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Effect of Organic and Non-organic Nitrogen Fertilizer Rates on Maize (*Zea-mays.*) in Hadow Center, Fafen Zone, County 05, Ethiopia.

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ABSTRACT

The study was conducted on the effect of non-organic nitrogen and organic fertilizer rates on Maize cultivars (Melkassa-2) production in Hadow center, Shabelley district, fafen zone, SRS, Ethiopia in 2021/22. The experiment was carried on non-organic and organic fertilizer rates for a factorial combination of four levels of inorganic nitrogen (0, 100, 150 and 200 kgha-1) and four organic fertilizer rates (0, 200, 300 and 400 kgha-1) on maize cultivar (melkass-2). The experiment was then laid out in 4X4 factorial arrangements using a RCBD with three replications. Each treatment combination was assigned randomly to experimental units within a block. A 2 m X 2 m (4 m2) plot was used for each experimental unit. The blocks were separated by 1 m whereas the space between each plot within a block was 0.5 m. Different levels of N were applied as Urea (46%N). Animal waste (cow waste) was applied one after the emergency and nitrogen was applied ones at the time of early vegetative growth after 5-6 weeks of planting both as a single application for each. The seeds were planted with spacing of 50 cm and 20 cm between row and plants respectively. The numbers of row in each plot were five rows and the total numbers of plants in each row were 10 plants and the three middle rows were considered for recording the agronomic data. Water application was based on rainfall and supplementary irrigation mainly furrows irrigation as crop water requirement. The data was collected from yield, yield components and related traits consisting of plants' height yield per plant and weight of the total grain. Plant height was measured only once after the plants' vegetative growth. Weight of Yield was measured from five randomly selected plants and converted to mean value and recorded as yield per plot. Total weight of the yield was identified, recorded and then converted into kilograms per hectare. The parameters' data considered in the experiment were subjected to statistical analysis, ANOVA and correlation analyses were performed for selected parameters using SPSS software. Mean comparison and differences were tested following least significant difference (LSD) procedure at alpha level 5%. There is a significance difference among the treatment, the highest productive fertilizer rate is the combination of (200,0kg/ha) of non-organic and organic fertilizer rates respectively with production level of 0.83kg/4m2 or 2,075 kg/ha, although the combination of 100kg/ha and 0 kg/ha was the 2nd most productive. However, the least productive rate was (200,400kg/ha) followed by (0, 0 kg/ha) in this study, So that the recommended fertilizer rate among the different rate in this experimental unit is (200, 0 kg/ha) of non-organic and organic fertilizer rates respectively in Hadow, Shabelley district, Fafen zone, Somali county, Ethiopia.

Key Words: RCBD, DAP, Hadrimout, NPS, ANOVA, Cultivars, Significance, Hectare, SPSS, Grain, Irrigation, Organic

1. Introduction

Maize (zeamaysL.) is belongs to a poaceae family. It was domesticated in mexico or central America around 4000BC, because this area is considered to be the home of Teasinte grass,near relative maize (Hozum,etal.,1998). Early civilization of the America depend on maize production Maize has an extremely wide distribution, the crop is known grown on all contents and has become an important food in many tropical, subtropical and warm temperate countries including most parts of tropical Africa. Maize is widely cultivated throughout the world and a greater weight of maize is produced each year than only other grain(Boswell,2000).Worldwide production was around 8000 million tons from over 150 million hectares in 2007 and nationally more than 3.93 million tons of maize was produced from 1.76 million hectares of land (CIMMYT, 1999). Maize is a robust annual grass up to 4-6m tall. The roots are adventitious root system, developing from the lower nodes of the stem near the soil surface, but a single system sometimes penetrating to depth of over 2m (Monteith, 2000).stem (culms) usually single and solid with inter nodes reaching 20-30cm,leaves are alternate ,simple with pronounced midrib.The leaf sheaths are after lopping ,auricled and liquated. The crop requires an average daily temperature of at least 20 0C for adequate growth and development, the optimum temperature is 25-30. Maize is considered a short

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day plant and follows the C4-cycle photosynthetic path way. It requires 600-1000mm of annual rain falls. A density of 40000 to 80000 plants per hectares assumed to optimum population for maize.

