

# Evaluation of Sunflower Hybrids Variability in Response to Drought Stress: Implications for Oil and Protein Content Optimization

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## Abstract

Oilseed crops are third most important for human being after cereals and sugars. Sunflower is a vital oilseed crop, which is grown globally for its oil purposes. Sunflower seeds are also the most important protein source. Sunflower contains two primary protein types: water-soluble albumins and salt-soluble globulins. The genotype plays a crucial role in determining the fatty acid composition of oil. However, environmental factors like water availability and temperature fluctuations during the grain-filling stage can also significantly impact on oil content. That's why this study was aimed to investigate the impact of water deficit environments on seed yield and related traits of sunflower hybrids. In this study seven sunflower hybrids (SF-177, PI-64 A 93, Hysun-33, Hysun-39, US-666, FSS-64 and Agsun-5264) were sown according to RCBD by using three replications. Data was recorded days taken to initiation of flowering, plant height, 1000 seed weight, oil content and protein content. Results showed that drought stress adversely affected all the parameters in this experiment, but some hybrids perform better for yield and oil content under drought conditions. Such as hybrid SF-177 and Hysun-39 represented least difference in 1000 achenes weight under normal and drought conditions. Hybrid FSS-64 (44.33%) and Hysun-33 (43.66%) showed highest oil content under drought conditions. While hybrid Agsun-5264 and Hysun-39 showed maximum protein content under drought stress.

**Keywords:** Drought, Sunflower Hybrids Variability, Achenes, Oil Content, Protein Content.

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## 1- INTRODUCTION

Oilseed crops play a crucial role in human life. They are the most important after cereals and sugars. Sunflower is a vital oilseed producer, which is grown globally for its oil purposes. Belonging to the Asteraceae family, it ranks as the fourth most significant oilseed crop worldwide. In Europe, it stands as the second most important oilseed crop after rapeseed [1]. Cottonseeds contribute 56%, sunflower 30%, canola 7%, rapeseed 6%, and mustard plants 1% to the production of edible oil [2]. Pakistan is experiencing a shortage (>65%) of edible oil. While the oil yield from all sources is growing at a rate of 2.56% annually, our consumption is increasing by 8% each year. Pakistan obtains 76.74% of its oil from cotton, 13% from mustard, 8% from

sunflower, and the remainder from canola and brassica sources (Pakistan Economic Survey 2017-18).

The genotype plays a crucial role in determining the fatty acid composition of oil [3]. However, environmental factors like water availability and temperature fluctuations during the grain-filling stage can also significantly impact both the oil percentage and fatty acid composition [4]. Water availability is a significant factor influencing achene and oil production in sunflower [5]. In the cultivation of confectionary sunflower, drought stress during vegetative growth and plant density are crucial variables affecting grain yield. To enhance the 1000-seed weight and marketability of sunflower seeds, farmers often opt for lower plant density in oily sunflower varieties [6].

Sunflower seeds are the most important among plant proteins due to their widespread availability and high protein content. Compared to other plant sources, sunflower contains very low quantities of anti-nutritional components. The deciding factor for the applicability of sunflower proteins lies in their functional properties. Sunflower protein exhibits emulsification properties like soy protein isolates, thereby expanding its use [7]. Sunflower seeds boast a high protein content which can increase in the meal based on effective dehulling and oil extraction processes [8]. The presence of fiber, soluble sugars, and polyphenols in high amounts restricts the utilization of this protein source. Nevertheless, these undesirable components can be significantly reduced by treating sunflower meal to obtain protein isolate [9]. Sunflower contains two primary protein types: water-soluble albumins and salt-soluble globulins. These two types are found in a ratio of 2:1.

Water scarcity and the increasing competition for water resources across various sectors necessitate the implementation of irrigation strategies in semi-arid Mediterranean regions. These strategies aim to conserve irrigation water while sustaining satisfactory levels of production [10]. The growth, development, and spatial distribution of plants are significantly hampered by various environmental stresses. Among these challenges, water stress is widely regarded as the most critical [11]. The scarcity of water, a vital component for life, significantly constrains plant growth and crop productivity, especially in arid regions, more than any other abiotic environmental factor. Water stress, a multidimensional abiotic stress, impacts plants at various growth stages [12], decrease in water availability and nutrient uptake, adversely affects crop growth and yield [13]. The combination of reduced precipitation and increased evapotranspiration increases the risk of drought for both natural and agricultural vegetation in these areas. Even short-term droughts can lead to substantial losses in crop yield. Decreased water supply, whether temporary or permanent, adversely affects morphological, physiological, and biochemical processes in plants [14].

