African Journal of Agricultural Research Vol. 6(22), pp. 5156-5167, 12 October, 2011
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.1132
ISSN 1991-637X ©2011 Academic Journals

*Full Length Research Paper*

# Ramifications of different externally applied nitrogen sources on the physiology and yield of hybrid maize (*Zea mays* L.)

**Muhammad Waseem[1]*, Asghar Ali[1], Muhammad Tahir[1] and Mumtaz Hussain[2]**

[1]Department of Agronomy, University of Agriculture, Faisalabad, 38040, Pakistan.
[2]Department of Botany, University of Agriculture, Faisalabad, 38040, Pakistan.

Accepted 13 September, 2011

**A two year field experiment was conducted to evaluate the ramification of nitrogen sources on the physiology and yield of hybrid maize (*Zea mays* L.) at the Agronomic Research Area, University of Agriculture Faisalabad, Pakistan, during 2008 to 2009. The experiment design was a randomized complete block design (RCBD) under factorial arrangement with three replications. Treatments comprised two hybrids: that is; $H_1$ (Pioneer-30Y87) and $H_2$ (Pioneer-31R88) with six nitrogen sources $S_0$ : control (0) kg N ha$^{-1}$, $S_1$ : chemical source (urea) @ 250 kg N ha$^{-1}$ , $S_2$: poultry manure (PM) @ 9.6 t ha$^{-1}$, $S_3$ : farm yard manure (FYM) @17.8t ha$^{-1}$ , $S_4$: press mud of sugarcane (PMS) @ 8.5 t ha$^{-1}$ and $S_5$: compost (C) @ 10.0 t ha$^{-1}$. Plant height (cm), 1000-grain weight (g), grain yield (t ha$^{-1}$), leaf area index, leaf area duration, dry matter accumulation, crop growth rate, and net assimilation rate varied with treatments in 2008, but plant height (cm), 1000-grain weight (g) and grain yield (t ha$^{-1}$) did not differ with treatments in 2009. Physiological traits, such as leaf area index, leaf area duration, dry matter accumulation, crop growth rate and net assimilation rate also responded to treatments. Hybrid maize $H_1$ (Pioneer 30Y87) produced more grain yield due to enhanced physiological traits with urea compared to other sources of N. Hybrid maize $H_1$ (Pioneer 30Y87) produced better grain yield and indirectly enhanced physiological traits when nitrogen sources were applied as chemical (urea) @ 250 kg N ha$^{-1}$ as compared to other sources of nitrogen.**

**Key words:** Nitrogen, hybrid maize, yield, physiological traits.

## INTRODUCTION

Maize is ranked third among the cereal crops in the world after wheat and rice. In Pakistan, it is grown on an area of 1026 thousand ha with the total production of 2968 thousand tons having an average yield of 2892 kg ha$^{-1}$ (Government of Pakistan, 2007). It is highly nutritive and its seed contains; starch (78%), protein (10%), oil (4.8%), fibre (8.5%), sugar (3.1%) and ash (1.7%) (Chaudry, 1983). Nitrogen plays a dominant role in different growth processes of plants, because it is an integral part of chlorophyll and enzyme (Power and Schepers, 1989).

Application of nitrogen at rates of 0, 168, 336, 504 and 672 kg ha$^{-1}$ to maize in municipal solid waste amended soil increased total dry matter and total plant nitrogen (Erikson et al., 1999). More taller plant and ear height is produced at low planting density in maize with increasing rate of nitrogen and split application of nitrogen, maize with high density and 50% higher nitrogen rates can increase leaf area and plant height compared to the recommended one (Amanulah et al., 2009). Poultry manure at 5 and 10 t ha$^{-1}$ enhanced maize production 39 to 43% and on residual basis, increased yield 73 and 93%. The combination of cocca pod ash at 5 t ha$^{-1}$ and poultry manure at 10 t ha$^{-1}$ gave the highest grain yield 6.5 and 5.58 t ha$^{-1}$ (Ayeni et al., 2010).

Pressmud from sugarcane is also a useful source of fertilizer; its impact is based on nutrient content of mud and spent wash (Partha and Sivasubramanian, 2006).

*Corresponding author. E-mail: mianwaseem_1028@yahoo.com. Tel: +923349804812.

Nutrients are essential for sustainable crop production and healthy food for the ever increasing world population. Nutrients are essential components of sustainable agriculture. Increasing crop production largely depends on the type of fertilizer which was used to supply essential nutrients for plants. The judicious management of fertilization must attempt to ensure both an enhanced and safeguarded environment (Jen-Hshuan, 2008). A number of factors may cause low yield of crops. Inappropriate crop nutrition management and poor soil fertility are the most important factors responsible for the low yield. Soil fertility can be enhanced through the application of mineral fertilizers as well as with the addition of organic matter to the soil. Nevertheless, imbalanced use of fertilizer without the application of organic manure and without knowing the requirements of crops and fertility status of soil causes problem such as deterioration of soil structure, environmental and ground water pollution etc. Similarly, continuous use of chemical fertilizer caused the depletion of soil fertility. Our study was conducted to evaluate the response of different nitrogen sources on the physiology and yield of hybrid maize.

## MATERIALS AND METHODS

Field studies to evaluate the response of different nitrogen sources on the physiology and yielding attributes of hybrid maize (*Zea mays* L.) was carried out at the Agronomic Research Area, University of Agriculture, Faisalabad during Autumn 2008 and 2009. Experiments were laid out in a randomized complete block design (RCBD) with factorial arrangement comprising three replications with a net plot size of 3 x 5 m. Treatment comprised two hybrids: that is; $H_1$ (Pioneer-30Y87) and $H_2$ (Pioneer-31R88) with six nitrogen sources $S_0$ : control (0) kg N $ha^{-1}$, $S_1$ : chemical source (urea) @ 250 kg N $ha^{-1}$ , $S_2$: poultry manure (PM) @ 9.6 t $ha^{-1}$ , $S_3$ : farm yard manure (FYM) @17.8t $ha^{-1}$ , $S_4$: pressmud of sugarcane (PMS) @ 8.5 t $ha^{-1}$ and $S_5$: compost (C) @ 10.0 t $ha^{-1}$. A recommended dose of fertilizer was applied. Organic nitrogen sources were applied on the basis of chemical analysis of the soil before four weeks of the sowing which contains: Nitrogen (0.040%), Phosphorus (7.2 ppm) and Potassium (145 ppm).

Urea was used as inorganic nitrogen source in split doses at the rate of 250 kg N $ha^{-1}$ (half at sowing and half in two equal splits-half at knee height and remaining half at tasseling. All the organic sources that is farm yard manure, pressmud of sugarcane, compost and poultry manure were applied at the time of sowing. Recommended 100 kg P $ha^{-1}$ and 100 kg K $ha^{-1}$ were applied at sowing, some from organic sources (poultry manure, farm yard manure, pressmud of sugarcane and compost) and the remaining from inorganic sources: that is Single Super Phosphate (SSP) and Sulphate of Potash (SOP). All other cultural practices were kept normal and uniform for all the treatments. Harvesting occurred on 25 November, 2008 and 10 November, 2009. The following attributes like plant height at maturity (cm), 1000-grain weight (g) grain yield (t $ha^{-1}$), Leaf Area Index, Leaf Area Duration, dry matter accumulation, crop growth rate and net assimilation rate were recorded and data regarding all the traits were collected using standard procedures and analyzed by using Fisher's analysis of Variance technique. LSD test at 5% probability was used to compare the differences among treatments means (Steel et al., 1997).

## RESULTS AND DISCUSSION

### Plant height at maturity (cm)

Plant height is an important part of straw yield as well as grain yield because its take part in photosynthates, transferring from roots to aerial part of plant. Genetic traits and environmental characteristics also significantly influence plant height. Hybrid maize showed statistically nonsignificant effects towards plant height at maturity during 2008 and showed significance in 2009. Data in Table 1 showed that $H_1$ (199.62) produces significantly more plant height as compared to $H_2$ (198.22) during 2009. These results are confirmation with Ahmad et al. (2008), Balik and Olfs (1998), Shih et al. (2000), and Stantiford (1987). As for data concerning the effect of nitrogen sources which was also significant in both seasons. $S_1$ (201.57) produced maximum plant height which was followed by $S_2$ (196.65). Plant height of $S_5$ (195.83) was at par with $S_2$. Minimum plant height was noted in $S_0$ (144.60). Plant height trends of year 2009 was maximum in $S_1$ (223.07) which was followed by $S_5$ (211.58) and minimum was observed in $S_0$ (158.07). Enhancement in plant height was due to availability of nitrogen to plant at proper time and in proper proportion. These results are very closely related with Mterechera and Morutse (2009), and Achieng et al. (2010). Plant height had indirect effect on grain yield of plant. Non significant interactive effects of maize hybrids and nitrogen sources was observed during both of the year 2008 and 2009.

