**INTERNSHIP REPORT**

**EFFECT OF FOLIAR APPLICATION OF NITROGEN IN N-STATUS OF MAIZE**

**By**

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**FAISALABAD**



**DEDICATION**

**Dedicated To**

**THE HOLY PROPHET MUHAMMAD**

**(P.B.U.H.)**

The greatest Social Reformer & A Model for Mankind

&

**My Worthy Parents**

Whose affectionate attitude, dexterous Guidance and Moral support inspired me to get on higher ideals of life

&

**TEACHERS**

Who guide me at each and every step during my studies

**CERTIFICATE**

It is certified that I am supervisor of **Aroma Shafiq** D/O **M. Shafiq** registration No. **2014-ag-5139** has gone through the content of this internship report submitted by her and this report is accepted in its present form.

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**ACKNOWLEDGEMENT**

**Hazrat Muhammad (SAW)** said:

***“A person, who is not thankful to his benefactor, is not thankful to Allah”.***

All praises and thanks for the **Almighty Allah**, the benevolent and the merciful. May Allah shower His mercies and blessings upon the **Holy Prophet Hazrat Muhammad (SAW),** whose life is guidance for us in all the tasks of life.

I express my prideful feelings of gratitude and indebtedness to my venerable external Supervisor **Miss Raheela Naz** and **Miss Farah Rasheed** for their sympathy attitude, fatherly behaviour and enlightened supervision throughout course of study and preparation of this manuscript.

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**INTRODUCTION OF AARI**

Ayub Agriculture research came into being in 1962 on the bifurcation of Punjab Agriculture College into separate teaching and research establishment. The institute has undergone evolution to build up human capabilities, which has played a vital role in boosting research efforts to meet the needs of increasing population and accelerated industrial needs, and serve farming community.

**OBJECTIVES**

The main objectives of the institute are:

1. Genetic improvement of crop varieties.
2. Development of production technology.
3. Introduction of new industrial and food plants.
4. Preservation / processing of agricultural products.
5. Farmer’s advisory service.

**SOIL CHEMISTRY SECTION**

Chemistry section (soil) came into existence along with the establishment of Punjab Agricultural College and Research Institute Lyllpur in (Faisalabad) 1907, initially with limited objectives of determining nutritional requirements of various crops. Later on research activities of section continued to expand both in scope and dimension and changed according to the needs of the time with the result that the present Biochemistry Section (1954), Soil Bacteriology Section (1975), Soil Testing Institute (1968), and Soil Independent Units, thus it is so to say mother section of all the present disciplines of agricultural chemistry under the control of the Director General agri. (research), Ayub Agricultural Research Institute, Faisalabad

**ACHIVEMENTS**

* Standardization of recommendations of fertilizers for different crops.
* Long term effect on physical and chemical properties of soil.
* Consumptive use of water for different crops.
* Management of poor quality subsoil water for irrigation.

**CHAPTER NO 1**

**INTRODUCTION**

Agriculture is the lifeline of Pakistan’s economy accounting for 19.5 per cent of the gross domestic product, employing 42.3 per cent of the labour force and providing raw material for several value-added sectors. It thus plays a central role in national development, food security and poverty reduction. The important crops (wheat, rice, sugarcane maize and cotton) account for 23.85 per cent of the value added in overall agriculture and 4.66 per cent of GDP. Maize contributes 2.7 per cent to the value added in agriculture and 0.5 per cent to GDP. Maize crop production stood at high record of 6.130 million tonnes during 2016 showing a major increase of 16.3 per cent over the last year’s production of 5.271 million tonnes (Economic survey of Pakistan,2016-17).

Maize (Zea mays L.) belongs to family Gramineae. It is the most important crop among cereals after wheat and rice in respect of area and production. Maize grain contains starch (72%), protein (10%), oil (4.8%), fibre (5.8%), sugar (3.0%), and ash (1.7%). Soil and climatic conditions of Pakistan are ideal for maize production. The use of maize in Pakistan for direct human consumption is declining, but its utilization in the feed and wet milling industry is growing at a much faster pace than anticipated. A number of factors are responsible for the low yield of the crop. Inappropriate crop nutrition management and poor soil fertility are the most important factors responsible for low yield (Anonymous. 2006).

