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RESPONSE OF SUNFLOWER TO DIBBLING TIME FOR YIELD AND YIELD COMPONENTS

Shahbaz Ahmad[1], Fayyaz-ul-Hassan[1], Hakoomat Ali[2] and Um-e-Robab[1]

[1]Department of Agronomy, University of Arid Agriculture, Rawalpindi.
[2]University College of Agriculture, Bahauddin Zakariya University, Multan.

Abstract: Sunflower can be a most suitable crop to bridge the gap between local production and consumption. Accurate determination of physiological maturity would be valuable for managing sunflower with respect to time of planting and its wider adaptability. The present study was contemplated to quantify the varying sowing time effects on sunflower yield. The experiment was conducted at the University of Arid Agriculture, Rawalpindi. The experiment was planted in a randomized complete block design in a split plot arrangement with five hybrids and six sowing dates. Hybrids differed significantly for head diameter, thousand seed weight, seed yield and biological yield while number of seeds remained statically non significant. However, sowing dates affected all parameters significantly. Early sowing produced heads of large size, gave maximum number of seeds per head and the highest biological yield. Crop sown on July 22nd produced the maximum seed yield and amongst hybrids, SF-187 gave the highest yield.

Keywords: Head-diameter, hybrids, seed yield and biological yield, sowing dates

INTRODUCTION

Sunflower can be focused as the most suitable crop as edible oil source in Pakistan. It is short duration, relatively drought tolerant and has shown potential to reduce the existing gap between production and consumption of edible oil because it contains 40-50 percent oil 17-20 percent proteins [Wang *et al*. 1997]. It can be grown twice a year and can be fitted well in our present cropping systems.

It can successfully be grown over a wide range of geographic area and is considered a crop adapted to a wide range of environment [Khalifa 2000]. However, yield is reduced when normal sowing is delayed in temperate and subtropical environments. The lower yields associated with late plantings have been hypothesized as due to warmer temperatures during the early growth period, which promotes excessive early stem growth and reduces time to flowering, while in cooler temperatures, reduced incident radiation post anthesis affects dynamics of grain filling [Andrade 1995].

A useful framework to investigate environmental and genotypic effects on crop performance defines yield as the product of total biomass produced and the fraction of that biomass partitioned to harvestable yield. Total biomass produced will depend on incident radiation, canopy fractional interception, and the efficiency with which intercepted radiation is converted into biomass. Bange *et al*. [1997] investigated the effect of sowing date on sunflower yield performance and found that changes in both biomass accumulation and harvest index were crucial in determining yield reductions associated with late planning in a subtropical environment. Biomass accumulation was mostly influenced by the amount of intercepted radiation rather than by radiation use efficiency. The observed reductions in harvest index were associated with a shortening in grain filling duration and a reduction in the daily rate of harvest index increase. Beard and Geng [1982] hypothesized that characters measured at harvest were highly dependent on early growth and, consequently, the observed lower yields, associated with late planting, due to the unfavorable environmental conditions during the early growth period.

Correct time of sowing, not only influences yield but also the kernel to husk ratio. Seed weight tends to decrease with delayed sowing, and greatest loss in the kernel. However, sowing outside the optimum period may be necessary to have a particular grade of oil [Weiss 2000]. The present study was aimed to quantify the sowing time variations with respect to yield and yield parameters of five sunflower hybrids under rain fed conditions.

MATERIALS AND METHODS

Five sunflower hybrids namely SMH-9706, SF-177, PARSUN-1, CRN-1435 and SF-187 were planted on, June 22, July 4, July 14, July 30, August 10 and August 21 at the research farm of the University of Arid Agriculture Rawalpindi during summer 2001. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications having split plot arrangement with a plot size of 3 x 5 m^2. The row to row distance was 75cm and plant to plant distance was maintained at 30 cm. Uniform dose of fertilizer @ 80 kg N and 50 kg P_20_5 per hectare was applied in the form of DAP and Urea and was incorporated in the soil during seed bed preparation. Sunflower seeds were planted with the help of dibbler, putting three seeds per hill. After emergence one plant per hill was maintained.

Head diameter of ten randomly selected plants was measured with the help of vernier calliper. The heads were threshed manually and number of seeds per head was counted. Three lots of 1000 seeds were weighed for thousand seed weight (TSW) with the help of electronic weight balance and average was calculated.