A maize grain is use for three main purposes staple food as feed for livestock and poultry, and as a raw material for many industrial products. The matured maize grain is rich with starch, protein, carbohydrate, dietary fiber, minerals and vitamins. Maize is adapted to a wide range of environmental conditions, but it is essentially a crop of warmer regions(Porter et.al,,2010).The bulk of crop is grown in tropical and subtropical regions. In Ethiopia is under cultivation from 500-400m above sea level (altitudes),it also found the grow even around 2700m altitude for green cob purpose. In Ethiopia the average productivity of maize is about 2.20t/ha/year, this indicated that much lower productive to the world which is 5.53t/ha/year. Maize cultivation under soil conditions in sand soils requires high quantity of nutrients (N and P). So there is a need to develop adequate fertilizer recommendations in order to achieve the level of productivity that could meet the demand of the increasing population in the area. This implies an intensification of the production by addressing the main constraints including farmers' fertilization practices.

Fertilizers may be distinct from liming materials or other non-nutrient soil amendments. Many sources of fertilizer exist, both natural and industrially produced (Karl et al., 2009) for most modern agricultural practices, fertilization focuses on three main macro nutrients: Nitrogen, Phosphorus and Potassium with occasional other supplements like rock dust for micronutrients. Farmers apply these fertilizers in a variety of ways through dry or pelletized or liquid application processes, using large agricultural equipment or hand-tool methods. Synthetic fertilizer application in farming system do have a varied-reaching environmental impacts, according to the Intergovernmental Panel on Climate Change, they expressed that Climate Change and Land, production of these fertilizers and associated land use practices are key drivers of global warming.(Mbow et al., 2020). The use of fertilizer has also led to a number of direct environmental consequences: agricultural runoff which leads to downstream effects like ocean dead zones and waterway contamination, soil micro-biome degradation, and accumulation of toxins in ecosystems. Indirect environmental impacts include: the environmental impacts of fracking for natural gas used in the Haber process, the agricultural boom is partially responsible for the rapid growth in human population and large-scale industrial agricultural practices are associated with habitat destruction, pressure on biodiversity and agricultural soil loss. In order to mitigate environmental and food security concerns, the international community has included food systems in Sustainable Development Goal 2 which focuses on creating a climate-friendly and sustainable food production system. Most policy and regulatory approaches to address these issues focus on pivoting agricultural practices towards sustainable or regenerative agricultural practices: these use less synthetic fertilizers, better soil management (for example no-till agriculture) and more organic fertilizers.

Organic and inorganic fertilization practice is a resource strategic management to achieve economic and sustained farming system. The importance of integrated fertilization practices include pooling and sharing of farm inputs, effective labor management, preservation and use of biomass such as non-conventional fodder and feed, utilization of farm manures, soil health and fertility, income generation activity and improvement in economic status by utilization of underutilized resources in an effective and remunerative manner. Population pressure on land leading to division and fragmentation of land holdings necessitates identification and adoption of suitable farming systems .Integrated fertilizer Farming system approach envisages the integration of farm yard manures and non-organic fertilizers utilization of crops with the main goal of increasing the income and standard of living of small and marginal farmers. The challenge is to upgrade the technological and social disciplines on a continuous basis and integrate these disciplines to suit the region and the farm families in a manner that may ensure increased production with stability and environmentally friendly.

Population in the most tropical countries is pressing hard for producing more food from the limited areas available for cultivation. However, sustainable agriculture can be achieved by seeking the optimal use of internal production inputs in a way which produces an acceptable production rate with a sustainable farming system that provides economically profitable return. Integrated farming system approach is not only a reliable way of obtaining fairly high productivity, but also a concept of ecological soundness leading to sustainable agriculture. Ethiopia is considered as the most populous country in the horn of Africa currently in 2025 G.C., with the population growth rate of over two per cent (2%), the population is increasing year after year. Therefore, the challenge of meeting the basic requirements of this increasing population is a major concern. The green revolution, a follow-up of modern agriculture has helped to solve the problem to a great extent. But the exploitative tendency of modern agriculture aimed at higher production per unit area, by using chemical fertilizers and pesticides is in fact, rapidly degrading the basic production capacity of the ecosystem so nutrients optimization has gained major consideration recently.

During the past few years, in many situations, over exploitation of natural resources initially did have short term gains, but has resulted in degradation of soil fertility and productivity and ecological imbalance. It has created serious problems of salinity, water logging, soil erosion, host of complex pests and diseases, menace and degradation of environment including air and water pollution. Therefore, to maintain the productivity of the land even after harvesting higher crop yields, on a sustainable basis and also to increase the productivity of the land year after year, a sound integrated fertilizers farming system has to be developed. Such an integrated nutrients farming system should have the objective to produce enough to meet the genuine demand and needs of the society, be profitable to the farmer, conserve natural resource base and provide healthy and safe environment in the long run. Considering the large variations that exist in soils, climatic situations in- different locations and economic and social conditions of the farmers, alternate integrated fertilization systems are to be developed (Nadagouda, 2000).

