SYNOPSIS ON

Dissertation - II

(AGR 690)

"Effect of Fly ash and Organic amendments on soil nutrient availability and growth parameter of Maize (*Zea mays* L.)''

Submitted To

Department of Agronomy

School of Agriculture

Lovely Professional University

Punjab (India) 144411

Submitted By

Lovepreet singh

Reg. No. 11614496

UNDER GUIDANCE OF

Dr. Premasis Sukul

Department of Soil Science

Lovely Professional University

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CERTIFICATE

This is to certify that this synopsis entitled **"Effect of Fly ash and Organic amendments on soil nutrient availability and growth parameter of Maize (*Zea mays* L.)"** submitted in partial fulfilment of requirements for degree – Master of Science in Agronomy by **Lovepreet Singh, Registration no. 11614496** to Department of Agronomy, School of Agriculture, Lovely Professional University, has been formulated and finalized by the student himself on the subject.

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(Signature of Student)	(Signature of Supervisor)
Lovepreet Singh	Dr. Premasis Sukul
11614496	UID: 20644

DECLARATION

I hereby declare that the project work entitled **— "Effect of Fly ash and Organic amendments on soil nutrient availability and growth parameter of Maize (*Zea mays* L.)"** is an authentic record of my work carried at **Lovely Professional University** as requirements of Project work for the award of degree -Master of Science in Agronomy, under the guidance of **Dr. Premasis Sukul**, Professor, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India.

Lovepreet Singh.
(Registration No. 11614496)

1. INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop and ranks third in production after rice and wheat in india. It is a plant belonging to the family of grasses (poaceae). It is cultivated globally being one of the most important cereal crops worldwide. It is called as miracle crop and also as a queen of cereals. Being a C4 plant it is very efficient in converting solar energy into dry matter. Maize is a heavy feeder of nutrients, so its productivity is largely dependent on nutrient management. Maize was mostly grown as primarily for household consumption and as staple food but its demand for feed and industrial uses has increased rapidly in the recent past. In India more than 50 percent of maize produce is being used as animal feed.(Singh *et al.,* 2003)

Maize is one of the world's leading crops cultivated over an area of about 139 Mha with a production of about 600 Mt of grain. Among the maize growing countries, USA has the largest area followed by Brazil, China, Mexico and India. In respect of production also USA stands first followed by China. In India, area, production and productivity of maize is 9.43 Mha, 24.35 Mt and 2557 kg/ha, respectively (*Anonymous* 2014-15). In Punjab, area, production and productivity of maize is 0.13 Mha, 0.50 Mt and 36.8 q/ha, respectively.

Maize crop based on the grain composition different types such as dent, flint, pop, pod, sweet, floury and waxy maize are suitable for specific usages. Among different types of maize, sweet corn is most popular for table purpose as well as green cobs. Maize grain consumption as boiled grains and vegetables purpose, it is also used for extracting sucrose as an industrial purpose. It is very profitable for rural farmers due to high cost of green cobs. It gives good return to the farmers and green stalk used as fodder. Maize suffers from number of pest and pathogens including nematodes in India. (Rai 1969; Payak and Sharma, 1980).

Maize is not only an important human nutrient but also a basic element of animal feed and raw material for manufacture of many industrial products. Maize crop is utilized in many ways like other grain crops. Many food dishes like chapatis are prepared out of maize flour and grains. Maize is also good feed for poultry, piggery and other animals. Maize ranks below wheat and sorghum but considerably above rice in nutrition value. Maize grain contains starch (72%), protein (10%), oil (4.8%), fiber (5.8%), sugar (3.0%), and ash (1.7%) (Chaudhry, 1983).

