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ORISUN-701, A NEW HIGH YIELDING AND DISEASE RESISTANT SUNFLOWER HYBRID RELEASED IN PAKISTAN

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ABSTRACT

Sunflower oil is a health-benefitting oil due to its low content of saturated fats, high levels of polyunsaturated fatty acid and good oxidative stability. This article discusses creating a novel and inventive high yielding, disease resistant having good quality oil sunflower hybrid developed by Oilseed Research Institute. This high yielding hybrid of sunflower has been developed through ABR line system by using cytoplasmic male sterility. The promising sunflower hybrid in the present study was an outcome of hybridization between ORI-42 x RL-86 which was first attempted in 2016 and evaluated in the Station Yield Trials, Micro Yield Trial as well as in National Uniform Yield Trials. This variety has wide adaptability and exhibited stable yield across multiple environments. Its maximum yield was observed 3870 kg per ha in MYT 2018 at Karor. It surpassed the check hybrids NKS-278 and AGSUN-5264 in National Uniform Sunflower Yield Trial during 2019 and Hysun-33 in National Uniform Sunflower Yield Trial during 2020. The new hybrid not only possesses excellent oil contents (40-42%), contains 41% oil contents, 49% oleic acid and 41% linoleic acid. but also showed complete tolerance against Charcoal Rot disease on the base of two years of studies. It has also resistance against all sucking insects and pests. Agronomic studies showed that this hybrid needs no special production technology package and fit in a better way with the existing agronomic practices. Due of its strong stem, the new Sunflower hybrid can tolerate lodging as well.

Keywords: Sunflower hybrid, ORI-SUN-701, oil content, disease resistance.

INTRODUCTION

Edible oil is the main food item imported into Pakistan, accounting for the majority of the \$4.5 billion trade deficit. Pakistan is the world's third-largest importer of palm oil, after China and India. Pakistan's edible oil import bill remained 3.562 billion this year (with the value Rs. 826.482 billion, 2023) as a result of Pakistan's reliance on imports to supply domestic demand for edible oil and oilseed meals as well there is rising demand and ballooning cooking oil prices.

Pakistan depends on other nations for more than 84% of
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its edible oil needs and in the form of import bill, which comes third in the list of import after petroleum products and machinery. Thereby, spending a big amount of foreign exchange every year. (Economic Survey of Pakistan, 2022-23).

Pakistan imports edible oil on a regular basis. Currently, during fiscal year 2023, out of 2.681 million tonnes edible oil (86% of the total availability i.e. 3.177 mt) only 0.496 million tonnes (15% of total availability) are used to meet country demand (Aftab *et al.*, 2019). Imported palm oil is bad for human health as it contains more saturated fatty acids. Pakistan imports 5% of soybean oil and 94% of palm oil annually. Presently Sunflower, canola, cotton and rapeseed/mustard are the main oilseed crops grown in Pakistan.

After rapeseeds and mustards, sunflower is Pakistan's second-largest oilseed crop. Furthermore, in the current

climate of rising cardiac difficulties, its oil quality with the larger amount of unsaturated fatty acids further raises its value from a health point of view. Sunflower oil is primarily composed of linoleic acid, a polyunsaturated fat, and oleic acid, a monounsaturated fat. Sunflower oil does not contain dietary cholesterol. Regular sunflower oil contains about 69% linoleic (C18:2) acid, about 20% oleic (C18:1) acid and about 11% saturated fatty acids-stearic (C18:0) acid 6% and palmitic (C16:0) acid 5%.

Sunflower oil is one of the healthier options among cooking oils, having the highest concentrations of polyunsaturated and mono saturated fatty acids. Also the high-oleic sunflower oil is suitable for industrial frying. Sunflower oil has one of the highest concentrations of polyunsaturated fat among cooking oils. It also contains some monounsaturated fat and is low in saturated fat, making it an overall heart-healthy option. In the scenario of climate, this crop can be sown in every part of Pakistan. It is a short duration crop which matures in 100-130 days (Hussain *et al.*, 2017) due to good yield and oil quality sunflower hybrids have more importance in agricultural systems of Pakistan but unfortunately there was no local sunflower hybrid under cultivation in the field at this time. Farmers have to purchase imported high-cost sunflower hybrids which sometimes not timely available and not well adapted to local climatic conditions. So there must be availability of local sunflower hybrids developed under our own climatic conditions and needs (Chandio *et al.*, 2022). For this purpose, Oilseeds Research Institute has locally developed sunflower hybrid ORISUN-701 having high yield and better oil quality.