Central two rows from each subplot were harvested for biological yield. Bundles were sun dried and weighed and yield was converted to kg ha^{-1}. The heads of plants harvested from central two rows were clipped and threshed manually for seed yield. Harvest index (HI) was calculated using the formula:

$$HI = \frac{\text{Economic yield}}{\text{Biological yield}}$$

The data of all the parameters under study were analyzed using appropriate techniques and Duncan's Multiple Range Test was employed to separate the means [Steel and Torrie 1980].

RESULTS AND DISCUSSION

Head diameter is an important yield component. The hybrids were statistically different from each other for this parameter (Table 1). The hybrid CRN 1435 had the maximum (18.30 cm) head diameter followed by SMH-9706. Hybrid SF –177 produced heads of the smallest size (15.37 cm). The head diameter showed a decreasing trend with delayed sowing. The differences among the planting times were statistically significant (Table 1). The crop planted on first sowing (June 22) had the largest (19.06 cm) head diameter while the crop planted on last sowing (August 21) produced the heads of the smallest size (13.84 cm). The effects on head diameter were much more pronounced in case of last two sowing dates. The reasons of smaller head could be related to the overall plant structure. Similar results were reported by Paul and Thompson [1982] who concluded that smaller plants with less stem girth would give smaller heads. Significant linear relationship (Fig. 1) between sowing dates and head diameter provides the clue that head diameter is dependent upon sowing dates.

Table 1: Effects of sowing dates on yield and yield components of sunflower hybrids

Hybrids	Head Diameter (cm)	Seeds Head^{-1}	TSW (g)	Seed yield (Kg ha^{-1})	Biological Yield (Kg ha^{-1})	Harvest index
SMH-9706	16.70 B	773.67NS	62.10 D	2108.25 A	3900.8 C	0.53 B
SF-177	15.37 D	685.79	56.97 E	2019.0 B	6125.9 B	0.30C
PARSUN-1	16.14 C	846.96	76.13 A	1830.0 C	3588.5 C	0.54 A
CRN-1435	18.30 A	877.13	64.42 C	2080.45 A	8337.2 A	0.28 D
SF-187	16.41 C	744.17	70.0 B	2125.29 A	5916.7 B	0.36 C
Date of Sowing						
22 June	19.06 A	952.9 A	56.58 F	2110.95 A	6422.6 A	0.36 D
4 July	16.66 C .6	812.4 B	60.61 E	2041.95 AB	5666.9 B	0.39 C
14 July	17.24 B	833.7 B	76.09 A	2178.3 A	5686.2 B	0.41B
30 July	16.86 C	780.0 B	72.95 B	2106.15 A	5196.0 C	0.44 A
10 August	15.85 D	708.85 C	66.65 C	1913.50 B	4605.3 CD	0.44 A
21 August	13.84 E	625.4 D	62.65 D	1844.2 B	4167.7 D	0.45 A

Number of seeds per head plays a remarkable role in determining the grain yield. Data on number of seeds per head presented in Table 1 showed non-significant differences among the hybrids. Number of seeds per head decreased when sowing was delayed. Earlier sowing produced the maximum number of seeds per head (Table 1). The maximum (952.9) number of seeds per head was produced in case of first sowing (June 22) which was significantly different from all other sowings. It was followed by second sowing (July 4) that was at par with third (July 14) and forth sowing (July 30). The lowest (625.4) value was recorded in case of last sowing (August 21) sowing. The lesser number of seeds found in delayed sowing may be related to the head size. Earlier sowings produced larger heads those ultimately encouraged the higher number of seed setting. De La Vega and Hall [2002] observed failures in seed set with delayed sowing because of either lack of fertilization or embryo abortion in the central portion of the floral disc. Significant linear relationship (Fig. 1) between sowing dates and seeds per head supports earlier findings.

