Impact of Foliar Phosphorus Application on Growth and Yield Performance of Maize (Zea mays L.) Varieties Under Coastal Conditions

Naveed Shah[1], Shah Faisal Pandrani[2], Muhammad Akram[3], Shah Dad[4], Mukhtar Ahmed[5] Shezad[6], Hussain Ahmad[7], Abdul Samad Jamil[8]

1. Department of Agronomy, Lasbela University of Agriculture, Water and Marine Science Uthal, Pakistan.
2. Department of Agriculture Lasbela University of Agriculture Water and Marine Sciences sub campus Wadh.
3. PARC - National Sugar and Tropical Horticulture Research Institute, Thatta.
4. Directorate of Agriculture Research (Dates) Kech at Turbat.
5. Department of Agronomy, Lasbela University of Agriculture, Water and Marine Sciences, Uthal, Balochistan, (Pakistan)
6. Department of Plant Protection, Ministry of National Food Security and research.
7. Department of Plant breeding and Genetics, The University of Agriculture Swat.
8. Department of Entomology, The University of Agriculture Swat.

Corresponding author Naveed Shah

Abstract: Maize production often faces challenges, including nutrient imbalances, which hinder its yield potential. This study evaluated the impact of varying foliar phosphorus levels on three maize varieties—Pak Afgoi, Islamabad Gold, and Sadaf Sufaid—under coastal conditions during the 2021 growing season at Lasbela University of Agriculture, Water and Marine Sciences (LUAWMS), Uthal, Balochistan. Conducted in a Randomized Complete Block Design (RCBD) with four replications, the experiment applied foliar phosphorus at 1% (37 g), 2% (74 g), and 3% (111 g) concentrations, along with a control. The 3% (111 g) application significantly enhanced maize growth and yield. Sadaf Sufaid demonstrated superior performance, achieving the shortest time to tasseling (59 days), the highest grain weight per cob (82.72 g), the largest leaf area (358.22 cm²), the greatest number of grains per cob (368.25), and the thickest cob diameter (4 cm). Additionally, it produced the most cob per plant (3) and the longest cob length (22 cm). These findings suggest that foliar phosphorus application at 3% (111 g) is optimal for maize productivity. It is recommended that farmers adopt this application level to enhance crop performance, while future studies should focus on its long-term effects and adaptability across diverse agro-climatic regions.

Keywords: Maize, Foliar phosphorus, Coastal agriculture, Yield performance.

INTRODUCTION

Maize (*Zea mays* L.) is native to Central America and is a grain crop species of the Family poaceae (Hugar & Palled, 2008). Most people worldwide receive their main nutrition protein carbohydrates phosphorus potash iron zinc calcium and vitamin B from the significant grain crops known as corn. Maize is just a plant with a very short growing season that is susceptible to using nutrients more effectively and has the ability to produce significant number of nutritious crops per land unit. It is a significant food crop that not only contains a lot of carbohydrates but also could supply energy and critical elements. Approximately 72% of it is starch, 10% is protein, 4.8% is oil, 8.5% is fiber, 3% is sugar, and 1.7% is ash (Tagne et al., 2008). It is a crop that requires a lot of minerals, so providing a sufficient and appropriate source is crucial for its own development and production.

In Pakistan, corn comes on third position after wheat and rice. Because of several limitations, a corn crop's value isn't being adequately utilized. One of these involves the delivery of improper minerals (Oad et al., 2004). Pakistan's lands typically contain just under 5% plant substances and have a poor amount of natural material (Sarwar et al., 2005) 4.8% of the total area of agriculture and 3.5% of the value of agricultural output are made up by corn. It's also grown on an estimated 0.9 million hectares and produces 1.3 tons annually. Baluchistan and Sindh generate only 2% to 3% of the world's corn. Differences in their emergence are the primary cause of this varied reaction (Tahir et al., 2008).

