Research Article

Macro Nutrients (Nitrogen and Sulfur) Role in Phenology and Physiology of Different Corn Hybrids under Agro Climatic Conditions of Peshawar

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Citation

Abdul Qahar and Bashir Ahmad. Macro Nutrients (Nitrogen and Sulfur) Role in Phenology and Physiology of Different Corn Hybrids under Agro Climatic Conditions of Peshawar. Vol. 4, Issue 1, 2015, pp 89-96

Received: 31/12/2014

Revised: 27/01/2015

Accepted: 02/02/2015

Abstract

Field experiments were conducted at the New Developmental Farm, the University of Agriculture KPK Peshawar during 2013 and 2014 on macro nutrients viz., Nitrogen (N) and sulfur (S) to study their effects on phenology and physiology of different corn hybrids. The N levels were 0, 250, 300 and 350 kg ha⁻¹, whereas S levels were 0, 20, 40 and 60 kg ha⁻¹ (Main plot factor), while maize hybrids were R-3305, R-2210 and R-2207 respectively, allotted to sub plots. Results showed that nitrogen level of 350 kg ha⁻¹ significantly increased days to 50% tasseling (59) and silking (65), plant height (247 cm), leaf area and leaf area index (6664 cm² and 3.56), respectively, while in control plots, earlier days to 50% tasseling and silking (51 and 55), minimum plant height (192 cm), leaf area and leaf area index (4515 cm² and 2.40) were observed. R-2210 delayed days to 50% tasseling (56), while R-2210 delayed days to 50% silking (61). R-2207 was found with maximum plant height (232 cm), whereas in case of leaf area and leaf area index, R-2210 was found with maximum values (5570 cm² and 2.91). S x N and N x H had significant effect on days to 50% tasseling, whereas N x H had significant effect on days to 50% silking, plant height, leaf area and leaf area index. Sulfur had insignificant effect on phenological and physiological parameters. It is concluded that nitrogen (350 kg ha⁻¹) as macro nutrient can be better exploited for improving physiological parameters and also manipulating phenology of different corn hybrids.

Key words: Nitrogen and sulfur fertilizer; leaf area; corn hybrids; phenology.

Introduction

Among cereals, maize (*Zea mays* L.) occupies an important position in the existing cropping systems of Pakistan because it ranks third after wheat and rice. Maize is grown in almost all provinces of the country, but in Punjab and in Khyber Pakhtunkhwa (KPK), it is cultivated on larger acreage. Maize grain is used as food and also as feed in the form of grain and silage for livestock and poultry besides being a good forage crop [1]. It is used as a source of raw material for many industrial

products e.g. for the preparation of corn starch, corn oil, dextrose, corn syrup, corn flakes, cosmetics, wax, alcohol etc.

Nitrogen (N) and sulfur (S) are very important in economic crop production because they are important part of the chlorophyll and constituent of many enzymes. Nitrogen is also an important constituent of low molecular weight compounds like nucleotide, amides and amines. Therefore, a balance quantity of nitrogen is important for good and economic production of maize crop, whose

yield has been very stagnant in Pakistan. [2].

Maize is called as queen of cereal because of its high yielding efficiency. [3] However, a balanced nutrition and soil nutrient management is an essential component and plays a significant role in increasing crop production and its quality [4]. Maize crop requires an adequate supply of nutrients particularly N, which is a major component, associated with high photosynthetic activity, vigorous vegetative growth and a dark green coloration of the leaves. N is also a component of protein and nucleic acids and when N is sub-optimal, growth is reduced [5].

Among macro nutrients, sulfur (S) is also recognized as significant for maize yield and absorbs as much sulfur as it absorbs phosphorous. When sulfur is deficient in soil, yield potential of the crop cannot be realized regardless of other nutrients even under good crop husbandry practices. Sulfur interactions with nitrogen nutrient is directly correlated to the alteration of the physiological and biochemical responses of crops and thus require intensive studies to explore this relation for good and quality crop production [6].

Keeping in view the above discussed facts this study was designed and undertaken to investigate the effect of nitrogen and sulfur levels on phenological and physiological aspects of different corn hybrids.

