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Standardization of Sowing Window and Phosphorus Requirement for *Kharif* Maize (*Zea mays* L.) in Vertisols

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ABSTRACT

A field experiment was conducted during kharif, 2016-17 on black cotton soils of RARS Farm, Nandyal to study the effect of sowing dates and phosphorus levels on growth, yield attributes and yield of maize. The experiment comprised of four main plots viz., crop sown during I FN of July, II FN of July, I FN of August and II FN of August and three sub plots viz., 75% recommended dose of phosphorus, 100% recommended dose of phosphorus and 125% recommended dose of phosphorus. The results revealed that all the growth parameters, yield attributes and yield was significantly influenced with the sowing dates. However, the influence of phosphorus levels on growth and yield parameters of maize was recorded to be non significant.

Key words: *Sowing dates, Phosphorus levels, Vertisols, Cobs, Kernel, Stover, Yield and Maize*

INTRODUCTION

Maize (*Zea mays* L.) is one of the major food crops of many countries in the world. It is cultivated in 150 M ha across 160 countries and contributes to 36 per cent (782 M t)[15] of grain production in the world. It is the most versatile crop grown across the globe. At present in India, it occupies 9.23 M ha with a productivity of 2.56 t ha^{-1} [17]. In Andhra Pradesh, maize is cultivated in 9.2 lakh ha out of which 7.4 lakh ha comes under *kharif* with an average productivity of 2187 kg ha^{-1}. However, the yields are low in *kharif* due to vagaries of monsoon, prolonged dry spells, excess moisture and terminal moisture stress. Time of sowing is a non monetary input which increases the yields of a crop without increasing the cost of cultivation. Generally sowings in scarce rainfall zone are taken up with the onset of monsoon in the month of July. Maize is sensitive to moisture stress at critical stages due to vagaries of monsoon. Therefore it is very essential to find out optimum time to avoid such problem. With regards to the nutrient management, phosphorus is an essential nutrient required to increase maize yield.

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Poor availability of phosphorus and low organic matter content of soil in semi-arid regions is the major constraints for high productivity of maize. In vertisols because of phosphorus fixation, there is no proper response to applied phosphatic fertilizers even at higher doses[13].

MATERIAL AND METHODS

A field experiment was conducted during *kharif*, 2016-17 on black cotton soils of RARS (Regional Agricultural Research Station) Farm, Nandyal, Andhra Pradesh. The soil was slightly alkaline in reaction, low in Nitrogen, high in Phosphorus and Potassium. The experiment comprised of four main plots main plots *viz.*, crop sown during I FN of July, II FN of July, I FN of August and II FN of August and three sub plots *viz.*, 75% recommended dose of phosphorus, 100% recommended dose of phosphorus and 125% recommended dose of phosphorus. (Note: The 75% recommended dose of phosphorus 60 kg P_20_5 ha^{-1}, 100% recommended dose of phosphorus 60 kg P_20_5 ha^{-1} and 125% recommended dose of phosphorus 75 kg P_20_5 ha^{-1}). The trail was laid out in split plot and replicated thrice. Five plants in each plot were marked separately for non- destructive sampling and destructive samples were drawn from the gross plot leaving the extreme border row. Statistical significance was tested by 'F' value at 5 per cent level of probability and wherever the 'F' value was found significant, critical difference was worked out and the values were furnished.

RESULTS AND DISCUSSION

The results of the investigation revealed that the growth parameters (plant height, leaf area and dry matter production) of maize were significantly influenced by sowing dates (Table 1.). With regard to phosphorus levels, application of 75% recommended dose of phosphorus recorded the higher values which was followed by 100% and 125% recommended dose of phosphorus without significant disparity between them.

Plant height

Among the sowing dates crop sown during II FN of July recorded higher plant height. It might be due to sufficient soil moisture along with favourable weather conditions that lead to increased nutrient uptake and metabolic functions of the plant. The lower plant height was recorded with crop sown during I FN of July. The optimum sown crop had longer period for growth period while late and early sown crop had shorter period for growth Shahzad ali *et al*.[12].

Phosphorus levels did not influence the plant height of maize. However, 75% recommended dose phosphorus recorded higher plant height compared higher doses of phosphorus. Optimum phosphorus fertilization increases the root formation and nutrient uptake and also enhances the physiological activity of plants. Higher levels of phosphorus did not increase the plant height which might be due to higher phosphorus fixation in vertisols[2].

Leaf area index

The leaf area index of maize tended to increase progressively with advancement in the age of the crop upto 60 DAS and declined towards harvest. Among the sowing dates, II FN of July recorded higher leaf area index compared to other sowing dates at all stages. The bright sunshine hours during crop which might have resulted in more synthesis of photosynthates, major portion of which was utilized for increasing leaf area[14]. The lower leaf area index was recorded with crop sown during I FN of July which might be due to cloudy weather, excess moisture in the root zone and high relative humidity. These results are in agreement with the findings of Jasemi *et al*.[5], who reported that reduced leaf area in maize due to either early or delayed sowing.