In Pakistan, corn is grown on an area of 1.41 million hectares with an average grain output of 5121 kg hectare and a yearly corn production of 7.23 thousand tones. Compared to other nations around the globe, overall output is significantly lower (GOP, 2019-2020). It is also typically obtained mostly in regions of KPK and Punjab. However, because of private sector initiatives and economic development project initiatives, corn production has recently expanded in usually non-maize cultivating areas like Sindh and to a lesser extent Balochistan. Because of their vast tracts of undeveloped territory, these two regions could be investigated for the growth of upcoming yield and yield components. Furthermore, it is planted on approximately 1118 thousand hectares, producing 4036,000 tons of food per year with an average return of 3598 kg ha^{-1} (GOP, 2010). Maize is grown in places that receive 36% of their rain and 64% of the irrigation. The Khyber region of northwest Pakistan, which has a semi-arid environment, produces very little maize (1868 kg ha^{-1}) (MINFAL at al.,2012) In Pakistan's Khyber Pakhtunkhwa province, improper handling of water and vitamins is the primary cause of development and crop yield being negatively impacted by a water deficit drought (Amanullah & Inamullah, 2014). Balanced fertilization is necessary for enhancing crop development. Rising production and output ratio Corn productivity was examined by Amanullah et al. (2009) as well as fertilizer use effectiveness in 2010–2013. Among the main Kharif food crops cultivated in Pakistan is maize, which has a land area under cultivation of 1083 thousand hectares and has increased output by 15.2 percent over the previous year (Agri. Statistics, 2010). From 1185 thousand tones in (1990-1991) to 4271 thousand tones in (2011-2012), maize output has increased (GOP, 2012). Due to favorable climate, an improvement in area, and a greater percentage of hybrid cultivars being planted, production has increased by 13.7% over past season. The greatest of the crops farmed inside the nation, corn has the best overall significant positive correlation at 3944 kg ha^{-1}. Following rice and wheat, maize contributes about 4.88% of the beneficial cereals, which account for 64.6% of all food grains (GOP, 2012). 4.8% of the total area of cropping and 3.5% of the amount of agricultural output are made up by corn. The adoption of higher yielding types and cultivars are largely to blame for the increased yield pattern that is anticipated to continue (GOP, 2011). According to the Pakistan Economic Council (2018), Pakistan produces 35-52% less corn, cotton, wheat, and sugarcane than many other countries' highest median production values. The poor nationwide yield potential is a result of producers' lack of technological advancement in the cultivation of maize. The assessment of the fundamental causes of Pakistan's low maize production hasn't received any detailed attention. Based on this context, the current research attempted to comprehend Pakistani producers' understanding of new agricultural methods and overall attitudes about implementing suggested approaches. A major obstacle to increasing cereal output worldwide, particularly throughout Pakistan, is insufficient soil nutrition which could have an impact on food security (Ahmed et al., 2019; Iqbal et al., 2017). Limited crop output is mostly caused by the high cost of artificial fertilizers, issues with sales, lack of basic, and transportation.

Although there is little data on the strategy phosphorus (P) given via the foliar route has lower utilization rates than P applied via the soil route. If applied in accordance with foliar studies, the phosphorus usage across the liquid fertilizer method could improve the soil applied phosphorus, which might boost the phosphorus use efficiency and reduce the crop's dependence on soil phosphorus. As a result, the recommended phosphorus levels will be reduced. Foliar spray has been described as a potential method that can boost the availability of nutrients to crops in order to increase output (Arif, 2006; Hameleers & Leach, 2001) showed that spray phosphorus treatment on corn caused a large rise in starch content and cob index but had no impact upon that generation of dry mass. The impact of foliar phosphorus spray varies depending on the type of crop, its climate, and the crop's stage. As stated by Mosali et al. (2004-2006) in order to assess the interaction between soil and foliar Phosphorus treatment on maize development in calcareous soils, this research was carried out. The soil nutrients may be improved by the foliar application of phosphorus, which could improve the phosphorus use efficiency and lessen the crop's dependence on soil phosphorus (Dixon, 2003) proposed that foliar phosphorous spraying is the most efficient technique for a producer to feed phosphorous in the final stages of the plant and increase nutrient use efficiency. The effect of foliar phosphorous spray varies depending on the type of plant, the climate, and the maturity of the plant.