The Oilseeds Research Institute Faisalabad has developed high-yielding sunflower hybrids from locally developed inbred lines and got approval from the Punjab Seed Council and Variety Evaluation Committee of the Pakistan Agriculture Research Council for general cultivation. But these efforts will not be fruitful until and unless seed from these approved hybrids is available in the market for cultivation at an affordable price. Presently, national and multi-national seed companies are importing and trading F₁ hybrid sunflower seeds. The prices of these imported sunflower hybrids are too high, with uncertain availability. The best genotypes identified for oil quality, achene yield and related traits through a heat map analysis approach could be utilized to harvest the maximum variation and ultimately to develop improved achene yield and oil quality hybrids by Dudhe *et al.* (2017), Babec *et al.* (2021), Dudhe *et al.* (2021) and Zhou *et al.* (2022). The sunflower hybrid seed production in the country is a big opportunity for cost-

effective, quality seed provision to the farmers on a sustainable basis. Local hybrid seed production not only reduces the cost of hybrid seed but also assures the sustainable availability of good quality, climate-resilient sunflower hybrid seed. The local hybrid seed production also strengthens the national research and development of sunflowers hybrid seed and creates job opportunities. Therefore, it is necessary to produce multiplication of newly developed hybrid seeds on large scale under the supervision of crop experts. The existing oilseed research infrastructure and human resources of the Oilseed Research Institute, Faisalabad, are limited to conducting research activities and not sufficient for commercial hybrid seed production. For the above-mentioned purpose of national interest, this breeding program of local sunflower hybrid development was planned and now successful and available for mass-scale seed production to overcome the problems in terms of the availability of quality seed.

There are three primary steps in producing hybrid. The First step is Selection of the Seed Parent (A-Line) and Male Parent (R-Line) on the basis of yield and combining ability, the second step is Multiplication of the seed of both parents, Thirdly, development and Production of F₁ Hybrids. For commercial hybrid seed parent female parent should be a male sterile line. In cyto plasmic male sterile system (A, B and R), An isogenic B-line should be used to maintain the male sterile line (A-line) once it has been identified. By crossing them to the R-line hybrid seed is produced.

Over the past two decades, per capita consumption of edible oil has climbed from 6 kg per year to 18 kg per year as a result of the country's growing population and shifting dietary preferences. Rapid urbanization, extremely high economic growth, increased consumption of roasted fast food and hotel fashion are all factors that contribute to this trend. Palm oil is becoming more popular because of its inexpensive cost and good stability when deep-frying.

The effects of the present landmark at national level include increasing the farmers' production per acre and ensuring the long-term availability of high-quality seed at fair prices and way forward towards self-sufficiency in edible oil. Resultantly, decrease in import of hybrid seed with readily available locally developed sunflower hybrid.

MATERIALS AND METHODS

Location of the experiment: All the experiments are carried out for evaluation of this hybrid in Oilseeds Research Institute, Faisalabad and at out-stations including sunflower growing areas of Punjab. Geographical coordinates of Faisalabad are t flat plains of North-East

Punjab. Its latitude towards North is 31°25'00" and longitude towards East is 73°04'59", and elevation of 186 meter above sea level. Its climate is arid or semiarid due to high evapotranspiration. The average yearly rainfall is recorded almost 13.417mm, while average temperature ranges from 21°C -28 °C during winter and in summer, average temperature varies from 30 °C-45 °C. The humidity on an average is 35.17 g.m-3(<https://www.weather-atlas.com/en/pakistan/faisalabad-climate#temperature>) recorded on yearly basis average.

Parentage/ Pedigree: A, B and R inbred lines were used for the development of this hybrid. ORI-42 A is a healthy vigorous cytoplasmic male sterile line maintained by crossing with its counterpart ORI-42 B line (maintainer line). ORI-42A is then hybridized with fertility restorer line RL-86 to constitute a hybrid combination FH-701. This hybrid was then tested and proved its worth in Station Yield Trial, Micro Yield Trial and National Uniform Sunflower Yield Trials (2019 & 2020) against standard check hybrids.

Breeding History: 2016 ORI-42A X RL-86 (Cytoplasmic Male Sterile Line) Fertility Restorer Line Hybrid ORISUN-701

Adaptability Studies / Yield Performance Trails: The candidate hybrid ORISUN-701 has been evaluated in irrigated areas all over the Pakistan and under different agro-climatic zones of Punjab. The yield data in different trials are given in tables below.

