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Super Raya: A new high yielding mustard variety released for general cultivation in south Punjab (Pakistan)

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Abstract
This paper reports the release of new variety "Super Raya" which is high yielding with erect growth habits. This variety was released in the year 2016 for arid and irrigated areas of agricultural lands. Super Raya has been evolved from a cross between KJ-148 and Khanpur Raya at Oilseeds Research Station, Khanpur during 2001-02. Progenies F_2-F_5 were advanced by pedigree selection method. It is tolerant to Alternaria Blight, Powdery mildew, Downy mildew and white rust with yield potential 4271 Kg/hectare. The sowing time of this variety is 1-15 October with seed rate 0.60-0.80 Kg/acre. Plant color is light green with height of 155-166 cm and growth habits is determinate type. Its 1000 seed weight has been observed about 4.8-5.3 g. Leaf color is light green and seed contains 42-44% oil contents in it. Its meal contains 30-35% protein. This variety takes 135-140 days to mature and due to good performance it is recommended for the Southern Punjab and Cholistan areas in meeting of Federal Seed Certifiation and Registration Department held on 12 August 2016. Moreover, Super Raya has got resistance against lodging, tolerant to aphid and best suited for Wheat-----Mung bean----- Mustard-----Bt Cotton, Wheat-----Fodder------ Mustard-----Sugarcane crop rotation.

Keywords: *Brassica juncea*, disease resistant, super raya, variety, yield

1. Introduction
Rapeseed and mustard are traditional oilseed crop in Pakistan and considered as second most important source of edible oil. The contribution of these crops in Pakistan towards edible oilseed production is about 16-20 % [4]. The consumption of domestic edible oil is higher than its production i.e 2.821 million tons in the country out of which about 0.684 million tons are met through local resources and rest of it (2.1 million tons) is met by import [4]. The bill on imported oil of Pakistan is considered to be the second largest after petroleum [1]. Brassica seed contain 30-35% erucic acid and 80- 100 µ m/g oil free meal. Seed meal of Brassica contains 35 % protein with balanced amino acid but the quantity of protein percentage is lower than its demand.

Among rapeseed and mustard, raya (*Brassica juncea*) is very popular among the farmers due to its special characters i.e high yielder, resistant to lodging, heat and pests. In Pakistan, earlier mustard varieties were low yielder and long duration which hinders their fitness in cropping pattern. Cultivar with low yield is a continuous threat for its expansion and sustainable production. Improved types of Brassica varieties have a yield potential of over 2500 kg per hectare which reflects that 2-3 times substantial increase in average yield is possible [2]. There is a dire need to develop high yielding and short duration mustard variety to meet the demand of population and which could also be used as intercropping.

Super Raya is a variety suitable for arid and irrigated areas of Punjab. The Commercial release of this new mustard variety "Super Raya" will certainly contribute much for the growers as well as for the country to bridge up the gap between production and demand. Super Raya possesses good genetic potential and agronomic traits as it has performed better in yield trials.

2. Material and Method
Super Raya was evolved as a result of cross Khanpur raya x KJ-148 at Oilseeds Research Station, Khanpur. Hybridization was started during 2001-2002 for the development of this variety through pedigree method. The evaluation of elite line was done against particular traits and it was advanced to F_5 generation. During 2006-07, best performed progeny was selected against yield and disease resistance character in F_5. This progeny/line was given the name KJ-206 and evaluated against different parameters in yield trials at various locations. Finally the selected line was evaluated in National Uniform Yield Trials during 2012-14. The average data of replication of each location was converted to kg/ha for comparison [3]. Yield data were subjected to ANOVA and means were compared by using LSD [7]. Various steps involved in the development of Super Raya are given in Table 1.

2.1 Hybridization
Khanpur raya, a locally developed high yielding variety, and local line KJ-148 (short duration and bold grain) were selected for hybridization. Khanpur raya was kept as a female parent and KJ-148 as a male parent. Both parents were sown alternately, in October in crossing block at Oilseeds Research Station during crop season 2001-02. At flowering, emasculation was done in the morning, and

emasculated flowers were covered with butter paper bag to avoid any foreign pollen contamination. On the next day the emasculated flower was pollinated with pollen of male parent by removing the butter paper bag. Crossed seed harvested from female parent was stored for raising generations.