The future of Somali region, Ethiopia agriculture depends heavily on the development of appropriate farming system as applicable to resource poor farm families and as suited to different agro ecological zones. The endowment of abundant sunshine, long growing season, responsive soil types and combination of surface water, ground water and seasonal rains and above all a progressive peasantry, offer vast scope for an intensive farming system through multiple cropping and diversified farming including animal husbandry, forestry, apiculture, fisheries and the like (Patil et al., 2008). Integration of various fertilizers in a farm ensures growth and stability in overall productivity and profitability. It also ensures recycling of residues, optimization of resources, and minimization of risk and generation of employment. Various nutrients that could be included in farming system are organic and inorganic fertilizers. A judicious mix of fertilizers complementary to organic fertilizers and suited to the given farm situation and farmer's preference would bring overall prosperity.

The goals of INFS are maximization of yield of farm to provide steady and stable Income rejuvenation/amelioration of system's productivity - and achieve agro- ecological equilibrium. A void build-up of insect-pests, diseases and weed population through natural cropping system management and keep them at low level of intensity with the optimization use of chemicals. Integrated fertilizers farming system approach as a biophysical and socio-economic capsule has immense potential to address instability of farming, food and nutritional insecurity, vulnerability and poverty of farmers as well as landless laborers. INFS is maintaining farming system in efficiency way by empowering our farming system with organic and non-organic fertilizer production for the crops. Then the Objectives of the study was to improve existing maize farming systems in the specific area and assess their relative viability with organic and non-organic fertilizers. To ensure optimum use and conservation of available resources with recycling farm residues within system, To improve overall profitability of farm household by complementing main allied fertilizers with each other with Development and evaluation of synergic effects and their actions associated with different soil nutrients farming system.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at Hadow center, Shabeley district, Fafen zone. The center is one of the centers in Shabeley districts in fafen zone of Somali Regional State, Ethiopia. It is 570 km from Addis Ababa, the study area lies between 9°35'N latitude and 42°8' E longitude and has an elevation of 1,609 m above sea level (Wudie, 2006). It receives annual rainfall that varies from 500 to 600 mm. The mean monthly minimum temperature varies from 5.8 °C in November to 14 °C from July to September and the mean monthly maximum temperature varies from 25 °C in July to 29 °C from March to April (Wudie, 2006). Unlike other parts of the region, the rainy season (GU) in the shabeley district has Dira' three sub seasons: (April - May), Hagaa (June - July), and Karan (August - September) all of which are equally important for cultivation of crops; availability water and pasture for livestock. Furthermore, the dr y season, Jilaal (October - March) is divided into two sub seasons: Deyr (October - November) and Kalil (December-March) (Devereux, 2006). Vegetation cover consists of various acacia species, bush trees and grasses which form the life-sustaining resources for local Somali pastoralists and agro pastoralists. The farming system in the study area is agro pastoral system (SCF-UK and DPPB, 2001). The prevailing agricultural system is the pastoral farming system.

2.2. Experimental Materials, Treatments and Design

Maize (malkessa. 2) cultivar seed was used in this study for a factorial combination of four levels non-organic fertilizers of urea (0, 100, 150 and 200 kgha-1) and four levels of organic fertilizer of animal waste (0, 200, 300 and 400 kgha-1) with three replications. The different levels of animal dug (wastes) were applied as a single after the germination of seeds and nitrogen was applied 5 to 6 weeks after planting as single application as well. Each treatment combination was assigned randomly to the experimental units within a block. A 2 m X 2 m (4 m2) plot was used for each experimental unit. The blocks were separated by 1 m whereas the space between each plot within a block was 0.5 m. The seeds were planted with spacing of 50 cm and 20 cm between row and plants respectively. The number of rows in each plot was five rows and the total numbers of plants in each row were 10 plants. The three middle rows were considered for agronomic data collection or recording. Water application was based on combination of rainfall and supplementary irrigation (furrow), weeding and Pesticides application were applied based on the crop requirement during the experiment.