Nitrogen plays an important role in crop growth and yield. It is highly associated with dark green colour of stem and leaves, vigorous growth, branching, leaf production and size enlargement. Nitrogen (N) occupies a conspicuous place in plant metabolism system. All vital processes in plants are associated with protein, of which nitrogen is an essential constituent. Consequently to get more crop production, nitrogen application is indispensable and unavoidable (Arshad., 2003).

Nitrogen plays a key role in agriculture by increasing the crop yield (Massignam., 2009). Nitrogen not only enhances the yield but also the food quality(Muhammad Anwar *et al.,* 2010). Optimum rate of N increases the photosynthetic processes; leaf area and total leaf biomass of plants are a determinant of higher crop yield. Since the previous fifty years, the yield of various crops increased globally due to maximum use of nitrogen along with good management (Muhammad Ashraf *et al.,* 2009).

All plants including cereals, oilseeds, fibre, and sugar producing and horticultural require a balanced amount of nitrogen for vigorous growth and development processes(Smil, 2001). Nitrogen plays a most important role in various physiological processes. It imparts dark-green colour in plants, promotes leaves, stem and other vegetative part’s growth and development. Moreover, it also stimulates root growth. Nitrogen produce rapid early growth, improve fruit quality, enhances the growth of leafy vegetables, increases protein content of fodder crops; It encourages the uptake and utilization of other nutrients including potassium, phosphorous and controls overall growth of plant (Bloom .A.J., 2015).

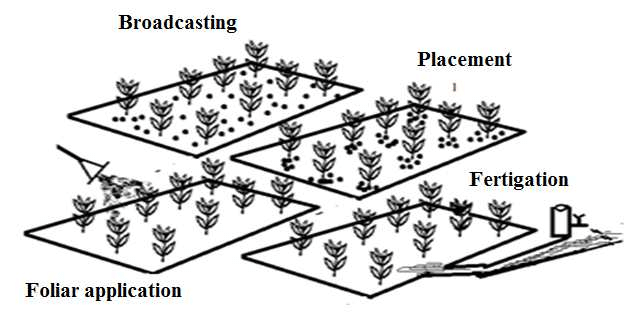
Deficiency of nitrogen causes reduced growth, appearances of chlorosis (changing of the green colour into yellow colour of leaves), and appearances of red and purple spots on the Leaves restrict lateral bud growth (from which leaves stem and branches develop), proper management of N for crop is essential. N must be applied before soil test and after analysis reports, the suggestions should be gathered from agricultural experts for right quantity application of nitrogen and its methods (A. Hemerly., 2016).

Fertilization is an important factor in the maize production technology to achieve optimum yield and quality of grains. Foliar feeding is a method of fertilizing plants directly. It involves directly spraying nutrients onto the plants leaves and stem where they are absorbed and used. It is considered an almost immediate way to feed your plant (Amanullah *et al.,* 2013).

The conventional practice of application of N has been replaced with the help modern techniques like, Fertigation and flooded application technology of nitrogenous fertilizer in addition to foliar application and so forth. The latest techniques of N applications significantly minimized the risk of N losses and enhanced its uptake by the plant Foliar fertilization is an agricultural practice extensively used to increase yield and quality of various crops. Foliar application has proved to be an excellent method as supplementing N-P-K needs (R.Venkitaswamy *et al.*, 2016).

Different methods of nitrogen application are used like Broadcasting method, Placement method, Fertigation method, foliar method. Broadcasting method refers to spreading nitrogen uniformly all over the field. Suitable for crops with dense stand, the plant roots permeate the whole volume of the soil; large doses of nitrogen are applied. Placement methodrefers to the placement of nitrogen in soil at a specific place with or without reference to the position of the seed. Placement of nitrogen is normally recommended when the quantity of nitrogen to apply is small. The nitrogen is thus carried into the soil in solution. In Foliar Nitrogen fertilizer is dissolved in water or liquid N is applied on foliage (Vegetative parts) of plants. Foliar application of N is discovered significant for maximizing of crop yield by enhancement of plant growth and development. In this method, sprayers are commonly used (Alagappan, S. *et al.,* 2016).

The objective of the present study was planned to use the nitrogen foliar fertilizer to enhance the nitrogen use efficiency by maize. It was hypothesized that use of foliar nitrogen may increase nitrogen concentration in maize crop.

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**CHAPTER NO 2**

**REVIEW OF LITERATURE**

Foliar fertilization facilitates the rapid absorption of mineral elements; it can be performed throughout the growing season particularly during peak periods of nutrients demand without interaction with the soil components, precipitation, adsorption onto soil surfaces or risk of loss by erosion (Fernandez and brown, 2013).

