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Mitigating Climate Change Effects on Maize Production through Sowing Time Alteration and Hormonal Application

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Field experiment was carried out at Agronomy Research Farm, The University of Agriculture Peshawar to study the impact of different sowing times and foliar application of salicylic acid on maize production. The research was carried out in randomized complete block design with split arrangement having three replications with plot size of 3.75 m x 4 m, with plant to plant distance of 25 cm and row to row distance of 75 cm. The experiment consisted of four sowing dates (25th May, 14th June, 4th July and 24th July) allotted to main plots, while CS 200 (Hybrid) and Azam and different levels of salicylic acid (0 mg L^{-1}, 100 mg L^{-1}, 200 mg L^{-1} and 300 mg L^{-1}) were assigned to subplots. Maize sown on 14th June resulted in maximum grains ear^{-1} (429.7), 1000 grains weight (274.6 g), leaf area index (2.3), leaf area $plant^{-1}$ (3513.5 cm^2), biological yield (10597 kg ha^{-1}) and grain yield (4268 kg ha^{-1}). Salicylic acid @ 300 mg L^{-1} resulted in maximum grains ear^{-1} (456.3), thousand grains weight (285.8 g), biological yield (10579.5 kg ha^{-1}) and grain yield (4200.7 kg ha^{-1}). Hybrid resulted in maximum grain yield (4801.1 kg ha^{-1}), biological yield (11230 kg ha^{-1}) and 1000 grains weight (318.1 g). The interaction between salicylic acid × varieties for chlorophyll content and grains ear^{-1} were found significant. It is concluded that maize CS-200 sown on 14th June along with foliar application of 300 mg L^{-1} of salicylic acid produced maximum yield and yield components.

Keywords: Sowing times, Salicylic acid levels, Maize, leaf area, chlorophyll, grains, yield

INTRODUCTION

Pakistan was listed as the 12th most highly exposed country to climate change by the World Bank. The economy of Pakistan is based on agriculture, which contributes 19.8% to the GDP and employs about 42.3% of the labor force, and is providing livelihood opportunities for approximately 62% of the rural population. Besides its importance for Pakistan, this sector is facing serious challenges from changes in climate, such as rise in temperature, droughts, floods, and losses in yields. Due to climate change, increase in temperature is expected in future which ultimately leads to change in rainfall pattern, which negatively affect most of the crops (Hanif and Ali, 2014). Proper positioning of the sowing time becomes more important due to climate change (Laux et al., 2010; Folberth et al., 2012; Liu et al., 2012). Besides soil health, irrigation, fertilizer application proper sowing time with appropriate variety selection is worthwhile (Ramankutty et al. 2002; Khan et al., 2009). Negative impact of climate change can be reduced by sowing crop at optimum time (Waha et al., 2013). Although maize is a summer crop and delay in sowing deteriorates its productivity due to limited time to complete its life cycle (Akmal et al. 2014; Hanif and Ali, 2014). Climate change has created challenges for the agricultural sector induced increases in temperatures, rainfall variation and the frequency and intensity of extreme weather events are adding to pressures on global agricultural and food systems (FAO, 2016).

Sowing dates had great impact in term of yield of different crops and it is one of the yield increasing methods because with the help of sowing dates we know about the proper time to sow a crop. Sowing dates is one of the major factor as to grow a crop because sowing dates means different environmental conditions such as light, humidity, temperature that can affect different plant growth stages as well as quality and quantity of crop (Dehghan, 2007). Planting of maize crop early can have a negative effect like it can increase transpiration, inhibits pollination and increase respiration that is because of the high temperature which in turn decrease grain yield, and if planting is delayed then the crop can't get maximum environmental condition which also result in the reduction of grain yield (Hortick and Arnold, 1965).

In Pakistan maize grown successfully due to favorable environmental conditions for it, but in comparison to other maize producing countries, its production at farmers field is very low (Bakht et al. 2006). Proper selection of sowing date can optimize maize yield as delayed sowing has negatively effect on grain yield. It has been observed that yield of maize was reduced due to late sowing. For optimum utilization of nutrients, solar radiations and moisture, it must be grown on optimum sowing date. Sowing dates affect growth and yield of maize by actually affecting the environment in which it is grown. Late planting disturbed the proper condition for maize which lead to poor performance or complete failure. Early planting also lead to serious reduction in maize yield because of dry condition in tasseling stage. To get greater yield from maize it must to grow it on optimum time to effectively utilize the solar radiation (Otegui et al., 1995).

Salicylic acid is of phenolic in nature and it help in regulating different plant physiological processes, like opening and closure of stomata, photosynthesis, inhibition of ethylene biosynthesis. It also acts as potential non enzymatic antioxidant which influence different plant processes positively such as ion uptake, stress tolerance in many plants and transpiration (Arfan et al. 2007). Salicylic acids have positive effect on different biological aspects in crops (Wang and Li, 2006). Salicylic acid is an endogenic phytohormone and it may positively affect many of the physiological processes, as it increases the seedling growth of the plant (Ahmad et al., 2012). Salicylic acid application has a great tolerance to environmental stresses (Kabiri et al., 2012). It also decrease membrane permeability and can maintain water content in tissue (Farooq et al., 2008). Exogenous application of salicylic acid resulted in plant tolerance to different biotic and abiotic stresses, it have also positive effect when used seed primed. In plants tolerant mechanisms, salicylic acid inhibit activation of biochemical pathways (Najafian et al., 2009). Effect of SA can also resulted in bio regulator effect which in turn have positively affected different plant physiological and biochemical processes such as photosynthesis, sink to source relation, elongation of cells, ion uptake, cell differentiation, protein synthesis, enzymatic activities and capability of plants toward antioxidant (El-Tayeb, 2005).

According to these facts, present experiment was conducted to know the desirable effect of salicylic acid with relation to early, optimum and delayed sowing time for obtaining higher yield of different maize varieties.