Assessing moisture levels in crops offers timely insights into potential risks during the growing season, aiding in the establishment of an early warning system for various stakeholders [15]. Thus, this study primarily aimed to investigate the impact of water deficit environments on seed yield and related traits of sunflower hybrids, including days taken to initiation of flowering, plant height, 1000 seed weight and quantitative characteristics such as seed oil content and protein content.

## 2- MATERIALS AND METHODS

### 2.1. Metrological Data

During the whole experimental period, climatic data is represented in graphical form.

### 2.2. Plant Material

Seven Sunflower hybrids were obtained from tissue culture lab of PBG department. Name of these hybrids are as follows:

1. SF-177
2. PI-64 A 93
3. Hysun-33
4. Hysun-39
5. US-666
6. FSS-64
7. Agsun-5264

### 2.3. Experimental Detail

These seven hybrids of sunflower were sown in research area by using Randomized Complete Block Design (RCBD) in spring 2020. Field was divided into two plots. One was irrigated five times for normal irrigation and other was irrigated three times as a drought stress. Each plot was divided into three sets of replications. From each replication five plants were selected to record data for following parameters:

1. Days taken to initiation of flowering
2. Plant height
3. 1000 achenes weight
4. Oil content %
5. Protein content %

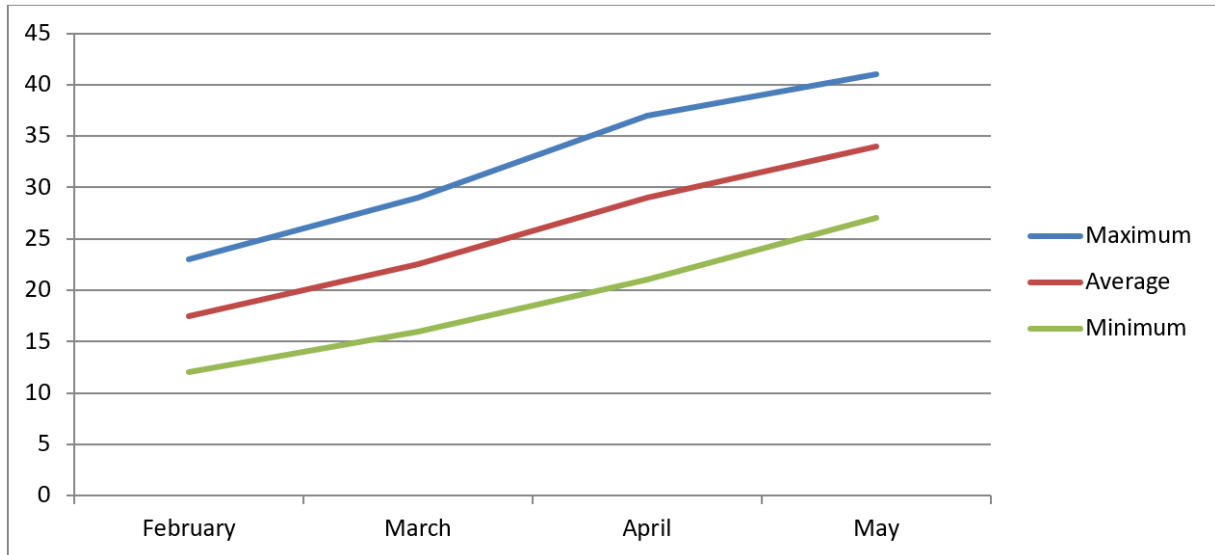
### 2.4. Biometrical Approaches

Recorded data of sunflower hybrids were analyzed by ANOVA according to procedure given by [16]. LSD all pairwise mean comparison test for hybrids and LSD all pairwise mean comparison test for hybrids x treatment were performed to check the significant or non-significant differences among sunflower hybrids.