2.2 Filial Generation Development

Crossed seed was sown in the field of Oilseeds Research Station Khanpur by drill method to get F_1 seed at the end of February. F_1 plants were sown during 2002-03 and were self-pollinated at flowering to get seed for F_2 generation. During 2003-16 filial generations were developed on the basis of superior attributes selection. From F_2 generation, 54 single plants with better performance were harvested separately. Out of these single plants, 52 plants were used to grow F_3 progeny rows. Thirty one plants were harvested separately from the selected rows on the basis of yield and disease resistant parameters, and were sown as progenies rows of F_4. Twenty four desirable selections were made in F_4 for raising F_5 generation, through which 11 plants were selected from progeny rows to grow F_6. Eight superior rows were selected for further study on the basis of better performance. The lines with high yield and disease resistance were evaluated in replicated yield trials for two years at different locations. Erucic acid and glucosinolates concentration of these rows were determined by National Agricultural Research Centre (N.A.R.C), Islamabad and National Institute of Food and Agriculture (N.I.F.A), Peshawar following the procedure used by Sadat *et al*., 2010**.** The best performing line (KJ-206) was evaluated in Zonal Varietal Trial, Micro Yield Trial and National Uniform Rapeseed Yield Trial for two years.

2.3 Planting of Trial

Randomized Complete Block Design (RCBD) was used in all the experiments with four replications. Each plot was maintained a size of 5 m x 1.8 m. Seed was sown with the help of drill maintaining an inter row and inter plant distances of 45 cm and 10 cm respectively. All standards of agronomic and cultural practices were applied uniformly for all treatments from sowing to harvesting in each experiment. Data regarding days to flowering, days to maturity, plant height and seed yield were recorded and analyzed statistically on the basis of mean values [6].

Table 1: Various steps involved in the development of mustard variety Super raya

Year	Generations/Trials	Remarks
2001-02	Original Cross attempted (Khanpur raya x KJ-148)	Hybrid seed was harvested for plantation.
2002-03	F_1 was raised	F_1 hybrid seed was harvested for F_2 plantation.
2003-04	F_2 generation was grown	F_2 hybrid seed was harvested for F_3 plantation.
2004-05	F_3 generation was grown	F_3 hybrid seed was harvested for F_4 plantation
2005-06	F_4 generation was grown	F_4 hybrid seed was harvested for F_5 plantation
2006-07	F_5 generation was grown	Superior line for yield and disease resistance were selected and given the number KJ-206 and were forwarded to yield trials
2010-11	Zonal Varietal Yield Trials	These trials were conducted at five different locations.
2011-12	Micro Yield Trial	These trials were grown at seven different locations in Punjab under coded numbers handled by Director, Oilseed Research Institute Faisalabad.
2012-14	National Uniform Rapeseed Yield Trial (N.U.R.Y.T)	These trials were conducted by National Coordinator Rapeseed, NARC Islamabad throughout Pakistan.
2012-14	Agronomic Trials	These trials were conducted at Oilseeds Research Station Khanpur.
2011-13	Entomological Trials	These trials were conducted at Oilseeds Research Station Khanpur and resistance against different diseases were observed.
2012-13 & 2015-16	DUS Studies	Data of particular line was recorded by Federal Seed Certification and Registration Department.
2016	Spot Examination	Candidate line was evaluated by Committee and was recommended for varietal approval
2016	On the basis of better performance, it was released by Punjab Seed Council, Lahore for general cultivation with the Particular commercial identity.	

3. Results and Discussions

KJ-206 (Super Raya) is an advanced line of cross, Khanpur raya x KJ-148, selected from segregating population on the basis of plant height, early maturity, pod shape, bold grain and seed color. It showed best performance in local environmental conditions.

3.1 Station Trials

The candidate line KJ- 206 was tested in replicated trials for two years, Preliminary Yield Trial (2008-09) and Advanced Yield Trial (2009-10) were conducted at Oilseeds Research Station, Khanpur. Mean data of grain yield of particular line was compared with Khanpur raya (check) (Table 2). It was observed that average yield of KJ-206 (Super Raya) was 2630 kg/ha compared with Check which yielded 2275 kg/ha showed 15% higher yield over check variety.