MATERIALS AND METHODS

An experiment was conducted at Agronomy Research Farm, The University of Agriculture Peshawar during the year 2017-2018. The experiment was laid out in randomized complete block design (RCBD) with split plot arrangement having three replications. Four salicylic,acid (SA) levels (0 mg L^{-1}, 100 mg L^{-1}, 200 mg L^{-1} and 300 mg L^{-1}) were applied at seedling stage (4th leaf collar stage) along with four sowing dates (25th May, 14th June, 4th July and 24th July) on maize crop. Main plots were assigned for sowing dates while subplots were assigned for SA levels. Plot size was 3.75 m x 4 m having R to R distance of 75 cm. Maize varieties hybrid (CS-200) and local (Azam) were used. Nitrogen and phosphorous were applied @ 120:60 kg ha^{-1} as Urea and SSP. Mean monthly temperature (^oC), rainfall (mm), relative humidity (%) and solar radiation (MJ m^{-2}) of the experimental site of Peshawar received from Pakistan Metrological Department (Fig. 1).All plots received agronomic practices uniformly.

Methodology before and after sowing

Field was irrigated ten days before sowing. When the field was in proper moisture condition than maize was sown on 25th May 2017. While other sowing dates were followed twenty (20) days interval. Salicylic acid was sprayed at fourth leaf collar stage on each sowing date. Seven irrigations and three hoeing were applied to each sowing dates.

Procedure for salicylic acid application

Three samples of salicylic acid i.e 100, 200 and 300 mg L^{-1} were taken for each subplot. Although salicylic acid is partially soluble in distilled water, therefore in one liter distilled water given sample and 20 mL ethanol was added at room temperature and stir with magnetic stirrer for 1 min. Pour each sample into separate 1 liter bottle with sprayer head and then each sample was applied to each subplot.

Following parameters were recorded during the course of study:

Chlorophyll content (mg cm^{-2}):

Data were recorded by selecting three random plants and then recording chlorophyll content of three leaves of each plant using chlorophyll meter (SPAD-502, Japan).

Light interception:

Data regarding light interception was recorded that light falling at the top of canopy, reflected light from the canopy and transmitted light through canopy by lux meter and hence light interception proportion (Q) was calculated by the following formula. $Q= (I_o\text{-R-T})\ I_o$

Where

Io= Amount of light falling on the top of the canopy

R= Amount of light reflected by the canopy

T= Amount of light transmitted through the canopy

Data on light interception was recorded when the plant reach to tasseling stage.

Leaf area Plant^{-1} (cm^2):

LA plant^{-1} was recorded by selecting five plants manually in each subplot at silking stage and then average was worked out to calculate Leaf area plant^{-1} by following formula.

Leaf area plant^{-1}= Leaf length × Leaf width × C.F

Leaf area index (LAI):

Leaf area index were recorded as the leaf area ratio to the below ground area using following formula:

LAI= Number of plants m^{-2} x Number of leaves plant^{-1} x Mean leaf area

Plants at harvest (ha^{-1}):

Plant at harvest were counted in three central rows in each subplot and then converted to plants at harvest ha^{-1} by using following formula:

$$\text{Plants ha}^{-1} = \frac{\text{Number of plants counted in three central rows}}{\text{R} - \text{R distance (m)} \times \text{row length (m)} \times \text{number of rows}} \times 10000\ \text{m}^2$$

Number of grains ear-1:

Data regarding no. of grains ear^{-1} were recorded by selecting five ears from each plot and then threshed and was counted and converted into average grains ear^{-1}.

Thousand grains weight (g):

Data regarding,,1000 grains weight was recorded from seed lot of each plot, two samples each of 1000 grains was collected randomly, weighted and average was calculated.

Biological yield (kg ha^{-1}):

In each subplot, 3 central rows were harvested, then it was sun dried, then for calculating biological yield it was weighed and converted to kg ha^{-1} by using the following formula:

Grain yield (kg ha^{-1}):

In each subplot, middle 3 rows were harvested, sun dried, threshed, cleaned, weighed with an electronic balance and data were changed to kg ha^{-1} by using following formula:

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain yield (kg) in two central rows}}{\text{No. of rows harvested} \times \text{Row length} \times \text{R-R distance}} \times 10000$$

Statistical analysis

The data was statistically analyzed by using analysis of difference methods suitable for RCBD with split plot arrangement. Means were compared using LSD test at 0.05 level of probability, when the F-values were significant (Steel et al. 1997).

RESULTS AND DICUSSION

Chlorophyll content (mg cm^{-2})

Analysis of the data revealed that different sowing times (SD), salicylic acid (SA), maize varieties (V) and SA × V interaction significantly affected chlorophyll content while possible interactions were found non-significant (Table. 1). Maximum chlorophyll content (40.5 mg cm^{-2}) was obtained at 25th May sowing, followed by 14th June sowing (37.6 mg cm^2), while minimum chlorophyll content (31.5 mg cm^{-2}) was obtained at 24th July sowing (Fig. 1(a)).

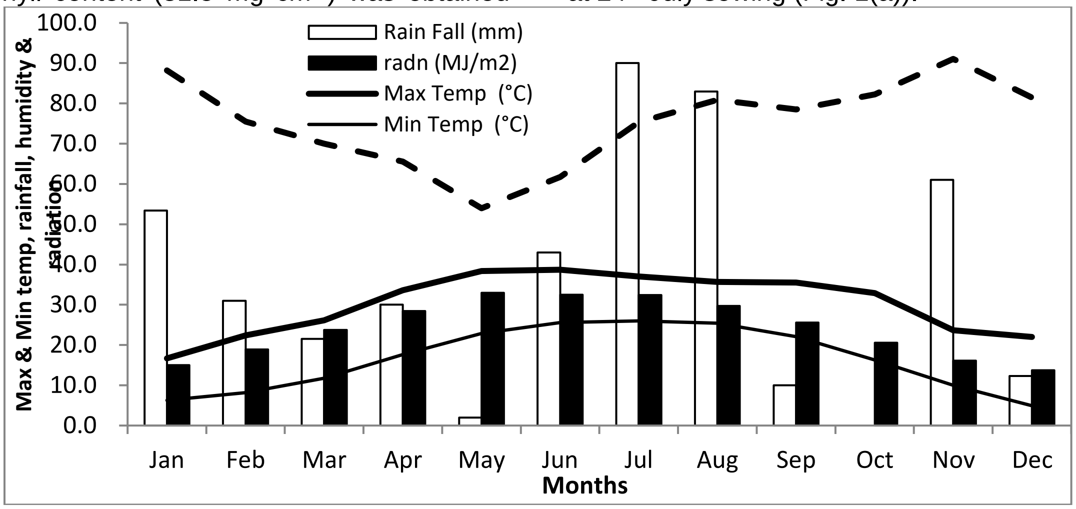

Figure 1; Mean monthly temperature (Max & Min) (ºC), rainfall (mm), relative humidity (%) and solar radiation (MJ/m^2) of the experimental site of Peshawar.