The second most important element that restricts crop growth is phosphorus (P). Even when soils use an appropriate amount of Phosphorus, the amount of phosphorus that plants can use is still not very high. However, a sufficient amount of Phosphorus is necessary in the majority of soils to allow crop production. Phosphorus consumption efficiency is still poor despite extensive research on application technique, source, and timing, according to (Raun & Zhang, 2006). To compensate for low phosphorus use efficiency, growers use an excessive amount of P fertilizer. Inefficient foliar P fertilization has been utilized for many decades according to Lanauskas et al., (2006) Excessive fertilizer P treatment causes excessive P losses from agricultural areas to water sources. As a result, there are now more foliar Phosphorus nutrients in the marketplace than ever before. Phosphorus solutions are used extensively as a fungicide in agricultural production. Several formulations with varying phosphorus or other emulsifying agent concentrations are offered on the market Phosphate, the dominant element, is essential for several physiological processes in plants (Khalil at al., 2004). Crops can use phosphorus including both organic and non-organic sources (MNFS&R, 2013-14). Even though it is dissolved in water, phosphorus is primarily applied to crops as chemical fertilizer, although occasionally Phosphorus fertilization methods lose their effectiveness when they interact with metallic and transform into unusable types (Hopkins et al., 2004). If applied to the foliage with a spray, phosphate is also used by crops (Amanullah et al., 2013).

Phosphorus compounds have been tried for several different kinds of soils, and a variety of techniques have been utilized to enhance or improve their effectiveness in corn. For the desired yield, nutrients and water management are easily applied to the corn. Delivery of phosphate (P) via spray might enhance the P content in plants as compared to soil application and absorption due to increased fixation of P in soil. Liquid fertilizer feeding is among the rising fields in fertilizer application.

MATERIALS AND METHODS

The experiment, titled *"Influence of Foliar Application of Phosphorus on Different Traits of Maize Varieties under Coastal Conditions,"* was conducted during the maize growing season of 2021 at the Research Farm of Lasbela University of Agriculture, Water, and Marine Sciences (LUAWMS), Uthal, Balochistan. Maize seeds of three varieties—Pak Afgoi, Islamabad Gold, and Sadaf Sufaid—were obtained from ARI Research Institute, Quetta, and sown under coastal environmental conditions. The experimental design followed a randomized complete block design (RCBD) with four replications, using plots of 3.6 m^2. Fertilizers included urea and sulphate of potash (SOP) applied in two doses at specific growth stages, while phosphorus was applied foliarly at concentrations of 0%, 1%, 2%, and 3% during the knee height and tasseling stages. A systematic irrigation system provided ten irrigations to the sandy loam soil, which exhibited poor water retention. Insect control was achieved using Amamectin and Bifenthrin applied at regular intervals.

The germination rate varied across replications, with Islamabad Gold demonstrating the highest germination percentage, earliest maturity, and best yield performance, followed by Pak Afgoi and Sadaf Sufaid. Manual weeding and a single "godi" were carried out to manage weeds. The crop was harvested after 105 days, with the cobs sun-dried for 16 days before yield evaluation. Soil samples were collected before sowing to analyze physical and chemical properties, revealing a sandy loam texture with limited water-holding capacity. Data were collected on physiological, morphological, and yield-related traits, including days to tasseling, silking, maturity, plant height, leaf area, number of cobs per plant, cob length, diameter, grain count, and grain weight per cob. Statistical analysis was conducted using Statistix 8.1, and the study highlighted the adaptability of maize varieties and the effectiveness of nutrient and pest management strategies under coastal conditions.

RESULTS

Days to tasseling

From analysis of variance (Table 4.1) it is declared that for Days to tasseling treatment phosphorus showed significant difference ($p<0.01$). However, interaction between varieties and treatments were significant difference ($p<0.05$) whereas ANOVA for varieties indicated non-significant results ($p>0.05$). Coefficient of variance was found at 1.41%.

The days to tasseling are the most important growth-limiting factors in which the days of the plants are counted from sowing to the tasseling stage of the plants. In this study, there were several effects of phosphorus on maize. Days from sowing to tasseling were counted, and the effect of different phosphorus levels was seen on the days to tasseling. The maximum result for days to tasseling were found in the control where about (59 days) were taken to tasseling, followed by treatment 1 with an average of (56 days). (Table 4.2) Moreover, in treatment 2, the Days to tassel were recorded at about (54 days). However, the minimum Days to tassel were noted in the treatment 3 just for (51 days). The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, with foliar phosphorus outperforming other treatments in terms of days to tasseling of the maize plant.

The maize varieties pak afgoi, islamabad gold, and sadaf sufaid showed no difference for days to tessling. Islamabad gold showed minimum value (50 days) when no foliar phosphorus was applied while the maximum value was observed in sadaf sufaid and islamabad gold (59 days) where foliar phosphorus was applied at 3% Overall the phosphorus levels interaction with maize varieties showed significant difference at $P<0.05$ while maize varieties showed non-significant effects on days to tasseling $P>0.05$.