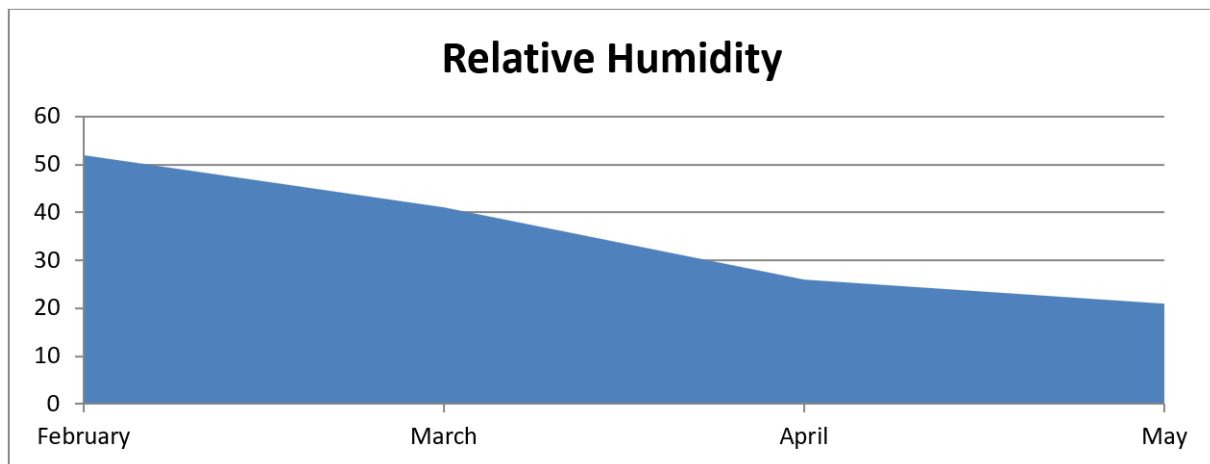
## 3- RESULTS AND DISCUSSIONS

### 3.1 Days taken to Initiation of Flowering:

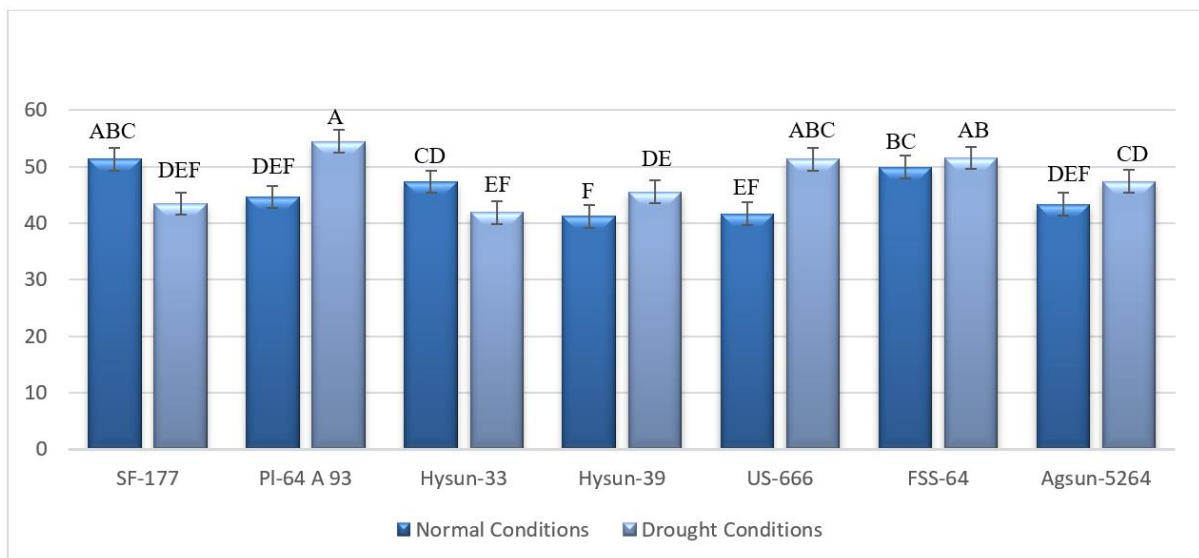
Less days taken to initiation of flowering is an escape policy to reproduce before harsh conditions [17]. But this strategy can cause decrease in achenes yield and oil content [18]. Analysis of variance showed the highly significant results. LSD all-pairwise means comparison test of days taken to initiation of flowering for treatment x hybrid showed highly significant differences as shown in Fig 3. The results of graphical representation of means of days taken to initiation of flowering for sunflower hybrid under normal and drought condition showed that hybrid Hysun-39 and US-666 had minimum days taken to initiation of flowering under normal condition. Hybrid PI-64 A 93 showed maximum days taken to initiation of flowering under drought condition. The average range of days taken to initiation of flowering was between 41 to 54.5 days.