STATISTICAL ANALYSIS

Throughout the time period, all the observed attributes were examined using analysis of variance (Steel *et al.*, 1997) to identify genetic changes among the recoded parameters. Almost all morphological features exhibit considerable variance for yield and parameters related to yield.

RESULTS AND DISCUSSION

Station Yield Trial: The candidate hybrid ORISUN-701 was tested in Station Yield Trial at Oilseeds Research Institute, Faisalabad during 2017. The yield data are presented in the Figure 1.

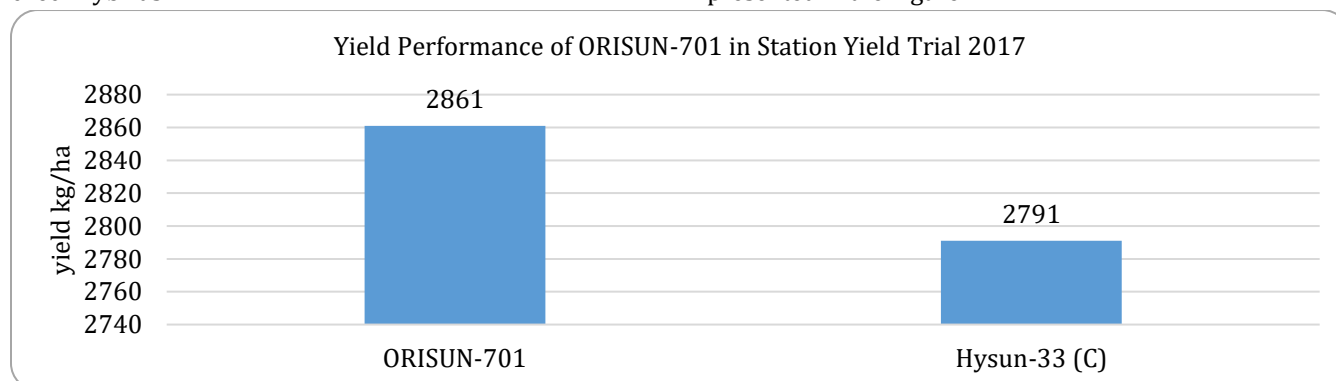


Figure 1. Yield Performance of ORISUN-701 in Station Yield Trial 2017 at ORI. Faisalabad. The above data of Station Yield Trial of 2017 indicated that ORISUN-701 yielded 2.5% more yield than check hybrid Hysun-33.

Out Station Yield Trials

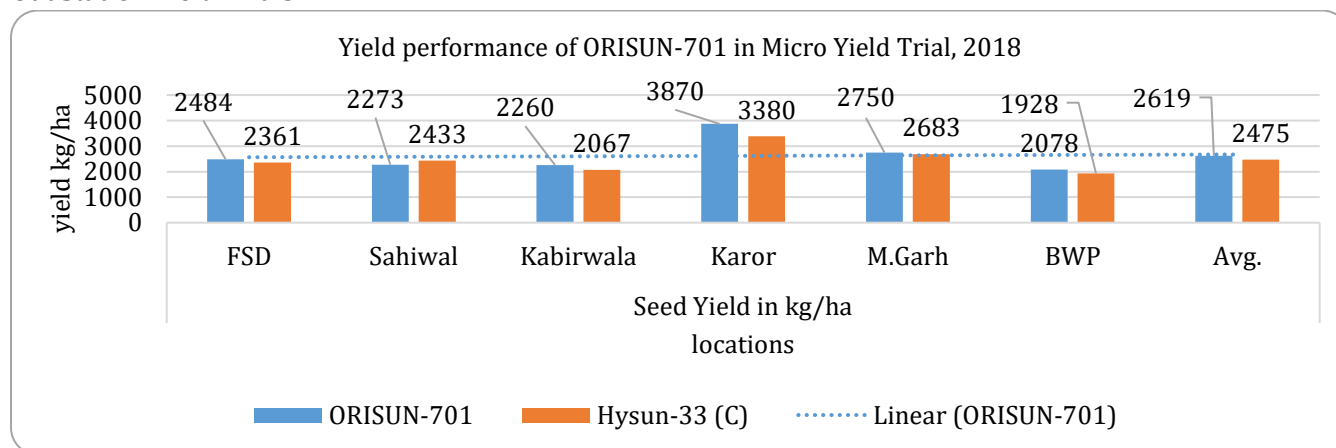


Figure 2. Yield performance of ORISUN-701 in Micro Yield Trial during 2018

The above data of Micro Yield Trial of 2018 indicated that ORISUN-701 yielded 6 % more seed yield than international check hybrid Hysun-33.

