LOVELY PROFESSIONAL UNIVERSITY

**M.Sc. THESIS SYNOPSIS**

# Impact of Biochar based on inorganic amendment on soil biochemical indicators and growth parameter under Wheat cultivation


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## SUPERVISORS CERTIFICATE

This is to certify that the work synopsis report in **"Impact of Biochar based inorganic amendment on soil biochemical indicators and growth parameter under Wheat cultivation"** submitted by **Rema Barman, 11714373,** at **Lovely Professional University, Phagwara, India** is a bonafide record of her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

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# CANDIDATES DECLARATION

We hereby certify that the work which is being presented in the **"Impact of Biochar based inorganic amendment on soil biochemical indicators and growth parameter under Wheat cultivation"** in partial fulfilment of the requirement for the award of the **"Master of Science In Agriculture"** and submitted to the school of Agriculture of Lovely Professional University is a work carried out under the supervision of **Dr. Arun Kumar K (Associate Professor, Agronomy)** Department of Agronomy, School of Agriculture, Lovely Professional University, Phagwara, Punjab.

The work presented in the report has not been submitted by us for the award of any other degree elsewhere.

**(Signature of the student)**

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## 1. TABLE OF CONTENTS

# INTRODUCTION

Wheat is a grass widely cultivated for its seed, a cereal grain which is a worldwide staple food. There are many species of wheat which together make up the genus *Triticum*; the most widely grown is common wheat (*T. aestivum*). The archaeological record suggests that wheat was first cultivated in the regions of the Fertile Crescent around 9600 BCE. Botanically, the wheat kernel is a type of fruit called a caryopsis. Wheat is grown on more land area than any other food crop (220.4 million hectares, 2014). World trade in wheat is greater than for all other crops combined. In 2016, world production of wheat was 749 million tonnes, making it the second most-produced cereal after maize. Since 1960, world production of wheat and other grain crops has tripled and is expected to grow further through the middle of the 21st century. Global demand for wheat is increasing due to the unique viscoelastic and adhesive properties of gluten proteins, which facilitate the production of processed foods, whose consumption is increasing as a result of the worldwide industrialization process and the westernization of the diet. Wheat is an important source of carbohydrates. Globally, it is the leading source of vegetal protein in human food, having a protein content of about 13%, which is relatively high compared to other major cereals, but relatively low in protein quality for supplying essential amino acids. When eaten as the whole grain, wheat is a source of multiple nutrients and dietary fiber.

Wheat is widely cultivated cereal, spread from 57ºN to 47ºS latitude. Hence, wheat is cultivated and harvested throughout the year in one country or other. China, India, Russian federation, USA, France, Canada, Germany, Pakistan, Australia and Turkey are most important wheat growing countries. In India, UP, Punjab, Haryana, MP, Rajasthan, Bihar, Gujarat, Maharashtra, Uttaranchal and West Bengal are the important wheat cultivating states.

HD6927 is double dwarf variety of wheat with an average height of 101 cm. It has profuse tillering. The ears are medium dense and tapering in shape with white glumes. Its grains are amber, medium bold, hard and lustrous. It is resistant to yellow and brown rusts but susceptible to karnal bunt and loose smut diseases. It takes about 157 days to mature.

Wheat is cultivated in a variety of soils in India. Soils with a clay loam or loam texture, good structure and moderate water holding capacity are ideal for wheat cultivation. Care should be taken to avoid very porous and excessively drained soils. Soil should be neutral in its reaction. Heavy soils with good drainage are suitable for wheat cultivation under dry conditions. These soils absorb and retain in rain water well. Heavy soils with poor structure and poor drainage are not suitable as wheat is sensible to water logging. Wheat can be successfully grown on lighter soils provided their water and nutrient holding capacities are improved. To improve the growth rate and development of wheat crop we are going to use biochar to increase the nutrient use efficiency.