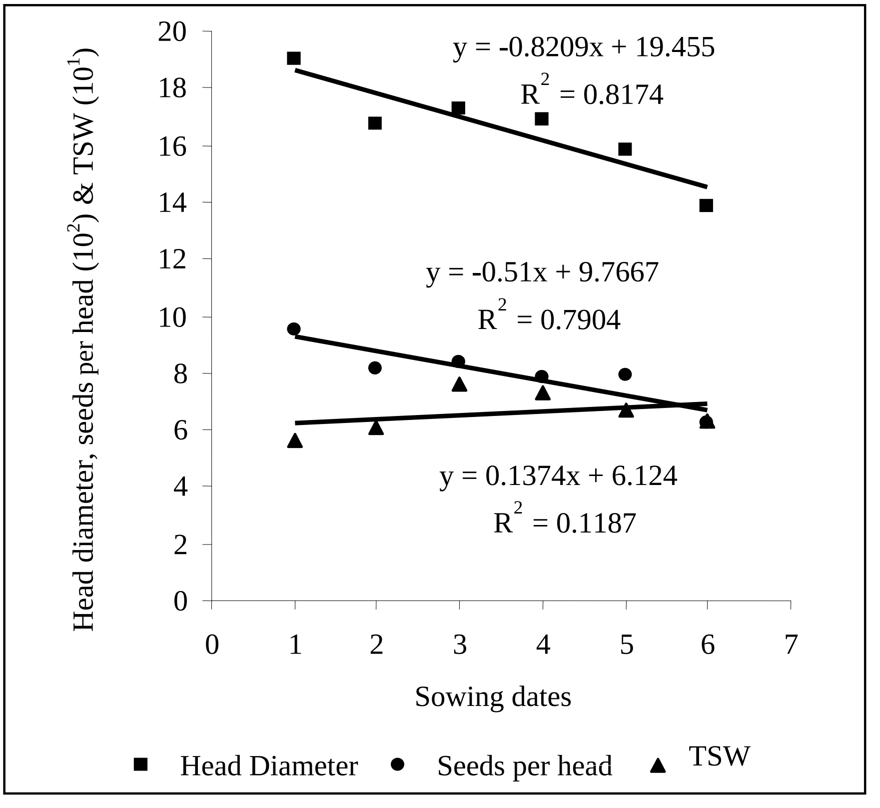

Fig. 1: Relationship among sowing dates, head diameter, seeds/head and TSW.

Thousand seed weight (TSW) is an important yield parameter. Table 1 showed that 1000-seed weight of sunflower hybrids was statistically different from each other. The maximum (76.13 g) TSW was recorded from PARSUN-1 followed by SF-187 (70.0). Hybrid SF-177 produced the lowest (56.97 g) TSW. Similar results were obtained by El-Ahmer *et al.* [1989] who collected information for 18 sunflower cultivars and reported different TSW among cultivars that may be attributed to the genetic make of the hybrids. Sowing dates had pronounced effect on TSW. The maximum (76.09 g) seed weight was obtained from third sowing (July 14) while the minimum (56.58 g) was recorded from first sowing (June 22) (Table 1). The minimum TSW produced by early plantation may be due the fact that plants of this particular sowing produced the plants with larger heads those ultimately encouraged the maximum number of seeds but assimilates were not supplied in an enough quantities to fully nourish large number of seeds. Ultimately seeds remained under nourished and had less TSW. The highest TSW produced by 14th July sowing could be related to the balanced plant structure and number of seeds produced per head. Plants of this particular date produced seeds of such a range which was fully nourished by assimilates produced by the plant structure. Cantagallo *et al*., [1997] found inverse correlation between grain number and weight. The non significant relationship (Fig. 1) between sowing dates provides the evidence that TSW is directly influenced by the development of other plant parts especially the source to sink relationship.

