potential source of organic manure (Brahmachari, 2004); neem cake coated with urea increases nitrogen assimilation as compared to untreated urea; neem leaves have both fertilizer and pesticidal potential when used in the preparation of vermi-compost (Gajalakshmi and Abbasi, 2004).To develop standard specifications for neem oil as a raw material of Neem Oil Coated Urea (NOCU), a study was undertaken by Kumar Rajesh et.al.,

2007. They evaluated 25 samples of neem oils comprising 11 samples of expeller grade (EG) oils, eight samples of cold pressed (CP) oils, three samples of solvent extracted oils and two commercial formulations. The soils fertilized with NOCUs (200 ppm of urea-N) were incubated at 27o C and 50 per cent water-holding capacity for a period of 15 days with Nitrapyrin (0.5% of N) coated urea kept as the reference and prilled urea as control. Samples were analyzed for NH4 +-N, NO2 --N, and NO3 --N using standard methods and calculated % nitrification inhibition (NI). The results revealed that all of the neem oils caused NI ranging from 4.0 to 30.9 per cent. It was found that two samples of EG oils and two commercial formulations were the best, causing 27.0-30.9 per cent NI.

Variants of neem coated urea on wheat-In six published works in which comparative performance of different variants of neem coatings on urea was studied vis-à-vis uncoated urea on wheat, no difference between the two sources of N was observed in 2 out of 7 comparisons. In the 5 comparisons where NCU performed better than urea, the per cent increase in wheat grain yield ranged from 4.3 to 12.7. Although Prasad et al. (2007) have reported this range as 3.6 to 23.8 %, it is not adequately supported by the published data. Thus, based on 7 comparisons, average increase in yield by applying NCU over that obtained with urea is 5.3% and as in case of rice, there is possibility that in more than 25% cases NCU may not outperform urea. Thind et al. (2010a) studied relative performance of NOCU vis-à-vis ordinary urea applied to wheat when applied at 48, 96, and 120 kg N ha-1 or drilled in between rows as asingle dose of 96 kg N ha-1 in sandy loam and clay loam soils. When nitrogen was applied in 2 equal split doses at the time of sowing and first irrigation, the NOCU did not out-perform urea in increasing grain yield at any level of N application in both the soils. Performance of NOCU at 96 kg N ha-1 drilled during sowing of wheat was better than urea or NOCU applied at 120 kg N ha-1 in 2 split doses in the sandy loam soil suggesting that while drilling NOCU could curb losses via ammonia volatilization, the nitrification inhibitor properties of NOCU helped in checking the nitrate leaching losses. In the fine textured soil, NOCU did not perform better than urea because loss of N via nitrate leaching was relatively small.