### 1000-grain weight (g)

1000-Grain weight is the most important parameter which has significant contribution to yield. The greater the weight of 1000-grain weight, then yield will be directly high. Hybrid maize had a significant effect on the 1000-grain weight during 2008 and was non significant in 2009. Data revealed in Table 1 that $H_1$ (249.72) produces significantly more 1000-grain weight as compared to $H_2$ (243.92) during 2008. These results are a confirmation of Sharif et al. (2004). As for data concerning the effect of nitrogen sources which was also significant in both seasons. $S_1$ (309.45) produced maximum 1000-grain weight while minimum 1000-grain weight was noted in $S_0$ (147.98). 1000-Grain weight trends of year 2009 is at par with the first year. Enhancement in 1000-grain weight was due to availability of nitrogen to plant at proper time in split doses and in proper proportion. These results are very closely related with Sudhu and Kapoor (1999), Tamayo et al. (1997) and Waseem et al. (2007). A significant interactive effect of maize hybrids and nitrogen sources was observed during both years. Maximum1000-grain weight was recorded in $H_1S_1$ (318.57) while minimum was found in interaction of $H_1S_0$ (152.30).

**Table 1.** Impact of nitrogen sources on plant height and yield attributes of hybrid maize during 2008 to 2009.

| Treatment | Plant height (cm) | | 1000-Grain weight (g) | | Grain yield (t ha$^{-1}$) | |
|---|---|---|---|---|---|---|
| **Year** | **2008** | **2009** | **2008** | **2009** | **2008** | **2009** |
| **A-Hybrids** | | | | | | |
| $H_1$ : Pioneer-30Y87 | 198.22$^{b}$ | 189.04 | 249.72$^{a}$ | 248.41 | 6.01$^{a}$ | 5.93 |
| $H_2$ : Pioneer-31R88 | 199.62$^{a}$ | 185.77 | 243.92$^{b}$ | 249.11 | 5.97$^{b}$ | 5.90 |
| LSD = 0.05 | 1.3685 | N.S | 1.78 | N.S | 0.016 | N.S |
| **B-Nitrogen sources** | | | | | | |
| $S_0$ : Control 0 kg N ha$^{-1}$ | 158.07$^{e}$ | 144.60$^{c}$ | 147.98$^{f}$ | 153.3$^{f}$ | 3.70$^{f}$ | 3.49$^{f}$ |
| $S_1$ : Chemical source (urea) @ 250 kg N ha$^{-1}$ | 223.07$^{a}$ | 201.57$^{a}$ | 309.45$^{a}$ | 302.33$^{a}$ | 7.43$^{a}$ | 7.16$^{a}$ |
| $S_2$ : Poultry manure (PM) @ 9.6 t ha$^{-1}$ | 197.60$^{d}$ | 196.65$^{ab}$ | 218.15$^{e}$ | 251.4$^{d}$ | 6.24$^{c}$ | 6.21$^{c}$ |
| $S_3$ : Farm yard manure (FYM) @ 17.8 t ha$^{-1}$ | 207.77$^{c}$ | 194.72$^{b}$ | 263.60$^{c}$ | 273.5$^{c}$ | 6.07$^{d}$ | 6.08$^{d}$ |
| $S_4$ : Pressmud of sugarcane (PMS) @8.5t ha$^{-1}$ | 195.43$^{d}$ | 191.07$^{b}$ | 281.57$^{b}$ | 277.5$^{b}$ | 6.53$^{b}$ | 6.54$^{b}$ |
| $S_5$ : Compost (C) @ 10 t ha$^{-1}$ | 211.58$^{b}$ | 195.83$^{ab}$ | 260.17$^{d}$ | 234.40$^{e}$ | 5.96$^{e}$ | 6.00$^{e}$ |
| LSD = 0.05 | 2.3704 | 5.9047 | 3.0924 | 2.4993 | 0.028 | 0.061 |
| **C-Interaction (H x NS)** | | | | | | |
| $H_1S_0$ | 156.50 | 144.43 | 152.30$^{j}$ | 163.40$^{i}$ | 3.59$^{j}$ | 3.45$^{g}$ |
| $H_1S_1$ | 233.70 | 205.17 | 318.53$^{a}$ | 307.33$^{a}$ | 7.65$^{a}$ | 7.16$^{a}$ |
| $H_1S_2$ | 195.73 | 199.03 | 229.60$^{h}$ | 237.40$^{g}$ | 5.90$^{i}$ | 6.52$^{c}$ |
| $H_1S_3$ | 206.50 | 197.33 | 241.50$^{g}$ | 261.53$^{f}$ | 6.18$^{f}$ | 5.98$^{f}$ |
| $H_1S_4$ | 196.33 | 192.27 | 287.37$^{c}$ | 285.53$^{c}$ | 6.70$^{c}$ | 6.36$^{d}$ |
| $H_1S_5$ | 210.53 | 196.03 | 269.03$^{e}$ | 235.3$^{gh}$ | 5.89$^{i}$ | 6.10$^{e}$ |
| $H_2S_0$ | 159.63 | 144.77 | 143.67$^{k}$ | 143.23$^{j}$ | 3.71$^{j}$ | 3.54$^{g}$ |
| $H_2S_1$ | 222.43 | 197.97 | 300.37$^{b}$ | 297.33$^{b}$ | 7.21$^{b}$ | 7.16$^{a}$ |
| $H_2S_2$ | 199.47 | 194.27 | 206.70$^{i}$ | 265.47$^{e}$ | 6.57$^{d}$ | 5.90$^{e}$ |
| $H_2S_3$ | 209.03 | 192.10 | 285.70$^{c}$ | 285.57$^{c}$ | 5.96$^{h}$ | 6.18$^{e}$ |
| $H_2S_4$ | 194.53 | 189.87 | 275.77$^{d}$ | 269.60$^{d}$ | 6.34$^{e}$ | 6.71$^{b}$ |
| $H_2S_5$ | 212.63 | 195.63 | 251.30$^{f}$ | 233.47$^{h}$ | 6.03$^{g}$ | 5.90$^{f}$ |
| LSD = 0.05 | N.S | N.S | 4.3733 | 3.5346 | 0.040 | 0.086 |

Means values in column not comprising same letter vary significantly at P=0.05. N.S = Non significant.

Similar trends of interaction were recorded in 2009 for 1000-grain weight. These results are in resemblance to Rizwan et al. (2003) and Sharif et al. (2004).

## Grain yield (t ha$^{-1}$)

Grain yield is a cumulative outcome of yield contributing parameter such as number of cobs per plant, number of grain rows per plant and 1000-grain weight etc., which was directly controlled by genetic characteristics of hybrids as well as some agronomic management practices and climatic factor during crop growth and development. Hybrid maize and nitrogen sources significantly affect the grain yield during 2008 and 2009. Data pertaining Table 1 showed that $H_1$ (6.01) produces significantly more grain yield as compared to $H_2$ (5.97) during 2008. Grian yield trend of both hybrids in 2009 was non significant. These results are in accordance with Sudhu and Kapoor (1999). As for data concerning the effect of nitrogen sources which was also significant in both seasons. $S_1$ (7.43) produced maximum grain yield and minimum grain yield was noted in $S_0$ (3.70). A grain yield trend of year nitrogen sources in 2009 is at par with year 2008. Nitrogen sources decreases the grain yield in 2009, which was due to less availability of nitrogen to plants at a proper time and in proper proportion. These results are very closely related with Waseem et al., (2007) and Ahmad et al. (2008). A significant interactive effect of maize hybrids and nitrogen sources was observed during both years. In 2008, the maximum grain yield was recorded in $H_1S_1$ (7.65) while the minimum was found in interaction of $H_1S_0$ (3.70). In 2009, the maximum grain yield was recorded in $H_1S_1$ while the minimum was