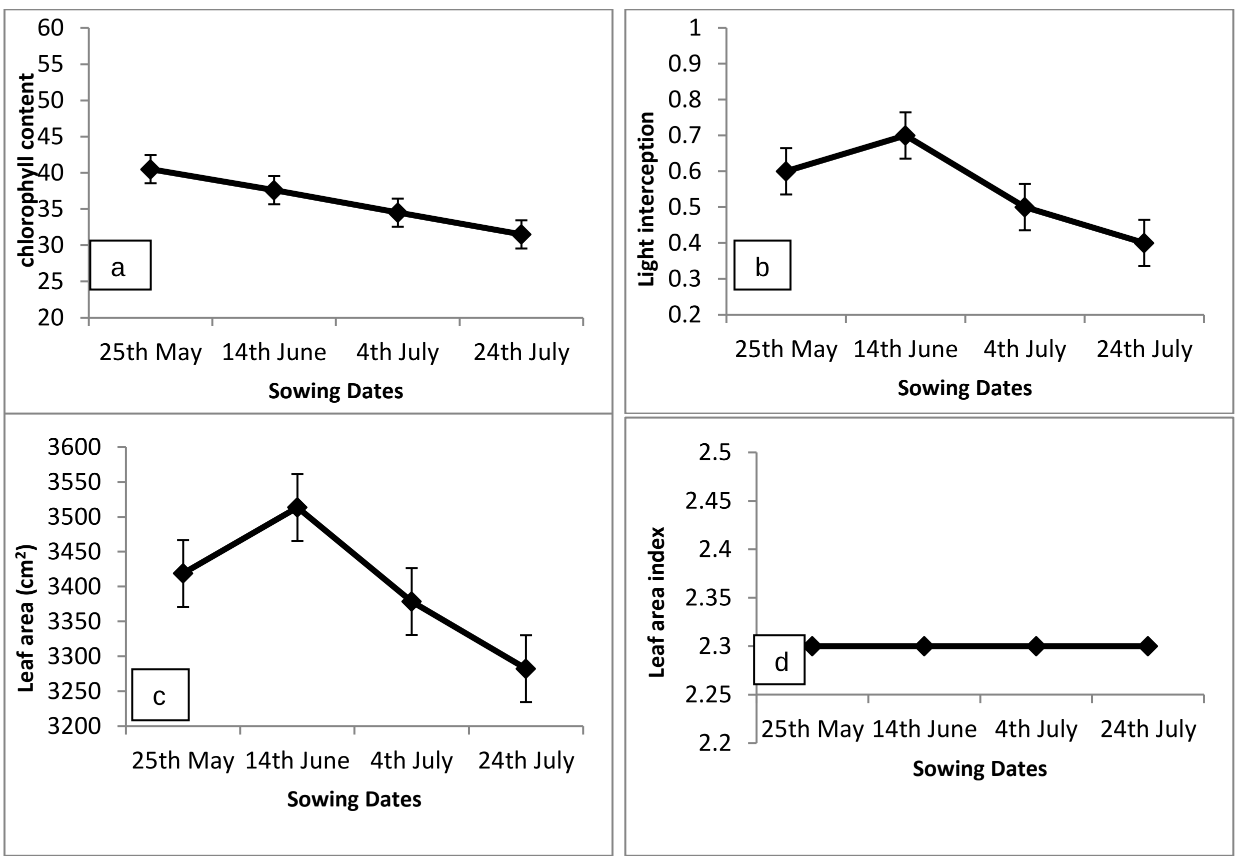

Figure 1;Chlorophyll content(a), Light interception (b), leaf area plant^{-1}(c) and leaf area index (d) as affected by sowing dates.

Table 1; Analysis of variance for chlorophyll content, light interception, leaf area plant^{-1} (cm^2), leaf area index, grains ear^{-1}, 1000-grains weight, biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}) of maize as affected by sowing dates and salicylic acid levels.

SOV	DF	Chlorophyll content	Light interception	Leaf area plant^{-1}	Leaf area index	Grains ear^{-1}	1000-grains weight	Biological yield	Grain yield
Rep	2	2.84375 NS	0.001904	13862.47	0.006161	31.32292	2.84375 NS	509.8854	733.8229
SD	3	357.1215***	0.236875***	220057***	0.097803***	10830.93***	357.1215***	82281.87***	164413.8***
Error 1	6	1.204861	0.001888	6825.163	0.003033	57.90625	1.204861	344.2465	470.5035
SA	3	1083.51***	0.180292***	37805.31**	0.016802**	76448.62***	1083.51***	37449.62***	38525.48***
V	1	1403.01***	0.573504***	108541.5 NS	0.048241***	335002.5***	1403.01***	46382911***	40408043***
SA x V	3	23.09375***	0.00289 NS	20343.86 NS	0.009042 NS	640.1771***	23.09375***	216.816 NS	363.2882 NS
SD x SA	9	2.575231 NS	0.003202 NS	17370.8 NS	0.00772 NS	72.18634 NS	2.575231 NS	1068.881***	1332.733 NS
SD x V	3	0.871528 NS	0.00309 NS	11710.08 NS	0.005204 NS	109.9826 NS	0.871528 NS	503.4549 NS	451.8438 NS
SD x SA x V	9	1.954861 NS	0.002839 NS	4728.704 NS	0.002102 NS	115.6863 NS	1.954861 NS	219.7604 NS	1012.353 NS
Error 2	56	1.400298	0.002074 NS	8543.621	0.003797	58.2128	1.400298	186.1443	652.7976
Total	95								
	CV 1	3.04 %	6.52 %	2.43 %	2.43 %	1.86 %	3.71 %	0.17 %	0.52 %
	CV 2	3.28 %	6.84 %	2.71 %	2.71 %	1.87 %	5.12 %	0.12 %	0.61 %

DF=Degree of freedom, SOV=Source of Variation, CV=Coefficient of variation, NS=Non-significant