Days to silking

From analysis of variance (table no 4.2), it is declared that treatment phosphorus showed significant difference ($p<0.01$). However, varieties along with their interaction with treatments indicated non-significant results ($p>0.05$). Coefficient of variance was found 1.33%.

The days silking are the most important growth-limiting factors in which the days of the plants are counted from sowing to the silking stage of the plants. In this study, the various effects of phosphorus on the maize from sowing to silking were counted, and the effect of different phosphorus levels was observed on the days leading up to tasseling. The maximum result for days to silking was obtained in the control for phosphorus level, where about (76 days) were recorded, followed by treatment 1 with about (72 days) taken to complete silking (Table 4.4). Furthermore, (68 days) were recorded in treatment 2 Days to silking. However, the minimum days to silking were noted in treatment 3, reaching just up to (66 days). The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, with foliar phosphorus outperforming other treatments in terms of days to silking of the maize**.**

Furthermore, the maize varieties showed non-significant difference for days to silking. Overall phosphorus levels and maize varieties showed non-significant difference effect on days to silking. Pak afgi, islamabad gold, and sadaf sufaid showed minimum value of (66 days) when no foliar phosphorus was applied while the maximum value was observed in sadaf sufaid (77 days) where the phosphorus level was applied at 3%. The phosphorus levels showed significant difference at $P<0.05$ while the interaction between maize varieties and phosphorus levels showed non-significant difference $P>0.05$

Days to maturity

From analysis of variance (Table 4.3), it is declared that for Days to maturity treatment phosphorus showed significant difference ($p<0.01$). However, interaction between varieties and treatments are significant difference ($p<0.05$) whereas ANOVA for varieties indicated non-significant results ($p>0.05$). Coefficient of variance was found 0.84%.

The days to maturity are the most important growth limiting factors in which the days of the plants are counted from sowing to the physiological maturity of the plants. In this study, there was a different effect of phosphorus on the maize's physiological maturity. The days from sowing to maturity were counted, and the effect of different phosphorus levels was seen on the days to maturity. The maximum result for days to maturity was obtained in control at about (103 days) (Table 4.6), followed by treatment 1 with an average of (101 days). Moreover, in treatment 2, the days to maturity were recorded at about (98 days. However, the minimum days to maturity were noted in treatment 3, reaching just up to (96 days. The experimental research study was conducted to observe the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, and the result of foliar phosphorus gave better performance than other treatments on the days to maturity of the maize plant.

The maize varieties showed no difference for days to maturity. Pak afgoi, islamanad gold, and sadaf sufaid showed minimum (96 days) where the foliar phosphorus level was applied at 3% while the maximum value was noted in islamabad gold (104 days). The maize varieties were significant while their interactive effect was non-significant at $P>0.05$.

Plant Height (cm)

From analysis of variance, (Table no 4.4) it is declared that treatment phosphorus showed significant difference ($p<0.01$). However, varieties along with its interaction with treatments indicated non-significant results ($p>0.05$). Coefficient of variance was found at 5.6%.

Plant height is one of the most important organs and has a greater contribution to dry matter production, particularly in fodder and grain crops. There was a different effect of phosphorus on different traits of plant height. The maximum result for plant height was obtained in treatment 3 with (172.77 cm) (in Table 4.8), followed by treatment 2 with an average height of (171.06 cm). Furthermore, the average plant height in Treatment 1 was (163.18 cm). However, in the control group, the minimum plant height was only (135.18 cm). Our results are highly significant for plant height. The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, and the result was that foliar phosphorus gave better performance than other treatments on plant height (cm) of maize plants

The maize varieties showed no difference for days to maturity. Pak afgoi showed minimum value (132.00 cm) for plant height in control while the maximum value was observed in Islamabad gold (175.15 cm) where phosphorus level was applied at 3%. Overall, the interaction between phosphorus levels and maize varieties were not significant at $P>0.05$.

Leaf area (cm^2)

From analysis of variance (Table no 4.5), it is declared that for Leaf area (cm^2) treatment phosphorus and varieties used in concerned experiment showed significant difference ($p<0.01$). However, interaction of varieties with treatments indicated non-significant results (p>0.05). Coefficient of variance was found to be 2.63%.