**Table 2.** Influence of nitrogen sources on leaf area index of hybrid maize during 2008 to 2009.

| Treat | LAI 30 DAS | | LAI 45 DAS | | LAI 60 DAS | | LAI 75 DAS | | LAI 90DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 |
| **A-Hybrids** | | | | | | | | | | |
| $H_1$ | 0.77$^{a}$ | 0.69$^{b}$ | 2.14$^{a}$ | 2.16$^{a}$ | 3.38$^{a}$ | 3.37$^{a}$ | 4.62$^{a}$ | 4.61$^{a}$ | 3.42$^{a}$ | 3.13 |
| $H_2$ | 0.73$^{b}$ | 0.73$^{a}$ | 2.06$^{b}$ | 2..05$^{b}$ | 3.25$^{b}$ | 3.27$^{b}$ | 4.49$^{b}$ | 4.47$^{b}$ | 3.38$^{b}$ | 3.14 |
| LSD | 0.014 | 0.013 | 0.01 | 0.01 | 0.011 | 0.01 | 0.012 | 0.015 | 0.0136 | N.S |
| **B-Nitrogen sources** | | | | | | | | | | |
| $S_0$ | 0.53$^{e}$ | 0.57$^{d}$ | 1.57$^{e}$ | 1.46$^{d}$ | 2.49$^{f}$ | 2.44$^{d}$ | 3.06$^{e}$ | 3.07$^{e}$ | 2.21$^{e}$ | 1.95$^{e}$ |
| $S_1$ | 0.87$^{a}$ | 0.86$^{a}$ | 2.33$^{a}$ | 2.42$^{a}$ | 3.69$^{a}$ | 3.75$^{a}$ | 5.15$^{a}$ | 5.19$^{a}$ | 4.09$^{a}$ | 4.03$^{a}$ |
| $S_2$ | 0.84$^{b}$ | 0.66$^{c}$ | 2.18$^{c}$ | 2.21$^{b}$ | 3.52$^{b}$ | 3.32$^{c}$ | 4.78$^{c}$ | 4.74$^{c}$ | 3.51$^{c}$ | 3.23$^{c}$ |
| $S_3$ | 0.83$^{b}$ | 0.72$^{b}$ | 2.21$^{b}$ | 2.16$^{c}$ | 3.47$^{c}$ | 3.54$^{b}$ | 4.65$^{d}$ | 4.75$^{c}$ | 3.52$^{c}$ | 3.33$^{b}$ |
| $S_4$ | 0.74$^{c}$ | 0.71$^{b}$ | 2.15$^{d}$ | 2.18$^{c}$ | 3.44$^{d}$ | 3.34$^{c}$ | 4.86$^{b}$ | 4.66$^{d}$ | 3.71$^{b}$ | 3.09$^{d}$ |
| $S_5$ | 0.69$^{d}$ | 0.72$^{b}$ | 2.16$^{cd}$ | 2.21$^{b}$ | 3.27$^{e}$ | 3.54$^{b}$ | 4.84$^{b}$ | 4.86$^{b}$ | 3.35$^{d}$ | 3.21$^{c}$ |
| LSD | 0.025 | 0.023 | 0.02 | 0.01 | 0.020 | 0.023 | 0.02 | 0.02 | 0.023 | 0.028 |
| **C-Interaction (H x NS)** | | | | | | | | | | |
| $H_1S_0$ | 0.57$^{g}$ | 0.51$^{g}$ | 1.62$^{h}$ | 1.52$^{h}$ | 2.45$^{j}$ | 2.39$^{k}$ | 3.01$^{j}$ | 3.11$^{j}$ | 2.05$^{l}$ | 2.07$^{i}$ |
| $H_1S_1$ | 0.91$^{a}$ | 0.83$^{b}$ | 2.37$^{a}$ | 2.47$^{a}$ | 3.74$^{a}$ | 3.79$^{a}$ | 5.21$^{a}$ | 5.24$^{a}$ | 4.17$^{a}$ | 3.97$^{b}$ |
| $H_1S_2$ | 0.82$^{cd}$ | 0.74$^{c}$ | 2.25$^{c}$ | 2.24$^{d}$ | 3.51$^{d}$ | 3.47$^{f}$ | 4.67$^{f}$ | 4.87$^{e}$ | 3.65$^{d}$ | 3.08$^{g}$ |
| $H_1S_3$ | 0.87$^{b}$ | 0.69$^{d}$ | 2.19$^{d}$ | 2.26$^{d}$ | 3.67$^{b}$ | 3.65$^{c}$ | 4.73$^{e}$ | 4.97$^{c}$ | 3.47$^{g}$ | 3.24$^{e}$ |
| $H_1S_4$ | 0.79$^{d}$ | 0.61$^{ef}$ | 2.14$^{ef}$ | 2.15$^{f}$ | 3.55$^{c}$ | 3.39$^{g}$ | 5.01$^{c}$ | 4.67$^{g}$ | 3.89$^{c}$ | 3.17$^{f}$ |
| $H_1S_5$ | 0.67$^{f}$ | 0.76$^{c}$ | 2.26$^{bc}$ | 2.33$^{c}$ | 3.37$^{e}$ | 3.56$^{d}$ | 5.07$^{b}$ | 4.82$^{f}$ | 3.29$^{j}$ | 3.26$^{e}$ |
| $H_2$ $S_0$ | 0.49$^{h}$ | 0.63$^{e}$ | 1.51$^{i}$ | 1.41$^{i}$ | 2.53$^{i}$ | 2.49$^{j}$ | 3.10$^{i}$ | 3.03$^{k}$ | 2.37$^{k}$ | 1.83$^{j}$ |
| $H_2$ $S_1$ | 0.84$^{bc}$ | 0.90$^{a}$ | 2.29$^{b}$ | 2.37$^{b}$ | 3.65$^{b}$ | 3.71$^{b}$ | 5.09$^{b}$ | 5.14$^{b}$ | 4.02$^{b}$ | 4.07$^{a}$ |
| $H_2$ $S_2$ | 0.87$^{b}$ | 0.59$^{f}$ | 2.12$^{f}$ | 2.17$^{f}$ | 3.53$^{cd}$ | 3.17$^{i}$ | 4.89$^{d}$ | 4.60$^{h}$ | 3.37$^{i}$ | 3.37$^{d}$ |
| $H_2$ $S_3$ | 0.79$^{d}$ | 0.75$^{c}$ | 2.23$^{c}$ | 2.07$^{g}$ | 3.27$^{g}$ | 3.44$^{f}$ | 4.57$^{h}$ | 4.52$^{i}$ | 3.57$^{e}$ | 3.42$^{c}$ |
| $H_2$ $S_4$ | 0.69$^{ef}$ | 0.81$^{b}$ | 2.17$^{de}$ | 2.21$^{e}$ | 3.33$^{f}$ | 3.29$^{h}$ | 4.71$^{e}$ | 4.65$^{g}$ | 3.53$^{f}$ | 3.03$^{h}$ |
| $H_2$ $S_5$ | 0.72$^{e}$ | 0.67$^{d}$ | 2.06$^{g}$ | 2.09$^{g}$ | 3.17$^{h}$ | 3.52$^{e}$ | 4.61$^{g}$ | 4.91$^{d}$ | 3.41$^{h}$ | 3.15$^{f}$ |
| LSD | 0.035 | 0.03 | 0.03 | 0.02 | 0.028 | 0.033 | 0.03 | 0.038 | 0.033 | 0.040 |

Means values in column not comprising same letter vary significantly at P=0.05. N.S = Non significant.

found in interaction of $H_1S_0$ (3.60). These results are a consequence of the find of Waseem et al. (2007) and Sudhu and Kapoor (1999).

## Physiological traits

### *Leaf area index at 30-90 DAS (days after sowing)*

Data in 30, 45, 60, 75, and 90 DAS showed that hybrid maize significantly affected the leaf area index during 2008 and 2009 (Table 2). In 2008, results revealed that leaf area index of hybrid $H_1$ gradually increased in 30 to 90 DAS and reached a maximum value, after 75 DAS it was sharply moved towards declining till maturity as trends shown in 90 DAS. In the second year experiment, 2009, similar increasing trend of hybrids maize $H_1$ towards leaf area index was found as shown in Table 2 (45, 60, and 75 DAS) and after it decreased steadily, and at 90 DAS expected leaf area index was maximum in $H_2$ in Table 2 (30 DAS). These results are similar to achievements of Kumar and Walia (2003) who reported that hybrid maize had significant effect on leaf area index. As for data concerning the effect of nitrogen sources which are also significant in both seasons. In 2008, leaf area index of nitrogen sources was maximum in $S_1$ from Table 2; 30, 45, 60, and 75 DAS and after it decreased gradually as shown in Table 2 (90 DAS) till maturity of the crop. Similar increasing and decreasing trends of leaf area index was observed in nitrogen sources in 2009 which was statistically at par with 2008. These results are a confirmation of Kumar and Walia (2003) and Kumar and Sundari (2002).