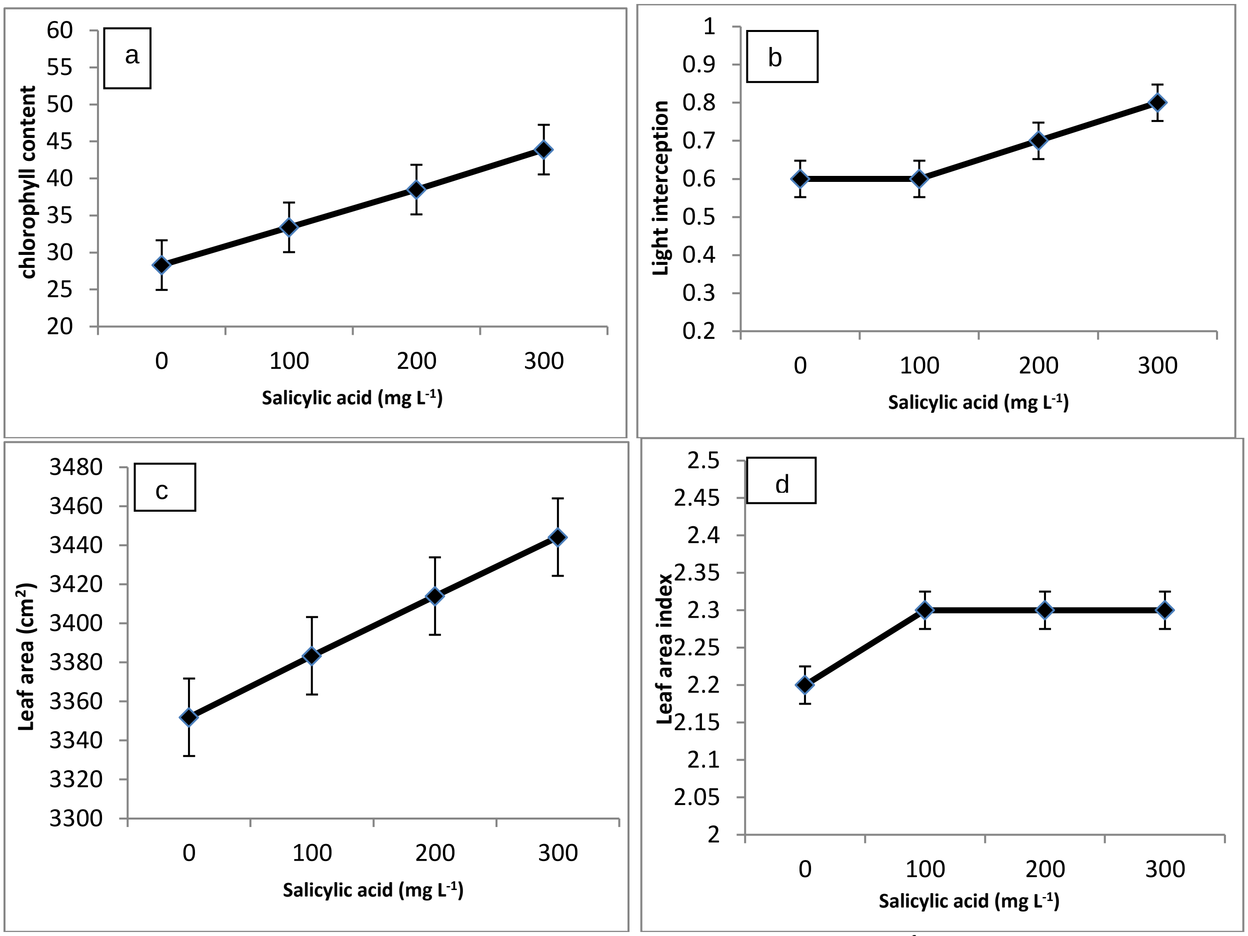

Figure 2; Chlorophyll content (a), Light interception (b), leaf area plant^{-1}(c) and leaf area index (d) as affected by salicylic acid.

The possible reason might be solar radiation, increase in thermal units increases chlorophyll content, so early and late planted maize receive less solar radiation hence resulted in lower chlorophyll content. Same results were reported by Singh and Usha (2005) that higher chlorophyll content in plants is due to proper temperature prevailing its growth period while lower chlorophyll content is because of low temperature. Plots treated with 300 mg L^{-1} of salicylic acid resulted in higher chlorophyll content (43.9 mg cm^{-2}), followed by 200 mg L^{-1} salicylic acid (38.5 mg cm^{-2}) applied plots, while less chlorophyll content (28.3 mg cm^{2}) was recorded for 0 mg L^{-1} of salicylic acid (Fig. 2(a)). These results are in line with Khodary (2004), El-Tayeb (2005), Agrawal et al. (2005) and Ghai et al. (2002) who reported that salicylic acid increases chlorophyll content. Similarly higher chlorophyll content (39.9 mg cm^{-2}) was observed for hybrid (CS-200), while lower chlorophyll content (32.2 mg cm^{-2}) was noted for Azam. Regarding interaction between SA × V, hybrid (CS-200) had more (39.9 mg cm^{-2}) chlorophyll content as compared to Azam (32.2 mg cm^{-2}) (Fig. 3(a)). Maize hybrid have dark green, wide and erect leaves and it has the capability to accumulate more chlorophyll content.

Light interception

Sowing dates (SD), salicylic acid (SA) and maize varieties (V) significantly affected light interception (Table 1). The interactions were found non-significant. More light (0.8) were intercepted on 14th June planting, while less light (0.5) interception were recorded on 24th July planting (Fig. 1(b)). Singh and Usha (2005) stated that proper temperature falling plant growth period resulted in higher chlorophyll content as well as leaf area which directly enhanced crop yield.

Similarly high amount of light (0.8) were intercepted at 300 mg L^{-1} of salicylic acid, while lower amount of light (0.6) were intercepted at control plots (Fig. 2(b)). Piatelli et al. (1969), Khan et al. (2003) and Sakhabutdinova et al. (2003) said that SA in plants enhanced nutrient uptake, chlorophyll synthesis protein synthesis, stomatal closure, transpiration, inhibition of ethylene biosynthesis and amount of light absorption which will lead to higher photosynthetic rate. In case of maize varieties, more light (0.7) were intercepted by hybrid (CS-200), while less light (0.6) were intercepted by Azam (Fig. 3(b)). Stewart et al. (1977) founded that due to upright leaves in hybrids more sunlight is penetrated resulted in increased plant population. Rosenthal and Gerik (1991) investigated that yield among various maize hybrids is different due amount of different light interception and use efficiency by plants.