Yield performance of ORISUN-701 in NUSYT, 2019 at Punjab locations

Table 1

Hybrid	Faisalabad	Bahawalpur	Multan	Average	% Increase
ORISUN-701	3004	2662	2374	2680	
NKS-278 (C)	2668	1462	2398	2176	23
AGSUN-5264 (C)	2446	2026	1732	2068	29

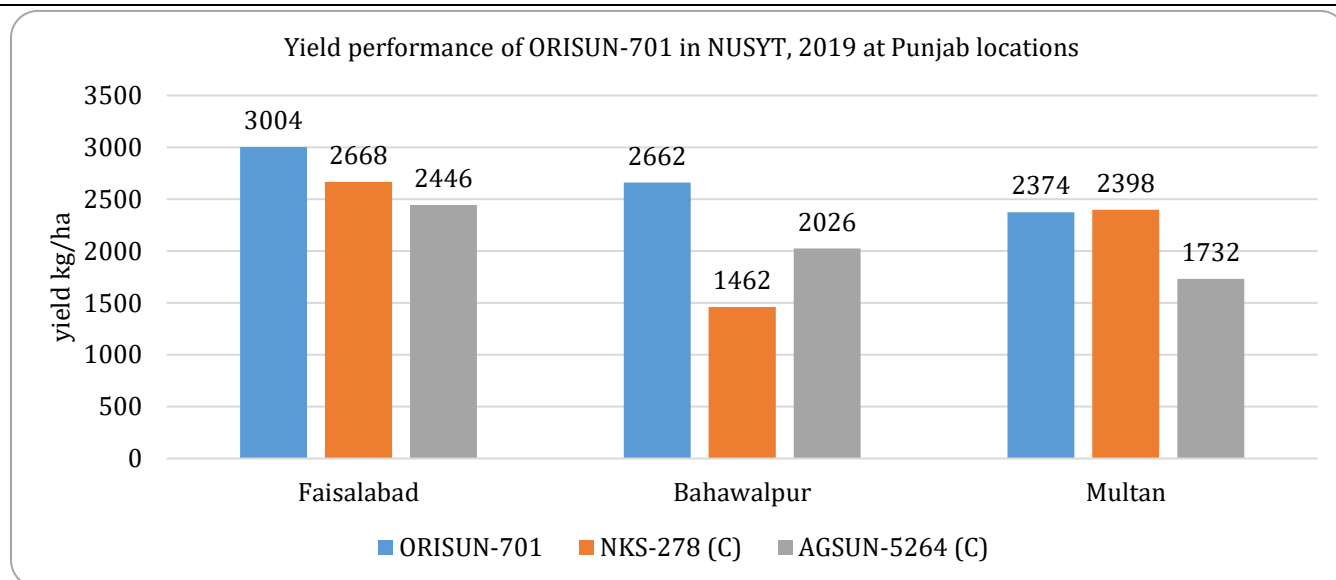


Figure 3. Yield performance of ORISUN-701 in NUSYT, 2019 at Punjab locations

Table-2

Hybrid	Faisalabad	Rajapur	Multan	Bahawalpur	Average	% Increase
ORISUN-701	3074	3159	3147	2779	3039	
Hysun-33 (c)	3003	2880	1597	2419	2197	38