A significant interactive effect of maize hybrids and nitrogen sources was observed during both years. In 2008, leaf area index increased regularly in interaction of $H_1S_1$ as shown in 30, 45, 60, and 75 DAS and reached a maximum value and after it return to decrease minimum

**Table 3.** Effect of nitrogen sources on leaf area duration of hybrid maize during 2008 to 2009.

| Treat | LAD 30-45DAS | | LAD 45-60DAS | | LAD 60-75DAS | | LAD 75-90DAS | |
|---|---|---|---|---|---|---|---|---|
| Year | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 |
| **A-Hybrids** | | | | | | | | |
| $H_1$ | 20.98$^{b}$ | 21.39$^{a}$ | 63.23$^{a}$ | 62.92$^{a}$ | 123.21$^{a}$ | 122.8$^{a}$ | 183.49$^{a}$ | 180.91$^{a}$ |
| $H_2$ | 21.83$^{a}$ | 20.84$^{b}$ | 60.80$^{b}$ | 60.76$^{b}$ | 118.8$^{b}$ | 118.8$^{b}$ | 177.9$^{b}$ | 175.99$^{b}$ |
| LSD | 0.1803 | 0.1380 | 0.3076 | 0.2139 | 0.3836 | 0.3292 | 0.4496 | 0.4322 |
| **B-Nitrogen sources** | | | | | | | | |
| $S_0$ | 15.73$^{d}$ | 15.26$^{d}$ | 46.15$^{e}$ | 44.55$^{e}$ | 87.74$^{e}$ | 85.86$^{e}$ | 127.23 | 132.50$^{f}$ |
| $S_1$ | 24.04$^{a}$ | 24.64$^{a}$ | 69.23$^{a}$ | 70.92$^{a}$ | 135.55$^{a}$ | 137.96$^{a}$ | 204.88$^{a}$ | 207.06$^{a}$ |
| $S_2$ | 22.73$^{b}$ | 21.53$^{c}$ | 65.52$^{b}$ | 62.96$^{d}$ | 127.76$^{b}$ | 123.38$^{d}$ | 189.94$^{b}$ | 183.09$^{d}$ |
| $S_3$ | 22.83$^{b}$ | 21.64$^{c}$ | 65.45$^{b}$ | 64.45$^{c}$ | 126.35$^{c}$ | 126.63$^{c}$ | 187.63$^{c}$ | 187.20$^{c}$ |
| $S_4$ | 21.70$^{c}$ | 21.66$^{c}$ | 63.65$^{c}$ | 63.07$^{d}$ | 125.90$^{c}$ | 123.08$^{d}$ | 190.18$^{b}$ | 181.26$^{e}$ |
| $S_5$ | 21.40$^{c}$ | 21.95$^{b}$ | 62.11$^{d}$ | 65.06$^{b}$ | 122.94$^{d}$ | 128.08$^{b}$ | 184.36$^{d}$ | 188.59$^{b}$ |
| LSD | 0.3122 | 0.239 | 0.5327 | 0.3706 | 0.6645 | 0.5702 | 0.7787 | 0.7485 |
| **C-Interaction (H x NS)** | | | | | | | | |
| $H_1S_0$ | 16.45$^{h}$ | 15.23$^{g}$ | 47.0$^{h}$ | 44.55$^{i}$ | 87.95$^{h}$ | 85.78$^{j}$ | 125.90$^{i}$ | 124.60$^{h}$ |
| $H_1S_1$ | 24.60$^{a}$ | 24.75$^{a}$ | 70.43$^{a}$ | 71.70$^{a}$ | 137.55 | 139.42$^{a}$ | 207.93$^{a}$ | 208.55$^{a}$ |
| $H_1S_2$ | 23.02$^{c}$ | 22.35$^{cd}$ | 66.23$^{c}$ | 65.17$^{e}$ | 127.57$^{e}$ | 127.73$^{e}$ | 189.97$^{e}$ | 187.38$^{e}$ |
| $H_1S_3$ | 22.95$^{c}$ | 22.13$^{d}$ | 66.90$^{c}$ | 66.43$^{d}$ | 129.90$^{c}$ | 131.07$^{c}$ | 191.40$^{d}$ | 192.67$^{c}$ |
| $H_1S_4$ | 21.95$^{e}$ | 20.70$^{f}$ | 64.6$^{de}$ | 62.25$^{g}$ | 128.80$^{d}$ | 122.70$^{gh}$ | 195.55$^{c}$ | 181.50$^{f}$ |
| $H_1S_5$ | 21.97$^{e}$ | 23.20$^{b}$ | 64.2$^{de}$ | 67.37$^{c}$ | 127.50$^{e}$ | 130.20$^{d}$ | 190.20$^{e}$ | 190.70$^{d}$ |
| $H_2$ $S_0$ | 15.0$^{i}$ | 15.30$^{g}$ | 45.30$^{i}$ | 44.55$^{i}$ | 87.53$^{h}$ | 85.95$^{j}$ | 128.55$^{h}$ | 122.40$^{i}$ |
| $H_2$ $S_1$ | 23.47$^{b}$ | 24.53$^{a}$ | 68.03$^{b}$ | 70.13$^{b}$ | 133.55$^{b}$ | 136.50$^{b}$ | 201.83 | 205.57$^{b}$ |
| $H_2$ $S_2$ | 22.42$^{d}$ | 20.70$^{f}$ | 64.80$^{d}$ | 60.75$^{h}$ | 127.95$^{de}$ | 119.03$^{i}$ | 189.90$^{e}$ | 178.80$^{g}$ |
| $H_2$ $S_3$ | 22.7$^{cd}$ | 21.15$^{e}$ | 64.0$^{e}$ | 62.47$^{g}$ | 122.80$^{f}$ | 122.17$^{h}$ | 183.85$^{f}$ | 181.72$^{f}$ |
| $H_2$ $S_4$ | 21.45$^{f}$ | 22.65$^{c}$ | 62.70$^{f}$ | 63.90$^{f}$ | 123.0$^{f}$ | 123.45$^{g}$ | 184.80$^{f}$ | 181.03$^{f}$ |
| $H_2$ $S_5$ | 20.82$^{g}$ | 20.70$^{f}$ | 60.03$^{g}$ | 62.75$^{g}$ | 118.37$^{g}$ | 125.95$^{f}$ | 178.53$^{g}$ | 186.40$^{e}$ |
| LSD | 0.4416 | 0.3379 | 0.7534 | 0.5241 | 0.9397 | 0.8064 | 1.1012 | 1.0586 |

Means values in column not comprising same letter vary significantly at P=0.05. N.S = Non significant.

as shown in Table 2 (90 DAS) while minimum leaf area index was found in interaction of $H_1S_0$ which gradually increases and decreases with passage of time as shown in Table 2 (30, 45, 60, 75, and 90 DAS). In year 2009, the interactive effects of $H_2S_1$ is high and low in $H_1S_0$ (Table 2) 30 DAS but as a whole, it was increasing gradually and reached maximum point in interaction $H_1S_1$ of (Table 2) 45, 60, and 75 DAS and minimum in $H_1S_0$. Leaf area index decreased steadily in $H_2S_1$ (Table 2) 90 DAS. The increase in leaf area index might be due to the availability of nitrogen to the crop at a proper time in inorganic treatments and slow release of nutrients from the organic sources throughout the growing season. These results are in accordance with Kumar and Walia (2003) and Kumar and Sundari (2002).

### *Leaf area duration (30 to 90 DAS)*

Leaf area duration showed those periods in life of the plant when its leaf remains green and photosynthetically active. Leaf area duration which was highly significant during 2008 and 2009. Data in Table 3 (30 to 45, 45 to 60, 60 to 75, 75 to 90 DAS) showed that in 2008, the maximum LAD at (30 to 45 DAS) noted in $H_2$, $H_1$ (45 to 60, 60 to 75, 75 to 90 DAS) and minimum in hybrids $H_1$ (30 to 45 DAS) and $H_2$ (45 to 60, 60 to 75, 75 to 90 DAS). Leaf area duration trend of 2009 differed from year 2008. Maximum LAD of hybrid $H_1$ (45 to 60, 60 to 75, 75 to 90 DAS) and minimum in hybrids in $H_2$ (30 to 45, 45 to 60, 60 to 75, 75 to 90 DAS) was found in 2009. These results recount the finding of Akbar et al. (2002). As for data concerning the effect of nitrogen sources which was also significant in both seasons. In 2008, nitrogen source $S_1$ (30 to 45, 45 to 60, 60 to 75, 75 to 90 DAS) produced maximum leaf area duration and minimum leaf area duration was found in $S_0$ (30 to 45, 45 to 60, 60 to 75, 75 to 90 DAS).

Progress in leaf area duration 2009 was at par with the first year. Enhancement in leaf area duration was due to