Maize has very high nutrient demand and its productivity mainly depends upon nutrient management system. Organic manures, like FYM / vermicompost, not only supplies micronutrients but also meets the requirement of micronutrients, besides improving soil health. FYM is one of the oldest manure used by the farmers in growing crops because of its easy availability and presence of all the nutrients required by the plants. Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with their litter and left over material from roughages or fodder fed to the cattle. Average it contains; 0.5% N, 0.2% P and 0.5% K. FYM is one of the components of INM as it a cheap and easily available source of organic nutrients. Application of this source of organic improves physical, chemical and biological condition of the soils. FYM can supply all the nutrients required by the plant, however with low quantity. (Reddy and Reddy, 2003).

Organic materials like FYM are used for increasing crop production but pure organic farming can never meet the increasing demand for nutrient supply, as sufficient quantities of organic materials are not available. Another way of supplying nutrients to soil is through biological inoculum but it also needs large amount of organic matter and alone cannot favour the plant nutrient supply to soil eco-system. (Hussain *et al*., 1999).

Farmyard manure (FYM) is one potential source of nutrients as a result of the high cattle population in the region where on average there are 6.1 cattle per family. (Legesse *et al.*, 1987).

FYM by improving soil physical, chemical and biological application has been proven to improve crop growth properties. However, availability of FYM in enough amount is always a concern. This improved soil condition will provide a favorable environment for seedling development and subsequent growth. (Mahmood *et al.*, 1997).

Fly ash is produced as a result of coal combustion in thermal power station and discharged in ash ponds. Combustion of bituminous and sub-bituminous coal and lignite for generation of electricity in thermal power plants produces solid wastes such as fly ash, boiler slag, bottom ash and Flue Gas Desulphurization (FGD) materials, which are commonly known as coal combustion by products (CCPs). (Vom Berg., 1998).

Nearly 50-60% of the fly ash is being stored at plant dump sites and other sites intented for this purpose. The disposal of such a huge amount of fly ash is one of the major problem of developing countries and is usualy disposal in basins or landfills near the power plants. Fly ash is some times used in building, cement industries and construction of roads. Fly ash of alkaline character and a high concentration of mineral sustances have resulted in attempts at using it as fertilizer or amendment to enhance the physico- chemical properties of soil. Fly ash contains a high concentration of toxic heavy metals such as Zn, Cu, Cd, Pb, Ni, Cr etc. (Rautaray *et al.*, 2003, Lee *et al.*, 2006,Tiwari *et al.*, 2008).

Earlier fly ash was seen as a waste but now time has changed and it is now considered as a valuable resource. Fly ash can be utilized as a soil amendment in agriculture, improving soil texture (Chang *et al.*1977; Phung *et al.* 1978; Garg *et al.* 2003), improving nutrient status of the soil (Rautaray et al. 2003), wasteland reclamation (American Coal Ash Association 1998; Jala and Goyal 2006) etc. Fly ash improve of the nutrient levels, increasing the water holding capacity, texture, reducing the acidity of the soil, use as an insecticide to effectively control various pests infesting several vegetables etc.

Due to the presence of almost all the nutrients required by plants, Vermicompost manure is now widely used by the farmers in growing crops. Vermicompost contains nearly 0.6-1.2% N, 0.13-0.22% P and 0.40-0.75% K. (Pawer and Patil 2007)

Vermicompost are organic materials broken down by interaction between micro-organism and earthworm in hemophilic process to produce fully stabilize organic soil amendments with low C:N ratio. (Ramasamy *et al.*, 2011) Application of vermicompost and compost decreased soil bulk density and increased water holding capacity of soil. (Smith *et al.*, 2000)

Vermicompost contains significant amount of nutrients, a large number of beneficial microbial population and biological active metabolites, particularly cytokinins, auxins, gibberellins and group b vitamins which can be applied alone or in combination with organic and inorganic fertilizers, so as to get better yield and quality of diverse crops produce. (Atiyeh *et al.*, 2002, Arancon *et al.,* 2006 and Jack *et al*., 2011)

Vermicompost is eco-friendly, non toxic, and consumes low energy input for composting and is a recycled biological product. (Lourdueary and Yadav 2005).
Vermicompost enhanced root elongation and formation of lateral roots in maize and also Vermicompost was found to enhance the nutrient uptake in plants by increasing the permeability of root cell membrane and stimulating root growth. (Pramanik *et al.,* 2007)

While comparing the performance of vermicompost with other compost materials, vermicompost was found to increase the exchangeable calcium and base saturation of soils within 200mm of surface soil, although the compost contained significantly more Ca than the vermicompost (Smith *et al.*,1999). Vermicomposts are peat like materials with high porosity, good aeration, high water holding capacity, good drainage and very high microbial activity (Arancon *et al.,* 2008).