Application of foliar fertilizer is an effective way of correcting soil nutrient deficiencies when plants are unable to absorb them directly from the soil. Foliar applied fertilizers provide a quicker response and are more effective for some nutrients than soil applied fertilizers. Chemical residues in the soil and its subsequent ground water pollution as a result of excessive use of fertilizers can be resolved by the use of small amounts of foliar applications to increase growth and yield in wheat. The use of both foliar and soil application of NPK have been found to increase grain yield in maize and pods/plant, seeds/pod and seed weight in lentil. Foliar nitrogen significantly increased the vegetative growth of the plants (H. Asumadu *et al.,* 2012).

Singh *et al.* (2005) checked the foliar application of nitrogen causes a tremendous increase in yield of crops. Significant increase in maize grain yield had achieved when a supplemental dose of 7 kg N ha-1 as urea spray was applied. Woolfolk *et al. (*2002) reported that Foliar N application, late-season, showed significant effect on yield, total grain N and straw yield of maize. Amanullah *et al.* (2010) reported significant effects of foliar application of nitrogen on phenology, growth and yield of maize. They concluded that 6% urea application as foliar spray increased yield and yield components of maize.

Amanullah *et al.* (2010) reported that our earlier study showed that late application of foliar urea at stage when (ear shoots were formed just before tassel formation) significantly increased grain yield in maize due to improvement in the yield components. Singh *et al.* (2005) suggested that a supplemental foliar application of urea at 7 kg N ha-1 significantly increased maize grain yield that the increase in grain yield with urea application at the V12 stage might be due to the extended growth period, increase in grain weight and number of grains per ear that probably may have resulted in higher harvest index in maize.

The foliar fertilizer can get directly to the place of use, the leaf cells and can act immediately without the mediation of the soil. Nutrient uptake can be sustained even in drought, with little water. Under ideal conditions, the nutrient utilization might reach 100% (Peter Jakab and Levente Komarek, 2017). Foliar fertilizer products might be suitable to improve the crop-forming elements and the amount of the yield. When applying these fertilizers, yield stability can be increased and they might affect the nutrient parameters as well (Jakab *et al.,* 2014).

Foliar fertilization is an agricultural practice of increasing importance in practical terms. In theory, application of nutrients sprays may indeed be an environmental friendly fertilization method since the nutrients are directly delivered to the plant in limited amounts, thereby helping to reduce the environmental impact associated with the soil fertilization. However, response to foliar sprays is often variable and not reproductive due to the exciting lack of knowledge of many factors related to the penetration of the leaf applied solution (Dimka Haytova, 2013).

Foliar applied nutrients are absorbed not only by the leaves but a small amount is also absorbed through woody cambium tissue of the bark. The research also proved that foliar fertilization is 8-20 times more effective compared to soil application, in terms of the amount of nutrients were absorbed and utilized in the plant metabolism (Phandis, 2010).

Chauhan *et al*. (2004) studied that foliar application of N was also an effective and economic method for improvement of quality characteristics of plants). Sangoi *et al,* (2007) stated that Likewise, splitting N at different growth stages could also be beneficial in increasing the grain yield of maize hybrid.

Li. (2007)reported that among the limiting factors; proper level and ratio of N are of prime importance. Foliar application of N could increase crop productivity many fold under moisture stress condition. Foliar spray not only provided the nutrients but can also provide a significant amount of water in the time of water stress. In addition to supplying a nutrient for plant growth, N application could enhance drought tolerance of plant to increase yield under water deficit. Research showed that Nitrogen application during grain filling could enhance the remobilization from stored carbohydrates in vegetative organs to grain under moderate water stress (WS), which might benefit starch synthesis and grain yield formation under post-anthesis drought. Dixon. (2003)stated that Foliar-applied N can be up to seven times more efficient than soil applied N.

Singh *et al*. (2005) reported the other benefits of foliar applied N include lower application rates (higher efficiency), plus the relative ease of obtaining timely, uniform applications. A combination of soil-applied and foliar applied N is the best management practice to reduce the efficient alternative for feeding N to plants. The tendency for nitrate to move below the root zone and eventually to groundwater was being significantly reduced with foliar applied Nitrogen. A supplemental dose of 7 kg N ha−1 as urea spray significantly increased maize grain yield. Foliar applications of urea to the chlorotic leaves of N-deficient maize restored both normal chlorophyll content and stomata behaviour of leaves.

