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The Effect of Sowing Date and Some Growth Physiological Index on Grain Yield in Three Maize Hybrids in Southeastern Iran

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Abstract: One of the most important objectives in farming systems is to minimize the risk probability as well as maximizing the production level. This study, using a spilt plot experiment based on RCBD with three replications, aims to study the effect of sowing date on yield and growth physiological index of maize cultivars. It was conducted in 2005/06 at the research farm of the Faculty of Agriculture in University of Zabol, Sistan-Baluchistan province, Southeastern Iran. Experiment factors were: Three maize hybrid cultivars (Namely, S.C 108, S.C 604 and S.C704) that were subplot and sowing dates (5 July, 20 July, 5 August and 20 August) that were main plots. Results indicated that sowing dates have significant effects on yield and physiological index in maize cultivars. They Maize hybrids have different response to these parameters. The highest grain yield and harvest index was obtained from 5 August. The first sowing date (5 July) was associated with a decrease in Leaf Area Index (LAI). Leaf Area Index Duration (LAID) and Crop Growth Rate (CGR). As a result, S.C 704 cultivar has the highest of CGR, LAI, LAID and grain yield (11.5 t ha^{-1}), On the contrary, S.C 108 cultivar has the lowest of the CGR, LAI, LAID and grain yield (6.4 t ha^{-1}). Consequently, it can suggest that S.C 704 cultivar should be applied and the sowing date should be adjusted to 5 August in conditions of Sistan. This could be contributed to optimum temperature and decrease wind speed during the flowering, grain formation and filling stage.

Key words: Yield, growth, harvest index, CGR, LAID

INTRODUCTION

Corn (*Zea mays* L.) is one of the most important cereal crops grown principally during the summer in Iran. This crop has much higher grain protein content than our staple food rice. The yield of maize in Iran is very little. Xue *et al.* (2002) reported that one of the most important effective factors is non-application of optimal maize hybrids and sowing. The work at that time focused more on breeding aspects rather than crop management. Imam (1966) reported that under the optimum planting time for maize conditions, would be from the last week of September to the end of October. High grain yield (2952 kg ha^{-1}) was obtained during this period. Elkarouri and Mansi (1980) was reported, that, the period from November to February is the best time for the highest dry matter production in the Khartoum area. It also was reported that the mean daily temperature is the major environmental factor that affects the crop development and yield. Mc Cormick (1974) reported that maize grain yield was reduced when sowing time was delayed to the end of October. Cirilo and Andarade (1996) was reported that delaying sowing date to mid-December reduced the individual 1000 kernel weight. El-Koomy (2005) and Gardner *et al.* (1990) were indicated that maize varieties differed in their growth characters in Gainesville Florida. Ahmad *et al.* (2001) informed that July 15 as an optimal sowing date for maize in Peshawar, in India. In addition, Sadek *et al.* (1994) and Zaki *et al.* (1999) reported that maize cultivars differed in yield and its components in the same region. Variation in biological yield at planting dates was associated with differences in the amount of intercepted radiation. Shorter cultivar had greater assimilated allocation to the grain than the taller cultivars (Benga *et al.*, 2000). The aim of this study the effect of sowing date and the cultivar on the yield and physiological index of maize under the Iranian field conditions during 2005/06.

MATERIALS AND METHODS

The experiment was carried out in a research farm at the University of Zabol, Sistan and Baluchistan, Southeastern Iran (61° 41'E, 30° 54'N, 483 m, 30 mm Average annual, 49 mm yearly rainfall). The experiment was carried out during 2005/06 growing season on a sandy-loam soil (Table 1). All phosphorus (65 kg ha^{-1}) and potassium (200 kg ha^{-1}) and half nitrogen

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Table 1: Soil Analysis results characteristics of the experimental area during the 2005/06

Year	Depth of soil (cm)	pH	Ec (mmohs cm^{-1})	N (%)	P (ppm)	K (ppm)	Sand	Silt	Clay
2005	0-30	7.8	3.3	0.06	12	130	71	14	15

Source: Agricultural Research Center of Sistan

(290 kg ha^{-1}) doses were applied with sowing while balance of nitrogen was applied at stem elongation stage. All other cultural practices including (Irrigation, thinning and weeding) were kept normal and uniform for all of the treatments.