Fly ash is a useful soil amendment to enhance the productivity of crops and fertility of soils. It helps to improve the physicochemical and biological properties of soil. It is also reported to be a source of many essential nutrients for plants. It contributes a larger role to modify soil pH also. It is necessary to exploit the positive points of fly ash for better agriculture. Therefore, attempts will be made to examine the effect of fly ash separately and along with organic amendments (FYM) on the fertility status of soil and growth & yield attributing characters of plant, taking maize as a standing crop.

2. REVIEW OF LITERATURE

A brief review of the relevant literature pertaining to different aspects of the investigation entitled, “ Effect of fly ash and organic amendments on soil nutrient availability and growth parameter of maize (*Zea mays* L.)” has been reviewed as following:-

Effect of fly ash and organic amendments on soil nutrient availability and growth parameter of Maize (*Zea mays* L.) :-

Shah *et al.,* (2009) conducted a field experiment to study growth and yield response of maize to organic and inorganic sources of N at the Agronomic Research Area, University of Agriculture, Faisalabad. Two maize varieties namely Composite-78 and Composite-79 were fertilized with farm yard manure @15000 kg ha-1 and urea @ 260 kg ha-1 on a sandy clay loamy soil. Composite varieties differed significantly in plant height, numbers of cobs per plant, number of grains per cobs, 1000-grains weight, grains yield and harvest index. Composite -78 performed best with respect to all growth and yield parameters expect numbers of plants per unit area and number of cob bearing plants. Combined use of urea and farm yard manure performed best than their sole application in respect of grain yield which was 6.13 tons ha-1.

It has been revealed that one time application of fly ash @ 40 t/ha alone or with FYM altered the soil texture with increasing clay and silt content and water holding capacity by 8-12 % both in surface and sub surface soil (Chandraka *et al.,* 2015). Integrated use of fly ash + lime + FYM resulted in higher pH (5.45) and higher Ca accumulation (3.7 %) in surface soil. It was further revealed that inclusion of FYM with lime, fly ash or gypsum resulted in about 5 q/ha higher yield over their sole application. One time application of fly ash to first crop stabilized maize yield up to third season with heavy metal (Pb, Cd, Cr) accumulation below toxic level in fly ash treatments (Chandraka *et al.,* 2015)

Maize and soybean showed an increase in plant height and metabolic rate in presence of fly ash at low dose application (Mishra *et al.,* 1986) This response was, in part, due to correction of boron deficiency by fly ash deposition. The high dose, however, caused reductions in pigment content and dry matter production. Reduction in plant growth at the highest dusting rate was attributed chiefly to the excessive uptake and accumulation of boron, and alkalinity caused by excessive soluble salts on the leaf surface.

Masto *et al.*, (2013) showed that soil bulk density and water holding capacity measured after the harvest of crop were not affected by the treatments. Soil P (+110%) and K (+64%) contents increased by LFA + BC application due to the presence of plant nutrient in BC and LFA. Soil enzymes like dehydrogenase activity (+60.7%), alkaline phosphatase (+32.2%), fluorescein hydrolases activity (12.3%) and microbial biomass (+25.3%) increased due to co-application of LFA and BC probably due to the pH-buffering and sorption of the organic matter to mineral surfaces to create a more reactive network for water, air and nutrient interactions in the soil. Available heavy metal (Zn, Ni, Co, Cu, Cd, and Pb) contents in soil decreased by LFA + BC application due to surface adsorption and precipitation caused by increase in soil pH. Maize grain yield increased by 11.4% for BC, 28.1% for BC + LFA treatment, and the yield was not significantly affected for the LFA alone treatment. Regression analysis showed soil P as the major factor for the increase in crop yield.