The effect on growth and yield of common bean as influenced by different nutrients treatment was studied at Hazara University, Mansehra (Pakistan) on soil having pH 6.4 and EC 0.17 ds m-1. They reported that foliar spray of NPK 20:20:20 significantly increased numbers of pods/plant (2.5), number of seeds/pod (3.7) and number of seeds/plant (8.6) in common bean (Rehman *et al.,* 2014).

Foliar spray of 10 kg KCL m-3 and 10 kg urea m-3 from the jointing stage of both corn and wheat to silking of corn and the full heading stage of wheat increased the N & K content in the plants and stimulated translocation to the grain increasing the protein content of wheat and corn grain by 15 and 4.9 g kg-1, respectively (Xu *et al*., 1999).

Amir Zaman khan *et al*. (2013) investigated that the response of maize (Zea mays L) to foliar application of nitrogen (2%) from different sources viz. urea, ammonium sulphate and calcium ammonium nitrate and its application time [15, 30, 45, and 60 days after emergence (DAE). It was concluded from the results that late foliar-N application (urea & AS) about one week before tasseling up to silking could increase maize productivity in the study area.

Hussain *et al.,* (2016) Disturbances in water balance in plants lead to impaired functioning of different gas exchange attributes, ultimately resulting in reduced plant growth. Under such conditions supplementary foliar application of N & K at the rate of 0.5 % N & K was found highly effective in ameliorating the adverse effects of water stress on gas exchange characteristics. Foliar spray of fertilizers partially minimized the nutrients deficiency in plants, increased photosynthesis related parameters. It can be concluded that N & K foliar supplementation @ 0.5 % each is effective in improving photosynthetic activity/ gas exchange characteristic under both normal and water stressed environments in sunflower plants.

Zhang *et al.,* (2009) two contrasting maize cultivars, i.e. 'Shaandan 9' (S9) and 'Shaandan 911'(S911) were investigated by examining foliar nitrogen modulation of N metabolism, water status and plant growth under short-term moderate water stress (SMWS). The results showed that these positive effects were more pronounced in S911 than those in S9 during SMWS. Greater correlations were performed amongst all parameters under SMWS than control. Hence, we suggest that foliar N should be firstly applied to drought sensitive cultivars under drought. Foliar fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots (Shaaban, 2001).

Ali Hassan Jassim *et al.* (2016) reported that foliar fertilizer led to increase vegetative growth and dry matter. Field experiment was conducted to study the effect of spraying three levels of urea spraying (control, one time at silk stage and two times at the silk stage and grain filling stage). Randomized complete block design with three replications was used. The results showed Spraying urea also led to significant increases in plant ear no. and grain yield, with a percentage increase of 11.7 and 4.9% and 6.1 and 5.4% at spraying one time and two time respectively compared to control. Spraying urea twice time led to significant increases in ear weight (about 6.9%) and 500 grain weight compared to control.

Seadh, S.E. *et al*. (2015) conducted a study in order to determine the effect of foliar fertilization and mineral nitrogen fertilizer levels on growth, yield and its components and grains quality of maize hybrid. Two field experiments were carried out at the Experimental Station Farm, Faculty of Agriculture, and Mansoura University, Egypt. It can be concluded that foliar fertilizing maize hybrid with the mixture of GA3 at the rate of 50 ml + AA at the rate of 500 ml + YE at the rate of 2000 ml/200 litre water/fed three times after 30, 37 and 44 days from sowing in addition mineral fertilizing with 96 kg N/fed in order to maximize productivity and grains quality and reduce production costs and environmental pollution.

Afifi M.H.M *et* al. (2011) conducted a study in which two field experiments were carried out during the two summer seasons of 2007 and 2008 seasons. The objective was to investigate response of growth, yield, and yield components and nutrients uptake of three maize cultivars. The results showed that urea foliar application significantly increased growth yield and yield components of maize varieties as compared with unsprayed treatment in both seasons and the highest values were obtained from 100% of recommended rate of soil-applied nitrogen fertilization with all varieties.

S. Iqbal *et al.,* (2013) conducted a study to check the effect of different nitrogen management methods on yield, yield components and quality attributes of maize hybrids under irrigated conditions. Results showed that plant height, cob diameter, number of grains per cob, grain yield and biological yield were significantly affected by the hybrids.