2.3. Agronomic Data Collection

Data on yield, yield components and related traits consisting of days to emergence, plants height, Days to maturity, yield per plot and weight of total yield was collected. Days to emergence was recorded when approximately 75% of the plants were emerged, Days to maturity was recorded when 90% of the plants were matured. Plant height measurement was done only ones after the plants' vegetative growth. Plant height and yield per plot measurement was done from five randomly taken plants and then the plants' yield (Biomass) and plant height were calculated as plant height and plant biomass weight per plot. Total weight of the yield was determined and recorded and then converted into kilograms per hectare (kg/ha).

2.4. Statistical Analysis

The data collected was subjected to statistical analysis. ANOVA and correlation analyses were performed for selected parameters using SPSS software. Mean comparison and differences were performed following least significant difference (LSD) procedure at alpha level of 5%. Interpretations and insertion of data into graphs were also performed.

3. Results and Discussion

Effect of organic manures and inorganic nitrogen fertilizer rates on plant's growth, development and crop yield has shown great impact on maize cultivar (melkassa-2). The combination of organic and inorganic nitrogen fertilization has shown high significance in plant's response in terms of plant height and biomass productivity as shown below. Even though the response of the crop to varied fertilizer rates have performed well but the combination of inorganic and organic fertilizer rates of (0,300 kg/ha) had the highest plant height with 3.43 m and the most productive rate was the combination of (200, 0 kg/ha) with an average production of 0.83kg/4m2 or 2,075kg/ha of the seeds separated from pod and cob.

3.1. Plant Height

Maize response's growth was highly significant at (P0.05) due application of nutrients into the plants, the maximum plant height was obtained from (0,300 kg/ha) fertilizer rate as shown below graph.1, Maize crop plants needs sufficient and adequate fertility for development and increased or improved production system, According to (Law-Ogbomo and LAW-OGBOMO, 2009). Nutrient doses were less effective at the some combinations than at other levels that show the need for an optimum rate of organic and inorganic element in studied area. (Fashina et al., 2002) expressed that the availability of efficient development nutrients resulted in enhanced overall activities, advanced cell multiplication, enlargement and luxuriant growth and also increased dry matter biomass productivity. Plant's height has shown its potential positive effect on the yield production as the second highest average plant height was the most productive rate in the trail. (F, 2004) expressed that artificial or inorganic fertilizer applications exerted a strong impact on developmental, improvements and yield production of maize. The effect of nutrient application was occasionally observed in plant's height as clearly stated in the below graphs. There was variation among the doses for the plant height of Melkass-2 as nutrient supply had promoted the plant growth, According to this study 200, 400kg/ha had produced and performed with the lowest plant height when compared to the all other experimental units followed by (0,0 kg/ha).

3.2. Plant Yield

The Maize variety plants have shown high significance difference between the applications of fertilizer rates on the

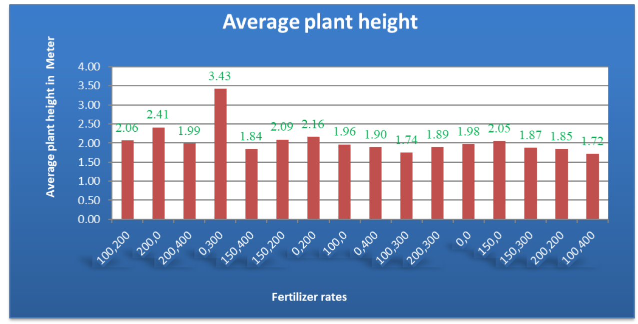

Figure 1: Average plant height

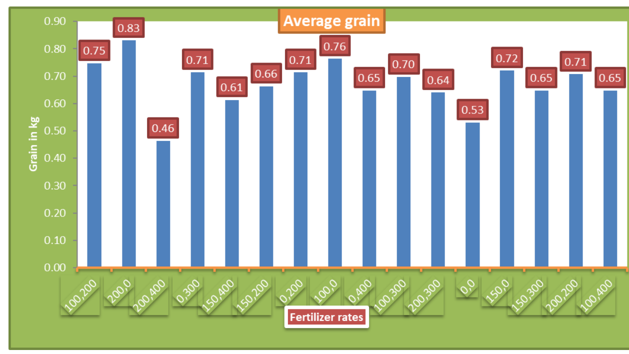

Figure 2: Average grain

maize cultivar (melkassa-2). The response of the crop to supplied nutrients shows how an optimized and effective fertilizer application can stimulate and increase the crop's productivity. (Adediran and Banjoko, 2003) expressed that maize cereal crop inhibited to perform higher production in areas with no or limited nutrition. The declined or at decreased fertility status of most tropical soils fails maize farming production system as such soils have a steadfast exhausting impact on the soil factor. The most productive fertilizer rates is (200, 0kg/ha) followed by (100, 0kg/ha) and (100, 200) kg/ha of non-organic and organic fertilizer rates. Though there was some well performing fertilizer rates in this experiment but the above mentioned were highest performing applied rates. (Adediran and Banjoko, 2003) observed that lower NPK fertilizer application results declined grain yield in the farming system