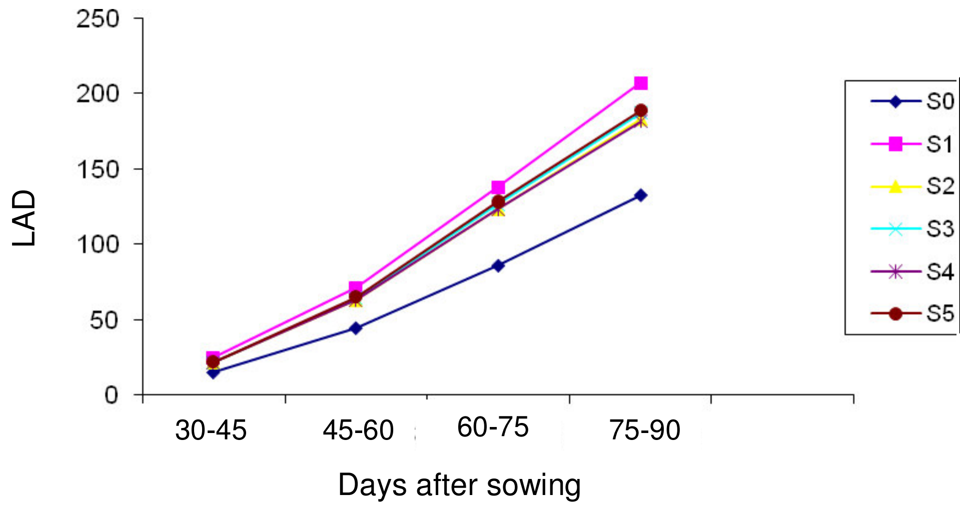


**Figure 1a.** Periodic leaf area duration as influenced by nitrogen sources during 2008.

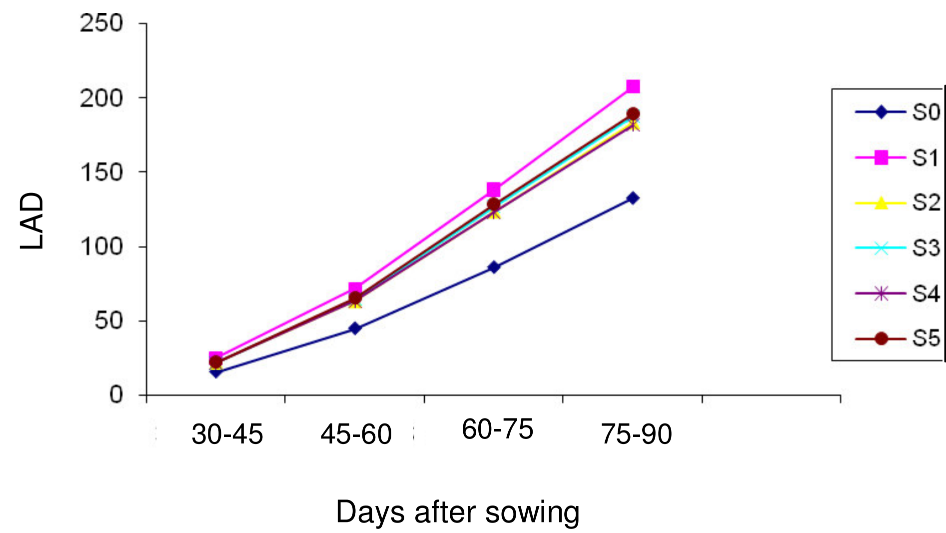


**Figure 1b.** Periodic leaf area duration as influenced by nitrogen sources during.

availability of nitrogen to the plant at a proper time and in proper proportion. These results are providing support to the finding of Akbar et al. (2002), Kumar and Walia (2003), and Kumar and Sundari (2002). Significant interactive effects of maize hybrids and nitrogen sources was observed during both years. In 2008, maximum leaf area duration was recorded in $H_1S_1$ (30 to 45, 45 to 60, 60 to 75, 75 to 90 DAS) and minimum was found in interaction of $H_1S_0$ (30 to 45, 75 to 90 DAS), $H_2S_0$ (45 to 60, 60 to 75 DAS). Similar trends of interactive effect was observed in the year 2009. These results are concise with the finding of Akbar et al. (2002), Kumar and Walia (2003), and Kumar and Sundari (2002). Figure 1a and b clearly showed how leaf area duration increased steadily with passage of time till maturity as influenced by different nitrogen sources. For measuring the degree of linear association a simple linear regression use between grain yield and LAD which was significant and positive during both year as shown in Figure 2a and b. Both grain yield and LAD was interdependent and directly related with regression line which accounted for 0.964 and 0.936 during 2008 and 2009. It is clear from the figure that if LAD increased then there was increase in grain yield.

***Dry matter accumulation (30-90 DAS) (g)***

Hybrid maize significantly influenced the dry matter accumulation during 2008 and 2009. Data 30, 45, 60, 75, 90 DAS (Table 4) showed that dry matter accumulation

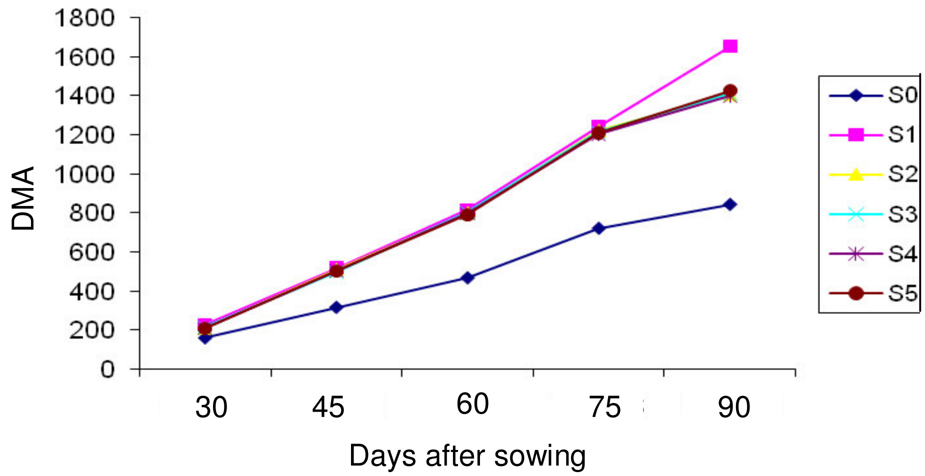


**Figure 2a.** Periodic dry matter accumulation (g $m^{-2}$) as influenced by nitrogen sources during 2008.

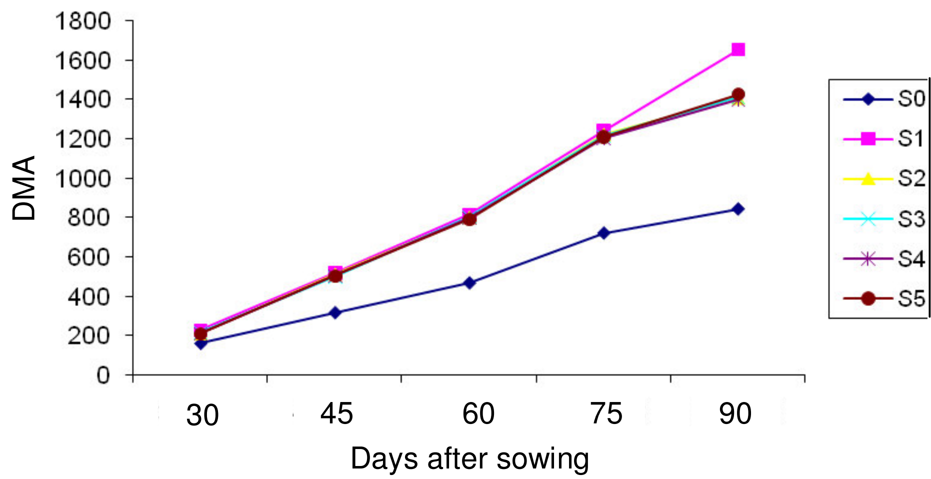


**Figure 2b.** Periodic dry matter accumulation (g $m^{-2}$) as influenced by nitrogen sources during 2009.

was gradually increased in $H_1$ from (30 to 90 DAS) and obtained maximum dry matter at harvesting except in Table 4 where maximum dry matter accumulation at 30 DAS in $H_2$ and minimum dry matter accumulation was observed in $H_2$ (45 to 90) during 2008. Dry matter accumulation in 2009 differed from year 2008. Data revealed that dry matter accumulation in $H_1$ 30, 60, 90 DAS was maximum and increased consequently minimum in $H_2$. But dry matter accumulation in 45 DAS, it was high in $H_2$ and low in $H_1$ and non significant in 75 DAS. However, it was increased regularly from 30 to 90 DAS in both hybrids. These results narrate the conclusion of Shapiro and Wortmann (2006). Nitrogen sources was also significant in both seasons. In 2008, dry matter accumulation was increased consequently and reached maximum at (45 to 90 DAS) in nitrogen sources $S_1$ as shown in 45, 60, 75, and 90 DAS except in 30 DAS in nitrogen source $S_4$ and minimum dry matter accumulation was noted in $S_0$ (30 to 90 DAS). Dry matter accumulation trends of year 2009 is entirely same with year 2008.