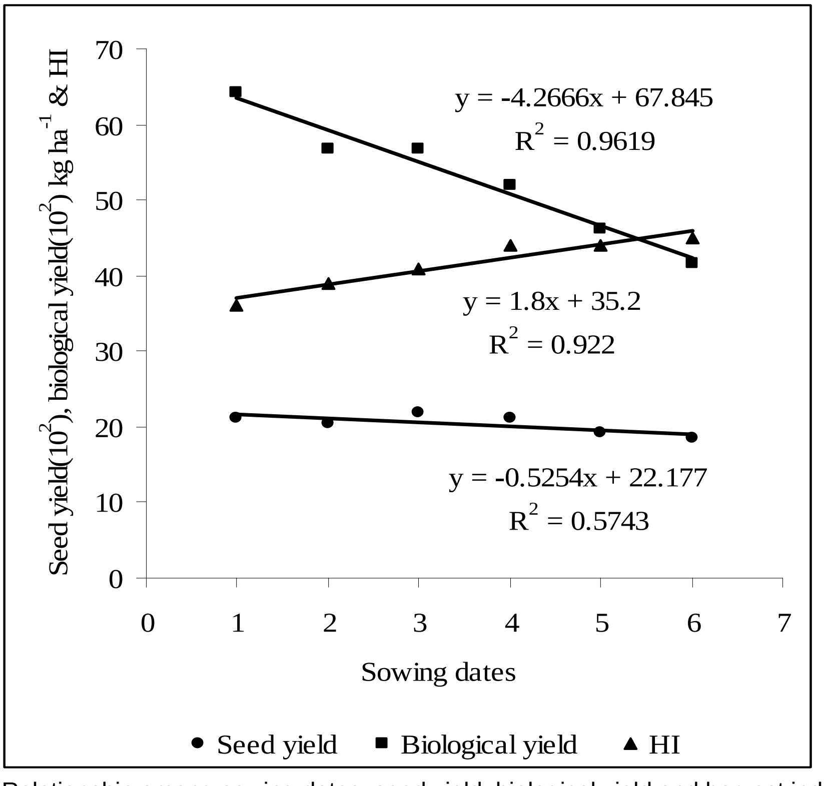

Fig. 2. Relationship among sowing dates, seed yield, biological yield and harvest index.

Final seed yield of crop is the inter play of individual yield components. The seed yield was significantly different among hybrids (Table 1). The highest yield (2125.29 kg ha^{-1}) was obtained in case of SF-187 that was at par with SMH-9706 (2108.5 kg ha^{-1}) and CRN-1435 (2080.45 kg ha^{-1}). The lowest value was recorded for PARSUN-1 (1830.0 kg ha^{-1}) followed by SF-177 (2019.0 kg ha^{-1}). These results are in confirmatory with those of Austin [1993] who reported significant differences in seed yield of different hybrids. Delayed sowing increased seed yield up to third sowing (July 14) but did not influence yield significantly delay beyond it had decreased yield significantly. The highest seed yield (2178.3 kg ha^{-1}) was produced by third sowing (July 14) (Table 1) that was at par with first, second and fourth sowings. The last sowing (August 21) produced the lowest seed yield (1844.2 kg ha$^{-1)}$ that was at par with fifth sowing (August 10) (1913.5 kg ha^{-1}). Late sown crop produced smaller plants, smaller heads, less number of seeds, lower TSW that was ultimately translated into less seed yield compared to early sowings. De La Vega and Hall [2002] concluded that late planting dates affect negatively sunflower yield through reduction in all components. Significantly linear relationship (Fig. 2) between sowing dates and seed yield gave a clue that seed yield is dependent more on dates i.e. length of crop life cycle than any other factor. Similar results have been reported by Hassan *et al*. [2003].

Biological yield represents the total amount of above ground biomass accumulation. Hybrids differed significantly from each other at 5% level of probability (Table 1). The hybrid CRN-1435 produced the maximum biological yield (8337.21 kg ha^{-1}) and hybrid SMH-9706 and PARSUN-1 showed lowest biological yield (3900.83 kg ha^{-1} and 3588.5 kg ha^{-1} respectively), which were statistically at par with one another. Sowing dates had pronounced effects on biological yield. The first sowing (June 22) produced maximum biological yield (6422.6 kg ha^{-1}) while last sowing (August 21) gave the lowest biological yield (4167.7 kg ha^{-1}) and it was at par with fifth sowing (August 10) (4805.45 kg ha^{-1}) (Table 1). These differences are attributed to the effect of environmental conditions under which crop growth and development occurred. These results confirmed the findings of Paul *et al.* [1990] who concluded that assimilate utilization is depressed at lower temperature and this imposes a greater restrictions on biomass production in sunflower. Similar to the seed yield total biomass production is dependent on crop life cycle. Significant linear relationship (Fig. 2) between sowing dates and biological yield are consistent with the findings of Bange *et al*. [1998].

The physiological efficiency and ability of a crop plant for converting the total dry matter into economic yield is known as harvest index (HI). The data pertaining to HI is presented in Table 1 showed that all the sunflower hybrids were statistically different from each other. The data revealed that PARSUN-1 gave maximum HI (0.54) while CRN-1435 gave the lowest HI (0.34). It has been concluded by Bindi *et al*. [1999] that HI is relatively stable across genotype. Similarly sowing dates showed significant differences for HI (Table 1). Crop sown on forth sowing (July 30) had maximum HI (0.49) which was similar to fifth sowing (August 10) and last sowing (August 21), while minimum value was recorded from first sowing (June 22) (0.36). De La Vaga and Hall [2002)] found slightly higher HI with earlier sowing which was considered to be influenced by accumulated intercepted radiation and grain filling duration. Significant linear relationship (Fig. 2) between sowing dates and HI confirms earlier findings. Significant linear relationship (Fig. 3) between biological yield and HI and non significant linear relationship between seed yield and HI (Fig. 4) also provide the evidence that HI is more dependent on total biomass production.