Three single cross cultivars, namely, S.C 108, S.C 604 and S.C 704 were sown at four sowing dates: 5 July, 20 July, 5 August and 20 August. The design was a Split-plot with three replication, with sowing date as the Main-plots and the cultivars as the Sub-plots. Plant spacing was 60 cm between row and 20 cm between plant holes. Three seeds were sown and after 3 weeks thinned to one plant/hole to give about 83333 plants ha^{-1}. Plot size was 6×3.6 m. Twelve plants were selected at random and used to determine yield and 1000 kernel weight. Leaf area was determined with a leaf area meter, Delta T Device Model. CGR, LAI and LAID values were calculated according to Gardner *et al.* (1985).

$$CGR = 1/SA.\ (W_2 - W_1)/\ (T_2 - T_1)$$

$$LAI = (1/SA).\ (LA_2 + LA_1)\ /2$$

$$LAID = (LA_2 + LA_1)/SA.\ (T_2 - T_1)/2$$

Where:

LA_1 and LA_2 = Area (cm^2)
SA = Soil area (cm^2)
T = Duration (day)
W = Dry weight (g)

Dry weight was determined after the plant materials oven-dried at 65°C for 72 h. The following parameters were measured from the center of two rows in each plot: Grain Yield (GA) (kg ha^{-1}), Biological Yield (BY) (kg ha^{-1}), Weight of 1000-Kernels (WS) (g) and Harvest Index (HI) at maturity. ANOVA test was conducted on the data by MSTAT-C statistical software using the SAS statistical producer and treatment means were compared using a Least Significant Different (LSD) test. The aim of this study is to the effect of sowing date and the cultivar on the yield and physiological index of maize under the Iranian field conditions during 2005/06.

RESULTS

Grain yield (GA), Biological Yield (BY) and 1000-Kernel Wt (KWT): The effects of sowing date and cultivars on the yield and 1000- Kernels wt are shown in Table 2.

Table 2: Effect of sowing date and cultivars on GA, BY, HI and SWT parameters

Treatments	GY (t ha^{-1})	BY (t ha^{-1})	1000-Kernel wt. (g)	HI (%)
Sowing date				
5 July	2.300b	8.080b	34.48a	26.42b
20 July	6.760a	16.820a	34.37a	38.60a
5 August	8.840a	20.370a	33.77a	45.26a
20 August	6.170a	15.960a	27.26b	38.22a
LSD	3.410	1.80	2.23	8.48
Cultivar				
S.C 108	6.400c	8.190c	28.85c	41.98a
S.C 604	8.900b	18.210b	31.18b	34.41b
S.C 704	11.500a	20.340a	33.57a	39.40a
LSD	0.55	0.97	1.58	4.36
CV %	4.50	2.30	6.70	8.50

Mean followed by the same letter(s) within a column are not statistically different at the p = 0.05 level. Where is the legend GY: (Grain Yield), BY: Biological yield, HI: Harvest index. Where is the CV % value of the sowing dates in Table 2

Table 3: Interaction of sowing date×cultivar on grain yield of the cultivars

Sowing sate	Cultivars: S.C 704	S.C 604	S.C 108	Mean
5 July	3262d	1536c	625d	1808
20 July	9410b	7110a	3659b	6726
5 August	10110a	7600a	5610a	7773
20 August	6350c	7270a	3440c	5687
Mean	7283	5886	3334	5501
LSD (% 5) = 340				

Mean followed by the same letter(s) within a column are not statistically different

Sowing date has a significant effect on grain yield. The sowing date of August 5th has the highest level of yielding compared with the other sowing dates experimented (Table 2). The cultivars grown varied significantly in their yield potential. S.C 704 has the highest yield (11.5 t ha^{-1}) compared to the other cultivars. The interaction effect of sowing date and cultivar on grain yield was significant (Table 3) and S.C 704 at sowing date in 5 August has the highest yield (10.1 t ha^{-1}). At optimum sowing date, S.C 704 out yielded all the cultivars with higher grain yield of 10.1 t ha^{-1}.

While S.C 108 produced lower grain yield of 6.4 t ha^{-1} all cultivars produced the highest grain and biological yield at optimum sowing date. Otegui *et al.* (1995) reported that the optimum sowing date resulted in higher grain yield than early and late planting dates, because of higher cob numbers and greater kernel number per plant.

Cultivar had a significant effect on the 1000- KW. S.C 704 higher seed wt than S.C 604 and S.C 108, which was reflected in their higher grain yields, compared to S.C 604 and S.C 108. The maximum grain yield (8.84 t ha^{-1}) was obtained from the 5 August sowing date that was not

statistically on a 20 July and 20 August (Table 2). Results showed that maximum BY was produced at 5 August but no significant different to 20 July and 20 August. Among the cultivars' BY, S.C 704 (20.3 t ha^{-1}) has the higher than other cultivars (Table 2). It is note worthy to mention that the results of cultivars difference in yield and 1000- Kernels wt may be due to the differences in genetic structure the maize genotypes. The genotypic differences in GY, BY and 1000- Kernels wt in agree with the results obtained by other researchers (Ahmed and Sadek, 1992; Sadek *et al*., 1994; Zaki *et al*., 1999; Begna *et al*., 1997).