Enhancement in dry matter accumulation was due to availability of nitrogen to plant at proper time and in proper proportion. These results are very closely related with Sharar et al. (2003). Significant interactive effects of maize hybrids and nitrogen sources was observed during both years. In 2008, maximum dry matter accumulation was recorded in $H_2S_4$ at (30 DAS), $H_1S_2$ (45 DAS), $H_2S_1$ (60 DAS), $H_2S_1$ (75 DAS) and $H_1S_1$ (90 DAS), while minimum dry matter accumulation was found in interaction of $H_1S_0$ (30, 45, 60, 90 DAS) except $H_2S_0$ (75 DAS). Dry matter accumulation in 2009 was maximum in all interaction of $H_1S_1$ (30 to 90) and minimum dry matter accumulation in interaction $H_1S_0$ (45, 90 DAS) and $H_2S_0$ (30, 60, 75 DAS). These results recounts the conclusion

**Table 4.** Influence of nitrogen source on dry matter accumulation (g $m^{-2}$ $day^{-1}$) of hybrid maize during 2008 to 2009.

| Treat | DMA 30 DAS | | DMA 45 DAS | | DMA 60 DAS | | DMA 75 DAS | | DMA 90 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 |
| **A-Hybrids** | | | | | | | | | | |
| $H_1$ | $209.02^{b}$ | $207.52^{a}$ | $484.98^{a}$ | $473.93^{b}$ | $760.81^{a}$ | $750.31^{a}$ | $1142.9^{a}$ | 1135.5 | $1431.6^{a}$ | $1367.3^{a}$ |
| $H_2$ | $212.35^{a}$ | $203.93^{b}$ | $470.09^{b}$ | $475.93^{a}$ | $758.82^{b}$ | $743.46^{b}$ | $1134.7^{b}$ | 1133.6 | $1367.5^{b}$ | $1343.8^{b}$ |
| LSD | 1.1448 | 2.6804 | 1.406 | 1.8620 | 1.482 | 2.0468 | 1.747 | N.S | 4.2707 | 11.661 |
| **B-Nitrogen sources** | | | | | | | | | | |
| $S_0$ | $160.55^{e}$ | $159.13^{d}$ | $351.33^{f}$ | $3.1522^{e}$ | $553.73^{d}$ | $466.72^{e}$ | $748.7^{f}$ | $719.8^{f}$ | $889.4^{f}$ | $841.8^{d}$ |
| $S_1$ | $232.22^{b}$ | $227.98^{a}$ | $529.35^{a}$ | $517.18^{a}$ | $830.40^{a}$ | $816.08^{a}$ | $1253.2^{a}$ | $1239.4^{a}$ | $1664..7^{a}$ | $1651.7^{a}$ |
| $S_2$ | $205.75^{d}$ | $211.48^{bc}$ | $495.47^{c}$ | $512.37^{b}$ | $803.05^{b}$ | $801.87^{bc}$ | $1220.4^{b}$ | $1221.3^{b}$ | $1493.2^{b}$ | $1406.1^{bc}$ |
| $S_3$ | $209.32^{c}$ | $215.32^{b}$ | $492.90^{d}$ | $498.35^{d}$ | $784.05^{c}$ | $805.32^{b}$ | $1203.1^{d}$ | $1214.2^{c}$ | $1466.6^{c}$ | $1410.3^{bc}$ |
| $S_4$ | $245.47^{a}$ | $209.98^{c}$ | $489.22^{e}$ | $504.43^{c}$ | $782.80^{c}$ | $799.52^{c}$ | $1210.5^{c}$ | $1203.7^{e}$ | $1429.5^{e}$ | $1397.8^{c}$ |
| $S_5$ | $210.80^{c}$ | $210.45^{c}$ | $506.93^{b}$ | $502.02^{c}$ | $804.87^{b}$ | $791.80^{d}$ | $1197.1^{e}$ | $1208.9^{d}$ | $1454.0^{d}$ | $1425.5^{b}$ |
| LSD | 2.5544* | 4.6427* | 2.4360* | 3.2250* | 2.5673* | 3.5451* | 3.0274* | 4.2892* | 7.3970* | 20.197* |
| **C-Interaction (H x NS)** | | | | | | | | | | |
| $H_1S_0$ | $155.57^{j}$ | $163.37^{g}$ | $345.40^{k}$ | $304.67^{g}$ | $543.70^{j}$ | $463.07^{h}$ | $775.0^{i}$ | $734.8^{h}$ | $882.3^{j}$ | $818.6^{h}$ |
| $H_1S_1$ | $236.60^{b}$ | $230.60^{a}$ | $537.23^{a}$ | $521.73^{a}$ | $824.10^{b}$ | $824.77^{a}$ | $1249.2^{b}$ | $1242.7^{a}$ | $1688.7^{a}$ | $1663.5^{a}$ |
| $H_1S_2$ | $207.40^{fg}$ | $211.77^{de}$ | $503.53^{e}$ | $513.07^{b}$ | $806.70^{d}$ | $802.53^{cd}$ | $1206.9^{f}$ | $1221.2^{d}$ | $1491.9^{e}$ | $1425.2^{cd}$ |
| $H_1S_3$ | $215.27^{d}$ | $211.13^{def}$ | $511.33^{d}$ | $495.33^{e}$ | $793.43^{f}$ | $809.47^{b}$ | $1194.7^{g}$ | $1199.4^{g}$ | $1532.9^{c}$ | $1459.4^{b}$ |
| $H_1S_4$ | $227.10^{c}$ | $215.03^{cd}$ | $495.37^{f}$ | $508.10^{c}$ | $782.90^{g}$ | $801.63^{de}$ | $1226.3^{d}$ | $1204.4^{efg}$ | $1475.2^{f}$ | $1391.0^{e}$ |
| $H_1S_5$ | $212.17^{de}$ | $213.20^{cde}$ | $517.0^{c}$ | $500.67^{d}$ | $814.03^{c}$ | $800.37^{de}$ | $1205.5^{f}$ | $1210.2^{e}$ | $1504.6^{d}$ | $1446.0^{bc}$ |
| $H_2 S_0$ | $165.53^{i}$ | $154.90^{h}$ | $357.27^{j}$ | $325.77^{f}$ | $563.77^{i}$ | $470.37^{g}$ | $722.4^{j}$ | $704.8^{i}$ | $882.3^{j}$ | $864.9^{g}$ |
| $H_2 S_1$ | $227.83^{c}$ | $225.37^{ab}$ | $521.47^{b}$ | $512.63^{bc}$ | $836.70^{a}$ | $807.40^{bc}$ | $1257.2^{a}$ | $1236.0^{b}$ | $1640.6^{b}$ | $1640.0^{a}$ |
| $H_2 S_2$ | $204.10^{gh}$ | $211.20^{def}$ | $487.40^{g}$ | $511.67^{bc}$ | $799.40^{e}$ | $801.20^{de}$ | $1233.8^{c}$ | $1221.4^{d}$ | $1494.4^{de}$ | $1387.0^{ef}$ |
| $H_2 S_3$ | $203.37^{h}$ | $219.50^{bc}$ | $474.47^{i}$ | $501.37^{d}$ | $774.67^{h}$ | $801.17^{de}$ | $1211.5^{e}$ | $1229.1^{c}$ | 1400.3 | $1361.1^{f}$ |
| $H_2 S_4$ | $263.83^{a}$ | $204.93^{f}$ | $483.07^{h}$ | $500.77^{d}$ | $782.70^{g}$ | $797.40^{e}$ | $1194.7^{g}$ | $1202.9^{fg}$ | $1383.8^{h}$ | $1404.7^{de}$ |
| $H_2 S_5$ | $209.43^{ef}$ | $207.70^{ef}$ | $496.87^{f}$ | $503.37^{d}$ | $795.70^{f}$ | $783.23^{f}$ | $1188.6^{h}$ | $1207.7^{ef}$ | $1403.3^{g}$ | $1405.0^{de}$ |
| LSD | 3.6125* | 6.5657* | 3.4450* | 4.5608* | 3.6307* | 5.0135* | 4.2813* | 6.0658* | 10.461* | 28.562* |

Means values in column not comprising same letter vary significantly at P=0.05. N.S = Non significant.

of Shapiro and Wortmann (2006). Figure 3a and b clearly showed how dry matter accumulation increased with passage of time till maturity as influenced by different nitrogen sources. For measuring the degree of linear association a simple linear regression use between grain yield and DMA which was significant and positive during both year as shown in Figure 4a and b. Both grain yield and DMA was interdependent and directly related with regression line accounting for 0.950 and 0.965 during 2008 and 2009. It is clear from the figure that if DMA increased, then there was increase in grain yield.

### *Mean crop growth rate (g $m^{-2}$ $day^{-1}$)*

It can be determine by dividing growth rate of plants to land area per unit time. Table 5 showed that hybrid maize significantly affects the crop growth rate during 2008 and 2009. Maximum crop growth rate was produced by $H_1$ (20.37) as compared to $H_2$ (19.25) during 2008. Crop growth rate trend of both hybrids during 2009 was at par with 2008. These results are a confirmation of Okeleye and Oyekanmi (2003). As for data concerning the effect of nitrogen sources which was also significant in both seasons. Nitrogen source $S_1$ (23.87) produced maximum crop growth rate and minimum crop growth rate was noted in $S_0$ (12.15). Crop growth rate trends of year 2009 for nitrogen sources is at par with 2008. Enhancement in crop growth rate was due to availability of nitrogen to plant at proper time and in proper proportion. These results are supportive to findings of Evans et al. (2003). Significant interactive effects of maize hybrids and nitrogen sources was observed during both years. Maximum crop growth rate was recorded in hybrid $H_1S_1$ (24.21) treatment combination while minimum was found in $H_1S_0$ (12.35). Similar trends of interactive effects was found in 2009. These results are in resemblance to Evans et al. (2003).