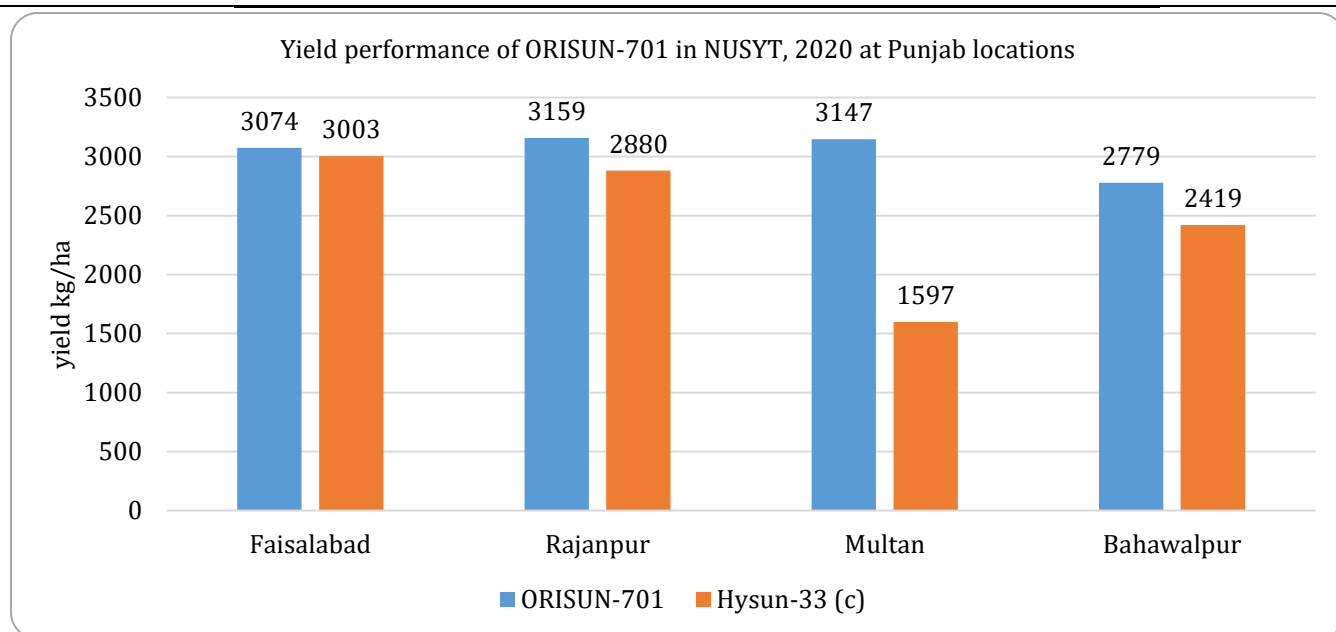


Figure 4 Yield performance of ORISUN-701 in NUSYT, 2020 at Punjab locations

The above data of National Uniform Sunflower Yield Trials indicated that ORISUN-701 yielded 23% and 29 % more seed yield during 2019 and 38 % more than standard check hybrids during 2020.

AGRONOMIC PERFORMANCE OF ORISUN-701

Table 3. Response of ORISUN-701 to different levels of NPK fertilizer during 2021 and 2021 at Oilseeds Research Institute, Faisalabad

Treatment	Nitrogen (kg/ha)	Phosphorus P ₂ O ₅ (kg/ha)	Potash K ₂ SO ₄ (kg/ha)	Seed Yield 2020 (kg/ha)	Seed Yield 2021 (kg/ha)	Mean (kg/ha)
1	119	85	62	2256	2479	2367
2	147	85	62	2467	2753	2610
3	124	99	62	2367	2578	2472
4	153	99	62	2657	2861	2759
5	160	115	62	2677	2890	2783

The mean data for yield was significant statistically and ranged from 2367 to 2783 kg/ha among treatments (Table-5). The maximum seed yield of 2783 kg/ha was produced by treatment 5 in which N: P: K was applied @ 160:115:62 kg/ha followed by treatment 4 with the seed yield of 2759 kg/ha that is statistically at par with the treatment 5.

Table 4. Response of FH-701 to different sowing dates during 2018-19 and 2019-20 at Oilseeds Research Institute, Faisalabad

Sowing Date	Yield (kg/ha)		Avg. (kg/ha)
	2018-19	2019-20	
1 st December	2123	2098	2111
15 th December	2329	2472	2401
1 st January	2190	2240	2215
15 th January	2472	2510	2491
1 st February	2310	2464	2387
15 th February	2220	2250	2235

The average yield performance of ORISUN-701 in sowing date trial was evaluated from December 1st to February 15th with fifteen days' interval. The yield data is presented in the Table-6. The table showed that the highest mean yield 2491 kg/ha was recorded in treatment-4 (15th January) and 2nd highest yield 2401 kg/ha was recorded in treatment-2 (15th December).

The treatment-3 (1st January) did not perform well due to foggy environment.
Disease reaction of ORISUN-701 against Charcoal rot: Disease rating Scale (Infection covered the stem length in cm): A = 1-10, B = 11-20, C = 21-30, D = 31 and above. Reference: CDRI, NARC.