3.3. Plant Height and Yield

The response of the crop for fertilizer rates was varied with the different fertilizer rates and accordingly the highest yield was obtained from the combination of inorganic and organic fertilizer rates of (200, 0 kg/ha) respectively. However, the highest height plant was not obtained from the most productive treatment but it was the 2nd highest in terms of plant height because the highest plant height was observed from (300, 0) kg/ha of organic and non-organic fertilizer rates respectively.

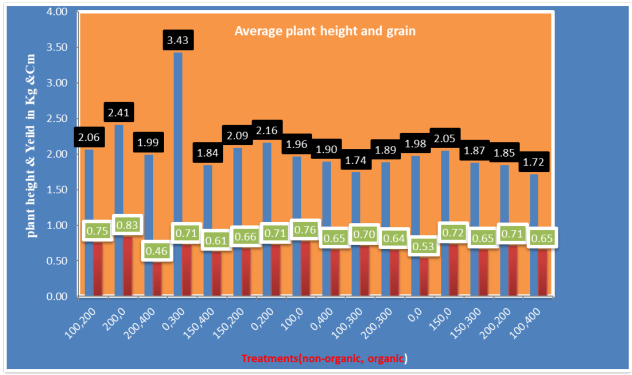

Figure 3: Plant height & yield in kg & cm

That shows the productivity of the crop was not highly dominated by the plant height however as shown in the above graph the plants' productivity was higher in some fertilizer rates and regardless of its influence on the plant height the plants response in terms of yield production was also varied.

4. Conclusion and Recommendations

Crop production improvement and modification of the agronomic practices with the latest and modern techniques is a way to solve the basic needs requirement of the highly increasing population in the world, Ethiopia as well as in Somali County of Ethiopia and in the Hadow centre of Shabelle district.

The effective and improved agronomic practices of maize has been an influential in the maize production system however, neither over nor under is needed for exploitive or as a limiting factor for the limited available resources in the production system. So that the impact of nitrogen fertilizer rates on maize was to be evaluated and the fertilizer application was productive compared to zero fertilizer rates in Hadow centre, even-though the variation among fertilizer rates was different. The fertilizer application has huge significance in both plants growth and crop's yield to smoothen and increase crop's productivity as an appropriate and optimized application rate was needed as it was seen in the result as that an over and under both hinders and inhibits the productivity of the crop in the selected area. Effective fertilizer rate in all forms stimulate the quantity and quality of the maize cropping system in the selected area although proper and better agronomic practices can enrich and generate stable and eco-friendly production system through a sustainable farming system.

The maize (Melkass-2) cultivar was subjected to eight different doses and the response of the plants was significant and varied from fertilizer rate to rate. The plant height performance was influenced by the different types of fertilizer rates though the highest yield and 2nd highest plant height was observed from the combination of 200, 0 kg/ha which means 200kg/ha and 0kg/ha of non-organic and organic fertilizer rates respectively. Even-though there were a fertilizer rate of 0,300kg/ha of non-organic and organic fertiliser rates with the highest plant height of 3.43 meters it did not perform well in the yield production compared to the most productive rate as mentioned in the graph.2 and 3.

Fertilizer rates were effective and productive however the level of production was different and Hadow centre maize growers/farmers can use both non-organic and organic fertilizer rates for maize production in the area particularly the highest performing combination of non-organic fertilizer rate of 200kg/ha and 0kg/ha of organic fertilizer rate with production level of 0.83kg/4m2 or 2,075 kg/ha which is in the range of average production level of maize in Ethiopia which is in the range of the average production rate of 3000kg/ha. Even-though 2nd most were (200, 0 kg/ha), (100, 0kg/ha) and the least 1st was (200,400kg/ha) followed by (0, 0 kg/ha) of non-organic and organic fertilizer rates respectively.

Conflict of Interest

Authors declare that there is no conflict of interest involved in publishing this research paper.

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