**Chapter No. 3**

**MATERIAL AND METHODS**

**BASIC ANALYSIS**

**Soil Analysis**

The following parameters were determined for soil samples:

1. pH

2. EC

3. Soil Organic Matter

4. Soil Extractable Phosphorous

5. Soil Extractable Potassium

6. Soil Sulphur

7. Plant Nitrogen

8. Plant Potassium

9. Plant Phosphorous

1. **PREPARATION OF SOIL SATURATED PASTE**

For soil saturated paste, 200 g of air dry soil was taken in a plastic beaker; distilled water was added and left the sample overnight. After leaving the sample overnight, it become homogeneous and was easy to mix. Next day mixed the soil samples with a spatula until an ideal soil paste was prepared. The soil paste should meet the following criteria.

• It should glisten.

• It should slide freely of the spatula.

• No free water should stand in depression.

1. **DETERMINATION OF SOIL pH**

* **Apparatus:**

1. Plastic beaker

2. Spatula

3. pH meter

* **Reagents:**

Buffer solutions of pH 7.0

* **Procedure:**

I connected the pH meter with electricity source. Then allowed it to warm up as per operating instructions of the model. After that I took the known standard buffer solution (pH 7.00) in the beaker and immersed the glass electrode, adjusted the reading of the pH meter to the same value as the pH of the buffer solution. Removed electrode and cleaned it with D.I water. Repeated the above procedure once more. Washed the electrode with D.I water. Then I put the electrode into saturated soil paste and note the reading .After that I washed the electrode.

**3. DETERMINATION OF SOIL ELECTRICAL CONDUCTIVITY**

The following method was used to measure the EC of soil.

* **Apparatus:**

1. Suction pump

2. Plastic beaker

3. Conductivity meter

* **Procedure:**

With the help of suction pump extract was obtained from saturated soil paste. After that calibrated the EC meter with the help of 0.01N KCl and determined cell constant. After calibrating the EC meter, immersed the electrode into the extract and measure value. Then washed the electrode before taking reading of next sample.

Cell constant was calculated by the formula:

K = 1.4118(dS m-1)/ EC of 0.01 N KCl

**4: DETERMINATION OF SOIL ORGANIC MATTER**

* **Reagents:**

**A.** Potassium dichromate (K2Cr2O7)1N

• Dry Potassium dichromate in an oven at 105oC for 2 hour and then cool in a desicator

• Dissolved 49.09 g potassium dichromate in 1L distilled water to prepare 1N solution of potassium dichromate

**B.** Concentrated Sulfuric acid (98%, Sp. gr. 1.84)

**C.** Concentrated phosphoric acid (H3PO4)

**D.** Ferrous Sulfate (FeSO4) 0.5 M

• Dissolved 196 g ferrous sulfate in distilled water and transferred it to 1 L volume after adding 5 mL Conc. Sulfuric acid.

**E.** Diphenylamine indicator

• Dissolved 1 g diphenylamine in 100 ml concentrated sulfuric acid.

• Shake it vigorously. After 30 minutes add 175 ml distilled water

* **Procedure:**

Took 1 g soil sample in a receiver. Add 10 ml potassium dichromate in it and shake it .Then add 20 ml concentrated 10 ml phosphoric acid in it and shake. Then add 5-10 drops of indicator it and titrate it against 0.5 M ferrous sulfate up to greenish end point. Also run a blank.

* **Calculations:**

**Oxidizable carbon %** = Blank - sample x 0.3 x 0.5/ weight of soil taken

**Total Organic carbon (%)** = % Oxidizable carbon x 1.35

**Organic matter (%)** = Total organic carbon % x 1.724

**5: DETERMINATION OF SOIL EXTRACTABLE PHOSPHOROUS**

* **Reagents:**

**A.** Sodium Bicarbonate, 5 N

• Dissolved 200 g sodium bicarbonate in distilled water, and transfer the solution to a 1L volumetric heavy walled Pyrex flask, let it cool, and bring to volume with distilled water, and adjust pH 8.5 with 5N NaOH.

**B.** Sulfuric Acid Solution (H2SO4) 5 N

• Dilute 148 mL con. Sulfuric acid (in fume hood) with distilled water, mix well, let it cool, and brings to 1L volume with distilled water.

**C.** Standard stock solution:

• Dry about 2.5 g potassium dihydrogen phosphate (KH2PO4) in an oven at 105 OC for 1 hour, cool in desiccator and store in an airtight bottle.