Table 5. Disease Reaction of ORISUN-701 for Charcoal Rot in NUSYT 2019 at Faisalabad

Name of Hybrids	Intensity Scale (A-D)	Remarks
ORISUN-701	B (17cm)	Tolerant
AGSUN-5264	C (23 cm)	Moderately Tolerant
NKS-278	C (22 cm)	Moderately Tolerant

Table 6. Disease Reaction of ORISUN-701 for Charcoal Rot in NUSYT 2020 at Faisalabad

Name of Hybrids	Intensity Scale (A-D)	Remarks
ORISUN-701	B (19cm)	Tolerant
Hysun-33	C (29 cm)	Moderately Tolerant

The average of two years (2019 & 2020) data showed that the candidate hybrid ORISUN-701 resistant to Charcoal Rot.

INSECT PEST REACTION OF ORISUN-701:

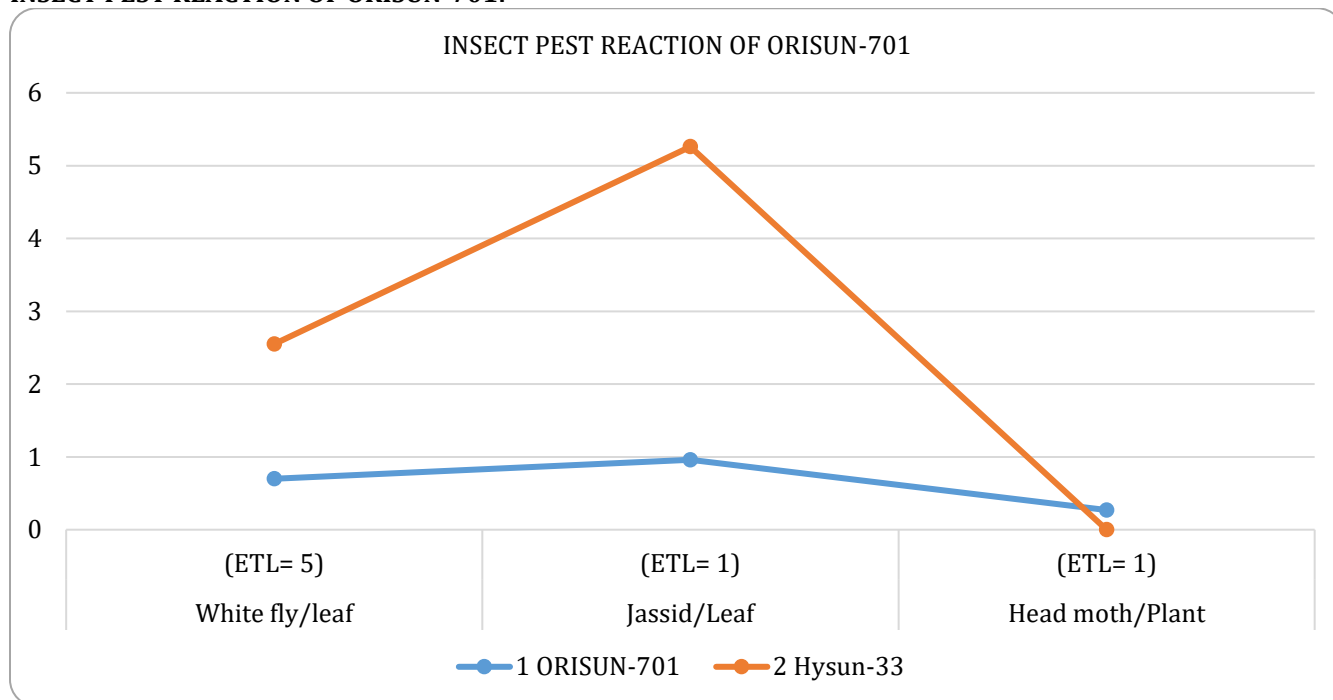