Biochar addition does not influence yield components of any crop, but resulted in increased soil N retention, which influenced rice dry shoot mass, spikelet's sterility, panicle number, and grain mass. Biochar also promoted increased soil pH, potassium content, and exchangeable sodium percentage and decreased calcium and magnesium concentrations in the soil .The rice-husk biochar used was slightly alkaline (pH 7.79), increased the pH of the soil, and contained elevated levels of some trace metals and exchangeable cations (K, Ca and Mg) in comparison to the soil. The biochar treatments were found to increase the final biomass, root biomass, plant height and number of leaves in all the cropping cycles in comparison to no biochar treatments.  Biochar made from manure and bones is the exception; it retains a significant amount of nutrients from its source. Because biochar attracts and holds soil nutrients, it potentially reduces fertilizer requirements. As a result, fertilization costs are minimized and fertilizer (organic or chemical) is retained in the soil for longer. In most agricultural situations worldwide, soil pH (a measure of acidity) is low (a pH below 7 means more acidic soil) and needs to be increased. Biochar retains nutrients in soil directly through the negative charge that develops on its surfaces, and this negative charge can buffer acidity in the soil, as does organic matter in general.

Biochar is a solid carbon rich material and by-product of pyrolysis, has been identified as an amendment to improve soil fertility as well as sequester carbon (C). Ammonium is generated by microbial processes and nutrient cascades that convert nitrogen from organic forms found mainly in proteins and nucleic acids into mineral forms (ammonium, nitrate and nitrite) that can intermittently be converted by nitrifying and denitrifying microbes to gaseous emissions that include volatile ammonia gas ($NH_3$), nitrogen gas ($N_2$), nitrous oxide ($N_2O$) and other reactive nitrogen. After application of biochar in soil enzyme activities were high in wet conditions in both soils with growing plants, with or without biochar.. In sandy till, alanine and leucine aminopeptidase activities decreased in biochar-treated soil, but not in the medium-fine sand. $\beta$-N-acetyl- D-glucosaminidase and phosphomonoesterase activities were enhanced in biochar-treated medium-fine sand. The effects of plant, season and soil type on the enzyme activities were clear and frequently observed, whereas the effects of biochar were only few and weak.

On this current situation, it is an urgent need to change the decline soil quality, conserve organic matter and improve soil nutrient use efficiency. The present study is proposed with the following objectives

1. To study the impact of rice husk biochar on soil biological and biochemical indicators
2. To evaluate the nutrient use efficiency as per different proportion of rice husk biochar
3. To study the soil physical and chemical parameter changes under influence of biochar
4. To correlate the nutrient status and biological indicators with growth and yield of wheat.
5. To understand and correlate the structural properties of biochar with soil biochemical functions.

# REVIWE OF LITERATURE

**Biochar:** The word "biochar" is a combination of "bio-" which is known as "biomass" and "char" as in "charcoal". It has been used in scientific literature of the 20th and 21st century. Biochar is charcoal which is used as a reclamations of soil physical condition .Physical condition of Biochar is solid which is high in carbon, and can remain in soil for thousands of years. Like most charcoal, biochar is made from biomass via pyrolysis. The present situation says that Biochar is under exploration as an influence to carbon sequestration. Apart from this, biochar can also enhance soil fecundity under low pH condition and also expand the agricultural production , and provide protection against some foliar and soil-borne diseases. Application of Biochar to agriculture soils has been advanced as a means to renovate soil luxuriance and diminish the climate change . Recently, data has been reported and says that modification of biomass into Biochar can not only consequence of renewable energy (synthetic gas and bio oil), but also eliminate the content of $CO_2$ in the atmosphere, which demonstrated more research on the effect and impact of Biochar in soil. It is indicated that application of Biochar into soil improves the structure and properties of soil, such as the water-holding capacity, organic matter content, aeration condition, pH value, cationic exchange capacity (CEC), and the formation of aggregates of soil. The leaching losses of nitrogen and phosphorous in soil and the releases of greenhouse gases ($N_2O$ and $CH_4$) from soil could be reduced in the presence of Biochar. Biochar has porous structure, charged surface, and surface functional groups (such as carboxyl, hydroxyl, phenolic hydroxyl, and carbonyl groups). These properties are the important factors that influence the migration, transformation, and bioavailability of contaminants in soil.

**Physiochemical properties of Biochar:** Biochar is made by bomass via pyrolisis. Thermal degradation of cellulose between 250 and 350ºC results in considerable mass loss in the form of volatiles, leaving behind a rigid amorphous C matrix. As the pyrolysis temperature increases, so thus the proportion of aromatic carbon in the biochar, due to the relative increase in the loss of volatile matter (initially water, followed by hydrocarbons, tarry vapours, $H_2$, CO and $CO_2$), and the conversion of alkyl and O-alkyl C to aryl C (Baldock and Smernik, 2002; Demirbas 2004). Around 330ºC, poly aromatic graphene sheets begin to grow laterally, at the expense of the amorphous C phase, and eventually coalesce. Above 600ºC, carbonization becomes the dominant process. Carbonization is marked by the removal of most remaining non-C atoms and consequent relative increase of the C content, which can be up to 90% (by weight) in biochars from woody feedstocks (Antal and Gronli, 2003; Demirbas, 2004). It is commonly accepted that each biochar particle comprises of two main structural fractions: stacked crystalline graphene sheets and randomly ordered amorphous aromatic structures. Hydrogen, O, N, P and S are found predominantly incorporated within the aromatic rings as heteroatoms (Bourke et al., 2007).