Kumar Pursushottam and Puri U.K. (2001) observed that application of 90 kg N and 15 tonnes FYM/ha resulted in the maximum plant height, cob length, grains/cob, grain weight, harvest index and thereby higher yields. Maximum agronomic efficiency was recorded with application of 45 kg N and 15 tonnes FYM/ha.

Tolessa and Friesen (2001) found that the growth and yield of maize were increased significantly with the application of enriched FYM. Enriched FYM increased grain yield by 40% compared to conventional FYM. However, the residual effect of enriched FYM was very marginal. Application of 25% NP enriched FYM gave the highest marginal rate of 296%. This remained robust when maize price decreased by 20% and fertilizer cost increased by 10%. It was concluded that application of enriched FYM is superior to conventional FYM and on par with recommended mineral fertilizers on maize grain yield. By following enrichment technology 75% of mineral fertilizers can be saved for maize production in Bako area.

Moliner *et al.,* (1982) obtained an increase in dry matter yield of corn (*Zea Mays* L.) on the Myakka fs when limed with either $CaCO_3$ or fly ash. In a separate experiment (Moliner et al., 1982), concentration of Ca in plant tissue was found to be significantly increased for for fly ash addition in soils. Extractable soil P was also increased by the addition of fly ash; however, plant P concentrations were decreased with the same treatments.

Nyamangara *et al.,* (2003) concluded that aerobically composted cattle manure from the smallholder farming areas of Zimbabwe was a poor source of N for maize growth in the short-term, even at high application rates. Combined application of manure with judicious use of N fertilizer can be positively exploited by smallholder farmers in Zimbabwe and other countries of sub-Saharan Africa, to increase yields through enhanced efficiency of use of scarce nutrient resources.

Statistical analysis revealed that the N/P fertilizers and FYM significantly ($p<0.05$) increased grain yield in all locations except for Walda in 1997 (Negassa *et al.,* 2001) . Interactions of FYM and NP fertilizer rates were significant ($p\leq0.05$) at all locations except for Shoboka. The application of FYM alone at rates of 4, 8, and 12 t ha-1 produced average grain yields of 5.76, 5.61 and 5.93 t ha-1, respectively, compared to 3.53 t ha-1 for the control treatment. Laboratory analysis confirmed that considerable amounts of macronutrients and small amounts of micronutrients were supplied by the FYM. There were significant residual effects of FYM and NP fertilizers applied in 1997 on maize grain yields in 1998. Based on the results of this study, the integrated use of properly managed FYM and low rates NP fertilizers could be used for maize production in the areas under consideration. Moreover, sole applications of FYM on relatively fertile soils like Walda and Harato are useful in maintaining soil fertilty and are encouraging for resource poor farmers.

Mohsin *et al.,* (2012) showed that yield and crop growth parameters were recorded by using standard procedures and was statistically analyzed using Fisher's analysis of variance technique and least significant difference (LSD) test ($P < 0.05$) was employed to compare the treatment means. Application of 50% N from Urea + 50% from FYM produced longer cobs (18.57 cm), maximum cob weight (216.4 g), maximum 1000-grain weight (279.1 g), higher grain yield (5793 kg ha-1) and maximum biological yield (14880 kg ha-1). On the basis of these results, it can be concluded that 50% N through urea and 50% N through FYM should be used for spring maize in order to get maximum yield.

Singh *et al.*(2011) reported an improvement of physical properties of the soil and a better growth & yield of rice on application of fly ash. Sheoran *et al.*, (2014) also suggested the possibilities of using fly ash to improve soil physicochemical properties and ultimately the crop production and safe environment by its safe consumption in agriculture.