Physical, chemical and biological properties of soil-Nitrogen can be applied in inorganic forms such as commercial fertilizers, organic forms such as manure or crop residues, or in a combination of them. If N is applied in the form of organic N, short-term N loss could be reduced because the mobility of organic N is relatively low in soil. However, if N is applied in the form of inorganic fertilizer N, the synchronization of N supply with crop demand can be relatively easily achieved. This can also minimize N loss into the environment. Many scientists have found out that application of NPK fertilizers alone does not sustain productivity under continuous intensive cropping system (Yaduvanshi 2003), whereas inclusion of organic manures improves physical properties (Li and Zhang 2007), increased NUE, reduced the risk of environmental pollution (Ming-gang et al. 2008), and soil fertility and crop yields (Yang et al. 2008, Ming-gang et al. 2008).Soil texture, moisture retention, water infiltration, soil softness and compaction are the soil characteristics, which determine suitable conditions for the uptake or intake of nutrients from soils for plant growth. Although these characteristics are technical in nature, which requiring scientific tests to understand, we have attempted to present sthe perceptions of farmers regarding these characteristics of soil in this section, post the application of NCU? The results are presented in Table 6.7. It can be observed from the table that, overall, 76 per cent of the farmers had noticed improvements in soil health post NCU use, while the proportion was 77 per cent in the case of paddy farmers and 71 per cent in respect of tur farmers. Out of these farmers, overall, about 98 per cent had noticed an improvement in soil moisture retention and water infiltration capacity of the soil systems. About 72 per cent accepted that there had been an improvement in soil softness. More than half of them also had observed that there was a decrease in compaction of soil and an increase in texture. However, in the case of paddy farmers, a majority of them (more than 59 %) had stated that there was an improvement in all these soil characteristics post NCU application. Similarly, in the case of tur farmers, a majority (more than 95%) had observed an increase in soil moisture retention capacity of the soil systems and an improvement in water infiltration characteristics. About 40 per cent of tur farmers also had perceived an improvement in soil softness, but only five per cent each had observed that the soil texture had improved with a decrease in compaction. It was reported that the thickness of coating fertilizers, affects the release pattern of nitrogen from fertilizers (Junejo et al., 2009). When urea is applied to the soil, a cascade of chemical and biological reactions transforms urea N into several other N forms, of which some are susceptible to loss and therefore lead to reduced availability of N to crop plants. Most notable two broad categories of transformations are: (i) hydrolysis of urea by urease enzyme which rapidly converts urea-N to ammonium-N and (ii) nitrification brought about by a group of nitrifying bacteria that leads to conversion of ammonium-N to nitrate-N. Although plants can use both ammonium-N and nitrate-N with equal ease, ammonium-N is susceptible to loss via ammonia gas, and nitrate-N can escape soil-plant system through leaching below the rooting zone and in gaseous forms via denitrification leading to reduced fertilizer N use efficiency. The neem oil coated urea (NOCU) has two advantages: (i) only 0.5 kg neem oil is needed per tonne of urea and (ii) the N content in urea meets the Fertilizer Control Order standards (Prasad et al., 2002).

Physiochemical properties of soil- Improved physio-chemical properties of the soil through the application of organic manure might be the other possible reason for higher productivity. Pandey et al., (2009). Soil pH was measured electrometrically using glass electrode pH meter, model N1G 333 (Jackson, 1973). Electrical conductivity (EC) was measured by the method of Richard (1954). Organic carbon in the soil samples was estimated by wet digestion method of Walkley and Black (1934) with slight modification. Available phosphorus in soil was estimated by the method of Olsen et al. (1954). Potassium was estimated by flame photometer (Perkin-Elmer model 52, flame photometer with acetylene of propane burner) following the method of Jackson (1973). The soil dehydrogenase activity was measured by the method of Casida et al. (1964) and alkaline phosphatase activity was measured by the method of Tabatabai and Brenner (1969). Available nitrogen in soil was estimated using the alkaline potassium permanganate method of Subbaih and Asija (1955). Microbial biomass was measured by plate count method of APHA.

Agronomical parameter- The data in revealed that protein content and protein yield were significantly influence by different nutrient management treatments. Protein content and protein yield were registered higher under the treatment T5 [RDF (120-60-60 kg N-P2O5-K2O ha-1) + ZnSO4 @ 25 kg ha-1 (P from DAP)]. However, it is statistically equivalent to treatments T2 and T6. The increased in protein content in wheat grain is influenced by nitrogen and micronutrient availability at the grain formation stage and other environmental conditions. Significant improvement in grain protein content might be due to its dependence on nitrogen content. While higher protein yield is due to protein content and grain yield. This could have explained on the basis of better availability of required nutrients in the crop root zone and enhanced photosynthetic and metabolic activity resulted in better partitioning of photosynthates to sinks, which reflected in quality enhancement in terms of protein contented protein yield. These findings are in close conformity with those reported by Kharub and Chander (2008). Organic nitrogen was estimated by the microkjeldahl method (Lang, 1958). Protein and free directly co-related to the productivity of cereals in general and wheat in particular (Abedi et al., 2010; Cerny et al., 2010). Fresh and dry weights of wheat (Triticum aestivum L. cv. WH-711) increased with the application of free urea 80 kg ha-1 (two split doses) and entrapped urea 40 kg ha-1 bound in organic matrix (OMEU) at 60 days and 120 days after sowing (Fig. 2). The increase in plant biomass by the free or entrapped urea was significantly higher over no fertilizer applied plants. Tiller number and plant height enhanced significantly with the application of FU as well as OMEU at 60 and 120 days after sowing (Fig. 2). The percentage increase of 40% in tiller number and 4% in plant height was recorded in 60 days old plants by the application of OMEU over free urea efficiency of the plant (Singh and Agarwal, 2001; Singh et al., 2011).