Leaf area (cm^2) is one of the most important characteristics. Leaf is the main source of primary production (water and nutrients) and carbon impacts on the canopy. Foliar use of phosphorus was applied to observe the effects of different traits of phosphorus on the leaf area of the plant. The maximum phosphorus affected leaf area of the plants was observed. The maximum result for leaf area (cm^2) was obtained in treatment 3 with (355.12 cm^2) (Table 4.10), followed by treatment 2 with an average area of (332.45 cm^2). Moreover, in treatment 1, the leaf area (cm^2) was recorded with an average area of (277.56 cm^2). However, the control had the smallest leaf area, reaching only (257.03 cm^2). The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, and the result was that foliar phosphorus gave better performance than other treatments on the leaf area (cm^2) of the maize plant.

The maize varieties pak afgoi, islamabad gold, and sadaf sufaid showed no difference for leaf area (cm^2). Sadaf sufaid showed minimum value (254.79 cm^2) in control where no phosphorus was applied while the maximum value for leaf area was obtained (358.22 cm^2) in Islamabad gold where the foliar phosphorus level was applied at 3%. Overall foliar phosphorus levels and maize varieties showed significant effect on leaf area (cm^2) of maize plants. While the interaction between phosphorus levels and varieties were non-significant at P>0.05

Number of cobs per plant

From analysis of variance (Table no 4.6), it is declared for Number of cobs per plant that treatment of phosphorus showed significant difference (p<0.01). However, varieties along with their interaction with treatments indicated non-significant results (p>0.05). Coefficient of variance was found 18.49%.

Maize cobs are the products of the maize crop, consisting of the central fibrous rachis of the female inflorescence (the maize ear), which is the part in which kernels grow. There were mostly minimums of 1.2 cobs in maize plants, but maximums of about 4 cobs were also estimated. This can also be the effect of different traits of phosphorus on maize plants. Data regarding the number of cobs per plant^{-1} revealed that phosphorus had different, significantly different effects on the number of cobs per plant. The maximum results for the number of cobs were obtained in treatment 3 about (2.41 cobs) per plant (Table no. 4.12), followed by treatment 2 with an average cob of (1.83 cobs) per plant. Furthermore, in Treatment 1, the average number of cobs per plant was (1.60 cobs) per plant. However, the minimum number of cobs per plant was noted to be under control, reaching only (1.00 cobs) per plant. The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, and the result of foliar phosphorus was better performance than other treatments on the number of cobs per plant of maize.

The maize varieties of pak afgoi, islamabad gold, and sadaf sufaid showed no difference in the number of cobs per plant. Pak afgi, Islamabad gold, and Sadaf sufaid showed minimum value of (1.00 cobs) where no foliar phosphorus was applied while the maximum value for number of cobs per plant was obtained in pak afgoi and Islamabad gold (2.50 cobs) where the foliar phosphorus level was applied at 3%.Overall foliar phosphorus levels showed significant but the interaction between the phosphorus levels and maize varieties showed non-significant difference at P>0.05.

Number of grains per cob

From analysis of variance (table no 4.7), it is declared that treatment phosphorus showed significant difference (p<0.01). However, varieties along with their interaction with treatments indicated non-significant results (p>0.05). The coefficient of variance was found to be 8.7%.

There would be approximately 530 grains in the cob. Maize grains are most used as a staple food and fodder in many parts of the world. The study was conducted to observe the effect of phosphorus on maize crops. The number of grains in maize significantly improved with the different foliar applications of phosphorus. Whereas the foliar effect of phosphorus H_2PO_4 effect was significantly higher on number of grains per cob. Maximum result for no of grains per cob was obtained in treatment 3 with (361.92) grains (table no 4.14) followed by treatment 2 with average no of grains per cob of (270.83). Moreover, in treatment 1 the plant height was recorded with average no of grains (194.75). However, the minimum number of grains per cob was noted in control reaching just up to (146.75) grains in the cob. The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single super phosphate were applied foliar to plants and the result of foliar phosphorus gave batter performance as to other treatments on no of grains per cob of maize plant.

The maize varieties of pack afgoi, Islamabad gold, and sadaf sufaid showed no difference in the number of cobs per plant. Islamabad gold showed a minimum value of (143.00) where no foliar phosphorus was applied while the maximum value for no of grains per cob (g) was obtained (368.25) in Islamabad gold where the foliar phosphorus level was applied at 3%. Overall foliar phosphorus levels showed significant P<0.05 while the interaction between phosphorus and maize varieties showed non-significant difference at P>0.05.