Stanley L. Chapman.,(1984) showed that 2 tons of agricultural limestone was equivalent to 4 to 6 tons of fly ash in raising soil pH. Most of the chemical changes occurred in the upper 2.5 cm of soil and within three months after treatment.

Panda *et al.(*2015) conducted a study on the effects of various concentrations of FA (20, 40, 60, 80 and 100%) on the growth and photosynthetic activity of *Oryza sativum* (rice) and *Zea mays* (maize). Plant growth was mostly enhanced in the treatments with 20–40% fly ash, being optimal at 60%. From 80% onwards, the measured parameters tended to reduce. The most economic level of fly ash incorporation was 60%, which improved the growth of maize and rice. Hence fly ash can be utilized as a substrate or as a soil ameliorating material for the growth of plants, leading to the sustainable utilization of solid waste material.

Kalantari *et al.*, (2010) **observe**d that the concentrations of N, P, K, Ca and Mg in the treatments were higher than in control (only soil). Fe and Mn concentrations in all treatments were significantly ($P < 0.01$) higher than control but the concentration of Cu was not affected by the treatments. Zn concentration in treatments having vermicompost was lower than in control. Physical properties of soil were affected by the application of compost and vermicompost.

Azarmi *et al.* (2008) showed that addition of vermicompost at rate of 15 t ha-1 significantly ($P < 0.05$) increased contents of soil total organic carbon, total N, P, K, Ca, Zn and Mn substantially compared with control plots. The soils treated with vermicompost had significantly more EC in comparison to unamended plots. The addition of vermicompost in soil resulted in decrease of soil pH. The physical properties such as bulk density and total porosity in soil amended with vermicompost were improved. The results of this experiment revealed that addition of vermicompost had significant ($P < 0.05$) positive effects on the soil chemical, physical properties.

Amanolahi *et al.*(2014) results showed that vermicompost application had great impact on corn growth especially when it was combined with chemical fertilizer. Integrated fertilizer management significantly increased leaf number, leaf area index, stem diameter, plant height, chlorophyll content and remobilization compared to full chemical and full organic treatments. In general, to get maximum growth and yield, the application of integrated organic and inorganic fertilizer is best option.

Nasab *et al.,* (2015) evaluated the treatments included levels of vermicompost (0, 4, 8 and 12 t/ha) as main plot and variety (700 and 704) as sub plot. Analysis of variance showed that the effect of vermicompost and variety on all characteristics was significant.

In a separate experiment it has been revealed that the addition of vermicompost to soil greatly enhanced the kernel yield in maize (Ramasamy *et al.*, 2011)

Peyvast *et al*.,(2008) showed that an addition of vermicompost to soil can increase plant height and number of leaves significantly. Spinach leaves and roots were highest when fertilized with vermicompost and lowest when the vermicompost was not supplied. The plants with 10% vermicompost added to soil gave significantly highest leaf area, potassium, phosphorus, total nitrogen, calcium and magnesium and nitrate-N in petioles and leaves, total soluble solids and microelements such as iron, copper, manganese and zinc.

Tatlari *et al.,* (2013) showed that the application of high levels of vermicompost neither is not only economic but also may have adverse effects on plant growth and development.

Dubey *et al*. (1999) characterized fly ash for its physical, chemical and nutrient capacity. The particle size distribution showed wide variation in the <0.25 mm size fraction. Bulk density lies between 0.85-1.16 g cm3. The available water holding capacity ranges between 40.1 to 55.6%. The organic carbon content lies between 1.9 to 4.5 kg-1. The fly ash is slightly alkaline in reaction. Cation exchange capacity was 2.8 - 4.1 c mol (p+) kg-1. The presence of various elements was in the order of Si>Al>Fe>Ca, Ti>Mg>K. The DTPA extractable micronutrients were in the order of Fe>Mn>Zn>Cu whereas available N, P, K show the trend as N>K>P. Application of fly ash in soil, deficient in Fe, Zn, Cu and Mn could increase their availability.