Sowing date caused significant difference in 1000-kwt. (Table 2). Early sowing dated plant was produced higher 1000- Kernels wt. of 34.4 g, whereas those of optimum and late sowing date attained lower 1000-Kernels wt. of 27.2 and 33.7 g (Table 2). The low 1000-Kernels wt. at late sowing date (20 August) confirms the findings of Gallagher *et al*. (1975) who reported that delay in planting date generally result in decreased individual grain mass, cob number per plant and eventually decrease in the grain yield.

Harvest Index (HI): The physiological efficiency and ability of a crop for converting the total dry matter into economic yield is known as HI (Sinclair, 1998). Sowing date and cultivars showed significant difference for this trait (Table 2). Cultivar sown at the 5 August had maximum HI value as 45.2%, which was similar to 20 August and 20 July (Table 2). On the other hand, the 5 July had minimum HI value as 26.4%. Mean comparisons indicated the maximum HI value was found for S.C 108 as 41.9% and minimum value was calculated for S.C 604 as 34.4% (Table 2).

Growth Analysis (GA): Sowing date and cultivars were showed highly significant for LAI values. 5 August was the best sowing date and produced the highest LAI values for all cultivars. S.C 108 obtained the lowest LAI value and S.C 704 obtained the highest LAI value (Fig. 1). From growth analysis data, time trends in LAI and CGR values were shown in Fig 1-2. S.C 108 cultivar had lower value in LAI and CGR than S.C 604 and S.C 704 cultivars during growth period. However, LAI value was reduced at the growing stage and this resulted from the inhibition of leaf area development and acceleration of senescence of leaves in lower position (Fig. 1).

Cultivars effect was highly significant for mean of CGR. From them, S.C 704 (21.69 g m^{-2}) has higher than compared to S.C 604 (19.53 g m^{-2}) and S.C 108 (12.83 g m^{-2}) (Fig. 2). On the other hand, it was observed that CGR parameters were increased with days after planting or growth of plant and then reduced to increase

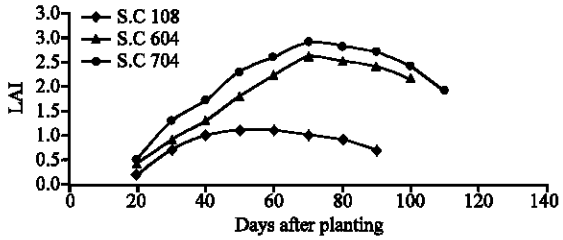

Fig. 1: The variation of LAI values in three maize cultivars at growth stage

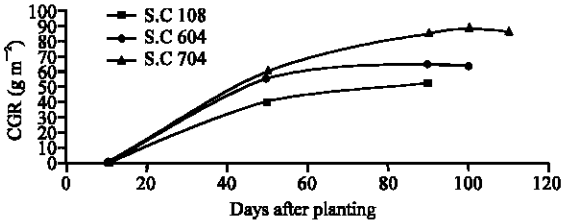

Fig. 2: The variation of CGR values in three cultivars at growth stage

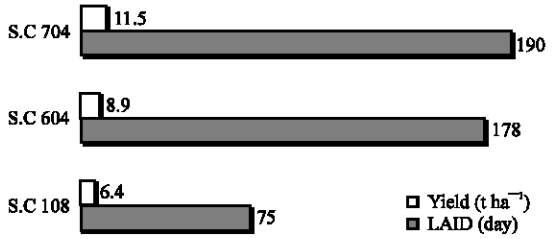

Fig. 3: The relation between LAID and grain yield

age of plant. Reduction of CGR was due to low photosynthesis Net Assimilation Rate and low LAI values. In addition, calculated results among these values are agree with Mineo and Ujihara (1991) that reported and verified a highly significant correlation between CGR and NAR (r = 0.979***) values.

Grain and Biological yield (GY and BY) and Leaf Area Duration (LAD): Its relation to crop is affected by clear efficiency of the Net Assimilation Rate (NAR) and the speed of Crop Growth Rate (CGR) (Kostrej, 1992). The obtained results show an apparent relation between the LAID and the Grain Yield which can be statistically proved. The LAID affects on the increase of dry matter (Fig. 3). The results were showed that yield has a linear relation with LAID. These results agree with Kostrej (1992). The more the LAID is, the higher the dry mater accumulation potential of the crop is.