• Dissolve 2.197 g dried potassium dehydrogenase phosphate in DI water and bring to 1L volume with DI water.

• Dilute 50 mL stock Solution to 250 mL final volume by adding DI water. This solution contains 100ppm P (Diluted stock solution).

• Prepare a series of standard solution from the diluted Stock Solution follows: Dilute 5, 10, 15, 20 and 25 mL Diluted Stock Solution to 500 mL volume. These solutions contain 1, 2, 3, 4, and 5 ppm P respectively.

**D. Reagent A:**

• Dissolved 12g ammonium heptamolybdate in 250ml distilled water.

• Dissolved 0.2908 g antimony potassium tartrate in 100 mL distilled water

• Add both dissolved reagents to 2L volumetric flask and add 1L 5 N H2SO4 to the mixture. Mix thoroughly and dilute to 2L volume with distilled water.

**E. Reagent B:**

• Dissolved 1.056 g L-Ascorbic acid (C6H8O6) in 200 mL Reagent A, and mix. This reagent should be prepared as required because it cannot be kept for more than 24 hours.

* **Procedure:**

Weigh 2.5 g air dry soil (2 mm) into a 250 ml Erlenmeyer flask; add 50 ml 0.5 M sodium bicarbonate solution.

**a)** Close the flask with a rubber stopper and shake for 30 minutes on a shaker at 200 – 300 rpm. Include one flask containing all chemicals but no soil (Blank).

**b)** Filter the solution through a Whatman No. 41 filter paper and pipette 10 ml clear filtrate into a 50 ml volumetric flask.

**c)** Add distilled water to about 40 ml volume, add 8 ml Reagent B, and bring to 50 ml volume.

* **Prepare a standard cure as follows:**

• Pipette 2 mL of each standard (1-5 ppm), and proceed as for the samples.

• Also make a blank with 10 ml 0.5 M NaHCO3 solution, and proceed as for the samples.

• Read the absorbance of Blank, standards and sample after 10 minutes at 882 nm wavelengths.

• Prepare a calibration curve for standards, plotting absorbance against the respective P concentrations

• Read P con. In the unknown samples from the calibration curve.

* **Calculations:**

**Extractable P (ppm)** = ppm P (from calibration curve) x Ax 50/ wt xV

Where,

**A**= Total volume of the extract (ml)

**Wt** = Weight of air dry soil (g)

**V** = Volume of extract used for measurement (ml)

1. **DETERMINATION OF SOIL EXTRACTABLE POTASSIUM**

* **Reagents:**

**A.** Ammonium Acetate Solution (NH4OAc), 1N

• Add 57 mL concentrated acetic acid (CH3COOH) to 800 ml DI water, and let the mixture cool.

• Adjust to pH 7.0 by adding more acetic acid or ammonium hydroxide, and bring to 1L volume with distilled water.

**B.** Standard Stock Solution:

• Dry 3g potassium chloride (KCl) in an oven at 120 oC for 1-2 hours and cool in a desiccator and store in a tightly stoppered bottle

• Dissolved 1.907 g dried potassium chloride in DI water and brings to 1L volume with DI water. This solution contains 1000ppm K (Stock Solution).

• Prepare a series of Standard Solutions from the Stock Solution as follows: Dilute 2, 4, 6, 8, and 10 ml Stock Solution to 100 ml final volume of each by adding DI water or 1 N ammonium acetate solution. These solutions contain 20, 40, 60, 80 and 100ppm K, respectively.

* **Procedure:**

Weigh 2.5 g air dry soil (< 2 mm) into a 50 mL centrifuge tube, add 50 mL ammonium acetate solution and shake for 5 mints. On a shaker. The tubes should be stoppered with a clean rubber or polyethylene stopper, but not corks, which may introduce errors.

Centrifuge until the supernatant liquid is clear and collect the extract in a 100 mL volumetric flask through a filter paper to exclude any soil particles. Repeat this process two more times and collect the extract each time.

Run a series of suitable potassium standards, and draw a calibration curve.

Measure the soil extractable potassium by feeding soil extract directly to flame photometer.

**7: DETERMINATION OF SULPHUR IN SOIL**

The commonly used method for s determination in alkaline soils is the extraction of SO4-S with 0.15% CaCl2.2H2O and measurement of SO4-S concentration in the extracts by a turbid metric procedure using barium chloride. A critical range of 10-13 mg/kg CaCl2-extractable SO4-Shas commonly been reported for the cereal (wheat, maize), oil seed (mustard), and crops.