**Biochar application in agriculture:** Rice is the most important crop all over the world. After harvesting of rice crop farmers generally pulverize the soil with paddy straw but the problem is that due to high C:N in the rice husk its takes lots of time to decompose and speciality in paddy straw is that, it have good elastic capacity so during pulverization the straw are remain same in the field. To solve that problem making of biochar is best solution under pyrolisis.

Sarah Carter, et al 2013 found that The rice-husk biochar used was slightly alkaline , increased the pH of the soil, and contained elevated levels of some trace metals and exchangeable cations (K, Ca and Mg) in comparison to the soil. The biochar treatments were found to increase the final biomass, root biomass, plant height and number of leaves in all the cropping cycles in comparison to no biochar treatments.

Obemah *et al.*, 2014 improve that Biochar (BC) is the carbon-rich product obtained when biomass, such as wood, manure, or leaves, is heated in a closed container with little or no available air. In more technical terms, BC is produced by so-called thermal decomposition of organic material under limited supply of oxygen (O2) and at relatively low temperature (<700 degreeC). The term "BC" is a relatively contemporary development, evolving in conjunction with soil management, carbon sequestration issues, and immobilization of pollutants . Addition of BC to agriculture soils has been projected as a means to improve soil fertility and mitigate climate change. Recently, it is reported that conversion of biomass into BC can not only result in the renewable energy (synthetic gas and bio oil), but also decrease the content of CO2 in the atmosphere, which reveal more research on the effect and behaviour of BC in soil . It is indicated that amending BC into soil improves the structure and properties of soil, such as the water-holding capacity, organic matter content, aeration condition, pH value, cationic exchange capacity (CEC), and the formation of aggregates of soil.

**Physical Chemical and Biological Properties of soil:** Soil is the back bone of agriculture. It has following properties like physical, Chemical, Biological. Physical properties like soil structure, soil texture, Bulk densty, porosity etc. Chemical properties such as pH, EC, CEC, micro and macro nutrient in soil.

Atanu Mukherjee *et al* 2013 have been found that Soil functions depend on three key properties, physical, chemical, and biological, and biochar has been applied as an amendment to test its impacts on soil properties. Whereas, biochar is widely considered as a soil amendment, the focus of the past studies has mostly been limited to the nutrient status of the amended soils including CEC, pH, nutrient content, vegetative growth, and the C sequestration potential of the amended soils. Positive effects of biochar have been reported on soil nutrient status and C sequestration, microbial community or soil biota, and greenhouse gas (GHG) emissions which are related to physical properties of soils. However, there is little published information about effects of biochar on soil physical properties and GHG emissions which are closely linked. Moreover, existing reviews on GHG emissions are somewhat conflicting in nature as some indicate reductions in GHGs upon biochar application, while others report enhancement. In other words, if one of the GHGs is suppressed by biochar addition another is either enhanced or not affected. Clearly, there is a knowledge-gap as to how biochar alters soil physical properties and the mechanisms responsible for GHG emissions. Thus, the objectives of this article are to collate and synthesize available information regarding the effect of biochar on soil physical properties, and associated effects on GHG emissions, and to identify, rationalize and prioritize researchable topics related to the use of biochar as a soil amendment.

**Biochar as a Carrier for Nitrogen Fertiliser:** Besides the release of N intrinsically embodied in the biochar there have been attempts to further enhance the delivery of N using biochar by adding nutrients to the biochar prior to soil incorporation. For example, Sarkhot *et al.* Has been proved that application of mixed biochar with filtered liquid dairy manure, by shaking the mixture for 24 h and then oven drying the biochar, which increased the biochar's N content. When the unamended and N enriched biochars were added to the soil in an 8 week incubation experiment, reductions in net nitrification, and net ammonification rates were reduced. However, enriching biochar with N did not alter the N2O flux, which averaged a reduction in the biochar treatments . These results were interpreted as being due to adsorption processes rather than enhanced immobilisation, since CO2 fluxes were also lower under biochar treatments. Sarkhot *et al.* thus concluded that N enriched biochar could be used as a slow release N fertilizer.