**Fig-1: Relative Humidity during the Period of Field Experiment**



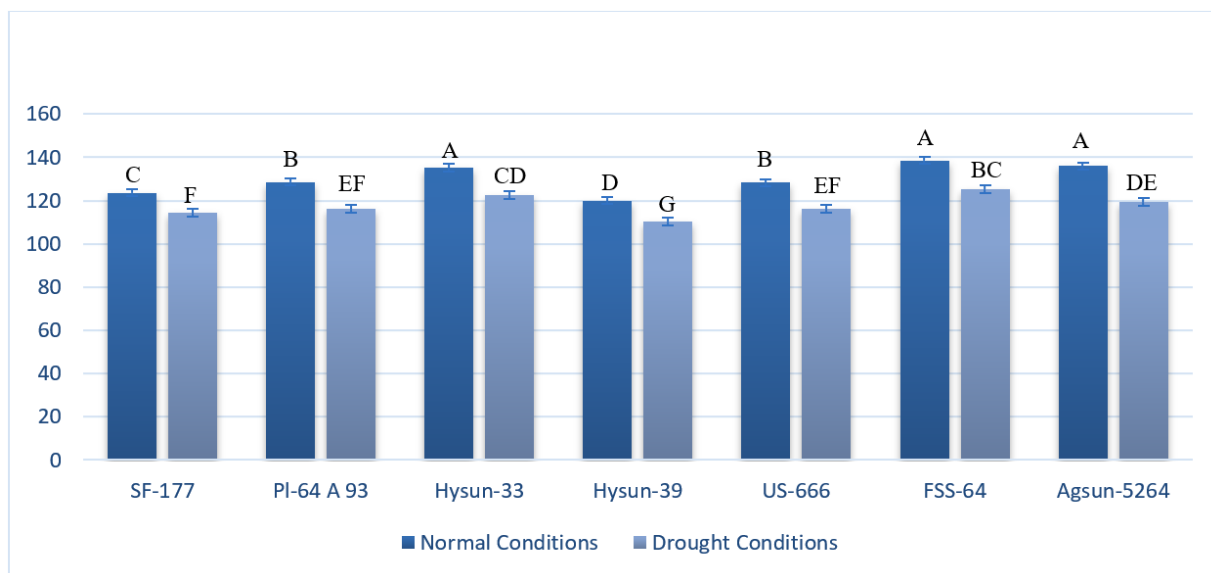
**Fig-2: Relative Humidity during the Period of Field Experiment**



**Fig-3: Graphical representation of LSD all-pairwise means comparison test of Days Taken to Initiation of Flowering for Hybrids x Treatment**

Plant height is an important trait which is related to lodging by wind. Analysis of variance showed the highly significant results. LSD all-pairwise means comparison test for treatment × hybrid showed highly significant differences as shown in Fig 4. The results of graphical representation of means of plant height for sunflower hybrid under normal and drought condition

showed that hybrid FSS-64 showed maximum plant height under both normal and drought conditions. While Hysun-39 showed minimum plant height under both normal and drought conditions. The average range of plant height under drought was between 110.33 to 155.33 centimeters.