* **Apparatus:**

Mechanical Shaker

Spectrophotometer or colorimeter

* **Reagents:**

**1.** Calcium Chloride Dehydrate Solution (CaCl2.2H2O), 0.15%

* Dissolve 1.5g CaCl2.2H2O in about 700mL DI water and bring to 1L volume

**2.** Hydrochloric Acid Solution (HCl), 6M

* Dilute 496.8mL concentrated HCl (37% sp.gr. 1.19) in DI water, mix well, let it cool, and bring to 1L volume

**3.** Barium Chloride (BaCl2.2H2O), Crystal

**4.** Sorbitol, 70% Aqueous Solution

* **Standard Stock Solution**:

Dissolve 0.5434g potassium sulfate (K2SO4) in DI water, and bring to 1L volume. This solution contains 100ppm SO4-S (Stock solution)

Prepare a series of Standard Solutions from the Stock Solution as follows:

Dilute 5, 10, 20, 30, 40 and 50mL Stock Solution to 100mL numbered flasks by adding 0.15% calcium chloride dehydrate solution, and then bring to volume. These standards contain 5, 10, 20, 30, 40 and 50ppm SO4-S respectively.

* **Procedure:**

**1. Extraction:**

* Weigh 5g air dried soil (2mm) into a 150mL Erlenmeyer flask.
* Add 25mL 0.15% CaCl2.2H2O solution (Do not use a rubber stopper, or wrap the rubber stopper in thin polythene. Errors result from gradual oxidation of S compounds present in the stopper).
* Shake for 30 minutes on a reciprocal shaker (180+ oscillations per minute).Filter the suspension through Whatman No. 42 filter paper. This procedure yields almost colourless extracts

**2. Measurements:**

* Pipetted 10 mL aliquot of the extract into a 50mL test tube, or a smaller aliquot diluted to 10mL with DI water.
* Added 1mL 6M HCl solution followed by 5mL 70% sorbitol solution from a pipette with an enlarged jet.
* Added about 1g BaCl2.2H2O crystals (using a measuring spoon).
* Shake vigorously (on a test tube shaker for 30 seconds) to dissolve the BaCl2.2H2O and obtain a uniform suspension.

**3. Prepare a standard curve as follows:**

* Pipette 10mL of each standard (0-50ppm), and proceed as for the samples.
* Also make a blank with 10mL 0.15% CaCl2.2H2O solution, and proceed for the samples.
* Read the absorbance (turbidity) of the blank, standards and samples on the Spectrophotometer at 470-nm wavelength.
* Prepared a calibration curve for standards, plotting absorbance against the respective SO4-S concentrations.
* Read SO4-S concentration in the unknown samples from the calibration curve
* **Calculations:**
* Soluble SO4-S (ppm) = ppm SO4-S (from calibration curve)x V/w.

Where,

**V=** Total volume of soil extract (mL)

**Wt=** Weight of air dry soil (g)

**8. DETERMINATION OF PLANT NITROGEN**

* **Reagents:**

**A.** Digestion Mixture (K2SO4: CuSO4. 5H2O: Se) 100: 10:1w/w ratio. The reagent grade chemicals were grind separately and then mixed for the preparation of digestion mixture.

**B.** Concentrated Sulfuric acid (98%, Sp.gr.1.84)

**C.** Sodium hydroxide (NaOH) 40 % 400 g NaOH was taken in 1L capacity beaker and made volume up to the mark for the preparing 40 % NaOH solution.

**D.** Boric acid 4% 40 g boric acid was dissolved in 1L distilled water to prepare 4% boric acid solution.

* **Digestion:**

I took 0.5 g grounded leaf sample in digestion tube .Then I added 3-5 g digestion mixture in it. After that I added 10 ml concentrated sulfuric acid in the digestion tubes and put them in digestion block. When the colour of the sample changed to light blue they were taken out and some distilled water is added into each tube.

* **Distillation:**

After digestion distillation of the digested samples was performed in the distillation unit .For distillation 30 ml of 40 % NaOH was added into the digestion tube and were fixed in the distillation unit. The distilled samples were taken in conical flasks containing 10 ml 4% boric acid. After distillation the samples were titrated against 0.1N sulfuric acid up to light pink colour end point.