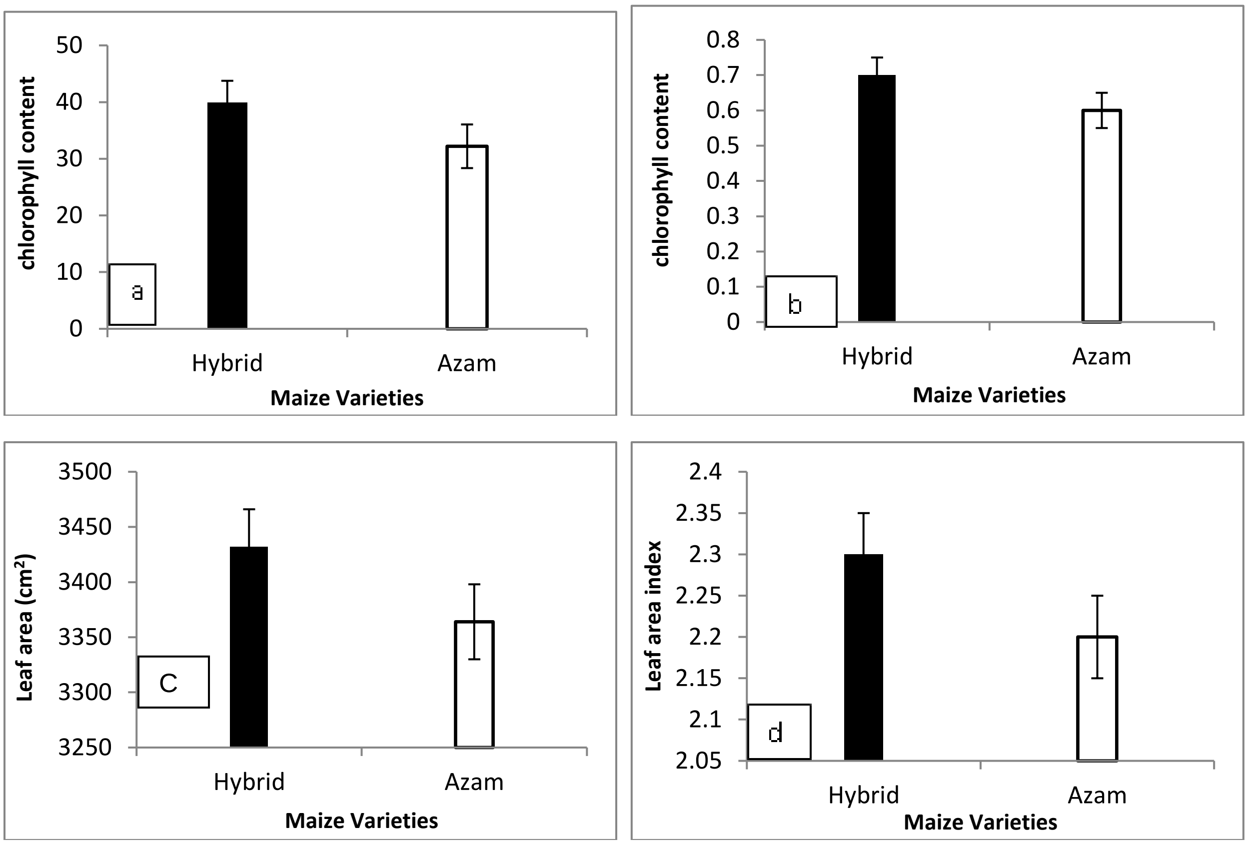

Figure 3;Chlorophyll content(a), Light interception (b), leaf area plant^{-1}(c) and leaf area index (d) as affected by maize varieties.

Leaf area,,plant^{-1},,(cm^2)

Data showed that leaf area plant^{-1} was significantly influenced by sowing times (SD), salicylic acid (SA) and maize varieties (V) (Table 1). The interactions were found non-significant. Mean table of the analysis showed that larger leaf area plant^{-1} (3513.5 cm^2) was measured when maize planted on 14th June, while smaller leaf area plant^{-1} (3282.4 cm^2) was measured from maize planted on 24th July (Fig. 1(c)). Increase in leaf area plant^{-1} might be due to more duration of solar radiation and thermal units available for growing periods. These findings are in line with Foster and Timmerman (2009) they observed that significant increase was observed in leaf area of maize when sowing is done early. Amarawat et al. (2013) said that variation in leaf area occur due to variation in planting period. In case of salicylic acid, larger leaf area plant^{-1} (3444.2 cm^2) was recorded for 300 mg L^{-1} salicylic acid applied plots, followed by 200 mg L^{-1} of SA (3414 cm^2) while smaller leaf area plant^{-1} (3351.9 cm^2) was recorded for 0 mg L^{-1} of salicylic acid (Fig. 2(c)).

Pancheva et al*.* (1996) and Anosheh et al. (2012) also stated that foliar application of salicylic acid enhanced leaf area of crops. Khan et al*.* (2003) also observed that salicylic acid had significant effect on plant dry matter production, leaf area and photosynthetic rates. Similarly higher leaf area plant^{-1} (3432 cm^2) was observed for hybrid (CS-200), while lower leaf area plant^{-1} (3364.8 cm^2) was noted for Azam (Fig. 3(c)). These outputs are similar with Awan et al. (2001) who said that leaf area plant^{-1} was significantly affected by different maize cultivars. Ayub et al. (2001) also concluded that due to varietal differences growth and yield characteristics were significantly affected.

Leaf area index

Sowing dates (SD), salicylic acid (SA) and maize varieties (V) significantly affected LAI of maize, interactions were found non-significant (Table 2). Maximum leaf area index (2.3) was recorded on 14th June which is statistically similar to 25th May and 24th July and minimum leaf area index (2.2) of maize was recorded on 24th July respectively (Fig. 1(d)). This increase in leaf area index might be due to that more solar light and thermal unit were absorbed which resulted in more leaf area production at optimum growth periods. These results was also stated by Foster and Timmerman (2009) who noted that planting maize at early and optimum time gives increase in leaf area index. Dat et al. (1998) also said that delayed planting reduce leaf area index. Concentration of 300 mg L^{-1} of salicylic acid produced maximum leaf area index (2.3), statistically similar to 200 and 100 mg L^{-1} salicylic acid while minimum leaf area index (2.2) was noted for control plots (Fig. 2(d)). Somayyeh and Sepehri (2012) and Abdel-Waheed et al. (2006) concluded that application of SA when applied exogenously enhanced leaf area index. Similarly hybrid (CS-200) have maximum leaf area index (2.3) while minimum leaf area index (2.2) was recorded for Azam (Fig. 3(d)). Soya et al. (2001) founded that maize hybrids have genetically improved leaf area, stem diameter, ear length which will lead to increase yield components of maize.