Figure 5. Insect Pest Reaction of ORISUN 701 at Faisalabad during 2019

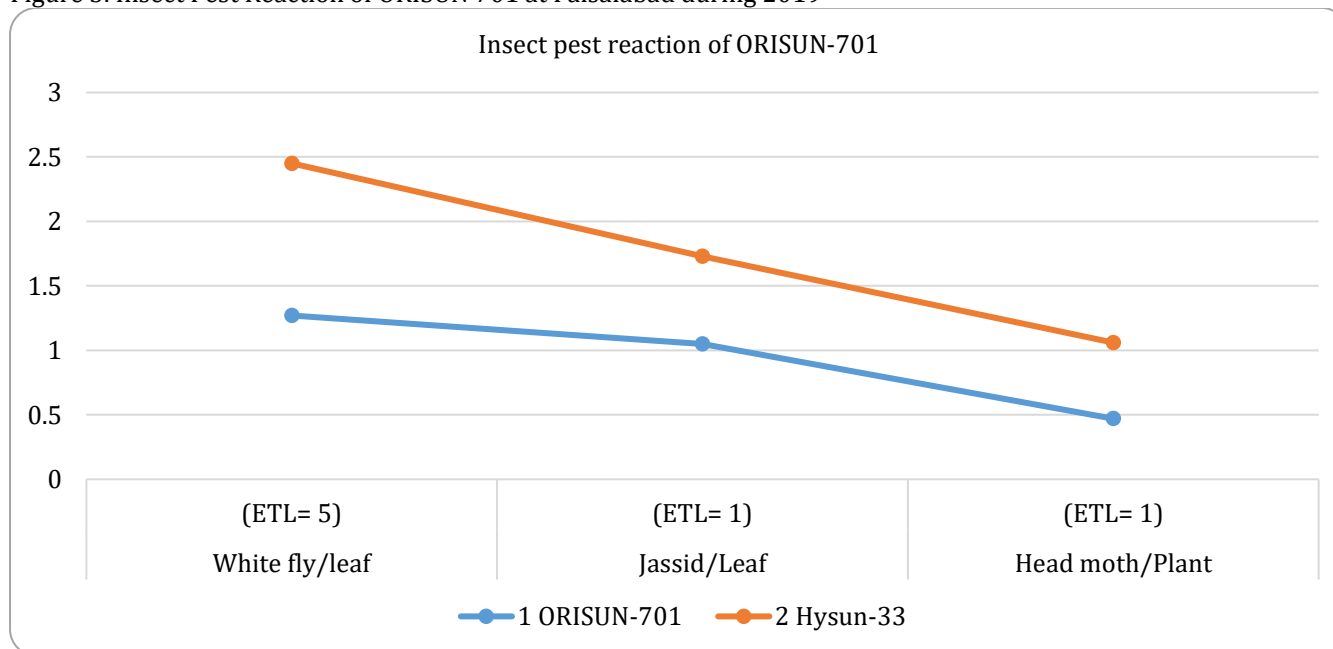


Figure 6. Insect Pest Reaction of ORISUN 701 at Faisalabad during 2020

Quality analysis of ORISUN-701:

Table 7. Oil quality analysis of ORISUN-701 with commercial hybrid Hysun-33

Name of Hybrid	Oil Content %	Oleic acid%(ν -9)	Linoleic acid%(ν -6)
ORISUN-701	41	49	41
Hysun 33 (C)	40	40	46
Sunflower Oil Standards*	-	14-40	48-74

*References: 1. Codex Alimentarius Commission, joint fao/WHO Fat & Oil Standards, United Nations, UK. 2. Australian Oilseeds Federation incorporated, quality standards, 2015-16.