**Biochar impact on soil enzymes:** Soil enzymes increase the reaction rate at which plant residues decompose and release plant available nutrients. The substance acted upon by a soil enzyme is called the substrate. For example, glucosidase (soil enzyme) cleaves glucose from glucoside (substrate), a compound common in plants. Enzymes are specific to a substrate and have active sites that bind with the substrate to form a temporary complex. The enzymatic reaction releases a product, which can be a nutrient contained in the substrate. Sources of soil enzymes include living and dead microbes, plant roots and residues, and soil animals. Enzymes stabilized in the soil matrix accumulate or form complexes with organic matter (humus), clay, and humus-clay complexes, but are no longer associated with viable cells.

Sudeshna Bhattacharjya *et al* have been found during the pot experiment on effect on soil biochemical properties, nutrient availability and yield of rice (Oryza sativa L.) and wheat (Triticum aestivum L.) that biochar application on SOC build-up, soil properties and crop yields in different studies varied greatly with the composition of biochars, soil types and environmental conditions. This necessitated the need for establishment of possible connections between biochar properties and the soil biological functioning, and their implications on soil processes. Soil biochemical properties act as quick indicators of soil quality as they are highly sensitive to alterations in management practices (Nannipieri *et al*. 2002). Soil enzyme activity reflects key microbial reactions involved into soil nutrient cycling (Nannipieri *et al*. 2002). In addition, the measurement of these biochemical properties along with soil available nutrient may help to understand biogeochemical effects of soil amendments such as biochar on nutrient cycling and crop growth (Lehmannn *et al*. 2011).

**Biochar impact on agromonical parameter:** Agronomical parameter are those parameter which gives results after applying of any treatment to field. The parameters includes plant height, leaf length, no. of tillars, no. Of panicle, panicle length, test weight, Dry matter etc.

Tariku *et al* 2017 says that after application of biochar the germination percentages (GP) range is increased in different treatments but the statistical analysis revealed that it is not statistically significant differences . Similarly, other parameters such as mean germination time (MGT) and germination index (GI) were also affected by different rate of biochar as compared to the control. Biochar application did not decrease germination.

The application of rice husk biochar in different concentration in wheat pots experiment sowing different plant height in every treatment. Significantly plant height were increased upto 45-75 days after sowing. As well as no of tillers also more in case of biochar treated plants. Rich husk biochar also increased the shoot and root biomass as compare to untreated biochar plant.

Seed number per pod at physiological maturity was significantly affected by different rate of biochar. The higher number of seeds was recorded in biochar applied plants .This implies that as the number of productive seeds per panicle increases the yield per hectare also increases. The increase may be associated with increase in the number of seeds per plant, sustained nutrient supply, increased photosynthetic activity , and good translocation efficiency. Similar to the present study, high seed numbers per pod were reported for soybean sown in low pH soil that was amended with biochar. According to  number of seeds/pods of pea was highly significantly affected by application of biochar of different origin.

# MATERIAL AND METHODS

## 3.1 Experimental Location

The experiment will be conducted on Agricultural research farm, LPU, phagwara. Geographically it is situated at 31 degree 22 minutes and 31.81 seconds' north latitude and 75 degree and 23 minutes and 3.02 seconds' east longitude with an altitude of about 252 meters above the sea level which falls under the Trans-Gangetic plain region of agro-climatic zone of Punjab.

