GROWTH AND DEVELOPMENT OF SUNFLOWER IN RESPONSE TO SEASONAL VARIATIONS

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SUMMARY

Field experiments have been conducted to quantify the growth and development of sunflower in response to seasonal variation over two seasons, i.e., Spring and Fall. Five sunflower hybrids were sown in a randomized complete block design. Growth and development parameters like stem girth, plant height and dry matter accumulation m⁻² were recorded at the time of maturity. The hybrid Suncross-42 produced the maximum stem girth in Spring which was significantly different from that of XF-263 which was the lowest in both seasons. Plant height followed a pattern similar to stem girth. The hybrid Suncross-42 produced the tallest plants in both seasons. Stem girth and plant height are considered major contributors to total dry matter production. Dry matter accumulation m⁻² followed a pattern similar to those of stem girth and plant height. The hybrid Suncross-42 produced the maximum dry matter in both seasons. Similarly, it produced maximum seed yields in both seasons. Overall superiority of the Spring crop over the Fall crop, in terms of stem girth, plant height, dry matter and seed yield production, may be related to the duration of crop in the field and environmental factors prevailing during the crop life cycle.

Key words: dry matter, life cycle, growth, development, seasonal variations

INTRODUCTION

Growth and development of a plant are a wonderful combination of many events at many different levels, from biophysical and biochemical to organismal, which result in the production of a whole organism. Growth can be measured as increase in length, width, volume, fresh or dry weight of a plant (Bidwel, 1979).

Various environmental variables affect growth and development differently. It had been concluded that temperature regulates the processes of plant growth and development as well as that the rate of plant development is mainly temperature driven (Ritchie and Ne Smith, 1991).

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Sunflower is a temperate zone crop but it can perform well under various climatic and soil conditions. It can withstand early frost in the Fall that usually kills maize and soybean. Amir and Khalifa (1991) concluded that sunflower seeds can germinate and grow successfully across a wide range of climatic environments including hot tropical climates. Similarly, Khalifa et al. (2000) concluded that this wide geographic, morphological and habitat-wise diversity of sunflower extending from very hot areas in the southwest of US to very cold areas in eastern Canada, might have contributed to the development of the unique characteristics of sunflower tolerance to both low and high temperatures and accounted for the wide adaptation of the crop.

Experimental and farm research trials indicated that sunflower can successfully be grown in two seasons (Spring and Fall) in Pakistan due to its wide range of adaptability (Rana et al., 1991). In Spring seasons, sunflower is sown under low temperature of January and February and it grows vegetatively under a range of low to medium temperatures of February and March, before entering the reproductive stage. The reproductive stage develops under high temperatures of May while the crop matures and is harvested under high temperatures of June-July.

Contrary to Spring, Fall crop is sown at high temperature under high humidity of July-August. Its germination and early vegetative growth proceed during high to medium temperatures of August and September before entering the reproductive stage. The reproductive phase of Fall crop evolves at medium temperatures of October. The crop matures and is harvested under low temperatures of November. So, the two opposite sets of environmental conditions prevail from germination to maturity of sunflower when grown in the two seasons, i.e., in Spring and Fall.

Being grown in opposite environmental conditions, all phases are affected accordingly. Germination and vegetative stage of the Spring crop take a relatively longer time due to lower temperatures as compared with the Fall crop where germination and vegetative growth take place under high temperatures, taking less time and completing these parts of the life cycle in a short time (Khalifa et al., 2000). Keeping in view the opposite set of environmental conditions under which sunflower is grown, the present study was contemplated to evaluate the seasonal variation effects on growth and development of sunflower hybrids.

**MATERIAL AND METHODS**

Field experiments were conducted at the University of Arid Agriculture, Rawalpindi, Pakistan, during Spring and Fall of 2000 to evaluate the effects of seasonal variations on the growth and development of sunflower. Five sunflower hybrids, Parsun 1, Suncross-42, XF, 263, SMH-9706 and Smh-9707, were sown in a randomized complete block design with three replications. Planting was done with a dibbler, placing 3-4 achenes per hill at a depth of 3-5 cm in the soil. The Spring crop was sown on 23rd February, the Fall crop on 18th August 2000. After
germination, one seedling per hill was maintained by manual thinning. A uniform dose of fertilizer, 120 kg N and 60 kg P$_2$O$_5$ per hectare, was applied in the form of urea and DAP and mixed with soil during land preparation.

From central two rows, ten plants were randomly selected for the measurements of stem girth and plant height just before the harvesting of the Spring and Fall crops, on 16th June and 11th November 2000, respectively. Stem girth was measured with the help of thread and meter rod at three places of each plant, i.e., bottom, middle and top, and averages were worked out. Plant height was measured in centimeters from ground level to the receptacle of the head. Harvested plants were left in the field for ten days for sun drying. Plants were oven dried for 48 h for dry matter determination as described by Jenkins and Leitch (1986). Heads were threshed manually and yield was calculated on hectare basis. Collected data were analyzed using microcomputer MSTAT, separately for both the seasons (Freed and Eisensmith, 1986). Duncan’s new multiple range test (Duncan, 1955) was used for separation of treatment means.