Table 2: Yield Performance of KJ-206 in Station Yield Trials at Oilseeds Research Station, Khanpur

Variety/Line	Seed yield in Kg/ha			% increase over check
	P.Y.T (2008-09)	A.Y.T (2009-10)	Avg.	
KJ-206	2550	2710	2630	15%
Khanpur Raya	2200	2350	2275	
L.S.D 5%	210	170		

3.2 Zonal Varietal Trials

KJ-206 was evaluated at five different locations i.e. Faisalabad, Sahiwal, Khanpur, Piplan and Bahawalpur of Punjab in Zonal Varietal Trial during 2010-11 (Table 3). Grain yield was observed at these different location and found average yield of Super Raya 1832 kg/ha as compared to yield (1587 kg/ha) of check variety. The results depicted that particular variety gave 14% more yield than Khanpur Raya.

Table 3. Yield Performance of KJ-206 in Zonal Varietal Yield Trial during 2010-11

Variety/Line	Seed yield in Kg/ha						% increase
	FSD	SWL	KPR	PIPLAN	BWP	Avg.	
KJ-206	2350	2220	2002	1200	1389	1832	14
Khanpur Raya	1929	2162	1690	1042	1111	1587	
L.S.D 5%	160	105	172	104	110		

3.3 Micro Yield Trials

The performance of promising line was further evaluated in Micro Yield Trial at seven different location i.e Faisalabad, Bahawalpur, Khanpur, Bahakar, Fateh Jang, Chakwal and Karor of Punjab during 2011-12. The average grain yield of Super Raya was 1755 kg/ha and Khanpur Raya gave 1569 kg/ha. Results of new variety revealed 12% higher yield as compared to check (Table 4).

Table 4: Yield Performance of KJ-206 in Micro Yield Trial during 2011-12

Variety/Line	Seed yield in kg/ha								% increase
	FSD	BWP	KPR	Bhakar	F/Jg	CHK	Karor	Avg.	
KJ-206	2547	2543	2150	1950	1074	798	1220	1755	12
Khanpur Raya	2469	2411	2022	1840	625	524	1091	1569	
L.S.D 5%	139	225	201	237	107	110	276		

3.4 Yield performance of KJ-206 at National Uniform Mustard Yield Trial (NUMYT)

Super Raya was evaluated in national testing system through Nation Uniform Mustard Yield Trial (NUMYT) consecutively for two years during 2012-13 and 2013-14 across the country. The location wise comparison of yield performance of promising line with standard variety is given in Table 5 and 6. Results of Super Raya at ten different locations during 2012-13 showed that it gave yield 2010 kg/ha and check variety (Khanpur Raya) yielded 1941 kg/ha which revealed its better performance over check. During 2013-14 performance of new variety was compared with check named as Khanpur Raya. The mean performance depicted it was high yielder than Khanpur Raya. The two years performance based evaluation of KJ-206 confirmed the results found on-station studies that it was high yielder as compared to check variety. The overall good performance of new variety across the country proved that it is well adapted to various climatic conditions of Punjab and Pakistan than earlier released varieties.

Table 5: Yield Performance of KJ-206 in N. U.M.Y.T. (10 locations) during 2012-13

Variety/Line	Seed yield in kg/ha										Mean
	NARC Isd	BARI ChK	ORI Fsd	NIA T-Jam	Pioneer Swl	ORS K-Pur	RARI B-pur	NIFA P-War	EON Lhr	AZRI DI Khan	
KJ-206	2000	332	2170	347	2922	2544	3280	1845	2652	2014	2010
Khanpur Raya	1083	355	2137	536	2958	2312	2894	2070	2553	2512	1941
L.S.D 5%	465	161	450	174	808	518	461	102	249	231	

Table 6: Yield Performance of KJ-206 in N. U.M.Y.T. (11 locations) during 2013-14