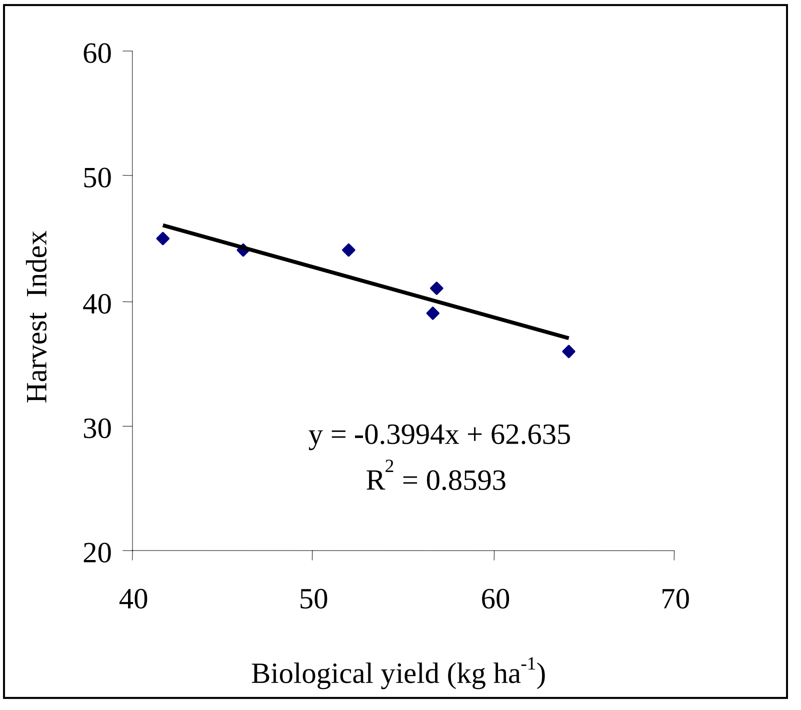

Fig. 3: Relationship between biological yield and harvest index.

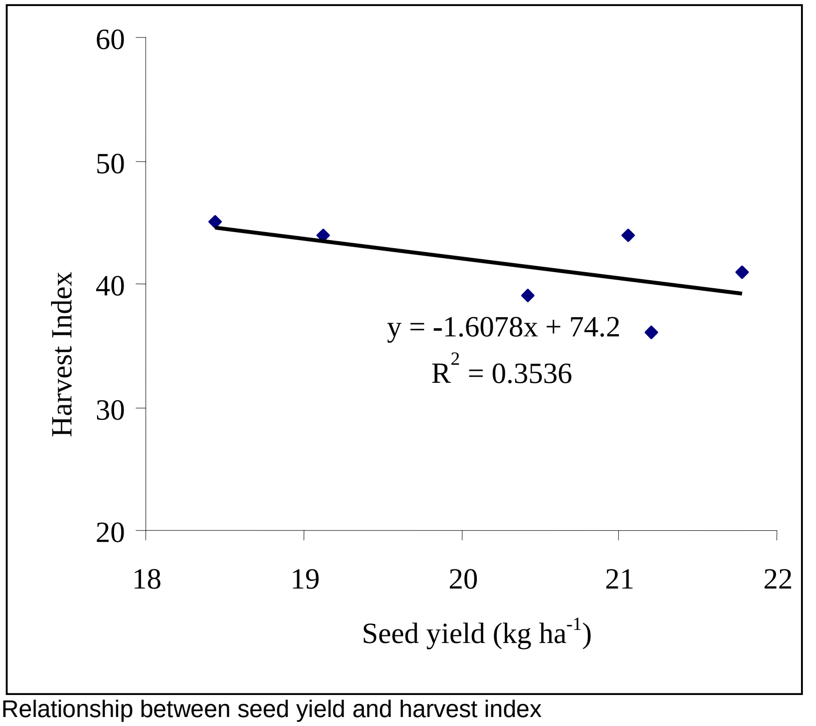

Fig. 4: Relationship between seed yield and harvest index

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