Khan *et al*. (2008) conducted an experiment to study effect of integrated use of boiler ash as organic fertilizer on physical properties of calcareous soil. The boiler ash was applied to wheat crop grown in pots having 20 kg soil and field @ 3, 12, 25, 50, 125 and 250 t ha^{-1} with basal dose 120, 90, and 60 kg ha^{-1}. The total porosity of soil increased with the levels of boiler ash application, on the other hand, dry bulk density declined, which is a positive effect of boiler ash.

Yeledhalli *et al*. (2008) revealed that the long term field experiments to study in effect of fly ash/ pond ash @ 30-40 t ha^{-1} (one time and repeat application) with recommended dose of NPK fertilizers alone or along with FYM @ 20 t ha^{-1} on sunflower maize crops in irrigated vertisols in rotation. The water holding capacity of soil increased from 64 to 67.5 per cent when pond ash applied @ 40 t ha^{-1} application.

Gupta *et al*. (2009) attempted to study the effect of fly ash (FA) on the physico-chemical characteristics viz. pH, electrical conductivity and trace element concentration. The treatment applied to soil was soil + NPK, 90% soil + 10% FA + NPK, 80% soil + 20% FA + NPK, 70% soil + 30% FA + NPK, 60% soil + 40% FA + NPK and 50% soil + 50% FA + NPK. The increasing proportion of fly ash in soil considerably increase the value pH, EC and trace element concentration.

Gourab and Joy (2011) studied effect of coal fly ash doses on chemical and microbial properties of laterite crop land soil. Sandy loam soil was mixed with Farm Yard Manure (10% w/w) and amendment with 5, 10, 20 and 40% w/w (50- 400 t ha^{-1}). The results shows that pH, EC, PO4, Ca and Na of soil increased with fly ash dose and time, but OC, NO3 and K decreased with increasing doses of fly ash.

Yeledhalli *et al.* (2007) conducted a field experiment and found that concentration of heavy metals in soils increased due to application of fly ash @ 40 t ha^{-1}. However, the combined application of fly ash @ 30 t ha^{-1} and FYM @ 20 t ha^{-1} resulted in lower concentration and was comparable with that in control inspite of their increase in concentration.

Reddy *et al*. (2010) conducted experiment in a fine loamy mixed hyperthermic Typic Haplustept soil during rabi, 2004-05 to study the effect of fly ash (FA) and FYM on physico-chemical properties and available nutrient status. The test crop was rice var. Tella Hamsa. Among the different combinations, application of fly ash @ 15 t ha^{-1} + FYM @ 10 t ha^{-1}(FA15 FYM10) recorded the highest available N (224.6 kg ha^{-1}), P (24.6 kg ha^{-1}), K (366.7 kg ha^{-1}), Fe (10.62 mg kg^{-1}) and Zn (0.95 mg kg^{-1}) contents after harvest of rice crop. The available Mn content was highest in FA10 + FYM10 (6.69 mg kg^{-1}). The available Cu content was not significantly influenced by fly ash levels.

Ram *et al*. (2011) obserbed that fly ash had low bulk density, high water holding capacity and porosity, rich in silt-sized particles, alkaline in nature and contains reasonable plant nutrients. The major content of fly ash was SiO_2 considerable amounts of oxides of Ca, Mg, K, P, and S, micronutrients (Cu, Zn, Mn, Fe, etc.) and low in N content.

Patil and Patil (2001) evaluated effect of weathered fly ash and FYM on bacteria, fungi and actinomycetes population at 30 and 60 days of treatments. There was increase in soil bacteria and fungi population at 30 and 60 days in all treatments with soil + fly ash + FYM was observed. On the other hand, a drastic reduction in soil actinomycetes population treated with fly ash was observed. Maximum stimulation of bacteria and fungi at 30 days of planting was noticed in the treatments soil + weathered fly ash and soil + weathered fly ash + FYM, respectively.