RESULTS AND DISCUSSION

Wide variations in stem girth were observed in the Spring crop. The hybrid Suncross-42 produced the maximum stem girth (9.96 cm) which was twofold higher than the lowest (4.50 cm) produced by XF-263 (Table 1).

Table 1: Effect of seasonal variations on growth and development of sunflower

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Spring Stem girth (cm)</th>
<th>Spring Plant height (cm)</th>
<th>Spring Dry matter (g/m²)</th>
<th>Spring Yield (kg/ha)</th>
<th>Fall Stem girth (cm)</th>
<th>Fall Plant height (cm)</th>
<th>Fall Dry matter (g/m²)</th>
<th>Fall Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARSUN-1</td>
<td>7.13 a*</td>
<td>6.36 a*</td>
<td>136.61 b*</td>
<td>110.53 b*</td>
<td>2953.20 a*</td>
<td>1491.93 a*</td>
<td>1757 b</td>
<td>1628 b</td>
</tr>
<tr>
<td>SMH-9706</td>
<td>7.40 a</td>
<td>6.23 a</td>
<td>148.21 ab</td>
<td>123.91 a</td>
<td>3183.62 a</td>
<td>1435.70 a</td>
<td>2122 a</td>
<td>1631 b</td>
</tr>
<tr>
<td>SMH-9707</td>
<td>7.10 a</td>
<td>6.06 a</td>
<td>137.63 b</td>
<td>108.84 b</td>
<td>3223.03 a</td>
<td>1467.38 a</td>
<td>1738 b</td>
<td>1353 c</td>
</tr>
<tr>
<td>Suncross-42</td>
<td>9.96 a</td>
<td>5.86 a</td>
<td>156.73 a</td>
<td>126.83 a</td>
<td>3355.86 a</td>
<td>1600.63 a</td>
<td>2175 a</td>
<td>1827 a</td>
</tr>
<tr>
<td>XF-263</td>
<td>4.50 b</td>
<td>4.26 b</td>
<td>86.41 c</td>
<td>72.98 c</td>
<td>1182.01 b</td>
<td>787.50 b</td>
<td>940 c</td>
<td>768 d</td>
</tr>
</tbody>
</table>

* Any two means sharing a common letter are non-significant at 5% level of probability.

All the hybrids were significantly different from the lowest one. However, the differences among the rest of the hybrids were neither wide nor significant. In the Fall, differences were narrow but significance pattern was similar to that of the Spring crop. The maximum (6.36 cm) stem girth was produced by Parsun-1, contrary to the Spring crop, while the smallest (4.26 cm) was again produced by XF-263. The possible reasons of having larger stem girth in the Spring crop than in the Fall crop could be the presence of the crop in the field for a longer period of time. The Spring crop remained in the field for more than 112 days while the Fall crop remained in the field for 85 days. The higher temperatures of the Fall might have encouraged the introduction of reproductive stage leaving less time for thickness of
the stem. The taller plants in the Spring crop would stand safely in the field only if they had a thick stem. Doddamani et al. (1997) found significant correlation of stem girth with environmental factors. The significant linear relationship between plant height and stem girth (Figure 1) for both seasons provided the clue that thickness of stem in sunflower is dependent on plant height.

In the Spring, plant height of the different hybrids varied widely (Table 1). The hybrid Suncross-42 had the tallest plants (156.73 cm), which was significantly different from the rest of the hybrids except SMH-9706. The hybrid XF-263 produced the smallest plants. Plant height of all hybrids decreased in the Fall. However, the pattern of difference remained the same except that the reduction in plant height of SMH-9707 was more than that in the other hybrids. Tallest plants (126.83 cm) were again produced by Suncross-42, which was again significantly different from the rest of the hybrids except SMH-9706. Plant height is considered a genetically controlled character. However, environmental conditions may modify this genetic potential, which is clear from the table. Pillai et al. (1995) concluded that plant height is dependent upon environmental factors. The taller plants produced in the Spring could be attributed to the total duration of the crop in the field and favorable environmental conditions during the vegetative growth period. Smaller plants produced by all hybrids in the Fall might have been the effect of early induction of the reproductive phase. The significant linear relationship between plant height and stem girth (Figure 1) for both seasons provides good evidence that taller plants would require thicker stems for structural support in the field.