From analysis of variance (table no 4.8), it is declared that treatment phosphorus showed significant difference (p<0.01). However, varieties along with its interaction with treatments indicated non-significant results (p>0.05). Coefficient of variance was found 7.34%. The cob's length (in cm) is the most important factor in determining how the grains are attached. The cob length can be observed when the grains are removed from the cob. And this can be calculated by the maximum result for cob length (cm) was obtained in treatment 3 with (21.25 cm) (table no. 4.16) followed by treatment 2 with an average cob length of (17.3 cm). Furthermore, in treatment 1, the cob length was recorded at an average height of (14.13 cm). However, the minimum cob length was noted to be under control, reaching only (9.46 cm). The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, and the result was that foliar phosphorus gave better performance as compared to other treatments on the cob length (cm) of maize plants.

The maize varieties of pak afgoi, islamabad gold, and sadaf sufaid showed no difference in the number of cobs per plant. Pak afgoi showed minimum value of (9.25 cm) where no foliar phosphorus was applied while the maximum value for cob length (cm) was obtained (21.50 cm) in pak afgoi where the foliar phosphorus level was applied at 3%. Overall foliar phosphorus levels showed significant difference at $P<0.05$ while the interaction between phosphorus and maize varieties were observed at $P>0.05$.

Cob diameter (cm)

From analysis of variance (table no 4.9), it is declared that treatment phosphorus showed significant difference ($p<0.01$). However, varieties along with their interaction with treatments indicated non-significant results ($p>0.05$). Coefficient of variance was found 11.67%. The maize diameter is the most important factor in determining how the grains are attached. The cob diameter can be observed when the grains are removed from the cob. The effect of different phosphorus levels was seen on the cob diameter (cm) of the maize crop. The maximum result for cob diameter was obtained in treatment 3 with (4.11 cm) (table no. 4.18) followed by treatment 2 with an average diameter of (3.72 cm). Furthermore, in treatment 1, the corn diameter was recorded at an average diameter of (2.66 cm). The minimum cob diameter (cm) was found to be under control, reaching only (1.81 cm). The experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single superphosphate were applied foliar to plants, and the result was that foliar phosphorus gave better performance than other treatments on the cob diameter (cm) of maize plants.

The maize varieties of pak afgoi, islamabad gold, and sadaf sufaid showed no difference for cob diameter (cm). Sadaf sufaid showed minimum value of (1.75 cm) where no foliar phosphorus was applied while the maximum value for cob diameter was obtained (4.18 cm) in Islamabad gold where the foliar phosphorus level was applied at 3%. Overall foliar phosphorus levels showed significant difference at $P<0.05$ while the interaction between phosphorus and maize varieties were non significant at $P>0.05$.

Weight of grains per cobs (g)

From analysis of variance (table no 4.10), it is declared that treatment phosphorus showed significant difference ($p<0.01$). However, varieties along with its interaction with treatments indicated non-significant results ($p>0.05$). Coefficient of variance was found to be 6.49%.

Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain. Maize is the most widely grown grain crop throughout the world. The weight of grains was taken in grams and also observed the different effects of phosphorus on the grains of maize crop. Maximum result for weight of grains per cob in grams was obtained in treatment 3 with (80.75 g) (table no 4.20) followed by treatment 2 with average weight of (72.12 g). Moreover, in treatment 1 the weight of grains in (g) was recorded with average height of (57.15 g). However, the minimum grain weight was noted in control reaching just up to (42.45 g). Analysis of variance table for weight of grains per cob (g) the experimental research study was conducted to see the effect of foliar phosphorus on three maize varieties. Three treatments of single super phosphate were applied foliar to plants and the result of foliar phosphorus gave batter performance as to other treatments on weight of grains per cob (g) of maize plant.

The maize varieties of pak afgoi, islamabad gold, and sadaf sufaid showed no difference for weight of grains per cob (g). Islamabad gold showed minimum value of (39.99 g) where no foliar phosphorus was applied while the maximum value for weight of grains per cob was obtained (82.72 g) in sadaf sufaid where the foliar phosphorus level was applied at 3%. Overall foliar phosphorus levels showed significant difference at $P<0.05$ while the interaction between phosphorus levels and maize varieties showed non-significant difference at $P>0.05$.

Table 0.1: Effect of foliar application of phosphorus on days to tasseling of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2: Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0: Control	51 f	50ef	52 e	59 a
	P_1:1%	53d	54 cd	55 c	56 b
	P_2:2%	57 b	56 b	56 b	53c
	P_3 :3%	58 a	59 a	59 a	51 d
Mean Varieties		54^{NS}	54^{NS}	55^{NS}	

Whereas any two means value compared statically differ significantly at $P<0.05$ probability level.