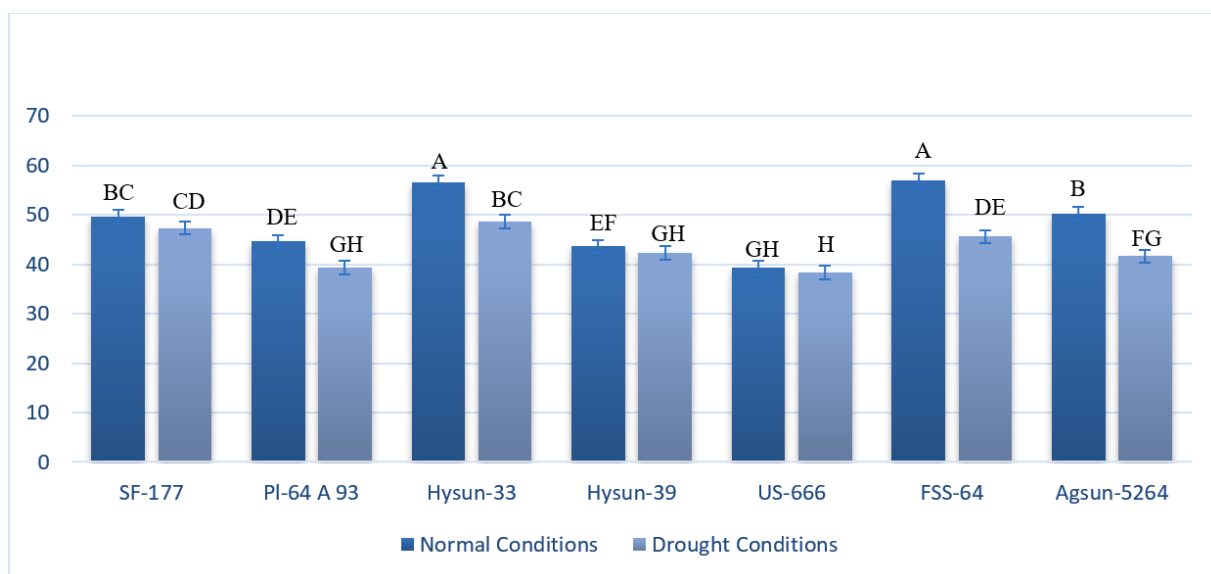


**Fig-4: Graphical representation of LSD all-pairwise means comparison test of Plant Height for Hybrids x Treatment**

### 3.3 1000 Achenes Weight

Achenes weight is the most important trait. Drought stress causes significant decrease in achenes weight. Analysis of variance showed the highly significant results. LSD all-pairwise means comparison test for treatment × hybrid showed highly significant differences as shown in Fig 5. The results of graphical

representation of means of 1000 achenes weight showed that hybrid SF-177 and Hysun-39 represented least difference in 1000 achenes weight under normal and drought conditions [6]. From these results it can be concluded that hybrids which have higher ability of maintaining achenes number can provide higher achenes yield under drought.

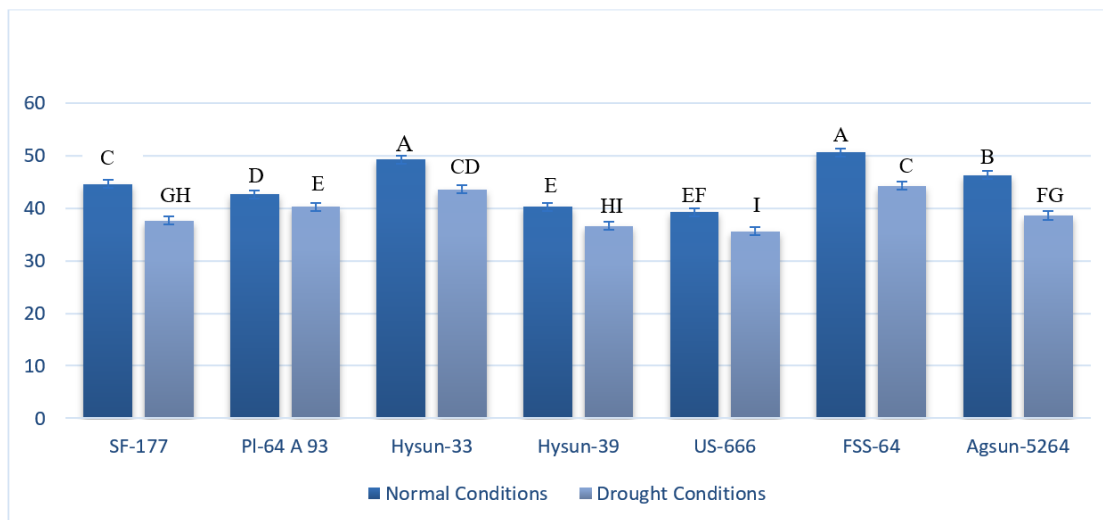


**Fig-5: Graphical representation of LSD all-pairwise means comparison test of 1000 Achenes Weight for Hybrids x Treatment**

