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Relationship Between Different Growth and Yield Parameters in Maize under Varying Levels of Phosphorus

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Abstract: The investigation to see the effect of different phosphorus levels viz., 0, 50, 75, 100 and 125 kg P_2O_5 ha^{-1} with a recommended constant dose of nitrogen @ 150 kg ha^{-1} on the leaf growth of two maize varieties was carried out. The experiment was laid out in Randomized Complete Block Design (factorial) with four replications. The maize cultivars included were Composite-17 against a standard variety Akbar. Leaf extension rate (LER) was calculated as the slope of a linear regression fitted to the points along the A-B position of the graph. Final leaf length (FLL) was measured as lamina plus sheath when the individual leaf was fully expanded. Using data for final leaf length and the calculated LER, the duration of leaf extension rate (LED) was calculated. Standard procedures were adopted to record the yield component parameters. The values of linear correlation (r) were worked out to get a relationship between FLL, LER with other growth and yield parameters influencing grain yield in maize. FLL and LER were positively correlated with phosphorus applications. Similarly number of grains per cob, grain weight per cob, 1000-grain weight and grain yield were also significantly correlated with FLL and LER. Therefore, the later two parameters were directly responsible for increasing the various yield components in maize.

Key words: Maize, Phosphorus levels, leaf growth, yield

Introduction

Corn or maize ***(Zea may*** L.) is the third most important cereal crop in the world after wheat and rice and is known as the "King of Grain Crops". It is extensively grown in temperate, tropical and sub-tropical regions of the world. Approximately 8 to 9 per cent of corn crop is to provide food for human consumption. It forms major diet part of millions of people in the form of bread cakes and porridge in many parts of the world like Asia, Africa and America. (Martin ***et al.***, 1976). Due to its high and readily available carbohydrates, maize grain is of much nutritive value and it contains about 72% starc,10% protein, 4.8% oil, 5.8% fiber, 3.0% sugar and 1.7 ash (Chaudhry, 1983). It important commercial products include corn starch, corn oil, alcohol and tanning materials for leather industry. In recent years increased quantities of corn have been used in manufacture of shortening compounds, soaps, varnishes, paints and similar other products. Moreover, starch of maize grain is being used in textile, paper, paperboard etc. (Delorite and Ahlgren, 1967).

Being a short duration crop it permits either raising of two maize crop or vacating the land in time for the sowing of another crop in the same field, thus making it possible to produce more food from a given area. Maize is sown in almost all the provinces of Pakistan, but Punjab and N.W.F.P. are main areas of production. Maize contributes 6.4 per cent to the total food grain production in Pakistan. During the year 1992 maize was cultivated on an area of about 856 thousand hectares with total production of 1185 thousand tones and average yield is 1.4 t ha^{-1}, (Anonymous, 1992).

Soil and climatic conditions of Pakistan are ideal for maize production but in spite of favourable conditions and high yielding varieties, the yield recovery at farmer's fields in Pakistan is very low as compared to other maize growing countries. The reason for low yield may be the injudicious use of inputs, lack of quality seed, plant protection measures and unavailability of irrigation water at critical growth stages. However, the use of suitable fertilizers in appropriate does to fertilizers responsive verities of maize greatly affects the crop yield. A considerable work to determine a suitable dose of fertilizer for different maize cultivars has been done in the past. The newly evolved maize genotypes with different growth behavior for exploring their yield potential necessitate readjustment of their growth fertilizer for their requirements.

Phosphorus is essential nutrient for plant growth and development. It plays a fundamental role in metabolism and energy producing reaction in plants. It is an integral part of nucleic acid, phytin and phospholipids and is essential for cellular respiration in the metabolism of the starch, protein and fats. Phosphorus application also stimulates blooming and seed formation of maize. Plenet ***et al.*** (2000b) investigated the effect of phosphorus deficiency on the radiation use efficiency (RUE) in maize. The lower biomass production in phosphorus deficient plants was accounted for by the reduced amount of phtosynthetically active radiation (PAR) absorbed by the canopy, which was itself the consequence of the reduced leaf area index No. effect of P deficiency was observed on the calculated RUE, even during the period when above ground biomass accumulation was the most severely reduced. These results obtained in yield crop condition string then the ideas that P deficiency affects plants growth, especially leaf growth, earlier and to a greater extent than photosynthesis per unit leaf area. Patel ***et al.*** (2000) conducted a study of see the response of phosphorus levels on the growth and yield of maize. The highest plant height, number of cobs per hectare, test weight and dry matter production were observed upon treatment with 60 kg P ha^{-1} which recorded the highest grain yield.

The present study was, therefore, undertaken to find out growth and yield response of a newly evolved maize variety "Compsite-17", to varying phosphorus levels against a standard variety "Akbar" grown in irrigated conditions at Faisalabad.

Materials and Methods

The investigation to see the effect of different phosphorus level Viz., 0,50,75,100 and 125 kg P_2O_5/ha with a recommended constant dose of nitrogen @ 150 kg ha^{-1} on the growth and yield of two maize varieties was carried out at Faisalabad. The experiment was conducted on a sandy clay loam soil, having initial NPK level of 0.05% of nitrogen, 7.51 ppm of phosphorus and 246.6 ppm of potash, respectively. The experiment was laid out in Randomized Complete Block Design (factorial) with four replications and the net plot size measured 3.6 × 7.0 m. The maize cultivars included were Composite-17 against a standard variety Akbar.