Grains ear^{-1}

Analysis showed that sowing dates (SD) notably influenced grains ear^{-1} (Table 1). More grains ear^{-1} (429.7) were counted from maize planted on 14th June, followed by 25th May planting (417.1), while less grains ear^{-1} (380.5) were counted from 24th July planting (Fig. 4(a)). The possible reason may be that mid sown of maize was the optimum time for it, while number of grains ear^{-1} was reduced when planting is delayed due to unfavorable condition. Conclusion of our results are connected to Ahmed et al*.* (2011) who said that number of grains ear^{-1} were enhanced for early planted crop as compared to late planted crop. Said et al*.* (2012) stated that maximum grains ear^{-1} were recorded from maize crop sown early as compared to late sown crop. Grains ear^{-1} were significantly affected by salicylic acid levels. Less grains ear^{-1} (328.2) were noted in plots untreated as in comparison to treated plots with 300 mg L^{-1} of salicylic acid (456.3) (Fig. 5(a)). Emam et al. (2013) observed that grains spike^{-1} were enhanced by exogenous application of salicylic acid. Similar results was also noted by Ashraf et al. (2010), who reported that foliar application of salicylic acid improve grains spike^{-1} which might be due to improved rubisco activity and photosynthetic capacity. More grains ear^{-1} (466.1) were recorded for hybrid (CS-200) while less grains ear^{-1} (348) were recorded for Azam (Fig. 6(a)). SA × V have significant effect on grains ear^{-1}, more grains ear^{-1} (466.1) were counted for hybrid (CS-200) as compared to Azam (348). Tollenaar (1991) and Yilmaz et al. (2008) showed that yield and yield components of corn were significantly affected by planting patterns, planting densities and maize hybrids.

Thousand grains weight (g)

Sowing dates (SD), salicylic acid (SA) and maize varieties (V) significantly influenced 1000 grains weight (Table 1). However, interactions were found non-significant. Mean data showed that heavier thousand grains (274.6 g) was noted when maize planted on 14th June, followed by 25th May planting (266.2 g), while lighter thousand grains (246 g) were recorded from 24th July planting (Fig. 4(b)). The possible reason could be that early planting of maize crop got optimum period for growing, while delayed maize planting got shorter and cooler period for growing which affected grain formation and fertilization of maize crop. These results are in accordance with Cirilo and Andrade (1996) and Ali (2015) who reported that lighter grains weight were recorded in late planting of maize. Application of 300 mg L^{-1} of salicylic acid resulted in heavier grains (285.8 g), followed by 200 mg L^{-1} (267.9 g), while lighter grains (236.9 g) were noted for control plots (Fig. 5(b)). Comparable output were documented by Farooq et al*.* (2008), Basra et al*.* (2006) and

Hussain et al., (2010) who said that application of salicylic acid enhance vigor of the seed and ultimately resulted in heavier and larger seeds. Dawood et al., (2012) also stated that salicylic acid improved 1000 grains weight of mungbean and sunflower. Heavier thousand grains weight (318.1 g) was observed for hybrid (CS-200), while lighter thousand grains weight (205.1 g) was observed for Azam (Fig. 6(b)). Benga et al., (2001) concluded that maize hybrid have improved plant morphology and maximum number of grains ear^{-1} were obtained, which directly enhanced thousand grains weight.