Reddy *et al*. (2007) studied effect of fly ash (0, 5, 10 and 15 t ha^{-1}) and farm yard manure (10 t ha^{-1}) on soil enzymatic activities. The addition of fly ash @ 10 or 15 t ha^{-1} along with FYM @ 10 t ha^{-1} recorded the highest content of urease, dehydrogenase and cellulose at 7, 15, 30 and

60 days after incubation, respectively and acid and alkaline phosphate activities decreased significantly with increase in levels of fly ash application.

Pradhan and Sahu (2004) studied the direct residual effects of fly ash on rice-groundnut productivity. The highest yields of rice (3.8 t/ha) and groundnut (1.4 t/ha) with high shelling out turn and oil content were obtained with 40 t fly ash, 5 t FYM per ha and 50% recommended dose of NPK.

Khan *et al*. (2008) conducted experiment to find out the effect of integrated use of boiler ash as organic fertilizer on yield of wheat in calcareous soil. The boiler ash was applied @ 3, 12, 25, 50, 125 and 250 t ha-1 in pots having 20 kg soil and field with basal dose of NPK 120, 90, and 60 kg ha-1 respectively for wheat crop. Yield and most of the yield components of wheat increased due to boiler ash application in the field as well as in the pots application of boiler ash @ 50 t ha-1 enhanced yield of wheat in calcareous soil.

Yeledhalli *et al*. (2008) conducted a long term field experiments sunflower maize crops grown under irrigated vertisols in rotation to study the bulk application of fly ash/ pond ash @ 30 and 40 t ha^{-1} (one time and repeat application) with recommended dose of NPK fertilizers alone or along with FYM @ 20 t ha^{-1}. The highest total yield of 35.7 q ha^{-1} was recorded in treatment receiving pond ash @ 40 t ha^{-1} along with FYM @ 20 t ha^{-1} followed by fly ash @ 30 t ha^{-1}.

Das *et al*. (2013) conducted a field experiments in kharif season 2012 at Instructional Cum Research Farm of Assam Agricultural University, jorhat on Inceptisols to study the effect of application of fly ash alone and in combination with recommended dose of fertilizers and farm yard manure on yield of rice. The results indicated that the treatments which received fly ash @ 5 and 15t ha^{-1} recorded a yield increase of 23.3% and 32.4%, respectively over absolute control. The highest rice yield (34.1 t ha^{-1}) was recorded in treatment 50% RDF + FYM 5 t ha^{-1} + FA 15 t ha^{-1}. On the other hand, fly ash applied @ 5 t ha^{-1} in combination with RDF 50% + FYM 5 t ha^{-1} produced 40.1% more yield over absolute control.

Yeledhalli *et al*. (2009) reported that application of fly ash level (30 and 40 t ha^{-1}) had relatively higher amount of heavy metal elements (Se, As and Pb) and radionuclide in soils than that with conjunctive use of fly ash and FYM. Further, the application of fly ash at maximum dose @ 40 t ha^{-1} increased the concentration of heavy metal elements and activity of natural radionuclide (40K, 226 Ra and 228 Ac) in edible parts of crops viz, Sunflower, Groundnut and Maize grown on Alfisol and vertisol. However, combined application of fly ash and FYM did not increase the heavy metal elements and radio nuclide activity in seeds or stover of crops.

Das *et al.*(2013) reported that the effect of RDF and fly ash on uptake of N, P, K and micronutrients (Fe, Mn, Cu and Zn) showed that, their uptake in straw and grain increased significantly over control with 100% RDF and RDF 50% + FYM 5 t ha^{-1}. Addition of chemical fertilizer alone or in combination with FYM resulted in higher available nutrient contents in soil and subsequent uptake of them in increased amount. Similarly it has been seen that uptake of available macro and micro nutrients increased significantly with increasing doses of fly ash. The interaction effect of fertilizer, FYM and fly ash was also statistically significant on uptake of available nutrients. The highest total uptake of N, P, K and Fe, Mn, Zn, Cu (119.22, 73.84 and 209.69 kg ha^{-1} and 3574.9, 1354.3, 180.2 and 104.9 g ha^{-1}, respectively) were recorded in treatment RDF 50% + FYM 5 t ha^{-1} + FA 15 t ha^{-1} and the lowest being 49.01, 27.83 and 53.87 kg ha^{-1} and 546.0, 397.3, 53.1 and 23.1 g ha^{-1}, respectively, in control.