Materials and Methods

This experiment was designed in randomized complete block design (RCBD) with split plot arrangement replicated thrice. Nitrogen levels were 0, 250, 300, and 350 kg ha⁻¹, whereas sulfur levels were, 0, 20, 40, and 60 kg ha⁻¹, respectively, whereas maize hybrids were R-3305, R-2210 and R-2207 respectively. Maize hybrids were sown on ridges with seed rate of 40 kg ha⁻¹ and sowing was done in 1st week of March in both growing seasons, respectively. The planting was done in rows, with row to row distance of

75 cm and plant to plant distance of 25 cm, and subplot size was 3.50 x 3.75 m² in order to maintain a plant population of 67333 plants ha⁻¹. The field was irrigated when needed and all other agronomic practices were carried out uniformly for all experimental units.

Nitrogen was applied as per treatments whereas phosphorous (P) and potassium (K) was applied @ 120 and 100 kg ha⁻¹ uniformly for the entire experimental plot as basal dose, respectively. Triple super phosphate (TSP) was used as source of phosphorous and murate of potash (MOP) was used as a source of potassium. All doses of P and K were applied at the time of sowing.

For nitrogen and sulfur, three sources of fertilizers were used i.e. ammonium sulphate (N and S) and Urea (N) and elemental sulfur (97% S). The nitrogen was applied in split doses, 1/3rd in seedling stage, 2/3rd at knee stage and remaining at boot stage, where as sulfur was applied all in sowing time.

Date was recorded on the following parameters.

1. Phenological parameters

- 1.1 Days to 50% tassling
- 1.2 Days to 50% silking
- 1.3 Plant height (cm)

2. Physiological parameters

- 2.1 Leaf area per plant (cm²)
- 2.2 Leaf area index

Procedure for data recording

1. Agronomic parameters

Days to 50% tassling and silking was measured by counting the number of days in each subplot with 50% of the plants produce tassels and silks from the date of emergence. Plant height of the plants was measured as the distance from base to the tip of the plant of five randomly selected plants in each sub plot at maturity stage and was then averaged to get the optimum plant height. The unit used was centimeter (cm).

2. Physiological parameters

Leaf area was calculated by multiplying leaf length and leaf width with a factor

0.75. The unit was cm^2 and then this value was multiplied with the average number of leaves per plant to get the leaf area per plant.

Leaf Area = Leaf Length x Leaf width x 0.75

Leaf area index was calculated by taking leaf area of the five randomly selected plants in each plot and then was averaged. Average leaf area per plant was then divided by the area occupied by one plant in m^2 to get the desired value of LAI.

$\text{LAI} = \text{Leaf area per plant (m}^2\text{)} / \text{Ground Area (m}^2\text{)}$

Statistical analysis

The data were analyzed according to ANOVA technique appropriate for randomized complete block design (RCBD) with split plot arrangement using Statistix 8.1 software. The treatment means were compared at $P < 0.05$ level of probability using LSD test [7].

Results and Discussion

Phenological parameters

Days to 50% tasseling, silking and plant height

Statistical analysis of the data indicated that nitrogen had significant effect on days to 50% tasseling, silking and plant height, whereas maize hybrids had significantly varied effect. Mean values for nitrogen levels showed that days to 50% tasseling, silking and plant height was increased (59 and 65 days, 247 cm) with nitrogen level of 350 kg ha^{-1} , respectively, however less days to 50% tasseling, silking and plant height were recorded in control plots (51 and 55 days, 192 cm). This might be due to vigorous vegetative growth of the crop because nitrogen being a major component of amino acids and hence plays a significant role [8]. With increases in nitrogen level, more days were taken to tasseling and silking [9].

Among hybrids, R-3305 and R-2207 took statistically similar days to 50% tasseling (55 days), however R-2207 took 60 days and R-3305 took 59 days to 50% silking, while R-2210 delayed days to 50%

tasseling and silking (56 and 61 days). R-2207 produced plants with maximum height of 232 cm as compare to other studied hybrids (Table 1). This could be because of the genetic characteristics of the hybrids [10]. N x H had significant effect on days to 50% tasseling and silking, and plant height, whereas S x N had significant effect on days to 50% tasseling as shown in Fig. 1, 2, 3 and 4, respectively. The probable reason for this could be that different hybrids had different response to nutrients levels, and application of sulfur with nitrogen improved the nutrients uptake that's why nitrogen had significant interaction with sulfur. Sulfur levels had no significant effect on any of the studied agronomic parameters. The probable reason for this could be that sulfur being a qualitative nutrient has no role in vegetative growth of the plant and therefore showed no significant effect [11].