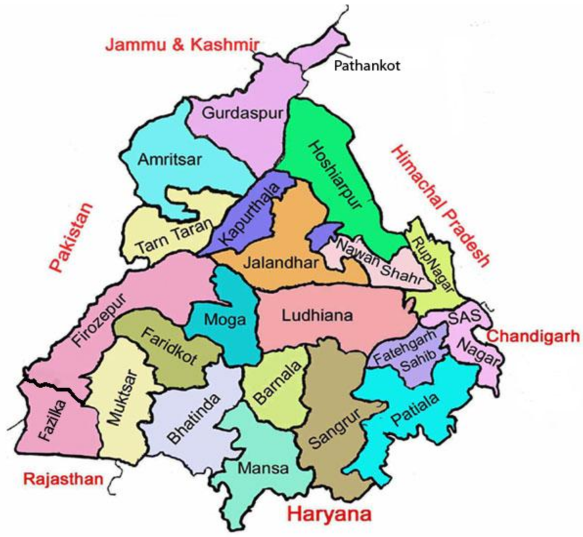


Fig 1: Map of Punjab

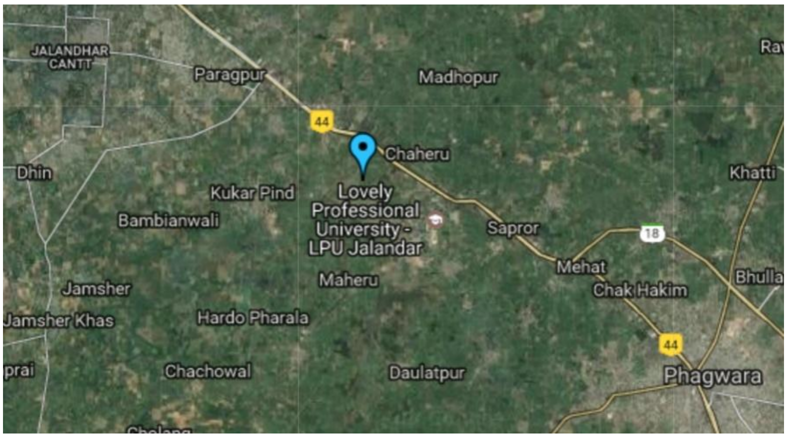


Fig 2: Satellite map of LPU

**3.2 Name of experiment:** Impact of Biochar based inorganic amendment on soil biochemical indicators and growth parameter under Wheat cultivation

**3.3 Experimental details:**

| | | |
|---|---|---|
| 1. Year of experimentation | : | 2017 |
| 2. Recommended dose of fertilizers | : | 50% , 75% and 100% |
| 3. No. of treatments | : | 8 |
| 4. No. of replications | : | 3 |
| 5. No. of pots in each treatment | : | 5 |
| 6. Total no. Of Pots | : | (8 x 3 x 5)=120 |
| 7. Expected Date of sowing | : | 2nd fortnight of November (30th Nov) |
| 8. Experimental design | : | Complete randomize design (CRD) |
| 9. Crop and variety | : | Wheat, HD 2967 |

**3.4 Treatment Details**

T1: Control

T2: 100% RDF

T3: 50% RDF + 3% Biochar

T4: 75% RDF + 3% Biochar

T5: 100% RDF + 3% Biochar

T6: 50% RDF + 5% Biochar

T7: 75% RDF + 5% Biochar

T8: 100% RDF + 5% Biochar

**Layout**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| T1R1 **1,2,3 4,5** | T1R2 **1,2,3 4,5** | T1R3 **1,2,3 4,5** | T1R4 **1,2,3 4,5** | T1R5 **1,2,3 4,5** | T1R6 **1,2,3 4,5** | T1R7 **1,2,3 4,5** | T1R8 **1,2,3 4,5** |
| T2R1 **1,2,3 4,5** | T2R2 **1,2,3 4,5** | T2R3 **1,2,3 4,5** | T2R4 **1,2,3 4,5** | T2R5 **1,2,3 4,5** | T2R6 **1,2,3 4,5** | T2R7 **1,2,3 4,5** | T2R8 **1,2,3 4,5** |
| T3R1 **1,2,3 4,5** | T3R2 **1,2,3 4,5** | T3R3 **1,2,3 4,5** | T3R4 **1,2,3 4,5** | T3R5 **1,2,3 4,5** | T3R6 **1,2,3 4,5** | T3R7 **1,2,3 4,5** | T3R8 **1,2,3 4,5** |

### 3.5 Laboratory analysis of soil sample

#### 3.5.1 Soil physic chemical analysis:-

**Soil pH**

pH will be conducted using glass electrode method by (Sparks, 1996) in a 1:2.5 ratio of soil water suspension in a pre-calibrated pH meter.

**Electrical conductivity (EC)**

Electrical conductivity is also measured using 1:2.5 ratio of soil water suspension in a pre-calibrated EC meter. It will be followed by conductivity meter method given by (Sparks, 1996).

**Soil Texture**

The method to find the composition of sand, silt and clay is by hydrometer method given by (Bouyoucos, 1962). Textural triangle given by (brady and weil, 2002) can also be used.