* **Calculations:**

**Total Nitrogen (%)** = Volume of 0.1 N H2SO4 x 0.14

**9. DETERMINATION OF PLANT POTASSIUM**

* **Apparatus:**

• Flame photometer

• Block digester

* **Procedure:**

**a. Digestion:**

• For digestion take about 1g dried and grounded plant sample in digestion tube.

• Add 10mL Tri acid to the same tube using a dispenser.

• Place tubes in a block digester.

• After digestion is complete, the tubes are removed, cool and volume made 100mL with DI water.

• Filter plant digest with whatman No 1 filter paper and collect filtrate in a small bottle for K determination.

**b. Standard stock solution:**

• Dry about 3g KCl in an oven at 120ᴼC for 1-2 hours and cool in a desiccator and in a tightly stopper bottle.

• Dissolve 1.907 g dried KCl in DI water and brings to 1L volume with DI water. This solution contains 1000ppm K (Stock solution).

• Using 100 ppm stock prepare 40 ppm sub stock by taking 40mL into 100mL flask and make the volume with DI water.

* **Measurement:**

• Run the flame photometer for at least 30 minutes before the actual work start.

• After that run the 40 ppm stock on the flame photometer and then feed the samples of unknown concentration to determine the K concentration.

• Note the readings and calculate the actual amount of K (ppm) in plant samples by multiplying with the dilution factor (DF).

**CHAPTER NO.4**

**RESULTS AND DISCUSSION**

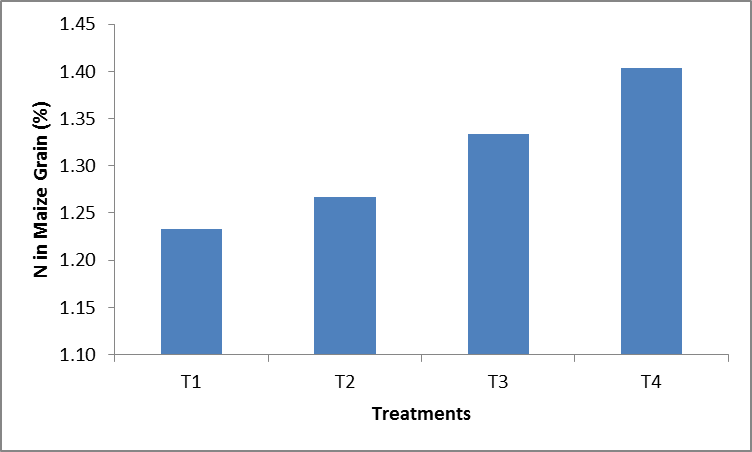
**Tab.1: Basic Soil Analysis**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Soil depth**  **(cm)** | **pH** | **EC**  **(Ds m-1)** | **OM**  **(%)** | **Av.P**  **(mg kg-1)** | **Av.K**  **(mg kg1)** |
| 0-15 | 7.5 | 1.34 | 0.67 | 10 | 220 |
| 15-30 | 7.70 | 1.31 | 0.62 | 9.9 | 220 |

**Tab.2: Concentration of Nitrogen in Maize Grain**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **R1** | **R2** | **R3** | **N%** |
| Control  (No NPK) | 1.23 | 1.17 | 1.21 | 1.233 C |
| 1% spray of UREA | 1.32 | 1.23 | 1.25 | 1.267 C |
| 2% spray of UREA | 1.31 | 1.35 | 1.34 | 1.333 B |
| 1% spray of UREA | 1.45 | 1.39 | 1.37 | 1.403 A |
| LSD |  |  |  | 0.066 |

**Nitrogen concentration in maize grain**

****

The data regarding nitrogen concentration in maize grain relative to the different treatments is shown in the above graph. The mean value of all treatments shows that the nitrogen concentration is directly proportional to the increasing levels of N fertilizer. Maximum concentration of nitrogen is recorded in T4 (1.403%) in which 3% foliar was applied. Least concentration was recorded in T1 (1.233%) which is controlled.

**CHAPTER NO. 5**

**SUMMARY**

The field experiment was conducted in Soil Chemistry Research area of AARI, Faisalabad to observe the effect of foliar application of nitrogen on the concentration of N in maize grains. There were four treatments along with three replications in which different concentration of foliar nitrogen was applied to the maize. The results were statistically analysed by using RCBD design. The data obtained from analysis shows that the concentration of nitrogen in maize (%) increases with the increase in foliar applied N fertilizer.

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