Phosphorus is a very essential element for root growth and energy transfer. Sufficient quantity of phosphorus enhances the nutrient uptake and availability, which leads to production of more leaf area index. However, higher levels of phosphorus did not increase leaf area index. Similar such findings were given byYang and Jacobsen[16].

Dry matter production

Among the sowing dates, II FN of July was observed to be optimum time of sowing for maize as it provided favorable environment for crop growth during all the crop growth stages. This might be due to increase in plant height and leaf area index of the crop. The lower dry matter accumulation recorded with I FN of July during all growth stages might be due to continuous rains after tasseling stage associated with cloudy weather. Either early sowing or delayed sowing markedly reduced the dry matter accumulation. This might be due to shorter vegetative stage and poor partitioning of dry matter in sink which might be the possible reasons[3].

Different levels of phosphorus failed to exert significant effect on dry matter accumulation. This might be due to the non significant effect of phosphorus on the growth attributes like plant height and leaf area index. Nsanjabaganwa *et al.*[8], and Hani *et al.*[2],also reported that higher levels of phosphorus did not increase the dry matter production in maize.

YIELD AND YIELD ATTRIBUTES OF MAIZE

Number of Cobs Plant^{-1}

The data pertaining to the number of cobs plant^{-1} are presented in Table 2. from the results obtained, it is evident that sowing dates significantly influence the number of cobs plant^{-1}. Crop sown during II FN of July recorded significantly higher number of cobs plant^{-1}. The lower number of cobs plant^{-1} was obtained with I FN of July which was comparable with II FN of August sowing which might be due to unfavourable weather during crop growing period. Either early or delayed sowing considerably reduces the number of cobs plant^{-1}. Maga *et al.*[6], observed significant variation in number of cobs plant^{-1} at different sowing windows.

Phosphorus levels did not exert significant influence on the number of cobs plant^{-1} in maize. However, 75% recommended dose of phosphorus recorded higher cob bearing plants. Higher doses of phosphorus fertilization did not increase cob bearing plants in maize in clay soil, which might be due to antagonistic relation with other nutrients which are in excess quantity in root zone[2].

Number of Kernels Cob^{-1}

Number of kernels cob^{-1} in maize was significantly influenced by different sowing dates whereas phosphorus levels did not influence the number of kernels per cob^{-1}. However, their interaction effect was found to be non significant presented in Table 2. Among the sowing dates, the higher number of kernels cob^{-1} was registered with the crop sown during II FN of July which was significantly superior over other sowing windows. The lower number of kernels cob^{-1} was recorded with crop sown during I FN of July, which might be due to lower dry matter accumulation, high evaporative demand at early stages followed by cloudy weather and excess moisture in root zone at kernel formation and maturity stages. Jaliya *et al.*[4], opined that early sown crop utilize available growth resources to produce and partition more assimilates to the various sinks for better yield attributing characters. Reduction in number of kernel per cob with early and late sowings could be due to reduced photosynthesis and photosynthetic materials during the kernel filling period which reduced the number of kernels at the top of the cobs as reported by Azadbakht *et al.*[1].

Perusal of the data indicated that phosphorus levels did not influence significantly the number of kernels cob^{-1}. Application of optimum dose of phosphorus significantly improved number of rows per cob and number of kernels per cob in maize as compared to lower and higher doses of phosphorus[10]. This could be attributed to the phenomenon that large cob size is promoted by proper pollination, translocation of sugar and starch which finally leads to proper seed set due to phosphorus fertilizer application.

Test Weight (1000 kernel weight)

The data on test weight of maize are presented in Table 2. The results indicated that sowing dates significantly influenced the test weight of maize but phosphorus levels did not influence significantly the test weight of maize. The interaction between sowing dates and phosphorus levels was found to be non significant. Assessment of data indicated that higher value for test weight was recorded with II FN of July. However, among the different sowing dates, minimum test weight was recorded with I FN of July. The possible reason might be excess moisture in root zone leads to affect the process of fertilization and translocation of food materials. Either early or delay in sowing date reduced kernel filling period which ultimately had a negative effect on test weight probably due to reduction of dry matter accumulation in kernels. The reduced test weight under early and delayed planting might be due to coincidence of kernel filling period with cool and rainy weather at the end of growing season which resulted in reduced test weight[1].

Phosphorus levels did not influence significantly the test weight of maize. However, among the different levels of phosphorus, 75% recommended dose of phosphorus recorded with higher test weight compared to higher doses. Phosphorus is an important nutrient which enhances energy transfer and physiological activity of the plant at optimum doses but at higher doses it might have caused zinc and iron deficiency which led to reducing kernel weight[2].