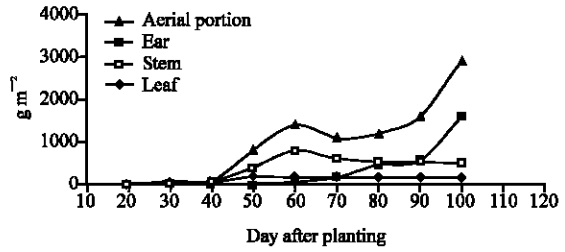

Fig. 4: Change of dry matter weight in various plant parts

Crop Growth Rate (CGR): The variation of total dry matter weight on the time trends is shown in Fig. 4. Total dry matter weight of plant, increased steadily throughout reproductive stage.

Changes of dry matter weight in various plant parts is presented in Fig. 4. With increased growth plant at the time unit dry matter of ear was increased in plants, similarly, dry matter of leaf increased with increased plant age, but with increased of age plant dry matter of leaf was decreased that was caused senescence of leaves in lower position of plant. With increased plant growth, dry matter of stem was increased but with increased of age plant to caused ear formation in plant stem dry matter was decreased and for this reason remobilization nutrition is from stem to ear.

Total dry matter was increased with increased age plant and was caused for seed formation and growth of ear in plant. This result is agreed with Kimio and Gotoh (1976).

DISCUSSION

Applying the optimum sowing date for maize cultivars has a positive effect on a grain yield and physiological index in maize. The study revealed that both sowing date and cultivar had significant effect on grain yield in used maize cultivars under the field conditions. Similar results have been obtained where seeding dates and varieties significantly influenced 1000-kwt. (Quayyum and Raquibullah, 1987; Abdul Rahman *et al*., 2001; Nielson *et al*., 2002). The sowing date×cultivar interaction significant affected grain yield. Plants at optimum sowing date performed the high yield; S.C 704 produced a higher grain yield (11.5 t ha^{-1}), while S.C 108 produced the lowest (6.4 t ha^{-1}). This result agree with finding by Otegui *et al.* (1995) that optimum planting date resulted in higher grain yield than early and late planting dates because of higher cob numbers and greater kernel numbers per plant. LAI within a maize canopy are major factor determining total light interception, which affects photosynthesis, transpiration and dry matter production (Stewart and Dwyer, 1999; Fortin *et al*., 1994). Sowing date and cultivar significantly affected LAI, CGR and LAID. Maize at optimum sowing date produced higher LAI, LAID, CGR and grain yield. The differences in LAI and other factors could be attributed to difference in heat units (average temperature) between sowing dates. S.C704 once again produced the highest LAI and other factors of all cultivars.

CONCLUSIONS

At all sowing dates, short growing season cultivar (S.C 108) produced less leaves than long growth season cultivars (S.C 604 and S.C 704) and as a result had a greater LAI leaf area index at long growth season cultivars. This resulted in higher dry matter accumulation for long season cultivars than short season cultivars. Grain yield of short season cultivar was less at all sowing dates; reverse long season cultivar (S.C 704) was higher grain yield at all sowing dates. The cultivar S.C 704 produced a higher grain yield, while the S.C 108 cultivar produced the lowest. Higher grain yield at S.C 704 could be attributed to the genetic characteristics include higher of CGR, LAI and LAID of this cultivar compared to S.C 604 and S.C 108. The physiological growth parameters such as LAI, CGR and LAID change with the sowing dates and cultivars and the highest value of this parameters (1.58, 23.86 g m^{-2} and 192.5 days, respectively), was at the optimum sowing date (August 05) and the best cultivar was S.C 704 that has the maximum of above parameters (1.79, 21.69 g m^{-2} and 190.9 days, respectively). Higher grain yield (8.8 t ha^{-1}) at 5 August than compared early and late date of planting might be due to the favorable agro climatic condition of particular temperature and wind speed. It could be concluded from the present study that corn varieties should be sowing date according to the areas of their adaptability for increased grain and biomass yield per unit area. The study further indicated that S.C 704 is an ideal corn cultivar for higher grain production when planted on August 05 in Sistan Region. Optimum planting date was obtained in (August 05) this could be attributed to optimum temperature at during the flowering, grain formation and filling stage, while date of planting at July 05 in the region was the highest of wind speed and mean air temperature (35.4 Centigrade) that caused low grain in all cultivars.

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