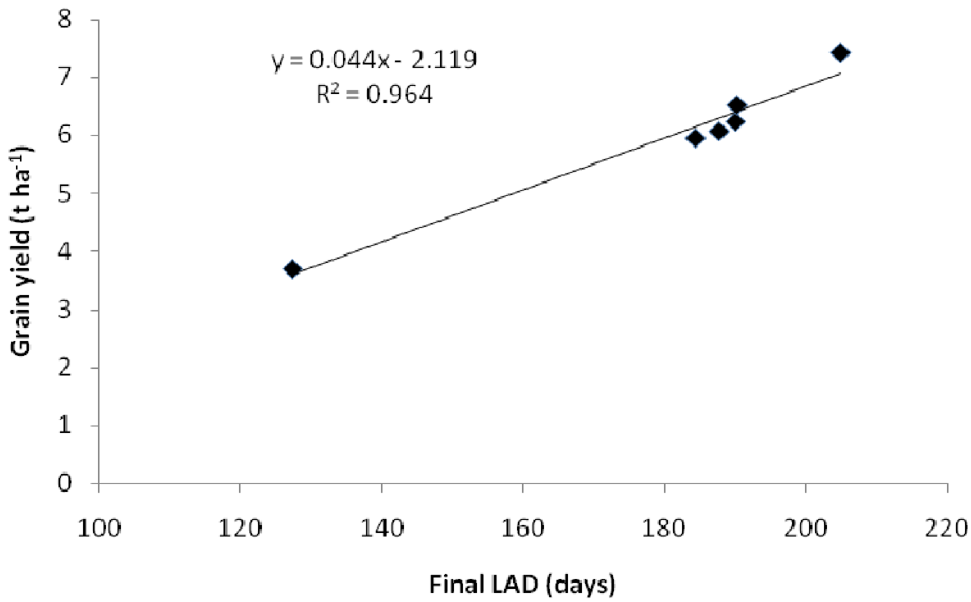


**Figure 3a.** Relationship between grain yield and leaf area duration during 2008.

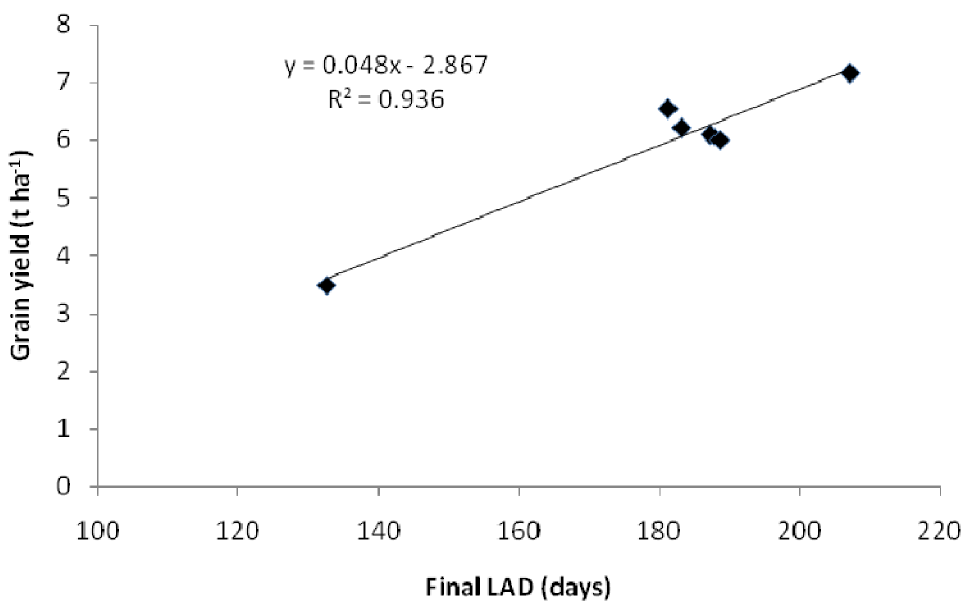


**Figure 3b.** Relationship between grain yield and leaf area duration during 2009.

***Net assimilation rate (g m$^{-2}$ day$^{-1}$)***

Hybrid maize has a significant influence on net assimilation rate during 2008 and 2009. Results in Table 5 showed that maximum net assimilation rate was concluded by hybrid $H_1$ (7.74) as compared to $H_2$ (7.64) during 2008. Trend of net assimilation rate of 2009 differed with 2008. It was maximum in $H_2$ (7.59) and minimum in $H_1$ (7.49). These results are in concordance with Ahmad et al. (1993), Randawa et al. (2002) and Akbar et al. (2002). As for data concerning the effect of nitrogen sources which was also significant in both seasons. Nitrogen sources $S_1$ (8.14) produced maximum net assimilation rate and minimum net assimilation rate was noted in $S_0$ (6.91). Net assimilation rate trends of year 2009 is at par with year 2008. Enhancement in grain

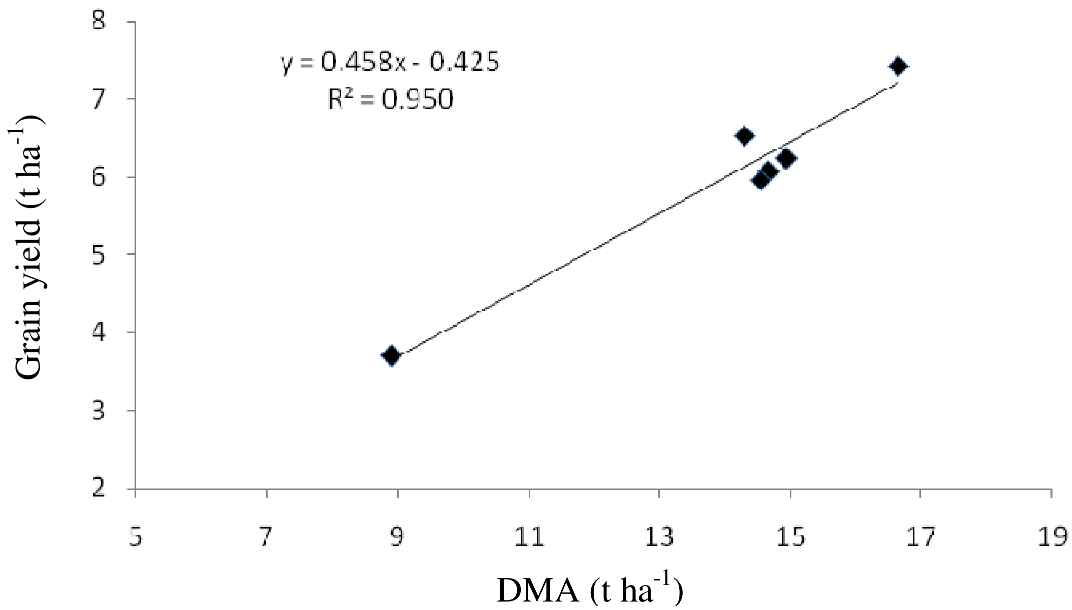


**Figure 4a.** Relationship between grain yield and dry matter accumulation during 2008.

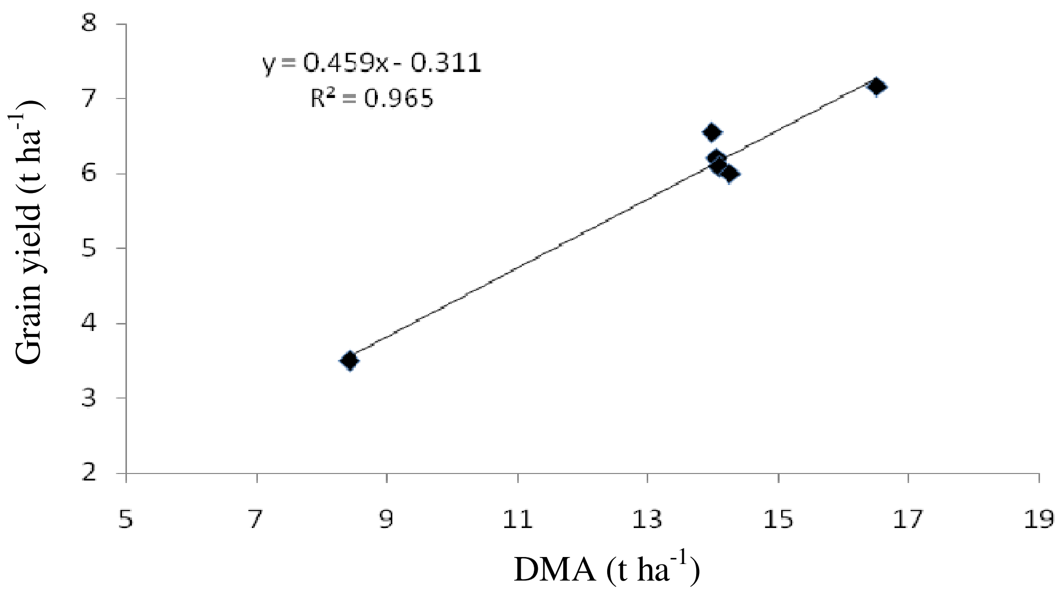


**Figure 4b.** Relationship between grain yield and dry matter accumulation during 2009.

yield was due to availability of nitrogen to plant at proper time and in proper proportion. These results are very closely related with Ahmad et al. (1993) and Randawa et al. (2002). Significant interactive effects of maize hybrids and nitrogen sources was observed during both years. Maximum net assimilation rate of interactive effects of $H_1S_1$ (8.17) was recorded and minimum was found in interaction of $H_2S_0$ (6.86). Similar trends of interaction was recorded in 2009. These results complement the finding of Ahmad et al. (1993), Randawa et al. (2002) and Evans et al. (2003).