Leaf extension rate (cm/day)

Leaf extension growth was measured every day with ruler from ligules of the one position down of the top leaf following the procedures of Maan ***et al.*** 1989. The data was then plotted using "MINITAB" statistical package. Leaf extension rate (LER) was calculated as the slope of a linear regression fitted to the points along the A-B position of the graph. (Kemal-ur-Rahim, 1988 and Iqbal, 1992).

Final leaf length (cm)

Final Leaf Length (FLL) was measured as lamina plus sheath when the individual leaf was fully expanded. (Iqbal, 1992).

Leaf extension duration (days)

Using data for final leaf length and the calculated LER, the duration of leaf extension rate was calculated as follows:

$$\text{Leaf extension duration} = \frac{\text{Final leaf length}}{\text{Leaf extension rate}}$$

The data collected was subjected to Fisher's analysis of Variance Technique at 5% probability. (Steel and Torrie, 1984). Pair wise comparisons were made by Tukey's method as given below: Least Significant Difference (LSD)= S.E. of means X Q (K, df). Q (K. df) was obtained from tables of the studentized range, where K = the number of means to be compared and d.f.= errors degree of freedom.

Results and Discussion

The values of linear correlation (r) were worked out to get a relationship between Final Leaf Length and Leaf Extension Rate with other growth and yield parameters influencing grain yield in maize (Table 1). There was a positive correlation between LER and FLL (r = 0.984), indicating that LER determined the leaf length which is the main factor responsible for leaf area (r = 0.880). However, there was a negative correlation between leaf extension duration (LED) and LER (r = -0.978) AND FLL (r = -0.939). Similer results were also observed by Iqbal (1992), Kemal-ur-Rahim (1988) and Maan ***et al.*** (1989).

FLL and LER were positively correlated with phosphorus applications, this indicates that phosphorus applications determined LER, FLL (r = 0.806) (r = 0.814)it Phosphorus was the main factor affecting the yield components and increase in grain yield of maize possibly due to increase in photosynthetic capacity of plants. Similarly number of grains per cob, grain weight per cob, 1000-grain weight and grain yield were also significantly correlated with FLL and LER. Therefore, the later two parameters were directly responsible for increasing the various yield components in maize. Plenet ***et al.*** (2000a) observed that under field crop conditions, phosphorus deficiency affects plant growth especially leaf growth to a greater extent than photosynthesis per unit leaf area.There was negative correlation between phosphorus levels and LED (r=-0.826)

Table 1: Values of the linear correlation coefficient (r) between different growth and yield parameters in maize

Parameters	LER	FLL	LED	CBP	LA	DW/P
FLL	0.984**					
LED	-0.978**	-0.939**				
CBP	0.744*	0.706*	-0.764*			
LA	0.880**	0.865**	-0.830**	0.785**		
DW/P	0.417NS	0.472NS	-0.435NS	0.162NS	0.085NS	
G/C	0.905**	0.923**	-0.871**	0.461NS	0.709*	0.568NS
GW/C	0.900**	0.927**	-0.858**	0.458NS	0.711*	0.572NS
TWG	0.874**	0.928**	-0.806**	0.477NS	0.727*	0.547NS
GY	0.897**	0.902**	--0.847**	0.712*	0.886*	0.235NS
C/P	0.291NS	0.213NS	-0.304NS	0.190NS	0.385NS	-0.361NS
H.I	0.288NS	0.217NS	-0.292NS	0.449NS	0.501NS	-0.372NS
F	0.806**	0.814**	-0.826**	0.587NS	0.590NS	0.712*
	G/C	GW/C	TWG	GY	C/P	H.I
FLL						
LED						
CBP						
LA						
DW/P						
G/C						
GW/C	0.915**					
TWG	0.943**	0.963**				
GY	0.832NS	0.844**	0.878**			
C/P	0.321NS	0.278NS	0.092NS	0.310NS		
H.I	0.158NS	0.149NS	0.139NS	0.562NS	0.515NS	
F	0.764**	0.763**	0.740*	0.558NS	-0.065NS	-0.230NS

LER	=	Leaf Extension Rate (cm/day)	FLL	=	Final Leaf Length (cm)
LED	=	Leaf Extension Duration (days)	CBP	=	Cob Bearing Plants
LA	=	Leaf Area (cm^2)	DW/P	=	Dry Weight per Plant (g)
G/C	=	Grains per Cob	GW/C	=	Grain Weight per Cob
TWG	=	Thousand Grain Weight (g)	GY	=	Grain Yield(t/ha)
C/P	=	Cobs per Plant	H.I	=	Harvest Index (%)
F	=	Fertilizer			

which indicated that phosphorus decreased the period of leaf expansion by increasing the LER (r = -0.806). Phosphorus levels also increased the dry weight per plant (r= 0.712), number of grains per cob (r= 0.764), grain weight per cob (r = 0.763) and thus and grain weight (r= 0.740) whereas leaf area, cob bearing plant and grain yield were not affected by phosphorus levels. The relationship between different yield components as affected by phosphorus application was also studied by Shah (1988), Ahmad (1989), Hassan (1991) and Hur (1993).

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