The hybrids evaluated in this experiment produced different amounts of dry matter. Suncross-42 produced maximum dry matter (3355.86 g) in the Spring, which was significantly different from that of XF-263 but statistically at par with the rest of the hybrids (Table 1). The hybrid XF-263 produced the minimum quantity of dry matter. In the Fall, dry matter production was lower in all hybrids as compared...
with that of the Spring. However, the patterns of dry matter production were similar in the two seasons. Again, Suncross-42 gave the maximum value which was significantly different from XF-263 but was at par with the rest of the hybrids. The hybrid XF-263 produced the minimum dry matter. Taller plants with thick stem gave maximum dry matter per unit area. A significant linear relationship (Figure 2) between plant height and dry matter per unit area favors the view point of Tekelwold et al. (2000) who concluded that tall plants supporting many leaves could increase total biomass through increased carbon fixation that can ultimately be partitioned. The higher dry matter production by the Spring crop could also be related to the life cycle of the crop. The Spring crop remained in the field for a longer period of time as compared with the Fall crop. A significant linear relationship (Figure 3) between duration of crop in the field and dry matter production is supportive to earlier findings of Hassan and Leitch (2001), who reported that dry matter production in linseed is directly dependent upon the duration of crop in the field. However, Villalobos et al. (1996) reported that sunflower biomass production is positively correlated with temperature and photoperiod.

Maximum seed yield was produced by Suncross-42 like all other parameters in both seasons. The higher yield obtained from the Spring crop confirms the earlier results of Habibullah et al. (1983), who reported that Spring crops have the overall advantage of better plant structure, better environmental condition during crop growth period and maturity over Fall crops. Better environmental conditions of Spring crop include also the slow and gradual rise in cumulative growing degree days.

REFERENCES


CRECIMIENTO Y DESARROLLO DE GIRASOL COMO REACCIÓN A LOS CAMBIOS ESTACIONALES

En los experimentos de campo fueron determinadas las magnitudes del crecimiento y desarrollo de girasol, como reacción a cambios estacionales, es decir, los cambios de primavera y otoño. Cinco híbridos de girasol fueron sembrados en el sistema de bloques al azar completos. Los parámetros de crecimiento y de desarrollo, como el diámetro del tallo, la altura del tallo y acumulaciones de la materia seca por m², iban determinándose en la fase de madurez. El híbrido Suncross-42 tuvo la máxima circunferencia del tallo en primavera, que era significativamente diferente del valor del híbrido XF-263 que tenía valores más bajos en ambas temporadas. La altura de la planta tenía valores similares como la circunferencia del tallo. El híbrido Suncross-42 tenía las plantas más altas en ambas temporadas. La circunferencia del tallo y la altura de la planta se consideran las características más importantes que contribuyen a la producción de materia seca. La acumulación de la materia seca por m² tenía valores similares como la circunferencia del tallo y la altura de la planta. El híbrido Suncross-42 produjo la mayor cantidad de materia seca en ambas temporadas. La ventaja total de la plantación de primavera, en relación con la de otoño, en cuanto al tallo, altura de la planta, producción de la materia seca y rendimiento de semilla, pueden relacionarse con la duración del período vegetativo y los factores exteriores dominantes durante el ciclo biológico de plantaciones.

CROISSANCE ET DÉVELOPPEMENT DU TOURNESOL FACE AUX VARIATIONS SAISONNIÈRES

Des expériences sur le terrain ont été faites pour quantifier la croissance et le développement du tournesol face aux variations saisonnières au cours de deux saisons i.e. le printemps et l’automne. Cinq hybrides de tournesol ont été semés selon le système de blocs complets randomisés. Les paramètres de croissance et de développement comme la circonférence de la tige, la hauteur de la plante et l’accumulation de matière sèche au m² ont été enregistrés au moment de la maturité. L’hybride Suncross-42 avait produit la circonferencia
de tige maximale au printemps, ce qui était significativement différent du cas de celle de l’hybride XF-263 qui était la moins grande pour les deux saisons. La hauteur de la plante présentait des valeurs semblables à celles de la circonférence de la tige. L’hybride Suncross-42 avait produit les plantes les plus hautes au cours des deux saisons. La circonférence de la tige et la hauteur de la plante sont considérées comme les caractéristiques qui apportent la contribution la plus importante à la production totale de matière sèche. L’accumulation de matière sèche au m$^2$ présentait un modèle semblable à celui de la circonférence de la tige et de la hauteur de la plante. L’hybride Suncross-42 avait produit le plus de matière sèche au cours des deux saisons. De la même façon, l’hybride Suncross-42 avait produit le maximum de rendement en graines au cours des deux saisons. La supériorité générale de la culture en termes de circonférence de la tige, de hauteur de la plante, de production de matière sèche et de graines sur la culture d’automne peut être reliée à la durée de la période de végétation et aux facteurs environnementaux présents au cours du cycle de vie de la plante.