Table 0.2: Effect of foliar application of phosphorus on days to silking of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	66^{NS}	66^{NS}	66^{NS}	76 a
	P_1:1%	69^{NS}	68^{NS}	69^{NS}	72 b
	P_2:2%	72^{NS}	73^{NS}	73^{NS}	68 c
	P_3:3%	76^{NS}	76^{NS}	77^{NS}	66 d

Mean Varieties	71^{NS}	71^{NS}	71^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.3: Effect of foliar application of phosphorus on days to maturity of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	103.25 a	103.65 a	102.45 ab	103 a
	P_1:1%	100.10 c	100.00 c	101.40 b	101 b
	P_2:2%	98.95 c	97.50 d	97.50 d	98 c
	P_3:3%	95.50 e	95.50 e	95.50 e	96 d
Mean Varieties		99^{NS}	99^{NS}	99^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.4: Effect of foliar application of phosphorus on plant height (cm) of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	132.00^{NS}	136.75^{NS}	136.80^{NS}	135.18c
	P_1:1%	161.75^{NS}	166.60^{NS}	161.80^{NS}	163.38b
	P_2:2%	180.03^{NS}	167.85^{NS}	165.30^{NS}	171.06 a
	P_3:3%	171.50^{NS}	175.15^{NS}	171.65^{NS}	172.77 a
Mean Varieties		161.32^{NS}	161.60^{NS}	158.89^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.5: Effect of foliar application of phosphorus on leaf area (cm^2) of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	255.21^{NS}	261.09^{NS}	254.79^{NS}	257.03d
	P_1:1%	277.45^{NS}	282.86^{NS}	272.38^{NS}	277.56 c
	P_2:2%	331.10^{NS}	338.56^{NS}	327.70^{NS}	332.45 b
	P_3:3%	355.88^{NS}	358.22^{NS}	351.25^{NS}	355.12 a
Mean Varieties		304.91 a	310.18 a	301.53 b	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.6. Effect of foliar application of phosphorus on no. of cobs per plant of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	1.00^{NS}	1.00^{NS}	1.00^{NS}	1.00 c
	P_1:1%	1.55^{NS}	1.55^{NS}	1.70^{NS}	1.60 b
	P_2:2%	2.00^{NS}	1.75^{NS}	1.75^{NS}	1.83 b
	P_3:3%	2.50^{NS}	2.50^{NS}	2.25^{NS}	2.41 a
Mean Varieties		1.76^{NS}	1.70^{NS}	1.67^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.7: Effect of foliar application of phosphorus on no. of grains per cob of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	147.75^{NS}	143.00^{NS}	149.50^{NS}	146.75 d
	P_1:1%	194.25^{NS}	194.50^{NS}	195.50^{NS}	194.75 c
	P_2:2%	274.75^{NS}	273.25^{NS}	264.50^{NS}	270.83 b
	P_3:3%	358.00^{NS}	368.25^{NS}	359.50^{NS}	361.92 a
Mean Varieties		243.69^{NS}	244.75^{NS}	242.25^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.8: Effect of foliar application of phosphorus on cob length (cm) of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:PakAfgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	9.25^{NS}	9.75^{NS}	9.40^{NS}	9.47 d
	P_1:1%	14.50^{NS}	14.10^{NS}	13.80^{NS}	14.13c
	P_2:2%	16.85^{NS}	17.55^{NS}	17.50^{NS}	17.30b
	P_3:3%	21.50^{NS}	21.00^{NS}	21.2^{NS}	21.25 a
Mean Varieties		15.52^{NS}	15.60^{NS}	15.48^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.9: Effect of foliar application of phosphorus on cob diameter (cm) of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	1.85^{NS}	1.85^{NS}	1.75^{NS}	1.81 d
	P_1:1%	2.65^{NS}	2.80^{NS}	2.53^{NS}	2.66 c
	P_2:2%	3.69^{NS}	3.63^{NS}	3.85^{NS}	3.72 b
	P_3:3%	4.04^{NS}	4.^{NS}	4.13^{NS}	4.11 a
Mean Varieties		3.06^{NS}	3.11^{NS}	3.06^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Table 0.10: Effect of foliar application of phosphorus on weight of grains per cob (g) of different maize varieties