**Total Organic Carbon**

The determination of soil organic carbon will be based on the Walkley-Black chromic acid wet oxidation method (Allison, 1965)

**Microbial biomass carbon**

Microbial biomass carbon of soil will be determined according to Vance *et al.*, (1987) including extraction of organic carbon (C) from fumigated and un-fumigated soils with $K_2SO_4$.

**Particulate Organic Carbon**

The procedure followed to determine Particulate Organic Carbon will be Camberdella and Elliot, given in 1992.

**Available Nitrogen**

The amount of available nitrogen present in the experimental field will be determined using the method by (Subbiah and Asija,1956).

**Ammonical and Nitrate N**

Exchangeable Ammonium-N and nitrate-N will be estimated by the methods described by Keeney and Nelson (1982).

**Total Nitrogen**

The method to find the amount of total nitrogen in the soil will be kjeldahl method which is invented by johanKjeldahl in 1883.

**Available phosphorous**

Available phosphorous will be determined using Olsen's method found by Olsen *et al* (1954) and (Jackson, 1973)

**Available potassium**

The method of flame photometer given by Toth and Prince, 1949 will be followed.

### 3.5.2 Soil Biochemical Analysis:-

**Dehydrogenise Activity**

Determination of dehydrogenise activity in soil will be conducted using method given by (Klein *et al*, 1971).

**Acid Phosphates**

Acid phosphatase activity was estimated colorimetrically using the method described by Tabatabai and Bremner (1969).

**Alkaline Phosphates**

Alkaline phosphatase activity was estimated colorimetrically using the method described by Tabatabai and Bremner (1969).

**Arylsulfatase**

Arylsulfatase activity was estimated colorimetrically using the method described by Tabatabai and Bremner (1970).

## 3.6 Agronomic Parameters to be evaluated

**Plant Height, Tiller Numbers, Leaf length**

In this experiment after application of rice husk biochar plant height, no of Tillers, and Leaf length are gradually increase at different level of biochar application. Significantly plant height are increased up to 75 days after sowing  as well as no of tillers also increased at different biochar application rate. Leaf Length also increased in biochar added pot as compare to control pot. After application of Rice husk biochar in wheat crop statistical analysis showed different significance in different agronomical Parameter.

**Panicle length and No of panicles**

Panicle length is measuring from the neck node (panicle base node) to the end of the panicle. Counting and recording the number of panicles except panicles shorter than the half of culm length and late emerging heads to find the no of panicles. After treating with rice husk biochar no of panicle and panicle length also increased at different rate of biochar application. Panicle are start emerging 60 days after sowing and no. of panicle are increased gradually upto 75 days after sowing as well as panicle length also increased upto 90 days after sowing. Statistical analysis of agronomic parameters are showed different significant level in different treatment.

**Yield Attributes**

Grain Yield

Test Weight of grain (as per Treatment)

.**Statistical Analysis**

The data obtained from all the observations shall be analyzed using the standard procedures using SPSS 22 to arrive at valid conclusions.

**PHOTOGRAPHS**

**Fig 1 RICH HUSK BIOCHAR**

**Fig 2 POTTING MIXTURE**

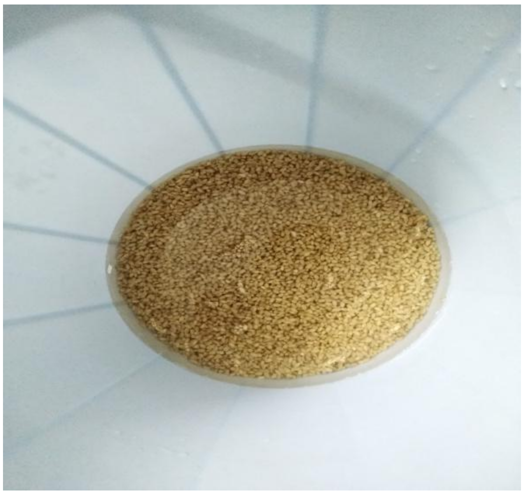

**Fig 3 SOAKING OF SEED**

**Fig 4 SOWING OF SEED**

**Fig 5 30 DAYS AFTER SOWING**

**Fig 6 45 DAYS AFTER SOWING**

**Fig 7 AGROMONIC PARAMETER**

**Fig 8 BOOTING STAGE**

**Fig 9 SPRAYING**

**Fig 10 IRRIGATION**

**Fig 11 HARVESTING OF PANICLE**

**Fig 12 HAVESTED GRAIN**

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