### 3.4 Oil Content %

Drought stress causes significant decrease in oil content in this experiment which is in with accordance to [19, 20]. Analysis of variance showed the highly significant results. LSD all-pairwise means comparison test for treatment × hybrid showed highly significant

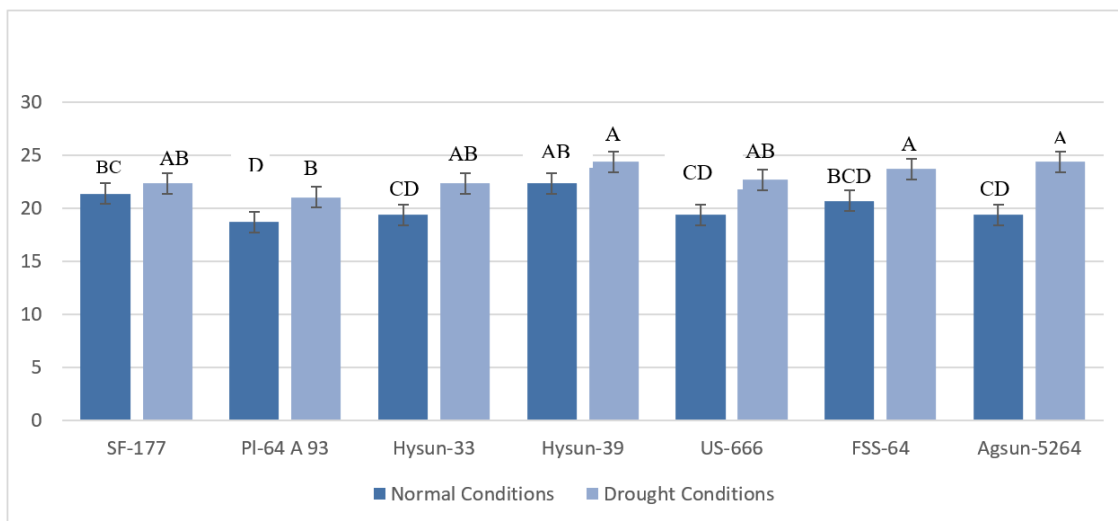
differences as shown in Fig 6. The results of graphical representation of oil content showed that hybrid FSS-64 (44.33%) and Hysun-33 (43.66%) showed highest oil content under drought conditions. The average range of oil content was between 35.66% to 50.66%.



**Fig-6: Graphical representation of LSD all-pairwise means comparison test of Oil Content % for Hybrids x Treatment**

Seeds of sunflower have high protein content which depends on dehulling and oil extraction processes. Drought significantly effects on protein content as well like all other traits. Analysis of variance showed the highly significant results. LSD all-pairwise means comparison test for treatment × hybrid showed highly

significant differences as shown in Fig 7. The results of graphical representation of means protein content showed that hybrid Agsun-5264 and Hysun-39 showed maximum 24.33% protein content under drought stress. The average range of protein content was between 18.66% to 24.33%.



**Fig-7: Graphical representation of LSD all-pairwise means comparison test of Protein Content % for Hybrids x Treatment**

## CONCLUSIONS

Drought stress or increasing competition for water resources adversely affects plant growth. That’s why plants take less days to maturity to reproduce before harsh conditions. But this strategy can cause decrease in

achenes yield and oil content. Similarly drought stress affected all the parameters in this experiment but some hybrids perform better for yield and oil content under drought conditions. Such as hybrid SF-177 and Hysun-39 represented least difference in 1000 achenes weight under normal and drought conditions. Hybrid FSS-64

(44.33%) and Hysun-33 (43.66%) showed highest oil content under drought conditions. While hybrid Agsun-5264 and Hysun-39 showed maximum protein content under drought stress. So these hybrids can be further evaluated for breeding programs on drought stress.

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