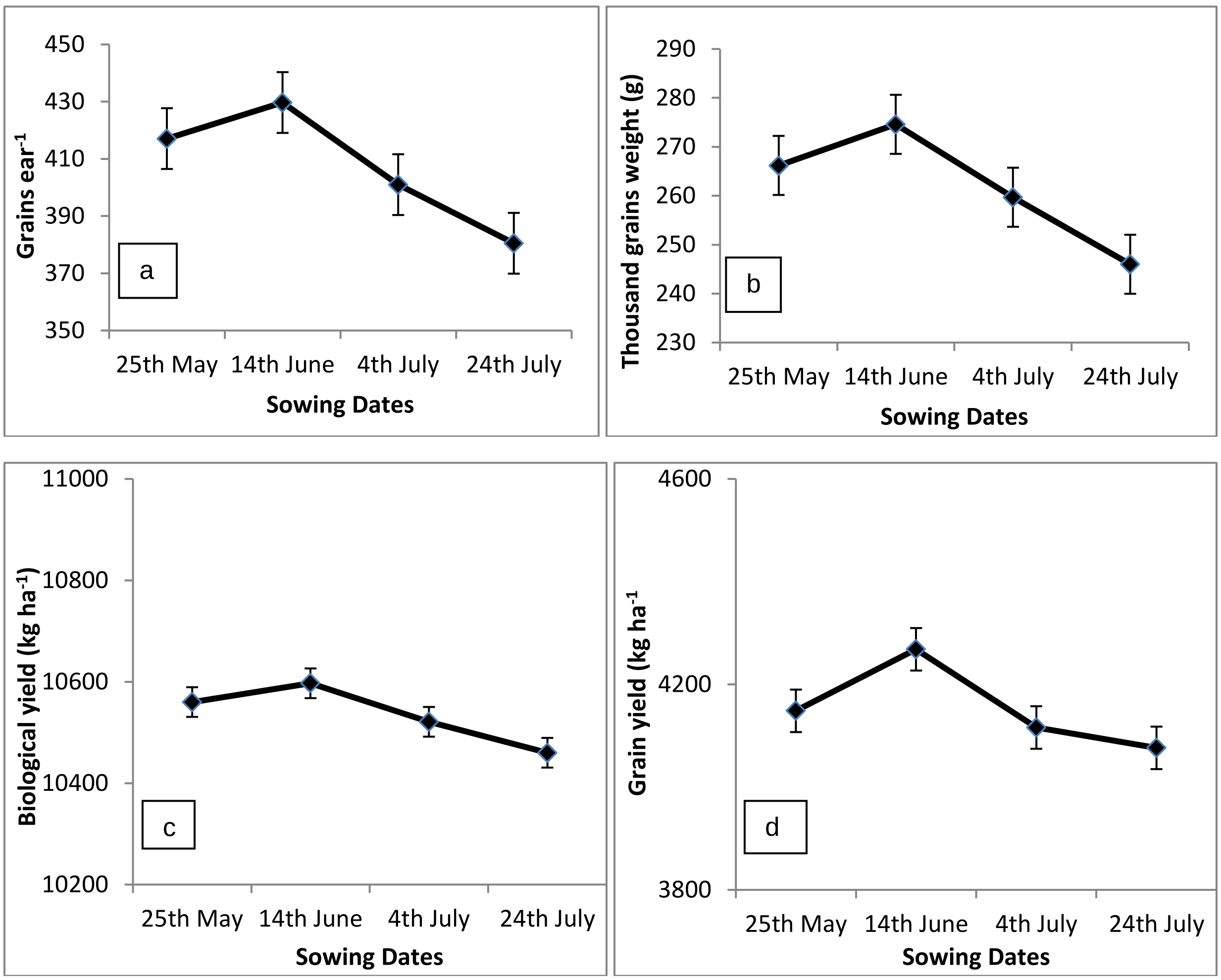

Figure 4;Grains ear^{-1}(a), thousand grains weight (b), biological yield (c) and grain yield (d) as affected by sowing time.

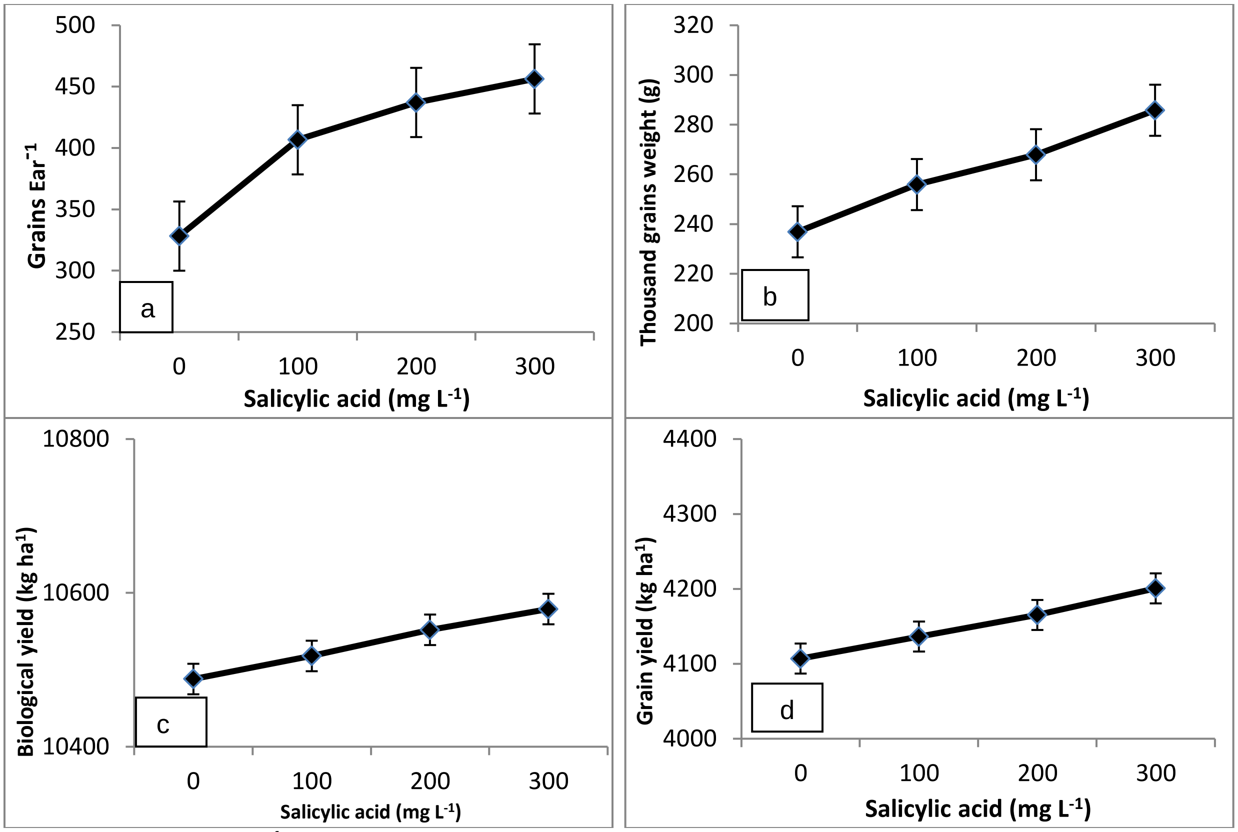

Figure 5; Grains ear^{-1}(a), thousand grains weight (b), biological yield (c) and grain yield (d) as affected by salicylic acid.

Biological yield (kg ha^{-1})

Data regarding biological yield of maize as automated by sowing dates (SD), salicylic acid (SA) and maize varieties (V) are reported in the Table 4. Significant differences were noted in the biological yield of maize by sowing dates, salicylic acid, maize varieties and interaction between SD × SA. Maize sown on 14th June resulted in maximum biological yield (10597.3 kg ha^{-1}), followed by 25th May sowing (10560.5 kg ha^{-1}), while minimum biological yield (10460.4 kg ha^{-1}) was noted on 24th July sowing (Fig. 4(c)). This could be due to more sunlight absorption and longer growth period for early sown crop which resulted in more dry matter and ultimately increased biological yield. These findings are matched with Maddonni et al., (2004) and Cirilo and Andrade (1996) who stated that delayed planting resulted in decrease dry matter. Aslani et al., (2012) also told that due to late sowing biomass was decreased. Maximum biological yield (10579.5 kg ha^{-1}) was recorded for plots that are treated with 300 mg L^{-1} of SA, while lower biological yield (10488.9 kg ha^{-1}) was recorded for plots that are untreated (Fig. 5(c)). Similar result was also documented by Gomez et al. (1993) who suggested that application of lower concentration of salicylic acid augmented plant biomass and yield of wheat. Ahmad et al. (2012) also observed that catalase and peroxidase content was accelerated by SA. Maximum biological yield (11230 kg ha^{-1}) was noted for hybrid (CS-200), while minimum biological yield (9839.8 kg ha^{-1}) was observed for Azam (Fig. 6(c)). Interaction between SD × SA exhibited that biological yield increased when sowing was delayed up to 14th June and have increase in SA, while further delay in sowing decrease biological yield. Soya et al., (2001) concluded that leaf ratio, ear ratio, stem ratio, dry herbage yield and green herbage yield were significantly affected by corn hybrids. Turgut et al., (2005) also suggested that corn hybrids had significantly affected dry matter yields and corn forage.