Materials and Methods

The details of experiment site, materials used and methodology adopted during the experiment as well as in data collection have been described below under suitable heads and sub heads.

Experimental Location

The proposed study will be carried out in Agriculture farm of Lovely Professional University, Phagwara, Punjab (31.2536° N, 75.7037° E) at altitude of 252 amsl which falls under Trans-Gangetic plain region of agro climatic zone of Punjab.

Brief information of the work

Crop used : Wheat

Period of work : 2017-2018

Design of Experiment : RBD

METHODOLOGY

pH

pH was determined using a portable pH meter (pH 97WP Milwaukee) in a 1:5 soil water suspension. Briefly 20g soil will be placed in a beaker containing 80ml deionized water, the beaker was shaken for half an hour and the pre-calibrated pH meter was put into the soil suspension to note the PH value.

Electric Conductivity (EC)

Electrical conductivity, a measure of the ionic transport in a solution between the anode and cathode is normally considered a measurement of the dissolved salts in a solution.

Soil Texture

size Mechanical composition of experimental soils i.e., proportion of sand, silt and clay particles was determined by hydrometer method (Bouyoucos, 1962). The texture of the soil was determined according to textural triangle proposed by USDA (Brady and Weil, 2002.

Total Organic Carbon: The determination of soil organic carbon is based on the Walkley-Black chromic acid wet oxidation method (Allison, 1965).

Soil Enzyme Activity

Dehydrogenase activities in the soils will be assessed following the method as described by Klein et al. (1971). Acid and alkaline phosphatase activities will be determined by Arun Kumar et al 2014.

Carbon Mineralization Potential

C mineralization potential will be measured according to Anderson and Domsch (1978).

Available Nitrogen

Soil available nitrogen was determined after Subbiah and Asija (1956).

Available Phosphorus

Soil available phosphorus was determined after Olsen et al. (1954) and Jackson (1973).