Objectives:-

1. To determine the effect of Fly ash in combination with Vermicompost at their different levels on growth attributing characters and yield of Maize
2. To assess the impact of the effect of Fly ash in combination with Vermicompost on different physicochemical and biological properties of soil under maize cultivation.
3. To study the effect of Fly ash in combination with Vermicompost on soil nutrient availability under maize cultivation.

3. Materials and methods:

Technical programme:

Name of experiment: Effect of fly ash and organic amendements on soil nutrient availability and growth parameter of maize (Zea Mays L.)

Location : The experiment will be conducted on Agricultural Research Farm, LPU, Phagwara.

3.1 Experimental detail

Plot treatments :

Fly ash, Farm yard manure and Vermicompost

T_0 = Control

T_1 = 100% (RDF+ Vermicompost)

T_2 = 100% (RDF + FYM)

T_3 = 100% Fly ash + 0% (RDF + Vermicompost)

T_4 = 20% Fly ash + 80% (RDF + Vermicompost)

T_5 = 40% Fly ash +60 % (RDF + Vermicompost)

T_6 = 60% Fly ash+ 40% (RDF + Vermicompost)

T_7 = 80% Fly ash + 20% (RDF+ Vermicompost)

Note – RDF (Recommended Dose of fertilizer) for Maize:-
NPK: 180, 60, 40 kg/ha
Fly ash = 20 tonnes/ha
Vermicompost = 5 tonnes/ha
Farm yard manure = 16 tonnes/ha

3.2 Details of Layout:

Design = RCBD (Randomized Complete Block Design)

Treatments = 8

Replications = 3

Total number of plots = 24

Gross plot size = 4.2 X 3.5 = 14.7 m^2

Net plot size = 5 X 4 = 20 m^2

Seed rate = 8-10 kg/ acre

Spacing = 60 x 20 cm

Layout:-

R1	IRRIGATION CHANNEL	R2	IRRIGATION CHANNEL	R3
T0		T2		T4
T1		T3		T5
T2		T4		T6
T3		T5		T7
T4		T6		T0
T5		T7		T1
T6		T0		T2
T7		T1		T3

4. OBSERVATION TO BE RECORDED

4.1 Growth attributes

1. Plant height (cm) at30, 60, 90 DAS

2. Number of plants in running meter at 30, 60, 90 DAS

3. Dry matter accumulation (g/plant) at 30, 60, 90 DAS

4. Leaf area index 30, 60 and 90 DAS

5. No. of leaves per plant

6. Stem Grith (cm)

4.2 Yield attributes

1. Number of cobs/plant
2. Length of cob (cm)
3. Number of grain/cob
4. Seed index (g)
5. Grain yield (kg/ha)
6. Stubble (kg/ha)
7. Harvest index (%)

4.3 Nutrient content

NPK content in stubble and grain and their uptake by crop

4.4 Soil Analysis

1. pH, EC and Organic Carbon
2. Total available N,P_2O_5 and K_2O (kg/ha) and Ca, Mg, S
3. Bulk density, CEC, Porosity, Dehydrogenase activity
4. Micronutrients Fe, Mn, Zn, Cu,
5. Heavy metals in soil: Hg, Pb, Cr

4.5 Economics

Benefit cost ratio (B:C)

4.6 Statistical analysis

Data generated in the experiment will be analysed as per standard statistical procedures

5. REFERENCES

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