Kernel Yield

The data on kernel yield are presented in Table 2.0. The perusal of data revealed that the kernel yield of maize was significantly influenced by sowing dates during the present investigation whereas the phosphorus levels did not influence the kernel yield. Interaction between sowing windows and phosphorus levels was found to be non significant.

Significantly higher kernel yield was recorded with II FN of July than all other sowing dates. This is in accordance with the results reported by Jaliya *et al*.[4], who reported that higher growth and yield parameters could be attributed to the favorable agro climatic conditions particularly temperature, solar radiation and relative humidity coincide with even rainfall distribution. The lower growth and yield parameters could be attributed to the uneven rainfall distribution, which causes water logging, that affects soil aeration and plant metabolism, especially photosynthesis, assimilate formation and translocation, cell division and elongation thus inducing stunted growth and development. The optimum sowing time causes encountering of kernel formation and filling stages with long days and maximum energy needed to photosynthesis resulting in higher yields while in late planting dates due to shorter growing period the plants have not enough time for complete maturity[1].

Different levels of phosphorus did not influence significantly the kernel yield of maize. Among the different levels of phosphorus, 75% recommended dose of phosphorus recorded higher kernel yield than 100% and 125% recommended dose of phosphorus. A good and optimum supply of phosphorus was associated with increased root growth due to which the plants explored more soil moisture and nutrients leading to increased kernel yield[7].

Stover Yield

The data pertaining to stover yield are presented in Table 2. The data indicated that sowing dates significantly influenced the stover yield of maize. However, phosphorus levels did not influence significantly the stover yield of maize. While the interaction effect between sowing dates and phosphorus levels was found to be statistically non significant.

Higher stover yield under II FN of July might be due to favorable weather conditions for better growth parameters like plant height, leaf area index and dry matter accumulation that led to efficient transfer of assimilates to sink resulting in higher stover yield. Obgomo and Remisson[9] reported that stover yield accrued to growth factors like higher plant height, LAI and efficient transfer of assimilate to sink leading to greater biomass.

Different levels of phosphorus did not exert significant influence on the stover yield of maize. The root growth of plants would be highest with optimum phosphorus levels, it enhances the nutrient uptake and other physiological functions of the plants which results in greater biomass production in maize[7].

Table 1. Growth parameters maize under different dates of sowing as influenced by different levels of phosphorus

Treatments	Growth parameters		
	Plant height at harvest (cm)	**Leaf Area Index at 60 DAS (cm)**	**Dry Matter production at harvest (g) plant $^{-1}$**
Dates of sowing			
D_1 : I FN of July	146.9	2.57	73.0
D_2 : II FN of July	186.5	3.26	95.2
D_3 : I FN of August	176.3	2.85	88.5
D_4 : II FN of August	167.0	2.64	86.8
SEm±	4.1	0.12	0.9
CD (P=0.05)	14.3	0.43	3.0
Phosphorus levels			
P_1 :75% RDP	170.7	2.85	86.0
P_2 :100% RDP	168.3	2.82	86.0
P_3 :125% RDP	168.0	2.83	85.5
SEm±	1.6	0.10	1.2
CD (P=0.05)	NS	NS	NS
Interaction (D × P)			
SEm±	7.2	0.22	1.5
CD (P=0.05)	NS	NS	NS

Table 2. Yield attributes and yield of maize under different dates of sowing as influenced by different levels of phosphorus

Treatment	**Number of cobs plant $^{-1}$**	**Number of kernels cob $^{-1}$**	**Test weight (g)**	**Kernel yield (kg ha $^{-1}$)**	**Stover yield (kg ha $^{-1}$)**
Dates of sowing					
D_1 : I FN of July	1.00	260.8	187.0	2997	3454
D_2 : II FN of July	1.10	337.8	214.0	3862	4249
D_3 : I FN of August	1.07	316.0	205.7	3514	3768
D_4 : II FN of August	1.01	310.4	198.4	3328	3701
SEm±	0.02	5.9	2.2	70.1	64.7
CD (P=0.05)	0.06	20.5	7.5	249.8	223.3
Phosphorus levels					
P_1 :75% RDP	1.10	309.3	202.3	3470	3913
P_2 :100% RDP	1.04	304.6	200.5	3405	3869
P_3 :125% RDP	1.03	304.8	201.0	3400	3731
SEm±	0.71	1.9	1.4	41.2	39.1
CD (P=0.05)	NS	NS	NS	NS	NS
Interaction (D× P)					
SEm±	0.034	10.2	3.0	125.3	112.0
CD (P=0.05)	NS	NS	NS	NS	NS

CONCLUSION

Sowing of maize during II FN of July found to be recorded higher kernel yield thereby higher net returns compared to other dates of sowing. Therefore, for getting higher monetary returns, sowing of maize during II FN of July was found to be the better option in black cotton soils. Application of 75% recommended dose of phosphorous was found to be sufficient enough in black cotton soils to get higher maize yields.

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