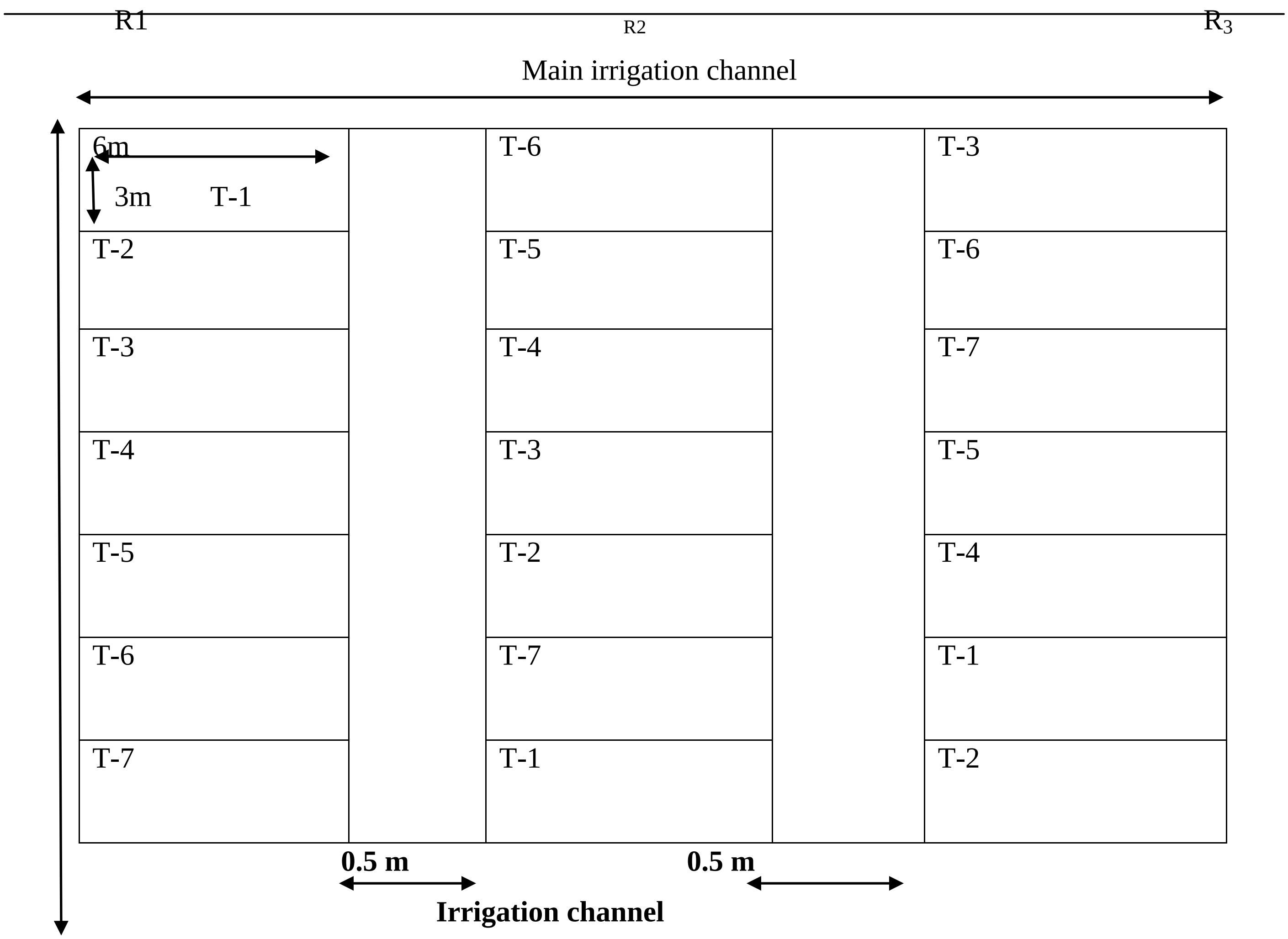
Total Phosphorus

Total phosphorus in soil was determined by digestion method (Olsen and Sommers, 1982).

Soil analysis

Numerical values of the soil enzyme activities, microbial biomass carbon, organic carbon and soil macronutrient will be subjected to multivariate analysis such as such as principal component analysis. The comparison of Soil organic carbon, microbial biomass carbon and soil enzyme activity among different treatment will be made using Ducan's multiple range tests.

Experimental Layout -



TREATMENT

T1= Control

T-2= 100% Recommended dose of fertilizer.

T-3= 75% Recommended dose of fertilizer + 25% Neem coated urea .

T-4= 50% Recommended dose of fertilizer + 50% Neem coated urea.

T5= 75% Recommended dose of fertilizer + 25% Vermicompost.

T6= 50% Recommended dose of fertilizer + 50% Vermicompost.

T-7= 50% Recommended dose of fertilizer + 25% Neem coated urea + 25% Vermicompost.

OTHER EXPERIMENTAL DETAILS

S.No	Experimental details	Description
1.	Total number of treatment combinations	1x7
2.	Experimental design	RBD
3.	Replications	3
4.	Total number of plots	7x3
5.	Plot size Gross area Total area	500 m2
6.	Test crop	Wheat HD2967
7.	Spacing	15-30cm rows
8.	Seed rate	4kg
9.	Fertilization	As per recommendation
10.	Irrigation	As per treatment
11.	Plant protection: herbicide	Plant protection

DETAILS OF CULTURAL OPERATIONS

Tillage Practices

The experimental field was prepared thoroughly by working twice with tractor drawn cultivator followed by rotavator to achieve optimum tilth. Subsequently plots were laid out as per the plan.

Seeds and Sowing

As per the recommendation to get desired plant population the seeds were dibbled at a depth of 2-3 cm in conventionally tilled soil by manually marked sticks.

Fertilizer Application

Nitrogen, phosphorous and potassium were applied through urea, single super phosphate respectively to all the plots (120 N, 60P_2O_5, 30 K_2O kg ha^{-1}). Organic fertilizer Vermi Compost is applied to treatments as per the treatment required.

Irrigation

All the plots were irrigated uniformly as and when required based on soil moisture content and phenological stages of crop growth.

Weed Management-

During wheat cultivation after 15 days of sowing I followed hand weeding. Then after 45 days I have applied post emergence herbicide to control broad leaf weed.

Harvesting-

Harvesting is done by sickle after 135 days of sowing. I have hervested for 1 sq meter area for every treatment.

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