Treatment		Maize Varieties			Mean (P) Levels
		V_1:Pak Afgoi	V_2:Islamabad gold	V_3:Sadaf Sufaid	
Foliar phosphorus levels	P_0:control	42.98^{NS}	39.99^{NS}	45.39^{NS}	42.45 d
	P_1:1%	56.77^{NS}	56.80^{NS}	57.89^{NS}	57.15 c
	P_2:2%	73.25^{NS}	70.43^{NS}	72.69^{NS}	72.12 b
	P_3:3%	79.12^{NS}	80.42^{NS}	82.72^{NS}	80.75 a
Mean Varieties		63.03^{NS}	61.66^{NS}	64.67^{NS}	

Whereas any two means value compared statically differ significantly at P<0.05 probability level.

Discussion

Results for days to tasseling, silking and maturity are similar to the findings of Amanullah et al., (2019), who reported early phonological parameters with high levels of P in maize crops. According to Amanullah et al., (2010), the early phonological development in maize with P application may be due to the increased root development which helps the plants obtain more P to complete their life cycle quickly**.** Singaram and Kothandaraman (1994) also found that higher P rates improved plant growth and development**.** Similarly, maize cultivars with higher P application had the shortest days to tasseling, silking, and maturity (Akbar et al., 2002; Rasheed et al., 2004). Furthermore, our results show conformation with Rafiullah et al., (2021). Moreover, line outcomes were observed by (Harshithaet al., 2017; Masood et al., 2011; Thavaprakaash et al., 2006). Moreover, Amanullah et al., (2016) concluded that the foliar P treated plots (rest) had better performance in terms of improved growth, higher yield, and yield components than control (no foliar spray). Wahid et al. (2020) reported that maize plant height increased with increases in P levels. Phosphorus increases plant growth and development by taking part in metabolic activity, enhancing the photosynthetic process and photosynthetic assimilation and, as such, increasing plant height. Similarly, Singaramet et al., (1994) observed rapid plant growth and development with the highest rate of P level. As with soil application of P foliar application could also increase plant height by supplementing soil-applied P. Furthermore, results for leaf area (cm^2) support the outcome of Amanullah et al., (2016). In terms of improved growth, higher yield, and yield components, they concluded that the foliar P treated plots (the rest) outperformed the control (no foliar spray). Line findings were documented by Harshitha et al., (2017). Furthermore, similar results were observed for the number of cobs per plant by Masood et al., (2011) who concluded that increasing the P level had a directly proportional effect on the number of cobs $plant^{-1}$ of maize. Furthermore, the number of cobs per plant was shown to be consistent with (Thavaprakaash et al., (2006**).** According to Arain et al. (1989), increasing the P application increased the number of cobs $plant^{-1}$ of maize. They argued that a smaller number of cobs $plant^{-1}$ in the control plots resulted the lower number of grains $plant^{-1}$which finally resulted **a** lower grain yield. Furthermore, results for number of grains per cob supported the outcome of Amanullah et al., (2016). In terms of improved growth, higher yield, and yield components, they concluded that the foliar P treated plots (the rest) outperformed the control (no foliar spray**)** line findings were recorded by (Harshitha et al., 2017; Rafiullah et al., 2020; Maqsood et al., 2011; Sharma & Sharma, 1991). Younis et al., (2014) suggested that foliar application of P could increase fertilizer use efficiency**.** According to Arain et al., (1989), the number of grains cob^1 of maize increased as P application increased. Similarly, Gooding and Devies, (1992) reported improved wheat performance following foliar application of p. seth, & Mosluh (1981) reported a significant increase in the number of grains per spike of wheat following foliar application of phosphorus Furthermore, the results of cob length (cm) are similar to the findings of Harshitha et al., (2017). According to Thavaprakaash et al., (2006), the results of cob length (cm) showed a line outcome. Moreover, results of results of Results of cob diameter (cm) were showed line outcome to Thavaprakaash et al., (2006). Furthermore, Results of weight of grains per cob are similar with the findings of Harshitha et al., (2017).

Conclusion and recommendation

The study concluded that the foliar application of single super phosphate (60 kg ha^{-1}) significantly enhanced maize growth and yield, improving various morphological and yield traits. It is recommended for farmers to adopt this application rate to achieve better productivity and quality. Further research is needed to evaluate its long-term effects and optimize its use in maize crop improvement programs.

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