## Conclusion

On the basis of two year experiment results, it was concluded that hybrid maize $H_1$ (Pioneer - 30Y87) produced better grai n yield and indirectly enhanced

**Table 5.** Impact of nitrogen sources on crop growth rate (g $m^{-2}$ $day^{-1}$) and net assimilation rate (g $m^{-2}$ $day^{-1}$) of maize during 2008 to 2009.

| Treatment | CGR(g $m^{-2}$ $day^{-1}$) | | NAR (g $m^{-2}$ $day^{-1}$) | |
|---|---|---|---|---|
| Year | 2008 | 2009 | 2008 | 2009 |
| **A-Hybrids** | | | | |
| $H_1$ | $20.37^a$ | $19.33^a$ | $7.74^a$ | $7.49^b$ |
| $H_2$ | $19.25^b$ | $18.99^b$ | $7.64^b$ | $7.59^a$ |
| LSD | 0.0753 | 0.1931 | 0.0374 | 0.0681 |
| **B-Nitrogen sources** | | | | |
| $S_0$ | $12.15^f$ | $11.37^d$ | $6.91^e$ | $6.82^d$ |
| $S_1$ | $23.87^a$ | $23.73^a$ | $8.14^a$ | $7.97^a$ |
| $S_2$ | $21.46^b$ | $19.91^c$ | $7.86^{bc}$ | $7.68^b$ |
| $S_3$ | $20.95^c$ | $19.92^c$ | $3.82^c$ | $7.53^c$ |
| $S_4$ | $19.74^e$ | $19.79^c$ | $7.52^d$ | $7.71^b$ |
| $S_5$ | $20.72^d$ | $20.25^b$ | $7.88^b$ | $7.56^c$ |
| LSD | 0.3435 | 0.3345 | 0.0647 | 0.1179 |
| **C-Interaction (H × NS)** | | | | |
| $H_1S_0$ | $12.35^h$ | $10.92^h$ | $6.95^f$ | $6.57^f$ |
| $H_1S_1$ | $24.21^a$ | $23.88^a$ | $8.17^a$ | $7.97^a$ |
| $H_1S_2$ | $21.41^d$ | $20.23^{cd}$ | $7.85^c$ | $7.61^{bcd}$ |
| $H_1S_3$ | $21.96^c$ | $20.81^b$ | $8.01^b$ | $7.57^{cd}$ |
| $H_1S_4$ | $20.81^e$ | $19.60^e$ | $7.54^{de}$ | $7.66^{bc}$ |
| $H_1S_5$ | $21.54^d$ | $20.55^{bc}$ | $7.91^c$ | $7.58^{cd}$ |
| $H_2$ $S_0$ | $11.95^i$ | $11.83^g$ | $6.86^g$ | $7.06^e$ |
| $H_2$ $S_1$ | $23.55^b$ | $23.57^a$ | $8.11^a$ | $7.97^a$ |
| $H_2$ $S_2$ | $21.51^d$ | $19.59^e$ | $7.87^c$ | $7.76^b$ |
| $H_2$ $S_3$ | $19.95^f$ | $19.03^f$ | $7.62^d$ | $7.49^d$ |
| $H_2$ $S_4$ | $18.66^g$ | $19.99^{de}$ | $7.48^e$ | $7.76^b$ |
| $H_2$ $S_5$ | $19.89^f$ | $19.95^{de}$ | $7.86^c$ | $7.54^{cd}$ |
| LSD | 0.1844 | 0.4730 | 0.0915 | 0.1668 |

Means values in column not comprising same letter vary significantly at P=0.05. N.S = Non significant.

physiological traits, when nitrogen sources was applied in chemical (urea) @ 250 kg N $ha^{-1}$ as compared to other sources of nitrogen.

## REFERENCES


Achieng JO, Ouma G, Odhiambo G, Muyekho F (2010). Effect of farmyard manure and inorganic fertilizers on maize production of alifisols and ultisols in Kakmega western Kenya. Agric. Biol. J. N. Am., 1(4): 430-439.

Ahmad R, Naseer A, Zahir ZA, Arshad M, Sultan T, Ullah MA (2008). Integrate use of recycled organic waste and chemical fertilizer for improving maize yield.

Ahmad R, AhmadN, Ahmad S, Ahmad T (1993). Sources-Sink relationship in maize under varying nitrogen regimes. Pak. J. Agric. Res., 14(12): 17-176.

Akbar H, Miftahullahjanm T, Ihsanullah A (2002). Yield potential of sweet corn as influenced by different level of nitrogen and plant population. Asin J. Plant. Sci., 1(16): 631- 633.

Balik J, Olfs HW (1998). Effect of mineral and organic fertilizer application on soil fertility parameters in a five years maize monoculture experiment. AgriC Biol. Res., 51(4): 319-328.

Chaudry AR (1983). Maize in Pakistan. Pb. Agri. Res.Coordination Board, University of Agriculture, Faisalabad.

Evans SP, Knezevic ZC, Lindquist LJ, Shapiro AC (2003). Influence of nitrogen and duration of weed inference on corn growth and development. Weed Sci., 51(4): 546- 556.

Jen-Hshuan HC (2008).The combined use of chemical and organic fertilizer and /or biofertilizer for crop growth and soil fertility.Dept.Soil and Environ.Sci, Nat. Chung Hsing Uni., 250 Kuo-Kuang Road, Taichung. Taiwan ROC, pp. 1-18.

Kumar B, Walia US (2003). Effect of nitrogen and plant population levels on competition of maize with weeds. Ind. J. Weeds Sci., 35: 2569-2583.

Kumar SMS, Sundari A (2002). Studies on the effect of major nutrients and crop weed competition period in maize. Ind. J. Weeds Sci., 35: 2569-2583.

Okeleye KA, Oyekanmi AA (2003). Influence of nitrogen fertilizer level on growth and yield of maize hybrids. Moor J. Agric. Res., 4(1): 26-36.

Partha N, Sivasubramanian V (2006). Recovery of Chemicals from Pressmud A Sugar Industry Waste, J. Indian Chem. Engr., 48(3): 160-163.

Randawa MA, Cheema ZA, Anjam M (2002). Influence of triantema portulacastrum infestation and nitrogen on quality of maize grain. Int. J. Agric. Biol., 4: 513-514.

Rizwan M, Maqsood M, Rafiq M, Saeed M, Ali Z (2003). Maize (*Zea mays* L.) response to split application of nitrogen. Int. J. Agric. Biol., pp: 19-21.

Sharif M, Ahmed M, Sharer M, Sm R, Khattak A (2004). Effect of organic and inorganic fertilizers on the yield and yield components of maize. Pak. J. Agric. Eng. Vet. Sci., 20(1): 11-15.

Sharar MS, Ayub M, Nadeem MA, Ahmad N (2003). Effect of different rates of nitrogen and phosphorus on growth and grain yield of maize. Asian J. Plant Sci., 2(3): 347-349.

Shapiro CA, Wortmann CS (2006).Corn response to nitrogen, row spacing and plant density in eastern Nebraska. Agron. J., 98: 529-535.

Shih CR, WC, Ho WC, Wen WY, Po RS, Chung CH, Wang CW, Wang YP (2000). Influence of organic matter and inorganic fertilizers on growth and N-accumulation of corn plants. J. Plant Nutr., 23(3): 297-311. (CAB Absts., 2000/08-2002/04).

Steel RGD, TorrieJH, Dicky DA (1997). Principles and procedures of Statistics. A biometrical Approach 3rd Ed. McGraw Hill Book Co. Inc. New York, pp. 400-428.

Stantiford EI (1987). Recent Developments in Composting. In: Debertoldi, M., Ferranti, M.L., Hermite, P., Zucconi, F. (Eds.), Compost, Production, Quality and Use. Elsevier, London, UK, pp. 52-60.

Sudhu B, Kapoor KK (1999). Effects of compost prepared from different farm wastes on growth and N and P uptake of maize. Environ. Ecol., 17(4): 823-826 (Field. Crop. Absts., 53(5): 3314;2000).

Tamayo VA, Munoz AR, Diaz AC (1997). Organic fertilizer application to maize on alluvial soils in a moderate climate. Actualidades Corpoica, 108: 19-249 (CAB Absts., 1996-1998/07).

Waseem M, Zamir SI,.Ali A, Iqbal A (2007). Influence of nitrogen sources on quantitative and qualitative traits of maize. Pak. J. Life Soc. Sci., 5(1- 2): 11- 14.