Physiological parameters

Leaf area (cm^2) and leaf area index

Nitrogen levels and years had exhibited significant effect on both physiological parameters; however maize hybrids had significantly varied effect. Sulfur levels had no significant effect. Maximum leaf area and leaf area index (6664 cm^2 and 3.56) was observed in plots with nitrogen application level of 350 kg ha^{-1} , followed by 300 (5563 cm^2 and 2.96) and 250 kg ha^{-1} (4798 cm^2 and 2.55), while minimum leaf area and leaf area index (4515 cm^2 and 2.40) was recorded in control plots. It might be due to the fact that nitrogen plays very important role in the growth and development of the plant parts as nitrogen is the main constituent of protein and hence resulted in vigorous growth and increased leaf area and leaf area index [12]. Nitrogen increased leaf area and leaf area index significantly because nitrogen being major component of chlorophyll and protein enhanced growth and development and hence produced plants with more leaf area and leaf area index [13]. Among

Table-1, Days to 50% tasseling and silking, plant height, leaf area and leaf area index of different corn hybrids as affected by nitrogen and sulfur.

Sulfur (kg ha ⁻¹)	Days to 50% tasseling	Days to 50% silking	Plant height (cm)	Leaf area (cm ²)	leaf area index
0	55	59	225	5196	2.77
20	55	60	226	5203	2.78
40	55	60	228	5249	2.80
60	56	60	227	5261	2.81
LSD _(0.05)	Ns	ns	ns	ns	ns
Nitrogen					
(kg ha ⁻¹)					
0	51d	55 d	192 d	4515 d	2.40 d
250	53 c	58 c	226 c	4798 c	2.55 c
300	57 b	61 b	240 b	5563 b	2.96 b
350	59 a	65 a	247 a	6664 a	3.56 a
LSD _(0.05)	0.23	0.50	1.93	130.53	0.07
Hybrids					
R-3305	55 b	59 c	221 c	5281 c	2.81 c
R-2210	56 a	61 a	226 b	5570 a	2.91 a
R-2207	55 a	60 b	232 a	5405 b	2.88 b
LSD _(0.05)	0.20	0.20	1.20	34.89	0.02
Year 1	55	59	228	5340	2.85
Year 2	55	60	227	5431	2.89
Interaction					
S x N	*	ns	ns	ns	ns
S x H	Ns	ns	ns	ns	ns
N x H	*	**	*	**	**
S x N x H	Ns	ns	ns	ns	ns

Means followed by different letters are significantly different from each other at 5% level of probability.

* = Significant at 5% level of probability.

** = Significant at 1% level of probability.

ns = Non-significant.

Fig 1. Days to 50 % tasseling of different maize hybrids as affected by nitrogen and sulfur

Fig 2. Days to 50 % tasseling of different maize hybrids as affected by nitrogen and hybrids

Fig 3. Days to 50 % silking of different maize hybrids as affected by nitrogen and hybrids

Fig 4. Plant height of different maize hybrids as affected by nitrogen and hybrids

Fig 5. Leaf area of different maize hybrids as affected by nitrogen and hybrids

Fig 6. Leaf area index of different maize hybrids as affected by nitrogen and hybrids

hybrids, R-2210 produced maximum leaf area and leaf area index (5570 cm² and 2.91), followed by R-2207 (5405 cm² and 2.88) and R-3305 (5281 cm² and 2.81). This might be due to the genetic characteristics of hybrids. Interaction nitrogen with hybrids (N x H) had significant effect on leaf area and leaf area index, which indicated that each hybrid responded differently to nitrogen levels as due to genetic characteristics of maize hybrids as shown in Fig. 5 and 6, respectively [14].

Sulfur levels had no significant effect on either of physiological parameters i.e. leaf area and leaf area index, respectively. This might be due to the fact sulfur has no role in vegetative growth of the plants and hence no significant effect was observed [15].

Conclusions

It has been concluded that nitrogen levels had significant effect on all agronomic and physiological parameters and with increasing nitrogen levels, a linear trend of increase has been observed and nitrogen @ 350 kg ha⁻¹ proved to have positive effect

on studied parameters. Moreover maize hybrids also responded to nitrogen levels and R-2210 was observed with good values for physiological parameters. However, sulfur levels had no significant effect on any of the agronomic and physiological parameters.

Acknowledgments

I am indeed thankful to my supervisor, Prof. Dr. Bashir Ahmad, department of Agronomy, University of Agriculture, KPK Peshawar for his moral and technical support in this research study.

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