Variety/Line	Seed yield in kg/ha											Mean
	NARC Isl	ORI Fsd	BARI Chk	Pioneer Swl	RARI B-pur	ORS K-Pur	NIFA P-War	Tarnab P-War	AZRI DI Khan	BARS Kohat	ARI T-jam	
KJ-206	1558	2878	824	2430	4271	1333	2500	2083	1931	2483	1167	2133
Khanpur Raya	1687	2322	834	1913	3572	1875	1778	1667	1957	1958	1292	1896
L.S.D 5%	NS	138	109	484	772	395	660	237	173	655	103	

3.5 Agronomic Performance

Agronomic trials of elite line were conducted against nine different level of fertilizer application during 2013-14. Maximum seed yield (2870 kg/ha) was obtained by treatment No. 5 in which N: P was applied @ 75:75 followed by treatment No.4 with yield of 2660 kg/ha (Table 7). The average yield performance of KJ-206 in sowing date trail was assessed from 20th September to 30th October with 10 days intervals. The data (Table 8) showed that highest mean yield 2072 kg/ha was recorded when KJ-206 sown on 30th September

Table 7: Response of KJ-206 to different levels of NP at Oilseeds Research Station Khanpur during 2013-14.

Treatment	Nitrogen (Kg/ha)	Phosphorus (Kg/ha)	Seed Yield (Kg/ha)
1	60	60	2231
2	75	60	2340
3	90	60	2180
4	60	75	2660
5	**75**	**75**	**2870**
6	90	75	2510
7	60	90	2650
8	75	90	2655
9	90	90	2640
LSD5%			245

Table 8: Response of KJ-206 to different sowing dates at Oilseeds Research Station Khanpur during 2012-13 & 2013-14.

Sowing Date	Yield (Kg/ha)		Av.(Kg/ha)
	2012-13	2013-14	
20th September	1750	1820	1785
30th September	1921	2222	2072
10th October	1655	1932	1794
20th October	1339	1791	1565
30th October	1287	1195	1241
LSD 5%	294	185	

3.6 Screening against Insects and Diseases

The response of variety Super Raya to various diseases and insects was studied at Oilseeds Research Station, Khanpur during two consecutive years 2011-12 and 2012-13. It was tested against Alternaria blight, Powdery mildew and White rust. Results of two years (Table 9) revealed that particular advance line was highly resistant against diseases. KJ-206 escaped from aphid attack when it was sown in optimum time in i.e. 1st fortnight of October [5].

Has also observed that crop sown in first week of October can escape aphid attack.

Table 9. Disease response of KJ-206 at Oilseeds Research Station Khanpur during 2011-12 & 2012-13

Variety/Line	Year	Alternaria blight	Powdery mildew	White rust
KJ-206	2011-12	0	5	0
	2012-13	0	4	0

*0= resistant 9= susceptible

3.7 Botanical Description of Rohi Sarsoon

Super Raya is erect with plant height 155-166 cm. Its plant color is dark green having determinate growth habbit. The color of leaf is dark green with presence of hairs. Its leaf size is medium. Super Raya takes 135-140 days to mature. Its petal color is yellow. Pod has long length conical beak shape. Its seed color is dusty black having bold size.

3.8 Quality characteristics

Super Raya quality characters were compared with check variety Khanpur Raya. Results revealed that it contains 30-35% percent erucic acid in oil, 80-100 µ mole/g glucosinolates in oil free meal. Seed of Super Raya contains 40-42% oil with yield potential 4271 kg/ha. The quality traits were recorded by N.A.R.C, Islamabad and NIFA Peshawar. Yield potential of new variety depicted that it is better than existing varieties containing sufficient amount of oil percentage in its seed.

3.9 Spot Examination and Approval

The candidate variety was evaluated by Spot Examination Committee during February 2016. The committee has recommended for submission of variety approval case to the expert sub-committee. The Expert Sub-committee approved KJ-206 as new commercial variety named as Super Raya and forwarded to Punjab Seed Council (PSC) for its final approval. The Punjab Seed Council approved variety for general cultivation in meeting held on 12 August 2016. Conclusively, Super Raya is not only high yielding variety but also resistant to various diseases and pests with better quality traits. Due to its better adaptability, it can be substituted with already existing approved varieties.

4. References

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