BOTANICAL DESCRIPTION AND OTHER CHARACTERISTICS OF FH-701		
SEEDLING CHARACTERISTICS		
1.1	SEEDLING LENGTH	90-115 mm (After 14 days)
1.2	SDL HAIRINESS	Medium
1.3	SDL COLOR	Light Green
1.4	ANTHOCYANIN	Medium
1.5	HYPOCOTYL ANTHOCYANIN COLORATION	Absent
1.6	SIZE OF COTYLEDONS	Medium
1.7	SHAPE OF COTYLEDONS	Oval
PLANT CHARACTERISTICS		
2.1	PLANT HEIGHT (cm)	190-215 cm
2.2	STEM ANTHOCYANIN	Absent
2.3	STEM DIAMETER	2.8-3.0 cm
2.4	STEM BRANCHING	Absent
2.5	PLANT COLOUR	Light Green
LEAF CHARACTERISTICS		
3.1	LEAF COLOUR	Green
3.2	LEAVES PER PLANT	32-35
3.3	LEAF ANTHOCYANIN	Absent
3.4	LEAF ATTITUDE	Semi erect
3.5	LEAF SURFACE	Smooth
3.6	LEAF SIZE	Large
3.7	PETIOLE LENGTH	12-15 cm
3.8	LEAF SHAPE	Cordate
3.9	LEAF MARGINS	Dentate
3.10	LEAF HABBIT OF PETIOLE	Semi-erect
FLOWER CHARACTERISTICS		
4.1	DAYS TO FLOWERING (50%)	75-85 days
4.2	RAY FLORET COLOUR	Yellow
4.3	DISC FLORET COLOR	Yellow
4.4	POLLINATION	Cross Pollination
HEAD CHARACTERISTICS		
5.1	HEADS/PLANT	Single
5.2	HEAD SIZE/DIAMETER	Large (16-22 cm)
5.3	HEAD SHAPE	Weakly convex
5.4	HEAD ATTITUDE	Slightly embracing
5.5	HEAD ANGLE	180-225
5.6	SEED WEIGHT/HEAD	200 g
SEED CHARACTERISTICS		
6.1	SEED COLOUR	Black
6.2	SEED SIZE	Medium
6.3	SEED SHAPE	Broad ovoid
6.4	000 SEED WEIGHT	55-60 gm
6.5	AVERAGE YIELD	3039 kg/ha
6.7	OIL %	41%
RESISTANT TO		
7.1	Charcoal rot	MR
7.2	Insects/Pests	MR

Botanical description and other characteristics of FH-701: Orisun-701 is a high yielding and lodging resistant sunflower hybrid with better oil contents, and medium seeded. It is equally suitable for all Sun

flower growing areas of Pakistan. It has medium cotyledon with oval shape. It's hypocotyl anthocyanin coloration is absent. Its seedling length varies from 90-115mm after 14 days.

Flower characteristics: Sun flower is a cross pollinated crop. Its ray floret and disc floret color is yellow has medium sized pink flower. It takes 75-85 to complete its 50% flowering.

Leaf characteristics: leaf colour is green and leaves per plant varies from 32-35, leaf anthocyanin is absent, leaf attitude is semi erect with smooth surface. it has large leaf size and 12-15cm petiole length. Leaf shape is cordate and leaf margins are dentate.

Head characteristics: It has single head/plant with the large head size 16-22cm diameter. Its head attitude is slightly embracing with 180-225 head angle. Seed weight per head is approximately 200g

Seed characteristics: Seed color is black with broad ovoid seed shape and medium seed size. Its 1000grain weight varies from 55-60g as compared to check hybrid that has 53-58g. its average yield is 3039 kg/ha as compared to check i.e 2197 kg/ha and 41% oil percentage.

CONCLUSION

ORISUN-701 was tested at Oilseed Research Institute, out stations and all growing areas of Sun flower in Pakistan. It out yielded other genotypes in all yield trials. It has distinguished character of high yielding and Lodging resistant. This sunflower hybrid has better oil contents, better Oleic acid percentage moderately tolerant to charcoal rot as compared to local cultivated checks. This newly approved variety "ORISUN-701" will help to increase its profitability and lead to revival of sunflower in Pakistan. The approved variety "ORISUN-701" is a high yielding with high oil content sunflower hybrid approved for general cultivation in Pakistan. It proved its significance in station yield trials and multilocation yield trials. It surpassed check varieties appreciably. It is being expected that "ORISUN-701" owing to its attractive characters will attain recognition among the agricultural society. Its adoption in terms of seed multiplication, purification and promotion at farmer's field will definitely add to stabilizing production. It is dropping ever-increasing oilseeds crops import bill of Pakistan. The ideotype of "ORISUN-701", it is perfect for promotion and cultivation in all areas of Punjab. The Punjab Seed Council (PSC), Lahore Punjab approved this new hybrid "ORISUN-701" under label for commercial cultivation all over Punjab, Pakistan. It is really a blessing in disguise for sunflower growers in Punjab Pakistan.

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Sajida Habib	:	Data Collection and guide in the write of the paper
Rizwana Qamar	:	Write up of paper graphic presentation of data
Ejaz U. Hassan	:	Reviewed the paper
Fida Hussain	:	Planning and evaluation of the experiment
Muhammad Anwer	:	Help out in research experiments, data collection and review
Saad B. Mustafa	:	Helped in statistical analysis
Maria Ghias	:	Collect the Reference and recheck
Sadia Kaukab	:	Technically evaluated the data and paper
Muhammad E. Khan	:	Helped in publication and corresponding with Journal