Grain yield (kg ha^{-1})

Data revealed that sowing dates (SD), salicylic acid (SA) and maize varieties (V) significantly affected grain yield, while all possible interactions were found non-significant (Table 1). Mean values for sowing dates showed that higher grain yield (4268.3 kg ha^{-1}) was noted when maize was sown on 14th June, followed by 25th May (4148.5 kg ha^{-1}), while lower grain yield (4076.4 kg ha^{-1}) was noted on 24th July sowing (Fig. 4(d)). The possible reason for this increase in grain yield is may be due to the fact that planting maize crop at optimum time enhanced grain yield due to favorable condition for growth as compared to early and late planting. These findings are related with Jaliya et al., (2008), Aziz et al., (2007) and Namakka et al., (2008) who investigated that at optimum planting time higher grain yield were recorded while for early and delayed planting lower grain yield were recorded. Application of 300 mg L^{-1} of salicylic acid resulted in higher grain yield (4200.7 kg ha^{-1}), while lower grain yield (4107 kg ha^{-1}) was noted for control plots (Fig. 5(d)). Nabi et al., (2013) stated that salicylic acid concentration resulted in higher grain yield as compared to untreated treatments. Rehman et al., (2011) also reported that grins per cob, grain yield and harvest index were significantly increased by SA in maize crop. Similarly higher grain yield (4801.1 kg ha^{-1}) was recorded for hybrid (CS-200) as compared to Azam. (3503.5 kg ha^{-1}) (Fig. 6 (d)). These result are matched with Duvick and Cassman (1999) who said that hybrids have been bred with increased grain yield and yield stability as their primary goal.

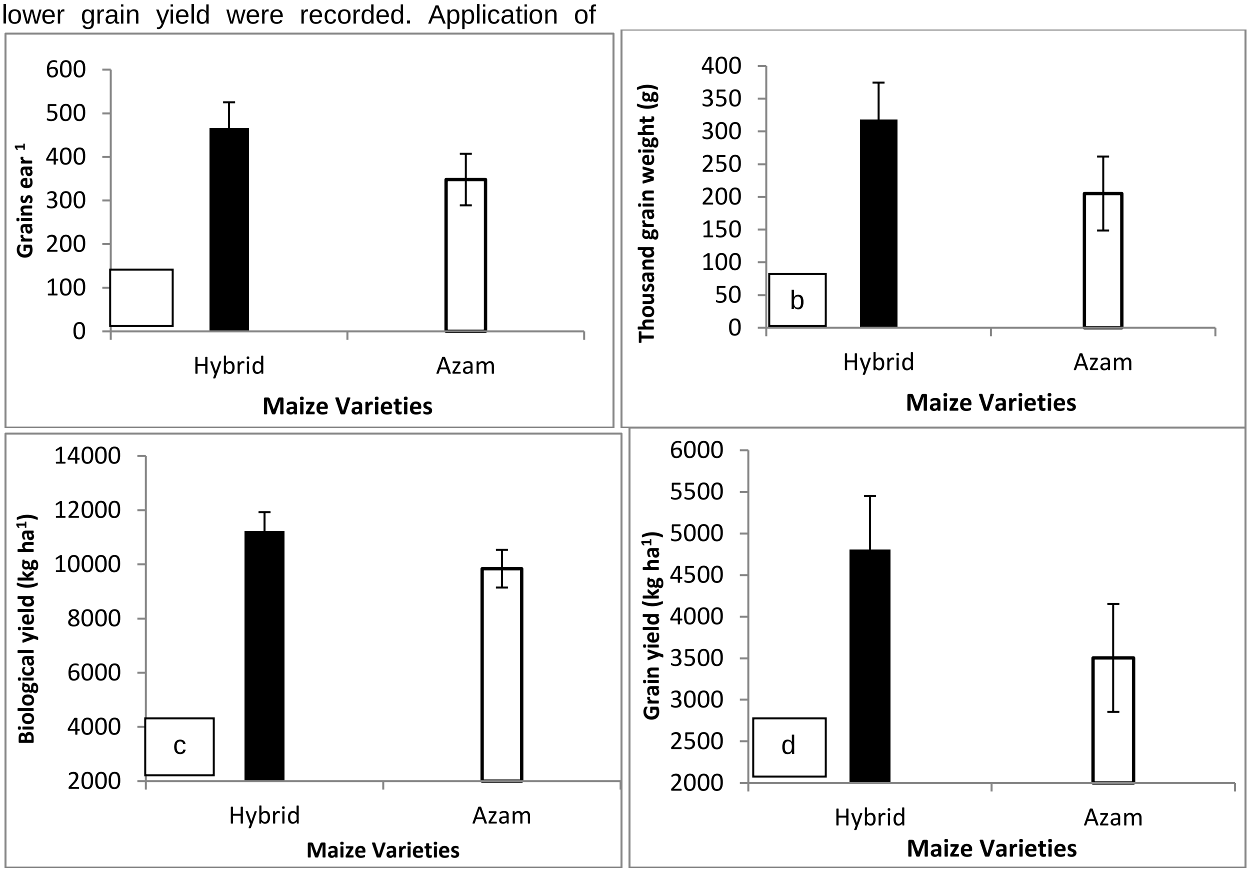

Figure 6;Grains ear-1(a), thousand grains weight (b), biological yield (c) and grain yield (d) as affected by maize varieties.

CONCLUSION

On the basis of findings, it is concluded that Maize variety CS-200 sown on 14th June resulted in maximum yield and yield components with foliar application of 0.2 kg ha^{-1} salicylic acid.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

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AUTHOR CONTRIBUTIONS

Zeeshan sharif designed and performed the experiment. Ishaq Ahman Mian analyzed the data. Asim Muhammad reviewed the manuscript and added overall corrections.

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